Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2020; 8(1): 1063-1071

Received: 22-11-2019
Accepted: 24-12-2019

Sumana Saha
Post Graduate Department of Zoology, Barasat Government College, 10, K.N.C. Road, Barasat, Kolkata, West Bengal, India

Shami Akhter
Post Graduate Department of Zoology, Barasat Government College, 10, K.N.C. Road, Barasat, Kolkata, West Bengal, India

Dinendra Raychaudhuri
IRDM Faculty Centre, Department of Agricultural Biotechnology, Ramakrishna Mission Vivekananda Educational and Research Institute, Narendrapur, Kolkata, West Bengal, India

Corresponding Author:
Sumana Saha
Post Graduate Department of Zoology, Barasat Government College, 10, K.N.C. Road, Barasat, Kolkata, West Bengal, India

Lentic biodiversity with special reference to insects and spiders of two freshwater ponds of Ramakrishna mission Ashrama, Narendrapur, S-24 Parganas

Sumana Saha, Shami Akhter and Dinendra Raychaudhuri

Abstract
Ponds at the local level are supposed to play the pivotal role in the conservation of aquatic biodiversity. This is primarily because both abundance and diversity of aquatic insects is expected to be more in freshwater habitats. We therefore cannot deny our responsibility in the matter of conservation. With this in mind a comparative study is carried out during August 2018-July, 2019 on the aquatic insect/spider diversity of two different ponds [managed & unmanaged] in RKM Campus, Narendrapur, S-24 Parganas, West Bengal. Weekly sampling was made to assess the pollution status of the referred ponds basing on the aquatic insect community and physicochemical properties of water. Hemipterans are found to be dominant in both the ponds. As per habitat orientation the fauna are of 6 different types and functionally of 4 types. Increase in DO content and water temperature, do increase the abundance of dominant species in both the ponds. Negative impact is noted for pH on the abundance. This study attempts to point out that unmanaged ponds have an important role to play in biodiversity conservation.

Keywords: Lentic system, insects, biodiversity, RKM Ashrama, Narendrapur

Introduction
Ecology of aquatic insects/spiders is being intensively studied from various perspectives, reflecting their abundance, diversity and important role in the communities and ecosystems they inhabit. In aquatic food webs, referred groups serve as food items for nearly the full range of vertebrate and invertebrate predators and many function as predators. Extensive information is available on their responses to a variety of environmental conditions, including factors that operate at the landscape level. Thus, their responses often are used as indicators of water quality conditions in freshwater systems. Ecological literatures on aquatic insects in the past decades reflect the current interest in the topic [1, 2, 3, 4, 5, 6, 7, 8]. Yet, enormous diversity coupled with their widespread distribution indicate that gap areas need further exploration. Aquatic insects primarily process wood and leaf litter reaching the wetland from the surrounding landscape. Nutrients processed by aquatic insects are further degraded into absorbable form by fungal and bacterial action. Plants in the riparian zone absorb these nutrients transported through the wetlands. In addition to this significant ecosystem function, aquatic insects are also a primary source of food for fishes and amphibians [9]. A high diversity of aquatic insect species is of value to humans and animals for a variety of reasons, out of which four are particularly important viz. (a) food webs, (b) biomonitoring, (c) fishing and (d) controlling noxious weeds [10].

Aquatic insects of inland wetlands comprise some well-known groups like mayflies (Ephemeroptera), dragonflies (Odonata), caddiesflies (Trichoptera), beetles (Coleoptera) and bugs (Heteroptera). Different functional feeding groups of aquatic insects such as shredders, scrapers, filter feeders and predators are important links in nutrient recycling [9]. The aim of this study is to investigate the diversity of aquatic insects/spiders in relation to water quality variables in order to explore their bioindication potential.

Study area
(Fig. 1): The survey was conducted since August 2018 to July 2019 within Ramakrishna Mission Ashrama Campus, Narendrapur, South – 24 Parganas (22.44°N Latitude, 88.4° E Longitude). For the present study two permanent water bodies designated as unmanaged pond and managed pond (Fig. 2) were selected.

