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Functional Feeding Groups among Aquatic insects of the East Kolkata Wetlands

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Abstract

Habitat complexity of wetlands supports diverse organisms where aquatic insects control the structure and dynamics of the food web. In the present study, biodiversity features of aquatic insects are dealt with reference to their taxonomic and functional diversity. Sampled specimen were assigned a habitat and 'functional feeding group' as proposed by Cummins and Klug (1979) . Insect specimen were collected in the sewage fed ponds of the East Kolkata Wetlands, where about 17 species of coleoptera , 25 species of hemiptera, 3 genus of odonates, 1 aperygota; besides juveniles of ephemeroptera, lepidoptera, zygopteraand dipteral were recorded. These were assigned' Functional Feeding Groups', based on their feeding mode, type of food, morpho-behavioral mechanisms of food acquisition and the size of the food particle.It was observed that the community was dominated by predators(38 species) while collectors/gatherers represented only by the Collembola,Ephemeroptera, members of the family Corixidae (hemiptera)and dipteran larva. Most of the coleopterans,hemipterans and odonate larva were predators with only the members of family Hydrophilidae(coleopterans) were scavengers. Shredders were presented by the lepidopteran larva only. Aquatic insects are considered as generalist predators. High ratio of predators as compared to the other groups is indicative of top down control where slow turnover of predatory taxa is dependent on fast turnover of prey species. Predatory fish often exhibit top-down control in water bodies with low macrophytic growth. However, in these wetlands with dense macrophytes and with predominance of non predatory carps,predation by fish is almost absent. As a result predatory insects control the abundance and diversity of other organisms.

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Introduction

Insects are generally dominant, species-rich and the most abundant group that have efficiently invaded all the available niche of the global ecosystem. Globally, there are about 45, 000 species of aquatic insects that are secondarily adapted to this system and represents only 3% of the total insect fauna.(Majumder*et al*.,2013).

Aquatic insects comprise about 11 orders (43 families with a total of 1044species) of which 8 are truly aquatic while others are fringe or semi aquatic fauna. These are mostly freshwater ones with only a fraction of them living in marine, estuarine and intertidal zones. Many insects have their larval and nymphal stages in water, with short aerial life. Studies reveal that Ephemeroptera, Coleoptera,Hemiptera, Odonata and Dipterans are dominant fauna of the freshwaters of south eastern West Bengal. (Khan and Ghosh, 2001).

As integral part of the aquatic biota, insects act as model organisms that define the structure and function of the inland waters, owing to their high abundance, higher birth rate, short generation time and large biomass. Any temporal change in their number and population composition is indicative of the change in water quality. The physical environment and hydrological parameters such as temperature, dissolved oxygen, pH and nutrient concentrations besides pond size, macrophyte coverage, type of substrate and water depth largely control the distribution, abundance and diversity of aquatic insects . (Bauernfeind and Moog, 2000).

Based on their ecological niche, food, feeding habit and mode of respiration, aquatic insects can be grouped as surface dwellers, mid water fauna, macrophytic and benthic community.

Moreover, on the basis of their feeding mode, type of food, morpho-behavioral mechanisms of food acquisition and the size of the acquired food particle, insect community can be classified into various 'Functional Feeding Groups' (FFG) (Cummins and Klug, 1996).The major groups of food in the aquatic system include coarse particulate organic matter (CPOM, particles >1mm), fine particulate organic matter (FPOM, particles <1 mm >0.45 µm) periphyton and the prey species.(Merritt and Cummins, 1996;Thanee *et al* .,2012).

The use of a functional feeding group (FFG) approach for freshwater invertebrates was proposed by Cummins and Klug (1979) that mainly focuses on their morphological and behavioral mechanisms of acquisition of food. Merritt *et al*. (2008) further refined the concept. This method of categorization links insect group with food resource.

The most commonly recognized functional feeding groups of aquatic insects are:

(1) Scrapers (grazers), which remove and consume attached algae and associated periphytic material (epilithiclayer)that grows on the surfaces of substrates. Thus these insects are inhabitants of areas with enough light to support algal growth.

