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PRELIMINARY STUDIES ON THE AQUATIC INSECT DIVERSITY OF ACHARYA JAGADISH CHANDRA BOSE INDIAN BOTANIC GARDEN (AJCBIBG), WEST BENGAL

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INTRODUCTION

Study of aquatic insects has been proceeding for centuries, possibly millennia. Freshwater habitats from puddles to rivers to lakes, including both lentic (still water) and lotic (running water) habitats, can be home to various species of aquatic insects (Cheng, 1985; Daly, *et al*., 1998; Glausiusz, 1997). This specially adapted group of insects makes up only 3-5 percent of all insect species, but is very taxonomically diverse (Daly *et al*., 1998).

Aquatic insects are important as they form an important link in many food chains. They consume other invertebrates, small fish, aquatic plants, algae, detritus, and decaying matter and on the other hand, they are also an important food sources for birds, fishes, reptiles, and amphibians. Aquatic insects are also often used to determine water quality based on type and number of species present.

Several works on aquatic fauna have been published in India of them some works are those by Vazirani (1969, 1984), Sharma and Rai (1991), Sivaramakrishnan *et al*., (1995, 1996, 2000), Thirumalai (1999), Anbalagan *et al*. (2004), Subramanian and Sivaramakrishnan (2005), Anbalagan and Dinakaran (2006), Dinakaran & Anbalagan (2007) and Ghosh & Nilsson (2012).

Aquatic insects of West Bengal has been investigated by Bhattacharya and Gupta (1991), Srivasatava and Sinha (1995), Bal and Basu (1994a,b), Biswas *et al*., (1995a,b,c), Biswas and Mukhopadhyay (1995), Choudhury and Chattopadhyay (1997), Bhattacharya (2000), De (Pal) and Sengupta 1993, Srivastava, 1993, Pal *et al*., (2000), Khan and Ghosh (2001), Saha *et al*., (2007), Nandy *et al*., (2001), Srivastava (1993).

But nothing has been known about the aquatic insect diversity of Acharya Jagadish Chandra Bose Indian Botanic Garden (AJCBIBG) except Nandi *et al.*, (2001). This present work was aimed to study the faunal diversity of aquatic insects and associated floral components in the water bodies of the Indian Botanic Garden, Shibpur, West Bengal.

All over the world about 45000 species of insects are known to inhabit diverse freshwater ecosystem (Balaram, 2005).This present study recorded the colonization of 70 species under 24 families of 5 orders in the seven water bodies of AJCBIBG, with the highest number species (28 species) of aquatic insects from the family Hemiptera (Table. 2). Among the 70 species reported from this garden, *Amphiops pedestris* Sharp, the only lone species was found reported form all the seven water bodies (Table. 2).

These seven water bodies were also enriched with 37 species under 20 families of floral components. Of them, *Lemna perpusilla, Wolffia arrhinza, Alternanthera philoxeroides* and *Alternanthera sessilis* were the most abundant species and recorded from all the water bodies of AJCBIBG (Table. 3).

