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An addition to Acridinae (Orthoptera: Acrididae) fauna with three new records and spatiotemporal behavior from Azad Jammu and Kashmir

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Abstract

Orthoptera are considered one of the most important group of phytophagous insects. Numerous individuals from orthopteran group are in direct competition with vertebrate grazers and considered as a serious pest of forage crop. The present study was conducted to explore the biodiversity and spatiotemporal distribution of subfamily Acridine from different localities of Azad Jammu and Kashmir. Specimen were collected with the help of Aerial net. During this survey eight species were recorded in three genera: *Acrida exaltata, A. gigente, A. turrita; Phlaeoba tenebrosa, P. infumata*, and *Ceracris versicolor, C. deflorate, C. nigricornis*. of these, three species under the genus *Ceracris* are recorded for the first time from Azad Jammu & Kashmir. In the case of spatiotemporal behaviour, the maximum temporally population was observed in October. Overall, results suggest a possibility of acridid grasshoppers to contribute to the native communities and provides information about the biodiversity, and population dynamics of grasshoppers for future research to enhance the sustainable management of this major diverse pest. Information about distribution, morphometry, and the identification key to known genera and species are provided.

Keywords: Acrididae, Acridinae, Grasshoppers, Azad Jammu and Kashmir, Pakistan

Introduction

The Order Orthoptera is generally classified as short-horned grasshopper (Caelifera) and long-horned grasshopper (Ensifera). The members of super family Acridoidea which is commonly known as grasshoppers and locust, cosmopolitan in distribution, and nearly 26,000 described species worldwide. The acridoid grasshoppers are widely distributed from tropical regions and deserts to the highest snow-covered mountains with their maximum population in the warmer regions of the world. These are polyphagous in nature. Among these, the family Acrididae is economically important which shows maximum diversity, comprising 1000 genera and 10,000 species. The members of subfamily Acridinae are purely graminivorous

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and feed on maize crop and pulses (Harris 1937 and Bohalen, 1973). The acridinae is characterized as head conical, foveoli lateral, distinct, but sometimes absent. Pronotum smooth and with tubercles. Hind tibia without outer apical spine. The Acridinae is distributed nearly all over the world and is well presented in the Palearectic region. Earlier (Ahmad 1958 and Moeed 1971), Perwin and (Ahmad 1983; Wagan 1990; and Malik 1993) studied and described some species from Pakistan. Suhail (1999) reported twelve species in five genera viz. *Acrida gigantea* (Herbts) *A. turrita (Linnaeus), A. lugubris* Burr. *A.exaltata* (Walker), *Gonista rotandata Uvarov, Phlaeoba infumata* (Brunner), *Ceracris deflorata* (Brunner), *C. nigricornis nigricornis* Walker, *C.nigricornis laeta* (I. Bolivar), *Duroniella gracillis* Uvarov *and D.laticornis* (Kruass) from various localities of Pakistan. (Shishodia & Tandon.,2004) reported 10 species under seven genera from Manipur, India. (Shishodia and Dey., 2006) reported 11 species under eight genera from Nagaland under the subfamily Acridinae. (Shishodia & Dey., 2007) recorded five genera and eight species in Acridinae from Mizoram. (Khan and Usmani., 2016) surveyed the northeastern states of India and reported seven species belonging to three genera of the Acridinae**. (**Ali and Panhwar., 1917) provided the checklist of Acrididia collected in 11 subfamilies, among these, Acridinae was most abundant with 20.82% followed by Oedipodinae, Gomphocerinae and Oxyinae with 17.61%, 17.47% and 14.40% respectively. While lowest population was observed in Cyrtacanthacridinae and Tropidopolinae with 3.06% and 2.49% respectively from Hazara division, Pakistan. Whereas (Mehmood, 1995) reported seven species under 3 genera of subfamily Acridinae from Azad Jammu and Kashmir region, of these genera the species *Gelastorhinus filatus* (Walker) and *G. baghensis* sp. under the genus *Gelastorhinus* was first time reported from study area. Since 1995, no work has been done on this economically important pest from Azad Jammu & Kashmir. Present study was therefore planned to explore the grasshoppers (Acridinae) fauna from study area to know its distribution and abundance.