(2) Shredders, chew conditioned litter or living macrophytic tissue**,** coarse particulate organic matter (CPOM), coarse detritus, decomposing leaf litter that fall down from riparian vegetation besides living or dead wood. These are bottom feeders with tearing mouthparts are mostly found in water bodies with tree cover.

(3) Predators prey on other animals and are found in all the habitats.

(4) Collectors are benthic animals that consume decomposing fine particulate organic matter (FPOM). This group can be further subdivided into a) collector-gatherers, which are specially adapted to collect fine particulate matter (FPOM) from the interstices of pond sediments. These scavenge dead organisms, detritus, or other food particles that get lodged in the sediment. b) collector-filterers, collect fine particulate

matter (FPOM) suspended in the passing water. Being filter-feeders these either swim through the water or remain at the bottom, filtering out floating particles. These may often feed on pieces of vegetation ripped up by shredders or tiny strips of biofilm dislodged by grazers. Besides, detritus, decaying plants and animals are also consumed.

(5) Omnivores consume both plant and animal matter.

(6) Two other, less common functional feeding groups among insects are the a)Macrophyte-piercers, which pierce the tissues of macroalgae and rooted hydrophytes.

b) Parasites are ubiquitous and develop on other animals. These are present in all types of habitats.

The designation of aquatic insects into the functional feeding groups considers several factors related to the origin and size of the food particle, type of food, whether plant or animal material, coarse or fine particulate matter. Besides, the source of food is also considered. Moreover, functional feeding group analyses are also used in water quality assessment, energy transfer studies and food chain modeling(Uwadiae,2010).The functional grouping reflects both convergent and parallel evolution leading to functionally similar organisms.

In the present context, biodiversity features of aquatic insects of the East Kolkata Wetlands are dealt with reference to their taxonomic and functional diversity, feeding habit and trophic status. Freshwater wetlands of East Kolkata support wide diversity of insects but are fast deteriorating under anthropogenic influences. Shallow water bodies, higher oxygen content, abundant nutrient, food resources and presence of floating and emergent macrophytes along with trophic complexity allow insects to flourish where various species show variability in their life history pattern. Numerous trophic and interspecific factors interact with the environmental parameters to yield the dynamic and diverse insect communities that are present in stagnant waters. Thus the primary goal of the present communication is to understand the community structure and functional diversity of the entomofauna.

Materials and methods

Site of study

Sampling was done in the sewage fed ponds of the East Kolkata Wetlands Kolkata, West Bengal for the period 2007-2009 and then from 2012 to 2015.

The East Kolkata Wetlands, situated in the eastern fringe of Kolkata (22°25' N to 22°40' N latitude and longitude 88°20' N to 88°35' N) is a Ramsar Site where city sewage and industrial effluents are dumped regularly. The organic load of the sewage is efficiently utilized for fish culture especially that provides sufficiently to the needs of the people around this periurban area. (Kundu *et al.,* 2008). This system of wetlands is biologically diverse which is under stress due to pollution and human interference.

Sampling Method

In the present study, insects from the sewage fed ponds were collected by insect nets such as sweep net and telescopic nets. The nets were moved through the water column or rapidly pushed into macrophyte beds and into the substratum for sample collection. (Merrit*et al.*,2002) For insects in the open water, towing of plankton n*et al*lowed us to collect the drifting insects. Those inhabiting the aquatic macrophytes were collected by kick method (Bath and Kaur, 1997) whereby the vegetation was disturbed and the circular net (mesh size 60µm) was dragged around the vegetation.

Specimens were immediately sorted and preserved in 70% ethyl alcohol.Identification of the specimen was done using standard keys. The family level identification was done following the manual of Subramanian and Sivaramkrishnan (2007). The

identified insects were confirmed in the entomological laboratory of Zoological Survey of India, Kolkata.

Further, all the genera encountered during the study were assigned a habitat and 'functional feeding group' which when combined for each genus surveyed forms a guild. Merrit and Cummins, 1996).

This classification system for assigning trophic guild is important for understanding nutrient cycling and trophic interactions in the wetland ecosystem.