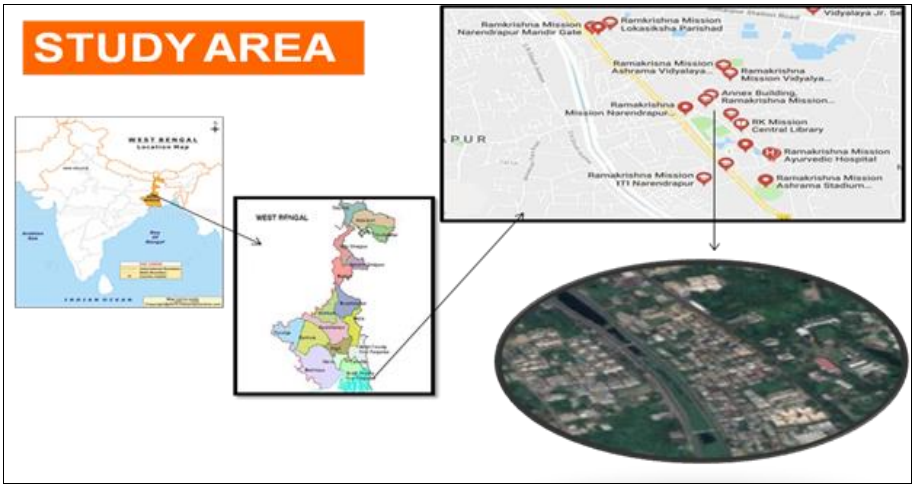


Fig 1: Study Area

Fig 2: Study Sites

Materials & Methods

Aquatic insects sampling

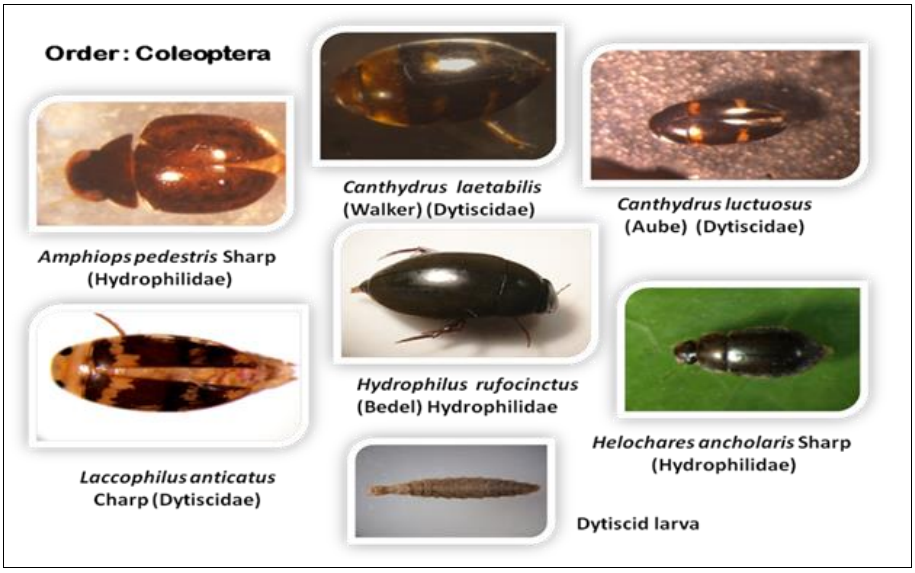
Specimens were sampled weekly (later pooled to generate data of the seasons) using a pond net (mesh opening: 500µm; diameter: 60cm; depth: 50cm) with adjustable handle (Fig. 3) and sorted out with fine camel hair brush and forceps. Collected samples were preserved in a plastic container filled with 70% alcohol as per recommendation [11]. The materials were studied using Stereo Zoom Binocular Microscope, model Olympus SZX-16. Insect/spider samples were identified following [9, 12, 13, 14, 15, 16, 17, 18] and their status were confirmed following [19, 20, 21]. Specimens were in the deposition of Post Graduate Department of Zoology, Barasat Government College, Barasat, Kolkata.