Materials and method

Study area

The total cover area of state of Azad Jammu& Kashmir is 1.330 million ha. This land size is divided into cultivated 0.173 million ha (13%), forest cover is 0.567million ha (43%) and also share 0.590 million ha waste land which is (44%). AJ&K falls within the Himalayan organic belt. The study area consists of 5 districts and data was collected from 20 different locations (Table 1). The ecosystem of the range or forest area is of great ecological and economic importance, as it provides a variety of habitats to both plant and animal life.

Surveys to adult acridid specimens were conducted from 2011 to 2012 from the grasslands and agricultural fields including Paddy, maize, Wheat, Barley, vegetable, bushes, grasses, rangelands of Muzaffarabad, Bagh, Poonch, Mirpur, Kotli. The specimens were handpicked or collected by a sweeping net whatever required. For all the recorded fauna the distribution of the species supported with GPS positions is provided.

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Table 1. Localities visited for the collection of Acridid grasshoppers

S. No	Districts	Localities	Latitude	Longitude	Altitude
1	Muzafrabad	Muzafrabad, Dhirkot, kotli	34°22'16.06" N	73"28'16.29" E	3470 ft
2	Bagh	Bagh, Arja, Birpani, kafful garh	33° 58' 28.95"N	73°47'29.49"E	3781 ft
3	Poonch	Hajeera Abbaspur, Rawalakot, pir gali	33° 46'17.96"N	73°53'45.42"E,	3111ft
4	Mirpur	Smahni, Bathar, Gari duppata, Dadyal, Mandhol	33°02'07.90" N	73°50'46.17"E	3198ft
5	Kotli	Tattapani, Senhsa, Bhimber, chikaar	33° 29' 05.15"N	73°54'22.15"E	2334 ft

Collection / killing

The specimens of Acrididae grasshoppers were collected from rice fields, dry maize fields, from short and long grasses with the help of a traditional insect net and by handpicking. The specimens were collected from 20 different localities of five districts of the study area. The specimens were collected during the year 2011-2012 in August - November. Recorded fauna was identified in Laboratory of entomology by using compound microscope Leica (MZ750.63-5.0) by following taxonomic keys of (Bie-Bienko & Mishchenko., 1951 Dirsh (1961, 1965), Johnsen (1982, 1990), Ritchie (1982), and Jago (1967). The terminology of Kirby (1914), Bei-Bienko & Mishchenko (1951) Dirsh (1965), and Hollis (1968) were followed. The collected specimens were transferred to the entomology laboratory and killed in an insect killing jar containing KCN.

Setting / preservation

Killed specimens were stretched on a standard stretching board. The stretched specimens pinned with standard entomological pins, scientifically labeled with (locality, host, date, and collector's name) preserved and stored in wooden boxes with Naphthalene balls for further taxonomic studies.

Diversity indices

Diversity indices was calculated by using past (v.4) software. Spatial Counter maps were constructed by using golden software surfer.

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Results

Eight species of family Acrididae in subfamily Acridinae (Orthoptera) belonging to three genera were collected from various localities of study area. All the species explored and reported from AJ&K were studied in detail using their morphological characters. The key to the genera and species wherever necessary is provided.

key to genera of subfamily acridinae from azad jammu and kashmir, pakistan

1. Hind femur with spine on both external and internal genicular lobe (Fig.1). …….*Acrida*
- Hind femur rounded or without external and internal genicular lobs ….....……2
2. Lateral carina of pronotum straigt, continuous (Fig.1) ……..…….……. *Phlaeoba*
- Lateral carina of pronotum diverging posteriorly ……...…….……. …. *Ceracris*

***Genus Acrida* Linnaeus,**

Type species: *Gryllus turritus* Linnaeus

The species under this genus exactly tally with published description (Kirby, 1914; Bei-Bienko & Mishchenko, 1951; Dirsh, 1965) of this genus.