Our aim of the study is to conserve these vital organisms as these help in nutrient processing, act as biondicator of pollution and is also effective biomonitoing agents. Besides, these are important dietary constituent of other organisms especially fish.

Hydrological parameters of the wetlands are also measured according to the standard methods of APHA (1998).

Results and discussion

The insect specimen collected and identified is provided in Table 2 along with their feeding habit, habitat, taxonomic classification and functional feeding groups.

In the Table 1 hydrological parameters of the ponds are provided. In Fig.1 Species richness and relative number of species in each order of the sampled insects are provided while Fig.2 shows the relative number of each species in each functional feeding group. Hydrological parameters of the wetlands are provided in Table 1.

Table 1. Hydrological Parameters in wastewater wetlands.

Sr no.	Hydrological Parameters	Value
1	pH	7.1-8.6
2	Dissolved oxygen	2.58 mg/L - 6.82 mg/L.
3	Hardness	171.0-228.6
4	Total alkalinity	293 - 314 mg/L.
5	Free carbondioxide	6.8-10.8 mg/L

From the present investigation, about 17 species of Coleoptera, 25 species of hemiptera, 3 genus of odonates, 1 aperygota,juveniles of one ephemeroptera, Lepidoptera and zygoptera besides abundant dipteran larvae were sampled from the freshwater bodies of the East Kolkata Wetlands . The sampling sites include stocking ponds, nursery ponds and even unmanaged derelict water bodies. The sewage canals however were devoid of any aquatic fauna (Table 2 and Fig.1).

The community was dominated by predators (38 species). Other groups include collectors/gatherers mostly represented by the Ehemeropteran and dipteran larva besides one genus of Collembole. The members of the family Corixidae(hemiptera) are scavengers while shredders are represented only bythe lepidopteran larva. The members of the family hydrophidae(coleoptera) are scavengers (Table2 and Fig. 2).

Functional feeding group analyses are intended to reflect the potential role of organisms in their ecosystems and the way they consume resources.Various ratios of the functional groups are used as surrogates for ecosystem attributes that focus attention on the nutritional resource base of a wetland ecosystem. This exert a balancing effect between gross primary production and community respiration(P/R)besides transport, storage and partitioning of coarse and fine particulate organic matter in the water column and also in the sediments (Merritt *et al.*,1999).The functional feeding group analyses highlights morphological characteristics including mouth part specialization and behavioral mechanisms of feeding by insects.

Table 2. Insect species collected from east kolkata wetlands.

