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Seasonal diversity of common phototropic coleopterans in Ballavpur wild life sanctuary: a dry deciduous forest of West Bengal, India

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ABSTRACT

Coleopteran species are beneficial to mankind as some of them can be used as biological control of arthropod pests. Many buprestid beetles are known to be useful bio control agents of weeds. Some beetles are important to improve nutrient cycling, soil structure, forage growth and also act as crop pollinators. Seasonal pattern of abundance of coleopteran species fluctuate in different seasons. Higher capture of coleopteran population was observed in monsoon and lowest in post monsoon during the study period. From the results, each coleopteran species has its own characteristic pattern of fluctuation in certain seasons. The variation in the pattern of distribution of coleopterans in different seasons reflected that the build-up of the monsoon was greater in compare to the other seasons.
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INTRODUCTION

Conservation and restoration of biodiversity has become an important objective of forest management in recent years[13,15]. Dobson et al.[6] warn that losses of trophic diversity cause trophic collapse in nature, which ultimately cause losses of biodiversity and ecosystem services.

Coleoptera is the largest order of organisms and accounts for about 40% of all insects including many functionally important groups[10,14] and thus they have a huge importance in ecosystem throughout the world. Some species are beneficial to mankind as some of them can be used as biological control of arthropod pest. According to Kromp[12] and Suenaga and Hamamura[24] ground beetles under family Carabidiae are one of the major bio control agents, as they are amongst one of the largest groups of beetles that are predators of a wide range of agricultural pest insects. Some of them are reported to act as weed controllers and detritivores in the decomposer systems. Many buprestid beetles are known to be useful bio control agents of weeds[5] and others are known to attack the dead and the fire killed trees[8] and help in the process of reducing the trees to humus, formation of which is an essential feature of the forest succession of plants and animals as well[8]. Some beetles contribute to the recycling of nutrients essential for future production, as for example dung beetle feed on manure, use it to provide housing and food for their young, and improve nutrient cycling, soil structure and forage growth in the mean time[21]. Moreover coleopterans also act as crop pollinators. According to Gottsberger[9] pollination occurs by large dynastid scarab beetles of the genus *Cyllocephala* sp. in two plants *Annona coriacea* Mart. and *Phillodendron selloum* Koch. On the other hand some affect the ecosystem negatively by competing food resources or damaging products and thus work as pest themselves.

Because of their functional diversity many researchers have used beetle communities to compare ecosystem conditions between natural versus plantation for-

Regular Paper

ests as well as to evaluate the impact of forest management on biodiversity[17,18,19]. Understanding seasonal patterns of Coleoptera is of interest for several reasons. First, seasonal information can be used to determine optimal sampling periods when studying biodiversity and habitat association. Second, some of them are often used in biological control, and seasonal information is needed to understand their co-occurrence with pest species[24]. Third, seasonal information of phytophagous coleopterans can be used to evaluate potential impacts on host flora.

Several studies have investigated seasonal activity to ground occurring Coleoptera in forests[3,7,16]. According to the works conducted by Bigger[4] and Wolda[29] the fluctuations in seasonal abundance and activity of the tropical insects are conditioned by the changes in the environmental factors. In India Banerjee et al.[2] undertook some studies on seasonal occurrence of coleopteran using light trap. However, such information in the state of West Bengal is scanty. Keeping their global ecological impacts in mind the present study aims to determine the coleopteran abundance in different seasons in Ballavpur Wild Life Sanctuary.

MATERIALS AND METHODS

Ballavpur Wild Life Sanctuary, a dry deciduous type of forest, near Santiniketan at approximately 23°29´N and 87°42´E with an average altitude of 58.9 meters above the sea level and covers an area of 3 sq. km. surrounded by villages. The dominant trees are *Acacia auriculiformis* Benth., *Shorea robusta* Gaertn.f. and *Eucalyptus globossus* Labill. The major herb species such as *Chrysopogon aciculatus* (Retz.)Trin., *Cyanodon dactylon* L.Pers., *Cyperus rotundus* Linn., *Evolvulus alisinoides* Wall., *Saccharum bengalense* Retz., *Saccharum spontaneum* Linn. and *Sporobolus diander* (Retz.) are found in the study area. Somewhere the soil is dry sandy and also there is hard uneven field with laterite soil and small pebbles. During the study period temperature varied between 9.0^{0}C (January 2005) to 45.0^{0}C (June 2005) and humidity ranged between 20% (April 2005) to 98% (July 2005) and rainfall varied between 0.00mm (January 2005) to 93.2mm (September 2004). The physicochemical data were obtained from the Meteorological department, Sriniketan at a distance of 3 km away from study area.

