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CONTENTS

INTRODUCTION

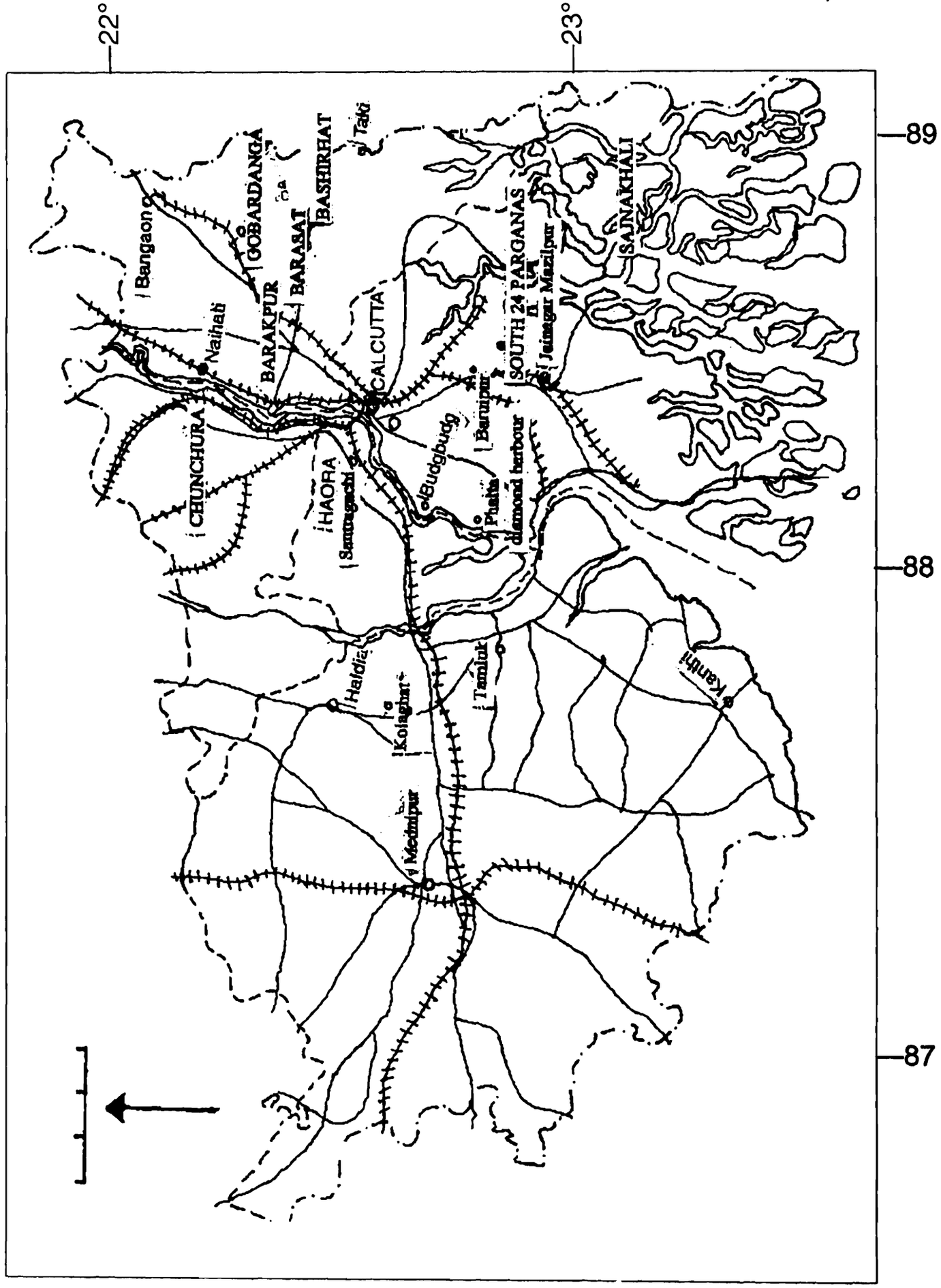
Among various biological components of freshwaters, the aquatic insects play an important role not only in the trophic dynamics of the ecosystem but also in the indication of changes in the quality of water due to pollution or degradation because of their ability to respond quickly to such changes. While most of the aquatic insect species constitute the food of many commercially important fishes, some others are predaceous, feeding upon spawn and frys or competing with them directly for natural food. Besides, several species, particularly of Belostomatid Hemiptera are known to predate heavily upon the mosquito larvae and thereby limiting their population size.

Eventhough the insects are terrestrial in origin, a large number of species belonging to several orders have adapted to aquatic mode of life completely or partially. It is estimated that about 3% of the total insects are aquatic, spending atleast a part of their life cycles in the water, and these comprise about 25,000 to 30,000 species (Cheng, 1976) .The highly diverse aquatic forms are spread over to 11 orders *viz.* Collembola, Plecoptera, Ephemeroptera, Odonata, Hemiptera, Megaloptera Neuroptera, Trichoptera, Lepidoptera, Coleoptera and Diptera. Out of these, taxa belonging to only a few groups like Ephemeroptera, Odonata, Hemiptera , Coleoptera and Diptera form the dominant component of fauna of the freshwater wetlands of this region. The Orders Trichoptera, Plecoptera, Neuroptera and majority of the aquatic species of Ephemeroptera are mainly confined to high altitudes or colder climate.

The taxonomy of the aquatic insects is not as properly worked out as those of their terrestrial counterparts because of difficulties in the identification of immature forms. Most of the aquatic insects pass their early part of life in water in immature condition and sometimes the immature duration covers major part of their life cycles. However, the taxonomy based on adults have fairly been worked out, particularly those belonging to temperate waters (Pennak, 1978; Ushinger, 1971).

In India, while a few earlier workers dealt with the taxonomy of aquatic insects of the country, mostly along with terrestrial members of the group dealt (Distant, 1902, 1906, 1910; d'Orchymont, 1925, 1928; Ochs, 1930; Vazirani, 1968, 1970), their works remained almost scattered. Recently, faunal account of the species occurring in the region has been consolidated (Srivasatva, 1993 on Ephemeroptera; Srivastava & Sinha 1993 on Odonata; Bal and Basu, 1994a, 1994b on Hemiptera; Biswas *et al.* 1995a, 1995b, Biswas and Mukhopadhyay, 1995 on Coleoptera, and Choudhury and Chattopadhyay, 1997 on Diptera) but these studies too remained confined to pure museum taxonomy and also included those species which were described by earlier workers but could not be observed/collected during last few dec

From ecological point of view, very little attention has been paid and mo the studies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CHUNCHURA
HAORA
Serampore
Budgbudg
Baruipur
Phalta
diamond harbour
Haldia
Kolaghat
Tamluk
Kanthi
Midnapur

on limnolgy / aquatic biology of freshwater wetlands either completely ignore this component or give simply a passing reference. This is practically due to non-availability of any consolidated document dealing with the identification and ecology of commonly occurring insects of freshwaters wetlands of the country. The few studies, which deal with specific groups of aquatic insects, are those of Tonapi, (1959) and Tonapi and Ozarkar (1969a, 1969b) on Coleoptera and Alfred (1973) on Diptera: Chronomidae. Limited number of studies has also been carried out on general entomofauna of some specific wetlands from taxo-ecological viewpoints which includes the works of Roy, 1982, Roy and Sharma, (1983) Roy *et al.*, (1988), De (Pal) and Sengupta (1993), Bhattacharya (2000) and Pal *et al.* (2000).

Realizing the importance of the group and general dearth of knowledge, the present studies were carried out during last 10 years (1991-2000) with a viewpoint to work out the commonly occurring insect fauna of different types of wetlands of South-eastern region of West Bengal State. Their occurrence and abundance in a large number of wetlands belonging to different types, identification keys, description of diagnostic characters, distribution and general remarks on their ecology have been dealt with.

It may be mentioned that attempt towards the studies of insect fauna was made from general ecological viewpoints and therefore, emphasis was given only to commonly occurring species, which are most frequently encountered and comprise the bulk of the density and biomass contributing substantially to the ecosystem. Therefore, the list of species is not exhaustive from taxonomic viewpoints.

MATERIAL AND METHODS

The present report is based on the studies carried out for a period of nearly 10 years (1991-2000) in a large number of wetlands of South-eastern West Bengal This region, which covers the districts of North 24 Parganas, Calcutta, South 24 Parganas, Hugly, Howrah and Medinipur of West Bengal State, located on either side of the major River Ganga near or on Sunderban delta, is full of almost all types of the wetlands and there are hardly any other region in the country which is as rich as this one. A large number of wetlands comprising of floodplain oxbow lake (open and closed types), locally known as *beels* and *bours,* Natural wetlands (*jheels*), urban recreational lakes and ponds, fish culture ponds, sewage-fed fish culture ponds, multipurpose village ponds and brackishwater ponds abound the region which comprised of 6 districts of West Bengal, Viz., North 24 Parganas, Calcutta , South 24 Parganas, Hugly, Howrah and Medinipur.

Altogether 20 Wetlands belonging to almost all types were surveyed which are listed in Table 1. The insect fauna was collected as a part of detailed studies on the general ecology and faunal resources of these wetlands.

The Qualitative collection was made with the help of hand operated nets of varying sizes by randomly netting different areas of the wetland. While surface floating/swimming insects

were collected with small circular nets made of either coarsely meshed cotton cloths of finely meshed polyester mosquito curtain cloth. Macrophytes-associated insects (Neuston and necton) were collected with the help of a hand operated D framed sweep net of the size of *50* cm. length, *25* cm. maximum breadth of the D. The frame was attached to a bag net made up of fine malmal cloth with mesh size of approximately 200 μ. The net was fixed on a long pole. The design and operation of the net was roughly based on those described by Junk (1977). For quantitative collection of fauna, the net was slowly pushed upside down to the bottom of littoral zone and quickly lifted after turning upwards the mouth of the net. After pulling the net near the shore, the vegetation projecting outward from the marginal area of the net frame, were cut off. The total area covered by the net was calculated. Three replicate samples from each site were collected. The macrophyte leaves and roots were then washed thoroughly several times in the net itself, removing all attached fauna manually from each strand with the help of a magnifying glass. The bulbs of water hyacinth were thoroughly examined. The contents of the net as well as macrophytes were again washed on a sieve of 0.5 mm and all fauna retained on the sieve were collected. Animals were first killed or narcotized slowly by putting few drops of 5% formaldehyde solution and then preserved either in 70% alcohol or 5% formalin. Samples were collected from the littoral zones only.

Different groups of insects were separated and identified to the lowest possible taxa with the help of Vazirani (1970, 1984), Biswas *et al.* (1995a, 1995 b) and Biswas and Mukhopadhyay (1993) for Coleoptera, Bal and Basu (1994a, 1994b), for Hemiptera and Srivastava and Sinha (1993) for Odonata. Emphasis was given to commonly occurring species. Identification was mainly based on the adults collected from the water or from nearby areas of the wetlands. Identification of the species based on immature stages was not possible for want of detailed and specific literature and also required level of expertise on the part of investigators. For density and relative abundance estimation, the quantitative samples were used, which contained both adults and immature stages. Analysis was done only by major Group-wise. Identification and enumeration were done simultaneously. Insects collected for qualitative studied were preserved in 4% formalin and sometimes in rectified spirit.

For the purpose of the analysis, all the wetlands studied are grouped under six major heads viz. I- Oxbow lakes, (beels and baors), II- Natural wetlands (jheels), III Fish culture forms (bheries), IV- Sewage-fed fish culture forms, V- Multipurpose village ponds (pukur) and VI- Urban recreational man made lakes/ ponds. The occurrence and abundance of insect fauna were also grouped accordingly.

Seasons are defined as Premonsoon (March-June), Monsoon (July-October) and Postmonsoon (November-February).

For relative abundance studies, species diversity and similarity analysis, one wetland in each category was selected as detailed below :

Type I. Beri Gopalpur Oxbow lake

Type II. Beri beel

Type III. Kalikapur fish culture pond

Type IV. Bantala sewage-fed pond-1

Type V. Canning multipurpose village pond

Type VI. Rabindra Sarovar urban lakes

The species diversity was assessed by species richness index (d) (Simpson, 1949)

$$D = \frac{S - 1}{\text{Loge } N}$$ S = no. of species, N = no. of individuals

The similarity analysis between the wetlands studied was carried out by computing Sorensen's Coefficient of Community (CC)

CC (Coefficient of community) = 2C/A=B (Sorensen, 1948)

Where A = number of species in sample A, B= no. of species in sample B and C = no. of species common to both samples.

RESULTS

Physico-chemical parameters of water quality

The range of some important physicochemical parameter of waters of the wetland studied are given in Table-2. It is clear that the differences in water temperature between wetlands were not significant as the lowest values ranged between 21.0-22.5°C and highest between 31.0-32.8 °C. Season-wise it was highest during premonsoon and lowest in post-monsoon. The mean monthly temperature during different months also did not vary much and fluctuated moderately throughout the year, excepting for a brief period of late post-monsoon (Dec-Jan), which corresponds to a moderate winter season of the region. The transparencies of the wetlands were low and ranged between 5—125 cm, highest in clear water zone of oxbow lakes. The pH values in all the wetlands were always above 7.5 and ranged between 7.5-8.6. Specific Conductivity varied from 328-1370 umhos/cm. The conductivity values exhibited and increasing trends from oxbow lakes (Type-I) to sewage-fed fish culture ponds (Type-IV). Almost similar trend was visible in case of chlorides, alkalinity and hardness. The dissolved oxygen values were always moderate in the wetland type and ranged between 4.6 and 8.8. The highest values were recorded from oxbow lakes.

Macrophytes

The occurrence and abundance of macrophytes in different wetland differed widely. While oxbow and natural wetlands harboured a large number of macrophyte taxa in abundance, the diversity as well as density in sewage-fed fish culture were minimum. Table 3 lists common species of macrophytes recorded from different types of wetlands over the period of investigation. All four oxbow wetlands belonging to type I was considerably infested with a variety of macrophytes from where maximum number of species (31) belonging to 12 families were recorded. The entire littoral zones were full of macrophytes. These were divided into three main categories, floating submerged and emergent. The floating types consisting of both free floating and rooted floating were comprised of largest number of species (12). Among rooted floating, *Nymphoides indicum* was the commonest species occurring throughout the year in both wetlands. Another species, *Nymphaea pubiscens* also occurred throughout the year in both wetlands. The most abundant free-floating species was *Eichhornia crassipes*, which dominated all other macrophytes throughout the year in both wetlands. Thick strands were observed in littoral zone. The other common free-floating species were *Pistia stratiotes* and *Lemna perpusilla*. The submerged macrophytes were both, rooted as well as free submerged. Among the former, *Blyxa roxburghii* and *Hydrilla verticillata* were abundant species. *Vallisnera spiralis* also occurred but in smaller strands. The free submerged category comprised of only one species, *Ceratophyllum demersum* which occurred abundantly throughout the year. Three species of the family Cyperaceae contributed mainly to erect emergent type. Prostate emergent species were *Ipomea aquatica* and *Alternanthera philoxeroides*. The macrophyte flora of the natural wetlands, belonging to Type-II were almost similar to Type-I except that the total number of species recorded (25) were lesser than type-I. The water hyacinth *Eichhornia* was the dominant component of macrophytes in this category too, but its intensity was much higher in several wetlands, where these had covered more than 75% of the total wetland area.

DIVERSITY OF INSECT FAUNA

The commonly occurring entomo-fauna of the wetlands studied belonged to 5 major orders, *viz.*, Ephemeroptera, Odonata, Hemiptera, Coleoptera and Diptera. While both adults and immature stages of Hemiptera and Coleoptera occurred in water, Ephemeroptera, Odonata and Diptera were represented only by their nymphs/larvae in aquatic ecosystem and adults were aerial. Altogether 70 species were recorded during the present investigation from all the wetlands studied. Highest number (63) was recorded from Type-I oxbow wetlands, followed by natural wetland (53) and lowest (26) from sewage-fed fish culture ponds. The urban recreational lake exhibited comparatively higher diversity as 43 taxa were recorded. (Fig. 1) These belonged to 53 genera and 20 families. Ephemeroptera was represented by 4 species belonging to 1 genus and 1 family ; Odonata by 19 species under 14 genera and 5 families; Hemiptera by 19 species comprising 14 genera and 8 families; Coleoptera by 23 species consisting of 19 genera and 4 families and of Diptera by 5 genera

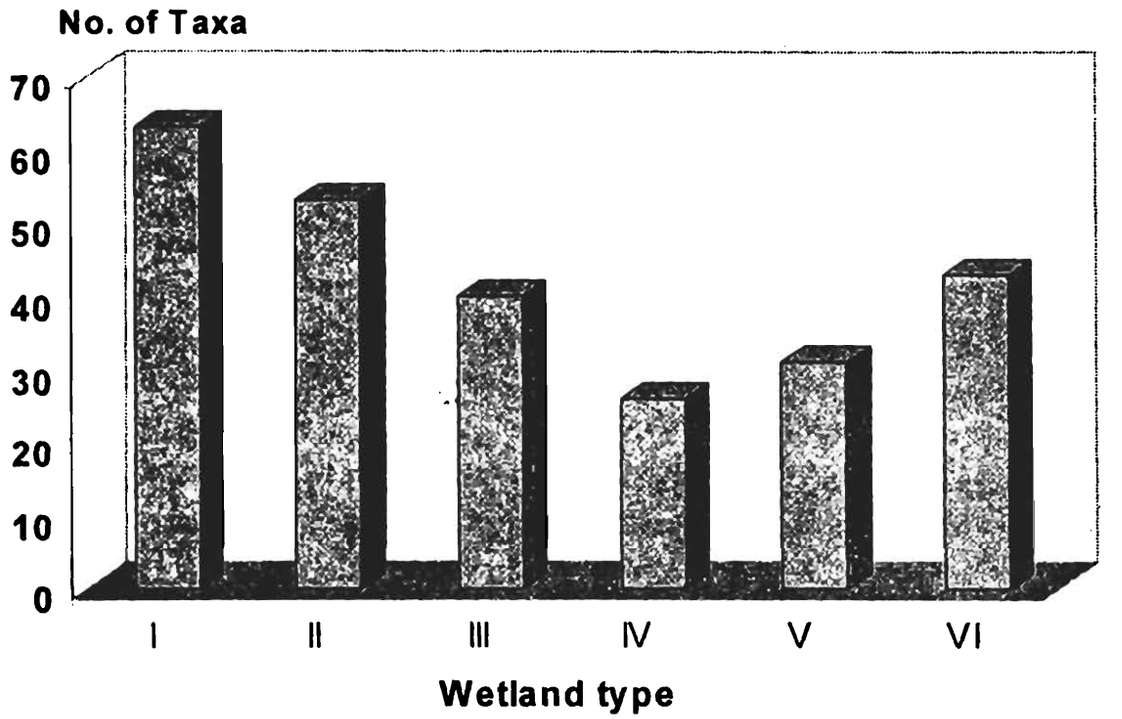


Fig. 1. Total Number of Taxa recorded from different wetlands.

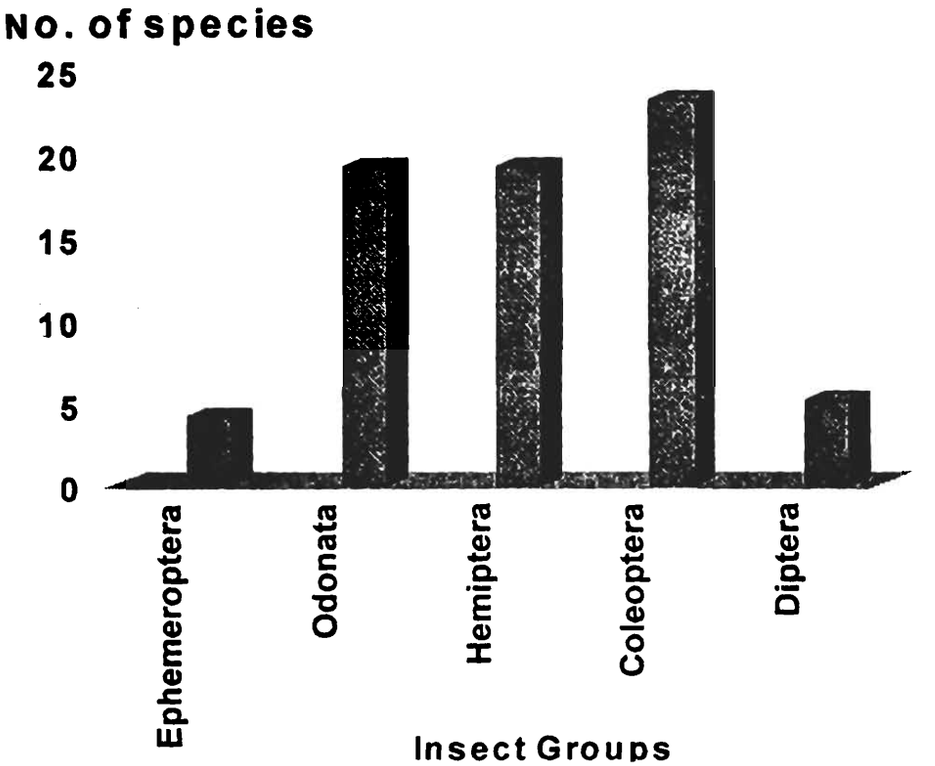


Fig. 2. Total Number of Taxa belonging to different groups recorded from all wetlands (combined)

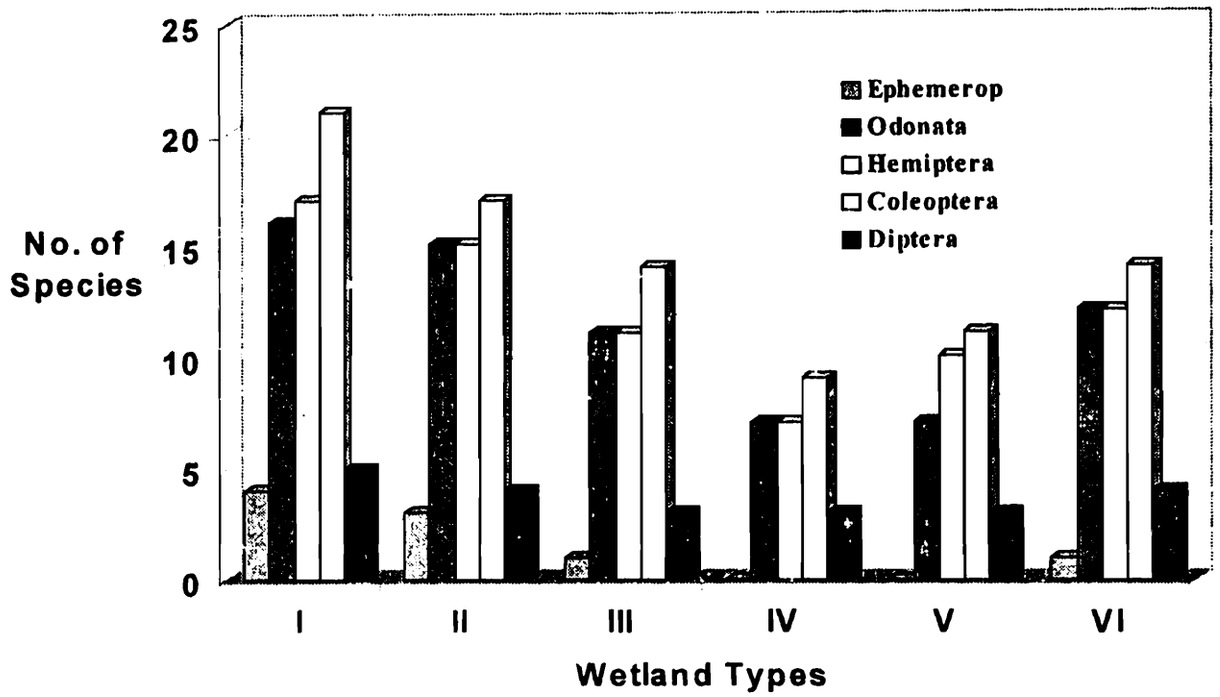


Fig. 3. Number of taxa of different groups wetland wise

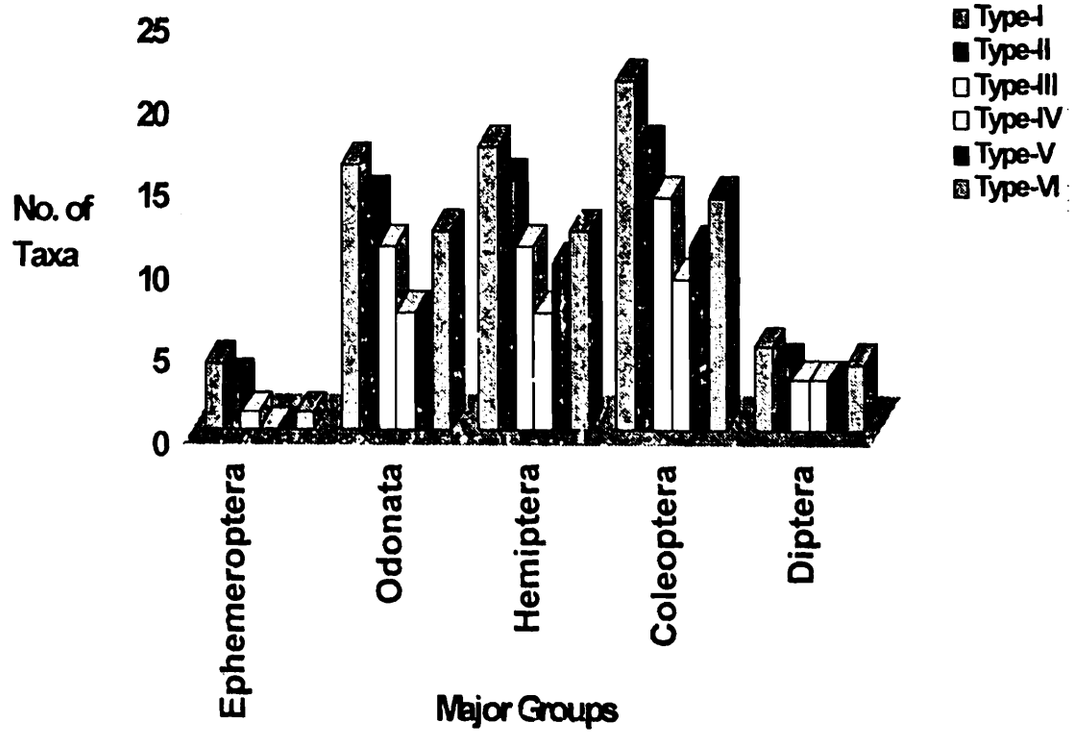


Fig. 4. Distribution of major groups of taxa in different wetlands

of 2 families (Table 4, Fig 2). The order of groupwise species richness of different wetland types was exactly similar to the combined species richness (Fig 3).

The order-wise description of the species recorded follows.

EPHEMEROPTERA

Ephemeropterands, commonly known as 'mayflies', are represented in aquatic ecosystem by their immature stages and the winged adults are terrestrial. The adults are small-sized insects which possess delicate many-veined, transparent wings that are held vertically when at rest. Fore wing large; hind wing small, reduced or absent; small setaceous antennae with two basal segments; multiarticulate filaments; large eyes, divided into upper larger and lower smaller lobes, mounted on cylindrical stalks and vestigial mouth parts. Abdomen 11-segmented, last two fused; 2 or 3 long, segmented filaments at the posterior end of the abdomen; mesothorax larger than prothorax and metathorax, legs slender and week.

The life span of adults is very short and no food is taken by them. They remain in the vicinity of wetlands in which the immature stages are passed. They are generally found clinging to emergent macrophytes, but at times they hover in large swarms over the wetlands. Mating generally occurs during flight. The minute and oval eggs are released by females in great numbers. Females release large number of minute, oval and coloured eggs by dipping the abdomen into the water. They are embedded in foamy or gelatinous mass.

The immature forms or nymphs of Ephemeroptera can be easily recognized by three long, segmented and fringed caudal filaments at the tip of abdomen and paired tracheal gills on the lateral or dorsal surface of 1-7 abdominal segments. Other important features are 10-segmented elongated body, large head, well-developed mouthparts, large compound eyes, filiform antennae and three prominent ocelli. The ephemeropteran nymphs pass through several molts before becoming adults. Besides the growth in body size, structural changes like increase in the number of antennal segments and size of compound eyes also take place at every instar.

The nymphs occur in all types of clean and well-oxygenated freshwaters, as they are very sensitive to oxygen deficiency, and generally occupy the shallower regions of the wetlands either on bottom debris or in macrophytes. They are omnivorous in feeding habit but food mainly consists of fine detritus. Most of the species are inhabitant of colder running as well as stagnant waters of mountainous regions.

The ephemeropteran fauna of West Bengal State comprises 17 species belonging to 9 genera and 5 families (Srivastava, 1993). Out of these 9 species, 5 of *Cloeon*, 1 of *Procloeon* (Family Baetidae) and 3 of *Caenis* (Family Caenidae) occur in this region of the state. Only 4 species belonging to genus *Cloeon* of family Baetidae were recorded from the wetlands studied.

SYSTEMATIC LIST

Order EPHEMEROPTERA

Family BAETIDAE

Genus *Cloeon* Leach

1. *Cloeon kimminsi* Hubbard
2. *Cloeon bicolor* Kimmins
3. *Cloeon bengalense* Kimmins
4. *Cloeon marginale* (Hagen).