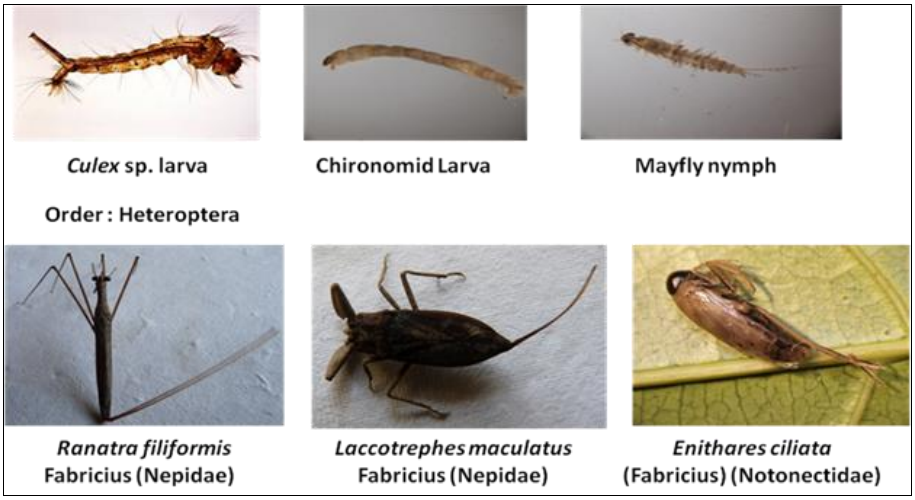
Fig 3: Sample collection

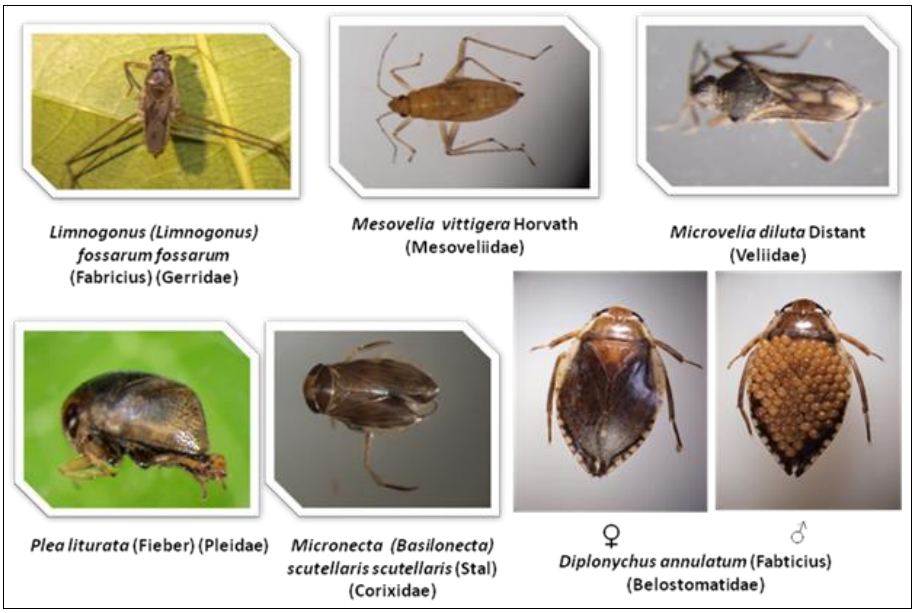
Physicochemical water quality parameters

Water samples were collected from each sampling period immediately before the sampling of aquatic fauna. Three replicates of selected physicochemical water quality parameters were recorded directly at the sampling site. pH was measured by a pH-meter Water proof Model Testr30, water temperature was measured by a hand-held thermometer and dissolved oxygen (DO) was measured by a HACH® Model sensION6 DO meter. Other water quality parameters were analyzed in accordance with the standard method procedures [22].