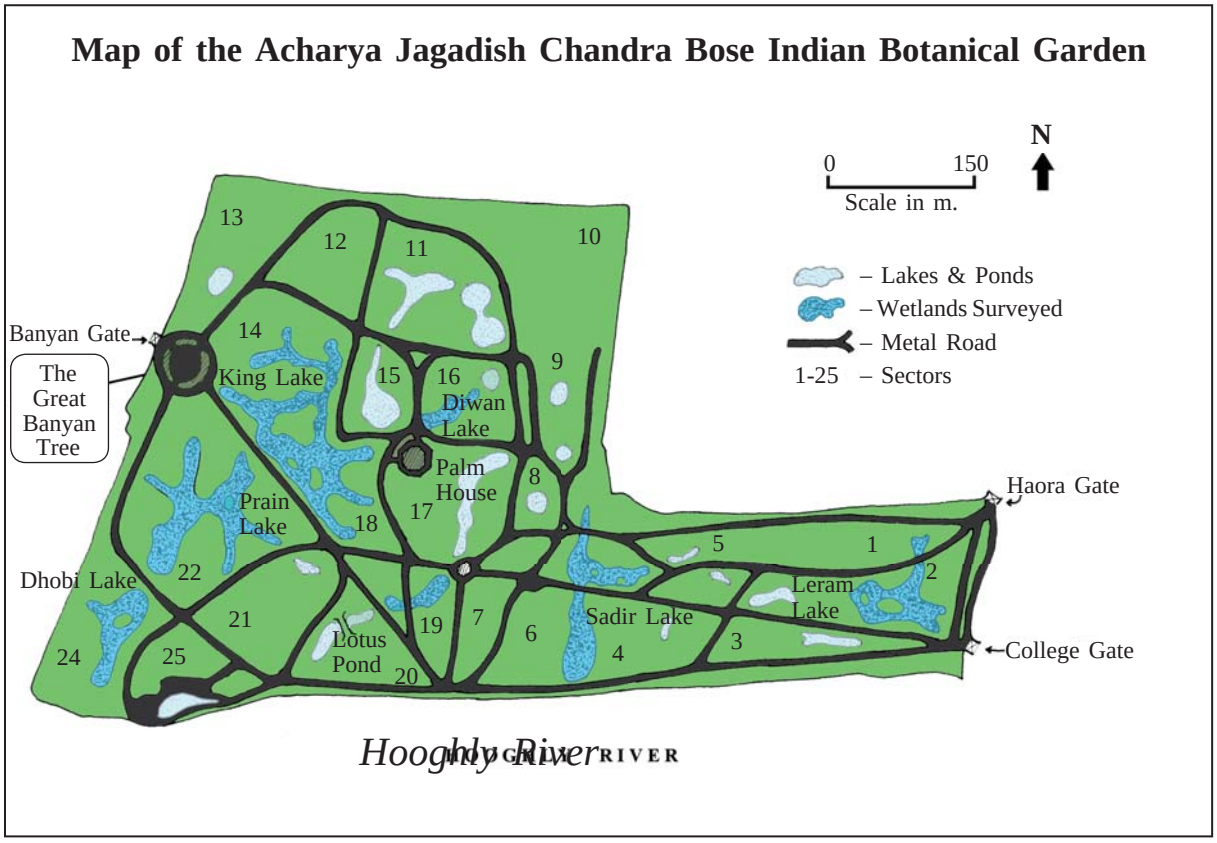


Fig. 1. Map of AJCBIBG and the study areas

MATERIALS AND METHODS

The study was conducted in Acharya Jagadish Chandra Bose Indian Botanic Garden (Map.1). With an area of 109 hectare. Acharya Jagadish Chandra Bose Indian Botanic Garden (AJCBIBG) is lying in between 22° 25´ N latitude and 88° 26´ E longitude in Howrah district of West Bengal. The land is formed by alluvial deposits laid down by the river Hooghly and fresh water flood plains, lakes, ponds which dominate the area under study. Among the 24 water bodies (small to large) of AJCBIBG seven sampling sites/lakes/ water bodies were selected for the study of aquatic insect faunal diversity in respect to their sizes, vegetative components and also their distances from the river Hooghly (Map.1).

According to the size of the water bodies, King Lake got rank 1, followed by Prain (2), Sadir (3), Leram (4), Dhobi (5), Diwan (6) and Lotus (7). Considering the closeness of the water bodies from the river Hooghly, Sadir Lake got rank 1, followed by Leram (2), Dhobi (3), Lotus (4), Prain (5), King (6) and Diwan (7). But on the basis of vegetative cover on the water bodies, Dhobi Lake got rank 1, followed by King (2), Prain (3), Leram (4), Lotus (5), Sadir (6) and Diwan (7) (Table.1).

