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Benthic Insect Abundance and Distribution in A Polluted Pond

KEYWORDS: Benthic insect, CCA, physicochemical factor, polluted pond

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ABSTRACT *The present work aims to analyze benthic insect abundance and species composition in a polluted pond. Sediment and water samples were collected monthly over one year-cycle (2009–2010). The distribution and abundance of benthic insects was affected by a number of ways. Multivariate statistical analysis of data was done to calculate the effect of environmental variables on benthic insect distribution during different months. Canonical correspondence analysis were plotted which clearly detected physicochemical factors (water temperature, conductivity, total dissolved solids, conductivity, organic carbon, organic matter, etc.) relation with benthic insects. Along-this pond variation of the benthic insect with climatic factors was well assessed, Ephemeroptera was highly affected by composition of clay, organic matter, total solids, water temperature and nitrate concentration whereas Hemiptera showed high positive correlation with calcium and dissolved oxygen. Diptera is one of the most dominating group among all another groups. Presence of high abundance of Chironomus larvae showed polluted condition of this pond.*

Introduction

Benthic macro-invertebrates inhabit river beds, lakes and reservoirs and are associated with various types of substrates such as mineral sediments, detritus, macrophytes and filamentous algae (Rosenberg and Resh, 1993). They are also important food resources for fish (Wallace and Webster, 1996) and some insectivorous birds.

Benthic insects particularly members of the order Ephemeroptera, Plecoptera, Tricoptera and Diptera (Dudgeon, 1999) are among the mostly commonly chosen groups of bioindicators used in environmental assessment because they provide more accurate information about the changing conditions than chemical and microbiological data, which gives short term fluctuations (Persoone and De Pauw, 1979). The abundance of Ephemeroptera, Plecoptera, Trichoptera and Chironomidae indicates the balance of the community, since Ephemeroptera, Plecoptera, Trichoptera are considered to be more sensitive and Chironomidae less sensitive to environmental stress (Plafkin et al., 1989). A community considered to be in good biotic condition will display an even distribution among these four groups, while communities with disproportionately high numbers of Chironomidae may indicate environmental stress (Plafkin et al., 1989). Reasons for the apparent popularity of aquatic insects in current biomonitoring practice are that they are ubiquitous, species rich, long lived and their ability to integrate temporal condition. According to Hynes (1960) nymphs and larvae of stoneflies, mayflies and caddisflies are integral components of the benthic fauna of the most relatively undisturbed streams. Since benthic macro-invertebrates reflect environmental changes, they are often used as indicators of the effects of human activity on water system. They also provide information on habitat and water quality (Woodcock and Huryn, 2007). Information about the effects of physical and chemical variables and habitat integrity on benthic insects has been increased in recent years; however, improving the knowledge on the relationship of abiotic properties to the benthic insect is crucial to understand the functioning of ecological processes and health of aquatic ecosystems. Hence, this study was undertaken to investigate the influence of physical and chemical variables on benthic insect communities along a gradient of anthropogenic disturbance in a polluted pond.

Methodology

During sediment collection three sediment sub-samples were randomly collected, were packed in plastic bags, labeled and brought to laboratory. The collected sediment was diluted with water and sieved on a mesh screen of 0.5 mm, sorted and preserved for taxonomic identification. The benthic insects were identified using identification keys Edmondson (1959), Needham and Needham (1962). Physicochemical analysis was done with the help of keys given by Theroux et al. (1943), Michael (1984) and Trivedy and Goel (1984).

Results and Discussion

Diptera: Diptera have aquatic larvae and pupae with terrestrial adults. Many other aquatic insects are also commonly referred to as "flies", but these taxa are not true flies as they do not belong to the order Diptera. Diptera inhabit a wide range of habitats and some taxa are extremely tolerant and occur in heavily polluted water bodies. Some true flies can be a nuisance due to their blood feeding behaviors. Chironomids are the most abundant and diverse group of aquatic insects. The red coloration comes from hemoglobin that allows the larvae to store oxygen and survive in situations with low dissolved oxygen. Chironomids are an important food source for insects, fishes, and birds. Diptera formed the most abundant group of benthic insect and it was represented by Chironomus, Helius, Culex and Pentaneura. The density of Diptera ranged from a minimum of 188 No/m^2 during June, 2009 to a maximum of 1262 No/m^2 in January, 2010 (Table-1; Fig-2). Total percent contribution of Diptera was 54% among all another groups (Table-1; Fig-1). Chironomus can survive in low oxygen as well as polluted condition of water body. Its presence in high number in these water bodies indicated that these water bodies are polluted.