Order	Family	Genus	Food	Feeding habit	Stage	Habitat
Coleoptera	Dysticidae Predaceous diving beetles	*Canthydrusangularis*Sharp	Fish spawn	Predators	Adult	Wetlands species
		Canthydruslaetabilis (Walker)	Fish spawn	Predators	Adult	Wetlands infested with macrophytes
		Canthydrusluctuosus(Aube)	Fish spawn	Predators	Adult	Sewage fed wetlands with high organic load
		*Neohydrocoptssubvittulus*Mots	Fish spawn	Predators	Adult	Lentic waters
	Dysticidae	*Hydrovatussp*	Invertebrates , fish eggs , fry	Predators	larvae	Fresh macrophytes near bottom along the littoral zone
		Laccophilusanticatusanticatus Sharp	Invertebrates , fish eggs , fry	Predators	Adult	Macrophytes of shallow wetlands Aduts are good swimmers, jumper, climber and diver.
		Laccophilusparvulus	Invertebrates , fish eggs , fry	Predators	Adult	Small numbers in wetlands
		*Laccophilusclarki*Sharp	Invertebrates , fish eggs , fry	Predators	Adult	Wetlands
		*Laccophilus*sp.	Invertebrates , fish eggs , fry	Predators	nymph	Sub submerged vegetations of wetland
		*Guignotusflammulatus*Sharp	Invertebrates , fish eggs , fry	Predators	Adult	Large sized beetles common in most wetlands
		*Hydrocoptussubvittulus*Motsch	Invertebrates , fish eggs , fry	Predators	Adult	common in most wetlands
		Cybistersp	Invertebrates , fish eggs , fry	Predators	Larva	Largest species , found in still waters with less vegetations .
	Hydrophilidae					
	Water Scavenger Beetles	*Berosusfairmairi*Zaitev	Detritus , algae and decaying vegetative matter	Scavengers	Adult	Shallower region of the wetland with abundant submerged macrophytes,
		*Berosusindicus*Motschulsky	Detritus , algae and decaying vegetative matter	Scavengers	Adult	Sewage fed ponds with high organic load. Strong swimmers and divers.
		*Amphiopspedestris*Sharp	Detritus , algae and decaying vegetative matter	Scavengers	Adult	Occur in water bodies with submerged vegetations
		Hydrophilusrufocinctus (Bede)	Detritus , algae and decaying vegetative matter	Scavengers	Adult	Wetland species
		Enochrusesuriens Walker	Detritus , algae and decaying vegetative matter	Scavengers	Adult	Natural wetlands and fish culture ponds
		Helocharesancholaris Sharp	Detritus , algae and decaying vegetative matter	Scavengers	Adult	Uncommon species , occurs in macrophyte strands from the littoral zones. Occur in ox -bow lake and freshwater wetlands
		Helocharespallens(Macleay)	Detritus algae and decaying vegetable matter	Scavengers	Adult	Shallow natural wetlands , among macrophytes
		*Helocharess*sp	Detritus algae and decaying vegetable matter	Scavengers	Larva	
	Chrysomelidae				Larva	
	Bruchidae	Found in2006- 2008			Larva	
	Curclionidae				Larva	
	Histeridae				Larva	
Hemiptera	Nepidae					
	Water scorpions Sluggish , prefers still water	*Ranatrafiliformis* (Fabr)	Live on nymphs of dragon flies , pupae of mosquito	Predators	Adult	Shallow part of the water bodies near submerged vegetations. Also live in trash and mud

	RanatravaripesStal	Insects and nymph of dragon fly	Predators	Adult	Clings to vegetations in shallow water
	Ranatrasp	Small invertebrates	Predators	Nymph	In all types of wetlands
	Laccotrepessp	Insects and nymph	Predators	Nymph	Edges of littoral zones
	Laccotrepes maculates Fabricius	Feed on adult insects and their nymphs.	Predators	Adult	Found in all types of wetlands .
Gerridae Water strider or Pond skater These skate across the water surface. The adults are incapable of flight	*Limnogonus (L) nitidus* (Mayr)	Micro-crustaceans below the water surface	Predators	Adult	Microcrustacea and insects available just below the water surface
	Limnogonusfossarumfossarum(Fabricius)	Micro -crustaceans below the water surface	Predators	Adult and Nymph	Abundant in sewage fed ponds in small group
	Aquarius adelaidis (Dohrn)	Micro -crustaceans below the water surface	Predators	Adult	Prevalent in natural wetlands
	*Rhagadotarsuskraepelini*Breddin	Micro -crustaceans below the water surface	Predators	Adult	Rarely found in ox bow lake
Notonectidae, Backswimmers .	*Anisopsbreddini*Kirkaldy	Adults. Aquatic insects, other invertebrates, fish eggs, fry. Nymph microcrustacean zooplankton.	Predators	Adult	Swimmers on surface water, cling to submerged vegetations. Abundant in ponds.
	Anisopssardeussardeus Herrich – Shaffer	Fish eggs , invertebrates , aquatic insects and microcrustacean zooplankton.	Predators	Adult	All types of wetlands
	Anisopssp	Fish eggs , invertebrates , aquatic insects and microcrustacean zooplankton.	Predators	Nymph	All types of wetlands
	*Anisopstahitiensis*Lundblad	Fish eggs , invertebrates , aquatic insects and microcrustacean zooplankton. own larvae, fish larvae and amphibian tadpoles	Predators	Adult	Slow moving waters , sewage fed wetlands .
	AnisopsbouvieriKirkaldy	Fish eggs, invertebrates , aquatic insects and microcrustacean zooplankton.	Predators	Adult	Wetland species
	*Anisopskuroiwae*Matsumura	Fish eggs , invertebrates , aquatic insects and microcrustacean zooplankton.	Predators	Adult	Wetland species
	Enitharesindica	Aquatic insects , fish eggs	Predators	Adult	Wetland species
	Nychimarshalli (Scott)	Aquatic insects	Predators	Adult	Wetland species
	Nychisp	Aquatic insects , microcrustaceans	Predators	Nymph	Wetland species