The insect collections have been made using drag net of one sq. mt. (75 – 80 mesh / $cm.^2$), aquatic insect collecting net with six feet long handle, box type sampler (20 X 20 X 40 cu. cm., Pal and Nandi, 1997). The study was conducted from December 2002 to 2004. The detail description of sampling sites are given below (Table.1)

Table 1. Description of sampling sites of AJCBIBG

No	Name of the site/ lakes/ water bodies	Rank given as per closeness to river Hoogly	Rank given as per size of the water bodies	Rank given as per vegetative components	Description of the water bodies
1	**King Lake**	6	1	2	This lake is situated in between Sector- 14 and 18. The area of the lake is about 26,875 sq. mts. More than 60% of the lake area is covered with *Eichhornia, Victoria amazonica* (leaf diameter is about 1.5 mt), *Pistia, Spirodella, Lemna, Wolfia, Azolla, Najas, Alternanthera, Hydrilla, Marsilia* and aquatic grass etc.
2	**Prain Lake**	5	2	3	This lake is situated at Sector 22 and area is about 24,600 sq. mt. The lake is more or less clear and sparsely vegetated with *Pistia, Azolla, Salvinia, Hrydrilla, Lemna, Nymphaea, Typha, Wolfia, Spirodella, Ipomoea* etc.
3	Leram Lake	2	4	4	This lake is situated at Sector 2 and area is about 13,600 sq. mt. Mostly, *Eichhornia, Pistia, Alternanthera,. Lemna, Spirodella, Wolfia,* and few marginal grasses *etc*. were enriched the floral components of this lake.
4	Dhobi lake	3	5	1	This lake is situated at Sector 24 and the area is about 10,350 sq. mt. The entire lake is covered with aquatic vegetations. The major floral components are *Eichhornia, Pistia, Spirodella, Typha etc*.
5	**Sadir Lake**	1	3	6	This lake is situated at Sector 5 and 6 and area is about 15,600 sq. mt (Map.1). Most of the portion of this lake is covered with *Pistia, Lemna, Alternanthera, Spirodella, Wolfia, Ipomoea* etc. Aquatic grass is also present in the marginal area of this lake.
6	**Diwan Lake**	7	6	7	This pond is situated at Sector 16 with an area of 3,600 sq. mt. The pond is more or less clear. *Victoria amazonica, Spirigyra, Lemna, Spirodella, Wolfia, Alternanthera, Hydrilla, Potamogeton, Najas* etc. are the only plant species found in this pond.
7	**Lotus Pond**	4	7	5	This pond is the smallest among the seven water bodies studied here and situated at Sector 19 and area is about 3,500 sq. mt. Eastern zone of this pond is covered with *Nelumboo and Nymphaea* of aquatic plants. The rest of the portion of this pond is covered with *Spirodella, Lemna, Wolfia, Pistia, Hydrilla, Najas etc* like vegetative components.

RESULTS & DISCUSSION

Altogether 70 species under 59 genera of 24 families belonging to 5 orders of aquatic insects along with 34 species under 26 genera of 19 families has been reported from the seven lakes of AJCBIBG (Table.2).

Table. 2. Order, Family and species of aquatic insects reported from seven water bodies

