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Research Article

AQUATIC COLEOPTERA ASSEMBLAGES IN DIFFERENT WETLANDS OF MANIPUR

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ABSTRACT

The diversity of beetles is very wide-ranging. They are found in almost all types of habitats, except sea and polar region. Among the variety of aquatic habitats, wetlands are diverse and productive ecosystems endangered by human pressure, which degradation implies a biodiversity loss worldwide. Among the biological assemblages of these habitats, aquatic Coleoptera is one of the most diverse and useful groups when assessing the ecological conditions of the ecosystems they inhabit. The aims of the present study were to analyze the aquatic beetles assemblage, biodiversity and relation between habitat and diversity of aquatic beetles in 9 wetlands of Manipur. A total of 1873 individuals and 56 water beetles species belonging to order Coleoptera under 11 families was collected. In general, wetlands presented high richness and diversity values among which Dytiscidae and Hydrophilidae have the highest species richness and most of recorded species have a wide biogeographically distribution.

INTRODUCTION

Background

Wetlands are the land where an excess of water is the dominant factor determining the nature of soil development and the types of animals and plant communities living at the soil surface. Wetlands are the transitional zones between terrestrial and aquatic environments and constitute a dynamic link between the terrestrial and aquatic system. These have many forms including marshes, estuaries, ponds, swamps, deltas, bogs, lakes, floodplains etc. The characteristic vegetation of aquatic plants distinguishes wetlands from other land forms or water bodies *(Butler, 2010)*. In Manipur, wetlands are swampy or low lying area where water accumulates either in the peripheral area or vicinity of the lakes. According to Cowardin *et al*., (1979), wetland are classified into 5 categories in association to its hydrological, ecological and geological aspects, such as; marine (coastal wetlands including rock shores and coral reefs), estuarine (including deltas, tidal marshes, and mangrove swamps), lacustarine (lakes), riverine (along rivers and streams) and palustarine ('marshy'- marshes, swamps and bogs). However, in Manipur only four types of wetlands such as estuarine (including deltas, tidal marshes, and mangrove swamps), lacustarine (lakes), riverine (along rivers and streams) and palustarine ('marshy'- marshes, swamps and bogs) are found.

The wetlands of Manipur are recognized as centre of biodiversity with high levels of aquatic insect diversity. Freshwater habitats are among the most sensitive to human alterations and thus are good indicators of the wider environmental quality (Hecker and Vives, 1995). Water beetles are the most diverse and are mostly found in the region between land and inland waters, a habitat specially rich and sensitive to environmental changes (Lachavanne and Juge, 1997). They are indicator of ecological diversity and habitat characteristics as they fulfill most of the criteria generally accepted in the selection of indicator taxa. A growing number of studies, however, have shown strong environmental influences on beetle assemblage structure (Larson *et al*. 2000, Fairchild *et al*. 2003, Eyre 2006, Eyre *et al*. 2006, Gioria *et al*. 2010, Touaylia *et al*. 2011), implying their potential use as bioindicators of anthropogenic disturbances. Water-beetle assemblages typically include a wide range of predators (e.g., Dytiscidae and larval Hydrophilidae) but also generalized algivores and detritivores (e.g., adult Hydrophilidae), consumers of filamentous algae (e.g., Haliplidae), and herbivores of vascular plants (e.g., Curculionidae and Chrysomelidae). An array of changes in the availability of food resources is thus likely to influence beetle species compositions (Fairchild *et al*., 2000). Continental wetlands of southern South America are very diverse and include meadows, marshes, bogs, perilacustrine communities, forests, and salt marshes. The

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structure and species composition of these environments vary according to the relief, substrate, water period, pH, salinity, alkalinity, mesoclimatic conditions and land-use patterns. These ecosystems are threatened by a number of human activities, of which the most important include increase nutrient loading, contamination, overgrazing and invasion by exotic species (Bronmark and Hansson, 2002). Grassland wetlands are areas that receive more grazing pressure since they have the best forage (Collantes and Faggi, 1999), which in turn increases land-degradation processes (Brönmark and Hansson, 2002). It is known that Manipur is blessed with diverse biological species both plants and animals (domesticated and wild) which is in short termed as Biodiversity and different type of habitats due to several land forms and altitude; as it is situated in the Indo Malayan Biological Hot Spot and it also contributed to a large regional aquatic biodiversity. Wetlands such as Ikop, Keibul Lamjao, Kharung, Loktak and Pumlen are the major wetlands of Manipur. Loktak was declared as Ramsar site as a wetland of very high priority and all other wetlands were placed in data deficient category.

However, many wetlands in Manipur have continued to experience an array of pressures and threats from both the natural and the anthropogenic activities. These threats have not diminished and freshwater biodiversity has further declined during the last decade. Some major threats are (i) Loss of habitat: The wetlands in the state are on the verge of eminent loss in their own ways, in particular from sedimentation due to deforestation and eutrophication. (ii) Encroachment by agricultural activities, human settlements and commercial activities such as increase of phoomdi dweller, shallowing of and filling of lake boundaries for settlement, for farming etc. (iii) Information gap: Information relating to the Government's measures to tackle the illegal hunting, poaching, destruction of habitats including chemical poisoning or to conserve biodiversity specific areas are either irrelevant to the local commitments or are seen unnecessary hindrance to their activities. (iv) Lack of knowledge: The people of remote areas particularly in the hills have no knowledge that there are rules and regulations to protect wildlife and importance and value of wetlands to maintain the ecological balance in nature.

