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Effects of Environmental Factors on Diversity of Orthopteran Population in District Rahim Yar Khan, Punjab, Pakistan

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ABSTRACT

Environment is the predominant factor for deciding the appropriation and abundance of Orthoptera species globally. During present study, the impact of major environmental factors on abrupt occurrence of Orthoptera species was examined. Orthopterans landed on vast agricultural fields of cotton, wheat, maize, sugarcane and other standing crops in fertile parts and sandy regions of district Rahim Yar Khan, Punjab, Pakistan. The survey on different localities of district Rahim Yar Khan, Punjab was conducted from January to December 2019, special attention was paid during rainy season. The total 4908 specimens of order Orthoptera, suborder Caelifera belonged to 8 species were collected from different localities of tehsils Sadiqabad, Rahim Yar Khan, Khanpur and Liaqatpur of district Rahim Yar Khan. The highest number of population, 2080 belonged to *Schistocerca gregaria* and lowest number of individuals belonged to *Acrida exaltata* were 135. However, other six species i.e., *Peokilocerus pictus, Oxya hyla hyla, Sphingonotus savignyi, Heteracris littoralis, Aiolopus thalassinus thalassinus, Diabolocatantops innotabilis* were 1090, 480, 386, 355, 195, 187 respectively. Among them 3472 were males and 1436 were females. The % relative abundance of Orthoptera species recoded from agricultural areas was 61.63 and 38.36 from desert areas. The species diversity indices, richness and equity of agricultural areas were 0.7766, 5.0377, 2.0110 and 0.8600 and sandy areas were 0.5132, 2.3663, 1.5268 and 0.6595 respectively. The highest numbers of specimens collected in the month of October were 1084 due to favourable environmental factors while lowest 112 specimens in the month of January due to unfavourable conditions. The abundance of Orthoptera populations were coincidence with different environmental factors i.e., temperature, humidity and rainfall in different months of year.

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INTRODUCTION

Orthoptera are most diverse order with more than 26000 species (Eades et al., 2015). Orthoptera are known to be a major component in grassland biodiversity (Weiss et al., 2013) as well as in agricultural lands (Luoto, 2000). Orthopterans are found in all terrestrial habitats in almost all continents, except for Antarctica. Despite the fact that, Orthopterans are principally known to the overall population by their most prominent species like rangeland grasshoppers, beetles, katydids and crickets, they incorporate a stunning variety of structures and ways of life. They assume a focal part in food networks, as they are generally essential herbivores and establish a

bountiful food asset for different gatherings like reptiles, bugs and birds (Pywel et al., 2002). A few animal varieties have a keystone character influencing grass networks (Lockwood, 2004), while others are known as great markers of land use change (Arm-strong and van Hensberen, 1999).

Orthopteran insects have differentiated into various ancestries that possess each possible earthbound environment outside the polar districts and assume basic parts in their biological systems (Uvarov 1966, Kevan 1982). Such variety in structure and capacity has drawn in scientists who utilize these insects as model frameworks for contemplating life systems, bioacoustics, synthetic environment, transformative nature, life history characteristics, neurobiology, physiology, and speciation (Branson et al., 2006; Simpson et al., 2005; Bouaichi and Simpson, 2003; Simpson and Miller, 2007). The Orthopterans are conveyed through the physiographic zones of the world, however their circulation to a great extent relies on the vegetations like prairies, deserts, woodland and rural fields.

Considerable work has been done on various species of grasshoppers from world by Joyee, 1952; Biehko and Mishchenko, 1963; Symmons, 1978; Lomer; Symmons and Cress, 2001; Bouaichi and Simpson, 2003; Song, 2004; Mukhtar et al., 2010; Nayeem and Usmani, 2012; Usman et al., 2012; Weiss et al., 2013 and Zhang and Hunter, 2017. A little bit work has been done on orthopteran diversity of Thar desert by Wagon, 2012; Riffat *et al*., 2013; and Riffat and Wagon,2012, 2015, but no attention was paid on incidences of Orthoptera species from Punjab. Knowledge about incidences of Orthoptera species is very poor as far as district Rahim Yar Khan is concerned. Therefore, it was important to carry out survey on it, so analysis of monetary issues can be made appropriately.

