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Invertebrate Species Richness Associated with Sugarcane Crop (*Saccharum Officinarum*) of Faisalabad

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ABSTRACT

A number of invertebrates are associated with sugarcane crop where they carry out many important functions. To explore invertebrate diversity of sugarcane crop an area of 10 acres was selected and aerial and foliage invertebrates were collected by using hand picking, hand net and forceps throughout sugarcane cropping season i.e. from September 2006 to February 2007. A total of 163 specimens were collected comprising of 24 species belonging to 21 families, 10 orders and 2 classes. February showed the least diverse sample comprising of 11 species and 23 specimens. While November sample was large and diverse with respect to occurrence of different species comprising of 17 species 32 specimens. The ascending order of months during the study period was February, January, December, September, October and November with respect to the number of species found. This work presents preliminary information on the fate of faunal diversity and similar future studies will definitely benefit farming industries.

Key words: Biodiversity, Species richness, Invertebrate fauna, Species diversity, Sugarcane.

INTRODUCTION

Biodiversity entails all forms of biological entities inhabiting the earth (Kothari, 1992) and hence is in fact the variability among the living organisms. Millions of years of interaction between adaptation and speciation are reported as reason of biodiversity (Hawksworth, 1995). The study of biodiversity or literally species diversity is challenging because it involves species hierarchical organization (Gotelli, 2002). It is not easy to record, describe or even count the exact number of species. Life forms are so diverse that many years of specialized training are required to be able to recognize and describe them and, such training will provide knowledge of just one small group of living organisms (Agarwal *et al*., 1996).

The simplest measure of species diversity is a species count. Simple species count remains the most popular approach to evaluate species diversity and to compare habitats and species assemblages (Humphries *et al*., 1996). Classification of species into functional groups highlights species effects on ecological diversity and the effects of such changes on species interactions (Ananthakrishnan, 1997). Biodiversity in crops can be summarized with two of its components i.e. species richness and evenness. The richness indicates the

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number of species present in a designated area whereas evenness stands for the relative abundance of each species (Vanclay, 1992). Species richness provides an extremely useful measure of diversity when a complete catalogue of species in the community is obtained (Magurran, 1988). More than half of the world's known animal species are insects (Wilson, 1992). A number of insects are associated with cash crop of sugarcane where they carry out many important functions. Today sugarcane is cultivated in tropical and sub-tropical regions throughout the world. Over 75% of the world's sugar comes from sugarcane (Baucum *et al*., 2006).

Such a useful crop is not an exception to the attack of insect pests during the period of its stay in fields. Borers, especially the top and stem borers attack results in 34.2% and 37.2% crop losses respectively (Aheer *et al*., 1994). The nymph and adult of *Pyrilla perpusilla* cause damage by sucking plant's nutrients while sitting on the lower surface of leaves. The worse effect of the attack of *P. perpusilla* on cane is that the existing sucrose in the cane is also used up and about 35% reduction in sugarcane yield results (Atwal, 1976). The cane juice becomes high in glucose, turns colorless and if used for making gur gives rise to a moist mass which does not solidify properly and has very poor quality (Rahman & Nath, 1940).

A number of other insects and mites are also associated with sugarcane. These phytophagous species of insects and mites belong to the orders Acarina, Coleoptera, Collembola, Dermaptera, Diptera, Hemiptera, Homoptera, Hymenoptera, Lepidoptera and Psocoptera (Hall, 1988). Studies on the population dynamics of sugarcane root borer (*Emmalocera depressella*) were conducted in sugarcane fields. Pest activity was observed from January to October, with a population peak occurring in the first fortnight of September (Pandya, 1998).

Integrating new methods with an emphasis on natural controls are found to be the best way of managing the pest species (Allsopp, 2003). However the first step in control is to identify pest fauna of the crop. There is no significant record of invertebrate faunal diversity of sugarcane of Faisalabad. Therefore, the present study is just a step forward in this regard.

