April 2008 *Volume 3 Issue 2*

Trade Science Inc.

Environmental Science

An Indian Journal

Ecology

ESAIJ, 3(2), 2008 [255-260]

Species diversity and seasonal abundance of acridid(Orthoptera:Acrididae) in a dry deciduous forest of West Bengal, India

Hiroj Kumar Saha, Parimalendu Haldar*

Department of Zoology, Visva -Bharati University, Santiniketan-731235, West Bengal, (INDIA)

Fax : 91-03461-261268

E-mail: pa_haldar@yahoo.co.in; hiroj1979@yahoo.co.in

Received: 16th March, 2008 ; Accepted: 21st March, 2008

ABSTRACT

The community structure of acridids plays vital role in functioning the forest ecosystem. They are potentially useful bioindicators for conservation planning and land management. Seasonal patterns and species diversity are important components of population structure in acridid community. A total of 25 sites were selected in and around the Chipkuthi forest, West Bengal for studying acridid population in different seasons i.e. (i) Early monsoon- June and July; (ii) Late monsoon- August and September; (iii) Early Winter- October and November; (iv) Late Winter-December and January; (v) Spring- February and March and (vi) Summer- April and May. Acridid diversity, abundance and species richness were observed in respect to different seasons. Study of seasonal occurrence and abundance revealed that *D.venusta* is widely distributed and it occupied the top place representing 23.21% than other species. The higher diversity, higher species richness and higher equitability index of acridids were observed in monsoon season. The highest diversity index and species richness indicate the suitable environment for acridid population. Statistical analysis infers that different species show different behavior and the different seasons also have different effect.

KEYWORDS

Acridid indicator;
Diversity;
Dry deciduous forest;
Seasonal pattern.

INTRODUCTION

In grassland faunal survey, grasshoppers are the most conspicuous among insects, and they often constitute one of the dominant groups of arthropods in terms of their contributions to diversity, abundance and biomass[17,22]. As primary consumers, they may be important in energy and nutrient cycling and they compete with live stock and wildlife for forage. Acridids, a group of most dominant phytophagus insects, play an important role in the functioning of forest ecosystems as they contribute to the diet of many bird and spider species[16,5,4,25]. Seasonal patterns and species diversity are important components of population structure in acridid community. Species diversity are important to the functional role of species in ecosystem. Ecological diversity may contribute more important role to various aspects of ecosystem stability[13,31,27].

Recent studies suggest that biodiversity contributes to ecosystem stability, structure and productivity[24,23,29];

which in turn contribute to sustainability. Although acridids are commonly perceived as important components of grassland; their role in forest ecosystems is largely uninvestigated. In India, there has been only a preliminary study of the Orthopteran fauna of a deciduous forest[30]. Grasshopper diversity was studied in Northern La Pampa, Argentina[32]; in Australian Tropical Savannas[2] and a moist deciduous forest in India[18]. However, in India little survey has been made so far on the acridid community in deciduous forests of West Bengal. In view of this the present investigation has been made for the evaluation of the species diversity and seasonal pattern of acridids on dry deciduous forest.

Study area

The area chosen for studying the acridid communities is located at Chipkuthi forest near Santiniketan at approximately 23°29′N and 87°42′E with an average altitude of 58.9 m. During the study period temperature varied between 3.5°C (Feb. 2005) to 39.5°C (May 2006) and humidity ranged between 20% (Apr. 2005) to 96% (Jul. 2005) and rainfall varied between 0.00mm (Jan. 2006) to 98.5mm (Jul. 2005). The physiochemical data were obtained from the Meteorological department, Sriniketan at a distance of 3 km away from study area.

Chipkuthi forest, a dry deciduous type, covers an area of 2.021 sq. km. surrounded by rural 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.) were found in the study area. Somewhere the soil was dry sandy and there was also hard uneven field with laterite soil and small pebbles.