METHODS AND MATERIAL

Survey areas

Present surveys were carried out in district Rahim Yar Khan, (28.4212° N, 70.2989° E) which comprise on Sadiqabad, Rahim Yar Khan, Khanpur and Liaqatpur from agricultural and sandy areas during January to December 2019. District Rahim Yar Khan is agricultural hub of southern Punjab and is also part of Cholistan desert. It is surrounded by Bahawalpur, Muzaffargarh and Rajanpur districts of Punjab, Ghotki and Kashmore districts of Sindh and India.

Sampling, Killing and preservation

The stock of insects both mature and immature was collected from various fields by hand picking, netting, sweeping and trapping. The captured material was killed by potassium cyanide and chloroform. After killing, stretching and preservation of specimens was done by following proper Entomological techniques explained by Vickery and Kevan (1964, 1983). Fully dry insects were preserved with labels showing collection date, habitat, locality and collector name. Important crops of district Rahim Yar Khan from where Orthopterans insects collected were cotton, wheat, sugarcane, brassica, corn and paddy fields.

Morphological identification

Identification of specimens was completed under the stereoscopic analyzing binocular microscope model Z730 made in China with magnifying lens 15X x 60X with the assistance of keys of Vickery and Kevan (1964, 1983) and depiction accessible in writing and on the site (http://www.orthoptera.org). Standard protocol of Uvarov (1966, 1977), Wagan (1990), Riffat and Wagan (2012, 2015) was also consulted for identification of different Orthoptera species.

Meteorological data

Up to date meteorological data during purposed period of study was taken from Punjab meteorological department (South Punjab).

Statistical Analysis

Shannon (H) and Simpson (D) diversity indexes were used to study the biodiversity. Richness (SR) and evenness (E) of species were also calculated by Margalef's formula and Pielou's equation respectively.

Shannon Index (H) was calculated by the formula given below:

$H = -\sum Pi (\log Pi)$

Here Σ = sum Shannon's Index of diversity, Pi shows the extent of every species in the sample. Pi = ni/N, though "ni" demonstrates the quantity of individuals of a particular animal varieties and "N" indicates the absolute number of individuals of the animal varieties in the sample.

Simpson's Index (D) can be calculated by:

$D = 1/\sum Pi^2$

Species richness, $SR = (S - 1)/\log N$

Here S = Sum of species and N = total individuals in the

sample.

Species evenness, E = H / Log S

Here H indicates Shannon diversity index (Shannon, 1949).

RESULTS AND DISCUSSION

Orthoptera are regularly predominant local herbivores in meadow environments worldwide and assume a vital part as primary consumers, as segments of the trophic organization, and in the cycling of supplements and energy of the biological system (Branson et al., 2006). A few types of grasshoppers are viewed as pests and in long stretches of flare-ups cause genuine harm to the yields and rangeland and contend with cattles for forage (Jonas and Joern 2008; Cigliano et al. 2014).

The total 4908 specimens of Orthoptera belonged to 8 species were collected from both agriculture and sandy areas of different localities of tehsils Sadiqabad, Rahim Yar Khan, Khanpur and Liaqatpur of district Rahim Yar Khan. The highest 2080 number of individuals were belonged to *Schistocerca gregaria*. The lowest number of individuals belonged to *Acrida exaltata* were 135. The number of insects belonged to other six species were *Peokilocerus pictus, Oxya hyla hyla, Sphingonotus savignyi, Heteracris littoralis, Aiolopus thalassinus thalassinus, Diabolocatantops innotabilis* were 1090, 480, 386, 355, 195, 187 respectively. The maximum specimens were collected from tehsil Sadiqabad which were 1457 and minimum specimens 1030 were collected from tehsil Liaqatpur. The total 1252 specimens were collected from tehsil Rahim Yar Khan and 1169 from Khanpur. Large numbers of specimens i.e., 3025 were recorded from agriculture areas as compared to sandy areas i.e., 1883 (Table 1). Among them 3472 were males and 1436 were females (Figure 1). Riffat et al., (2013) collected and studied 39 species of grasshopper from various areas of Sindh province. Wagan (1990) studied the biodiversity of Orthoptera fauna from Thar desert, Sindh, Pakistan. Mubashar et al., (2017) collected and studied 18 species of Orthoptera from Sialkot, Punjab, Pakistan. Bhumi et al., (2015) surveyed and collected 45 species of Orthoptera from Gujarat, India. Both present and past studies recorded more populations from agriculture crops as compared to sandy/desert areas due to variety of crops and more food and feedings in agricultural land.