Sl. No.	Family	Species	King Lake	Prain lake	Leram lake	Dhobi Lake	Sadir lake	Lotus pool	Diwan Lake	Total
A.	**Order Ephemeroptera**									
1	Family Baetidae	*Cloeon kimminsi* Hubbard		+			+	+	+	4
2	Family Caenidae	*Caenis* sp.						+		1
B.	**Order Odonata**									
3	Family Libellulidae	*Orthetrum sabina sabina* (Drury)	+	+		+	+		+	5
4		*Brachydiplax sorbina* (Rambur)	+				+			2
5		*Neurothemis tullia tullia* (Drury)			+					1
6		*Crocothemis* servilia servilia (Drury)	+					+		2
7		*Brachithemis contaminate* (Fabricius)	+	+			+		+	4
8	Family Gomphidae	*Ictinogomphus* rapax (Rambur)	+							1
9	Family Coenagrionidae	*Ceriagrion coromondelianum* (Fabrius)		+			+		+	3
10		*Pseudagrion australasiae* Selys	+		+		+			3
11		*Agriocnemis pygmaea* (Rambur)				+				1
12		*Ischnura aurora aurora* (Brauer)	+					+		2
C.	**Order Hemiptera**									
13	Family Belostomidae	*Diplonychus annulatus* (Fabricius)						+		1
14		*Diplonychus molestus* (Dufour)						+		1
15		*Diplonychus rusticus* (Fabricius)	+	+	+		+			4
16		*Lethocerus indicus* (Lepeletiler & Serville)	+						+	2
17	Family Micronectidae	*Micronecta scutellaris scutellaris* (Stal)	+					+		2
18	M. haliploides	*Micronecta haliploides* Horvath					+			1
19	Family Corixidae	*Sigara* (*Tropocorixa*) *distorta* (Distant)	+							1

Table 2. contd.

Sl. No.	Family	Species	King Lake	Prain lake	Leram lake	Dhobi Lake	Sadir lake	Lotus pool	Diwan Lake	Total
20	Family Pleidae	*Paraplea liturata* (Fieber)	+	+		+	+		+	5
21		*Paraplea frontalis* (Fieber)	+		+		+	+		4
22	Family Helotrephidae	*Tiphotrephes indicus* (Distant)	+	+			+			3
23	Family Gerridae	*Aquarius adelaidis* (Dohrn)		+			+			2
24		*Limnogonous* (*s. str*.) *fossarum fossarum* (Fabricius)	+	+	+		+		+	5
25		*Limnogonous (s. str.) nitidus* (Mayr)	+	+			+		+	4
26		*Neogerris parvulus* (Stal)	+							1
27		*Rhagadotarsus* (*s. str*.) *kraepelini* Breddin	+	+			+	+	+	5
28	Family Notonectidae	*Anisops breddini* Krikaldy		+						1
29		*Anisops bouvieri* Krikaldy	+	+	+	+	+	+		6
30		*Anisops sardeus sardeus* Herrich-Shaffer	+	+			+		+	4
31		*Anisops barbatus* Brooks	+	+				+		3
32		*Nychia sappho* Krikaldy					+			1
33	Family Nepidae	*Ranatra filiformis* Fabricius	+	+			+	+	+	5
34		*Ranatra digitata* Hafiz & Pradhan	+							1
35		*Ranatra varipes varipes* Stal	+	+	+		+	+	+	6
36		*Laccotrophes griseus* (Guerin- Meneville)	+						+	2
37	Family Mesoveliidae	*Mesovelia vittigera* Horvath	+	+	+		+	+		5
38		*Mesovelia horvathi* Lundblad						+		1
39	Family Veliidae	*Microvelia* (*s.str*.) *diluta* Distant	+	+						2
40	Family Hydrometridae	*Hydrometra greeni* Kirkaldy	+	+	+			+		4

Table 2. contd.