Methods

Sampling of acridids was conducted twice in a month at fifteen days intervals from June 2004 to May 2006. A total of 25 sites were selected in and around the forest. Acridids were surveyed inside a 10m×10m quadrat at each site by sweep net (30 cm diameter) sampling method for estimating grasshopper species composition[6,7,20]. In each quadrat 20 sweeps were taken for five minutes during 7.30 am to 10.30 am. All vegetation within a quadrat was swept including tall grasses, herbs, shrubs, bushes and trees up to a height of 2 meter. The acridids were collected and counted and brought to the laboratory for identification. All 21 species were confirmed from Zoological Survey of India, Kolkata. For convenience of data collection and interpretation, the year was divided into six Seasons depending on the environmental condition follows: (i) Early monsoon- June and July; (ii) Late monsoon- August and September; (iii) Early Winter- October and November; (iv) Late Winter-December and January; (v) Spring- February and March and (vi) Summer- April and May. The analysis of frequency distributions of species within communities as a function of seasons was conducted using two way ANOVA.

RESULTS

A total of 2966 individuals including 21 species of adult acridids were collected during the two years of studies from all the study sites in the Chipkuthi forest. Nineteen species belonged to the family Acrididae i.e. *Acrida exaltata* (Walker), *Aiolopus thalassinus tamulus* (Fabricius), *Aulacobothrus luteipes* (Walker), *Catantops pinguis innotabilis* (Walker), *Dittopternis venusta* (Walker), *Epistaurus sinetyi* Bolivar, *Gastrimargus africanus africanus* (Saussure), *Gastrimargus africanus orientalis* Sjist., *Gesonula punctifrons* (Stal.), *Heiroglyphus banian* (Fabricius), *Leva cruciata* Bolivar, *Oedaleus abruptus* (Thunberg), *Oxya fuscovittata* (Marschall), *Oxya hyla hyla* Serville, *Phlaeoba infumata* Burnner, *Phlaeoba panteli* Bolivar, *Spathosternum prasiniferum prasiniferum* (Walker), *Truxalis indica* (Bolivar), and *Tylotropidius varicornis* (Walker) while only two species i.e *Atractomorpha crenulata* (Fab.) and *Chrotogonus trachypterus trachypterus* (Blanchard) belonged to the family Pyrgomorphidae. From the TABLE 1 which reflects the variations in the seasonally distribution of acridids it would be observed that the seasonal pattern of abundance of the acridid fluctuated through consistently leading to the occurrence of higher captures during monsoon and spring than the other seasons of the two years.

TABLE 1: Comparative study of acridid community in different seasons of Chipkuthi forest

	1st year							2nd Year						
Species name	**EM**	**LM**	**EW**	**LW**	**SP**	**SU**	**P value**	**EM**	**LM**	**EW**	**LW**	**SP**	**SU**	**P value**
A. exaltata	2	3	0	0	5	0	Not	3	10	0	0	0	0	Not
A.crenulata	4	3	1	0	0	0	<0.01***	3	4	2	0	1	0	<.05**
A.luteipes	1	3	2	8	3	0	Not	5	3	0	2	1	0	<.05**
A.tha.tamulus	16	1	3	0	0	5	<0.1*	19	6	1	0	0	2	<.05**
C.pin.innotabilis	0	0	1	0	2	0	Not	0	0	0	0	0	0	NA
C.tar.trachypterus	9	7	13	4	14	15	Not	16	10	11	7	15	27	Not
D.venusta	67	66	13	62	76	35	Not	67	91	27	54	73	47	Not
E.sinetyi	7	21	11	0	0	0	<0.05**	11	37	8	0	0	0	<0.05**
G.afr.africanus	0	0	0	0	5	6	<0.01***	0	0	0	0	2	4	<0.05**
G.afr.orientalis	0	1	0	0	4	16	<0.01***	2	5	2	0	1	5	Not
G.punctifrons	37	12	0	0	0	2	<0.01***	38	11	0	0	0	1	<0.05**
H.banian	46	41	15	0	0	6	<0.001****	27	64	24	0	0	4	<0.05**
L.cruciata	3	0	7	6	30	11	<0.05**	11	0	8	3	32	22	<0.05**
O.abruptus	52	29	16	25	39	62	Not	55	75	26	41	43	40	Not
O.fuscovittata	53	50	68	10	12	33	<0.05**	41	95	54	5	4	17	<0.05**
O.hyla hyla	38	23	30	5	3	12	<0.05**	16	54	32	1	1	9	<0.05**
P.infumata	1	0	3	0	7	15	<0.05**	2	5	4	2	4	7	Not
P.panteli	0	0	1	0	4	0	Not	0	0	1	0	1	0	Not
S.pra.prasiniferum	16	3	0	3	3	2	<.05**	14	4	0	1	0	0	<0.01***
T.indica	19	11	8	5	11	4	<0.1*	18	13	7	5	8	9	<0.05**
T.varicornis	0	0	0	1	4	0	Not	0	0	3	0	3	0	Not
Total	371	274	192	129	222	224		348	487	210	121	189	194	