Despite Manipur is rich in aquatic beetles' biodiversity, but due to the lack of knowledge of its importance in ecological balance of aquatic environments. Taking into consideration the work will come out with the database of aquatic insects found in all wetlands of Manipur.

In order to assess whether aquatic beetles contribute to the maintenance of freshwater ecosystem, we determined the diversity and composition of aquatic beetle's communities' assemblages in nine protected wetlands of Manipur and the influence of environmental variables on the distribution of species, in order to detect differences between the different types of standing water habitats. Biological and environmental data were used to reach three main objectives: i) to analyze the composition of aquatic Coleoptera assemblages in the protected wetlands; ii) to assess differences between wetlands regarding biological data; and iii) to determine the main environmental factors influencing species distribution. Besides these, the aquatic insect's taxa and their relationships with several environmental variables will also be investigated. Again this paper is aimed to help further researchers by providing an overview for further researches in conservation management and restoration of wetland of Manipur.

MATERIALS AND METHODS

The present investigation is carried out during January 2016 to December 2016 in the Laboratory of Entomology, D.M. College of Science, Imphal. The study sites and 9 location sites are given in the following map.

Study area and Sampling Sites

Manipur is a small state in the North-Easternmost part of India. It lies between $23^0$83'N-$25^0$68' N; 93^0 03'E-94^0 78'E.The state comprises of nine districts, five in the hills and four in the valley. From the 9 districts of Manipur 9 collection sites were selected as sampling sites for collection of water beetles.

The geographical data for the study sites selected were comprised of wetlands and some lentic locations with their respective typical habitat illustrated for each site was given in. The geo-coordinates profiles of the 9 different sites of Manipur were provided herein (Table 1). The geographical coordinates were noted using a GPS recorder.

Aquatic insect sampling and identification

Aquatic beetles were collected from the 9 collection sites through an extensive survey during January 2016 to December 2016 for one hour at each site to standardize sampling effort per site. The insects were collected using D-Frame net, Pond net, Kicking net as well as triangular dip net and circular net with a mesh size of 0.5mm and dragged around the vegetation for one minute and such three drags constituted a sample. The number of individual was noted down. The large sized insects were captured using bottle traps in horizontal position and also vertical position. After two days the bottle traps were removed and trapped insects were preserved in 70% alcohol and brought back to the Laboratory of Entomology, P.G. Department of Zoology, D.M. College of Science, Imphal and identified with the help of standard identification manuals and published literature **(**Andersen *et al*. 2004; Bal *et al*. 1994a, b; Bouchard, 2004; Epler, 2010; Westfall *et al* 1996). Identification of adults and immature stages was done using Smith & Smith (2003), Subramanian & Sivaramakrishnan (2007). A number of identified insects were confirmed in the division of Entomology, IARI, Pusa, New Delhi. The illustrations and photographs are based on the examination of the material collected in this study. Male genitalia were removed from specimens that were first relaxed in lightly boiling water for 10 minute. An insect pin with a bent apex was inserted into the abdominal cavity to hook the base of the genital capsule. The entire capsule was then removed from the abdomen and placed in alcohol to dissect and examine. Male genitalia were then glued to a point and placed on the pin beneath the specimen.

Statistical Analysis

Data collected from the study were tested for normality. Data which failed normality were not used for further analysis. Species diversity (Shannon- Weiner index), component of dominance (Simpson dominance index) and Berger-Parker dominance were determined for each site. Comparison in species composition between different sites was estimated using single linkage cluster based on Bray-Curtis similarity. Species recorded in this study were ranked on the basis of

relative abundance of individual species. Data of species richness counts of one year from the nine sites were pooled to get rarefaction curves for comparison of estimated species richness between the sites. Biodiversity Pro version 2 was used to determine diversity indices, cluster analysis, rarefaction curves, species richness estimates and also used for rank abundance diagram. Pearson Correlation coefficient (r) was used to determine the interdependence of the parameters where physico-chemical parameters were correlated with themselves and abundance of insect species.

RESULTS

Composition and diversity of the aquatic Beetle community

We recorded a total number of 1873 specimens of aquatic beetles, which belonged to 12 families, 36 genera and 56 species (Table 1).

Table1 Number of individual and relative abundance of aquatic beetles (identified to family) in nine different wetlands in nine districts of Manipur, North East India.

Family	Number of Individual	Relative Abundance
Dytiscidae	918	49.01
Hydrophilidae	460	24.55
Noteridae	264	14.09
Chrysomelidae	33	1.76
Curculionidae	33	1.76
Hydrochidae	33	1.76
Haliplidae	51	2.72
Staphylinidae	31	1.65
Scirtidae	20	1.06
Dryopidae	15	0.80
Hydraneidae	20	1.06
Helophoridae	1	0.05
Total	1873	100

The number of individuals and its relative abundance of aquatic beetles species (identified to family) in nine different wetlands in nine districts of Manipur, North East India (Table 2).