SYSTEMATIC ACCOUNT

Family BAETIDAE

The larvae of the family are characterised by the presence of gills on the abdominal segments and absence of carapace.

Genus *Cloeon* Stephens

Larvae : Hind wing pad absent, gills present on first to seven abdominal segments, double on first and second, Carapace absent, mandibles without any tusk, antennae more than three times the head width, basal two thirds of caudal filaments with a narrow dark band at 3rd to 5th segments, all claws pointed, similar in shape and size.

Adults : The adults can be distinguished by the complete absence of hind wings.

The species identification was based on the adults only.

Key to the species of *Cloeon* adults

1. Wings hyaline without any specific pigmentation 2
– Wings not hyaline, vitreous with bristle brown costal and subcostal space including basal humeral cross vein ..... *marginale*
2. Coastal and subcostal space clear, sometimes with faint pigments only ..... *kimminsi*
– Costal and subcostal space not clear 3
3. Costal space luteous, subcostal space dark brown ..... *bicolor*

– Base of costal space and radius of male pale fuscous, whole of costal and subcostal area in female dark brown..... *bengalense*

1. *Cloeon kimminsi* Hubbard
(Figs. 5, 6 & 7)

1947. *Cloeon viridis* Kimmins, *Proc. R. Ent. Soc. Lond, (B)* 16 : 98

1974. *Cloeon kimminsi* Hubbard, *J. Kans. Ent. Soc.*, 47 : 358

1993. *Cloeon kimminsi* : Srivastava, Ephemeroptera, In : *State Fauna Series. 3: Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 35.

Diagnostic Characters : Head light yellow, with thin brown stripe, thorax pale green or dark green, wings hyaline, venations dark brown, slightly shorter than the body size, with yellow green bands in coastal and subcostal space. Abdomen yellowish green, with a reddish brown broad dorsal band over it. Tergites of subimago 2-9 in male with faint pigmentation and 2-7 in female with dark pigmentation pattern. Size 5.5-6.5 mm, females significantly larger than males. Cerci slightly longer than body, filiform, annulated.

Distribution : India : West Bengal (Bankura, Birbhum, Burdhaman, Kolkata, 24 Parganas, Dinajpur, Jalpaiguri, Mednipur, Nadia and Purulia districs) and Maharashtra (Western Ghat). Elsewhere : Malaysia.

Remarks : The species occurred abundantly in oxbow and natural wetlands and urban recreational lakes but was not recorded from sewage-fed fish culture ponds and multipurpose village ponds. Swarms were noticed during late postmonsoon. Great many were found hovering over the wetlands near the littoral macrophyte zones at late afternoon. This is the commonest ephemeropteran species of this region.

2. *Cloeon bicolor* Kimmins

1947. *Cloeon bicolor* Kimmins, *Proc. R. Ent. Soc. Lond, (B)* 16 : 97

1993. *Cloeon bicolor* Kimmins: Srivastava, In : *State Fauna Series. 3 : Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 35.

Diagnostic Characters : Head light, thorax pale brown with a dark median stripe; Abdomen white, trasluscent, segments 8, 9 and 10 pale reddish above and others with variable markings, mid dorsal band on segments 3 to 6; wings hyaline, white in male, pale in female, slightly shorter than the body length. Coastal and subcostal space pterostigmatic cross vein 5- slightly slanting, costal bands lighter and subcostal darker. Eyes orange in male , light grey in female. Size smaller than *C. kimminsi* (4.5-5.2 mm in length) does.

Distribution : India : West Bengal (24 Parganas, Bankura, Birbhum, Burdhaman, Jalpaiguri, Kolkata, Mednipur, Nadia and Purulia districts), Karnataka, Madhya Pradesh. Elsewhere : Bangkok.

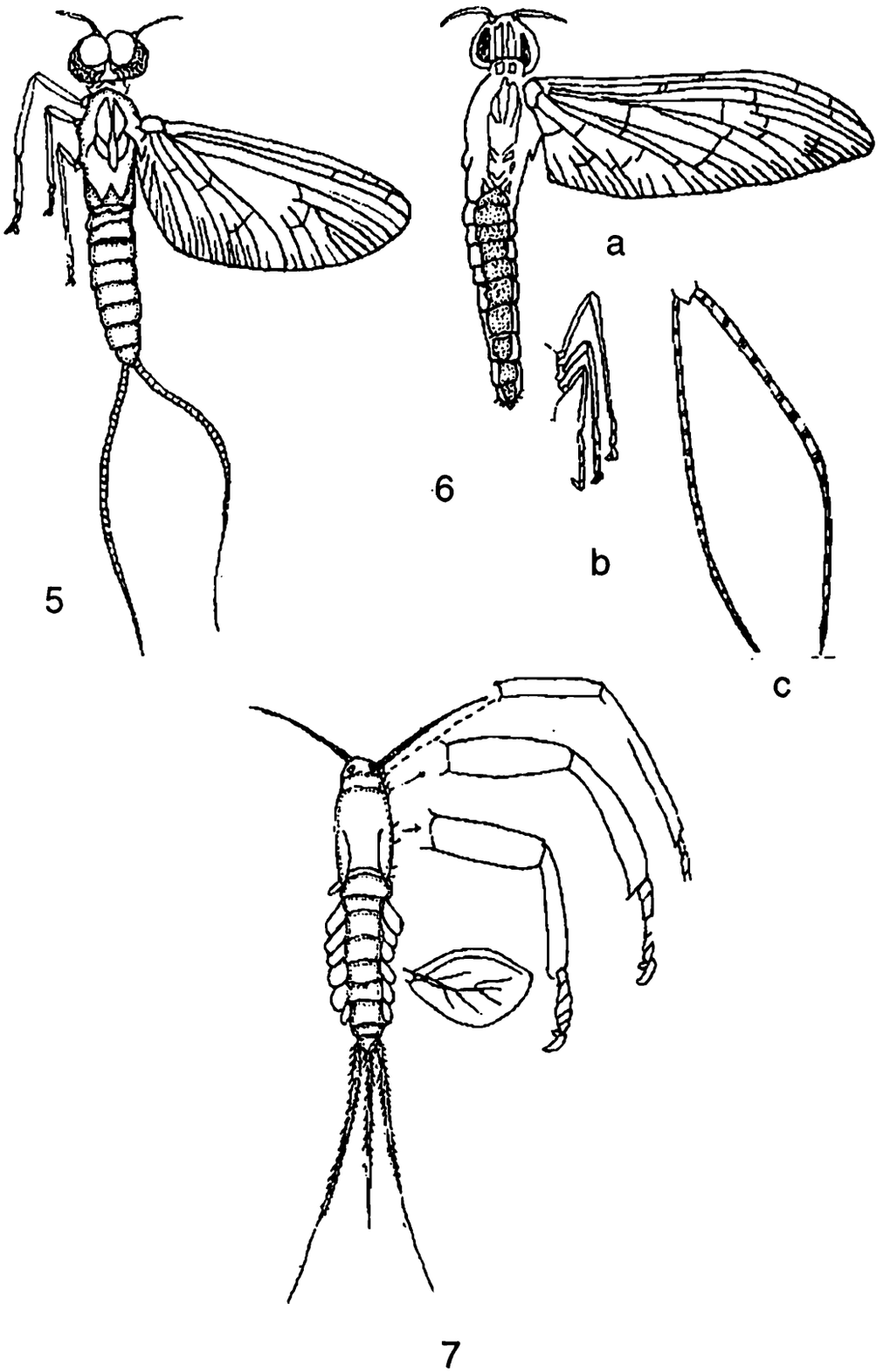


Fig. 5 : Male imago of *Cloeon kimminsi* Hubbard showing left legs and right wing

Fig. 6 : Female imago of *Cloeon kimminsi* Hubbbard : (a) Imago with right wing; (b) Legs; (c) cerci

Fig. 7 : Generalised diagram of nymph with right legs and one abdominal gill (enlarged). [Ephemeroptera]

Remarks : The species was recorded in moderate numbers from ox-bow wetland and natural wetlands only. The habit and habitat of this species was not much different with that of *Cloeon kimminsi.*

3. *Cloeon bengalense* Kimmins

1947. *Cloeon bengalense* Kimmins, *Proc. R. Ent. Soc. Lond, (B)* 16 : 95

1993. *Cloeon bengalense* : Srivastava, In : *State Fauna Series. 3 : Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 35.

Diagnostic Characters : Thorax dark brown in male dorsally but no marking in female; double dark reddish brown band on pronotum and broad dark brown median band on meso and metanotum. Abdomen 3-6 of males with dark reddish spot, of females with dorsal reddish brown stripe; wings in male hyaline with base of costa and radius and rest of veins pale brown. In female, costal and subcostal areas are dark brown. Coastal and subcostal space dark, 3 cross veins in stigmatic area. Slightly bigger in size than other *Coleon* species Length of adult female varies between 5.5-6.5 and male 4.5-5.2 mm.

Distribution : India : West Bengal (24 Parganas, Bankura, Birbhum, Burdhaman, Jalpaiguri, Kolkata, Malda, Mednipur, Nadia and Purulia districts), Karnataka, Madhya Pradesh.

Remarks : The species was of rare occurrence and was only recorded from type-I wetlands.

4. *Cloeon marginale* (Hagen)

1858. *Cloeon marginalis* Hagen, *Verti. Bot.Zool. Ges. Wien*; 8 : 447

1854. *Cloeon marginale* : Eaton, *Trans. Linn. Soc. London, (ser 2) Zool.* 3 : 181

1993. *Cloeon marginale* : Srivastava, In : *State Fauna Series. 3 : Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 35

Diagnostic Characters : Fore wing with darker bands in costal and subcostal space. The species can be differentiated from other species of *Cloeon* by the presence of white bulla in darker costal and subcostal space and from *C. bengalense* by 5 cross veins in stigmatic area. Size-range 4.0-5.0 mm.

Distribution : India : West Bengal (24 Parganas, Jalpaiguri, Kolkata and Malda), Maharashtra; Elsewhere : Bangladesh, Sri Lanka, Java, Sumatra, Philippines, Taiwan, and Tokin China.

Remarks : These insects occur only in cleaner wetlands with abundant macrophytes (Types I and II).

ODONATA
(Figs. 8 & 9)

Odonates, commonly known as dragonflies and damselflies, pass immature stages of their life cycle in water. Adults are arial and obtain oxygen for breathing directly from atmosphere. These beautifully coloured insects with long and slender 10-segmented bodies hover around water erratically from morning till evening. Presence of two pairs of long, narrow and net-veined wings, large and mobile head, two large compound eyes, minute filiform antennae, short legs for perching mouth parts adapted for specialized mode of feeding/ biting. The food generally consists of small flying insects, which is captured on the wings.

The aquatic odonates belong to two distinct suborders, Anisoptera and Zygoptera. The two suborders differ in several respects. The Zygoptera (damselflies) are slender, delicate and slow in flights. The two-paired wings are similar, which at rest are held parallel with the abdomen tilted upwards. The Anisoptera (dragonflies) are comparatively larger. The two pairs of wings are not similar; hind ones broader at base than the forewings. At rest, the wings are held horizontally outwards. The duration of adults is much shorter than nymphs. Mating in adults generally occurs while at rest on some emergent macrophytes.

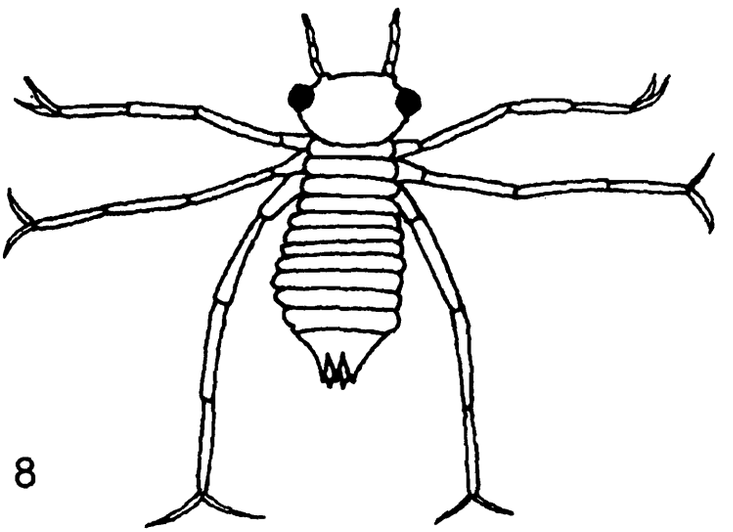
The immature part of life cycle consists of a series of nymphal stages known as naiads. The naiads are large, robust or elongated, grey or greenish in colour, sometimes with small spines on body. Labium is greatly modified as food-getting device which are very long and conspicuous, normally remain folded backward at the base of submentum. Damselfly nymphs are much more slender than dragonflies. Further, they have three leaf-like tracheal gills at the top of abdomen and caudal filaments, which are absent in dragonfly nymphs. The latter breath by cloacal chamber provided with necessary exchange of dissolved oxygen.

Adult odonates were seen depositing eggs everywhere in the water, on the surface of open water, in soil near the shore, on macrophyte stems and leaves and on floating submerged masses of filamentous algae. After hatching, they pass through a series of instars numbering between 11-14 and the duration of each instar varies considerably depending upon the species and prevailing temperature and food condition (Pennak, 1978). Besides growth in body size after shedding the exoskeleton at each instar, changes also occur in the structure of labium, compound eyes and antennal segments.

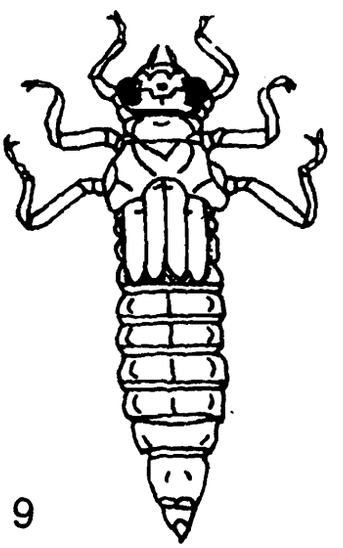
The nymphs mainly inhabit top soft layer of bottom soil/humus near littoral zone but have also inhabited submerged macrophytes. Most of the dragonfly nymphs (Fig. 9) belonging to family Libellulidae were found to be sluggish, dull in colour and remained hiding in the humus/top soil of the bottom. Similarly Corduliidae and Gomphidae nymphs also remain hidden in the bottom silt/humus. The damselfly nymphs (Fig. 8) generally remain attached to macrophytes and crawl slowly. The odonate nymphs are carnivorous and seize their prey. The labium, with its two lateral lobes, serves as a clamp to hold the food in position at the mouth. The prey is crushed with the mandibles. The food consists of crustacean, oligochaetes and other insects. Respiration in damselflies takes place with the help of three

tracheal gills and large tracheal trunks. In dragonflies, the rectal chamber is highly modified for respiration. It is almost separated from the rest of digestive tract by a constriction and contains longitudinal rows of minute thin tracheal gills, which project, into the cavity. The regular contraction and expansion movement of rectal wall takes in and expels out the water by way of anus.

The order Odonata was represented by 20 species belonging to 15 genera and 6 Families in the wetlands studied. This includes 8 species of Zygoptera (damselflies) and 12 species



8



9

Fig. 8 : Typical Damselfly nymph

Fig. 9 : Typical Dragonfly nymph

of Anisoptera (dragonflies). In a similar study, Roy *et al.* (1988) recorded only 8 commonly occurring odonate species (4 species each of Zygoptera and Anisoptera) from the wetlands of eastern Bihar. However, Srivastava and Sinha (1993) listed a total of 185 species under three suborders, Zygoptera (68 species), Anisozygoptera (3 species) and Anisoptera (114 species) from the State of West Bengal. The list includes a large number of species occurring in the hilly region of the state. Further, out of this, a total of 117 species have been listed only through literature review. Brief systematic accounts of species found during present studies are given below :

SYSTEMATIC LIST

Suborder ZYGOPTERA

Family COEGRIONOIDAE

Subfamily ISCHNURINAE

1. *Ischnura aurora aurora* (Brauer)
2. *I. senegalensis* (Rambur)
3. *I. rafostigma rufostigma* Selys
4. *Enallagma parvum* Selys

Subfamily PSEUDAGRINAE

5. *Ceriagrion coromandelianum* Fabricius
6. *Pseudagrion microcephalum* Rambur

Subfamily AGRIOCNEMINAE

7. *Agriocnemis pygmoea* (Rambur)

Family PLATYCNEMIDIDAE

Subfamily PLATYCNEMININAE

8. *Copera marginipes* (Rambur)

Suborder ANISOTERA

Family GOMPHIDAE

Subfamily ICTINOGOMPHINAE

9. *Ictinogomphus rapax* (Rambur)

Family CORDULIIDAE

Subfamily EPOPHTHALMIINAE

10. *Epophthalmia vittata vittata* Burmeister

Family LIBELLULIDAE

11. *Brachydiplax chalybea chalybea* Brauer
12. *B. farinosa* Kruger
13. *B. sobrina* (Rambur)
14. *Brachythemis contaminata* (Fabricius)
15. *Crocothemis servilla servilla* (Drury)
16. *Diplacodes trivialis* Rambur
17. *Diplacodes nebulosa* (Fabricius)
18. *Orthetrum sabina sabina* (Drury)
19. *Potamarcha obscura* (Rambur)

Key to the suborder of ODONATA

Fore and hind wings distinctly different in shape and venation; hind wings broader especially in anal area; head globular, male anal appendage paired superior and single inferior ..... Anisoptera

– Fore and hind wings more or less of same shape and venation; head transversely elongated, both inferior and superior male anal appendages paired. ..... Zygoptera

Key to the families of suborder ZYGOPTERA

– Discoidal cell with costal and hinder side subequal, inner distal angle obtuse .... Platycnemididae

– Discoidal cell with costal side much shorter than hinder side, inner distal angle acute or subacute ..... Coenagrionidae

Key to the Subfamilies of COENAGRINIDAE

1. Eighth abdomen of female with valvar spine; 10^{th} abdomen often raised into a bifid tubercle ..... Ischnurinae

– Eighth abdomen devoid of valvar spine; 10^{th} abdomen without tubercle 2

2. Legs relatively short and robust; wing petiolation longer ..... Pseudargiinae

– Legs relatively long and slender; pterostigma differs in shape and size in fore and hind wings, postocular colour spot well developed ..... Agriocneminae

Subfamily ISCHNURINAE

Key to Genera

Pterostigma differs in fore and hind wing; post ocular coloured spot present, abdomen 10 with closely opposed tubercle on apical border ..... *Ischnura* Charpentier

– Pterostigma not differing in fore and hind wing, a robust ventral apical spine on abdomen 8th ..... *Enallagma* Charpentier

Genus *Ischnura* Charpentier

Key to the species

1. Species with ground colour of both sexes bright orange red, abdominal segments 8-10 black ..... *I. rufostigma rufostigma*

– Species with ground colour of male and isochrome female blue or pale grass green 2

2. Abdomen 3-6 citron yellow ..... *I. aurora aurora*

– Abdomen 3-6 black on dorsum ..... *I. senegalensis*

1. *Ischnura aurora aurora* (Brauer)

1858. *Agrion delicatum* Hagen, *Verh. Zool. -bat. Ges. Wien*, VIII : 470.

1933. *Ischnura delicata* (Hagen) : Fraser, *Fauna Brit. India, Odon.*(1) : 360.

1993. *Ischnura aurora aurora* (Brauer): Srivastava and Sinha, Insecta : Odonata, In : *State Fauna Series 3 : Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 62.

Diagnostic characters : Body short (abdomen 16-20 mm, hind wing 10-15 mm); Pterostigma kite-shaped, rose red for its proximal half, hyaline in distal half. Abdomen 8-10 azure-blue, 10th with broad quadrate black dorsal spot.

Distribution : It is a very widely distributed species in India. Elsewhere : Nepal, China, Sri Lanka, Malaysia, Indonesia, Australia, Pacific Islands.

Remarks : The species was observed in small numbers from ox-bow lakes and natural wetlands.

2. *Ischnura senegalensis* (Rambur)

1842. *Agrion senegalensis* Rambur, *tns. Nevrop.* : 276.

1993. *Ischnura senegalensis* : Srivastava and Sinha, Insecta : Odonata, In : *State Fauna Series 3* : *Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 63.

Diagnostic characters : Pterostigma diamond-shaped, black outer angle and costal border narrowly white; abdomen 2 metallic blue black on dorsum, abdomen 10 back on dorsum, its apical border raised into two tubercles.

Distribution : India : West Bengal (Hooghly, Howrah, North and South 24 Parganas), Himachal Pradesh, Maharashtra, Manipur, Rajasthan, Uttar Pradesh. Elsewhere : Burma, Sri Lanka, Malaysia, Philippines, Japan, Africa.

Remarks : A commonly occurring species recorded in abundance from ox-bow lakes and natural wetlands, they were found near the shoreline along decaying and drying vegetation. They were seen flying in abundance away from the wetlands during early postmonsoon months.

3. *Ischnura rufostigma rufostigma* Selys

1876. *Ischnura rufostigmata* Selys, *Bull. Acad. Belg.*, (2), Xii : 283.

1993. *Ischnura rufostigmata rufostigmata* : Srivastava and Sinha, Insecta : Odonata, In : *State Fauna Series 3* : *Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 62.

Diagnostic characters : Pterostigma of fore wing narrow, elongate, diamond-shaped, bright brick red; abdomen 10 prolonged into two apical blunt spines.

Distribution : India : West Bengal (Kolkata, Malda, Birbhum, Howrah, North & South 24 Parganas), Assam, Bihar, Himachal Pradesh, Kashmir, Madhya Pradesh, Manipur Uttar Pradesh. Elsewhere : Burma.

Remarks : The species was only recorded from wetland type II, natural wetlands (Santragachi jheel), not a very common species.

Genus *Enallagma* Charpentier

4. *Enallagma parvum* Selys

1876. *Enallagma parvum* Selys, *Bull. Acad. Belg.* (2) Vol. XII : 537.

1993. *Enallagma parvum* : Srivastava and Sinha, Insecta : Odonata, In : *State Fauna Series 3 : Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 64.

Diagnostic characters : Abdomen pale, sky-blue, segment I with brown quadrate dorsal spot and narrow blue apical annule, segment 2 with broad thistle-shaped spot, with 3-7 fine apical annules confluent with a rounded spot, its apex extends into a narrow strip, 8-10 azure blue topped with mid dorsal narrow black stripe on segment 10.

Distribution : India: West Bengal (widely distributed, including Kolkata) Gujarat, Madhya Pradesh, Manipur, and Uttar Pradesh. Elsewhere: Burma, Ceylon.

Remarks : It was commonly found wandering in grassy field close to all the wetlands studied.

Subfamily PSEUDAGRINAE

Key to the genera of subfamily PSEUDAGRINAE

Frontal ridge on frons present, head and thorax of uniform colour without any markings, head devoid of any spot ..... *Ceriogrion* Selys

– Frontal ridge absent, head and thorax of different colour with dark markings, coloured spot present on head. ..... *Pseudogrion* Selys

5. *Ceriagrion coromandelianum* (Fabricius)

1798. *Agrion coromandelianum* Fabricius, *Ent. Syst. Suppl.* : 287.

1993. *Ceriagrion coromandelianum* : Srivastava and Sinha, Insecta : Odonata, In : *State Fauna Series* 3 : *Fauna of West Bengal*, pt. 4, *Zoological Survey of India, Calcutta* : 67.

Diagnostic Characters : Abdomen lemon-yellow in colour and without any marking which is the characteristic feature of the species.

Distribution : India : West Bengal (widely distributed), Andhra Pradesh, Assam, Bihar, Himachal Pradesh, Karnataka, Kerala Maharashtra, Manipur, Meghalaya, Mizoram, Orissa, Punjab, Tamil Nadu, Tripura, Uttar Pradesh. Elsewhere : Nepal, Sri Lanka, Burma, Malaysia, Indochina and Thailand.

Remarks : It is one of the commonest damselflies and is found in vicinity of all types of wetlands except sewage fed fish culture ponds. The species is readily recognized by its lemon yellow abdomen.

6. *Pseudagrion microcephalum* (Rambur)

1842. *Agrion microcephalum* Rambur, *Ins. Nevrop.* : 259.

1933. *Pseudagrion microcephallum* : Fraser, *Fauna Brit. India; Odonata*, (1) : 278.

Diagnostic characters : Head with orange pigment. Abdomen 2 with a goblet-shaped dorsal black spot, its stem very short, confluent with a narrow apical black ring. Superior and appendage expanded on the inner side, 2-3 small spines on the inner basal border.

Distribution : India : West Bengal (Bankura, Hooghly, Howrah, North and South 24 Parganas, Murshidabad, Jalpaiguri, Purulia), Uttar Pradesh, Bihar, Maharashtra, Madhya Pradesh. Elsewhere : Burma, Sri Lanka, Australia, Java.

Remarks : It was recorded from wetland types II and I. However, the species has been reported to be of common occurrence in and around Calcutta (Ram *et al.*, 1983).

Subfamily AGRIOENEMINAE

7. *Agriocnemis pygmoea* (Rambur)

1842. *Agriocnemis pygmoea* Rambur. *Ins. Nevrop.*, 278

1933. *Agriocnemis pygmoea* : Fraser, *Fauna Brit. India, Odonata,* (1) : 398.

Diagnostic characters : Labrum shining metallic blue, fore wing pterostigma yellow, hind wing black , Appendages 1-6 pale green, 7-10 and anal brick red in male, yellow in female, superior anal appends longer than inferior, vulvar scales robust.

Distribution : India : West Bengal (Calcutta, South 24 Parganas, Hawrah, Bankura, Birbhum, Barddhaman, Cooch Bihar, Jalpaiguri, Malda, West Dinajpur,), Uttar Pradesh, Bihar, Maharashtra, Maddhya Pradesh. Elsewhere : Burma, Sri Lanka, Australia, Java.

Remarks : It was one of commonest odonates recorded from all wetland types in abundance. Adults were mostly seen hovering on the shore grass.

Family PLATYCNEMINIDAE

8. *Copera marginipes* (Rambur)

1842. *Platycnemis marginipes* Rambur, *Hist. Nat. Ins. Nevrop.* : 240.

1993. *Copera marginipes* : Srivastava and Sinha, Odonata, In : *State Fauna Series 3* : *Fauna of West Bengal.* pt. 4, *Zoological Survey of India, Calcutta* : 80.

Diagnostic characters : Inferior and appendages at least four times in length of superior, broad at base, tapering but with rounded obtuse apex. Superior rudimentary, tubercles rounded, apex hooked.

Distribution : India : West Bengal (North and South 24 Parganas, Kolkata, Jalpaiguri), Assam, Bihar, Gujarat, Himachal Pradesh, Maharashtra, Meghalaya, Tamil Nadu, Uttar

Pradesh. Elsewhere : Burma, China, Java, Indonesia, Malaysia, Sri Lanka, Siam, Taiwan, Thailand.

Remarks : This species was generally found under the shade of shore trees or emergent macrophytes. It was seen in abundance near Rabindra Sarovar (Type-VI, Urban recreational lakes) during monsoon months.

Suborder ANISOPTERA

Key to the families of Anisoptera

1. Eyes well separated on dorsum vertex, occipital plate large trapezoidal ..... **Gomphidae**

– Eyes are broadly meeting on its dorsum 2

2. Eyes with a projection at posterior border, thorax metallic green, long membranous keel on surface of tibiae in male ..... **Corduliidae**

– Eyes without projection at posterior border, thorax non metallic, no membranous keel on tibiae ..... **Libellulidae**

Family GOMPHIDAE

9. *Ictinogomphus rapex* (Rambur)

1842. *Diastatomma rapex* Rambur, *Ins. Nevrop*; 169.

1993. *Ictinogomphus rapax:* Srivastava and Sinha, In : *State Fauna Series-3* : *Fauna of West Bengal*, pt. 4, *Zoological Survey of India, Calcutta* : 106.

Diagnostic Characters : Abdominal segment 8 widely dilated with leaf-like expansion, unmarked, with a broad basal yellow ring, face and femora largely black, hind femora with two rows of spines, posterior border of thorax margined with black, superior anal appendages acute at apex.

Distribution : India : West Bengal (Purulia, Kolkata and Howrah districts). Widely distributed throughout India except in desert areas. Elsewhere : Burma, Sri Lanka, Malaysia.

Remarks : The species was recorded only form wetland Type I-oxbow Lakes.

Family CORDULIIDAE

10. *Epophthalmia vittata vittata* Burmeister

1839. *Epophthalmia vittata* Burmeister, *Handb. Ent.*, II : 845.

1993. *Epophthalmia vittata vittata* : Srivastava and Sinha, In : *State Fauna Series 3* : *Fauna of West Bengal, pt.* 4, *Zoological Survey of India, Calcutta* : 118.

Diagnostic characters : Frons dark metallic blue, rounded spot on each side, crown-shaped spot in the middle; bluish green metallic reflex on sides of thorax; abdomen dark reddish brown, with bright yellow annules. Superior and appendage very little angulated on its outer middle spot.

Distribution : India : West Bengal (Kolkata), Andhra Pradesh, Karnataka, Kerala, Maharashtra, Tamil Nadu, Uttar Pradesh.

Remarks : The species was recorded in small numbers from Oxbow lake, urban lakes and fish culture ponds. It is the only species of genus recorded from West Bengal.