Light trap is used for the quantitative estimation of seasonal abundance of insects (Pradhan 1983). Coleopterans were collected continually over one year (July 2004 to June 2005) by means of a Pilani type light trap[1] placed in the Ballavpur Wild Life Sanctuary. In this forest the light trap was hanged in the trees at the selected spot 10 feet above the ground level. Collection was done thrice in a month at ten days intervals between half an hour after sunset and half an hour before sunrise. The phototropic insects were attracted to light trap and fell into the killing jar containing water with 40% formaldehyde. The species of interest were collected and counted and brought to the laboratory for identification. All the collected species were confirmed from Zoological Survey of India, Kolkata. For convenience of data collection and interpretation, the study period was divided into three Seasons[20] depending on the environmental conditions follows: (i) Monsoon (July to October) is accompanied by heavy rain fall; (ii) Post monsoon (November to February) comprised the winter season, comparatively with lower temperature and lesser precipitation and (iii) Pre monsoon (March to June) is the dry season with occasionally higher temperature. Various diversity parameters like species richness (S), species diversity index (Shannon-Wiener 1949), Margalef index (D_{Mg} = S-1/lnN), equitability index (J= H'/lnS) in the different seasons were studied. Relative abundance of different species in the community was determined by using following expressions:

% of Relative abundance (R.A) = n/N × 100

Where n = number of sampling units with species 'a' present, N = total number of individuals of all species.

RESULTS

Total assemblage of 367 individuals of 13 coleopteran species and their relative abundance percentage are displayed in TABLE 1. Among them, seven species (i.e *O.cervus, Onthophagus sp, A. varicolor, Apogonia sp, Sercia sp, O.catta* and *O.rhinoceros*) belonged to the family Scarabaeidae, two from Carabidae (i.e. *Chlaenius sp* and *Diplochila sp*) and Coccinillidae (i.e. *C. sexmaculata* and *E.ocellata*) and one from Dysticidae i.e. *C.tri.asiaticus* and Lampyridae i.e. *Photuris sp*. The species like *C.tri. asiaticus, O.cervus, Onthophagus sp* and *A. varicolor* made-

Regular Paper

TABLE 1 : Relative abundance percentage of coleopteran species in Ballavpur wild life sanctuary during the study period

Species	Family	RA % rank
Cybister tripunctatus asiaticus Sharp	Dysticidae	17.2
Onthophagus cervus (Fabricius)	Scarabaeidae	16.1
Onthophagus sp	Scarabaeidae	14.2
Anomala varicolor (Gyllenhal)	Scarabaeidae	13.6
Photuris sp	Lampyridae	9.5
Chlaenius sp	Carabidae	7.3
Cheilomenes sexmaculata (Fabricius)	Coccinellidae	6.3
Apogonia sp	Scarabaeidae	4.3
Serica sp	Scarabaeidae	3.5
Onthophagus catta (Fabricius)	Scarabaeidae	2.4
Diplocheila sp	Carabidae	2.2
Epilachna ocellata Redt.	Coccinillidae	2.2
Oryctes rhinoceros Linn.	Scarabaeidae	1.1

TABLE 2 : Community composition of coleopteran species in terms of seasonal RA % in Ballavpur wild life sanctuary

Species	Monsoon	Post monsoon	Pre monsoon	P-value
Onthophagus cervus (Fabricius)	8.0	49.2	13.4	<0.05
Cybister tripunctatus asiaticus Sharp	26.6	0	0	<0.0001
Anomala varicolor (Gyllenhal)	12.7	4.7	25.4	<0.01
Onthophagus sp.	16.8	3.1	14.9	<0.01
Cheilomenes sexmaculata (Fabricius)	3.8	6.3	14.9	ns
Photuris sp	8.4	12.6	10.4	ns
Chlaenius sp	5.9	11.1	8.9	ns
Serica sp	2.5	4.7	5.9	ns
Apogonia sp	5.9	0	2.9	<0.01
Epilachna ocellata Redt.	1.7	4.7	1.4	ns
Onthophagus catta (Fabricius)	3.8	0	0	<0.01
Diplocheila sp	2.1	3.1	1.4	ns
Oryctes rhinoceros Linn.	1.7	0	0	<0.01

up more than 61% of the total communities and rest of the species less than 39% during the study period.