Encountered insects/spider fauna







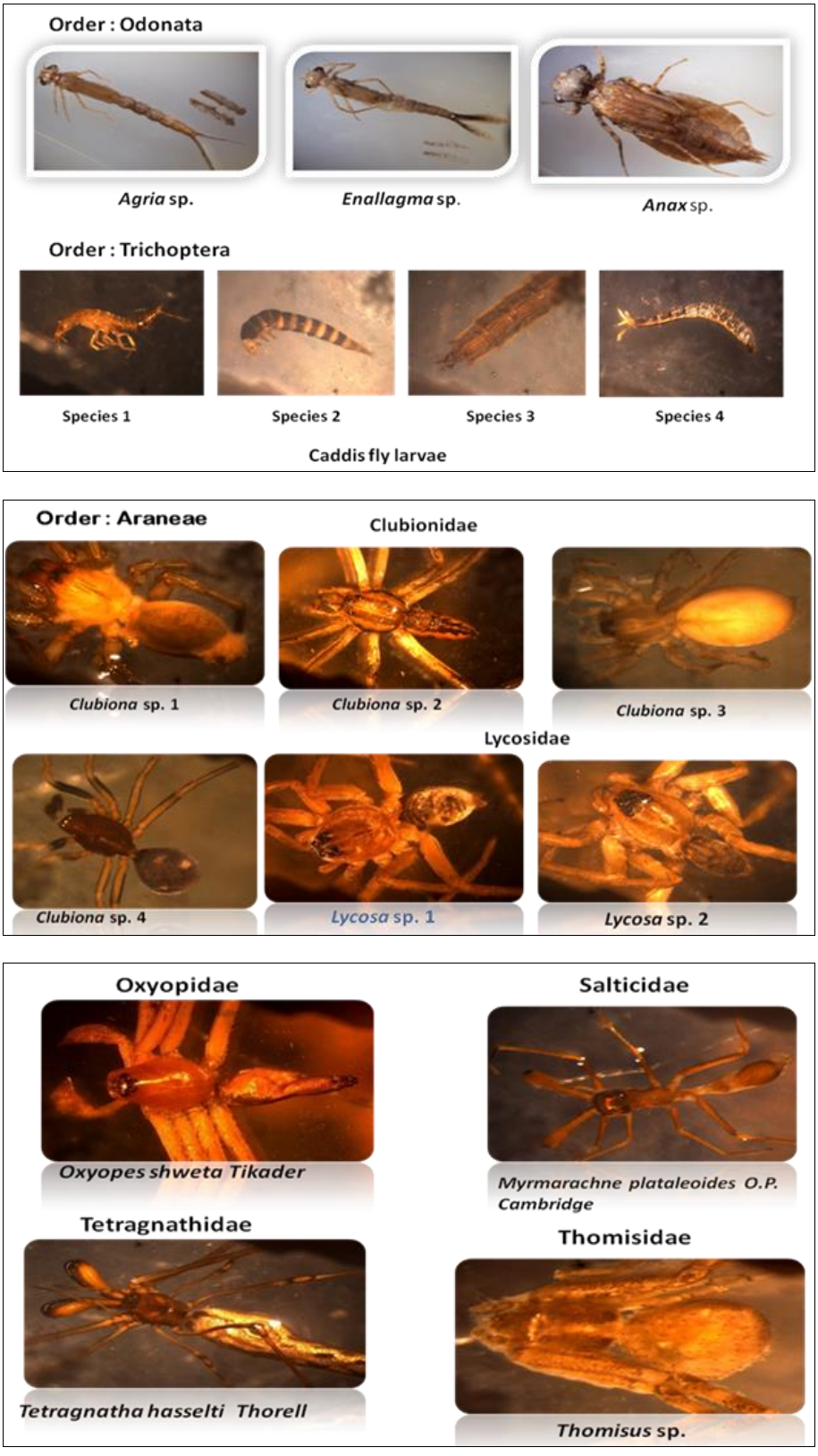


Fig 4: Aquatic insect & spider fauna collected from managed and unmanaged ponds

Results and Discussion

A total of 36 aquatic species belonging to 31 genera and 7 orders including 6616 individuals (managed pond: 2450; unmanaged pond: 4166) are recorded during the period of survey (Tables: 1A & B). The main taxonomic groups encountered are Araneae, Diptera, Coleoptera, Ephemeroptera, Hemiptera, Odonata and Trichoptera. Hemipterans in both the ponds are the dominant group (Tables: 1A & B; Figs. 4 & 5). These include *Enithares ciliata* (Fabricius) [Back Swimmer: Notonectidae] in managed pond while *Diplonychus annulatum* (Fabricius) [Giant Waterbug: Belostomatidae] in unmanaged pond (Tables: 1A & B, 2). The number of individuals of dominant aquatic insect is found to be maximum (989 & 841) in managed pond & unmanaged ponds respectively in the premonsoon season followed by postmonsoon and monsoon. Weather chart during the study period and water temperature in managed & unmanaged ponds are presented in the Tables 3