Fig 1 Map of Manipur showing 9 District

During the investigation, we found the highest number of individuals in Dytiscidae (918), followed by Hydrophilidae (460), Noteridae (264), Haliplidae (51), Chrysomelidae, Curculionidae, Hydrochidae (33 each), Staphylinidae (31), Scirtidae, Hydraneidae (20 each), Dryopidae (15) and Helophoridae (only 1 individaual). Dytiscidae and Hydrophilidae (both species and individuals) were the dominant families in the study areas (Table 3). Dytiscidae, including 12 genera and 25 species, had the highest dominance on the mountain. *Chasmogenus abnormalis* a distinctive species, was found only on the lake of Manipur without any record in other parts of India. Each of five species, including *Laccobius* sp. *Elmomophes brevicornis, Enochrus* sp., *Hyphydrus* sp., and *Helophorus* sp., was observed only at one point of sampling sites, respectively; *Laccobius* sp., *Enochrus* sp., *Hyphydrus* sp., was found only in Ukhrul, *Elmomophes brevicornis,* was only in Leimaram and *Helophorus* sp., was found only one individual from Loktak Lake. *Laccobius* sp., was found only from Ukhrul. The most frequent species in the study area were *Hydrocanthus guignoti and Hydrovatus acuminatus* while the most abundant ones was *Enochrus esureins*. All nine different sites of nine wetlands have roughly equal species richness. Species richness (S) was between 46 and 50 at most of the sampling sites, and was highest at Ukhrul site = (53), and the lowest at Tamenglong site = (44). The Shannon-Wiener diversity indexes in Ukhrul 3.646 were the most diverse followed by Loktak 3.597, Lousipat 3.588, Leimaram 3.584, Lamphelpat 3.506, Tamenglong 3.484, Churachanpur 3.46, Chandel 3.422 and Porompat 3.374. In Margalef index Ukhrul 9.051 was the greater diversity followed by Lousipat 8.985, Leimaram 8.759, Lamphelpat 8.297, Loktak 8.712, Churachandpur 8.473, Chandel 8.32, Tamenglong 8.159 and Porompat 7.973 respectively (Fig.2).

Aquatic beetle abundance in relation to its habitat types

The populations of different species of aquatic beetles were fairly distributed in the habitats types of nine wetlands of Manipur. The highest abundance species was caught in Ukhrul and Loktak Lake with 52 and 49 species and 280 and 247 individuals. The lowest species was caught in Tamenglong. Tamenglong had the lowest abundance with 43 species and 172 individuals. However, in terms of habitats the nine wetlands of Manipur were of fresh water lakes and characterized by waterlogged marshy and swampy. These areas were low lying, situated either in the peripheral area or vicinity of the lakes. Out of these nine wetlands 4 namely Porompat, Lousipat, Loktak Lake and Tamenglong were the permanent stagnant water body with soft substrata, coarse gravel with emergent vegetation at the edges provided suitable habitat for predaceous diving beetles under family Dytiscidae and were quite diverse in the various habitats of the marsh. Leimaram and Chandel was the shallow stream with slow running water, substrata with sand and rocks probably highly oxygenated water, little vegetation but packs of leaves and twigs accumulated in riffle areas. Ukhrul, Churachandpur and Lamphelpat were the lowland marshes with temporary water and lots of vegetation along its margin. From all wetlands, the family Dytiscidae was the most diverse and abundant. This can be attributed to their feeding behavior. As predators, their numbers are dependent on the available prey.

Table 2 Distribution of aquatic beetles species in nine different wetlands of Manipur