Key to the species of genus *Acrida*

1.Hind wings pinkish or black at base…… …….…….……. *Acrida exaltata*
- Hind wings not colored, transparent at base…….…… ……...2
2. Body and tegmina with pinkish markings ……..……..*Acrida gigentea*

-Body and tegmina without pinkish markings……..……..…. *Acrida turrita*

***Acrida exaltata* (Walker,)**

Truxalis exaltata (Walke, 1859). *Tryxalis brevicollis* (Bolívar,1893). *Acrida exaltata* (Kirby,1910). *Acrida curta* (Uvarov, 1936). *Acrida exaltata* (Dirsh & Uvarov.,1953).

Collected species agree with published description (Kirby, 1914; Bei Bienko & Mishchenko, 1951; Bhowmik 1986; Wagan, 1990; Mahmood, 1995; Usmani, *et al*., 2012).

Morphometry: (length in mm)

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Male: Body length 29.1-41, Head 6.2-9.4, Tegmina 25.4-33.2, Pronotum 6-7, Hind femur 19-23, Wing expanse 54.8-70.

Female: Body length. 49-56, Head 9.4-12, Tegmina 40-45.2, Pronotum 7-9, Hind femur 23-27, Wing expanse 70-73.

Material examined: 8♀, Rawalakot, 11.X.2011; 1♀, Bhimber, 6.X.2011; 3♀, Bagh, 11.X.2011; 5♀, Smahni, 6.IX.2011; 1♀ 1♂, Dhirkot, 5456 ft 34°01'53.54" N 73°34'19.71"E 23.VIII.2011; 2♂, Chhattar, 23.IX.2012; 2♂, Gari doppata, 2692ft, 24 km from Muzaffrabad, 22.VIII.2012; 1♂, Senhsa, 9.9.2012; 4♂, Kafful Garh, 3.X.2011; 2♂, Mandhol, 3.X.2011; 2♂ Bir pani, 27.VIII.2012; 3♂, Kotli, 27.X.2012; 1♂, Jandi Chontra, 3280ft , 67km from Mirpur, 9.X.2012; 3♂, Dadyal, 29.IX.2012; 2♂, Bindi Smahni, 2050 ft 23.IX.2012;1♂, Kotli, 22.IX.2012.

Habitat: The specimens of this species were collected from maize crop, sorghum and rice fields a from long green grasses and from rocky mountainous areas.

Distribution: Kashmir, Pakistan, India, Sri Lanka, Yemen.

***Acrida gigantea* (Herbst,)**

Truxalis giganteus (Herbst, 1786). *Truxalis giganteus* (Scudder, 1869). *Acrida gigantea* (Kirby, 1910) *Acrida gigantea* (Azim & Reshi., 2010).

The collected species agree with published description (Kirby,1914; Mahmood,1995; Azim, *et al*., 2010, Usmani, *et al*.,2012).

Morphometry: (length in mm)

Male: Body length 28-32, Head 5.4-8, Pronotum 5.1-6, Tegmina 22.1-28, Hind femur14.4-21.1, Wing expanse 47.3-69.3.

Female: Body length52.2-56, Head 10.2-11.2, Pronotum 9.2-10.1, Tegmina 41-43, Hind femur 28-31.3, Wing expanse 86.3-91.2

Material examined: ♀3♂1, Bagh, 9.X.2011;♀5 ♂,1 Kotli, 2334 14.X.2011; ♀27♂1, Rawalakot, ,27.X.2011; ♀3, Senhsa , 9.X.2011.

Habitat: The specimens was collected from open field, maize crop, tall grasses and mountains.

Distribution: Kashmir, India, Pakistan.

