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Wetland Plant, *Nelumbo nucifera* Gaertn. (Lotus) serving as a Habitat for Macroinvertebrates

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Abstract

The present communication deals with the study of association of macroinvertebrate fauna with a wetland plant, Nelumbo nucifera Gaertn. (Lotus) during the period extending from July, 2010 to June, 2011. The present study revealed association of 3 phyla with Nelumbo nucifera viz., Annelida (18.34%), Arthropoda (53.32%) and Mollusca (28.52%) constituting a total of 2388 organisms/m^2. The macroinvertebrates were found to utilize Nelumbo vegetation as their habitat as different stages of their life cycle viz., eggs, larvae, pupae and adults were observed to show an intimate relationship with the plant. Statistical analysis was done and Physico-chemical parameters were also analysed which showed well marked seasonal fluctuations.

Keywords: Macroinvertebrate, *Nelumbo nucifera* Gaertn., Phytophilous, Statistical indices

Introduction

One of the most important and attractive wetland plant species in India is the 'Sacred Lotus', *Nelumbo nucifera* Gaertn. which grows widely in temperate, sub-temperate, subtropical and tropical regions in South-East Asia[1]. The genus "*Nelumbo*" constitutes the plants exhibiting enormous phenotypic diversity including racial variants differing in shapes, sizes and shades. It is known to possess a great medicinal and food value. Besides this, it also acts as a natural water filter and home/shelter for wildlife.

In general, the macrophytes represent a "Phytal habitat"[2], "Mesohabitat"[3] and "Functional habitat"[4] many organisms. Habitat conditions like the distribution and species composition of macrophytes and associated epiphytic algae are important in structuring the community of phytophilous invertebrates[5,6,7]. Macrophytes belonging to family Nympheaceae are rich in chemical compounds[8,9], which might provide invertebrates (insects) with unique chemical cues to maintain specialized associations. Despite knowing such beneficial aspects about *Nelumbo nucifera*, its ecological relationship with macroinvertebrate fauna and its effects on the ecology of aquatic ecosystems has not gained much attention of biologists and research workers in India, particularly in Jammu. So, the present research was undertaken to throw light on the impact of *N. nucifera* on the aquatic ecology and its association with the macroinvertebrate fauna of a shallow pond in Jammu.

Material and Methods

Study area: The present study was conducted in shallow pond of Jammu showing prolific growth of macrophytes such as *N. nucifera*, *Marselia quardifolia*, *Azolla pinnata*, *Lemna* sp. and *Ceratophyllum demersum*. Due to the presence of thick vegetation cover, the pond bottom is rich in organic matter and serves as a suitable niche for many invertebrates and vertebrates.

Field and Lab Studies: For the analysis of physico-chemical parameters, the water sample was collected from the littoral regions of the stream. pH was measured using portable pH meter (Hanna model), dissolved oxygen, free carbon dioxide, carbonates and bicarbonates, chloride, calcium and magnesium were measured by following procedure recommended by A.P.H.A.[10]. Physical parameters like air and water temperature, depth, transparency and speed were also measured at the study sites.

Collection of *N. nucifera* was done from the littoral areas of the stream by quadrant method using Ekman's dredge having an area of 232 cm^2. The macrophytes so collected were put into separate polythene bags and brought to the laboratory for further studies. The plants were washed in the laboratory and the associated macroinvertebrates were isolated using sieve no. 40 with 256 meshes/cm^2 and preserved in 4% formation and 70% ethyl alcohol. Preserved samples of macrobenthic invertebrates were identified with the help of Ward, H.B. and Whipple, G.C.[11], Pennak, R.W.[12], Tonapi, G.T.[13] and Adoni, A.D.[14]. The egg masses of the macroinvertebrates were separately counted and preserved in 4% formalin.

Statistical analysis of the macroinvertebrate fauna associated with *E. crassipes* was done by calculating Margalef's Richness index ($\bar{d}$), Shannon-Weiner index ($\bar{H}$), Simpson's Dominance index (D) and Equitability index (J).