Species	Porompat	Lamphelpat	Lousipat	Loktak	Leimaram	Ukhrul	Tamenglong	Chandel	Churachandpur
Cybister sugillatus	2.	1.	2.	4.	1.	2.	2.	2.	1.
Cybister tripunctatus	2.	3.	2.	4.	1.	2.	2.	1.	3.
Leiodytes nicobaricus	15.	8.	5.	10.	7.	16.	7.	5.	10.
Laccophilus parvulus	13.	10.	12.	15.	8.	12.	6.	5.	7.
Laccophilus flexuosus	6.	8.	6.	12.	10.	5.	8.	9.	8.
Laccophilus chinensis	10.	8.	4.	9.	8.	3.	2.	2.	3.
Laccophilus anticatus	2.	1.	3.	2.	1.	5.	2.	2.	3.
Laccophilus sp.1	3.	2.	1.	4.	3.	4.	2.	2.	4.
Laccophilus sp.*2*		2.	1.	2.		2.		4.	2.
Laccophilus sp.3	1.	2.	4.		1.		1.	2.	1.
Hydroglyphus flammulatus	10.	8.	2.	14.	5.	12.	4.	2.	
Dytiscus sp.				1.		1.			1.
Hydroglyphus inconstans	8.	4.	3.	2.	8.	10.	5.	4.	2.
Copelatus indicus	2.	3.	1.	2.	4.	5.	1.	2.	
Copelatus sp.1		1.	1.	1.	2.	1.		2.	1.
Copelatus sp.2	1.			2.	4.	3.		1.	2.
Copelatus sp.3	3.	1.	2.		3.		2.	1.	10.
Hydrovatus acuminatus	20.	18.	14.	12.	15.	21.	13.		14.
Hydrovatus bonvouloiri	5.	15.	8.	10.	6.	9.	5.	12.	5.
Rhantus sp.	2.	3.	4.	2.	4.	9.	1.	12.	3.
Graphodesus sp.	3.	5.	4.	9.	3.	13.	2.	4.	2.
Hydaticus satoi	1.	3.	8.	5.	2.	10.	2.	5.	1.
Hydaticus sp.		2.	2.	1.		2.		2.	
Hyphydrus agabus		3.	2.	1.		15. 2.	1.		
Hydrocanthus guignoti	18.	12.	18.	13.	15.	10.	18.	12.	14.
Neohydrocoptus subvittulus	5.	12.	6.	15.	4.	13.	3.	12.	2.
Canthydrus incosistant	3.	4.	2.	10.	2.	4.	1.	30.	6.
Tropisternus sp.	3.	4.	5.	6.	8.	5.	4.	8.	
Laccobius sp.						1.			
Hydrophilus sp.	1.	2.	1.	2.	1.	1.	3.		4.
Regimbartia attenuata	4.	3.	2.	4.	3.	5.	6.	2.	2.
Amphiops sp.	5.	4.	8.	5.	4.	6.	7.	2.	
Amphiops mirabilis			2.	1.	1.	2.		3.	2.
Coelostoma stultum	1.		2.	1.	1.	2.		3.	4.
Helochares anchoralis	5.	8.	4.	5.	6.	4.	3.	4.	4.
Helochares crenatus	4.	3.	2.	4.	5.	3.	6.	2.	4.
Helochares atropiceus	5.	6.	4.	3.	2.	4.	8.	2.	4.
Enochrus esuriens	10.	8.	6.	5.	4.	8.	2.	2.	2.
Berosus indicus	2.	1.	4.	2.	2.	6.	4.		1.
Berosus pulchelus	4.	4.	3.	6.	2.	2.	6.	3.	20.
Enochrus nigropiceus	2.	4.	3.	6.	3.	4.	2.	4.	2.
Enochrus sp.						1.			
Paracymus sp.					1.	2.			2.
Chasmogenus abnormalis	1.	2.	1.	3.	2.	3.	2.	4.	2.
Cercyon sp.	4.	1.	2.	3.	2.	1.	1.	2.	2.
Donacia sp.	2.	4.	3.	3.	2.	6.	5.	3.	1.
Notiodes sp.	1.	3.	2.	4.	8.	6.	4.	4.	2.
Hydrochus sp.	2.	3.	5.	8.	6.	3.	2.	3.	4.
Haliplus sp.	2.		2.	4.	1.	2.	1.	1.	2.
Haliplus manipurensis	4.	3.	2.	6.	8.	2.	4.	3.	4.
Paedrus sp.	1.	4.	2.	23.	4.	6.	5.	4.	2.
Scirtid sp.	1.	2.	3.	1.	2.	2.	6.	2.	1.
Elmomophes brevicornis	0	0	0	0	15	0	0	0	0
Hydraena sp.	3.	1.	2.	2.	4.	2.	1.	2.	3.
Helophorus sp.	0	0	0	1	0	0	0	0	0

Table 3 Number of families of aquatic beetle species in nine different wetlands of Manipur.

Family	Porompat	Lamphelpat	Lousipat	Loktak	Leimaram	Ukhrul	Tamenglong	Chandel	Churachanpur
Dytiscidae	109	111	91	124	102	159	68	81	83
Hydrophilidae	51	50	59	56	47	60	54	41	55
Noteridae	26	20	26	38	21	25	22	37	22
Chrysomelidae	2	4	3	3	2	6	5	3	1
Curculionidae	1	3	2	4	8	6	4	4	2
Hydrochidae	2		2	4	1	2	1	1	2
Haliplidae	5	3	4	10	9	4	5	4	6
Staphylinidae	1	4	2	23	4	6	5	4	2
Scirtidae	1	2	3	1	2	2	6	2	1
Dryopidae	0	0	0	0	15	0	0	0	0
Hydraneidae	1	2	3	1	2	2	6	2	1
Helophoridae	0	0	0	1	0	0	0	0	0

Table 4 Number of individual and its habitat type of the species.