***Acrida turrita* (Linnaeus,)**

Gryllus (*Acrida*) *turritus* Linnaeus 1758. *Gryllus* (*Acrida*) *turritus* (Linnaeus, 1767). *Acrida turrita* (Dubrony, 1878). *Truxalis tenuis* (Beauvois, 1805). *Truxalis rufescens* (Beauvois, 1805). *Tryxalis carinulata* (Bolívar, 1889). *Acrida turrita* (Bolívar,1936). *Acrida sicula*

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(Dirsh, 1949). *Acrida tunetana* (Dirsh, 1949). *Acrida maroccana* (Dirsh, 1949). *Acrida carinulata* (Johnston, 1956).

The species similar with published description (Kirby, 1914; Ahmad, 1958; Mahmood, 1995).

Morphometry: (length in mm)

Male: Body length 30.4- 40.2, Head 7.1-9.2, Pronotum 6-7, Tegmina 25-27, Hind femur 18.3-20.3, Wing expanse 53.4- 63.6.
Female: Body length 52.2-56, Head 10.2-11.2, Pronotum 9.2.2010 Tegmina, 41-43, Hind femur 28-31.3, Wing expanse 86.3-91.2.

Material examined: ♂36 ♀25, Rawalakot, 1.X.2011; ♀1♂3, Muzaffrabad, 23.VIII.2012; ♀9 ♂11, Bagh, 28.IX.2011; ♀3 ♂7, Kotli, 15.VIII.2012,♀4♂2 , Chikaar, 4120ft 28.VIII.2012;♂11 Hajeera, 3.X.2011; ♂1 Dhirkot, 22.VIII.2011; ♂2, Gari Doppata, 2692 ft, 24 km from Muzaffrabad, 23.VIII.2011.

Habitat: The specimens were collected from maize, from long grasses in pastures and mountainous range lands.

Distribution: Kashmir, Pakistan.

Genus *Phlaeoba* Stål,

Type species: ***Gomphocerus rusticus*** Stål:

The collected species exactly similar to the published description (Kirby,1914; Bei-Bienko & Mishchenko,1951; Wagan,1990) of this genus.

Key to the species of Genus *Phlaeoba*

1.Vertex with long lateral carina, extending from occiput reaching the posterior end of head ……...…….……*tenebrosa*

- Vertex with short lateral carina, extending from occiput not reaching the posterior end of head…...……..……..…….……..…*infumata*

***Phlaeoba tenebrosa* (Walker,)**

Opomala tenebrosa (Walker, 1871). *Phlaeoba tenebrosa* (Kirby, 1910).The collected specimens of this species alike with published description (Bei-Bienko & Mishchenko., 1951) of this species.

Morphometry: (length in mm)

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Male: Body length23-23, Head 4-4 Pronotum 4-4, Tegmina 20-22, Hind femur 14-15, Wing expanse 44-48.
Female: Body length 28-31, Head 5-5, Pronotum6-6.1, Tegmina 25.2-26, Hind femur 14.4-18 Wing expanse 41-60.
Material examined: 1♀, Bagh,17. VIII.2012; 1♂ 1♀, Smahni, 2. VIII.2012; 1♀ Abbaspur, 2. X.2011; 2♂, Rawalakot, 18.IX.2011.

Habitat: The specimens collected from pastures, rice fields and from horticultural crops.

Distribution: Kashmir.

***Phlaeoba infumata* Brunner von Wattenwyl,**

Phlaeoba infumata (Brunner von Wattenwyl., 1893).The species were found similar with published description (Kirby, 1914; Bei Bienko & Mishchenko, 1951; Bhowmik, 1986; Mahmood, 1995; Usmani *et al*., 2012) of this species. Comparison showed few morphological variations in body length and hind femur length.

Morphometry: (length in mm)

Male: Body length 22.2-22.3, Head 4, Pronotum 5, Tegmina 5, Hind femur14-15, Wing expanse 42.6-48.
Female: Body length30.4-31.2, Head 4.4-5, Pronotum 6-6.1, Tegmina 23.1-28, Hind femur 16.3-17.3, Wing expanse 54.5-56.1.