TABLE 2 reflects that the seasonal pattern of relative abundance percentage of coleopteran fluctuate in different seasons. Three species i.e. *C.tri. asiaticus*, *O.catta* and *O.rhinoceros* were found only in monsoon whereas one species i.e. *Apogonia sp* was found in both monsoon and premonsoon but rest of the species were found in all seasons. The species like *C.tri. asiaticus* (26.6%), *O. cervus* (49.2%) and *A.varicolor* (25.4%) were highest dominant in monsoon, post monsoon and pre monsoon respectively.

TABLE 3: Comparative study of coleopteran diversity in Ballavpur wild life sanctuary

Seasons	N	S	H'	J	D_{Mg}
Monsoon	64.6	13	0.9636	0.8650	2.1945
Post monsoon	17.1	9	0.7310	0.7661	1.9309
Pre monsoon	18.3	10	0.8838	0.8838	2.1404

N: Total number in percentage; S: Species richness; H': Shannon- Weaner index; J: Equitability index; D_{Mg}: Margalef's index.

A total of 13, 9 and 10 coleopteran species and comprising about 64.6%, 17.1% and 18.3% of the total population were recorded during monsoon, post monsoon and pre monsoon respectively (TABLE 3). The general diversity index using Shannon formula shows a somewhat variable result in different seasons. The diversity index was highest during monsoon (0.9636) and lowest in post monsoon (0.7310) while the equitability index was highest during pre monsoon (0.8838) and lowest during post monsoon (0.7661). On the other hand Margalef index was also highest during monsoon (2.1945) and lowest in post monsoon (1.9309). Higher capture of coleopteran population was observed in monsoon and lowest in post monsoon during the study period. Results reflect that each coleopteran species has its own characteristic pattern of fluctuation in certain seasons. The frequencies of the species differed significantly among monsoon ($df = 12$; $F = 5.053$; $P = <0.0001$), post monsoon ($df = 8$; $F = 10.23$; $P = <0.0001$) and pre monsoon ($df = 9$; $F = 3.536$; $P = <0.001$) during the study period.

DISCUSSION

It is an established fact that the population of an insect species and its seasonal fluctuation is conditioned by the environmental factors. Even little alterations in such factors may produce large impact on the biological behavior of the species concerned. The variation in the pattern of distribution of coleopterans in different seasons reflected that the build-up of the monsoon was greater in compare to the other seasons. The abundance of insect changes over time for a variety of reasons, including climatic changes and availability of food resources[28]. It appears that species occurrence in different seasons is an important element of the dynamic species composition. Patterns of seasonal occurrence in phytophagus beetles are generally related to species

Regular Paper

characteristics (i.e. emergence schedule, generation time, voltinism and diapauses), availability of resource, and habitat structure[23,25]. Wolda[28] stated that the temperature is the most important factor determining the seasonal variation of insects. The night activity of carabids seems to be influenced mainly by the "lightness" factor, whereas in day activity the moisture plays an important role, too[11]. According to the majority of these studies carabid beetles living in forests are ascertained to be active mainly in the night (Gruschwitz 1983).

Ricklefs[22] and Bigger[4] have evidently shown that the tropical insects undergo seasonal fluctuations in their distribution and abundance, more so at place where the seasons alternate. Seasonal fluctuations in the species richness and their numbers throughout the different seasons during a defined period might be attributed to the difference in the reproductive period of each species. Analysis of diversity indices during different seasons indicated that the diversity of coleopterans in the study area underwent noticeable seasonal variations and the lowest diversity, species richness and equitability index were observed in post monsoon season.

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