Family LIBELLULIDAE

Key to the genera of Libellulidae

1. Distal antenodal nervure in forewing complete 2

– Distal antenodal nervure in forewing incomplete 3

2. Frons metallic above; lobe of prothorax large and fringed with long hairs ..... *Brachydiplax* Brauer

– Frons non-metallic above; always 12 or more antenodal nervure in forewing, abdomen of variable shape, not conspicuously dilated abdomen 1-6 ..... *Orthetrum* Newman

3. Lobe of prothorax large and fringed with long hairs; borders of discoidal field in forewing diverging widely at wing border and beginning with two rows of cells; discoidal cell in hind wing entire ..... *Diplacodes* Kirby

– Lobe of prothorax small and usually naked 4

4. Red or ochraceous species with basal or medial yellow marking to wings 5

– Variable coloured, darker species; Arc between the first and second antenodal nervures, two rows of cells between IR iii and Rspl ..... *Potamarcha* Karsch

5. Wings with basal yellow markings, face and frons red; antenodals in forwwings 9 to 10, eyes shortly contiguous ..... *Crocothemis* Brauer

– Wings with broad reddish yellow medial facia; face frons and also abdomen never red, antenodals in forewings 6 to 7 ..... *Brachythemis* Kirby

Genus *Brachydiplax* Brauer

Key to the species of *Brachydiplax*

1. Bases of all wings coloured; dorsum of thorax densely pruinosed ..... *B. chalybea* Brauer

– Bases of all wings usually not coloured, if coloured then very palely so ; dorsum of thorax dark metallic or marked with black 2

2. Forewings with 7 antenodal nervure, sexual organs in male distinctly projected and visible in profile ..... *B.sobrina* (Rambur)

– Forewings with 8 to 9 antenodal nervure; sexual organs in males barely visible in profile ..... *B. farinosa* Kruger

11. *Brachydiplax chalybea chalybea* Brauer

1868. *Brachydiplax chalybea* Brauer, *Verh. Zool. -bot. Ges. Wien.*, (18) : 173.

1993. *Brachydiplax chalybea chalybea* : Srivastava and Sinha, In : *State Fauna Series 3* : *Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 125.

Diagnostic characters : Wings hyaline with base having brown patch thorax pruinosed white or dorsum, laterally ochraceous with vestiges of lines on upper part of humerae and posterio lateral sutures metallic black.

Distribution : India : West Bengal (Kolkata, North and South 24 Parganas; Midnapore), Assam;. Elsewhere : Bangkok, Borneo, Burma, Celebes, Malaysia, Siam, Sumatra.

Remarks : The species was recorded in moderate numbers from wetland types I, II, V and VI. It is a comparatively larger species of *Brachydiplax* and can be distinguished from other species of the genus by the brown or golden brown colour of wing base.

12. *Brachydiplax farinosa* Kruger

1891. *Brachydiplax sobrina* : Selys *Ann. Mus. Civ. Genova*, (30) : 449.

1993. *Brachydiplax farinosa* : Srivastava amd Sinha, In : *State Fauna Series 3 : Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 125.

Diagnostic Characters : Anterior surface of frons margined with black; prothorax, thorax dark metallic green; nodal index high; lamina of male genitalia depressed, not visible in profile.

Distribution : India : West Bengal (North and South 24 Parganas, Jalpaiguri, Howrah), Assam. Elsewhere : Burma, Malaysia and Sumatra.

Remarks : The species was also recorded from all wetlands except Type IV- Sewage-fed ponds. However, they were never seen in abundance. The species can be distinguished from other species of the genus by the yellow colour of wing bases.

13. *Brachydiplax sobrina* (Rambur)

1842. *Libellula sobrina* Rambur, *Ins. Novrop.* : 114.

1993. *Brachydiplax sobrina* : Srivastava and Sinha, In : *State Fauna Series 3 : Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 126.

Diagnostic characters : Frons above metallic blue; Occiput dark brown with yellow geminate spot; prothorax dark brown, thorax with black metallic markings; abdomen black; lamina of great size and projecting.

Distribution : India : West Bengal (Calcutta, North and South 24 Parganas, Bankura, Burdwan, Howrah, Hooghly, Malda, Medinipur), Assam, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Meghalaya, Orissa, Punjab, Uttar Pradesh. Elsewhere : Bangladesh, Burma, Thailand, Vietnam and Sri Lanka.

Remarks : The species was not very common in the region and recorded only from a few wetlands. It can be distinguished from the other two species of the genus by uncoloured wing base.

Genus *Brachythemis* Brauer

14. *Brachythemis contaminata* (Fabricius)

1793. *Libellula contaminata* Fabricius, *Ent. Syst.*, (2) : 382.

1982. *Brachythemis contaminata* : Raja Ram *et al.*, *Rec. zool. Surv. India,* (80) : 184.

Diagnostic Characters : Body ochraceous, olivaceous-brown to reddish brown on its abdomen; prothorax with dark reddish brown transverse stripes, an abscure reddish brown humeral stripes on dorsum and two on sides of thorax; wings with bright orange fascia from base to within 2/3 cells to pterostigma.

Distribution : India : West Bengal (Kolkata, North and South 24 Parganas, Burdwan, Jalpaiguri, Malda, Midnapore, Murshidabad, West Dinajpur), Assam, Bihar, Himachal Pradesh, Madhya Pradesh, Punjab, Rajasthan, Uttar Pradesh. Elsewhere : Bangladesh, Burma, China, Formosa, Indonesia, Japan, Malaysia, Nepal, Philippines, Sri Lanka, Sumatra, Taiwan and Thailand.

Remarks : An abundant species in the region recorded from all wetland types. It can be tentatively distinguished from related species, *Crocothemis servilla* by its broad yellow medial fisca instead of small yellow basal markings in the latter.

Genus *Crocothemis* Brauer

15. *Crocothemis servilla servilla* (Drury)

1770. *Libellula servillia* Drury, *III, Ex. Ins.*, (1) : 112.

1934. *Crocothemis servilla servilla* : Fraser, *Faun. Brit. India, Odon.*, (3) : 345.

1993. *Crocothemis servilla servilla* : Srivastava and Sinha, In : *State Fauna Series 3* : *Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 142.

Diagnostic Characters : Head, occasionally dorsum of thorax, abdomen and anal appendages of male blood-red; female yellowish, ochraceous to olivaceons brown. Middle lobe of prothorax ridged transversely; bases of wings marked with rich, amber-yellow, apices being narrowly pale brown.

Distribution : India : West Bengal (widely distributed), Bihar, Himachal Pradesh, Madhya Pradesh, Manipur, Punjab, Rajasthan, Uttar Pradesh. Elsewhere : Australia, Burma, Indonesia, Iran, Iraq, Japan, Nepal, Philippines, Sri Lanka, Taiwan and Thailand.

Remarks : It is very common species/subspecies among Indian Libellulids. It was recorded from all wetland types.

Genus *Diplocodes* Kirby

Key to the species of *Diplacodes*

– Apices of the wings tipped with black ..... *D. nebulosa* (Fabricius)

– Apices of wings hyaline, adults marked with yellow, appendages also yellow ..... *D. trivialis* Rambur

16. *Diplocodes nebulosa* (Fabricius)

1793. *Libellula nebulosa* Fabricius, *Ent. Syst.*, (2) : 379.

1935. *Diplocodes nebulosa* : Fraser, *Fauna Brit. India, Odon.*, (3) : 335.

1993. *Diplocodes nebulosa* ; Srivastava and Sinha, In : *State Fauna Series 3* : *Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 135.

Diagnostic Characters : Frons dark violet with metallic lustre; prothorax, thorax, abdomen and legs black; apices of wing blackish brown; pterostigma dark reddish-brown between thick black nervures.

Distribution : India : West Bengal (Kolkata, North and South 24 Parganas, Bankara, Midnapore), Assam, Himachal Pradesh, Madhya Pradesh, karnataka, Kerala, Maharashtra,

Manipur, Meghalaya, Mizoram, Tamil Nadu, Uttar Pradesh. Elsewhere : Australia, Burma, China, Indonesia, Java, Malaysia, New Guinea, Sri Lanka, Vietnam.

Remarks : The species was not very common around the wetlands studied and recorded in small numbers from floodplain ox-bow lakes. a few individuals were seen near Barti beel (Type-II wetland). It can be recognized by dark prominent markings at the wing-apices.

17. *Diplocodes trivialis* (Rambur)

1842. *Libellula trivialis* Rambur, *Ins. Nevrop.*, : 115.

1987. *Diplocodes trivialis* : Lahiri, *Rec. zool. Surv. India,* Occ. Paper No. 99 : 202.

Diagnostic Characters : Face, frons and vesicle palest azure blue; prothorax pale brown to black, a mid dorsal stripe on dorsum; thorax greenish yellow, sutures finely black; wings hyaline; abdomen 1-3 with greenish yellow sutures finely black; apices of all wings absolutely clear, no basal markings, and appendages creamy white.

Distribution : India : West Bengal (widely distributed, including Calcutta and 24 Parganas. Also commonly found almost throughout India. Elsewhere : Australia, Burma, China, Indonesia, Iraq, Japan, Malaysia, Newguinea, Nepal, Pacific Is., Philippines, Scynchelles, Sri Lanka, Thailand, Vietnam.

Remarks : The species was recorded abundantly during monsoon months. However, a few individuals were seen almost throughout the year. The species can be distinguished by it creamy white anal appendages.

Genus *Orthetrum* Newman

18. *Orthetrum sabina sabina* (Drury)

1770. *Libellula sabina* Drury, Ill. *Evot. Ins.*(1) : 114.

1993. *Orthetrum sabina sabina* : Srivastava and Sinha, In : *State Fauna Series 3* : *Fauna of West Bengal,* pt. 4, *Zoological Survey of India, Calcutta* : 128.

Diagnostic Characters : Frons deeply notched to form two triangular facets in front; prothorax bright yellow; Thorax and abdomen greenish yellow; sutures of thorax finely black; abdomen enormously swollen at base and then abruptly slimmed and compressed laterally to the end.

Distribution : India : West Bengal (Kolkata, North and South 24 Parganas, Bankura, Burdwan, Howrah, Hooghly, Jalpaiguri, Malda, Murshidabad, West Dinajpur), Assam, Bihar, Himachal Pradesh, Manipur, Uttar Pradesh. Elsewhere : Burma, Samoa, Siam, Sri Lanka.

Remarks : This is one of the most common *Orthetrum* species in India, recorded from almost all wetland types. It was abundant near oxbow lakes and fish culture ponds. The species can easily be distinguished by its swollen basal abdominal segments.

Genus *Potamarcha* Karsch

19. *Potamarcha obscura* (Rambur)

1842. *Libellula obscura* Rambur, *Ins. Nevrop.* : 64.

1993. *Potamarcha obscura* : Srivastava and Sinha, In : *State Fauna Series 3* : *Fauna of West Bengal,* pt.4, *Zoological Survey of India, Calcutta* : 147.

Diagnostic Characters : Prothorax dark brown, thorax black; wing apices tipped with brown 2 rows of cells; and appendages black; arc situated between first and second antenodal nervures, without secondary reticulation, only one cubical nervure present in all wings.

Distribution : India : West Bengal (widely distributed including Kolkata and its surroundings), Himachal Pradesh, Madhya Pradesh, Uttar Pradesh; Elsewhere : Sri Lanka to Tibet and from West Coast of India to Philippines.

Remarks : The species commonly occurs on small weeds. It was recorded from fish culture ponds, sewage-fed ponds and urban lakes.

HEMIPTERA

Hemiptera are true "Bugs" The aquatic and semiaquatic members of the Order occur in and around all types of freshwaters They may be distinguished from other aquatic insect orders by 1) the presence of a piercing and sucking beak-like structure formed by the modification of the mouth parts, inserted near the anterior end of the head, 2) leathery anterior pair of wings at the base and membranous apically and completely membranous second pair, and 3) simple and gradual metamorphosis. These are aquatic or semi aquatic. The size-range is very vast, from minute to very large. The body shape varies greatly from long, cylindrical to oval and sometimes considerably flattened The prothorax is large and free, meso and metathorax united, scutellum very prominent and antennae 4-5 segmented. Apterous and macropterous individuals may be found in the same population / aggregation. There are generally 5 nymphal stages and the nymphs look like adults except they're comparatively of smaller sizes and sexual immaturity.

As compared to very rich hemipteran fauna, relatively a few species have adapted fully to aquatic habitats. However, there are a series of aquatic and semiaquatic families that show a gradual transition of habitats from damp shores to subsurface waters (Pennak, 1978). Some remain confined to the shore, some venture further and abound the floating algal mats and other floating objects, and some skate rapidly over the surface of water. The true aquatic species are normally found below the surface. Members of the families

Nepidae and Blastomatidae usually cling to the substrate but remain in contact with surface film, those belonging to family Pleidae clamber about in angled submerged macrophytes, and species of the families Corixidae and Notonectidae are excellent swimmers. Species occurring above water surface bear tracheal respiration system of terrestrial insects. Those species which are adapted to swim below the surface, come periodically to surface to renew the air supply in the tracheae. Excepting Corixids, where the pronotum breaks the surface film, in other families the tip of the abdomen is brought into contact with the air. Some members also store air between the wings and body In some other cases a film of air is carried by hydrofuge pubescence. Tracheal gills are absent in the entire order.

They are highly predaceous, feeding upon micro and macro-invertebrates and sometimes on fish eggs and fry. For this, forelegs are highly modified for seizing and holding the prey while body fluids are sucked up through the mouth parts with the muscular pharynx (Pennak, 1978). The eggs are generally laid on the surface or within the tissue of submerged macrophytes.

SYSTEMATIC LIST OF AQUATIC AND SEMI-AQUATIC SPECIES

Class INSECTA
Order HEMIPTERA
Suborder HETEROPTERA
Series CRYPTOCERATA
Family CORIXIDAE
Subfamily MICRONECTINAE

Genus *Micronecta* Kirkaldy

1. *Micronecta (Basileonecta) scutellaris* (Stal)

Family NOTONECTIDAE
Subfamily ANISOPINAE

Genus *Anisops* Spinolae

2. *Anisops bouvieri* Kirkaldy
3. *Anisops breddini* Kirkaldy
4. *Anisops sardea* Herrich-Shaffer

Family PLEIDAE

Genus *Plea* Leach

5. *Plea liturata* (Fiebr)

Family NEPIDAE

Subfamily NEPINAE

Genus *Laccotrephes* Stal

6. *Laccotrephes griseus* (Guerin)

Subfamily RANATRINAE

Genus *Ranatra* Fabricius

7. *Ranatra filiformis* Fabricius
8. *Ranatra sordidula* Dohrn

Family BELOSTOMATIDAE

Subfamily BELOSTOMATINAE

Genus *Diplonychus* Amyot and Serville

9. *Diplonychus annulatum* (Fabricius)
10. *Diplonychus rusticus* (Fabricius)

Genus *Lethocerus* Mayr

11. *Lethocerus indicus* (Lepeletier & Serville)

Family MESOVELIIDAE

Subfamily MESOVELLINAE

Genus *Mesovelia* Mulsant & Rey

12. *Mesovelia vittigera* Horvath

Family HYDROMETRIDAE

Genus *Hydrometra* Lamarck

13. *Hydrometra vittata* Stal

Family GERRIDAE

Subfamily GERRINAE

Genus *Limnogonus* Stal

14. *Limnogonus (Limnogonus) fossarum* (Fabricius)

15. ***Limnogonus (Limnogonus) nitidus*** (Mayr)

Genus *Neogerris* Matsumura

16. ***Neogerris parvula*** (Stal)

Genus *Gerris* Fabricius

17. ***Gerris spinolae*** Lethierry and Severin

Subfamily RHAGADOTARSINAE

Genus *Rhagodotarsus* Breddin

18. ***Rhagodotarsus kraepelini*** Breddin

Subfamily TREPOBATINAE

Genus *Naboandelus* Distant

19. ***Naboandelus signatus*** Distant

Key to series

Antenna concealed in grooves below the head, shorter than head ..... Series Cryptocerata

– Antenna not concealed but visible, equal to or a little longer ..... Series Gymnocerata

Key to the families of Cryptocerata

1. Hind tarsi with two distinct claws 2

– Hind tarsi with usually claws indistinct and small 3

2. Tip of abdomen with non-retractile, long and slender siphon; tarsi 1-segmented .... Nepidae

– Tip of abdomen with retractile, short and flat siphons; tarsi 2–or 3–segmented ..... Belostomatidae

3. Body flattened dorsally; fore-tarsi 1-segmented, palae scoop-like, fringed with setae and hairs; rostrum short, triangular, unsegmented ..... Corixidae

– Body rather convex; fore tarsi 2-segmented, not as above; rostrum rather cylindrical 4

4. Oval forms with all legs alike; hind tibiae and tarsi simple; rostrum 3-segmented; abdomen without mid ventral keel; tip of abdomen with appendages ..... Pleidae

– Elongate forms with long, oar-like hind legs; hind tibiae and tarsi ciliated, rostrum 4-segmented; abdomen with mid ventral keel; tip of abdomen without any appendage ..... Notonectidae

Key to the families of Gymnocerata

1. Apex of last tarsal segment entire; claws apical 2

– Apex of last tarsal segment cleft or bifid; claws of at least the front tarsi preapica 3

2. Head, shorter than pronotum; scutellum minute; both rostrum and tarsi 3-segmented, femora with stiff erect bristles ..... Mesovellide

– Head long, as long as entire thorax, body long, cylindrical, antennae and legs filiform ..... Hydrometridae

3. Hind femora short, distal end scarcely surpassing the end of abdomen; middle legs inserted about midway between front and hind legs; head with a central groove ... . Vellidae

– Hind femora long, surpassing the end of abdomen; middle legs inserted closer to hind legs than to forelegs; head without central groove ..... Gerridae

Family CORIXIDAE

The members of this family, usually called "water boatmen", are medium to small insects usually 2-16 mm in length. The body is somewhat flattened above and the colour is dark greyish with yellow or black markings. The wing membrane is without veins. Head is triangular, with short, broad triangular unsegmented labium. Antennae short, concealed, consist of 3-4 segments. Front tarsus 1-jointed, flattened and scoop-like called "Pala" which is the characteristics of the family. Scutellum is concealed and the male abdominal segments are asymmetrical. A file-like plate called "Strigil" is present in tergum VI of the male . Abdominal terga III-IV of nymphs and adults have metathoracic scent glands, opening near the 3rd coxa. Dorsum of the abdomen with alternative dark and light transverse band.

Corixids occur in both stagnant and running waters, generally at bottom near the littoral zone. A film of air envelops the body almost completely and there is also trapped beneath the wing. They come to surface for the renewal of oxygen. In wetlands with high dissolved oxygen content, they remain under water for substantially longer duration and obtain oxygen by diffusion through the air-water interface of the physical gills. The corixids are good flier

and take off easily from the surface of water. They swim by their dorsum. The food consists of debris, algae, Protozoa and other microscopic animals. The food is gathered from the muddy bottom by sweeping the flocculent material into the mouth with their first tarsi.

Although the family Corixidae is the largest family of aquatic Hemiptera consisting of about 500 species, distributed widely in the world, from below sea level to as high as 4575 meters in Himalaya, from arctic water beneath ice to hot springs with temperature around 35°C (Thirumalai, 1989), in India it is represented only by 35 species belonging to 4 genera (Thirumalai, 1994). During present investigations only one species, *Micronecta (Basileonecta) scutellaris* (Stal), was recorded from the wetlands studied. Roy *et al.* (1988) recorded 6 species from the wetlands of eastern Bihar.

1. *Micronecta (Basileonecta) scutellaris* (Stal)
(Fig. 10)

1858. *Sigra scutellaris* Stal, *Metens akad. Forh.*, 15 : 319.

1910. *Micronecta clione* Distant, *Fauna Brit. India*, 5 : 348.

1994. *Micronecta (Basileonecta) scutellaris scutellaris* : Thirumalai, *Rec. zool. Surv. India, Occ. Paper* No. 165 : 9.

Diagnosis : Pronotum grey or greyish brown, paler margins and with obscure elytral pattern; Tip of the left paramere club-shaped and possesses minute denticles; body more than 3.0 mm long.

Distribution : India: West Bengal (Calcutta, North 24-Parganas, South 24 Parganas). Elsewhere: widely distributed : Africa (Central); China; Indonesia; Malaysia; Saudi Arabia; Sri Lanka; Vietnam etc.

Remarks : This large species of water boatmen was abundantly recorded from all types of wetland studied. They were always conspicuous, particularly in multipurpose village ponds and fish culture ponds.

Family NOTONECTIDAE

The notonectids, commonly called as backswimmers due to their peculiar habit of swimming on their backs, are amongst the best known waterbugs. At surface these can be seen resting with their dorsal sides downwards, body at an angle and the tip of abdomen in contact with air. They are also seen clinging to submerged objects. The size ranges between 15-20 mm. They are strikingly coloured, sometimes multicoloured, on the dorsal surface of the head and thorax. Their bodies are long and slender, flat ventrally and convex dorsally. Eyes are large, remiform and occupy most of the head. Ocelli absent. Antennae short, 3-4 segmented and concealed from above. Rostrum short. First two pairs of legs are

adapted for grasping and the last pair is flattened and fringed, densely setose for swimming. The tarsi are with two apical claws and those of hind legs are much redundant and indistinct. The venter of abdomen is with prominent longitudinal keel with long hairs. These hairs alongwith the hairs on the sides of venter form air chambers.

Notonectids occur abundantly in all types of wetlands of this region including river pools and quitter region of river. They are powerful suimmer but for a short distance and swim by means of rapid strokes with the help of last pair of modified legs. Air is carried in two troughs on the ventral side of their abdomen, where it is held by three longitudinal fringes of hair. Some air is also carried under the wings and between head and thorax. They are mainly carnivores While adults feed on aquatic insects , other invertebrates and fish eggs and fry, the nymphal food mainly comprises microcrustaceans zooplankton.

Notonectids were represented by only 3 species belonging to Genus *Anisops* in the wetlands studied. From the State of West Bengal also only 13 species belonging to 3 genera have been reported of which 11 belonged to Genus *Anisops* (Bal and Basu, 1994). However, from India about 300 species belonging to 9 genera of Notonectids are known (Thirumalai, 1989).

Genus *Anisops* Spinola

Key to the species of the genus *Anisops*

1. Cephalic horn present; eyes not holoptic 2

– Cephalic horn absent, eyes holoptic basally; facial tubercle swollen prominently; stridulatory comp irregular in shape, composed of 7 irregular teeth .... *A. breddini* Kirkaldy

2. Much prominent cephalic horn with frons excavate of its entire length and bordered laterally by two carinae; stridulatory comb gradually narrow towards the apex, composed of about 18 teeth; rostral prong slightly shorter than the 3rd rostral segment; robust body ..... *A. sardea* Herrich-Shaffer

– Moderately prominent, cephalice horn with frons excavate triangularly and bordered laterally by two carinae; stridulatory comb composed of about 12 teeth; fusiform body. ..... *A. bouvieri* Kirkaldy

2. *Anisops bouvieri* Kirkaldy

1904. *Anisops bouvieri* Kirkaldy, *Wein ent. Ztg.*, 23 : 116.

1994. *Anisops bouvvieri*: Thirumalai, *Rec. zool. Surv. India, Occ. Paper* No. 165 : 13.

Diagnosis : Synthlipsis narrow; cephalic horn moderately prominent; frons excavate triangularly and broadened laterally by two carinae; rostral prong as long as the 3rd segment; stridulatory comb composed of about 12 teeth; body pearlaceous, about 5.5-6 mm long.

Distribution : India: West Bengal (Calcutta, Murshidabad), Assam, Andhra Pradesh, Andaman Is., Bihar, Madhya Pradesh, Orissa; Tamil Nadu. Elsewhere : Bangladesh; China; Malaysia, Myanmar, New Guinea; Thailand.

Remarks : This backswimmer hemipteran species was recorded from all wetland types except for the dish culture ponds (Type-III). However, this is a very common species found throughout India. It occurs in fresh water pools, lakes, ponds, forest streams etc.

3. *Anisops breddini* Kirkaldy
(Fig. 11)

1901. *Anisops breddini* Kirkaldy, *Entomologist*, 34 : 5-6.

1994. *Anisops breddini* : Thirumalai, *Rec. zool. Surv. India, Occ. Paper* No. 165 : 14.

Diagnosis : Synthlipsis narrow, less than one third the anterior width of vertex; cephalic horn present, rather much prominent, with frons excavate of its entire length and bordered laterally by two carinae; rostral prong slightly shorter than 3rd segment of rostrum; stridulatory comb gradually narrow apicad and composed of about 18 teeth; body pearlaceous 5.4-6.6 mm in length; eye holoptic.

Distribution : India : West Bengal (Calcutta, North 24-Parganas, South 24-Parganas), Kerala, Orissa; Tamil Nadu. Elsewhere : Indonesia; Myanmer. Malaya Peninsula; New Guinea; Sri Lanka; Sri Lanka; Vietnam.

Remarks : The species is characterised by the parallel lateral margin of pronotum, holoptic eyes and the structure of male stridulatory comb composed of a few flattened and spatulate combs. The species occurs abundantly in ponds.

4. *Anisops sardea* Herrich-Shaffer

1850. *Anisops sardea* Herrich-Shaffer, *Die Wanz. Ins.*, 9 : 41.

1905. *Anisops sardea* : Distant, *Fauna Brit. India*, 3 : 45.

1994. *Anisops sardea* : Thirumalai, *Rec. zool. Surv. India, Occ. Paper No.* 165 : 18.

Diagnosis : Body pale yellow or brownish yellow; cephalic horn much prominent with frons excavate of its entire length and bordered laterally by two carinae; stridulatory comb gradually narrow apicad, composed of about 18 teeth; rostral prong slightly shorter than the

3rd segment of rostrum. Body 7.5-8.4 mm (male) and 7.2-7.5 mm (female).

Distribution : India : West Bengal (Calcutta, South 24 Parganas, Darjeeling, Murshidabad), Orissa, Punjab, Tamil Nadu, Uttar Pradesh. Elsewhere: Afghanistan; Africa; Albania; Canary Is.; Myanmar; Pakistan; Syria; Turkey.

Remarks : The species was abundant in type-I wetlands but could not be collected from Type-IV, sewage-fed pond and Type VI, urban lakes. The species is known to occur in Mediterranean countries and Western Asia and also widely distributed in Ethiopian, Oriental and Palaearctic regions. It is a moderately larger species with the male having a cephalic projection, the two basal tibial setae of anterior legs in male spatulate. The ovipositor of female with longitudinal teeth and lateral tooth-like setae.

Family PLEIDAE

The Pleidae or "Pigmy backswimmers" are smallest aquatic Hemiptera with compact and strongly arched body. Head relatively large, rostrum short and three-segmented, antennae short and concealed, legs susbequal, tibiae and tarsi not flattened and ciliated along margins. The anterior leg modified for grasping, the femora being greatly enlarged.

These prefer dense submerged macrophyte strands of *Ceratophyllum* and *Chara.* Where they remain attached or clinging on leaves and stems. Mode of Locomotion consists of half creeping, half-swimming gait in the dense macrophytes They move from place to place by clinging to macrophytes. A supply of air is carried under wings. They feed vigorously on a variety of micro-invertebrates The eggs are inserted into macrophytes.

The family is represented by 3 genera and 40 species in the world (Thirumalai, 1989). From West Bengal 4 species belonging to two genera have been listed (Bal and Basu, 1994), but except *Plea liturata* , other three species are included in the list based on the material collected before 1910. During present studies only one species has been recorded. Roy et al. (1988) also mentioned only one confirmed species, *Plea frontalis* from eastern Bihar.

5. *Plea liturata* (Fieber)
(Fig. 12)

1844. *Plea liturata* Fieber Ent. *Monogr. Leipzig*, (5) 3 : 296.

1910. *Plea metiadusca:* Distant, *Fauna Brit. India, Rhynchota* 5 : 337.

1994. *Plea liturata* : Bal and Basu, In : *State Fauna Series 3* : *Fauna of West Bengal,* pt. 5, *Zoological Survey of India, Calcutta* : 552.

Diagnosis : Body about 2mm long, dull yellowish grey in colour; front of head provided

with markings; elytra coarsely but distinctly punctate; pronotum with fine punctures spread all over; abdominal keels prominent and not compact, moderately prominent spine-like process on 4th, 5th and 6th abdominal sclerites.

Distribution : India : West Bengal (Calcutta, South 24-Parganas). Elsewhere : Bali; Java; Sumatra; Malay Peninsula.

Remarks : This small-sized pigmy backswimmer is an uncommon species in the region and was recorded in small numbers from ox-bow lakes and only once from natural wetlands (Barti beel).

Family NEPIDAE

The insects belonging to this family are popularly known as "Water Scorpions" because of the fact that the forelegs somewhat resemble to the pedipalps of scorpions. The body is dorso-ventrally flattened or cylindrical with long slender legs, the anterior pair being raptorial with long and stout femur used mainly for capture of prey. 1-jointed tarsi and absence of ocelli are the characteristic feature of the family. Two long slender, nonretractile caudal filaments with groves on median surface and fitted together constitute the respiratory tube. By placing its tip at the surface film, oxygen in the tracheal system is replenished.