Sl. No.	Family	Species	King Lake	Prain lake	Leram lake	Dhobi Lake	Sadir lake	Lotus pool	Diwan Lake	Total
D.	**Order Coleoptera**									
41	Family Haliplidae	*Haliplus (Liaphlus) angustifrons* Regimbart							+	1
42	Family Noteridae	*Neohydrocoptus subvittulus* (Motschulsky)	+		+			+	+	4
43		*Canthydrus angularis* Sharp	+	+	+		+	+	+	6
44		*Canthydrus laetabilis* (Walker)	+	+					+	3
45		*Canthydrus luctuosus* (Aube)	+	+	+		+	+		5
46	Family Dytiscidae	*Hydroglyphus signatellus* (Klug)		+				+	+	3
47		*Cybister limbatus* (Fabricius)	+						+	2
48		*Leiodytes orissaensis* (Vazirani)	+			+				2
49		*Laccophilus sharpi* Regimbert	+							1
50		*Laccophilus anticatus anticatus* Sharp	+	+		+	+	+	+	6
51		*Laccophilus flexucsus* Aube	+				+		+	3
52		*Laccophilus parvulus parvulus* Sharp	+				+		+	3
53		*Hydrovatus sinister* Sharp	+							1
54		*Hydrovatus castaneus* Motschulsky	+							1
55	Family Hydrophilidae	*Hydrophilus indicus* (Bedal)	+							1
56		*Helochares anchoralis* Sharp	+		+					2
57		*Helochares lentus* Sharp	+							1
58		*Helochares pallens* Macleay	+							1
59		*Sternolophus rufipes* (Fabricius)		+					+	2
60		*Berosus indicus* Motschulsky	+							1
61		*Regimbertia acttenuata* Fabricius								
62		*Amphiops pedestris* Sharp	+	+	+	+	+	+	+	7
63		*Amphiops simplex* Sharp	+			+				2
64		*Enochrus esuriens* (Walker)	+							1

Table 2. contd.

Sl. No.	Family	Species	King Lake	Prain lake	Leram lake	Dhobi Lake	Sadir lake	Lotus pool	Diwan Lake	Total
65	Family Gyrinidae	*Dineutus indicus* Aube					+			1
66		*Orectochilus (Patrus) productus* Regimbart	+							1
67	Family Curculionidae	*Bagous* sp.	+				+			2
E.	**Order Diptera**									
68	Family Chironomidae	*Chironomus striatipennis* Keiffer					+	+		2
69	Family Culicidae	*Anopheles annularis* Van der Wulp	+			+			+	3
70		*Culex (Culex) bitaeniorhynchus* Giles	+				+			2
Total number of insect species = 70			53	27	14	9	31	23	25	

Among the seven water bodies studied here, the King Lake (75% insect species and 76.48% plant species) is more diverse than others in relation to both fauna and flora. This may be due to its size, over 60% vegetative cover and highest number of aquatic plant species. Korkeamaki & Suhonen (2002) study also support that the faunal distribution and their assemblage are strongly dependent on the composition and structure of vegetation (Fig. 2).

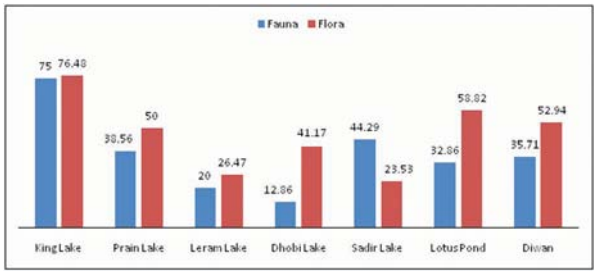


Fig.2. Percentage (%) composition of aquatic insects and plants in seven sites of AJCBIBG

Among the five orders of aquatic insects reported in this study, the predominant order of AJCBIBG was Hemiptera, followed by Coleoptera, Odonata, Diptera and Ephemeroptera respectively (Figure 1).

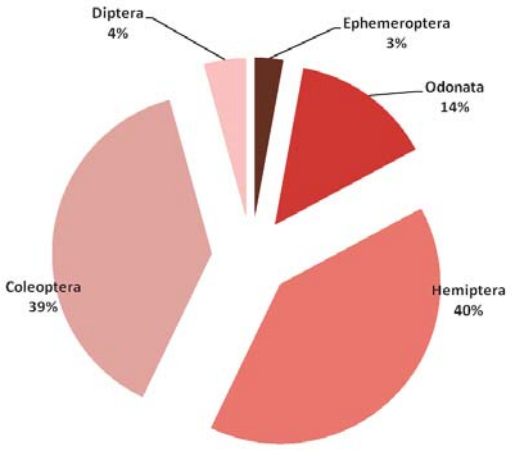


Fig.1. Distribution of aquatic insect species (in percent) in seven sites of AJCBIBG

Of them, the most dominant family of this garden was Hydrophilidae of the order Coleoptera and the ten families with single species, namely, Baetidae, Caenidae, Gomphidae, Corixidae, Helotrephidae, Veliidae, Hydrometridae, Curculionidae, Haliplidae, Chironomidae (Fig.3).