EM: Early monsoon; LM: Late monsoon; EW: Early winter; LW: Late winter; SP: Spring; SU: Summer; Level of significance: 10 %= *; 5% =; 1% =***; 0.1%= ****

A total of 16 acridid species of which *D.venusta, G.punctifrons, H.banian, O. abruptus, O.fuscovittata,* and *O.hyla hyla* were most abundant and comprising about 78.98% and *A.exaltata, A.crenulata, A.luteipes, C.tra. trachypterus, E.synetyi, L.cruciata,* and *P.infumata,* were least abundant and comprising about 7.28% whereas rest of the species comprising about 13.75% of the total population during early monsoon in the 1st year. Only one more species i.e. *G.afr.orientalis* was present in 2nd year and rest of the species were more or less similar observation.

In late monsoon a total of 15 species of which *D.venusta, E.synetyi, H.banian, O. abruptus, O. fuscovittata,* and *O.hyla hyla* were comprising about 83.94% and rest of the species comprising 16.06% of the total population during late monsoon in the 1st year whereas the population nearly double in 2nd year observation. Only one more species i.e. *P. infumata* was present in the 2nd year.

A total of 15 species of which only *Oxya* specie was abundant comprising about 51.04% whereas *A.exaltata, G.afr.africanus, G.afr.orientalis, G.punctifrons, S.pr.prasiniferum* and *T.varicornis* were absent but rest of the species were least abundant comprising about 48.96 % of the total individuals in early winter. The almost similar results were observed in 2nd year also but *A.luteipes* and *C.pin. innotabilis* were absent in 2nd year whereas *G.afr. orientalis* and *T.varicornis* were absent in 1st year study.

A total of 10 species of which only two species i.e. *D.venusta* and *O.abruptus* were abundant comprising about 67.44% but *A.leuteipes, C.tra. trachypterus, L.cruciata, O.fuscovittata, O.hyla hyla, S.pra. prasiniferum, T.indica,* and *T.varicornis* were least abundant comprising about 32.56 % whereas rest of the species were absent in late winter. More or less similar results were observed in 2nd whereas *P.infumata* was found in 2nd year and *T.varicornis* was found in 1st year study.

In spring season a total of 16 and 14 species were found whereas *D.venusta, L.cruciata* and *O.abruptus* were most dominant comprising about 65.31 % and 78.30 % in 1st and 2nd year observation. The species like *A.exaltata, C.pin.innotabilis,* and *S.pra. prasiniferum* were absent in 2nd year whereas *A.crenulata* was absent in 1st year.

A total of 14 and 13 species were found in summer whereas *D. venusta* and *O. abruptus* were dominant

comprising 43.30% and 44.84% in 1st and 2nd year respectively. Only one more species i.e. *S.pra. prasiniferum* was present in 1st year and rest of the species were similar distribution in both the years.

However, in the first year the dominant acridid species were *D.venusta, H.banian, O.abruptus, O.fuscovittata,* and *O.hyla hyla.* Almost similar results were found in the second year also. All the species were found in both the years while *C.pin.innotabilis* was absent in second year observation. The species like *D.venusta, H.banian, O.abruptus, and Oxya sp* made up more than 70 % of the total communities in every year and rest of the species less than 31 % in every year. On the basis of total number of individuals collected *D.venusta* was the most dominant species comprising 22.59 % and 23.18 % of the total number of individuals during 1st year and 2nd year respectively.