& 4 respectively. Table 5 depicts the mean values of selected physicochemical parameters of water quality during the study period. Increase in DO content and water temperature do increase the abundance of dominant species in both the ponds. Negative impact is noted for pH on the abundance of the dominant species (Table 6). As per habitat orientation the encountered aquatic insects are of 6 different types (Table 7; Fig. 6). Different functional groups of aquatic insects occupy different trophic levels of food chain & food web in pond ecosystem (Table 8; Fig. 7). These hemipterans, the dominant groups form food in different trophic levels of freshwater ecosystem [4, 5] (Fig. 7) which may be due to the presence of riparian vegetation and suitable substrates [23]. The riparian vegetation may provide them protection from predators and suitable environment for the growth of periphytic algae, which is an important food source for many of the aquatic insects [23]. These bugs are overall indicators of long term environmental conditions and constitute integral component of almost all freshwater communities [7, 24]. Because of their poor dispersal ability, this group of bugs serves as zoogeographical indicators for diverse habitats. Further, some members belonging to the families of the infra order Nepomorpha are useful in the biological control of mosquito larvae. Besides, a few species of corixids are known as indicators of water quality [19]. Moreover, study also indicates that the quality of aquatic environment is partially dependent on the abundance of aquatic bug population. Data further prompts to infer that different physico chemical properties of water are inter related and these factors either independently or conjointly influence diversity, density and distribution of aquatic insects in a particular water body [4, 5]. Thus, the inventorization of aquatic insects becomes imperative to understand the functional aspects of community structure in any aquatic ecosystem and provides information of energy flow [25]. This study attempts to point out that unmanaged ponds have an important role to play in biodiversity conservation [7]. Further the Class Insecta has many potential representatives that can be used as environmental bioindicators [24] (Fig.8).

Table 1A: Aquatic insects and spiders trapped from managed pond

S. No.	Insect Order	Species	Seasonal Occurrence			Total	Abundance%
			PrM	M	PsM		
I	Coleoptera	1. *Amphiops pedestris* Sharp	18	-	-	18	0.73
		2. *Canthydrus luctuosus* (Aube)	59	-	-	59	2.41
		3. *Helochares ancholaris* Sharp	-	6	20	26	1.06
		4. Dytiscid larva (sp. 1)	9	-	-	9	0.36
II	Diptera	5. *Culex* sp. (Larva + Pupa)	360	-	-	360	14.69
III	Hemiptera	6. *Enithares ciliata* (Fabricius)	989	311	325	1625	66.33
		7. *Plea liturata* (Fieber)	45	-	-	45	1.84
		8. *Ranatra filiformis* Fabricius	46	48	34	128	5.22
IV	Odonata	9. *Enallagma* sp. (Damsel fly nymph)	115	10	9	134	5.47
		10. *Anax* sp. (Dragon fly nymph)	2	-	-	2	0.08
V	Araneae	11. *Camaricus formosus* Thorell	1	-	-	1	0.04
		12. *Lycosa* sp. 1	26	1	-	27	1.10
		13. *Lycosa* sp. 2	13	1	-	14	0.57
		14. *Tetragnatha hasselti* Thorell	1	1	-	2	0.08
	Total		1684	378	388	2450	

Legend: PrM = Premonsoon; M= Monsoon; PsM= Postmonsoon

Table 1B: Aquatic insects and spiders trapped from unmanaged pond

S. No.	Insect Order	Species	Seasonal Occurrence			Total	Abundance%
			PrM	M	PsM		
I	Coleoptera	1. *Amphiops pedestris* Sharp	227	116	84	427	10.25
		2. *Canthydrus luctuosus* (Aube)	4	-	-	4	0.10
		3. *Canthydrus luctuosus* (Aube)	117	64	145	326	7.83
		4. *Helochares ancholaris* Sharp	22	15	50	87	2.09
		5. *Hydrophilus rufocintus* (Bedel)	2	-	-	2	0.05
		6. *Laccophilus anticatus* Charp	16	15	1	32	0.77
		7. Dytiscid larva (sp. 1)	20	5	1	26	0.62
		8. Dytiscid larva (sp. 2)	-	6	-	6	0.14
II	Diptera	9. Chironomous larva of Midge fly	-	4	5	9	0.22
		10. *Culex* sp. (Larva + Pupa)	-	-	33	33	0.79
III	Ephemeroptera	11. *Cloeon* sp. (May fly nymph)	9	2	14	25	0.60
IV	Hemiptera	12. *Diplonychus annulatum* (Fabricius)	841	395	468	1704	40.90
		13 *Enithares ciliata* (Fabricius)	40	99	384	523	12.55
		14. *Laccotrephes maculatus* Fabricius	-	1	2	3	0.07
		15. *Limnogonus fossarum* (Fabricius)	-	1	9	10	0.24
		16. *Mesovelia vittigera* Horvath	127	8	48	183	4.39
		17. *Micronecta(Basilonecta) scutellaris scutellaris* (Stal)	4	9	25	38	0.91
		18 *Microvelia diluta* Distant	-	10	1	11	0.26
		19. *Plea liturata* (Fieber)	33	31	52	116	2.78
		20. *Ranatra filiformis* Fabricius	95	50	53	198	4.75
V	Odonata	21. *Anax* sp. (dragon fly nymph)	3	4	8	15	0.36
		22. *Enallagma* sp. (Damsel fly nymph)	103	14	19	136	3.26

