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DIVERSITY OF ORTHOPTERAN FAUNA IN SUGARCANE AT UDAIPUR

DEVENDRA DHAKAD, RAJENDRA NAGAR*, JHABAR MAL, P. S. RATHORE AND R. SWAMINATHAN
Department of Entomology, Rajasthan College of Agriculture, Udaipur - 313 001
e-mail: rajendranagar86@gmail.com

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***Corresponding author**

ABSTRACT

Investigations on the orthopteran fauna in sugarcane were carried out in the Department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, during August to December, 2012. The orthopteran diversity comprised 32 genera belonging to 5 families during the period of survey. Members of the family Acrididae had the highest mean density values in August (29%), September (33.50%), October (55.50%), November (33.50%) and December (23.50%). Crickets of family Gryllidae were recorded to have the maximum mean density value of 12.50 per cent during the month of October, 2012. The families Pyrgomorphidae, Tetrigidae and Tettigonidae were thinly populated and thus had low mean density values. Among Acrididae, the relative density was the highest for the genus *Hieroglyphus* (10.02 to 16.47%) followed by that for *Oxya* (10.03 to 13.18%) and *Spathosternum* (8.07 to 12.61%). Similarly, among the gryllids, the genus *Trigonidium* was more abundant (29.30 to 36.70%); among pyrgomorphids, the genus *Chrotogonus* (42.58 to 49.99%); whereas, genera of Tetrigidae and Tettigonidae had an almost equal representation throughout the period of observation. The Shanon-Wiener Index values of diversity did not differ much for the months within the Acrididae ranging from 2.02 to 2.28; as well as among the different families of Orthoptera ranging from 2.87 to 3.01.

INTRODUCTION

Orthoptera exist in terrestrial habitats throughout the world often associated with fields and meadows, though some species prefer caves, deserts, bogs and seashores. Members of both suborders (Ensifera and Caelifera) are generally phytophagous but many species are omnivores. Grasshoppers are included in the list of destructive crop pests with the family Acrididae alone having more than 100 species that are pests of agricultural crops and pastures. Among the described species, some are consistently rare, while others are common and widespread; still others show huge population variability, often becoming local and temporary keystone species, while entire communities of these insects may be essential to ecosystem functioning over long period of time. Grasshopper species feed both on monocots and dicots. Habtewold and Landin (1992) reported that grasshopper assemblages (Acridoidea, Tetrigioidea and Tettigonioidea) in south-eastern Ethiopia consisted of 29 taxa, 26 of which were identified to species. Over 70 per cent of the species belonged to Acrididae and most of them were either pests or potential pests of cereal crops. Species richness, diversity and dominance within and between sites and seasons did not differ much during the 2-year period. Senthilkumar *et al*. (2009) observed that acridids inhabited a wide range of ecosystems from 58 selected study sites in Tamil Nadu comprising a total of 37 species belonging to 2 families and 11 subfamilies during the period of survey. The maximum species richness was recorded in forest ecosystem followed by wasteland, grassland and cropland. The diversity decreased with increase in altitude reaching a peak at 1100 MSL.

The increasing pressure of the anthropogenic factor has resulted in the drastic changes in the communities. The recent mesomorphic communities are reportedly dominated by *Oxya fuscovittata* (Marsch.), *Duroniella gracilis* Uv., *Chorthippus biguttulus* (L.), *Aiolopus thalassinus* (Fabr.), and xeromorphic communities, by *Calliptamus barbarus* (Costa), *Dociostaurus tartarus* (Stshelk.), *Oedipoda miniata* (Pall.) and *Acrotylus insubricus* (Scop.). The predominance and wide distribution of these species may indicate deep transformation of the ecosystems and destabilization of the environment in the Hissar Valley (Pokivailov, 2007). In agro-ecosystems, according to Inayat *et al*. (2010), sugarcane was the most preferred crop by majority of insect faunal species followed by fodder, wheat and *Brassica*. The maximum diversity was found in sugarcane; whereas, wheat supported maximum coleopteran predators and hemipteran pests. Wheat and *Brassica* fauna showed maximum similarity. Trophic guild analysis showed saprophagous (230) species to be the maximum, followed by phytophagous species (175), zoophagous (41) and omnivores (27) to be low. Chitra *et al*. (2001) recorded the orthopteran fauna in a rice ecosystem from January 1999 to January 2000 in Coimbatore, Tamil Nadu (India). Twenty-one orthopteran species belonging to 6 subfamilies were observed: Acrididae (6 species), Pyrgomorphidae (2), Tettigoniidae (7), Trigonidiidae (3), Oecanthidae (1) and Tetrigidae (2). Four species were classified as omnivores, *i.e.* *Conocephalus indicus, C. maculatus, C. longipennis* and *Anaxipha longipennis*, while some species never fed on rice even under confinement, *i.e.* *Holochlora albida, Mecopoda elongata* and *Morismus carinatus*.