Nepids are sluggish in nature and prefer still water. They are usually found in trash and mud or remain entangled with aquatic vegetation in the shallow littoral region of the wetlands. Highly predaceous insect species feed mainly on live insects and their nymphs. The prey is captured with the help of raptorial forelegs. The most important cosmopolitan genus, *Ranatra* occurs abundantly in this region. In the wetlands studied, the family was represented by two genera (*Laccotrephes* and *Ranatra*) and three species. From the state of West Bengal, Bal and Basu (1994) listed 9 species under these two genera but three species were included only on the basis of literaure review. Roy *et al.* (1988) also recorded only 4 species belonging to these two genera from eastern Bihar.

Key to the subfamilies and genera of family NEPIDAE

– Body elongately suboval and flattened; pronotum about as long as or a little shorter than broad; hind coxae widely separated; anterior coxae very short ..... Subfamily Nepinae

Genus *Laccotrephes*

Laccotrephes griseus (Guerin)

– Body slender, subcylindrical; pronotum slender and much longer than broad; hind coxae very close; anterior coxae very long. ..... Subfamily Ranatrinae

Genus *Ranatra*

Subfamily NEPINAE

Genus *Laccotrephes* Stal

6. *Laccotrephes griseus* (Guerin)
(Fig. 13)

1829. *Nepa greseus* Guerin, *Iconogr Regne Anim. Ins.*, : 352.

1910. *Laccotrephes griseus* : Montandon, *Annali Mus. Zool. Napoli*, 3(10) : 3.

1994. *Laccotrephes griseus* : Bal and Basu, In : *State Fauna Series 3 : Fauna of West Bengal, pt. 5, Zoological Survey of India, Calcutta* : 540.

Diagnosis : Abdomen above with light bluish tinge; anterior area of prosternum provided with a strong acute spine-like structure; abdominal appendages distinctly shorter then body. The parameres are symmetrical and slightly hooked.

Distribution : India : West Bengal (Kolkata, North 24-Parganas, Darjeeling), Pondicherry, Tamil Nadu; Elsewhere : Malaysia; Myanmar; Seychelles; SriLanka; Thailand.

Remarks : The species was recorded in moderate numbers from all types of wetlands. This is a very sluggish species and inhabits the bottom littoral weedy zones of stagnant water. It is very common in Peninsular India and occurs in permanent pond near the edges (Thirumalai 1994).

Subfamily RANATRINAE

Genus *Ranatra* Fabricius

Key to the species of *Ranatra*

– Head occasionally with distinct tubercle on the vertex; adults with abdominal appendages 3-4 mm., shorter than the body in length ..... *filiformis*

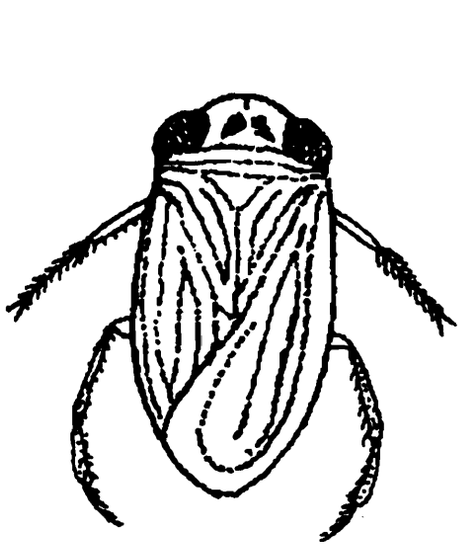
– Head without such tubercle on the vertex; adults with abdominal appendages either 3-4 mm or 7-8 mm., shorter than body ..... *sordida*

7. *Ranatra filiformis* Fabricius
(Fig. 14)

1790. *Ranatra filiformis* Fabricius, *Skr. nat. Selsk.*, 1 : 228.

1906. *Ranatra filiformis* : Distant, *Fauna Brit. India, Rhynchota*, 3 : 21.

1989. *Ranatra filiformis* : Thirumalai, *Rec. zool. Surv. India, Occ. Pap.* No. 118 : 31.



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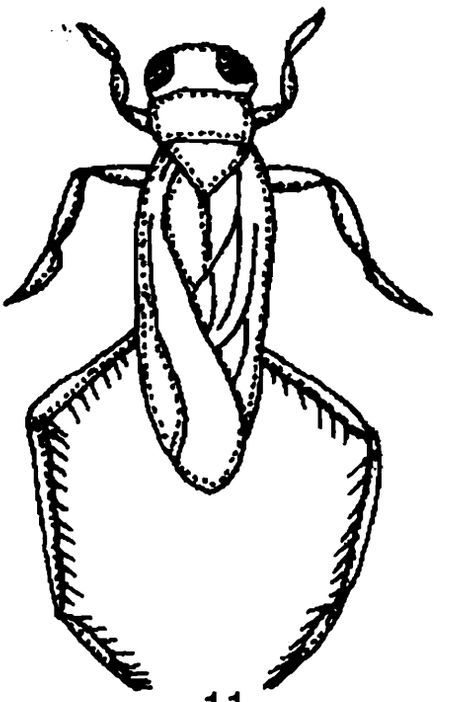

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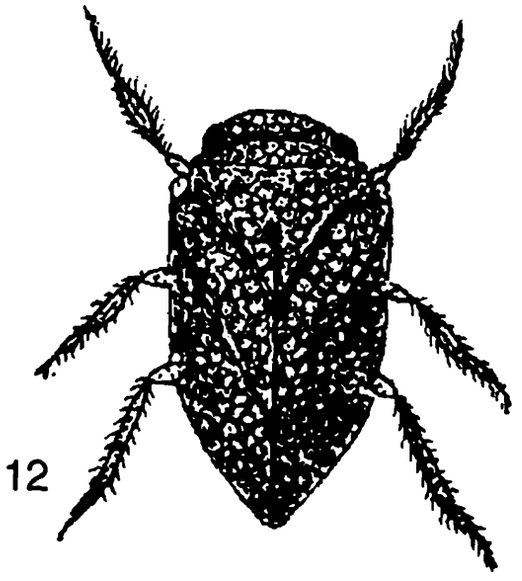

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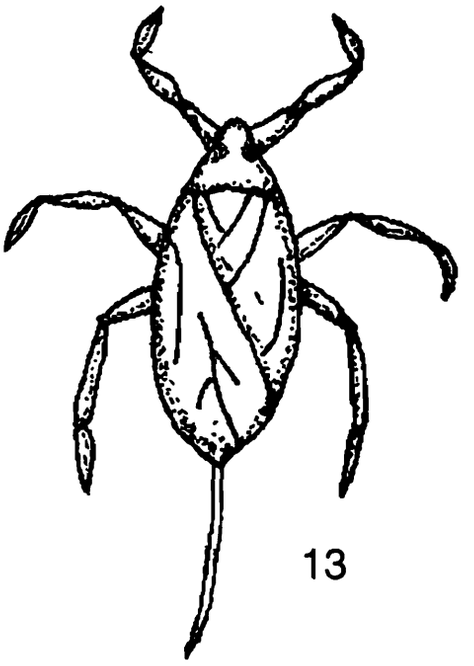

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Fig. 10 : *Micronecta scutellaris* (Stal)

Fig. 11 : *Anisops breddini* Kirkaldy

Fig. 12 : *Plea liturata* Fiebr.

Fig. 13 : *Laccotrphes griseus* (Guerin)

Diagnosis : Body elongated, about 27-28 mm long with abdominal appendages about 23 mm; teeth on anterior femur spinulose; head occasionally with a distinct tubercle on the vertex; metasternal process posteriorly triangular with a distinct mid-longitudinal ridge; interocular space slightly greater than the diameter of an eye.

Distribution : India : West Bengal (Kolkata, Howrah, North 24-Parganas) Assam, Bihar, Maharashtra, Orissa, Uttar Pradesh; Tamil Nadu. Elsewhere : Malay Peninsula; Philippines; Sri Lanka; Thailand.

Remarks : This is a comparatively smaller species of *Ranatra* and the males are identified by the presence of a tooth but with several stout spines on the inner margins of distally hook-shaped parameres and by the wide interocular space. The respiratory siphon is shorter than body. The species mostly occurs amid vegetation fringing the shallower parts of water bodies where it clings to the submerged vegetation. It preys on live nymphs of dragonflies and pupae of mosquito, which are caught between the raptorial forelegs. It was recorded in moderate numbers from all wetland types.

8. *Ranatra sordidula* Dohrn

1859. *Ranatra sordidula* Dohrn, *Stettin. Ent. Ztg.*, 21 : 409.

1906. *Ranatra sordidula* : Distant, *Fauna Brit. India, Rhynchota*, 3 : 22.

1994. *Ranatra sordidula* : Bal and Basu, In *: State Fauna Series 3 : Fauna of West Bengal*, Pt. 5, *Zoological Survey of India, Calcutta* : 543.

Diagnosis : Body elongated, 23-24 mm long, abdominal appendages approximately shorter than body; inter ocular space slightly greater than diameter of an eye; pronotum provided with an indistinct ridge at the posterior angle on each side; metasternal process posteriorly projectile with lateral concavity on each side; anterior tibia shorter.

Distribution : India : West Bengal (Kolkata, Hooghly, North 24-Parganas); Orissa; Elsewhere : Malay Peninsula; Sri Lanka; Thailand.

Remarks : The species is not of common occurrence in this region and was recorded only from Type-I, ox-bow wetlands.

Family BELOSTOMATIDAE

These insects are commonly known as "Giant waterbugs" because of their large sizes (10-110 mm in length). The body is flat , brown, oval or oblong-oval and of brown or dull greenish colour. Antennae 4-segmented and concealed in the pockets beneath the head , eyes prominent. The strong and thick front legs are raptorial and used for grasping. The middle and hind legs are broad, flat, and fringed with swimming hairs. The tarsi are 2 or

3-segmented, ocelli absent. The most characteristic feature in adult is the presence of retractile strap-like appendages at the abdominal apex which are used to obtain air. These air straps are homologous with the respiratory siphon of the related family Nepidae, being derived from the 8th abdominal tergum, each bearing a basal spiracle.

They are generally found on the bottom in shallower littoral zones where emergent macrophytes are in abundance. The larger species live in deeper waters, with or without macrophytes, clinging to some support, with the tip of the abdomen remaining in contact with the surface film. They are highly predaceous and feed on all kinds of aquatic organisms including fish eggs and fry. They secrete a toxic slivery substance that kills the prey within a short time.

About 150 species of Belastomatids are so far known from the world, most of which are distributed in tropical and subtropical regions. Some are cosmopolitan. Only 4 species belonging to genera *Diplonychus* and *Lethocerus* are known from West Bengal. Out of this, 3 species have been recorded during present investigations. Roy *et al.* (1988) from eastern Bihar also recorded same three species.

Key to the genera of Belostomatidae.

Body moderate in size, (13-22 mm in length), and more or less ovate, head in front of eyes sub triangularly produced, scutellum sub equilateral, two anterior tarsal claws of equal length on each. ..... *Diplonychus*

– Body large in size (40–110 mm), narrow and elliptical, head in front of eyes not conically produced, scutellum a little broader than long, one anterior tarsal claw on each ..... *Lethocerus*

Genus *Diplonychus*

Key to the species of *Diplonychus*

– Lateral basal margins of pronotum and embolium pale; fore tarsus 1-jointed .... *rusticus*

– Lateral basal margins of pronotum and embolium not pale; fore tarsus 2-jointed .... *annulatum*

9. *Diplonychus annulatum* (Fabricius)
(Fig. 15)

1803. *Nepa annulatum* Fabricius, *Systema Rhyngotorum*: 106.

1904. *Sphaerodema annulatum* : Distant, *Fauna Brit. India*, 3 : 35.

1962. *Diplonychus annulatum* (Fabricius) : Lauk and Menke, *Ann. Ent. Soc. Amer.*, 54 : 649.

1994. *Diplonychus annulatum* : Thirumalai, *Rec. zool. Surv. India Occ. Paper* 165 : 25.

Diagnosis : Body broad and oval, maximum width of hemelytra together is almost equal to their length; head as long as the interocular space; anterior tarsus with two segments; hemelytra devoid of any shining spot beyond the middle of the inner margin. Body more than 20 mm long.

Distribution : India : West Bengal (Kolkata, South 24-Parganas, Bankura, Burdwan, Howrah, Hooghly, Murshidabad); Assam, Bihar, Orissa; Elsewhere : Bangladesh; Pakistan.

Remarks : This large-sized Giant water bug species was recorded from all wetland types. It was abundant in Wetland type-I, II and III. A highly predaceous species was seen attacking animals much larger that its size likes tadpoles.

10. *Diplonychus rusticus* (Fabricius)
(Fig. 16)

'1794. *Nepa rustica* Fabricius, *Ent. Syst.*, 4 : 62.

1906. *Sphaerodema rusticum*: Distant, *Fauna Brit. India*, 3 : 36.

1962. *Diplonychus rusticus* (Fabricius) : Lauk and Menke, *Ann. Ent. Soc. Amer.*, 54 : 649.

1994. *Diplonychus rusticus* : Thirumalai, *Rec. zool. Surv. India. Occ. Paper* No. 165 : 25.

Diagnosis : Lateral basal margins of pronotum and embolium pale; tarsi 1-jointed and with a smaller claw, long, ventro lateral stripe of fine hairs on abdomen is narrower, suboval in shape, greatest expanse of hemelytra together is shorter than its length; head shorter than the inocular space; body 15-17 mm long.

Distribution : India : West Bengal (Kolkata, North 24-Parganas, South 24 Parganas, Hooghly, Bankura, Murshidabad), Bihar, J. & K. State, Orissa, Kerala, Maharashtra, Tamil Nadu. Elsewhere:Austria. Burma; China; Formosa; Indonesia; Japan; Java; Malay Peninsula; New Zealand; Philippines; Sri Lanka; Sumatra; Thailand; New Guinea.

Remarks : The species was recorded in moderate numbers in all wetland types except sewage-fed ponds. It is also a voracious feeder and has been reported to attack fish fry and fingerlings. It is also known to feed on a wide variety of aquatic organisms including mosquito larvae.

Genus *Lethocerus Mayr*

11. *Lethocerus indicus* (Lepeletier & Serville)
(Fig. 17)

1825. *Belostoma indica* Lepeletier and Serville, *Encycl. Meth*, : 272.

1909. *Lethocerus indicus* : Montondon, *Bull. Soc. Sci. Buc.,* 17 : 138.

1993. *Lethocerus indicus* : Bal and Basu, In : *State Fauna Series 3* : *Fauna of West Bengal,* pt. 5, *Zoological Survey of India, Calcutta* : 539.

Diagnosis : Body dorsoventrally flattened with large size (62-85 mm). Head between eyes with parallel sides; pronotum with a transverse fasciae at the basal end and a fine longiudinal carination in the middle; thick sets of swimming hairs on intermediate and posterior legs on the ventral side.

Distribution : India : West Bengal (Kolkata, North 24-parganas, Darjeeling, Purulia), Assam, Bihar, Kerala, Maharashtra, Mizoram, Orissa, Uttar Pradesh. Elsewhere: Burma; Java; Malay Peninsula; Pakistan; Philippines; Sumatra.

Remarks : This is the largest species of the aquatic hemipterans and was recorded from all wetland types. The species is characterised by its pair of retractable, strap-like appendages at the abdominal apex, each bearing a spiracle basally. Like other belostomids, it is also highly predacious and lives in large and small ponds, streams and swamps. It has been reported to kill even a full-grown frog and even a small woodpecker while some are known to feed on snails.

Family MESOVELIIDE

Popularly known as "Water Treaders" or "Pond weed bugs", are small, slender semi-aquatic insects are characterized by the saw-like ovipositor being (in female) which is about ¼ of the length of the body and 3-jointed tarsi. Macropterous forms have 2 or 3 closed cells in the forewing, with ocelli and scutellum is exposed. In apterous forms, the ocelli are absent or greatly reduced and the thorax is divided into 3 simple segments with no differentiation of scutellum or wing pad.

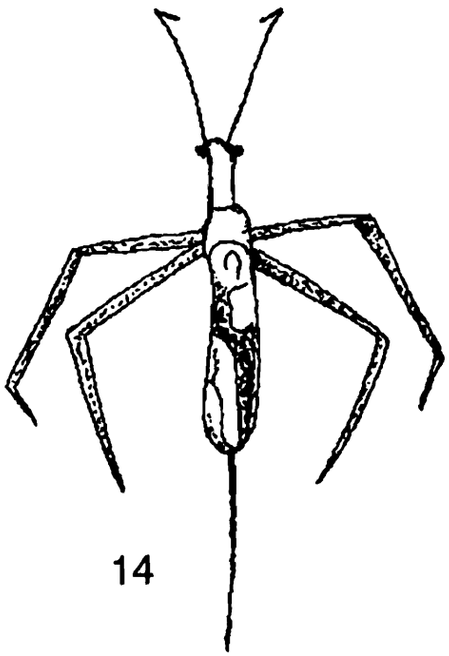
These insects occupy almost all types of wetland and found near the edge of waterbodies among emergent or floating vegetation and other objects. They run rapidly on the water surface. They feed upon small living or dead insects falling upon the water surface and some other aquatic organisms occurring just below the surface film. Females deposit the eggs in the tissue of emergent macrophytes.

The family is represented in the world by 30 species belonging to 9 genera, out of which only one species is available in West Bengal. The same species has been recorded during present studies. Only one species (not identified) was also reported from eastern Bihar by Roy *et al.* (1988), most probably the same species is, *Mesovelia vittigera* Horvath.

Genus *Mesovelia* Mulsant and Rey

12. *Mesovelia vittigera* Horvath

1895. *Mesovelia vittigera*_Horvath, *Rev. d'Ent.,* 14 : 160.



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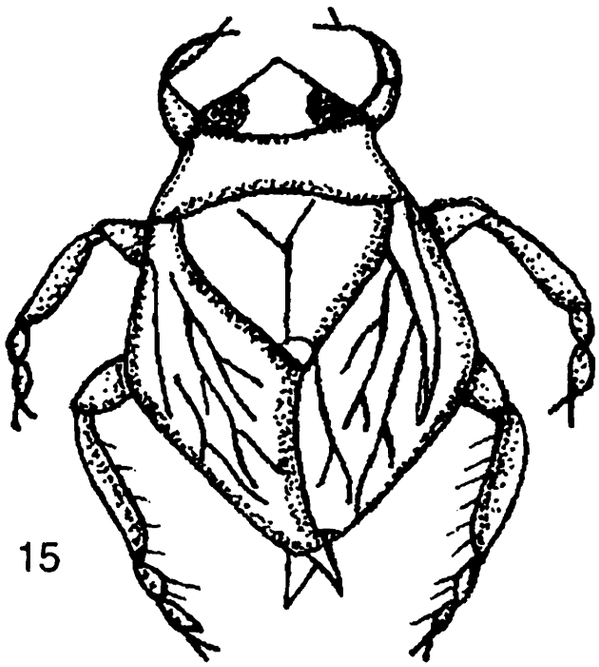

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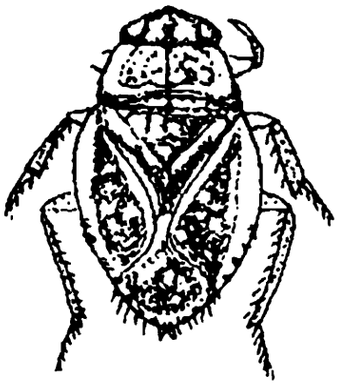

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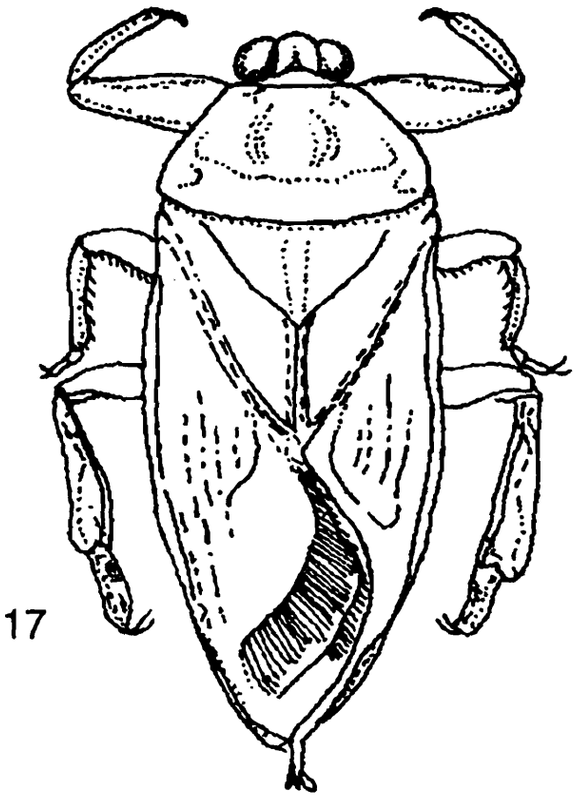

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Fig. 14 : *Ranatra filiformis* Fabricius

Fig. 15 : *Diplonychus annulatum* (Fabricius)

Fig. 16 : *Diplonychus rusticus* (Fabricius)

Fig. 17 : *Lethocerus indicus* (Lep. & Serv.)

1902. ***Mesovelia mulsanti*** : Distant, *Fauna Brit. India, Rhynchota,* 2 : 169.

1994. ***Mesovelia vittigera*** *:* Bal and Basu, In : *State Fauna Series 3* : *Fauna of West Bengal,* pt. 5, *Zoological Survey of India, Calcutta* : 513.

Diagnosis : Body elongate with prominent head; antennae 4-jointed, 2nd joint shortest; eyes large almost touching the anterior margin of pronotum; pronotum with lateral angles tuberculously subprominent; corium encloses 3 closed-cells on the outer half; scutellum large; tibiae hirsute.

Distribution : India: West Bengal (Kolkata, North 24 Parganas, South 24-Parganas, Jalpaiguri), Andaman Is., Orissa, Tamil Nadu, Uttar Pradesh; Elsewhere:Africa; Australia; Bangladesh; Burma; Egypt; Indonesia; Malaysia; Palestine; Philippines; Syria; Solomon Is.; Sri Lanka; Sumatra. The species is thus distributed over a wide range viz., South Europe, Eastern Palaearctic, Ethiopian, Orient, Australia, Oceanica, eastward to Samoa Islands.

Remarks : The species prefers stagnant or slow running water covered by emergent or floating vegetation and was recorded in very small numbers but from all wetland types. These were found mainly on the floating macrophytes.

Family HYDROMETRIDAE

The Marsh Treaders, as popularly called, have extremely slender brownish or greenish, stick-like body with thread-like legs Head elongated, as long as thorax, eyes large, placed slightly behind the middle of the head, ocelli absent, antennae filiform, 4–jointed aquatic metazoan at or near the surface film. The lengthening and narrowing of the body and appendages are adaptations to live on the surface film because weight is reduced and distributed over a large area of the water surface. The size ranges from 7-18 mm.

110 species of the family are known from the world but only one species is known to occur in West Bengal. The same species has been recorded during present investigations.

Genus *Hydrometra* Latereille

13. *Hydrometra vittata* Stal

1870. *Hydrometra vittata* Stal, *Ofvers. J.K. Vet.*-Acad Forh., 27 : 705.

1898. *Hydrometra greeni* : Kirkaldy, *Entomologist,* 31 : 2.

1903. *Hydrometra vittata* : Distant, *Fauna Brit. India, Rhynchota,* 2 : 170.

Diagnosis : Body very elongate (11.00-12.00 mm) with thread-like legs; head very long, longer than pronotum; eyes far from anterior margin of pronotum; antenna 4-jointed. Ist segment very short, 2nd and 4th subequal, 3rd segment longest; pronotum long, hemelytra shorter than abdomen. The hemelytra extends upto the 5th abdominal segment in both sexes

Distribution : India: West Bengal (Kolkata, North 24-Parganas, South 24-Parganas, Burdwan, Murshidabad), Orissa, Uttar Pradesh; Elsewhere: Burma; Japan; Malay Peninsula; Philippines; Sri Lanka.

Remarks : The extremely thin threadlike species was found to occur in moderate numbers in wetland types II III VI and I. The species is widely distributed all over India and is also reported to have been attracted towards light.

Family GERRIDAE

These are popularly known as "Water Striders" or "Pond Skaters" They are semiaquatic long-legged hemipterans. The body is allocated or oval shaped and covered with a velvety hydrofuge hair pile They are of black, grey or brown in colour, with light grey or yellow spots or lines on the dorsum. Antennae long, 4-segmented, ocelli absent. The forelegs are relatively short and raptorial, widely separated from the closely spaced and middle and hind legs. The middle legs longer than the others. Both winged and non-winged forms occur, but the latter are more common.

These insects are found skating or leaping about on the surface film of wetlands. When disturbed, they scatter wildly in all directions. They feed upon a number of microcrustaceans and insects that are caught just below the water surface. They were not seen flying.

The family is represented by about 450 species in the world. From West Bengal 18 species have been listed. Six species have been found to occur in the wetlands studied.

Key to the subfamilies of family GERRIDAE

1. Metacetabular suture dorsally continues to the posterior margin of mesonotum; primary intersegmental suture not produced anteriorly but laterally in front of metathoracic spiracle. 2

– Metacetabular suture dorsally not continuous to the posterior margin of mesonotum; primary intersegmental suture anteriorly produced laterally in front of metathoracic spiracle; metasternum distinctly present ..... Gerrinae

2. First abdominal ventrite present ..... Rhagadotarsinae

– First abdominal ventrite absent ..... Trepobatinae

Subfamily GERRINAE

Genus *Limnogonus* Stal

Key to the species of the genus *Limnogonus*

Posterior tip of pronotum distinctly angular; anterior part of pronotum with a pair of

linear, small Yellowish patches; 7th abdominal segment provided with connexival spines; 4th antennal segment slightly smaller than the first segment or subequal .... *nitidus*

– Posterior tip of pronotum rather convex; anterior part of pronotum with a pair of irregular yellowish patches; 7th abdominal segment remarably smaller than the 1st segment ..... fossarum

14. *Limnogonus fossorum* (Fabricius)

1775. *Cimex fossarum* Fabricius, *Systema Entomologiae* : 727.

1968. *Limnogonus fossarum* : Stal, *K. Sevenska Vet.-Akad. Handl.*, 7 : 133.

1994. *Limnogonus fossorum* : Bal and Basu, In : *State Fauna Series 3, Fauna of West Bengal*, pt. 5, *Zoological Survey of India, Calcutta* : 525.

Diagnosis : Body elongate, 9-10 mm long; Antennae 4-jointed, 1st joint longest; 2nd, 3rd and 4th joints shortest and subequal in length; pronotum with mid-longitudinal carination conspicuous and prominently present all along the length; anterior part of pronotum with a pair of irregular patches.

Distribution : India : West Bengal (Kolkata, North 24 Parganas, South 24 Parganas, Howrah, Darjeeling), Andaman & Nicobar Is., Andhra Pradesh, Assam, Bihar, Delhi, Goa, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Pondicherry, Rajasthan, Tamil Nadu.Elsewhere: Australia; Burma; China; Formosa; Java; Malacca; Philippines; Sumatra.

Remarks : This is comparatively smaller-sized gerrid and was noticed in small numbers in Wetland type V and VI and in moderate numbers in Wetland type-I.

15. *Limnogonus nitidus* (Mayr)

1865. *Hydrometra nitida* Mayr, *Verh. Zool. Bot. Ges. Wien*, 15 : 443.

1910. *Gerris nitida* : Distant, *Fauna Brit. India, Rhynchota*, 5 : 142.

1934. *Limnogonus nitidus* : Lundblad, *Arch.Hydrobiol. Suppl.*, 12 : 387.

1994. *Limnogonus nitidus* : Bal and Basu, In : *State Fauna Series 3, Fauna of West Bengal*, pt. 5 *Zoological Survey of India, Calcutta* : 525.

Diagnosis : Body of moderate size (6-8 mm in length); antennae 4-jointed, 2nd and 3rd joints shortest and nearly subequal in length; 4th antennae joint slightly smaller than the 1st joint or subequal; pronotum with the mid-longitudianal carination moderately prominent, posterior tip of pronotum remarkably angular; 7th abdominal segment with connexival spines.

Distribution : India : West Bengal (Kolkata, North 24-Parganas, South 24-Parganas, Hooghly, Bankura, Birbhum, Purulia), Andaman Is., Andhra Pradesh, Assam, Bihar, Delhi, Karnataka, Kerala, Orissa, Rajasthan, Uttar Pradesh; Tamil Nadu; Tripura. Elsewhere : Bangladesh; Burma; Java; Malaya; Sri Lanka; Sumatra.

Remarks : The species was recorded from all wetland types except oxbow wetlands. It was abundant in Type-II natural wetland.

Genus *Neogerris* Matsumura

16. *Neogerris parvula* (Stal)

1906. *Gerris parvula Stal, K. Svenska Eng. Zool.*, 4 : 265.

1868. *Limnogonus parvulus* : Stal, *K. Svenska Vet-Akad. Handl.*, 7 : 133.

1994. *Neogerris parvula* (Stal) : Thirumalai, *Rec. zool. Surv. India, Occ. Paper* No. 165 : 34.

Diagnosis : Body elongated 6.0-6.5 mm long; posterior tip of pronotum more or less convex, anterior part of pronotum with yellow patches; 1st antennal segment, longest and as long as or a little longer than the 2n^{d} and 3rd segments together, 4th antennal segment remarkably smaller than the 1st segment; mid longitudinal carination of pronotum indistinct and present on anterior half; anterior part of pronotum with a single roundish yellow patch which separates it from all other known species.