Abbreviations used: 1: Ephemeroptera, 2: Odonata, 3: Hemiptera, 4: Coleoptera, 5: Diptera.

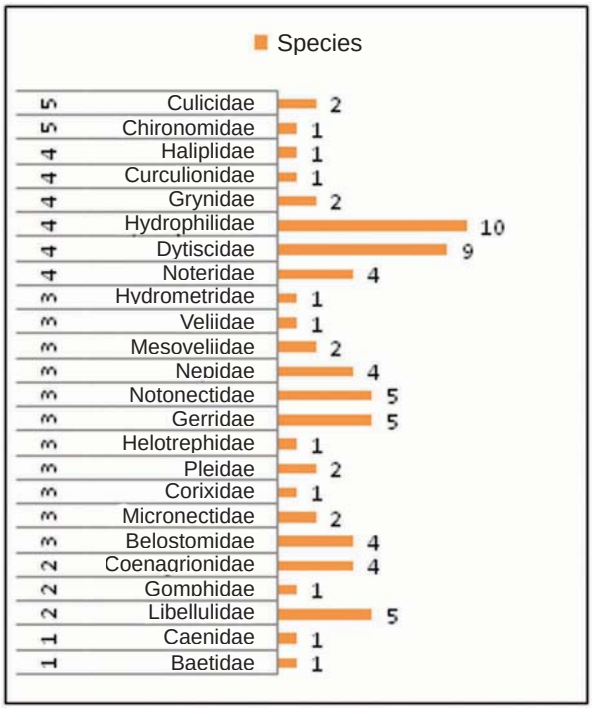


Fig.3. Number of aquatic insect species (Family-wise) reported from seven sites of AJCBIBG

Altogether, 28 species under 11 families of Hemiptera or water bugs were reported from seven water bodies of AJCBIBG during this study (Table.2). Of them, only *Anisops bouvieri* Krikaldy of the family Notonectidae (5species) was found to distribute in majority of the water bodies (6) studied during this present survey. A lone species of the family Corixidae, *Sigara* (*tropocorixa*) *distorta* (Distant) was reported only from King Lake of this garden during this survey. During this study, only four species of the family Nepidae were reported, of them, *Ranatra varipes varipes* Stal was found as very common water scorpions in AJCBIBG. With four species of two genera of Belostomatidae were enriched the aquatic insect fauna of AJCBIBG. Of them, *Diplonychus rusticus* (Fabricius) was found the most dominant species and reported from 4 water bodies of this garden. *Limnogonous* (*s.str.*) *fossarum fossarum* (Fabricius) and *Rhagadotarsus* (*s.str.*) *kraepelini* Breddin of the family Gerridae and *Mesovelia vittigera* Horvath of the family Mesoveliidae were the predominant species and reported from most of the water bodies in AJCBIBG. During this present study, two species of the family Pleidae were also found well distributed in seven water bodies. Only two species of the family Micronectidae of this order were rarely reported from this garden. The members of this family were not well distributed rather rarely found in this garden (Table.2).