Since different crop ecosystems vary in their composition of plant and insect species diversity, it was thought ideal to establish the diversity of orthopteran faunal complex in sugarcane crop ecosystem that as per available literature has been less investigated. Moreover, the basic idea of the paper was to elucidate the impact of anthropogenic influences on orthopteran fauna, especially in agro-ecosystems and the sugarcane crop in particular.

MATERIALS AND METHODS

The relative diversity of orthopteran fauna in the sugarcane field at the Agronomy Farm, Rajasthan College of Agriculture, Udaipur, was assessed during August through December, 2012, being more congenial period for growth and development of most insect species, as ample food and favourable climatic conditions (atmospheric temperature and relative humidity) exist.

Weekly observations were recorded for the orthopteran fauna through effective sampling with the help of insect net by sweeping, while the use of the Vortis Suction Sampler, a light-weight portable suction sampling system designed to extract insects from herbage or debris with many distinct advantages over previously accepted methods, was used to collect Orthoptera. The suction sampler was effective for the collection of tetrigids alone as other orthopteran fauna happened to get disturbed and often escaped before being collected due to the noise emitted by the machine.

The "*foot transect*" method was adopted to sample the adults in numbers walking into the wind through 1m wide strip selecting 10 different spots. In each area selected, known replicates of 20 m^2 strips was observed at random. The sampling was done in the forenoon from 8 to 10 a.m. and in the afternoon from 4 to 6 p.m.; standardized sweep sampling technique and hand picking especially for crickets was employed to estimate the relative abundance and community composition of grasshoppers (Orthoptera: Acrididae), wherever the vegetation was knee-high, covering the distance of 20 meters in length.

The statistical analyses made towards estimating the species abundance and diversity included estimation of mean density, relative density and shannon diversity index detailed out as:

Mean density

$$\text{Mean density} = \frac{\{\Sigma Xi\}}{N} \times 100$$

Where

Xi = No of insects

N = Total area sampled or Numbers of plants sampled

Relative density (RD-%) The species abundance was estimated expressing the data as relative density as given by Wheater *et al*. (2011)

$$RD\% = \frac{\text{Number of individual species}}{\text{Total number of indiviuals of all species}} \times 100$$

Shannon - Wiener diversity index ($\overline{H}$) - The species diversity among orthopterans of different families and within the Acrididae was worked out as suggested by Wheater *et al*. (2011):

Shannon - Wiener diversity index (H') = $-\Sigma$ pi ln pi

Where

Pi = the decimal fraction of individuals belonging to i^{th} species

RESULTS AND DISCUSSION

The weekly recorded mean values for orthopteran faunal diversity in sugarcane crop at the Agronomy Farm, Rajasthan College of Agriculture, Udaipur, have been presented in Tables 1, 2 and 3 on a monthly basis from August through December, 2012. It can be observed that insect members of the family Acrididae had the highest mean density values in October (55.50%). Crickets of family Gryllidae were recorded to have the maximum mean density value of 12.50 per cent during the month of October, 2012. The families Pyrgomorphidae, Tetrigidae and Tettigonidae were thinly populated and thus had low mean density values.

The sampling for Orthoptera fauna in sugarcane (between the rows of cane stands within and along the periphery of the cropped area) during the survey conducted and the subsequent collections made indicated the dominance of Acrididae over the other families of Orthoptera. The family Gryllidae was also well represented within the sugarcane crop, especially among the litter, where the adults were handpicked from their hiding places. Besides, the adult male gryllids could be located by listening to the calls/sound that they made. However, we did not make any measurements of the frequencies of the sound to facilitate their identification.