Species	Natural Habitat	Total number of individual
Cybister sugillatus	It inhibits in deeper water of open permanent water bodies. i.e. ponds	18
Cybister tripunctatus	It inhabits in permanent water bodies of considerable vegetation.	20
Leiodytes nicobaricus	The species is collected from very shallow zone just at the edge of the water bodies and commonly inhibited in exposed or semi-shaded, temporary and permanent water a body which is rich in vegetation and plant debris, such as ponds, pools and drainage ditches in primary and cultivated areas.	83
Laccophilus Parvulus	They are found in varieties of lentic habitats and along margins of streams.	88
Laccophilus flexuosus	A wide variety sun warmed shallow permanent pools and ponds generally among rooted vegetation.	72
Laccophilus chinensis	They were collected from exposed muddy temporary ponds.	49
Laccophilus anticatus	They were collected from the midst of aquatic weeds and often found crawling or running easily on the edge of wetland, on algal mat or on dry land.	19
Laccophilus sp.1	They were found from the temporary ponds or newly formed or re-watered ponds.	25
Laccophilus sp.2	Collected from both permanent and temporary ponds.	13
Laccophilus sp.3	Wide variety of lentic habitats and along margins of streams.	12
Hydroglyphus flammulatus	They were often found in pools and streams with mineral substrate.	58
Dytiscus sp.	They are found in emergent vegetation in large permanent water bodies. i. e. ponds.	3
Hydroglyphus inconstans	The beetles were collected from the margin of the permanent gravel pit pool.	46
Copelatus indicus	They are collected from shallow temporary habitats that often associated with streams.	20
Copelatus sp.1	They are collected from shallow temporary habitats that often associated with streams.	9
Copelatus sp.2	They are collected from both temporary and permanent water but most commonly in shallow water with heavy decaying leaves.	12
Copelatus sp.3	They were collected from both permanent and shallow temporary waters with heavy decaying leaves.	13
Hydrovatus acuminatus	They were collected from open shallow water bodies with large vegetation.	127
Hydrovatus bonvouloiri	They were collected from shallow water with aquatic vegetation and also in the water containing debris near the bank.	75
Rhantus sp.	They were collected from permanent water bodies but mostly collected from shallow margin.	40
Graphodesus sp.	They were collected mostly from the margin of the deeper ponds and small lakes.	37
Hydaticus satoi	They were collected from both permanent and temporary waters.	37
Hydaticus sp.	They were collected from both permanent and temporary waters.	9
Hyphydrus birmanicus	They were collected from heavily vegeted lakes, ponds, streams etc.	15
Agabus amoenus sinuaticollis	They were collected from temporary waters such as puddles.	6
Hydrocanthus guignoti	They were collected from the open waters with leaf litter.	130
Neohydrocoptus subvittulus	They were collected from temporary ponds and small lakes.	72
Canthydrus incosistant	They were collected from algal mat, weeds, muddy water on edge of lakes, ponds, streams etc.	62
Tropisternus sp.	They were found in both lenthic habitat and along margins of streams and lakes with substantial amounts of algea and in the mud and compost.	43
Laccobius sp.	They were collected from the margin of streams.	1
Hydrophilus sp.	They were found in shallow ponds and streams with abundant vegetation.	15
Regimbartia attenuata	They were collected from the banks of wetland among the growing mass of aquatic plants.	31
Amphiops sp.	They were collected from the water with emergent vegetation.	41
Amphiops mirabilis	They were collected from the water with emergent vegetation and sometimes also found walking on algal mat.	11
Coelostoma stultum	The species were collected from the algae and rotting plant remains at the edges of streams.	14
Helochares anchoralis	The species were collected from weedy shallow and in marshy places and also occur in the mud just above the water edge.	43
Helochares crenatus	Lentic species and inhabits permanent water bodies. The species was found in the very shallow zone just at the edge of the lake. The beetles were crawling among plant debris such as accumulations of rotten leaves and twigs.	33
Helochares atropiceus	Lenthic species inhabits permanent water bodies. The species was found in the very shallow zone just at the edge of the lake. The beetles were crawling among plant debris such as accumulations of rotten leaves and twigs.	38
Enochrus esuriens	They were collected from weedy shallow areas of water, damp places and muddy edges of water.	47
Berosus indicus	They were collected from both permanent and temporary water that usually near large streams.	22
Berosus pulchelus	They were collected from both permanent and temporary water that usually near large streams.	50
Enochrus nigropiceus	They were collected from ponds, marshes and margins of lakes and streams	30
Enochrus sp.	They were collected from ponds, marshes and margins of lakes and streams	1
Paracymus sp.	They were collected from shallow water with large organic matters.	5
**Chasmogenus abnormalis*	They were collected in along densely vegetated lake margins.	20
Cercyon sp.	The species were collected from the rotting vegetables at the edge of lake.	18
Donacia sp.	They were collected from the floating leafs of rooted macrophytes.	29
Notiodes sp.	They were collected from the submerged aquatic vegetables.	34
Hydrochus sp.	They were collected from lenthic habitat with shallow waters and occasionally from margin of lakes	36
Haliplus sp.	They were collected from the large ponds with heavily vegetation.	15
Haliplus manipurensis	They were collected from standing water of the large ponds with larges vegetation.	37
Paedrus sp.	They were collected from the shorelines of waters.	51
Scirtid sp.	They were collected from emergent vegetation with rotten plant materials on shorelines.	20
Elmomophes brevicornis	They were collected from the shallow region of lakes streams with emergent vegetation.	15
Hydraena	They were collected from both lenthic and lotic habitat	20
Helophorus sp.	They were collected from shallow margin of lakes.	1
Total		1873

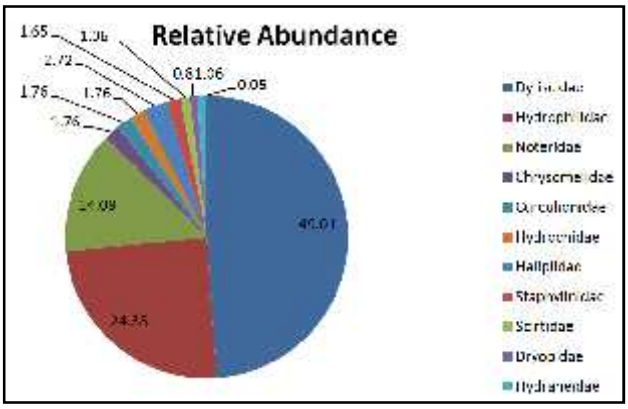


Fig.2 Species diversity of the aquatic beetles in nine different wetlands of Manipur