	Vellidae	*Microvelialeveillei* (Lethierry)		Predators	Adult	Wetland species
		*Microveliadouglassi*Scott		Predators	Adult	Wetland species
		Microveliasp		Predators	Nymph	
	Pleidae	*Parapleafrontalis*	Micro-invertebrates	Predators	Adult +	Angled submerged vegetations
	Pigmy Backswimmers	(Fieber)			Nymph	Dense submerged vegetation remain
	Smallest aquatic					attached o stem and leaves
	hemiptera ,	*Paraplea*sp (Fieber)	Micro	Predators	Larva	Cling to Macrophytes
	Creeps through	*Plea* sp	Micro	Predators	nymph	Cling to Macrophytes
	macrophytes .					
	Belostaomatidae	*Diplonychusrusticus*(Fabricius)	Invertebrates and	Predators	Adult and	Pond bottom in the Shallow littoral
	Giant Waterbugs		Fish fry , eggs		nymph	zones
						with emergent vegetations
		Diplonychusmolestus	Invertebrates and	Predators	Adult	Pond bottom in the Shallow littoral
		(Dufour)	Fish fry			zones
						with emergent vegetations
		Diplonychusannulatus (Fabr)	Invertebrates and	Predators	Adult	Pond bottom in the Shallow littoral
			Fish fry			zones
						with emergent vegetations
		Diplonychussp	Invertebrates and	Predators	nymph	Pond bottom in the Shallow littoral
			Fish fry			zones
						with emergent vegetations
	Mesoveliidae	*Mesoveliahorvathi*Lundblad	Small dead or alive	Predators	Adult	Edge of water bodies among emergent
	Pond weed bugs or		insects			vegetation
	Water Treaders	*Mesoveliavittigera*Horvath	Small dead or alive	Predators	Adult +	Edge of water bodies among emergent
			insects		nymph	vegetation
	Corixidae ,Water	*Micronectascutellaris*(Stal)	Debris , algae ,	Gatherers	Adult	Swimmers near bottom of wetlands
	Boatman . Largest		protozoa and other			
	family of aquatic		microscopic			
	hemiptera.		organisms			
		*Micronecta*sp	Debris , algae ,	Gatherers	Nymph	Swimmers near bottom of wetlands
			protozoa and other			
			microscopic			
			organisms			
Odonata	Coenagriidae	*Pseudagrion*sp	Feed on molluscs,	Predators	Nymph	Top layer of pond bottom near littoral
Damselflies			other insects,			zones , submerged macrophytes
and			crustaceans, worms,			
Dragonflies,			and small fish, eggs			
			and fry.			
		*Ishnura*sp	Feed on smaller	Predators	Nymph	Top layer of pond bottom near
			organisms			littoral zones
		*Coeriagrion*sp	Feed on smaller	Predators	Nymph	Top layer of pond bottom near
			organisms			littoral zones
	Libellulidae		Feed on smaller	Predators	Nymph	Top layer of pond bottom near
			organisms			littoral zones
Ephemer - optera	Baetidae	*Cloeon*sp.	Fine detritus	Collector-	Nymph	Macrophytes in the littoral zones
Mayflies		Small Minnow Mayflies		Gatherers/Colle		
				ctor-		
				filterers/Scrape		
				rs		
Diptera	Chironomidae (Larvae)	*Chironomussp*	Algae collect fine	Collectors	Larva	Pond bottom
	(Meigen, 1803)		particles of detritus			
			from the bottom or			
			from the water,			
			shredding dead			
			leaves, and preying on			
			other invertebrates.			