		23. *Agria* sp. (Damsel fly nymph)	-	7	-	7	0.16
VI	Trichoptera	24. Caddis fly larva (Sp.1)	-	3	-	3	0.07
		25. Caddis fly larva (Sp. 2)	1	1	-	2	0.05
		26. Caddis fly larva (Sp. 3)	-	1	-	1	0.02
		27. Caddis fly larva (Sp. 4)	-	-	2	2	0,05
VII	Araneae	28. *Camaricus formosus* Thorell	1	-	-	1	0.02
		29. *Clubiona* sp.1	-	4	12	16	0.38
		30. *Clubiona* sp.2	-	4	3	7	0.17
		31. *Clubiona* sp.3	-	-	4	4	0.10
		32. *Clubiona* sp.4	-	-	3	3	0.07
		33. *Lycosa* sp. 1	18	35	35	88	2.11
		34. *Lycosa* sp. 2	54	17	10	81	1.94
		35. *Oxyopes shweta* Tikader	3	1	2	6	0.14
		36. *Myrmarachne plalaleoides* O.P. Cambridge	-	-	2	2	0.05
		37. *Tetragnatha hasselti* Thorell	21	5	2	28	0.67
		38. *Thomisus* sp.	-	-	1	1	0.02
	Total		1761	927	1478	4166	

Legend: PrM = Premonsoon; M= Monsoon; PsM= Postmonsoon

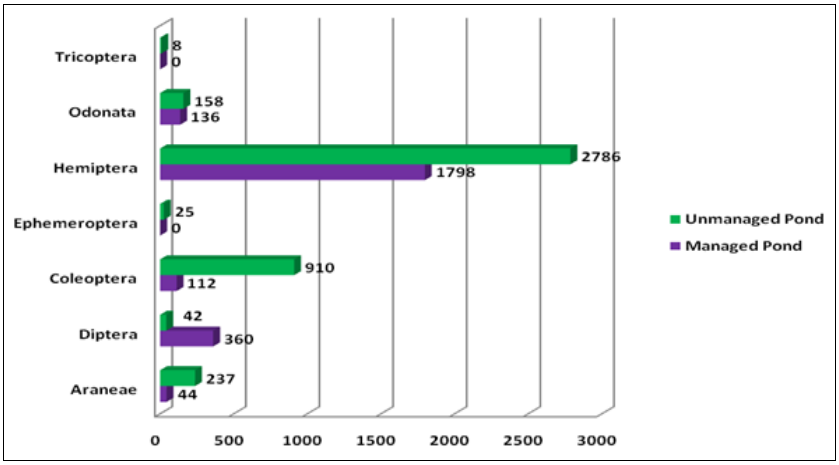


Fig 5: Total no. of individuals trapped from managed & unmanaged ponds

Table 2: Total no. of dominant species encountered in different seasons in managed & unmanaged ponds

Dominant Species	Managed Pond			Unmanaged Pond		
	PrM	M	PsM	PrM	M	PsM
Enithares ciliata (Fabricius) 	989	311	325	-	-	-
Diplonychus annulatum (Fabricius) 	-	-	-	841	395	468

Table 3: Weather Chart during the study period

Season	Avg. Temperature (oC)	Avg. Humidity (%)	Rain fall (mm)
Premonsoon	29.26	63.25	1.00
Monsoon	36.83	82.67	4.53
Postmonsoon	23.42	69.75	0.52

Table 4: Water temperature in Managed and unmanaged pond

Season	Average water temperature (oC)	
	Managed pond	Unmanaged pond
Premonsoon	22.12	22.70
Monsoon	21.57	22.24
Postmonsoon	22.01	22.07