Table 1. Collection of Orthoptera species from various localities of district Rahim Yar Khan.

Species	SDK		RYK		KPR		LQR		Total		Grand Total
	AA	SA	AA	SA	AA	SA	AA	SA	AA	SA	
Schistocerca gregaria	299	319	225	300	210	290	200	237	934	1146	2080
Peokilocerus pictus	207	120	176	99	165	95	153	75	701	389	1090
Oxya hyla hyla	140	00	125	00	112	00	103	00	480	00	480
Sphingonotus savignyi	115	00	99	00	90	00	82	00	386	00	386
Heteracris littoralis	68	40	50	40	50	35	42	30	210	145	355
Aiolopus thalassinus thalassinus	35	20	35	18	27	20	24	16	121	74	195
Diabolocatantops innotabilis	30	22	30	20	27	18	25	15	112	75	187
Acrida exaltata	25	17	20	15	18	12	18	10	81	54	135
Total	919	538	760	492	699	470	647	383	3025	1883	4908

Note: Sadiqabad (SDK), Rahim Yar Khan (RYK), Khanpur (KPR) and Liaqatpur (LQR), Agriculture Area (AA) and Sandy Area (SA).

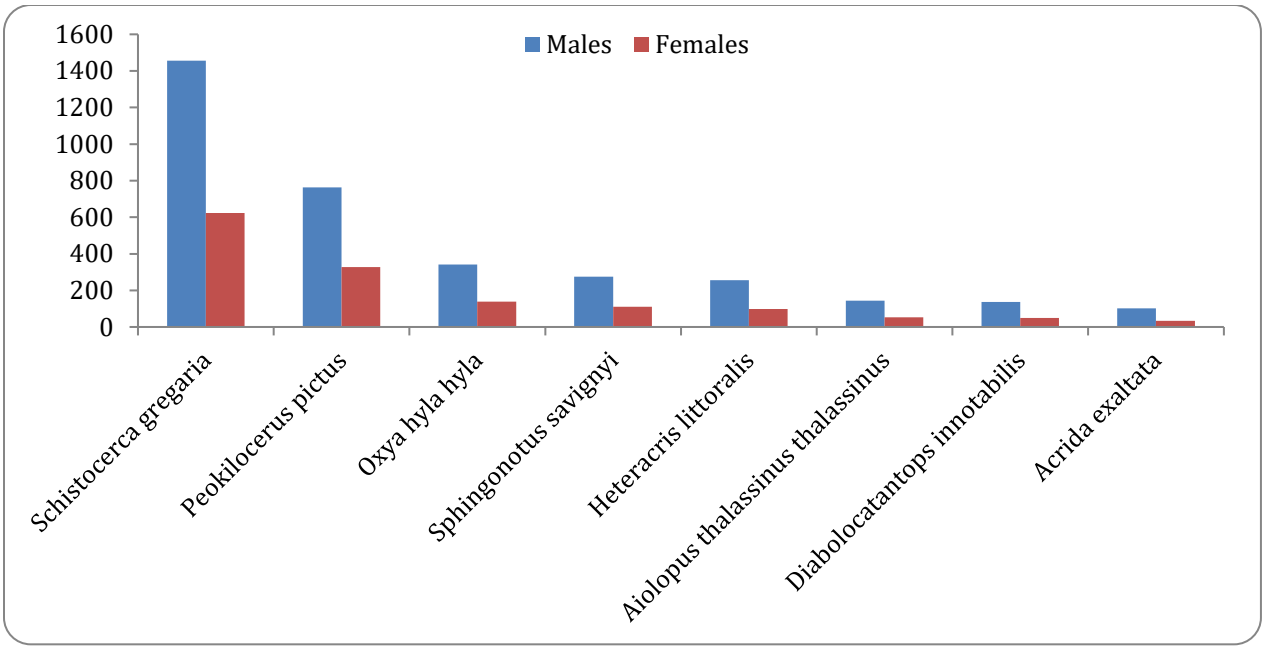

Figure 1. Numbers of males and females of Orthoptera species from district Rahim Yar Khan.

