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Alternanthera philoxeroides (alligator weed) as a habitat of macro invertebrate fauna in a freshwater pond of Jammu district, (J&K)

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Abstract
Aquatic macrophytes play an important role in structuring communities in aquatic environments by providing physical structure, increase habitat complexity and heterogeneity and affect various aquatic organisms including macro invertebrate fauna. Lentic environments possess at their littoral regions extensive macrophyte strands which constitute the abundant substrate for macro invertebrates. The abundance and variance of aquatic vegetation are the main factors determining the qualitative and quantitative richness of macro invertebrate fauna. The associations of macro invertebrates to aquatic macrophytes create numerous benefits for these, as direct or indirect obtaining of food, shelter, oxygen and other favourable conditions for their growth. The present studies extending from July, 2013 to June, 2014 were conducted to find out the association between macro invertebrates and an emergent macrophyte (*Alternanthera philoxeroides*) inhabiting the freshwater pond of Jammu. Studies revealed that *Alternanthera philoxeroides* was found to harbour 21 invertebrate taxa chiefly belonging to 3 major Phyla viz., Annelida (class Clitellata) represented by a single taxon, Arthropoda (class Insecta) represented by 18 invertebrate taxa and Molluscas comprised of 2 taxa only. Overall the mean abundance of associated macro invertebrate fauna with *Alternanthera philoxeroides* contributed an average of 2097 ind. m $^{-2}$. Quantitatively, Phylum Mollusca showed maximum abundance of all the three phyla and constituted an average of 1314 ind. m^{-2} whereas Phylum Arthropoda showed maximum abundance qualitatively.

Keywords: Abundance, macro invertebrates, macrophytes, qualitatively, quantitatively.

1. Introduction
Aquatic macrophytes form an important element of the aquatic environment in freshwater ecosystems. They provide diverse type of habitat to aquatic animal life, especially macro invertebrate fauna associated with them. There are many attributes of macrophytes that affect invertebrate abundance, diversity and community composition. Examples of such attributes include the architecture of the leaves and the growth habit of the plant. Many species of aquatic macrophytes and their dense strands have an enormous spatial heterogeneity and therefore not only provide shelter for many species of invertebrates but also play an important role in stabilizing environmental conditions (Nessimian and De Lima, 1997) [9]. They provide favourable conditions for many groups by serving both as substrate and food source for herbivores and periphyton feeders and subsequently for their predators (Glowacka *et al*., 1976; Wilcox and Meeker, 1992) [2, 20]. There is a direct relation between the quantity and richness of aquatic macrophytes and that of its associated fauna (Hynes, 1970) [4]. In addition, Hargeby (1990) [3] stated that the aquatic macrophytes' seasonal growth is an important factor that influences the abundance of invertebrates. Needham (1929) [8] reported that macro invertebrates living on macrophytes were many times abundant than those living in bottom sediments. The organism's body size also influences their abundance by limiting the parts a given species can occupy on the macrophyte. Smaller organism utilizes macrophytes better because they can go through crevices and can cover either sides of a leaf (Raffaelli *et al*., 2000) [14]. Emergent macrophytes are the most particularly productive of all aquatic macrophytes since they make the best use with their roots in sediments beneath water and their photosynthetic parts in the air.
Vast amount of work has been done on macro invertebrates diversity in our district but very few work has been carried out on the association of macro invertebrates with aquatic macrophytes so the present work has been conducted to find out the association of macro

invertebrates with an emergent macrophyte (*Alternanthera philoxeroides*) in order to explore the biotic community particularly associated with this aquatic weed.

2. Material and methods

The study was carried out for a period of 12 months extending from July, 2013 to June, 2014 in Barnai pond in the vicinity of Jammu city at a distance of about 10 Km from University of Jammu. Potential water sources for pond include surface runoff and discharge of waste water from the nearby locality. This pond houses a great diversity of macrophytes and *Alternanthera philoxeroides* is one of them, which is found abundantly growing along the littoral zone of this water body

Barnai Pond

2.1 Sampling

In order to find out the habitat preference of invertebrate fauna provided by *Alternanthera philoxeroides*, macrophyte was collected with the help of an iron hook from predestined stations of the Pond by taking an area of (1x1) m^2 and placed them in a metallic sampler of known area in square meter. The plant was then washed separately by vigorously shaking in a bucket full of water so as to isolate the attached fauna. The water was filtered using sieve no.40 with mesh size 256 meshes cm^{-2} and organisms retained were segregated and preserved in 5% formalin for further identification purpose. The quantitative determination of macro invertebrates associated with macrophyte was done by using formula.

N=O/A x S x 10,000

N = no. of ind. m^{-2}

O= no. of organisms counted.

A= area of metallic sampler in square meter

S = no. of samples taken at each station.