A total of 27 species of aquatic beetles of the six families of the order Coleoptera is the second largest order among the five orders found in seven water bodies of AJCBIBG. Among them, the family Hydrophilidae shared maximum number of species. *Amphiops pedestris* Sharp was the only species of the family Hydrophilidae distributed in all the water bodies studied in AJCBIBG. The next largest family of this garden of Coleoptera was Dytiscidae with nine species. During this present study, all the species were distributed more than one water body except, *Hydrovatus sinister* Sharp, *Hydrovatus castaneus* Motschulsky and *Laccophilus sharpi* Regimbert. The most common species was *Laccophilus anticatus anticatus* Sharp reported from six water bodies of this garden. During this study, all the four species of the family Noteridae was found to distribute in all the water bodies of AJCBIBG. Only two species of the family Gyrinidae were encountered. Of them, *Dineutus indicus* Aube only reported from Sadir Lake and *Orectochilus (Patrus) productus* Regimbart from King Lake. But the curculionids were reported from both the King and Sadir lakes .Only one species of the family Haliphidae or crawling water beetles of the order Coleoptera was collected from the aquatic vegetation of the Diwan Lake (Table.2).

During this present study, 10 species of damsel and dragon flies of the three families were reported from the seven water bodies of AJCBIBG. Of them, *Orthetrum sabina sabina* (Drury) was the dominant species and reported from the five water bodies and *Neurothemis tullia tullia* (Drury) reported only from Leram Lake of this garden (Table.2).

Only three species of true flies, one from family Chironomidae and two from family Culicidae were reported from more than one water bodies during this survey (Table.2).

PLATE I

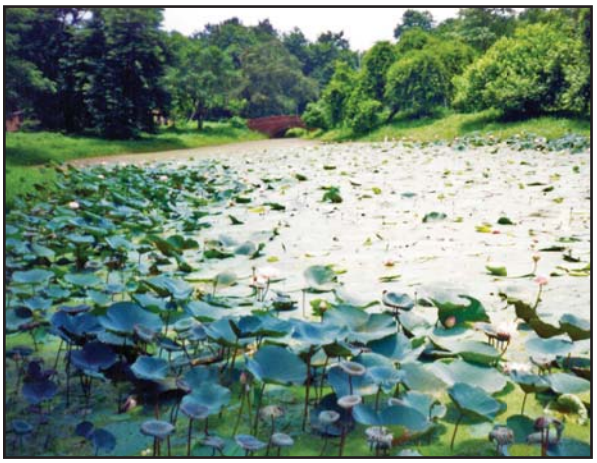
Collect specimens from King Lake

Collect specimens from Diwan Lake

Collect specimens from Dhobi Lake

PLATE II

Prain Lake



Lotus Pond

Sadir Lake

Leram Lake

Only two species of Mayflies under two families were reported from this garden. Among them, *Cloeon kimminsi* Hubbard was more abundant and distributed in more Water bodies (4) than *Caenis* sp. (1) (Table.2).

During this study, Only 34 species under 19 families of aquatic plants were reported from the seven water bodies of Acharaya Jagadish Chandra Bose Botanic garden. Of them, *Lemna perpusilla, Wolffia arrhinza, Alternanthera philoxeroides* and *Alternanthera sessilis* were very common and found all the water bodies under studied (Table. 3). It is also evident from the table.3, that King lake shared maximum number of floral species (26), followed by Lotus (20), Diwan (18), Prain (17), Dhobi (14), Leram 99) and Sadir Lake (8) (Table.3).