MATERIALS AND METHODS

The study was conducted during the months of September 2006 to February 2007 i.e. throughout the sugarcane cropping season. An area of 10 acres at Gatti, near Nishatabad, Faisalabad was selected to collect aerial and foliage invertebrates by using hand picking, hand net and with the help of forceps. After collection specimens were preserved in 70% ethyl alcohol solution (Ethanol) with few drops of glycerin to avoid fragility. Each collection made was labeled accordingly containing the date of collection, locality name, micro and macro habitat and technical name. The collected specimens were identified up to species level with the help of available, related taxonomic material in the Borror (1954); Blanford & Godwin (1908); Gude (1914); Henery (1935) and also from online electronic keys present on web sites.

Data was analyzed statistically to determine species diversity, species richness and species evenness with Shannon-Weiner diversity Index (Shannon,

1948). Species richness or diversity index (H') was calculated using following equation:

$$H' = \frac{N \ln N - \sum n \ln n}{N}$$

Evenness was calculated as by the formula:

$$E = \frac{H'}{\ln N}$$

The quantity E has been termed as evenness and may also be referred to as homogeneity or relative diversity. Based on the sample, E overestimates the population evenness.

$$D = 1 - E$$

The measure D is the measure of heterogeneity of dominance. Where **N** is the total number of individuals per sample, **n** the number of individuals per species per sample, **H'** is the diversity of invertebrates, **E** is the evenness and **D** is the dominance.

RESULTS

A total of 163 specimens were collected comprising of 24 species belonging to 21 families, 10 orders and 2 classes (Table I).

Diversity & Relative Abundance

The class insecta was the dominant group represented by various species belonging to various orders. Hemiptera was the most dominant order comprising of *N. viridula* (3), *E. florida* (1), *D. singulatus* (14) and *P. perpusilla* (18). Next in line were Diptera and Coleoptera orders comprising of *S. stercorania* (6), *M. domestica* (11), *D. melanogaster* (7), *C. vomitoria* (5) and *D. armigera* (4), *D. stenosticka* (3), *C. septempunctata* (16), *R. tardyi* (2) respectively. Hymenoptera had *P. olivaceus* (9), *C. spp* (8) and *L. humile* (2) while Orthoptera consisted of *O. japonica* (9) and *C. fasciatus* (3). Lepidoptera and Odonata comprised of *A. lactinea* (3), *D. saccharalis* (4) and *P. intensa* (2), *A. apicalis* (2) respectively. The last order of class Insecta was Phasmida comprising of *C. morosus* (2).

In the class Gastropoda, Basommatophora was more dominant order than Eupulmonata comprising of *B. peregrine* (16) and *P. pygmaeum* (13), respectively (Table I). Overall diversity was 2.9 while evenness and dominance were 0.57 and 0.43, respectively (Table II).

Monthly Variation

27 specimens were found in September. 15 species that were recorded in this month were *P. olivaceus* (3), *C. septempunctata* (4), *R. tardyi* (1), *C. morosus* (1), *N. viridula* (1), *E. florida* (1), *D. singulatus* (1), *P. perpusilla* (2), *S. stercoraria* (1), *M. domestica* (2), *D. melanogaster* (2), *C. vomitoria* (2), *O. japonica* (1), *P. pygmaeum* (2) and *B. peregrine* (3) representing diversity 2.6, evenness 0.78 and dominance 0.22.

30 specimens were collected during the month of October. 17 species that were recorded in this month were *P. olivaceus* (2), *D. stenosticka* (1), *C. septempunctata* (2), *R. tardyi* (1), *C. morosus* (1), *N. viridula* (1), *D. singulatus* (2), *P. perpusilla* (5), *S. stercoraria* (2), *M. domestica* (1), *D. melanogaster* (1), *C. vomitoria* (1), *A. apicalis* (1), *O. japonica* (2), *C. fasciatus* (1), *P. pygmaeum* (2)

and *B. peregrine* (4) representing diversity 2.67, evenness 0.79 and dominance 0.21.