Dytiscidae and Noteridae generally preferred leaves of submerged aquatic vegetation in clear freshwater lake and are predacious in nature. On the contrary, Hydrophilidae are water scavenger beetles and generally occur in shallower regions of wet land with abundant macrophytes and feed mainly on detritus, algae and decaying vegetative matter. The difference between the insect communities of temporary and permanent wetland can be illustrated by comparing the average proportion of the main insects in both wetlands. The table 4 & 5 show the most striking difference between the permanent and temporary wetland. The temporary wetlands have a significantly greater number of mobile species. In contrast, permanent wetlands have a significant proportion of higher size species like *Cybister* sp. All other characteristic species either did not differ in frequency between permanent and temporary water bodies or had a preference for temporary water bodies.

make the small marsh or temporary wetland of Manipur into lakes. Equal range of habitats was seen to all wetlands and more species of aquatic beetles were shared among them. Some species of water beetles appeared to be unique in one or two natural habitats. The existence of these unique species is an important consideration for biodiversity conservation because they serve as indicators in the quality of the habitat. The unique presence of some species in a particular habitat may indicate the provision of specific habitat requirements such as the vegetation structure, amount of accumulated detritus and the presence of food which are important considerations in biodiversity conservation. In Manipur, the *Elmomophes brevicornis* was the unique species of Leimaram whereas *Enochrus* sp. *Hyphydrus* sp. and *Laccobius* sp. for Ukhrul and *Helophorus* sp. for Loktak Lake.

The close proximity and the similarity in vegetation structure of these species, *Hydrovatus acuminatus* and *Hydrocanthus guignoti* have the highest abundance at 127 and 130 respectively. However, the indices of diversity differed slightly due to the seasonal flooding that made the aquatic beetles to move from one habitat to another during flooding. In Manipur, the Hydrophilids predominate in terms of number and species richness due to the multiple roles they play in the wetland ecosystem. At the adult stage, many hydrophilids are scavengers thus they probably made the habitat more favorable to other organisms by converting the organic debris into more readily available food. Moreover, they also are providing food as prey to other organisms in the system. By converting plant and animal debris into organic matter, these scavenger beetles likewise play an important role in the nutrient production system of the marsh.

Table 5 Nine selected different types of wetland and its natural habitat in Manipur.

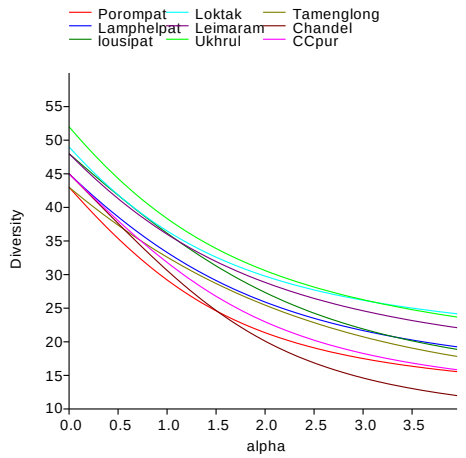
Wetland	Natural Habitat
Porompat	Large permanent water body with soft substrata having coarse gravel and provided with a flooded litter zone.
Lamphelpat	Lowland marshes with temporary water and lots of vegetation along its margin.
Lousipat	Permanent low lying water body with emergent vegetation, algae and plant debris.
Loktak Lake	Large permanent lake with heterogeneous mass of vegetations, organic matter at various stages of decomposition (Phumdis) floating over it.
Leimaram	Shallow stream with slow running water, substrata with sand and rocks probably highly oxygenated water, little vegetation but packs of leaves and twigs accumulated in riffle areas.
Tamenglong	Lowland temporary water body having soft substrata with emergent vegetation.
Chandel	Permanent water body with soft substrata and emergent vegetation on edge.
Moreh	Lowland permanent water body with sandy substrata having less vegetation.
Churachandpur	Lowland temporary water body with soft substrata having less vegetation.

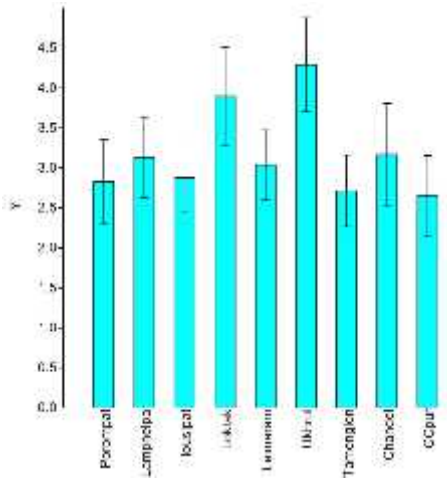
Table 6 Diversity indexes of nine different wetlands of Manipur.