Hemiptera:

Aquatic hemipteran adults and larvae unlike most aquatic taxa in that the adults and larvae occupy the same habitat. Aquatic and semiaquatic Hemiptera can be separated into two groups based on their antennal morphology and the habitat in which they are generally found. Hemiptera insects like all higher organisms, require a source of oxygen. Since water does not contain as high a volume of oxygen as air, so alternate breathing methods were developed. Aquatic breathing methods may be divided into two types, aeropneustic and hydropneustic (McCafferty, 1981). Aeropneustic breathing methods allow the insect to continue to utilize sur-

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face air for respiration. Hemiptera formed second abundant group and it represented by species Notonecta, Coroxid, Belostoma, Hebrus, Sigara and Hespercorixa. The monthly variations in density of various taxa of Hemiptera (No/m^2) in the selected study area are given in (Table-1; Fig-2). The population density of Hemiptera ranged from a minimum of 143 No/m^2 during October, 2009 to 579 No/m^2 in December, 2009. Total percent contribution of Hemiptera was 27% among all another benthic insects (Table-1; Fig-1). The high or low abundance of Hemiptera in present study can be related to presence of macrophytes.

Coleoptera:
Coleoptera constitute an important part of the benthic insects of freshwater habitats. Small and temporary water bodies have more species than large and permanent ones (Larson, 1985). These insects are not particular in their choice of water bodies and occur in wide variety of habitats (Galewwski, 1971). Coleoptera formed third abundant group and this group was represented by Hydrophilus, Dytiscus, Berosus and Haliplus. The population density of Coleoptera ranged from a minimum of 94 No/m^2 during May, 2009 to maximum of 461 No/m^2 during January, 2010 and total percent contribution of Coleoptera was 18 % (Table-1; Fig-1& 2). The dominance of Coleopteran during winter could be related to the availability of food and vegetation which enhanced the growth.

Trichoptera:
Trichoptera is the largest order of insects in which most members are truly aquatic. Trichoptera are important in aquatic ecosystems because they process organic material and are an important food source for fish. This group was represented by Limnephilus, Phryganaea and Polycentropus. The population density of Trichoptera ranged from a minimum of 4 No/m^2 during April, 2009 to a maximum of 15 No/m^2 in January, 2010 and total percent contribution of Trichoptera is negligible (Table-1; Fig-1& 2). Low frequency clearly indicated that Trichoptera are sensitive to pollution but can live in polluted water if good amount of availability of food and oxygen.

Ephemeroptera:
Mayflies are often an indicator of good water quality because most mayflies are relatively intolerant of pollution. Mayflies are also an important food source for fish. Most mayflies have three caudal filaments (tails) although in some taxa the terminal filament (middle tail) is greatly reduced and there appear to be only two caudal filaments (only one genus actually lacks the terminal filament). Ephemeroptera formed fifth and least abundant group and this group was represented by Baetis and Caenis. The population density of Ephemeroptera ranged from a minimum of 3 No/m^2 during March, 2009 to 7 No/m^2 in November, 2009 (Table-1; Fig-2). Ephemeroptera presence indicated that these larvae are able to survive in polluted waters when there is sufficient oxygen (> 2.6 mg/l).

