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Biodiversity of Noctuidae (Lepidoptera) in Agro-Forest Area of Faisalabad

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ABSTRACT

Faisalabad, the third largest city of Pakistan, is located in the central part of the Province Punjab and its Agro-Forest Area consists of 120-acres. The designation of the agro-forest area, one of the most visited places in Faisalabad, as a Biosphere Reserve offers an opportunity to develop a methodology for biodiversity count and also the assessment of human effects on insect biodiversity. Two types of habitats were selected for biodiversity study: crop area and forest area. The data obtained by trapping, hand picking and netting during Aug-Oct. 2000 showed the diversity of Noctuids, their richness and evenness. A total of 4184 specimens of lepidopterous insects were captured out of which 1084 belonged to noctuidae representing 13 species. In crop area, a total of 3004 individuals were collected, in which 792 were the noctuids. Similarly 292 noctuid specimens were collected in a total of 1180 individuals in the forest area. When diversity of both the areas was compared, it was concluded that the Noctuidae was more diverse over forest area than crop area.

Key Words: Biodiversity; Noctuidae; Lepidoptera; Agro-Forest area

INTRODUCTION

Biodiversity refers to all the forms of biological entities inhabiting the Earth-including prokaryotes and eukaryotes, wild plants and animals, micro-organisms, domesticated animals and cultivated plants, and even genetic material like seeds and germplasm (Kothari, 1992). *Species* diversity is used to describe the variety of species (whether wild or domesticated) within a geographical area. (Anonymous, 2000).

In short, biodiversity is a contraction of the term biological diversity that refers to the variety within the living world. Diversity in forestry parlance is an amalgamation of species richness and evenness. The "richness" indicates the 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) in which Lepidoptera is the 2nd largest and the most diverse order in the class Insecta (Benton, 1995). Upto now more than 100,000 species of Lepidopterous insects have been studied (Richards & Davies, 1977).

The economic importance of the Lepidoptera arises almost entirely from the activities of the larvae. They have chewing-type mouthparts and are among the world's greatest pests (Price *et al.,* 1996). Of the three sub-orders of Lepidoptera, *Jugattae or Homoneura*; with two families, *Hetrocera*; the moths and millers that are mostly night fliers, *Rhopalocera* are butterflies and skippers; the day fliers. Noctuid insects; family *Noctuidae* and sub-order *Hetrocera,* are of great importance in larval stages. These are phytophagous and act as serious pests also somewhat pollinators and defoliators (Skaife, 1979).

Agroforests are defined as complex agroforestry systems that look like and function as natural forest ecosystems, but are integrated into agricultural management systems (Ishizuka *et al.,* 1995). Typically, the agro-forest area consists of densely cropped and planted sites with increasing *naturalness* and surrounded by decreasing intensity of developmental areas. Forest ecosystems which are responsible for the sustainable development, sustainable economy, sustainable society and sustainable use are worst hit by the pace of industrial development and other man made activities. A number of these anthropogenic activities, such as farming, urbanization, communication infrastructures, etc, create patchworks of modified land types that cause a fluctuation in the regional biodiversity. So a decrease in the biodiversity exhibited due to these similar patterns occurs throughout the world (Samways, 1992). Through consistent monitoring efforts, these areas can be treated as field experiments for addressing basic ecological questions and issues related to the impact of humans on their environment (McDonnell & Pickett, 1990; Niemelä, 1999), and for the assessment of biodiversity. Thus there is an urgent need to assess the effects of these activities on native biodiversity, and, where possible, to minimize their adverse effects (Andersen, 1999).

The objectives of the present research were to explore the lepidopterous insect fauna of Faisalabad and to estimate the species richness, species evenness and species diversity

of noctuidae in forest agro-ecosystem.

MATERIALS AND METHODS

The agro-forest area or commonly known "Gutwala", situated in north-east and 24 Km away from the main city, was selected for the study of biodiversity. It consists of 120 acres of land under forest ecosystem that is integrated into agricultural management systems. The agro-forest area was classified into two parts i.e., crop area and forest area. In crop area different agricultural crops were marked while forest area was marked with different types of vegetations.

For comprehensive biodiversity study both areas were further divided into three parts each i.e., crop area: sugar cane, cotton and maize; while forest area: shisham, sufaida, mulberry (phulai, bamboo, grasses of different types were also marked in forest area)

Collection was made randomly by netting, hand picking and light trapping; one light trap per part of both areas. Sampling was done for 3-consecutive days in each week, then all the collected specimens were manually stored and identified to species level and total population per month was also counted. Most species only occurred as adults in our samples. To minimize counting a species twice all larvae were carefully examined and if they might have been the same species as an adult, we counted them as a single species. The meteorological data were recorded to know environmental impact on the dispersal and diversity of noctuid insects. Temperature, humidity and rainfall data were taken for each census day and were averaged for each month.