	Culicidae (Larvae)	*Anopheles Larva* *Culex Larva*	Algae, collect fine particles of detritus from the bottom or from the water, shredding dead leaves, and preying on other invertebrates.	Collector/ Gatherer,	Larva	Soft muddy substratum
Aperygota	Collembola	Springtail		Collector/Gatherer	Adult	Pond Bottom
Lepidoptera				Shredders	Larva	
Hymen - optera					Larva	
Isopoda					Larva	
Dermaptera					Larva	
					Larva	

The factor for variation in species richness at the local scale is its relationship with productivity. Generally more primitive orders of aquatic insects show lower diversity in feeding mode.

Mode of feeding and environmental variables determines the presence of various functional feeding group of insects in an ecosystem. The relative proportion of each functional feeding group of the macroinvertebrate communities generally determine ecosystem functioning. Understanding community structure and ecosystem functioning besides identifying their determinants is one of the main objectives of ecology.

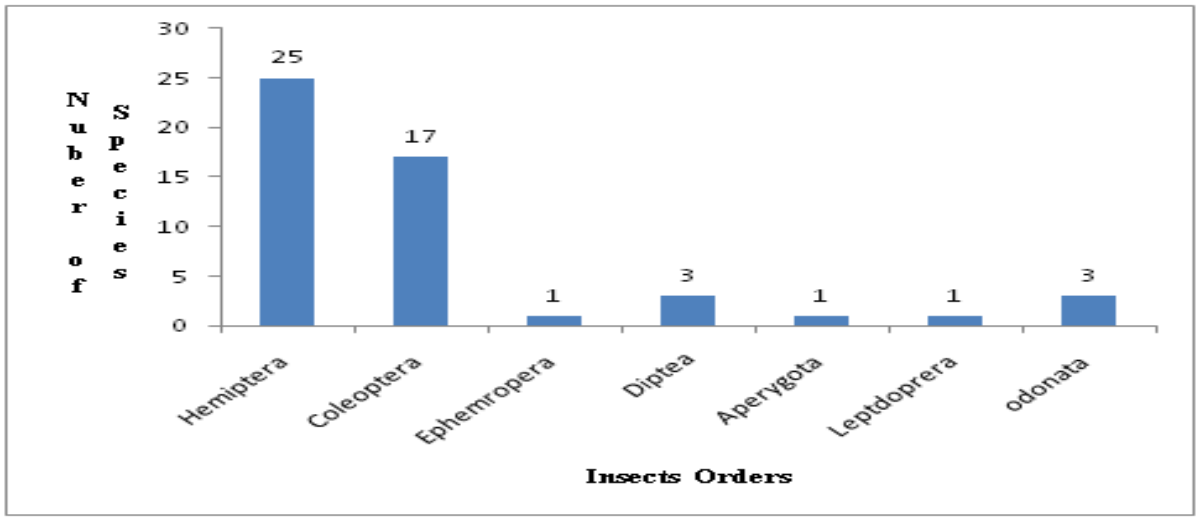

Fig. 1 . Number of Species in the different Orders of Insects from the East Kolkata Wetlands.

Generally functional feeding group analyses link CPOM with the shredders, FPOM with the collectors, and between primary productions (periphyton) with scrapers. Detrital processing in aquatic systems are affected by shredders that feed on litter which allows conversion of about 30% of the of CPOM leaf litter to FPOM , enhancing the growth of collectors that feed on FPOM. Generally, shredders enhance the release of dissolved organic matter. Hence such analyses link the balance between food resource and aquatic insect assemblages.

Thus insect communities exert profound impact on the primary production by grazing, breaking down of detritus besides mineralization of nutrients.

About 5000 species of aquatic insects are found in India that forms the most heterogeneous and disharmonic assembly(Susheela,2014).Most are omnivorous and opportunistic, that ingest a wide variety of food items available in their environment (Cummins, 1973).

True aquatic insects spend certain part of their life-cycle closely associated with water. The following aquatic insect orders are reported from the East Kolkata Wetlands (Table2and Fig1).

Order: Collembola

This oldest insect order comprises of small sized animals that are found on the surface of the water in ponds infested with vegetations or organic detritus. These are exclusively collector-gatherers. During the study period these have been rarely sampled.