Table 1 Monthly Benthic insect abundance and distribution in a polluted pond

Group	Feb'09	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Percent contribution
DIPTERA	884	681	536	370	188	588	742	667	732	827	608	1262	54%
HEMIPTERA	394	268	341	257	296	260	244	336	143	348	579	560	27%
COLEOPTERA	316	185	222	94	266	218	140	165	185	248	302	461	18%
TRICHOPTERA	10	7	4	6	10	5	8	9	9	7	13	15	1%
EPHEMEROPTERA	4	3	4	4	5	4	4	3	4	7	6	5	0%

Fig. 1 Percent contribution of different groups of benthic insects

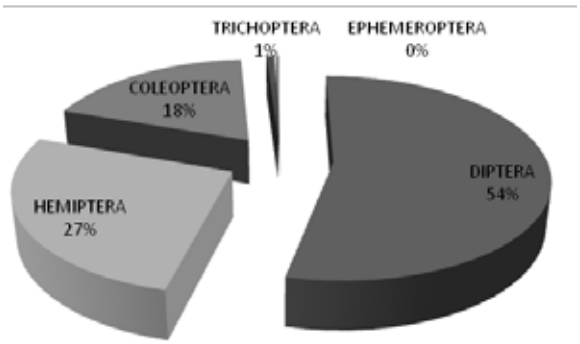
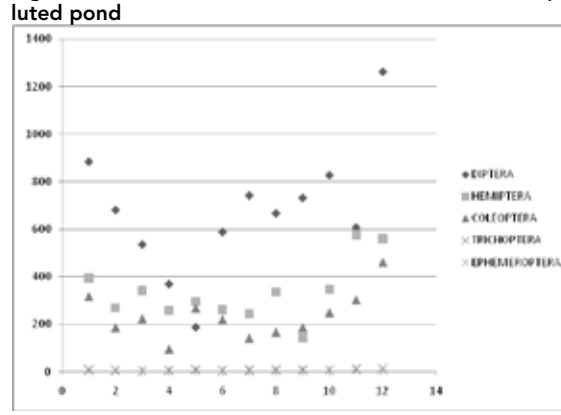


Fig. 2 Benthic insect abundance and distribution in a polluted pond



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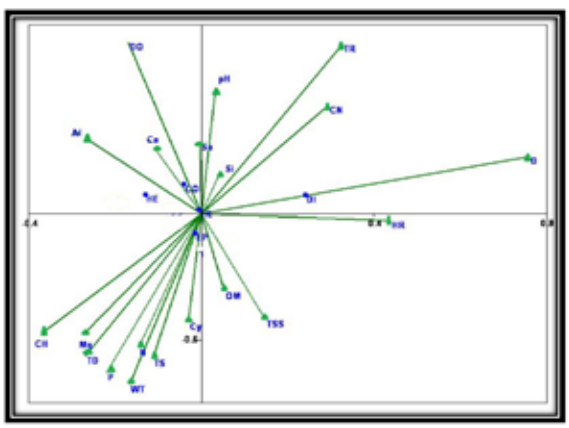
Canonical correspondence analysis (CCA): The eigen values, values of p and Cumulative percentage variance of groups-environment relation of axes 1-4 are depicted in the table of Fig 3. Diptera showed high positive correlation with Depth of this pond. Ephemeroptera showed high positive correlation with TSS, Organic matter Whereas Ephemeroptera showed negative correlations with Clay, TS, Water temperature, Nitrate and Phosphate. Hemiptera showed high positive correlation with calcium and dissolved oxygen. In this Pond, important factors affecting benthic insect distribution are Water temperature, Dissolved oxygen, Nitrate, Phosphate, Alkalinity, pH, Hardness, Conductivity, Magnesium, Transparency, Chloride, Depth, Among the above parameters, total dissolved solids, total suspended solids and total solids are considered as the most important factors which affects the benthic insects.



Axis	Eigenval	p	%
1	0.01843	0.3564	46.23
2	0.008716	0.2673	21.87
3	0.00557	0.9307	13.98
4	0.003323	0.5149	8.336

Fig.3: Canonical correspondence analysis (CCA) diagram of 20 environmental parameters (Water temperature-WR, pH-pH, Dissolved-oxygen- DO, Nitrate-N, Phosphate-P, Alkalinity-AL, Hardness-HR, Calcium-Ca, Magnesium-Mg, Transparency-TR, Chloride-CH, Conductivity-CN, Depth-D, Total dissolved solids-TD, Total suspended solids-TSS, Total solids-TS, % organic matter-OM, composition of Sand-Sa, Silt-Si, Clay-Cy) and 5 benthic insect groups (Diptera-DI, Coleoptera-CO, Hemiptera-HE, Trichoptera- TR and Ephemeroptera-EP) in a polluted pond

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