Data obtained were analysed for species richness and evenness (diversity indices) in both areas separately. Diversity, species richness and species evenness were calculated by Shannon-Diversity Index.

$$H = \sum \left(pi - In(pi) \right)$$

or

$$H' = \frac{n \log n - \sum_{i}^{k} fi \log fi}{n} \qquad (Diversity)$$

$$H' \max = \log k \quad (Max.Diversity)$$

$$J' = \frac{H'}{H' \max} \quad (Evenness)$$

$$D = 1 - J' \quad \text{(Dominance)}$$

For Diversity Comparison

$$t_{cal} = \frac{H_1' - H_2'}{S^2_{H1' - H2'}}$$

The diversity indices calculated from both of two areas was compared by t-test (Hutcheson, 1970). H_1' is the diversity index from crop area and H_2' is the diversity index from forest area. $S^2_{H1' - H2'}$ is the standard error of the difference between two diversity indices.

Estimation of species. Estimation of noctuid species in the entire agro-forest area was made as described by MacArthur and Wilson (1967).

RESULTS AND DISCUSSION

The research studies were conducted from Aug-Oct. in 2000. A total of 4184 specimens of lepidopterous insects were captured, out of which 1084 were the noctuids representing 13 species. Diversity, Species richness and evenness were calculated by Shannon index (1948). This index considers both the number of species and the distribution of individuals among species. For a given number of species, the largest value H´ results when every individual belongs to different species, and J´ is the relative measure of diversity (Peet, 1974; Kikkawa, 1996).

The diversity values in both of the areas shown in Table I**,** the crop area was not evenly distributed (0.68) with the dominance of 31% of some species such as *Agrotus ipsilon* and *Spodoptera litura* (0.31). The forest area was evenly distributed (0.99) with only a dominance value of 0.003 % (0.003) which was negligible.

Table I. Result of Shannon-Weiner Diversity Index

Biodiversity components		Crop area	Forest area
Diversity	(H´)	0.7605	1.113
Max. Diversity	(H´max)	1.1139	1.1139
Evenness	(J´)	0.6827	0.9996
Dominance	(D)	0.3172	0.0003

Table II. Meteorological data for three months

Months	Temperature (C°) Avg. Max.	Min.	Relative Humidity (%) Avg.	Rainfall (mm) Total
August	37.6	27.5	60	49.2
September	36.1	24.5	58	27.4
October	35.0	19.3	57	0.0

Table III. Comparison of means for locality

Areas	Means
Crop Area	20.308
Forest Area	7.487

Fig. 1. Monthly changes in the population of 13-species of Noctuidae in crop area

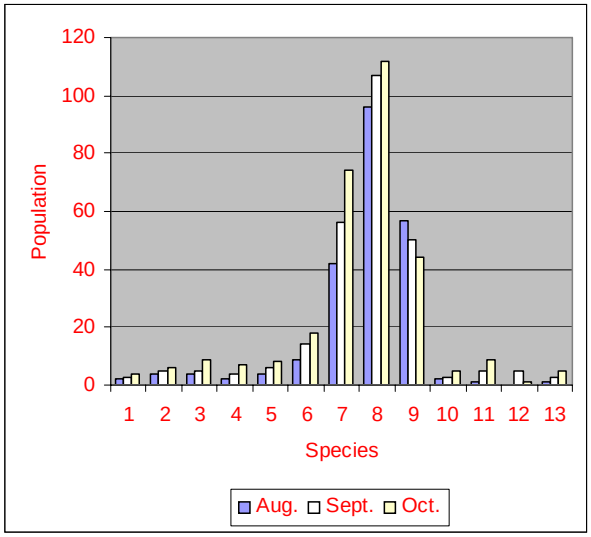
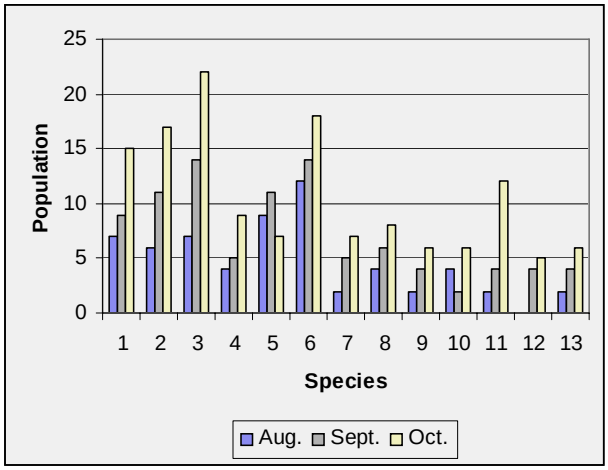