2.2 Identification of associated invertebrate fauna with *A. philoxeroides*

The invertebrate fauna associated with the macrophyte was identified using pertinent literature viz., Ward and Whipple, 1959 [19]; Pennak, 1978 [12] and Adoni, 1985 [1].

2.3 Community analysis

The following biological indices were used to explore the biotic community associated with *Alternanthera philoxeroides*; The Shannon−Wiener diversity index, 1949 (H) [15], Margalef's richness index, 1958 (R) [7], Pielou's Evenness index, 1966 (J) [13], Simpson's diversity index, 1949 (D) [16].

3. Results and Discussion

During the entire investigative period extending from July, 2013 to June, 2014, *Alternanthera philoxeroides* was found along the margins of the pond. Maximum growth of this emergent weed occurred during the summer months, originating from the parent stock. This macrophyte was found to be rooted in the substratum and spread as a tangled mat over water surface. After summers in early winters, plant was found to shed leaves and become prostrate, thus, forming mat which supports next season's growth.

Seasonal variations in the quantitative abundance of macro invertebrate fauna associated with *Alternanthera philoxeroides* revealed that during winter months extending from November to March, no association was recorded due to the complete absence of this plant (Table 3). Most of the macro invertebrate fauna associated with *Alternanthera philoxeroides* was recovered during summer months among which June constituted its maximum abundance, thus, comprising 1044 $ind.m^{-2}$. It was further revealed that the number of macro invertebrate fauna associated with the plant goes on declining till October along with the decline of this aquatic weed (Table 4). The plausible reason is that summer is the favourable season for the growth of this weed during which it was found abundantly along the margin of pond. During summers, an increase in temperature is further expected to increase the bacterial growth rate and abundance which, in turn, provides abundant food available by decomposing decaying organic matter producing there in to the macro invertebrates. Singh and Roy (1991a) [17] and Pal (2000) [11] also observed that during summer season death and decaying of emergent plants take place which result in high rates of detritus production thus providing favourable conditions for coleopteran growth and abundance. Jim Conrad's in his newsletter (2013) [5] reported that *Physa acuta* (Tadpole snail) eat dead plant and animal matter or detritus which is abundantly available during summers due to high decomposition rate.

Perusal of Table 1 revealed the association of macro invertebrate fauna with *A. philoxeroides.* Qualitatively, it was found that this weed harboured 21 invertebrate taxa chiefly belonging to 3 major phyla viz; Annelida (single taxon), Arthropoda (18 taxa) and Mollusca (2 taxa) (Table 1). Quantitatively, maximum abundance was seen by Mollusca (1314 $ind.m^{-2}$) followed by Arthropoda (603 $ind.m^{-2}$) and Annelida (180 $ind.m^{-2}$) (Table 2).

3.1. Annelida

Among annelids, *Tubifex tubifex* was the sole representative inhabiting this alligator weed (Table 1). These sludge worms were recovered from the roots of the plant, since this plant was found rooted in the substratum rich in decomposed organic matter and subsequently provides feed and favourable environment to them. Hence their association with roots seems merely for the feeding purpose. Ohtaka *et al*. (2011) [10] too described oligochaetes as the common members of macrophyte associated communities.

3.2. Arthropoda

Class Insecta with 3 orders viz; Coleoptera, Diptera and Odonata were recovered from Phylum Arthropoda. Coleoptera comprised of 14 taxa viz; *Laccophilus sp., Helochares sp., Berosus sp., Paracymus evanescens, Regimbartia attenuate, Dactylosternum abdominale, Hydroglyphus sp., Uvarus sp., Dysticus larva, Canthydrus sp., Hydrocanthus sp., Noteridae larva, Canthydrus larva and Paederus sp.* The representatives of Diptera involved only 3 taxa viz., *Tabanus tabanus, Chironomus larva* and *Tanypus larva* whereas Odonata was represented by a single taxon named as *Erpetogomphus sp*. (Dragonfly larva) (Table 1). Larval forms of class Insecta were mainly recorded from the roots of the plant where as adult forms, including beetles were found to be associated with both stem as well as leaves of the plant. Singh and Saini (1983) [18] also reported aquatic insect fauna from emergent plants like *Scripus articulatus* and *Polygonum barbatum* from some lentic

water bodies of Rewa district. Moreover emergent macrophytes provide excellent, diverse niches for both larvae and adult of several insects as referred by Maitland (1978) [6].

3.3. Mollusca

It embodied single class ie. Gastropoda with only two representatives' viz., *Physa acuta* and *Gyraulus ladacensis.* They were exclusively found entangled with the roots of the plant throughout the study period. In reference to the present observation, Maitland (1978) [6] also reported that the emergent macrophytes provide excellent diversedniches for molluscs.