Distribution : India : West Bengal (Kolkata, North 24-Parganas, South 24-Parganas, Darjeeling, Jalpaiguri, Murshidabad, Purulia), Andhra Pradesh, Assam, Bihar, Kerala, Orissa, Pondichery, Uttar Pradesh; Tamil Nadu. Elsewhere : Bangladesh; Burma; China; Iran; Japan; Java; Malay Peninsula; Myanmar; New Guinea; Oman; Philippines; Pakistan; Singapore; Sri Lanka; Solomon Is.; Taiwan; Thailand; Vietnam. This gerrid, thus widely distributed in Indo Australian region, enjoys a distribution from the eastern part of the Arabian Peninsula to Solomon Is. and from Ryuku Is. to Java.

Remarks : Although this species is reported to be very common in slow running streams, reservoirs, ponds and rain-fed pools, it was recorded form ox-bow lake and natural wetlands in small numbers.

17. *Gerris spinolae* Lethierry and Severin
(Fig. 18)

1896. *Gerris spinolae* Lethierry and Severin, *Cat. Gen. Hem.*, 3 : 63.

1902. *Gerris spinolae* : Distant, *Fauna Brit. India, Rhynchota*, 2 : 180.

1994. *Gerris spinolae* : Bal and Basu, In : *State Fauna Series 3 : Fauna of West Bengal*, pt. 5, *Zoological Survey of India, Calcutta* : 527.

Diagnosis : Body 11.0 mm–12 mm long. Anterior lobe of pronotum distinct; anterior of pronotum with a pair of protuberances; a black distinct carina on the posterior lobe of pronotum; posterior femora distinctly longer than the body; antennal 3rd segment much shorter than the 2nd antennal segment and a little shorter than the 4th.

Distribution : India : West Bengal (Kolkata, North 24-Parganas, South 24-Parganas, Darjeeling, Murshidabad), Uttar Pradesh; Elsewhere : Burma.

Remarks : It was also recorded in small numbers from wetland types I and II.

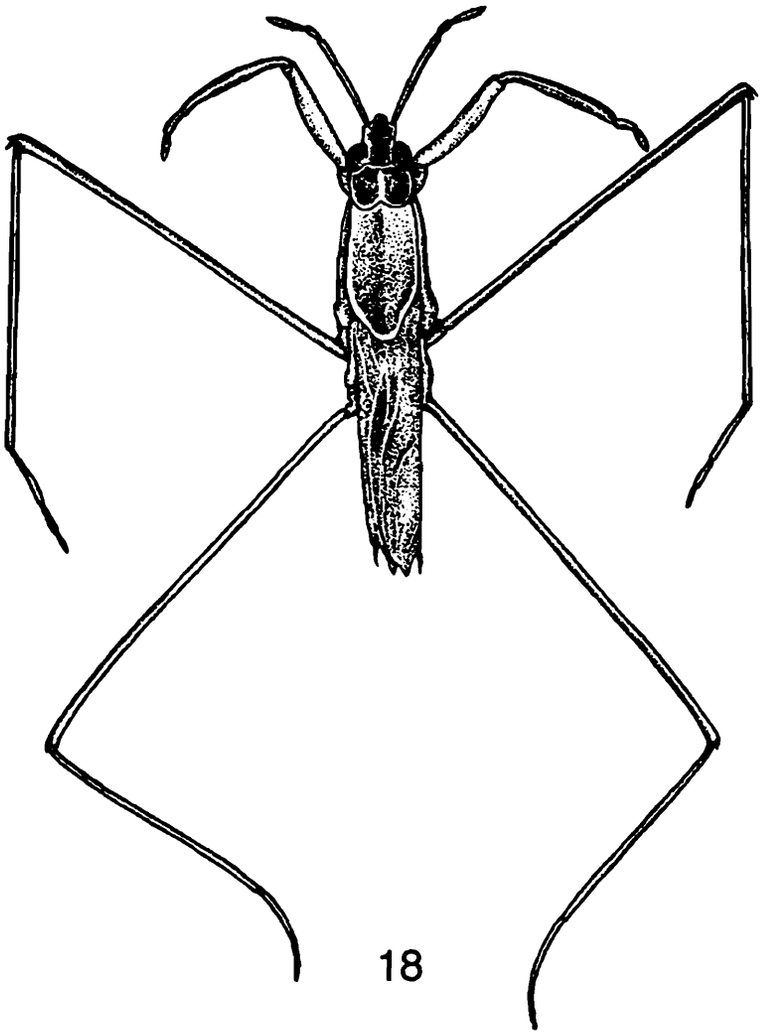


Fig 18 : *Gerris spinolae* Leth. & Serv.

Subfamily RHAGADOTARSINAE

Genus *Rhagadotarsus* Breddin

18. *Rhogadotarsus kraepelini* Breddin

1904. *Rhagadotarsus kraepelini* Breddin, *Mt. Mus.* Hamburg, 22 : 137.

1994. *Rhagadotarsus kraepelini* : Bal and Basu, In : *State Fauna Series 3* : *Fauna of West Bengal*, pt. 5, *Zoological Survey of India, Calcutta* : 518.

Diagnosis : Body sub-elongate with a long, slender abdominal anal appendage; antennae 4-jointed; with basal two joints shorter than the rest, 2nd joint shortest, while 3rd and 4th joints subequal in length; eyes inwardly somewhat roundly truncated; pronotum very short, appearing only as a broad collar; middle legs much longer than the hind legs.

Distribution : India : West Bengal (Kolkata, North -24 Parganas); Andhra Pradesh, Arunachal Pradesh, Karnataka, Kerala, Pondichery, Tamil Nadu; Elsewhere : Burma; China; Formosa; Java; Malay; Philippines; Singapore; Sri Lanka.

Remarks : A species of rare occurrence in the wetlands studied. It was recorded only once from ox-bow lakes.

Genus *Naboandelus* Distant

19. *Naboandelus signatus* Distant

1905. *Naboandelus signatus* Distant, *Ann. Mag. Nat. Hist.*, 5 : 152.

1918. *Naboandelus signatus* : Paiva, *Rec. Indian Mus.*, 14 : 26.

1994. *Naboandelus signatus* : Bal and Basu, In : *State Fauna Series 3* : *Fauna of West Bengal*, pt. 5, *Zoological Survey of India, Calcutta* : 519.

Diagnosis : Body short (about 2 mm) and broad; head with rounded eyes hardly projecting over the anterior angles of pronotum; antennal segment I longest and longer than head, segments II, III and IV segments subequal in length; pronotum transverse with a large central yellow spot; anterior margin of pronotum truncate, posterior margin rather moderately convex; in female, abdomen about as long as pronotum and mesonotum together while in male, a little longer; mid legs much longer than hind ones.

Distribution : India : West Bengal (Kolkata, North 24 Parganas); Elsewhere : Burma.

Remarks : It was also of rare occurrence in the region.

COLEOPTERA

Coleoptera comprises the largest order of Insecta which are chiefly terrestrial but a few families have adapted well to aquatic or semi-aquatic mode of life either in their larval stages or as adults. Although aquatic coleopterans, commonly known as water beetles, are highly diverse and distributed to nearly 14 families (Pennak, 1978), only a few namely, Haliplidae, Dystiscidae, Gyrinidae and Hydrophilidae are chiefly represented in the wetlands of this region.

They are minute to large (0.6 to 15 cm) in size and usually sclerotised insects. The front wings are much thickened, veinless and meeting in mid dorsal straight line, the hindwings are membranous, with a few veins and the apex folded beneath when at rest, sometimes absent. Mouth parts are typical biting or chewing type in usual case. Antennae 9-11 segmented, larvae worm-like, usually with 3 pairs of thoracic legs, which are 5 or 6, with 10 segments and sometimes with prominent circi. The pupae are with appendages and do not form a puparium. The water beetles show wide diversity of colour, form and life pattern.

The water beetles are also very diverse in their mode of life and behaviour. Some are very good swimmer and efficient diver (Family Dytiscidae), some are water surface crawler, and with slow movement (Family Haliplidae) and some others are whirling (Family Gyrinidae). The feeding habits vary from highly predaceous (Family Dystiscidae) to Scavenger (Hydrophilidae). Almost all the species of this region belonging to families Haliplidae, Dytsicidae and Gyrinidae and majority of the species of the family Hydrophilidae are truly aquatic, passing their entire life in water. Adult water beetles are found everywhere in the region, not only in lentic waterbodies like ponds, pools, oxbow lakes, natural wetlands, fish culture farms and highly specialized sewage-fed fish culture ponds but also in running waters of the rivers.

SYSTEMATIC LIST OF TAXA

Family DYSTISCIDAE

Subfamily Noterinae

1. *Hydrocoptus subvittulus* Motschulsky
2. *Canthydrus laetabilis* (Walker)
3. *Canthydrus luctuosus* (Aube)

Subfamily Laccophilinae

4. *Laccophilus anticatus* Sharp

5. *Laccophilus parvulus* Aube

Subfamily Hydroporinae

6. *Hyphydrus renardi* Severin
7. *Hydrovatus bonvouloiri* Sharp
8. *Hydrovatus confertus* Sharp
9. *Guignotus flammulatus* (Sharp)
10. *Guignotus pendjabensis* Guignot
11. *Uvarus quadrilineatus* (Zimmermann)

Subfamily Dytiscinae

12. *Cybister tripunctatus* Sharp

Family GYRINIDAE

Subfamily Enhydrinae

13. *Dineutus unidentatus* (Aube)

Subfamily Orectochilinae

14. *Orectochilus productus* Regimbart

Family HALIPLIDAE

15. *Haliplus angustifrons* Regimbart

Family SPERCHEIDAE

Subfamily Spercheininae

16. *Spercheus gibbus* Champion

Family HYDROPHILIDAE

Subfamily Hydrophilinae

17. *Helochares anchoralis* Sharp

18. ***Enochrus escuriens*** Walker
19. ***Sternolophus rufipes*** Fabricius
20. ***Hydrophilus rufocinctus*** (Bedel)
21. ***Amphiops pedestris*** Sharp
22. ***Berosus indicus*** Motschulsky
23. ***Regimbartia attenuata*** (Fabricius)

SYSTEMATIC ACCOUNT

Key to the aquatic families

ADULTS

1. Eyes completely divided by the lateral margins of the head ..... Gyrinidae
– Eyes not divided 2
2. Hind coxa in the form of a large plate ..... Haliplidae
– Hind coxa normal, hind tarsi 5-segmented 3
3. Antennae clubbed ..... Hydrophilidae
– Antennae not clubbed ..... Dytiscidae

LARVAE

1. Legs six-segmented with distinct tarsus and with one or two claws 2
– Leg 5-segamented with tarsus and claw fused together into a single segment, ... 4
2. 10th abdominal segment with four apical hooks ..... Gyrinidae
– No apical hooks, ... 3
3. Ninth abdominal segment present ..... Haliplidae
– Ninth abdominal segment rudimentary, apparently absent ..... Dystiscidae
4. Eight complete abdominal segment, ninth and 10th reduced ..... Hydrophilidae
– Nine complete abdominal segament; tenth reduced but distinct..... Limebiidae*

*not represented in the present collections.

Family DYTISCIDAE

The members of this family of Coleoptera are amongst the few aquatic insect groups, which have adapted perfectly well to aquatic life. All adults and larvae are aquatic. Mostly inhabitants of lentic freshwater wetlands, they also occur in running as well as brackish waters. These beetles generally occupy clean and fresh macrophytic leaves near the bottom along littoral zone. Some species are known to leave water and fly from one wetland to other. They are active swimmers and swift divers.

Adult Dystiscidae range from 1.4 to 3.8 mm in length The body is covered with an adherent layer of grease, which holds dust particles or detritus. They are usually black or brownish black in color, sometimes marked with dull yellow, orange or bronze shades. The hind coxa is very large and 2nd and third legs are widely separated. Hind legs of the dystiscid beetles are very important and contribute mainly to swimming movements. These are more or less flattened, elongated and hairy. Antennae very long, threadlike with 11 segments. Ten pairs of spiracles are present, the first two on the thorax, three to nine on the abdominal segments and 10th on the tip of abdomen. The spiracles open in subelytral chambers and help in oxygen supply. During submergence, these beetles utilize the oxygen of the tracheae and subelytral chambers. The beetles can remain in submerged condition only for a very short duration and come to surface for oxygen replacement at the interval of every few minutes. The posture of the adult beetles in water is at an oblique angle with head downwards and the tip of the abdomen including 10th spiracle penetrating the surface film. The contact of the terminal spiracles with atmosphere maintains the oxygen supply in elytra. In males of some genera the first three segments of anterior tarsi are greatly swollen to form an acetabulum, which helps in holding two individuals during copulation. The females generally deposit the eggs on floating macrophyte leaves near the shore.

These beetles are highly predaceous and feed vigorously upon almost all invertebrates and fish eggs and fry. Because of their highly predatory nature, these are commonly known as 'predaceous diving beetles.

Only 12 commonly occurring species under 8 genera have been recorded during the present investigations from the selected wetlands of five southeastern districts of the state. De and Sengupta (1993) have recorded 16 species from a few wetlands of Calcutta and sorrounding districts. Although 69 species have been included in the list of West Bengal Fauna by Biswas *et al.* (1995a), many species in the list have not been recorded for over 50 years and even some are included on the basis of literature review.

Key to the subfamilies of DYTISCIDAE

1. Scutellum not visible; three basal segments of the protarsi enlarged into rounded oval or subtriangular pallet ..... *Dytiscinae*

– Scutellum visible 2

2. 4th segment of pro and mesotarsi much reduced, prosternal process arched and oblique ..... *Hydroporinae*

– 4th segment of pro and mesotarsi not reduced and subequal to 3rd segment; prosternal process usually straight 3

3. Posterior legs with a single tarsal claw ..... *Laccophilinae*

– Posterior legs with two tarsal claws of equal length ..... *Noterinae*

Key to the genera of subfamily Noterinae

– Curved spurs present on the apex of fore tibiae ..... *Canthydrus*

– Curved spurs absent on the apex of fore tibiae ..... *Hydrocoptus*

Genus *Hydrocoptus* Motschulsky

1. *Hydrocoptus subvittulus* Motschulsky
(Fig. 19)

1858. *Hydrocoptus subvittulus*_Motshulsky, *Etud. Ent.*, 8 : 53 (1859)

1995a *Hydrocoptus subvittulus* : De and Sen Gupta, *Rec. zool. Surv. India*, 93 : 126.

Diagnostic cheracters : Body oblong oval, 1.8-2.1 mm long, head rusty-red; puncturation obsolete, eyes large with fine rows of punctures; antennae pale-yellow; prothorax with puncturation obsolete on disc; elytra brown with reddish brown border of lateral margin, puncturation small and arranged in distinct rows; legs long, slender, concolourous with head and armed with spines.

Distribution : India: West Bengal (Kolkata, North and South 24-Parganas), Assam, Bihar, Gujarat, Orissa, Tamil Nadu, Maharashtra, Elsewhere : Burma, China, Indonesia, Sri Lanka.

Remarks : The species was recorded during post monsoon and early premonsoon months (November-March) from all wetlands.

Genus *Canthydrus* Sharp

Key to the species of *Canthydrus*

– Elytra brownish black, with testaceous yellow spots; pronotum testaceous; smaller in size (2.25-2.7 mm) ..... *laetabilis*

– Elytra black, with three orange spots; larger in size (3.0-3.25 mm) ..... *luctuosus*

2. *Canthydrus laetabilis* (Walker)
(Fig. 20)

1859. *Hydroporus laetabilis* Walker, *Ann. Mag. Nat. Hist.* 3(2) : 205.

1995b. *Canthydrus laetabilis*: Biswas *et al.*, Insecta:Coleoptera:Adephaga. In : *State Fauna Series 3* : *Fauna of West Bengal*, pt. 6(A), *Zoological Survey of India, Calcutta* : 85.

Diagnostic characters : Body oblong-oval; head brownish yellow; eyes large; antennae brrownish yellow, short and slender; prothorax with its front margin darker and with dark punctures; elytra streamlined, brownish black with two basal orange yellow spots and one transverse irregular spot situated post medially; legs with front tibiae short and its apical spur curved, hind tarsi with swimming hairs, claws simple.

Distribution : India: West Bengal (Kolkata, North and South 24 Parganas), AndhraPradesh, Assam, Bihar, Kerala, Orissa, Punjab, Rajasthan, Uttar Pradesh and West Bengal.

Remarks : The species occurs in all types of wetlands except sewage-fed fish culture pond. They are found in abundance in wetlands with macrophytes. It has been reported to predate heavily on fish spawn. (Jhingran 1985).

3. *Canthydrus luctuosus* (Aube)
(Fig. 21)

1838. *Hydrocanthus luctuosus* Aube, in *Dejean's species coleopteres*, Paris, 6 : 408.

1995. *Canthydrus luctuosus* : Biswas *et al.*, Insecta : Coleoptera : Adephaga, In : *State Fauna Series 3* : *Fauna of West Bengal*, Pt 6a, *Zoological Survey of India, Calcutta* : 85.

Diagnostic characters : Body 3.0-3.25 mm long; head brownish black with anterior portion yellowish, prothorax black merging into orange-yellow on sides, elytra black with orange-yellow markings and ventral surface deep brown.

Distribution : India: West Bengal (Kolkata, North 24-Parganas and South 24-Parganas), Andhra Pradesh, Bihar, Karnataka, Kerala, Maharashtra, Orissa. Tamil Nadu.

Remarks : One of the commonest species of beetles in sewage fed fish culture ponds. Probably the species prefers the wetland with high load of organic enrichment.

Subfamily LACCOPHILINAE

Genus *Laccophilus* Leach

Key to the species of *Laccophilus*

– Elytra brownish yellow to reddish brown with zigzag double markings, generally thick and coalescent, ventral surface with metacoxal plate reddish brown to black, other parts paler. ..... ***parvulus***

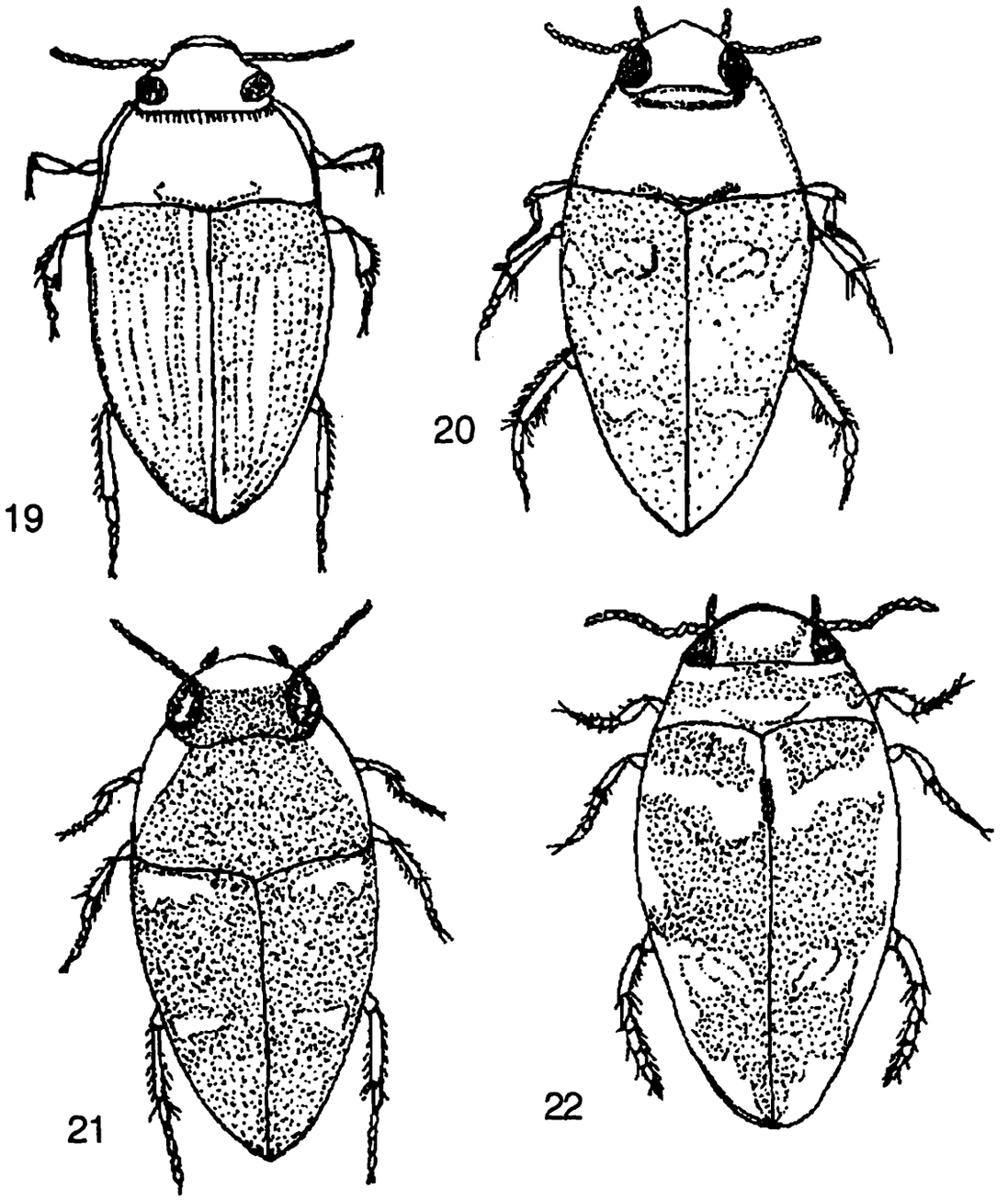


Fig. 19 : *Hydrocoptus subvittulus* Motsch.

Fig. 20 : *Canthydrus laetabilis* (Walker)

Fig. 21 : *Canthydrus luctuosus* (Aübe)

Fig. 22 : *Laccophilus anticatus* Sharp

– Elytra without such zig zag markings; ventral surface brownish yellow and abdominal sternites slightly darker ..... *anticatus*

4. *Laccophilus anticatus* Sharp
(Fig. 22)

1890. *Laccophilus anticatus* Sharp, *Trans. Ent. Soc. London* : 341

1993. *Laccophilus anticatus* : De and Sengupta, *Rec. zool. Surv. India*, 93 : 125.

Diagnostic characters : Body oval, 3.0-3.2 mm. long; head brownish yellow, and often with faint brownish markings, eyes large; antennae brownish-yellow, long and narrow; prothorax transverse, prebasal portion with transverse dark streak; elytra blackish; with yellow patches on anterior half and a pair of small patches on posterior half, punctures present; legs in male with basal three joints of front and middle tarsi a little dilated and armed with "sucker pallettes" underneath, hind tarsi with swimming hairs and with a single straight claw.

Distribution : India : West Bengal (Kolkata, Hooghly, Murshidabad, North 24-Parganas), Assam, Bihar, Orissa and Manipur.

Remarks : The species is of common occurrence in macrophyte-infested floodplain wetland (Type-I). They prefer to inhabit macrophyte strands. The adults are good swimmer, diver, climber and jumper.

5. *Laccophilus parvulus* (Aube)
(Fig. 23)

1838. *Laccophilus parvulus* Aube, in *Dejean's Species Coleopteres, Paris*, 6 : 429

1968. *Laccophilus parvulus* (Aube) : Vazirani, *Oriental. Ins.* 2 : 247-249.

1995. *Laccophilus parulus* (Aube) : Biswas *et al.*, In : *State Fauna Series. 3* : *Fauna of West Bengal,* pt. 6a, *Zoological Survey of India, Calcutta* : 89.

Diagnostic characters : Body elongate, about 3.5-3.7 mm long, rather subdepressed. Head brownish yellow, punctured, eyes large. Antennae concolourous with head, long and narrow. Prothorax transverse, also brownish yellow and with a narrow streak of black towards the middle of anterior and posterior margins. Elytra testaceous-reddish with zigzag double markings, generally thick and coalescent, posterior lateral margin with a few hairs. Legs in male with basal 3 joints of front and middle tarsi a little dilated, hind tarsi with swimming hairs and having straight single claw. Ventral surface with metacoxal plate reddish brown to blackish, rest pale.

Distribution : India : Andhra Pradesh, Assam, Bihar, Goa, Gujarat, Madhya Pradesh, Maharashtra, Manipur, Orissa, Rajasthan, Tamil Nadu and West Bengal (Medinipur, North

24-Parganas). Elsewhere : West Pakistan, Indochina (Saigon), Thailand, Indonesia, Ceylon.

Remarks : The species occurred in small nunbers in Wetland types II and VI.

Subfamily HYDROPORINAE

Genus *Hyphydrus* Illiger

Key to the genera of *Hydroporinae*

1. Claws of hind tarsi mostly unequal, the external claw nearly invisible, prosternal process oblong ..... *Hyphydrus*
– claws of hind tarsi equal 2
2. Prosternal process broadened at apex, sutural angles of the elytra acuminate. ..... *Hydrovatus*
– Prosternal process not broadened at apex 3
3. Elytra with a sutural striae ..... *Guignotus*
– Elytra without a sutural striae if present, only near apex; pronotal striae continued on the elytra ..... *Uvarus*

Genus *Hyphydrus* Illiger

6. *Hyphydrus renardi* Severin
(Fig. 24)

1890. *Hyphydrus renardi* Severin, *Ann. Soc. Ent. Belg.*, 34 : 191.

1993. *Hyphydrus renardi* : De and Sengupta, *Rec. zool. Surv. India*, 93 : 117.

Diagnostic characters : Body broad, oval, 3.2-3.8 mm long; head brown-yellow, puncturation rather large; antennae short, 4th segment distinctly short; prothorax concolourous with head, with posterior part black; elytra brown with black markings, puncturation mixed with small and large; legs with spines and hairs, front and middle tarsi smaller than the hind tarsi with spines; ventral surface reddish-brown.

Distribution : India : West Bengal (Medinipur), Bihar, Orissa, Uttar Pradesh, Madhya Pradesh, Tamil Nadu and Rajasthan. Elsewhere : Burma.

Remarks : A rare species, recorded from oxbow lakes only.

Genus *Hydrovatus* Motschulsky

Key to the species of *Hydrovatus*

– Body length 3 mm or more; punctation on pronotum and elytra more impressed ..... *bonvouloiri*

– Body length usually less than 3 mm; punctation on pronotum and elytra less impressed ..... *confertus*

7. *Hydrovatus bonvouloiri* Sharp
(Fig. 25)

1882. *Hydrovatus bonvouloiri* Sharp, *Sci. Trans. R. Dublin Soc.*, 2 : 335.

1993. *Hydrovatus bonvouloiri* : De and Sengupta, *Rec. zool. Surv. India*, 93 : 119.

Diagnostic characters : Body oval, shinning, about 3.5 mm. long; head reddish brown, glabrous; antennae long and slender; prothorax concolourous with head; elytra also reddish brown, punctate usually with four rows of setiferous punctures; legs with front and middle tarsi broader and armed with spines and hairs, first 3 segments a little dilated, 4th segment minute, hind tarsi elongate with swimming hairs.

Distribution : India: West Bengal (Kolkata, North 24-Parganas), Bihar, Karnataka; Elsewhere: Burma, China, Formosa, Indonesia, Malayasia, Philippines and Sri Lanka.

Remarks : The species is not of common occurrence in wetlands studied and observed in small numbers from wetland type I and III.

8. *Hydrovatus confertus* Sharp
(Fig. 26)

1882. *Hydrovatus confertus* Sharp, *Sci. Trans. R. Dublin Soc.*, 2 : 329.

1995a. *Hydrovatus confertus*: Biswas *et al.*, Insecta : Coleoptera : Adephaga, In : *State Fauna Series. 3* : *Fauna of West Bengal,* pt. 6a, *Zoological Survey of India, Calcutta* : 94.

Diagnostic characters : Body broadly oval, about 2.2-2.5 mm long; head reddish-brown; antennae concolourous with head, elongate; prothorax reddish-brown, punctures irregular; elytra also reddish-brown, puncturation somewhat regular, moderate and rather denser than on pronotum. Other characters as in *bonvouloiri.*

Distribution : India : West Bengal (Kolkata, Howrah, Medinipur) Bihar, Kerala, Punjab, Uttar Pradesh, Rajasthan and Tamil Nadu. Elsewhere: Burma, China, Indonesia, Sri Lanka, Thailand and Vietnam.

Remarks : The species inhabits shallow water with aquatic vegetation.