Table 1: List of various invertebrate species associated with Sugarcane crop (*Saccharum officinarum*).

Class	Order	Family	Species	No. of Speci-men	No. of species & specimens/ order
Insecta	Hymenoptera	Vespidae	*P. olivaceus*	9	(3)(19)
		Formicidae	*Camponotus spp*	8	
			L. humile	2	
	Coleoptera	Chrysomelidae	*D. armigera*	4	(4)(25)
			D. stenosticka	3	
		Coccinellidae	*C. septempunctata*	16	
		Curculionidae	*R. tardyi*	2	
	Phasmida	Phasmatidae	*C. morosus*	2	(1)(2)
	Hemiptera	Pentatomidae	*N. viridula*	3	(4)(36)
			E. florida	1	
		Phyrrhocoridae	*D. singulatus*	14	
		Lophopidae	*P. perpusilla*	18	
	Diptera	Scatophagidae	*S. stercorania*	6	(4)(29)
		Muscidae	*M. domestica*	11	
		Drosophilidae	*D. melanogaster*	7	
		Calliphoridae	*C. vomitoria*	5	
	Lepidoptera	Papilionidae	*A. lactinea*	3	(2)(7)
		Pyralidae	*D. saccharalis*	4	
	Odonata	Libellulidae	*P. intense*	2	(2)(4)
		Coenagrionidae	*A. apicalis*	2	
	Orthoptera	Acrididae	*O. japonica*	9	(2)(12)
		Tettigoniidae	*C. fasciatus*	3	
Gastro-poda	Eupulmonata	Punctidae	*P. pygmaeum*	13	(1)(13)
	Basommato-phora	Planorbidae	*B. peregrine*	16	(1)(16)
Total	10	21	24	163	(24)(163)

Table 2: Shannon-Weiner diversity index for invertebrates associated with Sugarcane crop (*Saccharum officinarum*).

	Diversity (H')	Evenness (E)	Dominance (D)
Sugarcane crop	2.9	0.57	0.43

In November 32 specimens consisted of 17 species named *P. olivaceus* (2), *Camponotus spp*. (1) *D. stenosticka* (1), *C. septempunctata* (3), *N. viridula* (1), *D. singulatus* (3), *P. perpusilla* (4), *S. stercoraria* (2), *D. melanogaster* (2), *C. vomitoria* (2), *A. lactinea* (1), *P. intensa* (1), *A. apicalis* (1), *O. japonica* (2), *C. fasciatus* (1), *P. pygmaeum* (3) and *B. peregrine* (2) were recorded representing diversity 2.72, evenness 0.77 and dominance 0.23.

December had 16 species comprising of 26 specimens which were *C. spp*. (2), *L. humile* (1), *D. armigera* (1), *D. stenosticka* (1), *D. singulatus* (3), *P. perpusilla* (2), *S. stercoraria* (1), *M. domestica* (3), *D. melanogaster* (1), *A. lactinea* (2), *D. saccharalis* (1), *P. intensa* (1), *O. japonica* (1), *C. fasciatus* (1), *P. pygmaeum* (4) and *B. peregrine* (1) representing diversity 2.63, evenness 0.80 and dominance 0.20.

Table 3: Monthly variation in Shannon-Weiner diversity index for invertebrates associated with Sugarcane crop (*Saccharum officinarum*).

Biodiversity Components	September	October	November	December	January	February
Diversity (H')	2.60	2.67	2.72	2.63	2.40	2.90
Evenness (E)	0.78	0.79	0.77	0.80	0.74	0.73
Dominance (D)	0.22	0.21	0.23	0.20	0.26	0.27

Table 4: Monthly variation of various invertebrate species associated with Sugarcane crop (*Saccharum officinarum*).