Diversity indices viz; Shannon-Wiener diversity (H), Margalef's richness (R), Pielou's evenness index(J) and Simpson's diversity index(D) were applied to the macro invertebrate community associated with the plant. The values of SWD (H) was observed to be 1.88 permissible range (1.5-3.5) and SD (D) was recorded to be 0.26 (permissible range 0-1). PE index (J) expresses how evenly the individuals in a community are distributed and the presently observed value was found to be 0.61 which is getting closer to 1 which clearly depicts that the individuals were evenly distributed. MR index (R) was calculated to be 3.69, it has no limit value and it shows variation depending upon the number of species. (Table 5).

Table 1: Associated macro invertebrate fauna with *Alternanthera philoxeroides*

Phylum	Class	Order	Family	Genus
Annelida	Clitellata	Oligochaeta	Tubificidae	*Tubifex tubifex*
Arthropoda	Insecta	Coleoptera	Hydrophilidae	*Laccophilus sp.*
				Helochares sp.
				Berosus sp.
				Paracymus evanescens
				Regimbartia attenuate
				Dactylosternum abdominale
			Dystiscidae	*Hydroglyphus sp.*
				Uvarus sp.
				Dysticus larva
			Noteridae	*Canthydrus p.*
				Hydrocamthus sp.
				Noteridae larva
				Larva of canthydrus
			Staphylinidae	*Paederus sp.*
		Diptera	Tabanidae	*Tabanus tabanus*
			Chironomidae	*Chironomus larva*
				Tanypus larva
		Odonata		*Erpetogomphus sp.*
Mollusca	Gastropoda	Megagastropoda	Physidae	*Physa acuta*
			Planorbidae	*Gyraulus ladacensis*

Table 2: Groupwise annual abundance of individuals (per meter square) associated with *Alternanthera philoxeroides*

Groups	Individuals(per meter square)
Phylum Annelida Class Clitelleta	
Order Oligochaeta	180
Total Annelida	180
Phylum Arthropoda Class Insecta	
Order Coleoptera	396
Order Diptera	198
Order Odonata	9
Total Arthropods	603
Phylum Mollusca Class Gastropoda	
Order Megagastropoda	1314
Total Mollusca	1314
Total Organisms	2097 ind.m^{-2}

Table 3: Seasonal variations of *Alternanthera philoxeroides* in a vegetated Pond + present; - absent

Months	***Alternanthera philoxeroides***
July	+
August	+
September	+
October	+
November	-
December	-
January	-
February	-
March	-
April	+
May	+
June	+

Table 4: Seasonal variations in the quantitative abundance of macro invertebrates associated with *Alternanthera philoxeroides*

Months	Phylum			Total
	Annelida	Arthropoda	Mollusca	
	Class Clitelleta	Class Insecta	Class Gastropoda	
July	180	99	180	459
August	-	18	225	243
September	-	54	-	54
October	-	18	-	18
November	-	-	-	-
December	-	-	-	-
January	-	-	-	-
February	-	-	-	-
March	-	-	-	-
April	-	144	-	144
May	-	18	-	18
June	-	135	909	1044

Table 5: Diversity indices applied on macro invertebrate fauna associated with *Alternanthera philoxeroides*

Diversity Indices	Macro benthic invertebrates
Shannon-Wiener diversity(H)	1.88
Margalef's richness(R)	3.69
Pielou's evenness index (J)	0.61
Simpson's diversity index (D)	0.26

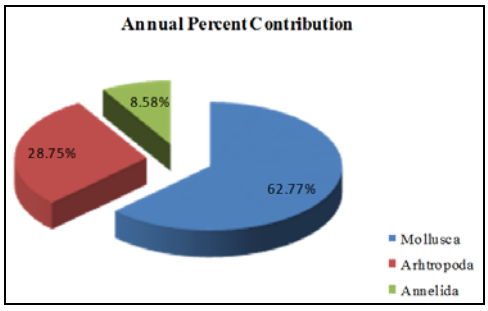

Fig 1: Pie chart showing the dominance pattern of associated macro invertebrate fauna with *Alternanthera philoxeroides*

Fig 2: Depicting association of macro invertebrates with various parts of *Alternanthera philoxeroides*

4. Conclusion

So, we concluded that it is noteworthy to study that aquatic plant communities play an essential role in providing suitable habitat for macro invertebrates and highly influences the composition of associated fauna. In the present investigation, a wide variety of macro invertebrate fauna was recorded with various parts of this aquatic weed which indicated their preferable association with the different parts of the plant. Providing such an important role in aquatic invertebrate assemblage, aquatic macrophytes may also be used in various management practices taking into account biodiversity restoration and even act as a major part of human economic interest.

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