Genus *Guignotus* Houlbert

Key to the species of *Guignotus*

– Latero basal plica on pronotum not or hardly continued on elytra; body 2.3-2.5 mm long..... *flammulatus*

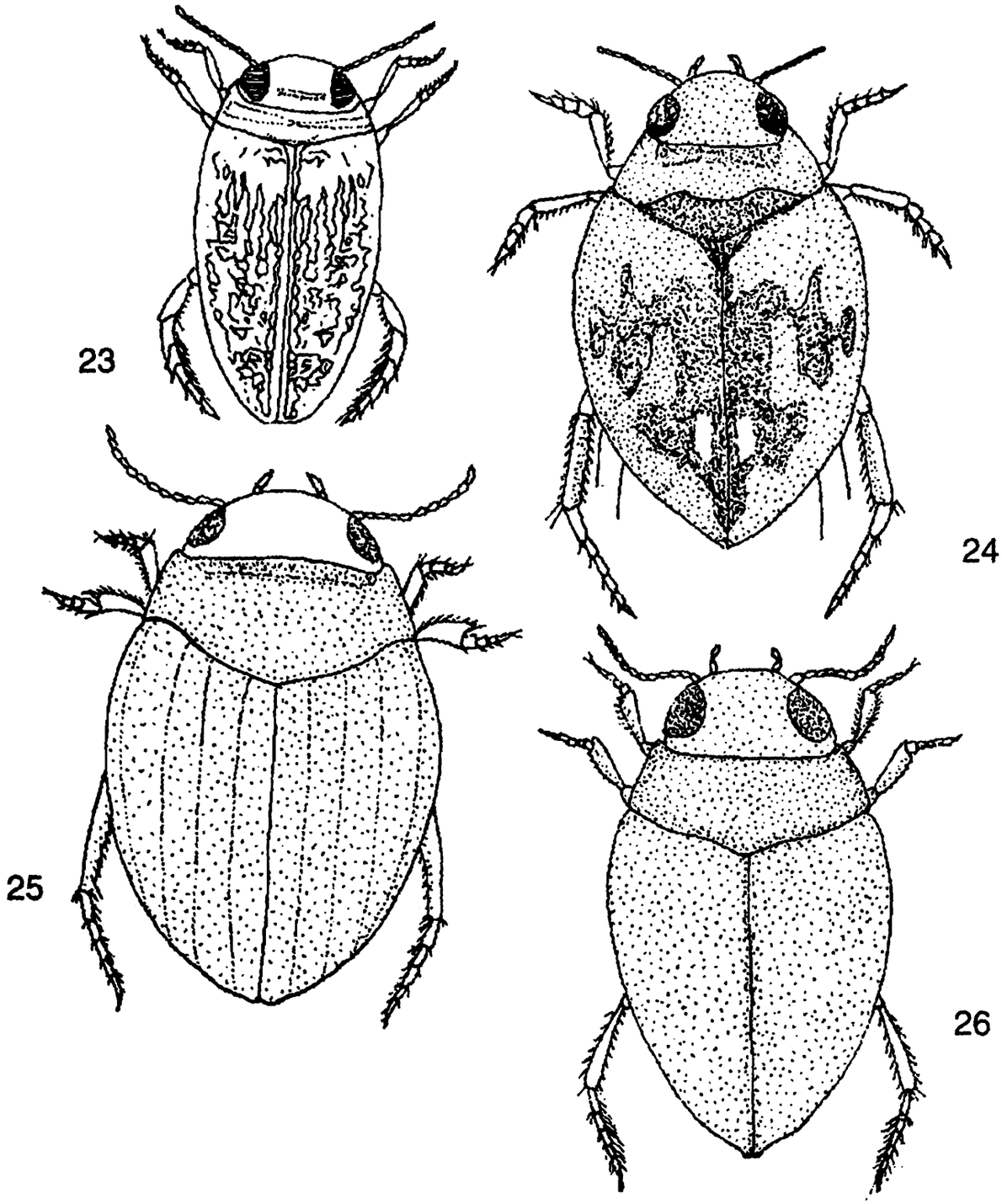


Fig. 23 : *Laccophilus parvulus* (Aube)

Fig. 24 : *Hyphydrus renadri* Severin

Fig. 25 : *Hydrovatus bonvouloiri* Sharp

Fig. 26 : *Hydrovatus confertus* Sharp

– Latero basal plica on pronotum distinctly continued on elytra, body always less than 2 mm long. ..... *pendjabensis*

9. *Guignotus flammulatus* (Sharp)
(Fig. 27)

1882. *Bidessus flammulatus* Sharp, *Sci. Trans. R. Dublin Soc.*, 2 : 359.

1977. *Guignotus flammulatus*: Vazirani, *Proc. zool. Soc. Calcutta*, 25 : 121.

1993. *Guignotus flammulatus*: De and Sengupta, *Rec. zool. Surv. India*, 93 : 122.

Diagnostic characters : Body rather oblong, about 2.4 mm long; head with a basal transverse blackish marking, vertex punctate; antennae long and slender; prothorax brownish-yellow as in head with black streak on anterior and posterior border; elytra with black markings and with minute setiferous, somewhat dense puncturation; legs with front and middle tarsi armed with spines and hairs, hind tarsi. elongate and with swimming hairs.

Distribution : India : West Bengal (Kolkata, Hooghly, Bardhaman), Bihar, Gujarat, Maharashtra, Madhya Pradesh, Orissa, Rajasthan, Tamil Nadu and Uttar Pradesh. Elsewhere : Bangladesh, China, Indonesia, Japan, Thailand and Vietnam.

Remarks : Fairly large-sized beetles occurring in all types of wetlands.

10. *Guignotus pendjabensis* Guignot
(Fig. 28)

1854. *Guignotus pendjabensis* Guignot, *opusc. Ent. Lund*, 19 : 221.

1995a. *Gunignotus pendjabensis*: Biswas *et al.*, Insecta : Coleoptera : Adephaga, In : *State Fauna Series 3 : Fauna of West Bengal*, Part 6a, *Zoological Survey of India, Calcutta* : 97.

Diagnostic characters : Body rather elongate-oval, about 1.8 mm long, head brownish yellow, with fine puncturation; antennae elongate and slender; prothorax concolourous with head, puncturation moderate, latero-basal plica distinct; elytra also brownish yellow, punctate with two longitudinal dark markings on each elytron; legs with first three segments of front and middle tarsi dilated and 4th segment minute or obsolete, hind tarsi with swimming hairs; ventral surface dark, punctate.

Distribution : India : West Bengal (Kolkata), Goa, Gujarat, Maharashtra, Madhya Pradesh, Orissa and Rajasthan; Elsewhere:Bangladesh and Pakistan.

Remarks : The species generally inhabits secluded places in flood plain and natural wetlands (jheels/beels and bours) in small numbers.

Genus *Uvarus* Guignot

11. *Uvarus quadrilineatus* (Zimmermann)

1923. *Bidessus quadrilineatus* Zimmermann, *Ent. Blatter*, 19 : 34.

1993. *Uvarus quadrilineatus*: De and Sengupta, *Rec. zool. Surv. India*, 93 : 120.

Diagnostic characters : Body oblong, about 1.5 mm long, finely pubescent; head brownish-yellow, finely punctured and with dark spots; antennae brownish-yellow, slender; prothorax with anterior margin brown and darker in the middle, finely punctured, elytra concolourous with head, with bands, puncturation fine and dense, pubescence short and fine, discal plica subequal to pronotal plica; legs with spines and hairs, hind tarsi elongate and with swimming hairs.

Distribution : India : West Bengal (Kolkata), Bihar.

Remarks : This is the smallest species of Dytiscidae, available in different types of wetlands. It generally inhabits the lower vascular portion of the macrophytes, particularly roots and bulbs of *Eichhornea* Sp. It is an active predator, recorded almost throughout the year.

Genus *Cybister* Curtis

12. *Cybister tripunctatus asiaticus* Sharp
(Fig. 29)

1882. *Cybister asiaticus* Sharp, *Sci. Trans. R. Dublin Soc.*, 2 : 731.

1899. *Cybister tripunctatus* var. *Asiaticus* Regimbart, *Ann. Soc. Ent. France*, 68 : 351-352.

1995. *Cyleister tripunctatus asiaticus* : Biswas *et al.*, In : *State Fauna Series 3* : *Fauna of West Bengal.* pt. 6a, *Zoological Survey of India, Calcutta* : 111.

Diagnostic characters : Body elongate-oval, about 28 mm long; head blackish; antennae long, narrow yellowish red; prothorax concolourous with head, with reddish yellow lateral stripe; scutellum triangular and black; elytra also black with green metallic iridescence with reddish yellow, lateral border punctured; legs with spines and swimming hairs; ventral surface reddish-brown to black.

Distribution : India : West Bengal (Kolkata), widely distributed; elsewhere: Afganistan, Bangladesh, Nepal, Pakistan and Sri Lanka.

Remarks : This is the largest species of Dytiscidae, prefers mainly to the less flowing waters of ponds and urban lakes with sparse vegetation, recorded from all wetland types.

Family GYRINIDAE

The gyrinids or whirling beetles occur in the groups of a few to thousands on the surface of wetlands. They are generally found in almost all types of ponds, lakes, floodplain and natural wetlands, river pools etc. in the margin areas. Their movement is highly peculiar. They glide about each other in rapid irregular curves near the shore. When undisturbed for

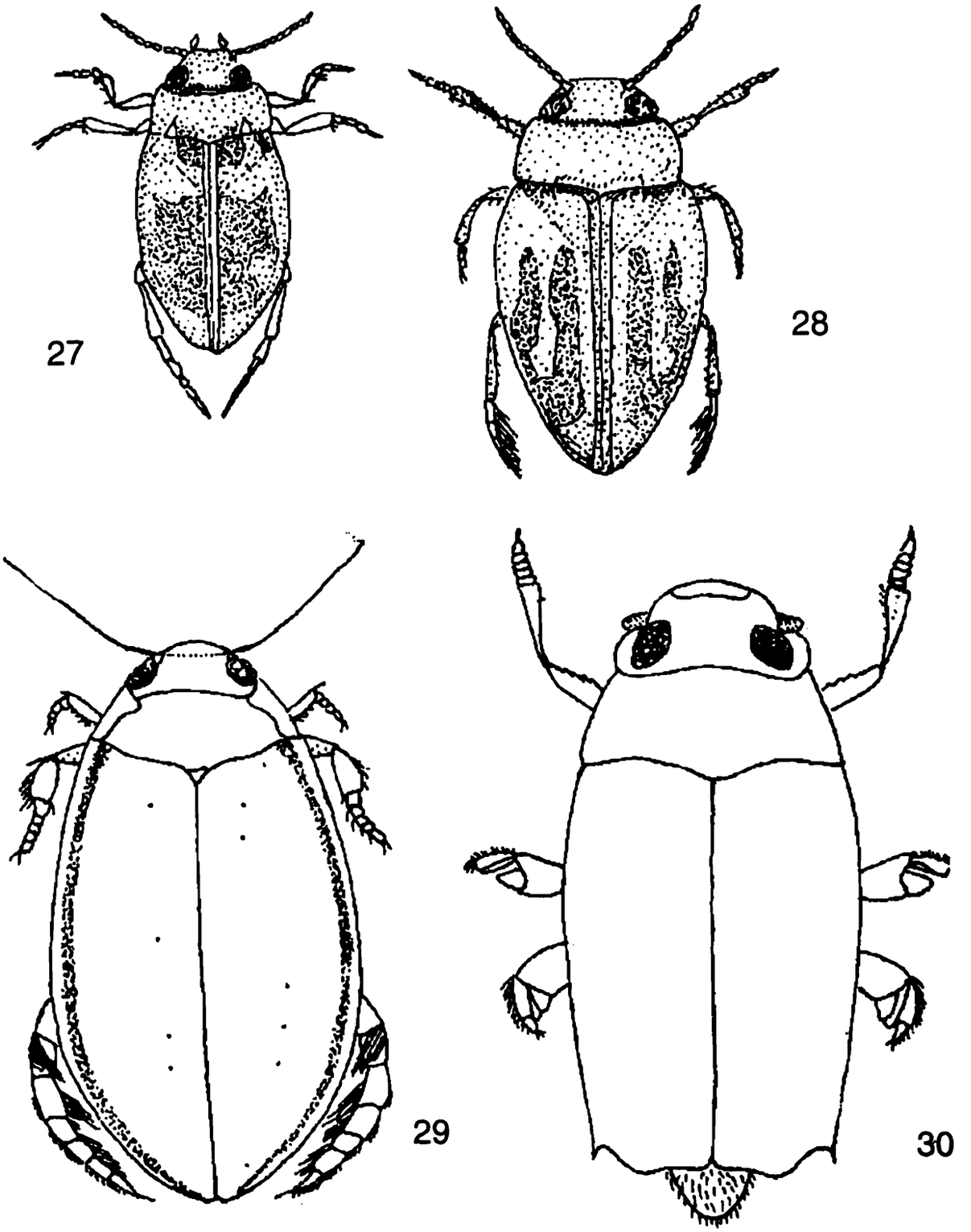


Fig. 27 : *Guignotus flammulatus* (Sharp)

Fig. 28 : *Guignotus pendjabensis* Guignot

Fig. 29 : *Cybister tripunctatus asiatics* Sharp

Fig. 30 : *Dineutus (spinosodineutus) unidentatus* (Aube)

longer duration, they float quietly on water surface. When disturbed they fly quickly in all directions. These are generally found on the water surface but are also efficient divers. Inspite of their good flying power, these are unable to take off directly from the water surface and need some emergent macrophyte to climb and then fly.

These beetles are shiny blacks in colour; oval in shape with somewhat depressed body, abdomen extending beyond elytra. The most distinctive features are compound eyes, which are divided at the edge of the head by the insertion of the antennae, half for arial vision and other half for vision inside water. The middle and hind legs are greatly flattened paddle-like and fringed, which help in rapid locomotion. The antennae are very peculiar, the third segment in very much enlarged and following segments look-like a short spindle-like mass.

The air supply is being carried under the elytra when submerged. They are reported to be scavengers, feeding upon dead animal matter and vegetation, besides the insects falling upon water surface. Gyrinids are found to breed throughout the year in the wetlands of this region. Eggs are laid on submerged macrophyte.

The family is represented by only two genera, *Dineutus* and *Orectochilus*, each with one species in the wetlands studied. De and Sengupta (1993) also recorded only these two species from a few wetlands of the region. However, a total of 21 species belonging to these two genera have been reported from the state of West Bengal (Biswas *et al.*, 1995), most of which are confined to Himalayan and sub-Himalayan region. Out of these, many species have not been recorded for last 70 years and even for some, the material was also not available to authors.

Genus *Dineutus* MacLeay

13. *Dineutus (Spinosodineutus) unidentatus* (Aube) (Fig. 30)

1838. *Dineutus unidentatus* Aube, *Species Coleopteres*, 6 : 788.

1995b. *Dineutus (Spinosodineutus) unidentatus*: Biswas *et al.*, In : *State Fauna Series 3* : *Fauna of West Bengal*. Pt. 6a, *Zoological Survey of India, Calcutta* : 125.

Diagnostic characters : Body elongate, black, 6-7 mm long; antennae very short, black with bronze colour shade; prothorax also black, lateral margin little arched, puncturation sparse; elytra concolourous with prothorax, epipleural angle extended into a strong spine and apex with fine denticles; legs with front tarsi armed with spines and spongy hairs, middle and hind legs paddle-like; ventral surface reddish brown.

Distribution : India : West Bengal (Kolkata, Darjeeling, Howrah, Murshidabad), Bihar, Kerala, Madhya Pradesh, Meghalaya, Orissa, Rajasthan and Tamil Nadu; Elsewhere : Burma, Indonesia, Malaysia, Sri Lanka and Thailand.

Remarks : Except wetland type III, these beetles were recorded from all other types of wetlands. These were observed in abundance from floodplain wetlands and natural wetlands. The adults were genearly seen swimming/gyrating on the surface near the emergent vegetation or above the submerged macrophytes.

Subfamily ORECTOCHILINAE

Genus *Orectochilus* Eschscholtz

14. *Orectochilus productus* Regimbart
(Fig. 31)

1883. *Orectochilus productus* Regimbart, *Ann. Soc. Ent. Fr.*, 6(5) : 422.

1993. *Orectochilus productus*: De and Sengupta, *Rec. zool. Surv. India*, 93 : 116.

Diagnostic characters : Body elongate, black, 4-5 mm long; head black; prothorax concolourous with head, with pubescence on lateral sides; scutellum short and transverse; elytra bronze-black, epipleural angle extended into a small spine; legs with front legs simple, middle and hind legs short, paddle-like, flattened and tarsi folded fanwise.

Distribution : India : West Bengal (Kolkata, Darjiling, Medinipur, Nadia), Assam, Bihar, Kerala, Madhya Pradesh and Tamil Nadu.

Remarks : The habit and habitat of the species is almost similer to *Dineutus unidentatus*.

Family HALIPIDAE

The crawling water beetles as the Haliplids are commonly known, are comparatively smaller-sized with oval, deeply convexed body that is widest near the anterior edge of elytra. These are usually brown or pale in colour with black markings. The elytra with small punctures arranged in longitudinal rows. The most prominent feature of the family is the presence of an enlarged plate-like coxae on hind legs covering third to fifth ventral abdominal segments. Except for the long hairs on the tarsi, the legs are not modified for swimming purpose. With the result these beetles are poor swimmers. Swimming is feeble and consists of week and alternate movements of legs. Their mode of locomotion is mainly crawling. Air supply is carried under elytra and coxal plate where it is in direct contact with thoracic and abdominal spiracles. Fresh supply of air is being taken from the water surface with the help of the tip of the abdomen. Their preferred habitat is small leaves, submerged macrophytes and masses of filamentous algae. These are reported to mainly vegetarian in feeding habits.

The family was represented by single species in the wetlands studied, although Biswas *et al.* (1995b) reported the existence of 4 species from the region. De and Sengupta (1993) also could collect only one species.

Genus *Haliplus* Latreille

15. *Haliplus angustifrons* Regimbart
(Fig. 32)

1891. *Haliplus angustifrons* Regimbart, *Ann. Soc. Ent. Belg.* 36 : 112.

1995b. *Haliplus (Liaphlus) angustifrons*: Biswas *et al.*, In : *State Fauna Series 3* : *Fauna of West Bengal*, pt. 6a, *Zoological Survey of India, Calcutta* : 134.

Diagnostic characters : Body broad, narrowed in front and sharply so towards posterior end, about 3 mm long; head brownish-yellow, vertex sparsely punctured; antennae long; prothorax brownish yellow, darker marginally, densely punctured; elytra concolourous with head, sutural puncture, marked and closely situated, intestinal punctures small and deep; legs long, slender with fringed hairs; ventral surface concolourus with head.

Distribution : India: West Bengal (Calcutta), Bihar, Himachal Pradesh, Orissa, Punjab; elsewhere : Burma.

Remarks : Except for wetland types III and IV, it was recorded from all other wetland types.

Family HYDROPHILIDAE

The hydrophilids, commonly termed as water scavenger beetles, are characterized by their short-clubbed antennae that generally remain concealed beneath the head and long maxillary palps resembling antennae. These are black or brown black in colour. Like Dytiscidae, they also make contact with the surface water film with the anterior edge of their body but unlike former, their hind legs move alternatively while swimming and are not very good swimmers. Further, ventral surface is not as strongly concave as in Dytiscidae.

They occur in shallower region of the wetland with abundant macrophytes, particularly emergent ones. Adults are good flyers and some leave the water and crawl on land. The air supply is through trachaeal system and spiracles from the subelytral chamber and from silvery film of air retained on the ventral side of the body by hydrofuge hairs. For the renewal of oxygen supply, the beetles come to the surface with the body slightly inclined to one side so as to keep the cleft between head and thorax in contact with the surface film. The surface film is broken by the antennal tip. They feed mainly on detritus, algae and decaying vegetative matter.

Biswas and Mukhopadhyay (1995) listed 40 species of Hydrophilidae from West Bengal. Only 8 species which occur commonly in the wetlands of the region were recorded from the wetland studied. De and Sengupta (1993) also reported similar number of species from a few ponds of Calcutta and surrounding districts. Similarly, Roy *et al.* (1988) also recorded only11 species from eastern Bihar.

Key to to the subfamilies of *Hydrophilidae*

– Front coxal cavities apparently closed behind, antenna with not more than 3 segment before cupula, 2nd segment and cupula pubescent, the latter appearing as part of the club ..... Spercheinae

(Spercheus gibbus)

– Front coxal cavities apparently open behind, antenna short but with 5 well developed segments before cupula , the antennal club 3-segmented and pubescent. Maxillary palpi long, exceeding the length of antennae ..... Hydrophilinae

Key to the tribes and genera of *Hydrophilinae*

1. Scutellum a long trangle, antennae at most 8-segmented 3

– Scutellum not longer than its width at base; antennae at most 9-segmented 2

2. Eyes divided by a conspicuous and cpomplete canthus reaching the vertex behind, posterior legs without swimming hairs ..... Amphiopini

Amphiop

(Amphiop pedestris)

– Eyes very convex and prominent without complete canthus; posterior legs with long swimmming hairs. ..... Berosini

a) Antennae of 7 segments (4+3); upper surface never of a uniform deep and shinning black ..... Berosus

(Berosus indicus)

b) Antennae of 8 segments (5+3); upper surface always of a uniform deep and shinning or metallic black ..... Regimbartia

(Regimbartia attenuata)

3. Meso and meta-sternal carina not reunited intimately ..... Hydrobiini

a) Curved pseudobasal segment of maxillary palpi convex poesteriorly ..... *Helochares*

(Helochares ancholaris)

b) Curved pseudobasal segment of maxllary pulpi convex anteriorly ..... *Enchrus*

(Enchrus esuriens)

– Meso and metasternal carina reunited and forming only one ridge .... Hydrophilini

a) The anterior femora only are clothed with pubisence at base, prostital carina without any anterior brush of long setae, such setae absent or very much reduced on middle and posterior femora ..... *Hydrophilus*

(Hydrophilus rufocinctus)

b) All femora clothed at base with a silky procumbant and pubescence;..... Prostital carina ridge-like with an anterior brush of long seatae .... *Sternolophus*

(Sternolophus rufipes)

Subfamily SPERCHEINAE

Genus *Spercheus* Kugel

16. *Spercheus gibbus* Champion
(Fig. 33)

1919. *Spercheus gibbus* Champion, *Ent. Mon. Mag.*, 55 : 238.

1928. *Spercheus gibbus* Champion : d'Orchymont, *Catalogue of Indian Insects, Palpicornia*, pt. 14 : 30.

1995. *Spercheus gibbus* Champion : Biswas and Mukhopadhyay, Insecta : Coleoptera : Hydrophilidae, In : *State Fauna Series 3* : *Fauna of West Bengal.* pt. 6a, *Zoological Survey of India, Calcutta* : 148.

Diagnostic Characters : Body dark brown both dorsally and ventrally, convex dorsally, broad, tuberculate and denselypunctured.Head transverse, eyes large and protuberent. Antennae 3-segmnmented, second segment and cupula pubescent, prothorax strongly transverse, its lateral morgin with prominent stiff hairs. Scutellum small, triangular and punctate. Elytra broad and abruptly narrowed posteriorly. Legs with tibiae flattened and armed with spines, tarsi fringed with hairs.

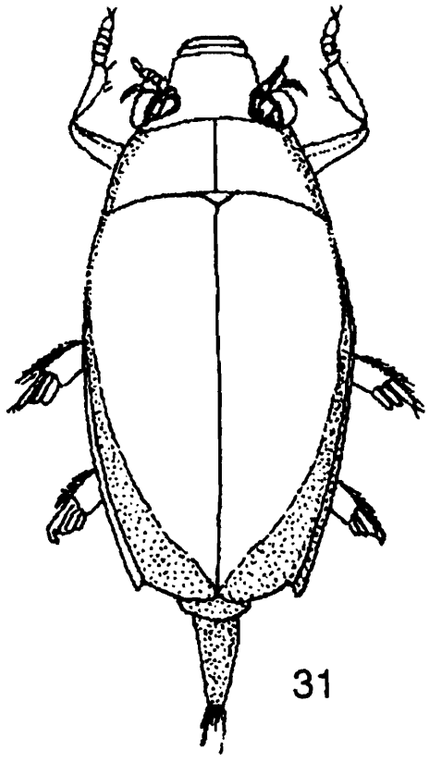
Distribution : Bihar and West Bengal (Kolkata and North 24 Parganas)

Remarks : The species was not of very common occurrence and was recorded only from ox-bow and fish culture ponds. They move almost in an inverted position on the underside of the water surface film.

Genus *Helochares* Mulsant

17. *Helochares anchoralis* Sharp
(Fig. 34)

1980. *Helochares anchoralis* Sharp, *Trans. Ent. Soc. Lond.*.: 35.



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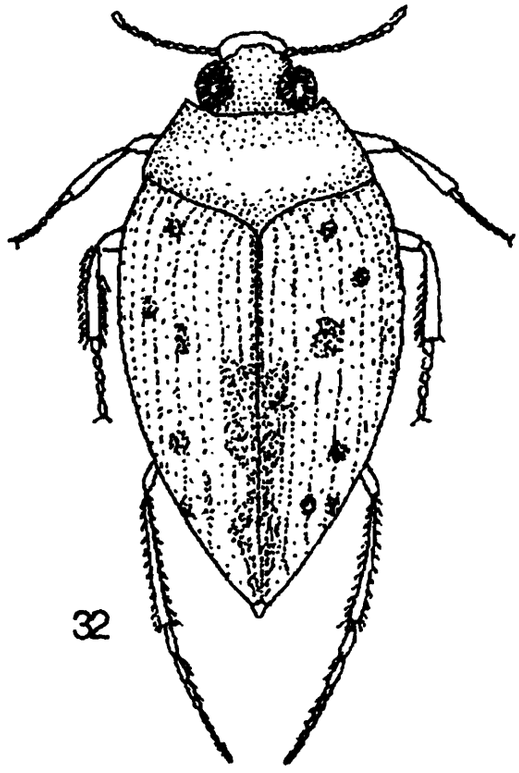

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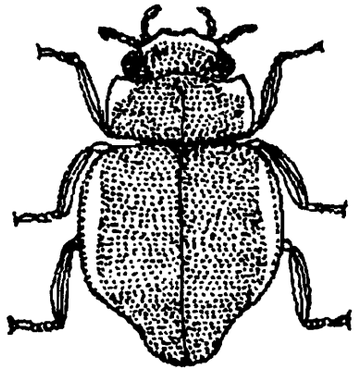

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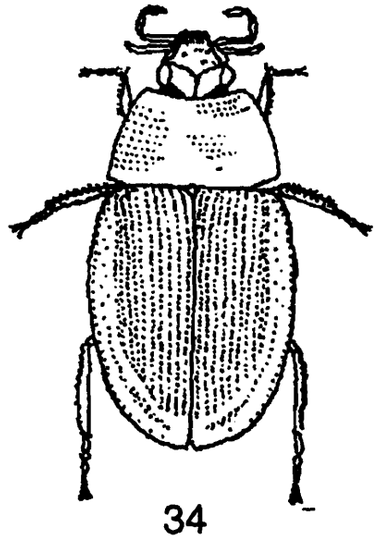

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Fig. 31 : *Orectochilus productus* Regimbart

Fig. 32 : *Haliplus angustifrons* Regimbart

Fig. 33 : *Spercheus gibbus* Champion

Fig. 34 : *Helochares ancholaris* Sharp

1995. *Helochares anchoralis*: Biswas and Mukhopadhay, Insecta : Coleoptera : Hydrophilidae, In : *State Fauna Series 3* : *Fauna of West Bengal.* Pt. 6a, *Zoological Survey of India, Calcutta* : 157.

Diagnostic characters : Body elongate, about 6 mm long, dark brown with blackish patches; head densely punctate, dark posteriorly and with Y-shaped frontal suture; antennae 9-segmented, last segment elongate and densely pubescent; prothorax densely punctate; scutellum small; elytra densely and evenly punctate; legs with distinct claws and spines, 1st joint of hind tarsi very short and the 2nd joint longer and claws with a basal swelling and a characterstic expodium; ventral surface dark brown.

Distribution : India : West Bengal (Kolkata, South 24-Parganas); Elsewhere : Indochina, Indonesia and Sri Lanka.

Remarks : Not very common, recorded only from oxbow lakes and natural wetlands. Occurs along the macrophyte strands in the littoral zones.

18. *Enochrus esuriens* (Walker)
(Fig. 35)

1859. *Philiphydrus esurines* Walker, *Ann. Mag. Nat. Hist.*, (3) 2 : 209.

1995. *Enochrus esuriens* : Biswas and Mukhopadhyay, Insecta: Coleoptera : Hydrophilidae, In : *State Fauna Seires 3* : *Fauna of West Bengal*, pt. 6a, *Zoological Survey of India, Calcutta* : 158.

Diagnostic characters : Body oval, 2.5 mm long, reddish brown, head black with a yellow spot in front of eyes; eyes normal; antennae 9-segmented, clubs darker and densely pubescent, prothorax densely and finely punctate; scutellum triangular; elytra reddish brown, interstitial punctures smaller than serial punctures; legs simple, 1st joint of tarsi short and last joint longest, claws simple; ventral surface black.

Distribution : India : West Bengal (South 24-Parganas). Elsewhere : Sri Lanka, Sunda Island and Vietnam.

Remarks : A common species of water beetle recorded from all wetland types except IV and V.

Genus *Sternolophus* Solier

19. *Sternolophus rufipes* (Fabricius)
(Fig. 36)

1792. *Hydrophilus rufipes* Fabricus, *Entom. Syst.*, 1 : 183.

1993. *Sternolophus rufipes* : De and Sengupta, *Rec. zool. Surv. India*, 93 (1-2) : 131.

Diagnostic characters : Body elongate, about 13 mm long, shinny black; head with Y-shaped frontal suture, maxillary palpi reddish brown; antennae 9-jointed. (6+3), brownish black and pubescent; prothorax transverse with 2 rows of setiferous punctures on lateral side of pronotum; scutellum triangular; elytra punctured; legs at base with silky and dense pubescence, hind tarsi compressed and oar-like; ventral surface black and pubescent.

Distribution : India : West Bengal (Kolkata, North and South 24 Parganas) Bardhaman, Murshidabad, Puruliya and Medinipur), Bihar, Kashmir, Maharashtra, Punjab and South India; Elsewhere : East Asia, Sunda Island.

Remarks : This is the commonest hydrophilid species found in all the wetlands studied. It is seen both near the macrophyte strands as well as in open water.