Table 5: Physico-chemical parameters of water samples

Parameters	Methodology	Desirable Limit	Permissible Limit	Pre-Monsoon		Monsoon		Post- Monsoon	
A. Physical:				MP	UMP	MP	UMP	MP	UMP
pH	Electrometric	6.5–8.5	No relaxation	7.71±0.01	6.62±0.01	8.48±0.02	7.70±0.01	8.78±0.01	8.50±0.01
Dissolved O_2 mg/l	Electrometric			3.51±0.03	4.24 ±0.02	3.18±0.01	3.83±0.02	2.71±0.02	3.39±0.01
Dissolved Solids, mg/l	Ion Selective Method	500	2000	970±0.04	840±0.03	954±0.04	865 ±0.02	980±0.04	876±0.05
Turbidity, NTU	Nephelometric	1	5	362±0.01	140±0.01	388±0.03	154 ±0.02	357±0.03	198±0.03
B. General									
Iron, (as Fe) mg/l	Photometric	1.0	No relaxation	2.124±0.03	0.332±0.04	2.453±0.03	0.413±0.01	2.237±0.02	0.235±0.03
Manganese mg/l	Photometric	0.1	0.3	0.767±0.03	0.123±0.02	0.890±0.04	0.154±0.05	0.548±0.02	0.743±0.01
Total Hardness (as CaCO3) mg/L	Titration Method	200	600	192±0.03	248±0.04	179±003	264 ±0.06	195±0.03	296±0.01
C. Toxic Substances									
Total Arsenic Mg/L	Photometric	0.01	No relaxation	0.009±0.03	0.004±0.01	0.005±0.04	0.007±0.03	0.003±0.01	0.008±0.01

Legend: MP = Managed Pond; UMP = Unmanaged Pond

Table 6: Co-efficient of Correlation (r) Values between abundance of dominant species and physico-chemical parameters

Parameters	Managed Pond *[Enithares ciliata* (Fabricius)]	Unmanaged Pond [*Diplonychus annulatum* (Fabricius)]
pH	-0.9573*	-0.8304
Dissolved O_2	0.8006	0.7666
Dissolved Solids	0.1499	-0.8978
Turbidity	-0.3810	-0.5678
Iron	-0.7748	-0.1011
Manganese	0.1421	-0.4030
Total Hardness	0.3563	-0.6471
Total Arsenic	0.9388*	-0.9227*
Water Temperature	0.6682	0.9143*

* Correlation is significant at the 0.05 level

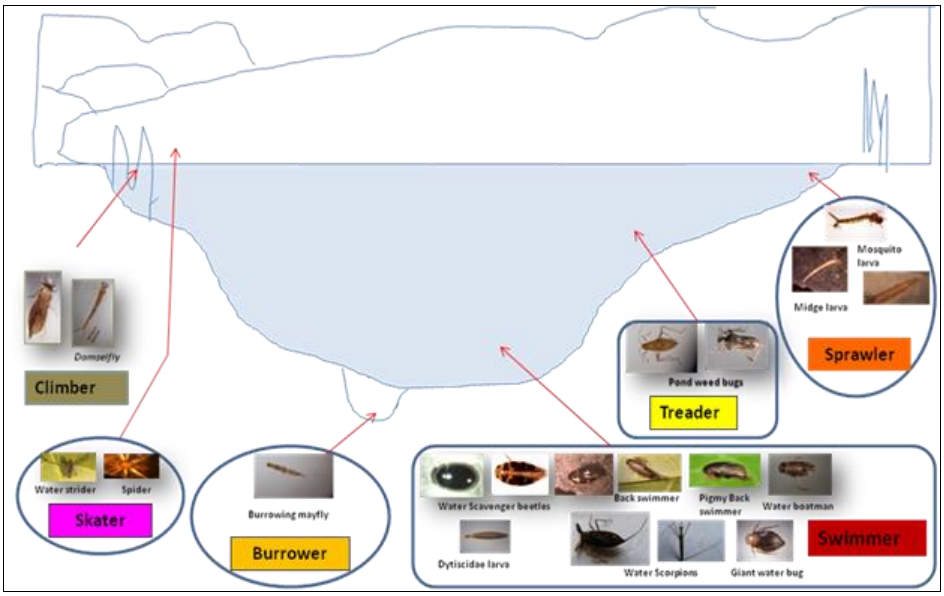


Fig 6: Habitat orientation of aquatic insects

Table 7: Encountered insect fauna as per habitat orientation

S. No.	Types	Encountered Group
1.	Burrower	Mayfly nymph [Order : Ephemeroptera]
2.	Climber	Dragonfly & Damselfly nymphs [Order : Odonata]
3.	Skater	Water strider [Order : Hemiptera] & Spider [Order : Araneae]
4.	Sprawler	Midge & Mosquito larva [Order : Diptera] & Case-making Caddisfly larva [Order : Trichoptera]
5.	Swimmer	Water Scavenger Beetles (Adults & Larva) [Order : Coleoptera], Back Swimmer, Pigmy Back Swimmer, Water Boatman, Water Scorpion, Giant Water Bug [Order : Hemiptera]
6.	Treader	Pond weed bugs [Order : Hemiptera]