Material examined: ♀5♂1, Bagh 20. X.2012; ♀5♂1 Smahni, 2.VIII.2012; 4♀ 1♂, Rawalakot, 18.IX.2012; ♀1♂,1Abbaspur, 2.X.2012; 1♀ Kotli 14.X.2012; ♀2♂1, Smahni, 14.VIII.2012; ♂1, Choch (Kotli), 27.IX.2012.

Habitat: The species have been collected from grasses, thorny shrubs and open fields.

Distribution: Pakistan, Kashmir, India, Bhutan, Nepal.

Genus *Ceracris* Walker,

Type species: ***Ceracris nigricornis*** Walker,

The collected specimens exactly confirmed with published description (Kirby,1914).

Key to the species of genus *Ceracris*

1. Hind femur red on ventral side (Fig.3) …..……..... *versicolor*
- Hind femur not red, yellowish on ventral side……..…….……..…….2
2. Hind tibia blue (Fig.4) ……..…….*deflorata*
- Hind tibia black (Fig.5) …….……..……...……..…...*nigricornis*

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Ceracris versicolor (Brunner von Wattenwyl,)

Duronia versicolor (Brunner von Wattenwyl, 1893). *Ceracris nigricornis* (Uvarov, 1921). *Ceracris* (Willemse, 1951). *nigricornis* (Bei-Bienko & Mishchenko., 1951).

The given species exactly similar with published description (Kirby, 1914; Bei-Bienko & Mishchenko, 1951).

Morphometry: (length in mm)

Female: Body length 30-31, Head5-5.1, Pronotum 4.4-6, Tegmina 19.4-24.2, Hind femur15-17, Wing expanse 43-53.4
Material examined: ♀2, Bagh, 16.VII.2011; ♀2, Dadyal, 9.I0X.2011.

Habitat: The specimens have been collected from grasses, thorny bushes.

New Record: This species has been recorded for the first time from Azad Jammu & Kashmir.

Distribution: Kashmir, Burma, Thiland.

Ceracris deflorata **(Brunner von Wattenwyl,)**

Duronia deflorata (Brunner von Wattenwyl, 1893). *Phlaeoba cinctalis* (Kirby, 1914),

Ceracris deflorata (Otte, 1995). This species exactly resemble with published description (Kirby,1914).

Morphometry: (length in mm)

Male: Body length18.1-20, Head4-4.1, Pronotum 4-5, Tegmina 3-4, Hind femur12.1-13, Wing expanse 33-36.8.
Female: Body length 25.4-29, Head 5-5, Pronotum 5.2-6.1, Tegmina 20.1-23, Hind femur 15.2-16, Wing expanse 43.6-50.
Material examined: ♀4, Bagh, 3781ft 33°58'28.95" N 73°47'29.49"E 5.IX.2012; ♀1♂1, Smahni, 6.IX.2012; ♂2, Dadyal, 6.IX.2012;♂1, Abaspur, 18.X.2012; ♂2, Pir gali, 6.X.2012.

Habitat: The specimens of this species have been collected from grasses range land having pine trees.

New Record: This species has been first time recorded from this region.

Distribution: Kashmir, Burma, Bangladesh.

Ceracris nigricornis nigricornis **Walker,**

Ceracris nigricornis (Walker, 1870). *Ceracris nigricornis nigricornis* 1998. This species purely similar with published literature (Kirby, 1914) 6.6mm difference was found in tegmen length.

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Morphometry: (length in mm)

Male: Body length 20-22, Head 4-4.3, Pronotum 4.2-5 Tegmina
12-15.3, Hind femur13-13.4 Wing expanse 27.2-33.1.
Female: Body length 26-30, Head4.4-6, Pronotum 5.2-5.4, Tegmina19-20.3, Hind femur 15-16.3 Wing expanse 42-44.6.
Material examined: ♀5,♂1, Pir gali, 5.VII.2012; ♂1, Smahni, 6.IX.2012.