Table 2 shows the % relative abundance Orthoptera species from agriculture and sandy areas of different localities of district Rahim Yar Khan. The relative abundance Orthoptera species from agriculture was 61.63 % as compared to 38.36 % of sandy areas. Table 3 recorded diversity indices of Orthoptera species recovered from agriculture and sandy areas. The diversity indices of agriculture areas were higher than sandy areas of selected habitat. The diversity indexes, richness and species equity of agricultural areas were 0.7766, 5.0377, 2.0110 and 0.8600 and sandy areas were 0.5132, 2.3663, 1.5268 and 0.6595 respectively. Table 4 listed month wise Incidence of Orthoptera species from district Rahim Yar Khan from January to December 2019.The highest specimens collected in the month of October were 1084 while lowest 112 specimens were collected in the month of January. The highest numbers of Orthoptera collected in October and November were due to favourable environmental factors like temperature, humidity and rainfall in these months and lower numbers of Orthoptera populations were collected in the months of January, February and December due cold environment and low humidity and rainfall. Williams et al., (2007) also studied that the favourable climatic conditions increases the species rich of insects communities. Orthoptera are quite possibly the main invertebrate gathering for ecological checking and appraisal (Maas et al., 2002).

Table 2. % relative abundance Orthoptera species from agriculture and sandy areas of different localities of district Rahim Yar Khan.

Location	SDK		RYK		KPR		LQR		Total	
	AA	SA	AA	SA	AA	SA	AA	SA	AA	SA
% Relative Abundance	63.07	36.92	60.70	39.29	59.79	40.20	62.81	37.18	61.63	38.36

Table 3. Diversity indices, species richness and species evenness of Orthoptera species from agriculture and sandy areas.

Location	Shannon Index	Simpson Index	Margalef Index	Pielou Index
AA	0.7766	5.0377	2.0110	0.8600
SA	0.5132	2.3663	1.5268	0.6595

Note: Agriculture Area (AA) and Sandy Area (SA).

Table 4. Month wise Incidence of Orthoptera species from different localities from January to December 2019.

Month	Incidence of Orthoptera species				
	SDK	RYK	KPR	LQR	TOTAL
January	45	25	22	20	112
February	50	28	25	22	125
March	60	35	30	28	153
April	72	42	35	32	181
May	80	62	55	38	235
June	80	68	60	48	256
July	97	85	77	63	322
August	165	152	143	130	590
September	247	233	227	202	909
October	290	277	265	252	1084
November	193	185	172	155	705
December	78	60	58	40	236

Table 5 shows temperature, humidity, rainfall for the relevant months of the year 2019 along with Orthopterans abundance. This shows that the species abundance and richness were in relations to the temperature, humidity and rainfall and maximum in optimum temperature. The rainfall and humidity might increase because of expanding carbon dioxide levels prompting improved vegetation development and moisture contents which in turn increase the Orthoptera populations (Claussen et al., 2003). The present study revealed that the population of Orthoptera increases with increases in temperature, rainfall and humidity and decreases with decrease in temperature, rainfall and humidity which is parallel to the work of Claussen et al., 2003. According to Williams and Jackson (2007) and Williams et al., (2007) the environmental change may reshuffle networks and biotic connections. Suttle et al., (2007) showed tentatively that environmental effects could be valuable than biotic interactions for occurrence of species. The insect's survival activities are affected by weather conditions, among all the environmental factors, the temperature is the most important parameter influencing insect's at all developmental stages (Uvarov, 1931). The populations of Orthoptera increases in summer due to favorable environmental conditions and rapid development and decreases in winter due to unfavorable environmental conditions and delayed life cycle.

Table 5. Average Weather reports along with Orthopterans abundance in district RYK, Punjab during 2019.

Month	Avg. Temperature(C^{o})	Avg. Humidity (%)	Avg. Rainfall (mm)	Orthopterans abundance
January	20	28	2.00	112
February	21	33	3.00	125
March	27	33	3.40	153
April	38	17	3.50	181
May	40	17	7.25	235
June	41	48	23	256
July	38	52	24	322
August	37	65	49	590
September	37	65	53	909
October	37	68	59	1084
November	32	55	12	705
December	24	44	03	236

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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