Genus *Hydrophilus*

20. *Hydrophilus rufocinctus* Bede)
(Fig. 37)

1892. *Hydrophilus rufocinctus* Bedel, *Rev. d"Ent. Caen.* 10 : 309.

1893. *Hydrophilus rufocinctus* : Kuwert, *Deut. Ent. Zeits* : 90.

1993. *Hydrophilus rufocinctus* : Biswas and Mukhopadhyay, Insecta : Coleoptera : Hydrophilidae, In *: State Fauna Seires 3* : *Fauna of West Bengal*, pt. 6a, *Zoological Survey of India, Calcutta* : 158.

Diagnostic characters : Body medium-sized, elongate, blackish brown, convex normally; punctures restricted to inner side of eyes and anterior side of head, eyes normal. Antennae brownish, 9-segmented, antennal club perfoliate. Prothorax transverse narrowed in front. Scutellum not longer than its basal width, pronotum narrowed behind; elytra with rows of punctures alternatively, two rows of non-setiferous and one row of setiferous punctures. Pronotal and elytra margins yellowish red. Anterior femora only clothed with pubescence at base of long setae. Tarsi strongly compressed and oar-like. Claws of all tarsi dentate at base.

Distribution : India : West Bengal, "North India" (without defnite locality).

Remarks : A common species recorded from all wetland types.

Genus *Amphiops* Erichson

21. *Amphiops pedestris* Sharp
(Fig. 38)

1890. *Amphiops pedestris* Sharp, *Trans. Ent. Soc. Lond.* : 354.

1993. *Amphiops pedestris* : De and Sengupta, *Rec. zool. Surv. India*, 93 : 132.

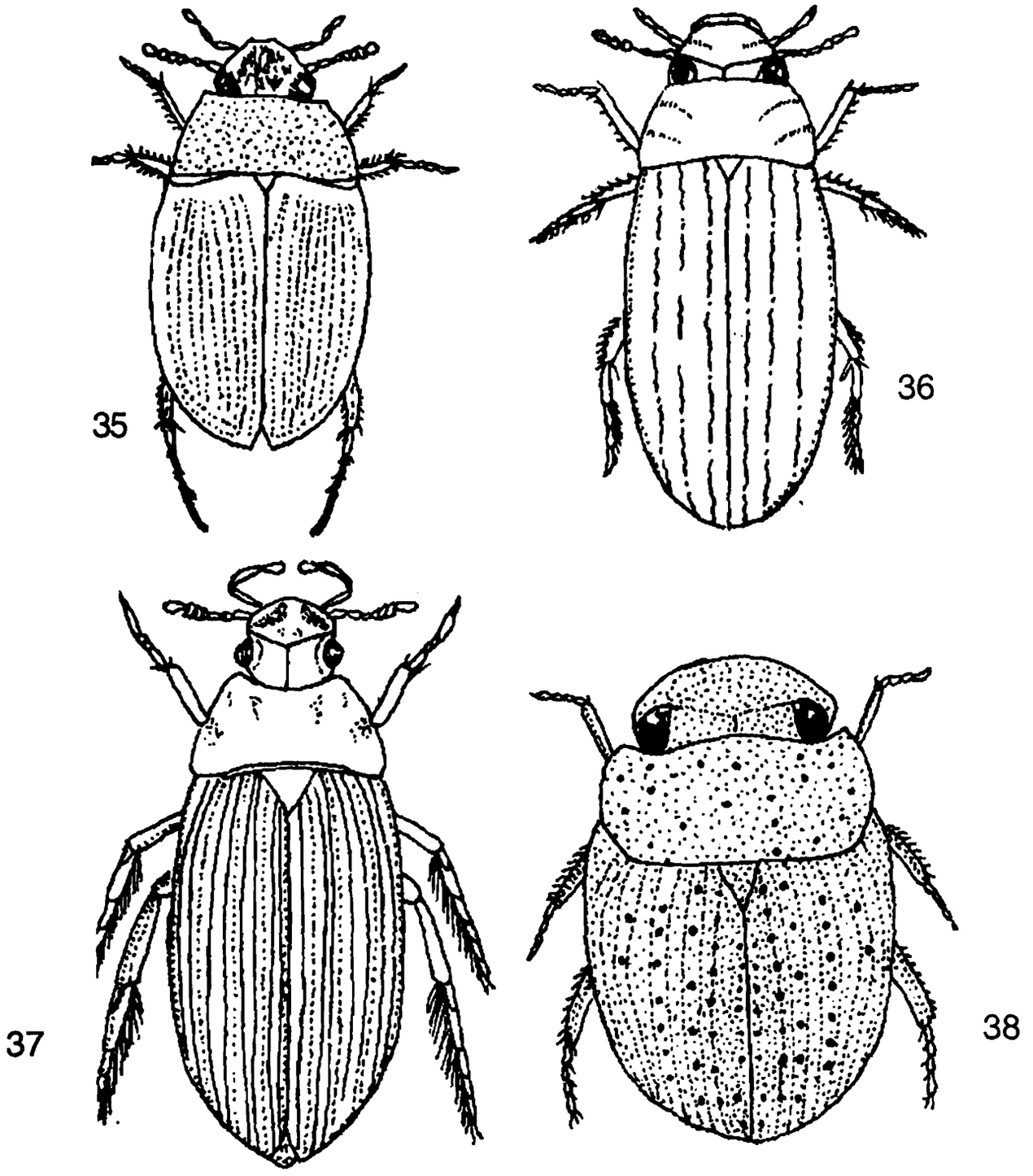


Fig. 35 : *Enochrus esuriens* Walker

Fig. 36 : *Sternolophus rufipes* (Fabricius)

Fig. 37 : *Hydrophilus rufocinctus* Bedel

Fig. 38 : *Amphiops pedestris* Sharp

Diagnostic characters : Body somewhat rounded and punctate, about 3 mm long; head reddish brown; eyes divided by a conspicuous and complete canthus reaching the vertex; prothorax concolourous with head, puncturation moderately dense and with a few large, irregular punctures; scutellum triangular and punctate; elytra yellowish brown with roar of punctures; legs simple, armed with spines, posterior legs without swimming hairs; ventral surface concolourous with head.

Distribution : India : West Bengal (Kolkata), Bihar, Pondicherry and Tamil Nadu.

Remarks : The species mainly occurred along the submerged vegetations of wetland type I, but was also recorded from type III wetlands.

Genus *Berosus* Leach

22. *Berosus indicus* Motschulsky
(Fig. 39)

1861. *Berosus indicus* Motschulsky, *Bull. Soc. Imp. Nat. Moscou*, 34 : 110.

1995. *Berosus indicus* : Biswas and Mukhopadhyay, Insecta : Coleoptera : Hydrophilidae, In : *State Fauna Series 3* : *Fauna of West Bengal*, pt. 6a, *Zoological Survey of India, Calcutta* : 163.

Diagnostic characters : Body elongate, more than 3 mm with brown to yellow colour and punctate, head markedly deflexed, densely punctured; eyes prominent and protuberant; antennae 7-segmented (4+3), prothorax brownish yellow, with dense punctures specially on disc of pronotum; scutellum a long triangle and punctate, elytra highly patterned, narrowed posteriorly with about 10 rows of dark punctures, epipteural angle extended into strong spine; legs with long swimming hairs; ventral surface punctate and dark brown in colour.

Distribution : India : West Bengal (Kolkata, North and South 24-Parganas, Murshidabad), Assam, Bihar and Maharashtra.

Remarks : This is fairly common in water bodies with high organic load like multipurpose village pond and sewage-fed pond. These beetles are strong swimmers and divers. They climb upon the emergent macrophytes quickly.

Genus *Regimbertia* Zaitzev

23. *Regimbertia attenuata* (Fabricius)
(Fig. 40)

1801. *Hydrophilus attenuata* Fabricius, *Syst. Eleuth*, 1 : 235.

1995. *Regimbertia attenuata* : Biswas and Mukhopadhyay Insecta : Coleoptera : Hydrophilidae, In : *State Fauna Series 3* : *Fauna of West Bengal*, pt. 6a, *Zoological Survey of India, Calcutta* : 163.

Diagnostic Characters : Strongly convex, elongate, compressed on sides, deep and shinning black and punctate.Head rounded anteriorly, puncturation dense and distinct, eyes large.Antennae 8- segmented. Pronotum narrowly applied within the emergination of anterior side of elytra. Scutellum elongate and triangled. Elytra strongly narrowed posteriorly, punctate and pubescent. Legs with spines and swimming hairs, mid and hind tibiae with long swimming hairs on inner side. Body black ventrally.

Distribution : India : Bihar, Maharashrta and West Bengal (Kolkata) : Elsewhere : Sri Lanka, Indochina, Annam, China., Cambodia, Sumatra, Philippines, Formosa, Japan and Australia.

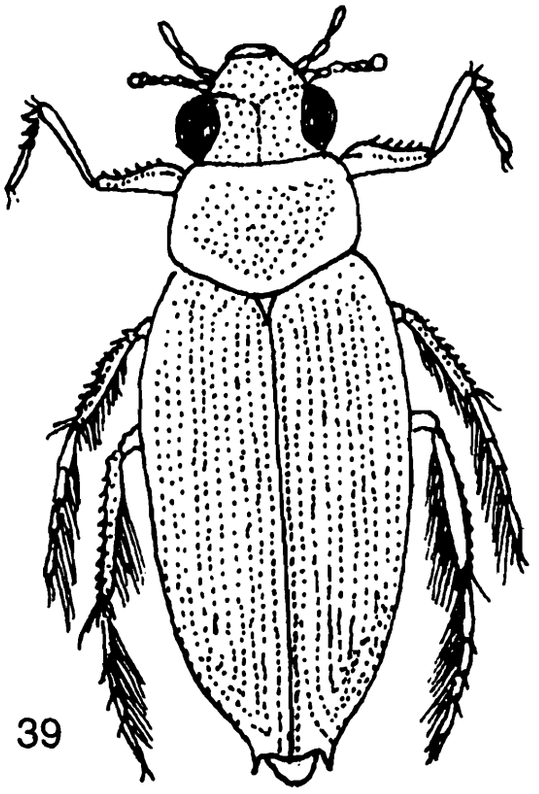
Remarks : It occurred in the wetlands with abundant macrophytes.

DIPTERA

In freshwater ecosystems the order Diptera is represented only by the larvae and pupae of a large number of species belonging to several families. These larvae and pupae occur in almost all types of freshwater and sometimes in great numbers. Out of 23 families represented in freshwaters, only a few like Culicidae and Simulidae are exclusively aquatic (Pennak, 1978). Aquatic dipteran larvae differ widely in their structure and habitat. These are generally distinguished by their soft, flexible, elongated, worm-like and segmented bodies, absence of eyes and jointed thoracic legs. The body generally consists of 12 segments, 3 thoracic and 9 abdominal, but in many species several segments are fused together. The surface of the segments may be smooth or with bristles, spines or tubercled. The short stumpy prolegs on some segments are the characteristics of some important aquatic dipteran families. The number of prolegs varies greatly from family to family. The head is vestigial and mouthparts are modified or reduced and simple.

Some larvae swim rapidly by quick wriggling movement but others are creepers. The creeping takes place with the help of prolegs, spines, suckers and sticky saliva. The food consists of heterogeneous plant and animal debris including microorganisms, detritus, periphyton, macrophytes etc. for which mouthparts are modified accordingly. Respiration generally takes place by internal air filled tracheal system that branches and ramifies to all the tissues. The families, which derive oxygen exclusively from water, are characterized by the presence of thin walled tracheal gills or blood gills. The respiratory mechanism is complex and varies greatly in different families. The larval duration varies greatly in different species, which ranges between a few weeks to several years. The pupal stages last less than two weeks.

In the wetland studies the dipterans were chiefly represented by the larvae of only two families *viz.* Culicidae and Chironomidae. Because of the extreme difficulties in the identification of larval Diptera, not many Genera/Species could be separated and identified. Although there may be many more, only 3 commonly occurring and abundant genera of Chironomidae and two of Culicidae are dealt with here. The occurrence of these genera was



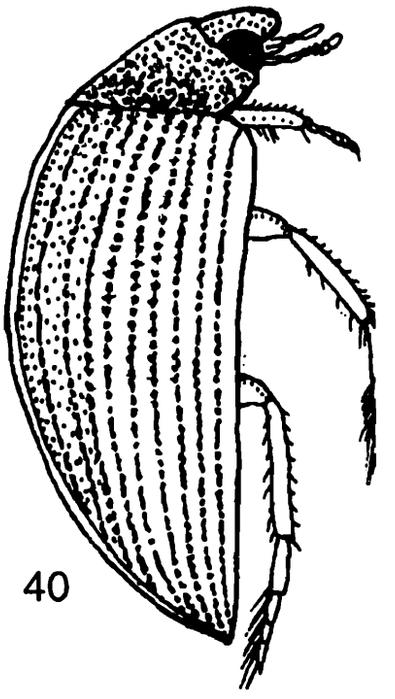


Fig. 39 : *Berocus indicus* Motsch.

Fig. 40 : *Regimbertia attenuata* (Fabricius)

(all dorsal view)

supported by the identification of some adults collected from vegetation around the wetlands. These genera comprise the bulk of the dipteran larvae in terms of numerical density. Besides other characters like shape of the body and head, the larvae of the two families can be distinguished by the presence and absence of proleg. While it is absent in Cucilidae, in Chironomidae, two pairs of prolegs are present, one on prothorax and the other at the end of abdomen.

Family CHIRONOMIDAE

The true midges are distributed widely throughout the world and occur in almost all types of water including brackish and marine waters. The range of habitats occupied by them is unparalleled among other insect groups. In freshwaters, they inhabit littoral and benthic regions of natural lakes, large wetlands, ponds, temporary pool, bogs, marshes, swamps, fast flowing streams and rivers etc.

The larvae (Figs. 41, 42) are elongated and cylindrical, having two pairs of proleg, one

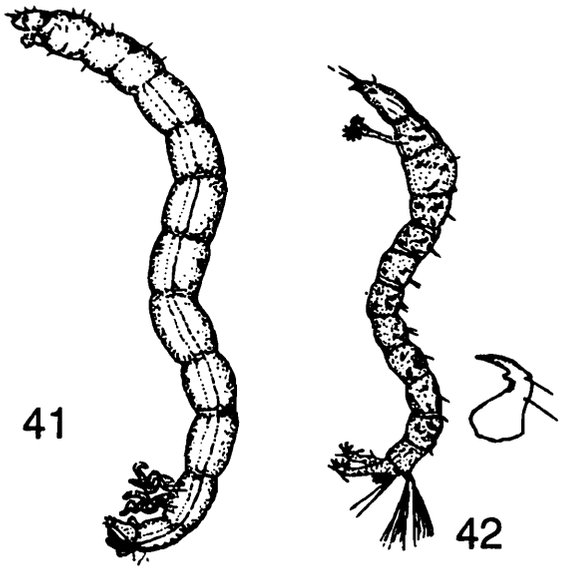


Fig. 41 : General structure of *Chironomus*

Fig. 42 : Larval structure of *Pentaneura* (Diptera)

each on first thoracic and last abdominal segments. The species recorded form this region is red in colour, which is due to the presence of dissolved haemoglobins in the blood. Spiracle is absent but gills are present on the penultimate abdominal segment. Some species construct fragile tubes composed of algae, fine silt and sand grains cemented together by saliva. The water passes through the tube, as it is open at both ends. Chironomid larvae feed mainly algae, detritus and macrophytes. Locomotion is by way of a series of creeping movements.

Chironomid larvae serve as of the most important food items of a large number of fishes. Besides, they display an exceptionally wide range of sensitivity to environmental conditions. Due to their differential sensitivity, they are considered as a good monitor of water quality particularly organic pollution and euthrophication. Many species thrive and flourish in highly organically polluted or eutrophicated waters.

The family is represented by three genera belonging to two subfamilies in the wetlands studied.

Key to the recorded subfamilies and genera of *Chironomidae* (Larvae)

1. Antennae retractile, usually elongated, proleg long, anterior pair with a common base Subfamily Tanypodinae

   a) Antennae three forth as long as head, mandibles hook-like. Segment of the body with a longitudinal hair fringe on each side, head about 1 ½ times ..... as long as broad, ventral pair of anal gill attached to base proleg, remote ..... from anus ..... Genus *Clinotanypus,* Kieffer 1913

   b) Antennae one and a half times as long as head, mandibles curved, lingua.. with 5 dark teeth..... Genus *Ablabesmya* Johannsen, 1905

– Antennae not retratile, usually short, translucent premandibles present just anterior to labial plate 2

2. Third antennal segment not annulated, paralobial plates present .... Subfamily Chironominae

– Eleventh body segment with two pairs of ventral blood gill. Antenna 5-segmented, first antennal segment not long and curved, antennal tubercles much wider than long, parabial plates well separated, labial plate with 11 0r 13, middle tooth of labial plate longer, trifid or notched at base ..... Genus *Chironomus* Meigen, 1803

– Third antennal segment annulated, paralabial plates absent .... Subfamily Diamesinae*

Remarks : The genus *Ablabesmya* was recorded from ox-bow lakes and one urban recreational lake (Rabindra Sarovar). Genus *Clinotanypus* was observed only in flood plain wetlands and natural wetland. Genus *Chironomus* was recorded from all wetlands but they occurred in huge numbers in multipurpose village ponds and sewage-fed fish culture ponds.

Family CULICIDAE

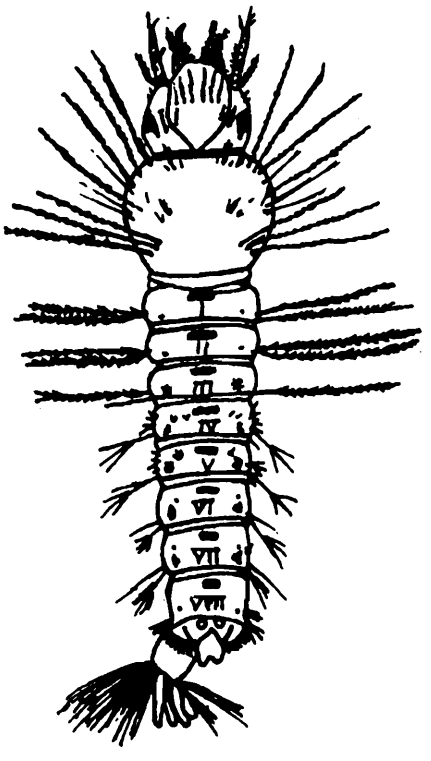
The family Culicidae is one the few important families of Diptera which are known by their disease transmitting nature. Several species of mosquitoes are well known for their role in diseases like, malaria, yellow fever, dengue and encephalitis etc. The larvae of most of the species are aquatic which can be distinguished from other dipteran larvae by their thoracic segments being fused which are thicker than rest of the body. The family Culicidae , represented by two subfamilies Culicinae, commonly known as mosquitos, and Chaoborinae known as phantom midges, are universal in distribution. Although the two subfamilies resemble superficially, these can be very well differentiated by the structure of wings in adults, which are scaly in mosquitoes and hairy in phantom midges. While the larvae of mosquitos are characterized by non-prehensile antennae and presence of mouth brush, the phantom midges have prehensile antennae and no mouth brush.

Only subfamily Culicinae was collected from the wetlands studied, which was represented by two genera *Culex* and *Anopheles*. The larvae occur in quieter place of the wetlands in comparatively cleaner zones, not very close to macrophytes. These were generally seen swimming below the water surface in their characteristics wriggling movement. While the *Culex* larvae (Fig. 44) remain hanging in sub water surface at an angle with the tip of the respiratory tube at the surface, the *Anopheles* (Fig. 43) larvae lie horizontally just below the water surface. They feed upon algae, protozoa and organic debris by filtering with the help of mouth brushes.

Key to genera of subfamily *Culicinae* (Larvae)

1. Spiracles sessile on 8th abdominal segment, respiratory tube absent. .....

*Not represented in the wetlands studied



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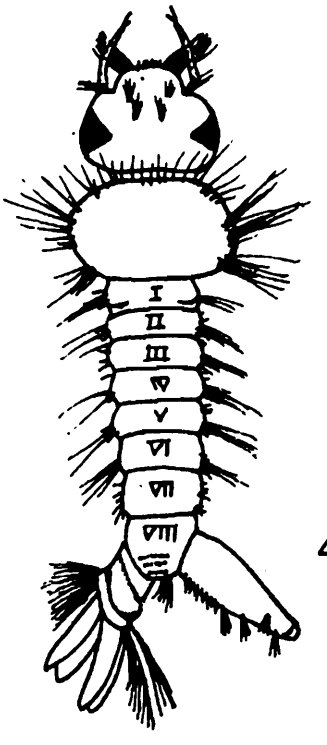

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Fig. 43 : Larva of *Anopheles*

Fig. 44 : Larva of *Culex*

..... *Anopheles*

– Spiracles at the tip of respiratory tube, as long as wide; respiratory tube present and with pecten and several pairs of ventral tuft of hairs or single hair ..... *Culex*

Remarks : Both genera were recorded from all types of wetland but their density was much higher in multipurpose village pond.

TOTAL DENSITY A RELATIVE COMPOSITION OF DIFFERENT INSECT GROUPS

Table 5 summarizes the total density (no/sqm) and relative composition of different insect groups in one-selected wetlands of each type. The density varied widely betweeen the wetlands. It was highest in Type-I oxbow lakes followed by natural wetlands. The lowest density was observed in Fish culture pond. The high density in Types I and II are related to abundant macrophytes and comparatively cleaner conditions. Lowest density in Fish culture ponds might be due to heavy predation pressure exerted by fishes.

Diptera larvae (Chironomidae) contributed maximum to insect fauna of all wetlands but

their share differed widely between the wetlands. The highest contribution (60%) was noticed in sewage-fed ponds, which was probably due to input of highly enriched organic sewage. Chironomids are well known to flourish in organically enriched medium. This was followed by multipurpose village ponds (49.2%). These ponds are also originally rich because of dumpling of domestic refuse etc. Their share was lowest in fish culture ponds. This may be related to increased grazing pressure due to intensive fish culture. The contribution of Ephemeroptera nymphs was minimum, which varied between 2 and 7%. They were recorded only from the wetlands with comparatively lower levels of organic enrichment or pollution. They were totally absent from sewage-fed ponds, village ponds and fish culture ponds. The ephemeroptearn are very sensitive to the degradation/pollution of aquatic ecosystem. Odonate larvae also exhibited noticeable sensitivity to organic enrichment. Their contribution was only 6% in sewage-fed pond as compared to 18.5% in natural wetlands and 16.5% in oxbow lakes. Their lower abundance in fish culture ponds also may be due to increassed predation pressure by fishes. Hemipteran and coleopteran contributed moderately and steadily in all wetlands, showing their comparatively lower sensitivity to organic enrichment. The distribution and abundance of hemipteran and colepoteran were heavily dependent of macrophytes. Because of the quicker movements and tendency to remain on surface films or macrophytes by their adults provided them protection from being extensively grazed by fishes. This may be one of important reasons for their increased availability in intensive fish culture ponds (Fig. 45).

Abundant species

Out of the 70 species recorded from these wetlands only a few were of very common occurrence and abundant contributing significantly to the ecosystem. Table 6. lists such abundant species. It may be seen that 5 species each of Odonata, Hemiptera and Coleoptera and one of Diptera constituted the group of most abundant insect fauna.

Species Diversity

The species diversity or species richness index (d) in the selected wetlands of each type are depicted in Fig. 6. The species richness was highest in Type-I, oxbow lakes (8.4399) followed by Type II, natural wetland (7.4501) and lowest in Type-IV sewage-fed pond (3.7059) followed by Type-VI multipurpose village pond (4.4514).

Similarity between wetlands

The analysis of the similarity indices (Coefficient of Community) between the wetland types revealed the highest similarity between Type I, oxbow lakes and Type II, natural wetlands. This was followed by Types I and III. The next in order were Types IV, Sewage-fed ponds and Type V, multipurpose village pond which showed considerably high degree of similarity. Lowest values were recorded between Types IV, and I followed by II and IV

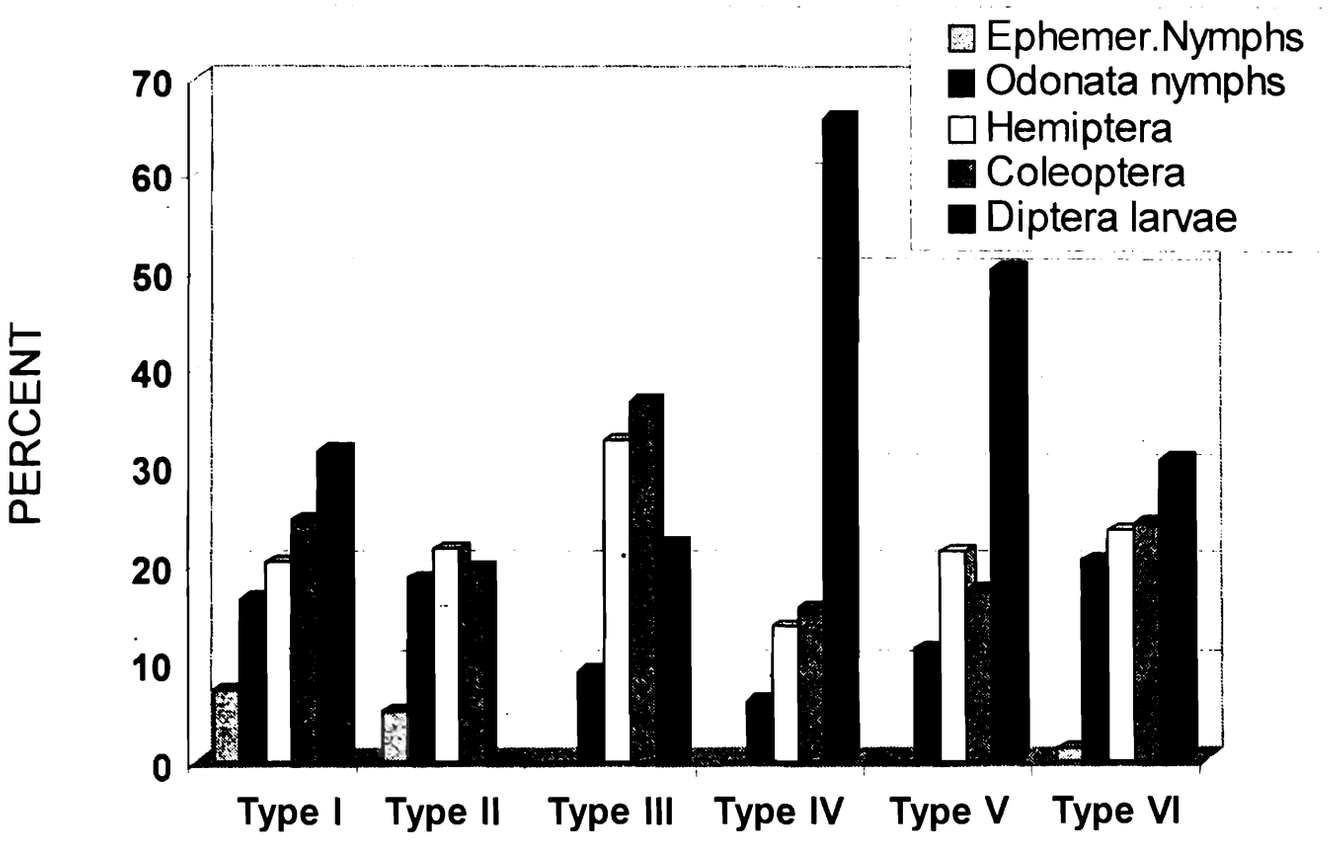

Fig. 45 : Relative composition of different insect groups in different wetland types

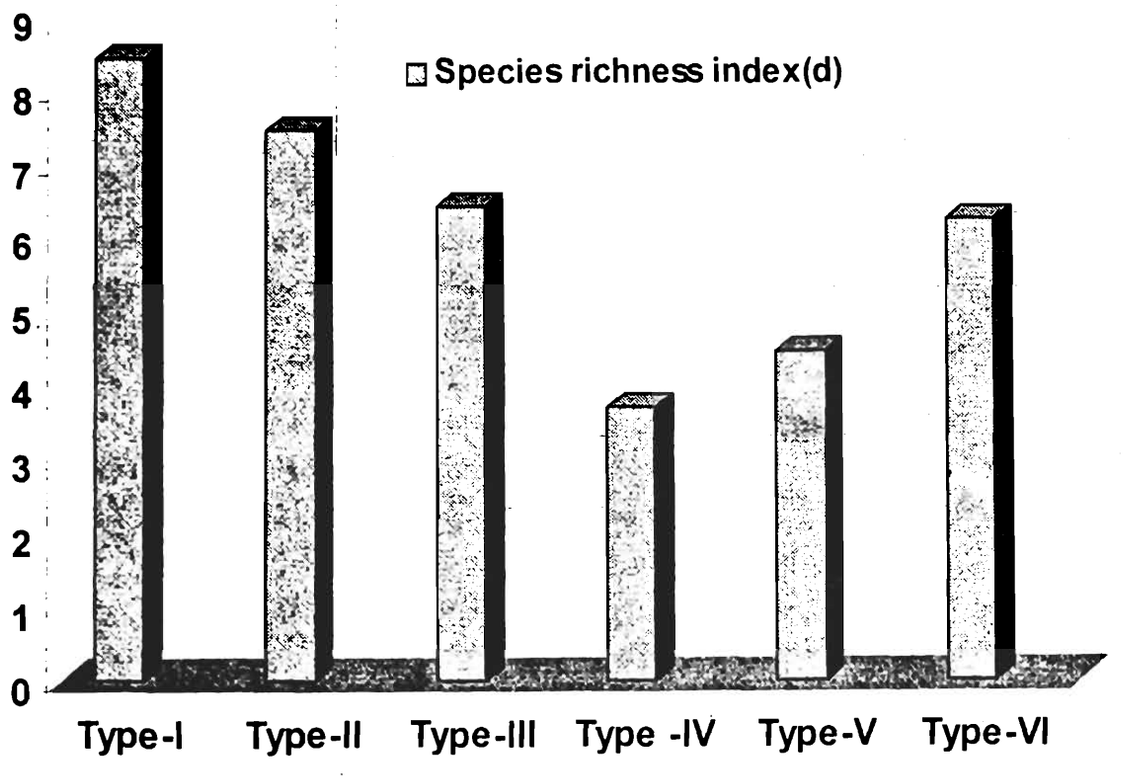

Fig. 46 : Species richness index (d) in different wetland types

and III and IV (Table 7).