Results and Discussion

The pond surveyed in the present study faces many stresses of anthropogenic origin which affect the distribution of its

inhabitants as the sensitive individuals are not able to sustain alterations in their habitat and may not survive and some get elimnated[15]. Many macroinvertebrates show phytophily which may be mechanism devised for achieving better conditions for their survival.

A total of 2388 organisms/m^2 from 23 taxa of macrobenthic invertebrates belonging to 3 phyla were viz., Annelida (18.34%), Arthropoda (53.32%) and Mollusca (28.52%) were obtained from *N. nucifera* during the present investigation (table 1).

In phylum Annelida, 5 taxa were recorded in association with *N. nucifera.* These included *Tubifex tubifex* and *Lumbricillus* sp. which were obtained from the roots of *Nelumbo* whereas Naidids (*Dero digitata*, *D. furcatus* and *Chaetogaster* sp.) were recorded from its roots as well as the expanded leaf lamina. Occurance of *D. liminosa* and *Chaetogaster limnaei* constituting 0.45% of phytophilous fauna of floating leaved macrophytes has been documented by Arimoro, F.O., Ikomi, R.B. and Efemuna, E.[16]. Naidu, K.V., Kalpana, K. and Kumar, S.[17] and Poi de Neiff, A. and Carignam, R.[18] also recorded *Dero* and *Aulophorous* as the most common faunal elements associated with macrophytes. Further, according to Bouchard, R.W.Jr.[19], Naidid oligochaetes increase their number in response to organic pollution. The presence of Naidids with *N. nucifera* in the present study suggests that the plant might be providing nutrient rich environment which favours the growth of these worms. In a study conducted by Parikh A. N. and Mankodi P.C.[20] higher planktonic production, macrophytic decay and shallowing of pond due to evaporation subsequently increased the nutrient (nitrates) concentration.

Arthropods constituted the taxonomically and numerically richest phylum associated with *N. nucifera* as revealed from (table 1) which included individuals from class Increase icta and Arachnida.

Arachnida added 1.44% to the total phytophilous fauna associated with *N. nucifera* with *Piona* sp. and *Hydrodroma* sp. as its representatives. Arimoro, F.O., Ikomi, R.B. and Efemuna, E.[16] also reported Hydrarachnida from floating plants (*Nymphea lotus*). They suggested that the mites used the leaves for constructing their webs for seeking shelter and feeding purposes. In addition to this, spawns of mites were also observed from the underside of lamina of *N. nucifera* (figure 1) in the present work. The spawns were composed essentially of roughly sphearical gelatinous matrices with eggs embedded in them. Similar observations were made by Uchida, T.[21] who recorded clumps of eggs of *Piona obturbans* from *Cladophora* sp. whereas spawn of *Acercus ornatus*, *Arrhenurus* and *Limnesia fulgida* from leaves of *Elodea* and walls of aquarium. From this association, it appears that mites may be deriving nutrients, protection and shelter from predators by using *N. nucifera* in this manner.

The present studies revealed that the phytophilous entomofauna contributed 51.88% to the plant associated fauna. The insects included individuals from 3 orders viz., Coleoptera (16.26%), Hemiptera (6.21%) and Diptera (29.39%) contributing 51.88% to the total fauna obtained from *Nelumbo* (table 2).

Interestingly, larvae and air filled pupal cases of *Donacia* sp. (Order - Coleoptera; Family Chrysomelidae) were also recovered from the roots of *N. nucifera* (figure 2-4). The association of *Donacia palmate* with *Nelumbo lutea* has already been reported by Whiteman, N. and Sites, R.W.[22]. Adult *Donacia* are feeders of *Nelumbo* leaves. *Donacia* females are known to lay eggs on the leaves of water lilies from which larvae hatch out and traverse through the elongated petioles to *N. nucifera* to reach its roots where they feed and respire. The larvae were found to possess specialized respiratory structures at the posterior end of their body (figure 5) which the larvae insert into the roots of *Nelumbo* for respiration. Phytophilous Hemiptera recorded from *Nelumbo* were represented by three taxa belonging to family Pleidae, Belostomalidae and Notonectidae.