Among the members of the family Acrididae, the relative density was the highest for the genus *Hieroglyphus* (10.02 to 16.47%) followed by that for *Oxya* (10.03 to 13.18%). Similarly, among the gryllids, the genus *Trigonidium* was more abundant (29.30 to 38.01%); among pyrgomorphids, the genus *Chrotogonus* (42.58 to 49.99%); whereas, among tetrigids and tettigonids, the collected genera showed an almost equal representation throughout the period of observation from August to December (Table 1). The orthopteran abundance data when analyzed showed significantly highest mean totals per 20 sq. m. as 116.67 for Acrididae (Table 2). A comparison made among the different months of observation as presented in Table (3) indicated that Acrididae dominated in all the months with relative density values ranging from 51.51 to 54.91 per cent, also showing a near equal representation. The gryllids had the relative density values above 10 ranging between 12.88 to 15.39 per cent, while the other three families, Pyrgomorphidae, Tetrigidae and Tettigonidae registered a relative density between 10 and 12 per cent. The Shanon-Wiener Index values did not differ much for the months within the Acrididae (2.02 to 2.28) as well as among the different families of Orthoptera (2.87 to 3.01).

At the generic level, among acridids, *Hieroglyphus*, *Oxya* and *Spathosternum* dominated, the major reason that could be logically attributed is that both these genera are often abundant during August to November, thereafter their numbers decline and in the case of species of the *Hieroglyphus* group in particular, they do not occur beyond November and later until the next monsoon season. Among gryllids, *Trigonidium* was abundant and among pyrgomorphids, *Chrotogonus* had the highest numerical abundance. It could be observed that grasshopper species were more evenly distributed in the

Table 1: Generic diversity of orthopteran fauna in sugarcane at Udaipur

Faunal Diversity Family	Numbers* Collected During (2012) Identified Genera	August	September	October	November	December
Acrididae	*Acrida*	7 (9.45)	5 (7.77)	12 (9.48)	3 (6.59)	4 (8.14)
	Aiolopus	4 (7.47)	3 (6.35)	7 (7.44)	4 (7.37)	4 (8.14)
	Aulocobotrus	1 (4.73)	2 (5.50)	1 (3.72)	2 (5.71)	1 (5.15)
	Catantops	3 (6.68)	3 (6.35)	5 (6.44)	3 (6.59)	1 (5.15)
	Gastrimagus	1 (4.73)	4 (7.09)	2 (4.55)	1 (4.66)	1 (5.15)
	Gonista	1 (4.73)	5 (7.77)	2 (4.55)	1 (4.66)	1 (5.15)
	Hieroglyphus	8 (10.02)	19 (14.19)	28 (14.16)	24 (16.47)	9 (11.51)
	Parahieroglyphus	1 (4.73)	1 (4.49)	3 (5.26)	5 (8.07)	1 (5.15)
	Oxya	10 (11.08)	9 (10.03)	16 (10.84)	15 (13.18)	10 (12.07)
	Phlaeoba	3 (6.68)	1 (4.49)	2 (4.55)	1 (4.66)	2 (6.30)
	Spathosternum	13 (12.50)	10 (10.52)	22 (12.61)	5 (8.07)	9 (11.51)
	Trilophidia	1 (4.73)	1 (4.49)	1 (3.72)	1 (4.66)	1 (5.15)
	Heteracris	3 (6.68)	2 (5.50)	7 (7.44)	1 (4.66)	2 (6.30)
	Cataloipus	2 (5.59)	2 (5.50)	3 (5.26)	1 (4.66)	1 (5.15)
Mean Density (%)		29.00	33.50	55.50	33.50	23.50
Gryllidae	*Acheta*	1 (19.61)	5 (29.30)	5 (24.04)	6 (29.33)	3 (26.77)
	Gryllus	2 (24.02)	2 (20.72)	5 (24.04)	3 (22.17)	1 (18.93)
	Oecanthus	1 (19.61)	2 (20.72)	1 (13.88)	2 (19.20)	1 (18.93)
	Trigonidium	6 (36.70)	5 (29.30)	14 (38.01)	6 (29.33)	6 (35.42)
Mean Density (%)		5.00	7.00	12.50	8.50	5.50
Pyrgo-morphidae	*Atractomorpha*	1 (24.99)	2 (29.91)	4 (28.70)	3 (33.00)	1 (26.78)
	Pyrgomorpha	1 (24.99)	1 (24.43)	4 (28.70)	1 (23.34)	1 (26.78)
	Chrotogonus	7 (49.99)	6 (45.70)	10 (42.58)	6 (43.66)	5 (46.39)
Mean Density (%)		4.50	4.50	9.00	5.00	3.50
Tetrigidae	*Acrydium*	1 (22.48)	3 (30.49)	1 (24.99)	1 (22.48)	1 (22.66)
	Criotettix	1 (22.48)	1 (21.56)	1 (24.99)	2 (27.54)	3 (32.05)
	Ergatettix	2 (27.54)	2 (26.40)	1 (24.99)	1 (22.48)	1 (22.66)
	Scelimena	2 (27.54)	1 (21.56)	1 (24.99)	2 (27.54)	1 (22.66)
Mean Density (%)		3.00	3.50	2.00	3.00	3.00
Tettigonidae	*Conocephalus*	2 (25.18)	3 (27.97)	3 (26.32)	2 (25.18)	2 (25.18)
	Euconocephalus	3 (29.07)	2 (24.22)	5 (32.23)	1 (20.56)	3 (29.07)
	Elimaea	1 (20.56)	1 (19.78)	1 (18.61)	2 (25.18)	2 (25.18)
	Phaneroptera	2 (25.18)	3 (27.97)	2 (22.79)	3 (29.07)	1 (20.56)
Mean Density (%)		4.00	4.50	5.50	4.00	4.00