Class	Order	Family	Species	Sep	Oct	Nov	Dec	Jan	Feb	Total
Insecta	Hymenoptera	Vespidae	*P. olivaceus*	3	2	2	-	1	1	9
		Formicidae	*Camponotus spp*	-	-	1	2	3	2	8
			L. humile	-	-	-	1	-	1	2
	Coleoptera	Chrysomelidae	*D. armigera*	-	-	-	1	1	2	4
			D. stenosticka	-	1	1	1	-	-	3
		Coccinellidae	*C. septempunctata*	4	2	3	-	3	4	16
		Curculionidae	*R. tardyi*	1	1	-	-	-	-	2
	Phasmida	Phasmatidae	*C. morosus*	1	1	-	-	-	-	2
	Hemiptera	Pentatomidae	*N. viridula*	1	1	1	-	-	-	3
			E. florida	1	-	-	-	-	-	1
		Phyrrhocoridae	*D. singulatus*	1	2	3	3	3	2	14
		Lophopidae	*P. perpusilla*	2	5	4	2	3	2	18
	Diptera	Scatophagidae	*S. stercorania*	1	2	2	1	-	-	6
		Muscidae	*M. domestica*	2	1	-	3	3	2	11
		Drosophilidae	*D. melanogaster*	2	1	2	1	1	-	7
		Calliphoridae	*C. vomitoria*	2	1	2	-	-	-	5
	Lepidoptera	Papilionidae	*A. lactinea*	-	-	1	2	-	-	3
		Pyralidae	*D. saccharalis*	-	-	-	1	1	2	4
	Odonata	Libellulidae	*P. intensa*	-	-	1	1	-	-	2
		Coenagrionidae	*A. apicalis*	-	1	1	-	-	-	2
	Orthoptera	Acrididae	*O. japonica*	1	2	2	1	2	1	9
		Tettigoniidae	*C. fasciatus*	-	1	1	1	-	-	3
Gastro-poda	Eupulmonata	Punctidae	*P. pygmaeum*	2	2	3	4	2	-	13
	Basommato-phora	Planorbidae	*B. peregrine*	3	4	2	1	2	4	16
Total	10	21	24	27	30	32	26	25	23	163

In January 12 species comprising of 25 specimens were recorded which were *P. olivaceus* (1), *C. spp*. (3), *D. armigera* (1), *C. septempunctata* (3), *D. singulatus* (3), *P. perpusilla* (3), *M. domestica* (3), *D. melanogaster* (1), *D. saccharalis* (1), *O. japonica* (2), *P. pygmaeum* (2) and *B. peregrine* (2) representing diversity 2.4, evenness 0.74 and dominance 0.26.

February sampling yielded 11 species comprising of 23 specimens. The specimens were *P. olivaceus* (1), *Camponotus spp*. (2), *L. humile* (1) *D. armigera* (2), *C. septempunctata* (4), *D. singulatus* (2), *P. perpusilla* (2), *M. domestica* (2), *D. saccharalis* (2), *O. japonica* (1) and *B. peregrine* (4) (Table II) representing diversity 2.90, evenness 0.73 and dominance 0.27 (Table III and IV).

Ecological Status

Out of 24 species 11 species were pest, 3 were prey, 8 were predator, while 2 were pests of other than sugarcane. Among all collected specimens 87 were pests. The pest species were *D. stenosticka* (3), *R. tardyi* (2), *C. morosus* (2), *N. viridula* (3), *D. singulatus* (14), *P. perpusilla* (18), *D. sacchralis* (4), *O. japonica (9), C. fasciatus* (3), *E. pygmaeum* (13) *and B. peregrine* (16). Prey category included *M. domestica* (11), *D. melanogaster* (7) and *A. lactinea* (3) while *P. olivaceus* (9), *C. spp* (8), *L. humile* (2), *C. septempunctata* (16), *E. florida* (1), *S. stercoraria* (6), *P. intense* (2) *and A. apicalis* (2) were found to be predators. 2 species *D. armigera* (4) and *C. vomitoria* (5) were found of pest other than sugarcane (Table V).