Fig. 2. Monthly changes in the population of 13-species of Noctuidae in forest area



The meteorological data were recorded to know the environmental impact on the dispersal and diversity of coccinellid species. Temperature, humidity and rainfall data were taken for each census day and were averaged for each month (Table II). A slight fluctuation in monthly collected population was attributed to the ecological conditions (Fig. 1, 2). The ecological conditions i.e. the monsoon season and the rapid growth of plants (Coley & Aide, 1991; Diniz & Morais., 1997) and climatic factors (Didham *et al.*, 1998) caused the dispersal of insects within this agro-forest area. The random collection methods also considered for this fluctuation (Kikkawa, 1996) but estimation of the noctuidae over the entire area overcomes this factor (MacArthur & Wilson, 1967).

In crop area, a total of 3004 individuals were collected in which 792 specimens belonged to the family noctuidae with mean value 20.308 (Table III), similarly 292 noctuid specimens were collected with mean value 7.487 (Table III) in a total of 1180 individuals in the forest area. *Erias insulana* has more population with mean value of 55.50, *Erias vitella* and *Helicoverpa armigera* has less population as compared to *E. insulana* with mean values 27.17 and 31.0 respectively and population of these insects significantly differ from both crop and forest habitats (Table IV). In forest area, the distribution of noctuidae species *Agrotus ipsilon* and *Spodoptera litura* were found with highest number of population. H´ value showed that these noctuid species were more diverse over forest area. The distribution of 13 species of noctuidae was heterogeneous in the entire agro forest area (Williamson, 1973; Williams *et al.*, 1996). Gray's (1989) postulated that in habitats affected by increased disturbance, diversity should decrease; opportunist species should gain dominance and mean size of

Table IV. List of Noctuid insects and their respective numbers in the three months from crop and forest area

Species name	Crop Area				Forest Area				Grand total	Avg. no. of spp./month
	Aug.	Sept.	Oct.	Sub-total	Aug.	Sept.	Oct.	Sub-total		
Agrotus segetum	2	3	4	9	7	9	15	31	40	6.667
A.flammatra	4	5	6	15	6	11	17	34	49	8.167
A.ipsilon	4	5	9	18	7	14	22	43	61	10.17
Autographa nigrisigna	2	4	7	13	4	5	9	18	31	5.167
Plusia orichalceres	4	6	8	18	9	11	7	27	45	7.50
Spodoptera litura	9	14	18	41	12	14	18	44	85	14.17
Helicoverpa armigera	42	56	74	172	2	5	7	14	186	31.0
Earias insulana	96	107	112	315	4	6	8	18	333	55.5
E.vittella	57	50	44	151	2	4	6	12	163	27.16
Sylepta derogata	2	3	5	10	4	2	6	12	22	3.67
Trache notabilis	1	5	9	15	2	4	12	18	33	5.5
Sesamia inferens	0	5	1	6	0	4	5	9	15	2.5
Euproctis lunata	1	3	5	9	2	4	6	12	21	3.5
	224	266	302	792	61	93	138	292	1084	---

the dominant species decrease. Our results corroborate this hypothesis to some extent. The actual reason, if not, could be the disturbance through cultural practices; spraying, hoeing, pest scouting and monitoring, which cause a decrease in diversity in crop area.

Diversity comparison

$t_{cal} > t_{tab}$

Since t_{cal} lies in the rejection region, therefore, H_o was rejected. It was concluded that the diversity indices are not same for the two areas.

Estimation of Noctuid species. The collected specimens were 13 (Table IV) species and the estimated number of noctuid species in the entire area was 43 (McArthur & Wilson, 1967).

"The number of species of a particular group of organism increases approximately as the fourth root of the area". In other words, the number of species can be predicted as

$$\textit{Estimated number of species} = \textit{Constant} \times (\textit{Area})^{0.25}$$

CONCLUSIONS

From the species richness and diversity comparison through t-test, it was concluded that the forest area was relatively more diverse than crop area (Hammond & Miller, 1998). The total number of noctuid insects in crop area was more than the forest area. There was no significant difference of noctuid population in each month in crop area. The total number of insects as well as the noctuid insects in the forest area was, although, less than the crop area but their diversity calculated from Shannon index was higher than crop area. The apparent reason was the high humidity and high temperature, and with dense plantation causing the small scale dispersal of insects in forest area as revealed when sampling was being done in this area.

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