*Refers to numbers collected from 3 replicates of 20 m^2 strips by net sweeping / Vortis suction sampler; Figures in parentheses are Relative Density values (%) after square root transformation "x + 1 of original data

Table 2: Abundance of Orthopteran families in sugarcane during August to December, 2012 at Udaipur

Family	Mean (No./20m^2)
Acrididae	116.67
Gryllidae	25.67
Pyrgomorphidae	17.67
Tetrigidae	9.67
Tettigonidae	14.67
S. Em. +	4.525
C. D. (P=0.05)	14.753

month of October, 2012 as compared to the other months. The sampling was restricted to a limited period (August to December) hence the orthopteran fauna abounding during other months of the year could not be accounted for. The present work included only the adult grasshoppers and crickets during the period of study; though a good number of nymphs existed that were excluded from the analyses for the want of their correct generic level identification. From the available literature it was noted that many workers have studied the diversity of orthopteran fauna in different ecosystems including agro-ecosystems, however, such studies in sugarcane happen to be meager, that too encompassing the diversity of arthropods as a whole rather than only the Orthoptera. Similar studies on the seasonal occurrence and relative abundance of acridids from three distinct vegetation sites (dry mixed broadleaved forest, open grassland and a paddy-based agro-ecosystem at Santiniketan and its vicinity, West Bengal (India), revealed that *Spathosternum prasiniferum* (Walker) was most frequent and showed the greatest density. Of the 18 species, 15 were found in the forest area, 11 and 9 were found in the grassland and cultivated land, respectively (*Haldar et al.*, 2000). In our study *Spathosternum prasiniferum* happened to dominate together with the genera *Hieroglyphus* and *Oxya*.

From sugarcane fields of Tamil Nadu, Xavier Innocent and Merlindayana (2012) recorded 9 species of Orthoptera from a total catch of 195 individuals having the second largest specie richness. In a systematic investigation on the arthropod community in sugarcane fields in Zhanjiang (Guangdong province), Li Ji *et al*. (2011) recorded 117 species of arthropods, comprising 2 classes, 15 orders and 62 families. Among them, 54 species of insect pests belonged to 8 orders and 28 families, 43 species of natural enemies belonged to 9 orders and 23 families and 20 species of others (neutral insect group) belonged to 4 orders and 11 families. Earlier, Adnan *et al*. (2004) collected 11,702 insects belonging to different orders

Table 3: Comparative Orthopteran faunal diversity in sugarcane at Udaipur [agronomy farm, RCA, during 2012]

Families	Monthly Mean Relative Density (%) During 2012				
	August	September	October	November	December
Acrididae	53.48	53.08	54.91	51.79	51.51
Shanon-Wiener Index for acridids	2.28	2.25	2.17	2.02	2.22
Gryllidae	12.88	14.08	14.71	15.39	14.00
Pyrgomorphidae	10.11	9.75	11.24	10.34	9.90
Tetrigidae	11.24	11.05	8.17	10.73	11.70
Tettigonidae	12.29	12.04	10.97	11.74	12.90
Shanon-Wiener Index for all	2.99	3.01	2.87	2.87	3.00

of which 117 species were identified; wherein only 8 Orthoptera were represented in their collections including acridids, tettigonids, gryllids and tetrigids from sugarcane in 3 different localities of Pakistan. Such studies do conform to our findings that Orthoptera are abundant in sugarcane fields.

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