Table: 5 Ecological status of various invertebrate species associated with Sugarcane crop (*Saccharum officinarum*).

Class	Order	Family	Species	Pest	Prey	Predator	Pest other than Sugarcane	Total
Insecta	Hymenoptera	Vespidae	*P. olivaceus*	-	-	9	-	9
		Formicidae	*Camponotus spp*	-	-	8	-	8
			L. humile	-	-	2	-	2
	Coleoptera	Chrysomelidae	*D. armigera*	-	-	-	4	4
			D. stenosticka	3	-	-	-	3
		Coccinellidae	*C. septempunctata*	-	-	16	-	16
		Curculionidae	*R. tardyi*	2	-	-	-	2
	Phasmida	Phasmatidae	*C. morosus*	2	-	-	-	2
	Hemiptera	Pentatomidae	*N. viridula*	3	-	-	-	3
			E. florida	-	-	1	-	1
		Phyrrhocoridae	*D. singulatus*	14	-	-	-	14
		Lophopidae	*P. perpusilla*	18	-	-	-	18
	Diptera	Scatophagidae	*S. stercoraria*	-	-	6	-	6
		Muscidae	*M. domestica*	-	11	-	-	11
		Drosophilidae	*D. melanogaster*	-	7	-	-	7
		Calliphoridae	*C. vomitoria*	-	-	-	5	5
	Lepidoptera	Papilionidae	*A. lactinea*	-	3	-	-	3
		Pyralidae	*D. saccharalis*	4	-	-	-	4
	Odonata	Libellulidae	*P. intensa*	-	-	2	-	2
		Coenagrioni-dae	*A. apicalis*	-	-	2	-	2
	Orthoptera	Acrididae	*O. japonica*	9	-	-	-	9
		Tettigoniidae	*C. fasciatus*	3	-	-	-	3
Gastro-poda	Eupulmonata	Punctidae	*P. pygmaeum*	13	-	-	-	13
	Basommato-phora	Planorbidae	*B. peregrine*	16	-	-	-	16
Total	10	21	24	87	21	46	9	163

DISCUSSION

Present study revealed that there are a large number of invertebrate species associated with sugarcane but only a few species are dominant. Among invertebrate faunal diversity, insects are extremely important to ecosystems as they perform essential natural processes that sustain biological system. Indeed, our present ecosystem would not function without insects (Wiggins, 1992). Insects in a sugarcane fields carry out number of important functions pollinators, parasites, predators, ecosystem engineers, nutrient cycling bioturbation, suppression of soil pests, and a variety of other functions which are necessary for proper ecosystem functioning (Brussard *et al.*, 1997).

Predators are important as natural indigenous components in agro ecosystems, with several groups being of particular importance: carabids, staphylinids, coccinellids, chrysopids and syrphids (Booij & Noorlander, 1992). For example *C. spp., P. intensa*, *C. septempunctata* are important predators in an agroecosystem. *D. saccharalis* play an important role as parasitizing host. A number of species such as *D. cigulatus*, *P. perpusilla* can become nasty pest if there number increases the threshold limit (La Salle, 1999). Presence of *R. tardyi* and *C. septempunctata* can help the landscape diversification. *C. septempunctata* is the pest of sugarcane that often limits the population of other invertebrates as it also feeds on soft bodied invertebrates (Menalled *et al*., 2001; Hyvonen & Salonen, 2002). Variations in insect diversity relate to factors such as climate, latitude and habitat. The main factors responsible for the fluctuation of population size of *P. perpusilla* are the egg parasitoid, predators and rainfall (Ganehiarachchi *et al*., 2000). Moreover it was also observed that mollusks were also present there that are phytophagous which utilize plant material as their food.

Sugarcane (*S. officinarum*) is one of the important cash crops of Pakistan. It occupies a central position in agriculture economy. This study provides preliminary information on the fate of faunal diversity. There is a dire need of future studies in this respect because such studies have been reported to have significant and direct benefits to the farming industries.

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