0	Porompat	Lamphelpat	Lousipat	Loktak	Leimaram	Ukhrul	Tamenglong	Chandel	Churachandpur
Taxa_S	43	45	48	49	48	52	43	45	45
Individuals	194	201	187	247	214	280	172	198	180
Dominance_D	0.04682	0.03859	0.03658	0.03359	0.03468	0.03268	0.03928	0.04974	0.04352
Simpson_1-D	0.9532	0.9614	0.9634	0.9664	0.9653	0.9673	0.9607	0.9503	0.9565
Shannon_H	3.374	3.506	3.588	3.597	3.584	3.646	3.484	3.422	3.46
Evenness_e^H/S	0.6792	0.74	0.7534	0.7449	0.7503	0.7373	0.7581	0.6805	0.707
Brillouin	3.056	3.177	3.222	3.296	3.254	3.358	3.128	3.092	3.108
Menhinick	3.087	3.174	3.51	3.118	3.281	3.108	3.279	3.198	3.354
Margalef	7.973	8.297	8.985	8.712	8.759	9.051	8.159	8.32	8.473
Equitability_J	0.8972	0.9209	0.9269	0.9243	0.9258	0.9229	0.9264	0.8989	0.9089
Fisher_alpha	17.11	18.01	20.89	18.34	19.24	18.8	18.4	18.17	19.26
Berger-Parker	0.1031	0.08955	0.09626	0.06073	0.07009	0.075	0.1047	0.1515	0.1111
Chao-1	46.27	48.5	48.83	51.55	51.27	53.07	45.15	45.33	46.24

The aquatic beetles have similar species despite the differences in the species richness and abundance in the various wetland natural habitats. This can be due to the similarity of the characteristics among habitats resulting from the flooding that

Some species of hydrophilids were predaceous during the larval stage. As such, they also help to regulate the populations of their prey, thus minimize competition in the ecosystem.





DISCUSSION

Aquatic beetles diversity and its abundance

The result obtained from the present survey of aquatic coleoptera assemblages in different wetlands of Manipur shows that it was not more or less distinct difference in beetle fauna both qualitatively and quantitatively in nine different types of wetlands. These studies contribute to the better knowledge and understanding towards the diversity of aquatic beetle's species in different wetlands of Manipur. In general, the higher diversity and abundance of aquatic beetle's fauna were found in Ukhrul and Loktak Lake. The lowest diversity values were found in Tamenglong. From the different wetlands of the Manipur, we found 56 beetle's species, of which 49.01 % was known from the Family Dytiscidae followed by Hydrophilidae. 24.55 %, Noteridae 14.09 % and Haliplidae 2.72% and 1% each from other remaining families. According to Shannon-Wiener diversity indexes Ukhrul 3.646 were the most diverse selected wetland from Manipur than the other eight wetlands such as Loktak 3.597, Lousipat 3.588, Leimaram 3.584, Lamphelpat 3.506, Tamenglong 3.484, Churachanpur 3.46, Chandel 3.422 and Porompat 3.374. Margalef index also shows that Ukhrul 9.051 was the greater diversity followed by Lousipat 8.985, Leimaram 8.759, Lamphelpat 8.297, Loktak 8.712, Churachandpur 8.473, Chandel 8.32, Tamenglong 8.159 and Porompat 7.973. Further analysis such as Dominance, Simpson, Evenness, Brillouin, Menhinick Equitability, Fisher alpha, Berger-Parker and Chao-1 was given in Table no 6.

Factors influences in aquatic beetles biodiversity management

In all studied wetlands, both in temporary and permanent water body the small sized beetles were by far the most abundant whereas medium-sized and large sized beetles were occurred in permanent water body with smaller numbers, which is in accordance with results from similar studies in Alberta, Canada (Larson, 1985). In our study, the number of individuals of species varied greatly between seasons of the year with peak abundances in winter. At Gwalior (M.P.) in earlier observation regarding insect abundance both in quality during colder months and quantity during summer seasons in pond water were reported (Kaushik *et al*. 1990). The studied wetlands presented high richness values and some of them constitute the habitat for rare or endemic species in Manipur, giving a high conservation value to these habitats. It was suggested not only the landscape management but also the individual site protection (Bilton *et al*. 2009). However, it would bring a very interesting measure especially for temporary ponds in agricultural areas that can be considered keystone structures for the maintenance of biodiversity (Tews *et al*. 2004). Although it was necessary to have the knowledge of the main environmental factors in driving aquatic beetle distribution and differences regarding biological composition to establishing adequate management measures for each type of aquatic ecosystem. Several studies highlighted the contribution of standing waters to regional freshwater biodiversity (Williams *et al*., 2003; Picazo *et al*., 2010) and the usefulness of aquatic Coleoptera as surrogates of biodiversity (Foster *et al*., 1990; Sánchez-Fernández *et al*., 2004, 2006; Guareschi *et al*., 2012). Therefore, management measures in standing water bodies should consider water beetles as indicators, as they are sensitive species to ecological changes and habitat characteristics.

Habitat Ecology of aquatic beetles biodiversity

On the basis of present study regarding the habitat types of aquatic beetles, it is evident that the quality and quantity of aquatic vegetation and nature of the wetlands plays important role in determining the distribution, diversity and abundance of insect communities. The habitat and diversity of aquatic beetles was most favorable in small water bodies of having mostly slow currents, shallow depth and rich vegetation in comparison to the larger water bodies. They thrived where the water shares by the nymphs or larvae of other aquatic insects and similar small arthropods which they consume. Dense merged vegetation affords an abundant food for their coin habitants and thus assures an adequate supply of prey for the beetles. And at the same time the plants provide shelter in which the beetles hide, rest, and lurk for their prey. Most species deposits their eggs on the surface of leaves or into the tissues of utilized parts of plants. Thus aquatic vegetation has come to be essential in many of the vital activities of these beetles.

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References

Butler, S., ed. (2010): Macquarie Concise Dictionary (5th edn.). Sydney, Australia: Macquarie Dictionary Publishers Ltd., Sydney.