In the 1st year the highest value being obtained in early monsoon(26.18%) followed by late monsoon (19.41%), spring(15.72%), summer (15.86%), early winter(13.59%), late winter (9.13%) whereas highest in late monsoon (31.43%) followed by early monsoon (22.46%), early winter(13.56%), summer(12.52%), spring (12.20%) and late winter(7.81%) in 2nd year study. The lowest number of population was found in late winter in both the years. From our results, each acridid species has its own characteristic pattern of fluctuation with the occurrence of population in certain seasons.

The general diversity index using Shannon formula shows a somewhat variable result in different seasons. The diversity index was highest during early monsoon (0.9904 and 1.0336) and lowest during late winter (0.724 and 0.6343) in both two years study. The equitability index was highest in summer (0.3639%) during 1st year whereas highest in early monsoon (0.368) during 2nd year study. The lowest equitability index was observed during late winter (0.3144 and 0.2754) in both the years.

TABLE 2: Comparative study of different indices in acridid community in different seasons

Ecological	1st Year				2nd year			
units	N	S	H'	J	N	S	H'	J
EM	371	16	0.9904	0.3572	348	17	1.0336	0.3648
LM	277	15	0.9623	0.3583	487	16	0.9805	0.3536
EW	192	15	0.9135	0.3373	210	15	0.9534	0.352
LW	129	10	0.724	0.3144	121	10	0.6343	0.2754
SP	224	16	0.9236	0.3331	189	14	0.7819	0.2962
SU	224	14	0.9606	0.3639	194	13	0.9259	0.3609

N: Total number; S: Species richness; H': Shannon- Weaner index; J: Equitability index

Our objective is to test whether all the species show different effects in different seasons or not. So the three statistical hypotheses have to test simultaneously. The hypotheses are:

$H_{01}: \alpha_1 = \alpha_2 = \ldots.. = \alpha_{21} = 0$ against H_{11}: not H_{01}

and

$H_{02}: \beta_1 = \beta_2 = \ldots. = \beta_6 = 0$ against H_{12}: not H_{02}

$H_{03}: \gamma_{ij} = 0 \forall_i, _j$ against H_{13}: not H_{03}

Here α is effect due to species and β is effect due to season and γ_{ij} ($\forall_i$ and $\forall_j$) is the effect due to the ith species and jth site. H_{01}, H_{02}, H_{03} represent null hypothesis and H_{11}, H_{12}, H_{13} represent alternative hypothesis. Let MSA is the mean sum of squares due to species and MAB is that for the season, MSAB is for the interaction, let also MSE is the error sum of squares so construct three F statistic as F_1 = MSA/MSE, F_2 = MSB/MSE and F_3= MSAB/MSE, if observed $F_1 > F\alpha_{;20,126}$ then H_{01} is rejected that is different species show different behavior, if $F_2 > F\alpha_{;5,126}$ then H_{02} is rejected that is different season has different effect on a particular species, and if $F_3 > F\alpha_{;100,126}$. All the calculations are done using a MATLAB programme 6.0 versions. The same calculation has been performed for the 2nd year also but here the study has been performed over 20 species instead of 21 species. From the TABLE 3 it infers that different species show different behavior and different seasons also have different effect.

DISCUSSION

The population of acridids showed variation in two

TABLE 3: Analysis of two way anova for seasonal distribution in acridids

1st Year					2nd Year			
F Value	Mean Sq	Sum of Sq	Df	Sources	Df	Sum of Sq	Mean Sq	F Value
10.63	6.75	33.7507	5	Season	5	81.8173	16.3635	30
34.88	22.16	443.15	20	Species	19	486.183	25.5886	47
3.547	2.253	225.277	100	Interactions	95	210.471	2.21549	4
	0.635	80.0324	126	Residuals	120	65.9263		

years of study as well as in different seasons of the year. The variation in the pattern of distribution of acridids as found here in between the different seasons and perhaps more significantly the build-up of the monsoon in contrast to that of other seasons.