Table 8: Different functional groups (of aquatic insects) occupying in different trophic levels of food chain & food web in pond ecosystem

S. No.	Functional Group	Insect
1.	Collectors/Gatherers/Shredders/Filterers	Water boatman [Order : Hemiptera], Mayfly nymph [Order : Ephemeroptera], Case-making caddisfly larva [Order : Trichoptera] Mosquito larva [Order : Diptera]
2.	Scavengers	Water Scavenger Beetles (Adults & Larvae) [Order : Coleoptera]
3.	Generalized Predators	Spiders [Order : Araneae]
4.	Predator ↔ Prey	Water Scorpions, Giant Waterbug, Water Strider, Backswimmer, Pond weed bug [Order : Hemiptera], Dragonfly & Damselfly nymphs [Order : Odonata]

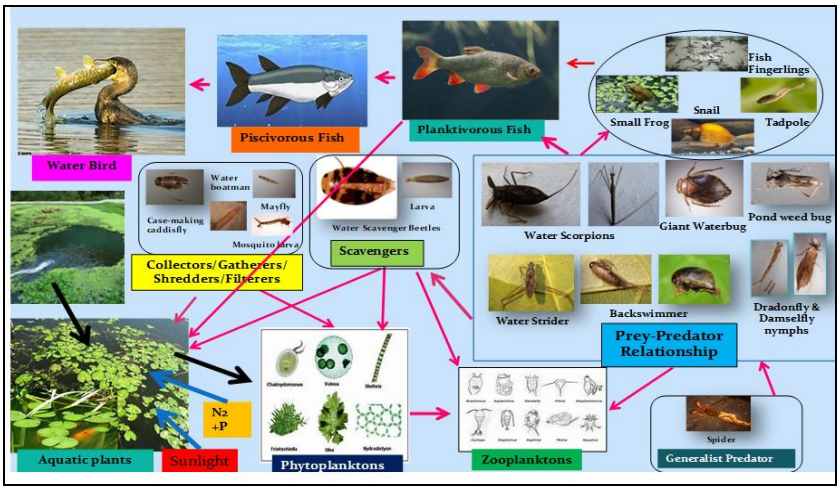


Fig 7: Probable food chains

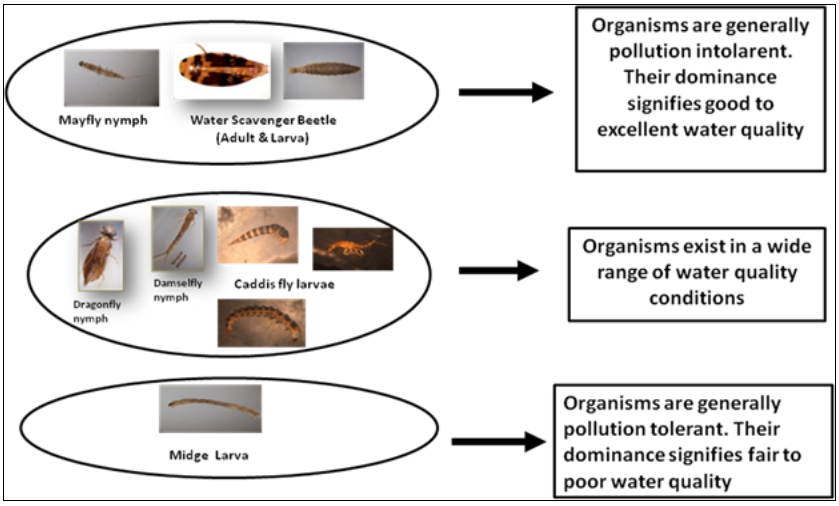


Fig 8: Aquatic insect groups indicator of pollution

Acknowledgements

The authors express their deep sense of gratitude to The Hon'ble Vice Chancellor, Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI), Narendrapur and The Principal, Barasat Government College for necessary logistic support. The authors also wish to acknowledge The Secretary & The Dean, RKMVERI, Narendrapur for necessary permission to carry out the project within the campus.

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