Among the Dipterans, Chironomids (Grazers) were the most abundant functional group (among the dipterans) found encased in muddy cases (tunnel shaped) formed over the lamina. Increased population of chironomids was recorded with the decomposition of *Nelumbo* crop which may be attributed to the increased palatability and enhanced digestibility of decomposing plants as compared to their freshly blooming counterparts. The decomposing plants leach out nutrients and offer an organically rich diet to the grazers. Similar findings have been reported by da Silva, F.L., Oliveira, H.R.N., Escarpinati, S.C., Fonseca - Gessner, A.A. and Paula, M.C.D.[23] who advocated that live aquatic macrophytes are not good food resource for majority of members of aquatic macroinvertebrates since they are difficult to digest.

Mollusca was reported to be the second most abundant phylum contributing to 28.32% of the phytophilous fauna of *N. nucifera* and was represented solely by *Gyraulus* sp. The expanded lamina was found to be an ideal substrate for the growth of epiphytic algae on which these grazers feed causing its skeletonization (figure 6). Not only adult *Gyraulus* but its gelatinous egg masses as well as young crop (figure 7-8) was also reported from the underside of *Nelumbo* leaves touching the surface of water. The incidence of oviposition of molluscs over the *Nelumbo* leaves indicates it acts as a suitable site for oviposition. It works as a potential mechanism for avoiding hypoxia by fulfilling their need of a well oxygenated moist environment even when they are laid in clusters of many. The present finding has been further supported by Woods, H.A. and Podolsky, R.D.[24] while examining the effect of light level and associated photosynthetic organisms on the distribution of oxygen inside the gelatinous egg masses of four temperate gastropod species concluded that photosynthesis by macrophytes can drive large changes in internal oxygen profiles of the egg masses deposited on them.

Table-1
Annual Percent Contribution of different Classes from Individual Group of phytophilous macroinvertebrates recorded from *Nelumbo nucifera* (July 2010 to June 2011)

Phylum	Classes	*Nelumbo nucifera*	
		Number of Individuals (n/m^2)	Annual Percent Contribution
Annelida	Oligochaeta	438	18.34
	Total	438	18.34
Arthropoda	Arachnida	34.5	1.44
	Insecta	1239	51.88
	Total	1264.5	53.32
Mollusca	Gastropoda	676.5	28.32
	Total	676.5	28.32
Total ORG./m^2		2388	

Table-2
Annual Percent Contribution of different orders of Class-Insecta to the phyophilous fauna of *N. nucifera*

Orders	Number of Individuals (n/m^2)	Annual Percent Contribution
Coleoptera	388.5	16.26
Diptera	702	29.39
Hemiptera	148.5	6.21
Total	1239	51.88

Table-3
Values of various statistical indices applied on the phytophilous macroinvertebrates recorded from *N. nucifera*

Shannon–Weiner diversity index ($\bar{H}$)	0.947 – 1.987
Simpson's Dominance index (D)	0.171 - 0.520
Equitability index (J)	0.565 – 0.964
Margalef's Richness index ($\bar{d}$)	0.505 – 2.011

Table-4
Range of some physico-chemical parameters of the pond (July, 2010 to June, 2011)

Range	Water Temp.	Depth	DO	pH	FCO_2	CO_3^{2-} (mg/l)	HCO_3^-	Ca^{2+}	Mg^{2+}	Cl^-	PO_4^{2-}
Units	(°C)	(cm)	(mg/l)	nil	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
Minima	16.9	12.0	2.4	6.5	0.0	0.0	183.0	8.82	12.15	15.96	0.0
Maxima	30.0	31.7	15.2	8.4	48.0	36.0	463.6	32.88	31.59	77.84	1.75

Conclusion

Current research paper highlights the ecological importance of *N. nucifera* with special reference to its role as an appropriate habitat for phytophilic fauna. The study shows varied phytofauna associated with this wetland plant including annelids, arthropods and molluscs among which arthropods, particularly, insects showed greatest affinity towards it. The associated fauna was observed to utilise this plant for a wide array of life activities like feeding/ grazing, gliding, oviposition, pupation etc. It is clear from this work that *N. nucifera* is an asset in the fresh water ecosystems as it promotes species density and diversity.

Figure-1 to 8
Association of macroinvertebrate fauna with *N. nucifera*

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