It is an established fact that the population of an insect species and its seasonal fluctuation is conditioned by the environmental factors and those even little alterations in such factors may produce large impact on the biological behavior of the species concerned. Several workers such as Agarwal[1], Iqbal and Aziz[15], Lulka et al.[19], Haldar[11] and Saha et al.[28] have evidently shown that the acridids undergo seasonal fluctuations in their distribution and abundance, more so at place where the seasons alternate. The five most abundant species such as *D.venusta*, *H.banian*, *O.abruptus*, *O. fuscovittata* and *O.hyla hyla* comprising 70 % of the acridid assemblages, had their highest number in different seasons. These species which appears to prefer a mixed diet of grasses are very common and widely distributed in the Chipkuthi forest. In both the years *A.exaltata* was found in monsoon whereas as *A.crenulata* was absent in late winter and summer. In early winter and spring seasons *P.panteli* was found in both the years while *C.pin.innotabilis* was only found in 1st year. In both the years *A.leuteipes* was totally absent in summer season whereas *G.afr.africanus* was only found in spring and summer seasons. In both years the species like *A.tha.tumulus*, *E.sinetyi*, *G.punctifrons* and *H.banian* were absent in late winter and spring seasons. 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. On the analysis of diversity indices during different seasons in the study area indicated that the diversity of acridids inhabiting the study area underwent noticeable seasonally variations.

In general, the winter season prevalence the lower temperature might have adversely affected the biological activity of acridid leading to their little abundance and low acridid species. On the other hand most of the species were abundant in two seasons, one is monsoon and the other is spring due to favorable environmental condition for acridid populations. The similar observation was recorded by EI-Shazly and Shahpa[9] and Hazra et al.[12]. This sort of high population growth in this specific season is probably due to special nature of some of their host plants which are found to release tender young leaves during these seasons. During monsoon it enhances the growth rate of vegetation which ultimately influences acridid population. The species like *S.spontaneum* and *S.bengalense* are plenty in spring season where as *C.dactylon*, *E.alisinoides*, *C.aciculatus* are abundant only in monsoon season but *C.dactylon*, *C.rotundus*, *S.diander* and *C.aciculatus* are available throughout the year at the study sites.

Vegetation seems to be the key requisite in determining the occurrence of acridids. Anderson[3] concluded that vegetation had a definite influence upon grasshopper distribution. Kemp et al.[21] observed that the occurrence of acridid species primarily depends on the presence of host plant species. Fielding and Brusven[10] also reported a positive correlation between plant and grasshopper species richness on Southern Idaho rangeland, USA. D.Otte[26], analyzing North and South American Scrub region found that as the number of plant species increased, the number of grasshopper species also increased. Evans[8] also found significant correlation between species richness of grasshoppers and number of plant species in a tall grass prairie community. Capinera and Horton[6], Huffaker and Gutierrez[14] mentioned that grasshopper species are characterized by striking fluctuation in their population.

CONCLUSION

In the present study it is concluded that monsoon season was better healthy in comparison to other seasons due to higher diversity, higher species richness and higher equitability of acridids. Therefore, the acridids considered in this study could be successfully used for bioindication of different season of the forest ecosystem. The additional statistical analysis also proved that those species which found in certain season and posses specificity for seasonal characteristic in the forest ecosystem. The discovery of acridid species that appear to be strong indicators of environmental conditions suggests that acridids may be effective 'tools' in monitoring ecological condition in forest ecosystems. On the other hand it has been suggested that large numbers of species are needed to maintain ecosystem structure and function.

Ecology

ACKNOWLEDGMENTS

Authors are thankful to the Ministry of Environment and Forest, New Delhi for the financial assistance. We thank Zoological Survey of India, Kolkata for confirming the identification of different acridids species. Our thanks are also due to Prof. P. Nath, Head, Dept. of Zoology, Visva- Bharati University for providing laboratory facilities.