The analysis has very clearly separated the Sewage-fed ponds (Type IV) from all other wetlands except, type V, multipurpose village ponds. The similarity between the sewage-fed ponds and village pond was obvious, as both were highly enriched in organic matters of human origin. The markedly lower similarity between oxbow lakes and sewage-fed pond was also due to entirely different conditions.

DISCUSSION

The diversity of insect fauna in different wetland types varied widely which was chiefly dependent on the availability of macrophytes and general physico-chemical conditions of the water. The significance of macrophytes in the distribution and abundance of freshwater insects has been well established (Pieczynska and Ozimek, 1976) because a large number of species obtain their food and take shelter under these plants, both in free living and attached conditions ((McLachlan, 1975; Soszka, 1975). A diverse flora is found to be responsible for greater faunal assemblage and the establishment of stable insect communities (Boyd, 1971). The floodplain wetlands, representing intermediate conditions between lotic and lentic ecosystems, with abundant macrophyte belonging to 31 very commonly occurring species, served as unique habitats for the colonization of rich and diverse insect communities which is abundantly clear from the largest number of taxa recorded from these wetlands. The species diversity (richness) indices also exhibited highest values for these wetlands. The natural wetlands, also with abundant macrophytes- both in diversity and density, were only second to oxbow lakes in terms of insect diversity. The fish culture ponds under type III exhibited a different condition where diversity of insect fauna was not as much affected as their density, particularly of the species that pass their immature stages in water like odonates and chironomids. This was probably due to heavy peradation pressure exerted by cultured fishes upon their nymphs or larvae, which are generally benthic. The lower diversities in sewage-fed fish.culture pond and multipurpose village pond were probably due to their high organic load. The high load of BOD, conductivity and alkalinity etc. in these two types of wetlands was quite apparent. In case of former, drawl of highly organic sewage to enhance the nutritional status and in case of latter excessive uses including the dumping of kitchen refuse were responsible for their increased organic enrichment. High organic load while restricted the species diversity, increased the density of some species that could tolerate the prevalent environmental conditions. This was visible from the increased density of chirornomid larvae, which are well known to flourish in organically polluted environment and are good indicators of water pollution / eutrophication (Mahadevan and Krishnaswamy, 1984). The lowest species richness (diversity) values in sewage-fed fish ponds followed by multipurpose village pond clearly indicated degraded conditions.

There were some marked differences in the diversity and density of different insects groups in different types of wetland, which probably depended upon their differential response

to prevailing environmental conditions. The ephemeropterans, which are very sensitive to the degradation/ pollution of aquatic ecosystem, were recorded only from the wetlands with comparatively lower levels of organic enrichment or pollution like oxbow lakes and natural wetlands. They were totally absent from sewage- fed ponds, village ponds and fish culture ponds. Odonate larvae also exhibited noticeable sensitivity to organic enrichment. Their contribution was only 6% in sewage-fed pond as compared to 18.5% in natural wetlands and 16.5% in oxbow lakes. Their lower abundance in fish culture ponds also may be due to increased predation pressure by fishes as already indicated The distribution and abundance of hemipteran and colepoteran were found to be mainly dependent on macrophytes. They were represented by highest number of species in all wetlands and also contributed moderately and steadily to the insect density, showing their comparatively lower sensitivity to organic enrichment. Because of their quicker movements, tendency to remain on surface films or remain entangled with macrophytes provided them protection from being extensively preyed by fishes. This may be one of important reasons for their increased availability in fish culture ponds too. The qualitative dominance of Coleoptera and Hemiptrea over other groups in the freshwater of this region has been well-documented (Roy *et al.*, 1988, Pal *et. al.*, 2000).

While a number of workers have reported that plants do not support specific faunal associations (Rook, 1984, Schramn *et al.*, 1987 and Korinjow, 1989), Kornijow and Gulati (1992) observed that species diversity and abundance of animal communities inhabiting the different plant species differed markedly. A preliminary analysis of the habitat preference during present investigations revealed no significant preference of any plant species by any group of insects.

From the present studies, three clear patterns of insect diversity were apparent. First, most of the species of Hemiptera and Coeloptera were typical components of nekton or neuston communities found exclusively associated with macrophytes. Second, most of odonates and chironomids were *eurotrophic*, living both on bottom sediments and on hydrophytes (Kornijow and Gulati, 1992) and third, the variety of species exclusively associated with bottom sediment was limited to some odonate, ephemeropteran and dipteran larvae.

The bulk of both, macrophyte associated as well as benthic macro-invertebrate densities were contributed by only a few species of each group and remaining species occurred in small numbers or appeared for limited duration during certain period of the year. Such numerically abundant species play the main role in the production dynamics of the ecosystem. The numerically abundant species at any given moment of time comprised of 2-3 species each of Odonata, Hemiptera Coleptera and 1 of Diptera.

The similarity analysis revealed interesting results. The analysis has very clearly separated the Sewage-fed ponds (Type IV) from all other wetlands except type V, multipurpose village ponds. The similarity between the sewage-fed ponds and village pond was obvious, as both were highly enriched in organic matters of human origin. The markedly lower similarity between oxbow lakes and sewage-fed pond was also due to entirely different conditions. The closer similarity between Type I and Type II wetlands were due to closely resembling

ecological conditions of water quality and macrophyte abundance.

Although 70 species of commonly occuring insects were recorded from the twenty wetlands studied, it is presumed that further intensive seasonal surveys to many more wetlands belonging to different types and detailed taxonomic studies may reveal some species which may be significant, both ecologically and taxonomically.

SUMMARY

The present contribution is the result of the extensive and intensive studies on aquatic entomofauna carried out during last 10 years (1991-2000) which deals with the diversity and abundance of commonly occurring aquatic insect fauna in a large number of wetlands of south eastern region of West Bengal state covering the districts of North 24 Parganas, Kolkata, South 24 Parganas, Hugly, Haora and Mednipur, located on either side of the major river Ganga. Studies were carried out in 20 selected wetlands belonging to different categories, which were grouped under six major types *viz.*. floodplain oxbow lakes (Type-I), natural wetlands (Type-II), fish culture ponds (Type III) , sewage-fed fish culture ponds (Type-IV), multipurpose village ponds (Type V) and urban recreational lakes Type VI). Besides the record of their occurrence and abundance in different wetland types, their diversity and similarity indices, the identification keys, diagnostic characters, distribution and general ecological remarks have also been incorporated.

The commonly occurring entomo-fauna of the wetlands studied belonged to 5 major orders, *Viz.*, Ephemeroptera, Odonata, Hemiptera, Coleoptera and Diptera. While both adults and immature stages of Hemiptera and Coleoptera occurred in water, Ephemeroptera, Odonata and Diptera were represented only by their nymphs /larvae in aquatic ecosystem and adults were aerial. Altogether 70 species were recorded during the present investigation from all the wetlands studied. Highest number (63) was recorded from Type-I Oxbow wetlands, followed by natural wetland (53) and lowest (26) from sewage-fed fish culture ponds. The urban recreational lakes exhibited comparatively higher diversity as 43 taxa were recorded. These insects belonged to 53 genera and 20 families. Ephemeroptera was represented by 4 species belonging to 1 genus and 1 family; Odonata by 19 species under 14 genera and 5 families; Hemiptera by 19 species comprising 14 genera and 8 families; Coleoptera by 23 species consisting of 19 genera and 4 families and Diptera by 5 genera of 2 families.

Total density of aquatic insects in one selected wetland of each type varied widely between 1550/sqm and 441/sqm, highest in oxbow, related to abundance of macrophyte and lowest in fish culture ponds which was probably due to extensive predation by fishes.

Relative composition studies in the selected wetlands revalued the dominance of dipteran larvae (Chrinomidae) in all the wetlands but their shares varied widely. It was highest in highly enriched sewage-fed ponds. Their comparatively lower contribution in intensive fish culture ponds was probably due to intense grazing pressure exerted upon them by fishes. The contribution of Ephemeroptera nymphs was minimum and they were recorded only from the

wetlands with comparatively lower levels of organic enrichment or pollution. Odonate nymphs also exhibited noticeable sensitivity to organic enrichment. Their contribution was lowest in sewage-fed pond and highest in natural wetlands. Hemipteran and coleopteran contributed moderately and steadily in all wetlands, showing their comparatively lower sensitivity to organic enrichment but their distribution and abundance were heavily dependent of macrophytes. Their quicker movements and tendency to remain on surface films or macrophytes provided them protection from being extensively grazed by fishes.

Out of the 70 species recorded from the wetland studied only a few species were of common and abundant occurrence. Five species of each, Odonata, Hemiptera and Coleoptera and one species of Diptera (Chironomidae) constituted the list of most abundant taxa.

The species diversity or species richness index (D) in the selected wetlands of each type are given in Table 7. The species richness was highest in oxbow lakes (8.4399) followed by natural wetland (7.4501) and lowest in sewage-fed pond (3.7059) followed by multipurpose village pond (4.4514).

The analysis of the similarity (Coefficient Community) between the wetland types revealed highest similarity between Type I, oxbow lakes and Type II, natural wetlands. This was followed by Types I and III. The next in order were Types IV, Sewage-fed ponds and Type V, multipurpose village pond which showed considerably high degree of similarity. Lowest values were recorded between Types IV and I followed by II and IV and III and IV. The analysis clearly separated the sewage-fed pond from other wetlands except the multipurpose village pond, which was also organically very rich.

ACKNOWLEDGEMENTS

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Table 1. DETAILS OF WETLANDS STUDIED

Sl. No.	Name	Location	Approx area (acres)	Source	Nature	Remarks
Wetland Type I- Oxbow Lake (*Baors/beels*)						
1.	Gopalpur Baor	North 24-Parganas, Bongaon	160	Ichamati River	Moderately Alkaline	Heavily infested with macrophytes of all types. Littoral zone with abundan decaying vegetation's co-operative fishing.
2.	Sasadanga Baor	do	120	do	do	Heavily infested with macrophytes of all types Littoral zone with moderate decaying. vegetation's unorganised fishing.
3.	Dumur Baor	do	350	do	do	Moderately infested with macrophytes. Littoral decaying vegetation in patches. co-operative fising.
4.	Beledanga Baor	do	165	do	do	do

Wetland Type II. Natural Wetlands (Jheels)						
Sl. No.	**Name**	**Location**	**Approx area (acres)**	**Source**	**Nature**	**Remarks**
5.	Barti beel	Barrackpore	800	Rainwater Drainage	Alkaline	Moderately infested with macrophytes. Littoral decaying vegetation in patches. *Eichhornea* sp. in abundance. Co-operative Fishing.
6.	Badu beel	North 24-Parganas, Madhyamgram	20	- do -	- do -	- do -
7.	Santragachi jheel	Hawrah	10	- do -	Highly alkaline	Heavily infested with macrophytes. Littoral decaying vegetation covers almost the entire wetlands. *Eichhornea* sp. in abundance. No organised fishing.
8.	Kashipur Hugla jheel	Hugli	15	- do -	- do -	Moderately infested wit macrophytes. *Echhornea* sp. in abundance.
9.	Dankuni wetland	Hugli	25	- do -	- do -	Moderately to heavily infested with macrophytes in different zones. *Eichhornea* sp. in abundance.

Wetland Type-III. Large Fish Culture Ponds (*Bheri*)						
Sl. No.	**Name**	**Location**	**Approx area (acres)**	**Source**	**Nature**	**Remarks**
10.	Kalikapur Bheri	S. 24-Pgs., Kalikapur	100	Rainwater Drainage	Moderately alkaline	Sparsely infested with macrophytes. Extensive fish culture. Periodical release of fingerlines and harvesting of common carps and exotic carps. Manual weed control.
11.	Bagnan Bheri	Howrah Bagnan	-	- do -	Highly alkaline	- do -
12.	Baranagar	N. 24-Pgs.	-	- do -	Moderately alkaline	Moderately infested with macrophytes, intensity varies from region to region. Seasonal fishing.
Wetland Type IV- Sewage Fed Fish Culture Pond						
13.	Bantala pond-I (East Calcutta Wetlands)	South 24-Parganas, Bantala	5	Rainwater Sewage of Kolkata	Highly organic load, Alk	High organic load due to input of sewage. Very thin littoral strands of macrophytes. *Eichhornea* sp. present Intensive fishing, weed control.

Sl. No.	Name	Location	Approx area (acres)	Source	Nature	Remarks
14.	Bantala Pond-II	- do -	3	- do -	- do -	- do -
15.	Brace Bridge pond (West Calcutta wetlands)	South 24-Parganas, Budge Budge	3	- do -	- do -	- do -
Wetland Type V-Multipurpose Small (Village/Ponds (Pukur))						
16.	Canning pond	South 24-Parganas, Canning	1.2	Rainwater	Highly eutrophic	High organic load due to disposal of kitchen refused and other matters. Sparsely infested with submerged as well as floating macrophytes. *Ecchornea* sp. present small patches. Emerget vegetation Moderate. Not organised fishing but used extensively for bathing, washing and other domestic purposes.
17.	Domjur pond	Howrah	1.5	- do -	- do -	- do -
18.	Kharagpur	Medinipur	1.5	- do -	- do -	- do -

Wetland Type VI Urban Recreational (man made) Lakes(Lake/Sarobar)						
Sl. No.	**Name**	**Location**	**Approx area (acres)**	**Source**	**Nature**	**Remarks**
19.	Rabindra Sarobar	Calcutta	76	Rainwater	Moderately eutrophic	Moderately infested with macrophytes. *Ceratophyllum* sp. dominate. Decaying vegetation at some place. No fishing visited by large number of people daily.
20.	Subhas Sarobar	- do -	18	- do -	- do -	Moderately infested with macrophytes. Seasonal sport fishing.

Table 2. GENERAL PHYSICO-CHEMICAL CHARACTERESTICS OF WETLAND TYPES (COMBINED RANGE OF VALUES)

	Wetland					
	Type-I	Type-II	Type-III	Type-IV	Type-V	Type-VI
	Oxbow wetlands (baors/ beels)	Natural wetlands (beels/ jheels)	Fish culture ponds (bheries)	Sewage-fed fish culture ponds (sewage bheries)	Multipurpose village pond (pukur)	Urban recreational (man made lakes)
Water Temperature (C)	22-32.4	21.75-33.0	22.5-32.5	21.75-32.2	21.0-31.0	25.4-32.8
Secchi Disc Transparency (cm)	65-125	78-110	50-85	50-90	65-75	80-110
Ph	7.5-8.2	7.8-8.6	7.9-8.5	8.0-8.6	7.8-8.3	7.8-8.7
Specific conductivity (umhos/cm)	330-465	410-505	650-980	975-1370	450-810	328-719
Dissolved Oxyzen (mg/l)	5.2-8.8	5.0-9.0	4.8-8.2	4.5-8.5	5.0-7.8	4.60-7.1
Total alkainity (mg/l)	125-172	155-195	190-275	175-265	155-225	246-366
Chloride (mg/l)	17-38	27-48	75-130	90-175	105-175	28-50
Total Hardness (mg/l) (CaCO3)	125-180	150-190	185-235	200-260	190-260	175-230

Table 3. LIST OF MACROPHYTE TAXA RECORDED FROM THE WETLANDS STUDIED

C =Present, - =Absent

	Type-I	Type-II	Type-III	Type-IV	Type-V	Type-VI
	Oxbow wetlands (baors/ beels)	Natural wetlands (beels/ jheels)	Fish culture (bheries)	Sewage-fed fish culture ponds (sewage bheries)	Multipurpose village pond (pukur)	Urban recreational (man made lakes)
A. Floating						
Rooted floating						
Family Nymphaeaceae						
Nymphaea pubiscens	C	C	-	-	C	C
Nelumbo nucifera	C	-	-	-	-	C
Nymphoides indicum	C	C	C	-	-	-
Family Scrophulariace6ae						
Limnophila heterophylla	C	C	-	C	-	-
Limnophila indica	C	-	C	-	C	C
Free Floating						

	Type-I	Type-II	Type-III	Type-IV	Type-V	Type-VI
	Oxbow wetlands (baors/ beels)	Natural wetlands (beels/ jheels)	Fish culture (bheries)	Sewage-fed fish culture ponds (sewage bheries)	Multipurpose village pond (pukur)	Urban recreational (man made lakes)
Family Aroideae						
Pistia stratiotes	C	C	-	C	C	-
Family Lemnaceae						
Lemna perpusilla	C	C	-	-	-	C
Spirodella polyrrhiza	C	-	-	-	C	-
Wolffia arrhiza	C	C	-	-	-	C
Family Onagraceae						
Trapa bispinosa	C	C	-	C	C	-
Family Pontederiaceae						
Ecchornia crassipes	C	C	C	C	C	C
Family Salviniaceae						
Azolla pinnata	C	C	-	-	-	C
Family Hydrocharidae						
Hydrocharis cellulosa	C	-	C	-	-	-
B. Submerged						
Rooted Submerged						
Family Characeae						
Chara bramchypus	C	C	C	C	C	C
Family Hydrochorideae						
Blyxa roxburghi	C	C	-	-	C	C
Hydrilla verticillata	C	C	C	-	C	C
Otellia alismoides	C	-	C	-	-	C
Vallisneria spiralis	C	C	-	-	-	C
Family Naiadaceae						

	Type-I Oxbow wetlands (baors/ beels)	Type-II Natural wetlands (beels/ jheels)	Type-III Fish culture (bheries)	Type-IV Sewage-fed fish culture ponds (sewage bheries)	Type-V Multipurpose village pond (pukur)	Type-VI Urban recreational (man made lakes)
Potamogeton crispus	C	C	C	-	-	C
Family Najadaceae						
Najas indica	C	C	-	-	C	C
Naja minor	C	C	-	-	-	C
Free Submerged						
Family Lentibullariaceae						
Utricularia stellaris	C	C	C	-	C	C
Family Ceratophyllaceae						
Ceratophyllum demersum	C	C	-	-	-	C
C. Emergent						
Erect :						
Family Cyperaceae						
Cyperus exaltatus	C	C	C	C	C	C
Elocharis dulcis	C	C	C	-	C	-
Scripus articulatus	C	C	C	C	-	C
Family Typhaceae						
Typha angustata	C	C	C	C	C	C
Family Polygonaceae						
Polygomum barbatum	C	C	C	-	-	-
Family Leguminosae						
Aeschynomene indica	C	C	-	-	-	-
Prostate						
Family Amaranthaceae						
Alternanthera philoxeroides	C	C	C	C	C	-
Family Convolvulaceae						
Ipomia aquatica	C	C	C	C	C	C
No. of Taxa	**31**	**26**	**16**	**11**	**17**	**22**

Table 4. OCCURRENCE AND ABUNDANCE OF INSECT SPECIES IN DIFFERENT WETLANDS
C =Present/Common, CC =Abumdant, R =Uncommon, - =Absent

	Length range (mm) (adults)	No. of species in the group all wetlands	Type-I Oxbow wetlands	Type-II Natural wetlands	Type-III Fish culture ponds	Type-IV Sewage-fed fish culture ponds	Type-V Multipurpose village ponds
ARTHROPODA-INSECTA							
EPHEMEROPTERA		-					
Family Baetidae							
Cloeon bengalense Kimmins	5.0-6.0		C	-	-	-	-
Cloeon bicolor Kimmins	5.0-5.6		R	C	-	-	-
Cloeon kimminsi Hubbard	4.8-6.2		C	C	-	-	-
Cloeon marginale (Hagen)	4.0-6.0		C	C	-	-	-
ODONATA		**19**					
Family Coegrionoidae							
Irschnura aurora aurora (Brauer)	21.0-22.0*		C	C	-	-	-
I. senegalensis (Rambur)	22.0-23.0*		C	-	C	C	-
I. rufostigma rufostigma Selys	21.0-22.0*		-	C	-	-	-
Enallagma parvum Selys	19.0-20.0*		CC	CC	C	C	CC
Ceriagrion coremandelianum (Fabricius)	29.0-32.0*		CC	CC	C	-	C
Pseudagrion microcephallum (Rambur)	29.0-31.0*		C	C	-	-	-
Agrocnemis pygmoea (Rambur)	18.0-20.0*		CC	CC	CC	C	CC
Family Platycneminidae							
Copera marginipes (Rambur)	28.0-29.0*		-	C	-	-	-
Family Gomphidae							
Ictinogomphus rapax (Rambur)	25.0-27.0		C	-	-	-	-
Family Corduliidae							
Epophthalmia vittata vittata Burmeister	21.0-22.0		C	-	C	-	-

	Length range (mm) (adults)	No. of species in the group all wetlands	Type-I Oxbow wetlands	Type-II Natural wetlands	Type-III Fish culture ponds	Type-IV Sewage-fed fish culture ponds	Type-V Multipurpose village ponds
Family Libellulidae							
Brachydiplax chalybea chalybea Brauer	21.0-25.0*		C	C	-	-	C
Brachydiplax farinosa Kruger	22.0-24.0*		C	C	C	-	C
Brachydiplax sobrina (Rambur)	16.0-22.0*			C	C	-	-
Brachythemis contaminata (Fabricus)	18.0-23.0		CC	CC	CC	C	-
Crocothemis servilla servilla (Drury)	23.0-25.0*		C	C	C	C	C
Diplacodes brivialis Rambur	20.0-23.0*		C	C	C	-	-
Orthetrum sabina sabina (Drury)	31.0-40.0*		CC	-	CC	C	C
Potamarcha obscura (Rambur)	29.0-32.0		-	C	-	C	-
HEMIPTERA		**19**					
Family Corixidae							
Micronecia scttelaris (Stae)	2.5-3.5		-	C	-	-	C
Family Notonectidae							
Anisops bouvieri Kirkaldy	5.5-6.5		CC	CC	-	C	C
Anisops breddeni kirkaldy	5.5-6.5		C	C	C	-	-
Anisops sardia Herrich-Shaffer	7.5-8.4		C	C	C	-	-
Family Pleidae							
Plea liturata Fiebr	2.0-2.0		C	R	-	-	-
Family Nepidae							
Laccotrephes greseus (Guerin)	15.0-20.0		C	C	C	C	C
Ranatra filiformis Fabricius	27.0-28.0		CC	CC	CC	CC	CC
Ranatra sordidula Dohrn	23.0-24.0		C	-	-	-	-
Family Belostomatidae							
Diplonychus annulatum (Fabricius)	21.0-22.0		CC	CC	CC	C	CC
Diplonychus rusticus (Fabricius)	15.0-17.0		C	C	C	-	C
Lethocerus indicus (Lep. & Serv.)	65.0-75.0		CC	C	CC	C	C
Family Mesoveliidae							

	Length range (mm) (adults)	No. of species in the group all wetlands	Type-I Oxbow wetlands	Type-II Natural wetlands	Type-III Fish culture ponds	Type-IV Sewage-fed fish culture ponds	Type-V Multipurpose village ponds
Mesovelia vittigera Horvath	2.5-3.0		C	C	C	C	C
Family Hydrometridae							
Hydrometra vittata Stal	1.0-12.0		C	C	C	-	-
Family Gerridae							
Limnogonus (L.) fossarum fossarum (Fabricius)	9.0-10.0		C	-	-	-	R
Limnogonus (L.) nitdus (Mayr)	6.0-8.0		-	CC	CC	C	C
Neogerris parvula (Stal)	6.0-6.5		C	C	-	-	-
Gerris spinolae Leth. & Sev.	10.0-12.5		C	C	-	-	-
Rhaghadotarsus kraepelini Breddin	3.5-4.5		R	-	-	-	-
Naboandelus signatus Distant	2.23-2.2		C	-	R	-	-
COLEOPTERA		**23**					
Family Dystiscidae							
Hydrocoptus subvittulus Motschulsky	1.8-2.2		CC	CC	C	C	C
Canthydrus laetabilis (Walker)	2.3-2.7		CC	CC	C	-	C
Canthydrus luctuosus (Aube)	3.0-3.3		-	C	-	CC	-
Laccophilus anticatus Sharp	3.0-3.2		C	-	C	-	C
*Laccophilus parvulus*Aube	3.5-3.7		-	C	-	-	-
Hyphydrus renardi Severin	3.3-3.8		C	-	-	-	-
Hydrovatus bonvouloiri Sharp	3.3-3.6		C	-	C	-	-
Hydrovatus confertus Sharp	2.3-2.5		C	C	C	C	C
Guignotus flammulatus (Sharp)	2.4-2.5		CC	CC	CC	C	CC
Guignotus pendjabensis Guignot	1.7-1.9		C	C	C	-	-
Uvarus quadrilineatuus (Zimmermann)	1.4-1.5		C	C	C	C	C
Cybister tripunctatus Sharp	2.8-3.0		C	C	-	-	-
Family Gyrinidae							

	Length range (mm) (adults)	No. of species in the group all wetlands	Type-I Oxbow wetlands	Type-II Natural wetlands	Type-III Fish culture ponds	Type-IV Sewage-fed fish culture ponds	Type-V Multipurpose village ponds
Dineutus unidentatus (Aube)	6.0-7.2		CC	CC	-	C	C
Oreclochilus productus Regimbart	4.5-5.5		C	C	C	-	-
Family Halipidae							
Haliplus angustifrons Regimbert	2.9-3.8		C	CC	-	-	C
Family Hydrophilidae							
Sperchares gibbus Champion	4.0-4.2		C	-	C	-	-
Helochares ancholario Sharp	5.8-6.2		C	C	-	-	-
Enochrus esuriens Walker	2.2-2.8		C	C	C	-	-
Sternolophus rufipes (Fabricus)			CC	CC	CC	C	C
Hydrophilus rufocinctus (Bedel)	31.0-32.0		CC	C	C	CC	C
Amphiops pedestris Sharp	3.0-3.2		C	-	C	-	C
Berosus indicus Motschulsky	2.6-3.0		C	C	-	C	C
Regimbertia attenuata Fabricius	4.8-6.2		C	C	-	-	
DIPTERA		**5**					
Family Chironomidae							
Ablabesmya sp.			C	-	-	-	-
Clinotanypus sp.			C	C	-	-	-
Chironomus sp.			C	C	C	C	C
Family Culicidae							
Anopheles sp.			C	C	C	C	C
Culex sp.			C	C	C	C	C
Total No. of Taxa		**70**	**63**	**54**	**40**	**26**	**31**

* abdominal length

Table 5. Relative composition of major groups of aquatic insects (Percent)

Order	Type-I Beri Gopalpur	Type-II Barti beel	Type-III Kalikapur bheri	Type-IV Bantala pond-I	Type-V Canning pond	Type-VI Rabindra Sarobar
Ephemeroptera nymphs	7.2	5.0	-	-	-	1.2
Odonata nymphs	16.5	18.5	9.0	6.0	11.4	20.4
Hemiptera	20.2	21.5	32.5	13.5	21.2	23.5
Coleoptera	24.5	19.4	36.5	15.5	16.2	24.2
Diptera larvae	31.6	35.6	22.0	66.0	49.2	30.7

Table 6. List of abundant insect species

	Odonata
1.	*Enallagma parvum* Selys
2.	*Ceriagrion coremandelianum* Fabricius
3.	*Agrocnemis pygmoea* (Rambur)
4.	*Brachythemis contaminata* (Fabricius)
5.	*Orthetrum sabina sabina* (Drury)
	Hemiptera
6.	*Anisops houvieri* Kirkaldy
7.	*Ranatra filiformis* Fabricius
8.	*Diplonychus annulatum* (Fabricius)
9.	*Lethocerus indicus* (Lep. & Serv.)
10.	*Limnogonus (L.) nitidus* (Mayr)
	Coleoptera
11.	*Hydrocoptus subvittulus* Motschulsky
12.	*Canthydrus laetabilis* (Walker)
13.	*Guignotus flammulatus* (Sharp)
14.	*Sternolophus rufipes* (Fabricius)
15.	*Hydrophilus rufocinctus* (Bedel)
	Diptera
16.	*Chironomus* sp.

Table 7. Coefficient of similarity between the wetlands

	Coefficient of similarity					
Wetland Types	I	II	III	IV	V	VI
I	-	-	-	-	-	-
II	0.8305	-	-	-	-	-
III	0.7573	0.6595	-	-	-	-
IV	0.4719	0.6	0.606	-	-	-
V	0.6383	0.6588	0.676	0.7368	-	-
VI	0.6981	0.7216	0.6746	0.6666	0.7027	-