Order: Ephemeroptera(Mayfly)

Among this group the nymph stage is longer which live for years under the water while the adults are short lived and terrestrial. These are generally detritivores and feed on bottom debris or macrophytes. The nymphs occupy shallow wetlands and are extremely sensitive to oxygen deficiency (Arimo and Muller, 2010).So these are general inhabitants of unpolluted water. In the present studies, these have been occasionally sampled. *Cloeon* sp. has been recorded in the sewage fed wetlands but according to previous authors these are unrepresented in such water bodies. (Khan and Ghosh, 2001).

Order: Diptera

Dipteraor "two wings" includes flies, midges or grats. The midgeflies are exceptionally sensitive to pollutants, while those that endure higher pollutant level are abundant in the sewage fed wetlands. These are mostly dominant in shallow freshwater system especially among the macrophytic community and also in the sediment.

These serve as food for larvivorous fish. Some larvae are planktonic while others are clingers, sprawlers or burrowers. Dipterans feed on shredded living and dead plant tissue, collect food from substrate either prey or parasitize other macro invertebrates. Dipterans were collected from shallow region. (Sharma and Agrawal,2012) The larva of *Chironomus* sp are abundant in areas with high organic matter hence tolerant to poor water conditions. These have been widely sampled and almost ubiquitous in this sewage fed wetlands especially among the *Eichhornia*.

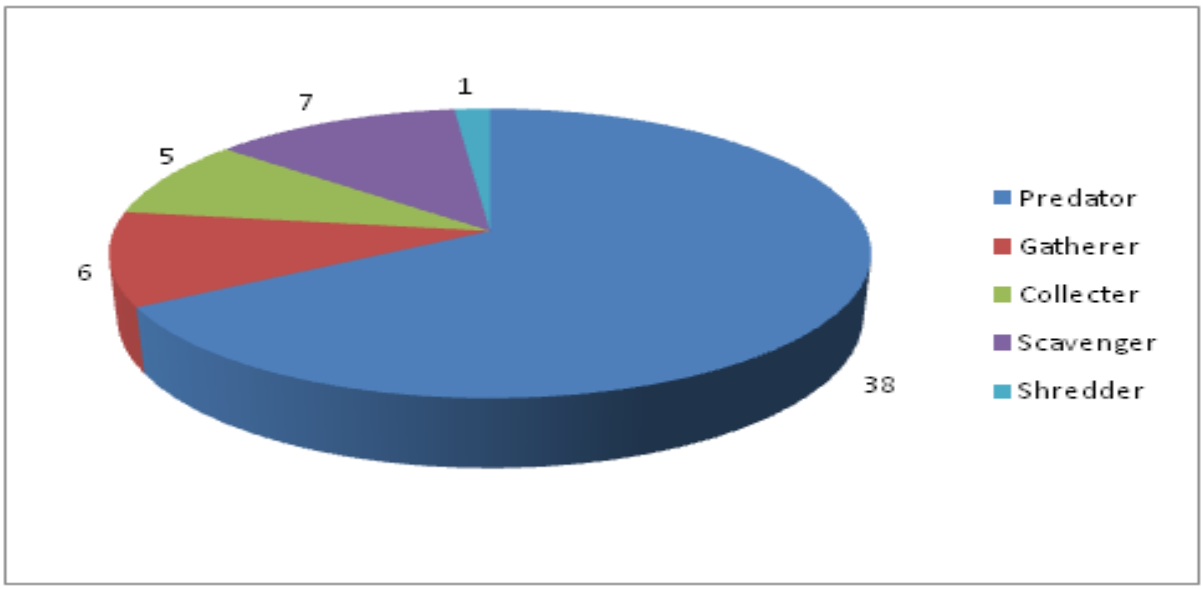

Fig. 2. Number of insect species in each Functional Feeding Groups.

Order: Coleoptera

Coleopteraor "shield-wing" beetles are highly diverse and are the largest order of insects, distributed through 14 families. However, only few are aquatic that mostly inhabit the margins of lentic water bodies. Both the adults and the larvae live in the water where some are sensitive while others are tolerant to pollutants. (Biswas *etal*., 1995).