Table. 3. Floral species reported from the seven sites of AJCBIBG

Sl. No.	Family	Species	King Lake	Prain Lake	Leram Lake	Dhobi Lake	Sadir Lake	Lotus pond	Diwan lake	Total
1	Zygnemataceae	*Spirogyra* sp.				+		+	+	3
2	Aroideae	*Pistia stratiotes*	+	+	+	+		+	+	6
3	Lemnaceae	*Lemna minor*	+	+	+	+		+	+	6
4		*Lemna perpusilla*	+	+	+	+	+	+	+	7
5		*Spirodella polyrrhinza*	+		+	+	+	+	+	6
6		*Wolffia arrhinza*	+	+	+	+	+	+	+	7
7	Pontedesia	*Eichhornia christata*	+	+	+	+		+		5
8		*Eichhornia crassipes*	+	+		+	+			4
9	Salviniaceae	*Azolla bipinnata*	+	+				+		3
10		*Azolla pinnata*	+	+						2
11		*Salvinia cuculata*		+						1
12	Hydrochorideae	*Hydrilla vertricillata*	+					+	+	3
13		*Hydrilla dentana*	+					+	+	3
14		*Vallisneria spiralis*	+					+		2
15	Naiadaceae	*Potomogeton crispus*	+							1
16		*Aponogeton nalans*	+							1
17	Najadaceae	*Najas minor*							+	1
18		*Najas indica*	+						+	2
19	Scrophularineae	*Limnophila*, sp. *heterophylla*, sp.	+							1
20	Ceratophyllaceae	*Ceratophyllum demersum*	+	+	+	+		+	+	6
21	Lentibulariaceae	*Utricularia stellaris*	+	+						2
22	Amarantaceae	*Alternanthera philoxeroides*	+	+	+	+	+	+	+	7
23		*Alternanthera sessilis*	+	+	+	+	+	+	+	7
24	Cyperaceae	*Cyperas compressus*	+	+			+		+	4

Table. 3. contd.

Sl. No.	Family	Species	King Lake	Prain Lake	Leram Lake	Dhobi Lake	Sadir Lake	Lotus pond	Diwan lake	Total
25	Nymphaceae	*Nelumbo nucifera*						+		1
26		*Nymphaea rubra*	+					+		2
27		*Nymphaea lotus*						+		1
28		*Victoria amazonica*	+						+	2
29	Alismaceae	*Saggitaria sagittifolia*	+					+	+	3
30	Cyperaceae	*Cyperus exaltatus*		+		+	+			3
31	Hydrophyllaceae	*Ipomoea aquatica*		+		+		+	+	4
32	Marsiliaceae	*Marsilea minuta*	+						+	2
33		*Marsilea quadrifoliata*	+					+		2
34	Typhaceae	*Typha angustata*		+		+				2
Total number of Plant species = 34			26	17	9	14	8	20	18	

During this present study, among the five orders of aquatic insects the members of the orders Hemiptera (28 species) and Coleoptera (26 species) were found as most successful colonizer and *Amphiops pedestris* Sharp was only species found from seven water bodies of AJCBIBG. From this analysis this can be said that, the member of these two orders may get a suitable habitat for their colonization than other insect groups in these water bodies.

Because, we know colonization is taken to be the end product of a series of steps in an individual insect's behavior. According to Fernando (1959), these steps are (i) dispersal, (ii) location of new habitat, (iii) selection of a new habitat and (iv) colonization itself. These steps have evolved as a result of two types of stimuli: proximate factors, such as environmental temperature and photoperiod, and ultimate factors, such as presence and availability of suitable food and substrate or suitable oviposition sites.

However, we have shown that the diversity of aquatic insects of these seven water bodies of AJCBIBG which may serve as a baseline data for future workers. Therefore, more analysis on water quality, vegetative quality, food sources of these water bodies will definitely bring interesting results.

SUMMARY

The study revealed the colonization of 70 species under 24 families of 5 orders in the seven water bodies of Acharya Jagadish Chandra Bose Indian Botanic Garden, Howrah, West Bengal. Of the five orders reported from this Botanic garden, Hemiptera shared maximum number of species (28 species). Among the 70 species reported from this garden, *Amphiops pedestris* Sharp of the order Coleoptera was found common form all the seven water bodies. Considering the floral diversity, altogether 37 species under 19 families were reported from these seven water bodies.Of them, *Lemna perpusilla, Wolffia arrhinza, Alternanthera philoxeroides* and *Alternanthera sessilis* were the most abundant species and recorded from all the water bodies of AJCBIBG.

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