REFERENCES

[1] N.S.Agarwal; Indian Journal of Entomology, **17**, 230-240 **(1955)**.
[2] A.N.Andersen, J.A.Ludwig, L.M.Lowe, D.C.F. Rentz; Austral Ecology, **26**, 213-222 **(2001)**.
[3] N.L.Anderson; Annual Entomological Society of America, **57**, 736-742 **(1964)**.
[4] G.E.Belovsky, J.B.Slade; Oikos, **68**, 193-201 **(1993)**.
[5] C.E.Brock, J.H.Bock, M.C.Grant; Ecology, **73(5)**, 1706-1717 **(1992)**.
[6] J.L.Capinera, D.H.Horton; Environmental Entomology, **18**, 8-14 **(1989)**.
[7] E.W.Evans, R.A.Rogers, D.J.Opfermann; Environmental Entomology, **12(5)**, 1449-1454 **(1983)**.
[8] E.W.Evans; Canadian Journal of Zoology, **66**, 1495-1501 **(1988)**.
[9] M.M.EI-shazly, W.M.Shahpa; Environmental Informatics Archives, **2**, 564-588 **(2004)**.
[10] D.J.Fielding, M.A.Bruseven; Agriculture, Ecosystems and Environment, **43**, 31-47 **(1993)**.
[11] P.Haldar; Journal of Bengal Natural History Society, New series, **5(1)**, 31-42 **(1986)**.
[12] A.K.Hazra, M.S.Sishodia, R.S.Barman, T.K. Mukherjee; Environment and Ecology, **4(2)**, 319-322 **(1984)**.
[13] R.J.Hobbs, R.Groves, S.D.Hopper, R.J.Lambeck, B.B.Lamont, S.Lavorel, A.R.Main, J.D.Majer, D.A. Saunders; 'Function of biodiversity in Mediterranean ecosystems in Australia', The function of biodiversity in Mediterranean ecosystems G.W. Daris and D.M. Richardson (eds.); Springer Verlag, Heidelberg. Ecological Studies, **109**, 233-284 **(1995)**.
[14] C.B.Huffaker, A.P.Gutierrez; Ecological Entomology 2nd ed, John Wiley and Sons, Inc. New York, 756 **(1999)**.
[15] M.Iqbal, S.A.Aziz; Indian Journal of Zoology, **2 (1)**, 37-43 **(1974)**.
[16] A.Joern; Pan American Acridological Society, 75-100 **(1986)**.
[17] A.Joern, S.Gaines; 'Population Dynamics and Regulation in Grasshoppers', In R.F.Chapman, A.Joern (eds); Biology of grasshoppers, Wiley; New York, 415-482 **(1990)**.
[18] P.C.Joshi., Jeffrey A.Lockwood, N.Vashishth, A. Singh; Journal of Orthoptera Research, **8**,17-23 **(1999)**.
[19] J.M.Lulka, S.K.Tandon, P.Halder, M.S.Shishodia; India, Oriental Insects, **16**, 63-75 **(1982)**.
[20] W.P.Kemp, S.J.Harvey, K.M.O'Neill; Oecologia, **83**, 299-308 **(1990a)**.
[21] W.P.Kemp, S.J.Harvey, K.M.O'Neill; American Entomologist, **36**, 44-49 **(1990b)**.
[22] J.A.Lockwood; 'Grasshopper Population Dynamics: A Prairie Perspective', S.K.Kin, M.C. Gangwere, M.Muralirangan, Muralirangan (Eds); 'The bionomics of grasshoppers', CAB International, 103-123 **(1997)**.
[23] J.B.Larsen; Forest ecology and Management, **73**, 85-96 **(1995)**.
[24] Naeem, L.J.Thompson, S.P.Lawler, J.H.Lawton, R.M.Woodfin; Nature, **368**, 734-736 **(1994)**.
[25] M.A.Oedekoven, A.Joern; Acta.Oecologica, **19**, 507-515 **(1998)**.
[26] D.Otte; Journal of Biogeography, **3**, 197-209 **(1977)**.
[27] G.Peterson, C.R.Allen, C.S.Holling; Ecosystems, **1**, 6-18 **(1998)**.
[28] H.K.Saha, H.Anand, P.Haldar; Journal of Environment and Sociobiology, **2(1/2)**, 71-76 **(2005)**.
[29] D.Tilman, D.Wedin, J.Knops; Nature, **379**, 718-720 **(1996)**.
[30] L.K.Vats, K.Mittal; Indian Journal of Forestry, **14**, 61-64 **(1991)**.
[31] B.Walker; Conservation Biology, **9**, 747-752 **(1995)**.
[32] M.L.D.Wysiecki, N.E.Sanchez, S.E.Ricci; Journal of Orthoptera Research, **9**, 211-221 **(2000)**.