Cowardin LM, Carter V, Golet FC, LaRoe ET. (1979): Classification of wetlands and deepwater habitats of the United States. U.S. Fish & Wildlife Service Pub.FWS/OBS-79/31, Washington, DC.

Hecker, N., Vives, P.T. (Eds.), (1995): The Status of Wetland Inventories in the Mediterranean Region. MedWet, IWRB Publication No. 38. ICN Portugal, Oxford

Lachavanne, J.B., Juge, R. (Eds.), (1997): Biodiversity in Land-inland Water Ecotones. Unesco and The Parthenon Publishing Group, Paris.

Larson, DJ, (1997): Habitat and community patterns of tropical Australian Hydradephagan water beetles (Coleoptera: Dytiscidae, Gyrinidae, Noteridae). *Australian Journal of Entomology* 36: 269-285.

Fairchild GW, J Cruz, AM Faulds, AEZ Short, JF Matta. (2003): Microhabitat and landscape influences on aquatic beetle assemblages in a cluster of temporary and permanent ponds. *J. N. Am. Benthol. Soc*. 22:224-240

Eyre MD. (2006): A strategic interpretation of beetle (Coleoptera) assemblages, biotopes, habitats and distribution, and the conservation implications. *J. Insect Conserv*. 10:151-160.

Eyre MD, GN Foster, ML Luff, SP Rushton. (2006): The definition of British water beetle species pools (Coleoptera) and their relationship to altitude, temperature, precipitation and land cover variables. *Hydrobiologia* 560:121-131.

Gioria M, A Schaffers, G Bacaro, J Feehan. (2010): The conser-vation value of farmland ponds: predicting water beetle assemblages using vascular plants as a surrogate group. *Biol. Conserv*. 143:1125-1133.

Touaylia S, J Garrido, M Bejaoui, M Boumaiza. (2011): Altitudinal distribution of aquatic beetles (Coleoptera) in northern Tunisia: relationship between species richness and altitude. *Coleopt. Bull*. 65:53-62.

Brönmark C, LA Hansson. (2002): Environmental issues in lakes and ponds: current state and perspectives. *Environ. Conserv*. 29:290-306.

Fairchild GW, AM Faulds, JF Matta. (2000): Beetle assemblages in ponds: effects of habitat and site age. *Freshw. Biol*. 44:523-534

Collantes MB, AM Faggi. (1999): Los humedales del sur de Sudamérica. In AI Málvarez, ed. Tópicos sobre humedales subtropicales y templados de Sudamérica. Montevideo, Uruguay: UNESCO, p 15-25.

Kaushik S, Sharma S, Saxena MN, Saxsena DN. (1990): Abundance of insects in relation to physicochemical characteristics of pond water at Gwalior (M.P.). Proceedings of the National Academy of Sciences, India Vol. LX Part I

Bilton DT, McAbendroth LC, Nicolet P, Bedford A, Rundle SD, Foggo A, Ramsay PM, (2009): Ecology and conservation status of temporary and fluctuating ponds in two areas of southern England. *Aquat. Conserv*. 19:134-146.

J Tews, U Brose, V Grimm, K Tielbörger, WC Wichmann, M Schwager, F Jeltsch, (2004): Animal species diversity driven by habitat heterogeneity/diversity: the importance of keystone structures. *J. Biogeogr*. 31:79-92.

D Williams, (2006): The biology of temporary waters. Oxford University Press, Oxford. p 348

Williams P, Whitfield M, Biggs J, Bray S, Fox G, Nicolet P, Sear D (2003): Comparative biodiversity of rivers, streams, ditches and ponds in an agricultural landscape inSouthern England. *Biol Conserv*. 115:329–341

Foster GN, Foster AP, Eyre MD, Bilton DT. (1990): Classification of water beetle assemblages in arable fenland andranking of sites in relation to conservation value. *Freshwater Biology* 22: 343–354

Sanchez-Fernandez D, Abellian P, Velasco J, Millian A. (2003): Los Coleopteros Acuaticos de la Region de Murcia. Catalogo Faunıstico Areas Prioritarias de Conservaci on. Monografıas SEA, vol. 10. SEA: Zaragoza.

Guareschi, s., c. Gutiérrez-cánovas, F.picazo,D. Sánchez-fernández, P. Abe-llán, J. Velasco & A. Millán. (2012): Macroinvertebrate biodiversity: patterns and sur-rogates in mountainous Spanish national parks.Aquatic Conservation: Marine and Freshwater Ecosystems, 22(5): 598–615.

Picazo, F., D. Sánchez-Fernández, P. Abe-Llán, J. L. Moreno & A. Millán. (2010): Conservación de la biodiversidad en la provin-cia de Albacete: patronese indicadores. Instituto de Estudios Albacetenses, Albacete.

Sánchez-Fernández, D., P. Abellán, J. Ve- Lasco & A. Millán. (2004): Selecting areas to protect the biodiversity of aquatic ecosystems in a semiarid Mediterranean region. Aquatic Conservation: Marine and Freshwater Ecosystems, 14: 465–479.

Sánchez-Fernández, D., P. Abellán, A.Mellado, J. Velasco & A.Millán. (2006): Are water beetles good indicators of biodiversity in Mediterranean aquatic ecosystems? The case of the Segura river basin (SE Spain). *Biodiversity and Conservation*, 15: 4507-4520

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