In the present study, members of the family Hydrophilidae and Notoridae are abundantly present in the East Kolkata Wetlands which is in contradiction to the findings of Ghosh and Khan(2001).Hydrophilidae is numerically dominant in these water bodies. *Canthydrus. laetabilis, Helochares ancholaris* and *Enochrus esuriens* are also reported from organically loaded sewage fed wetlands which is in contradiction to the findings of Ghosh and Khan(2001). These are predominantly predators but some members are scavengers.

Order: Hemiptera

Hemiptera or true bugs are common in the slow-moving, shallow littoral zones of water bodies around the edges especially on submerged aquatic plants. Both the adults and larval stages live in water. In our observation, this group represents highest species richness probably due to their tolerant nature.

These predatory insects generally feed on the mosquito larva, gnats and midges or even on fish eggs and frogs. These have raptorial forelegs and sharp piercing, sucking mouthparts. Water scorpions prefer still and derelict waters and cling to substratum or remain in contact with surface water film. Among this order Corixidae **,**is the largest family with 500 species where both the adult and nymphal stage are aquatic. Interestingly some species such as *Nychi marshalli, Diplonychus annulatus (Fabr)* was sampled during 2006- 2009 but not recorded in 2012-2015. Previously, *Rhagadotarsus kraepelini* and *Gerris* sp were not recorded in sewage fed wetlands. In the current study, these two species were reported to be abundant in the sewage fed ponds. In the present study*, Anisop stahitiensis* Lundblad has been first recorded by the authors from the Indian mainland. (Jehamalar *et al*., 2014).

Yang and Kovac, 1995 and Nieser (2004) remarked that this species is found only in lentic waters, but in the present study, it has been collected from the sewage-fed ponds of this region.

Order: Odonata

Larvae of dragonflies and damselflies are most common in standing or slow-moving waters especially in the marshes and also in the pond bottom. Adults are fast flying insects. Both the nymphs and adults of the odonates are predators, with adults prey mostly on mosquito larvae**,** fish eggs and fry. However, these themselves form the diet components of fish, amphibians, birds and mammals. Odonates in littoral zones potentially control zooplankton abundance, but in the present study, odonates are less common probably due to the presence of aquatic vegetations.(Subramanian, 2009) Few samples of Aperygota (Collembola) and larval forms of Lepidoptera have been also found.

Considerable amounts of organic nutrients and inorganic pollutants are laden in the East Kolkata Wetlands that have immense influence on the community structure of the insects. Some of the species sampled are known to have particular requirements with regard to nutrients, water quality, substrate components and the structure of vegetation.

Members of the order Ephemeroptera, Odonata, and Hemiptera show feeding specialization while coleoptera, and diptera show diverse feeding habit displaying different trophic groups. In the present study, it was found that hemipterans and coleopteras are part of the typical nekton and neuston communities and are quantitatively dominant. Observations reveal that most are predators as according to Cummins(1973), aquatic insects as generalist predators. High ratio of predators in these water bodies as compared to the other groups is

indicative of top down forces or top down control(Table2and Fig. 2).

In wetlands with stagnant water, predation regulates aquatic insect communities although predatory effects are related to habitat complexity. Wetlands generally have a structurally complex habitat of dense macrophyte beds that allows greater refuge for the predators as evidenced from the present investigation. High ratio of slow turnover of predatory taxa indicates higher proportion of fast turnover of non predator or prey taxa. Thus diving beetles, bugs and dragonfly larvae being top predators greatly affect the structure and dynamics of the whole food web although, their prey selectivity is poorly understood. Predatory fish often exhibit top-down control of aquatic insect communities in water bodies with low macrophytic growth.

In the fish ponds of East Kolkata Wetlands where non predatory carp culture is ubiquitous, insectivorous fish with low market value are generally weeded out. When predation by fish is absent, predatory insects may control the abundance and diversity of other organisms. (Khan and Ghosh, 2001) This probably allows growth of more predatory insects. Thus fish and predatory insects interact to increase the effect on prey population, compared to when either is present alone.

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