Habitat: The specimens collected from grasses, maize & vegetable fields.

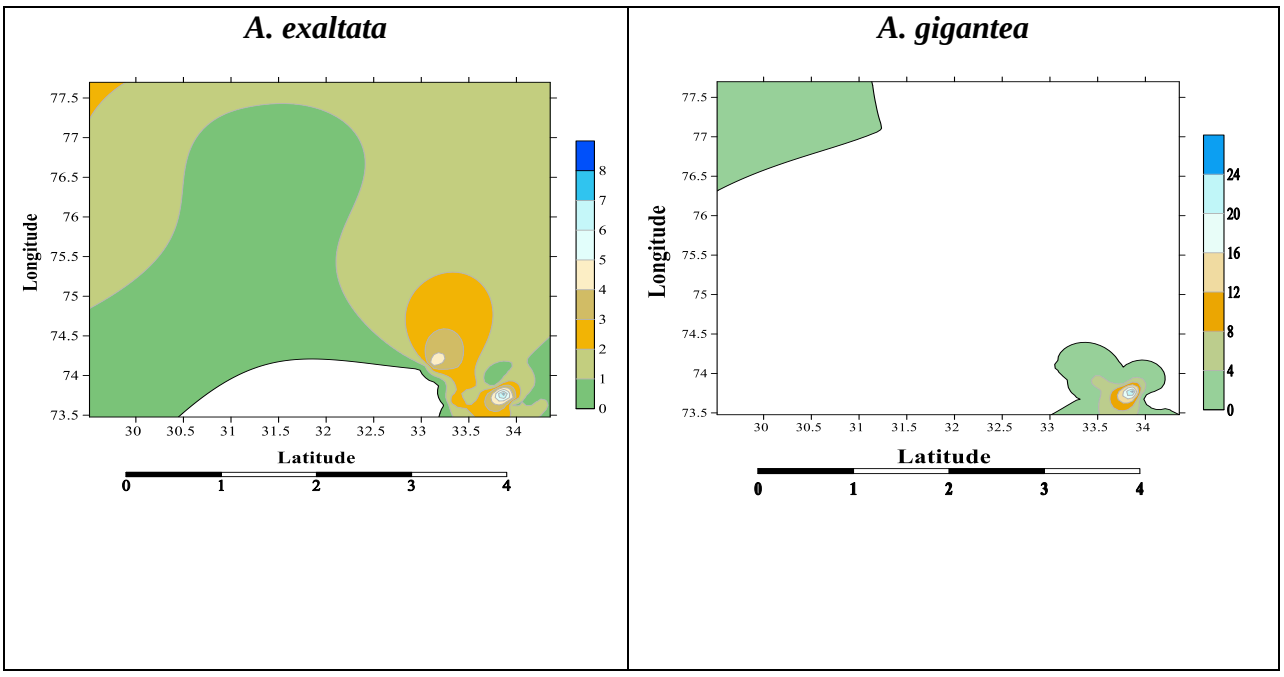
New Record: This is the first record from Azad Jammu & Kashmir.

Distribution: Kashmir, China, Tajikistan, Kyrgyzistan,South Korea, North Korea.

Spatial and temporal distribution

The spatial trend maps can be explained by the presence and distribution of the host plant in the sampled area. The maximum population density of *A. gigantea, A. exaltata* was recorded in the area of Rawalakot as in these areas the cultivation proportion of rice and pastures were relatively high. All the species showed clustering in the areas of favorable hosts and dispersion to other areas which were represented by the spatial counter maps (Fig. 2). Temporal pattern of species shown in (Fig. 3) two species as *A. turrita* and *A. gigantea* occurred in August and maximum population recorded in October.

Table 01. Spatial counter maps of different species described from AJK.



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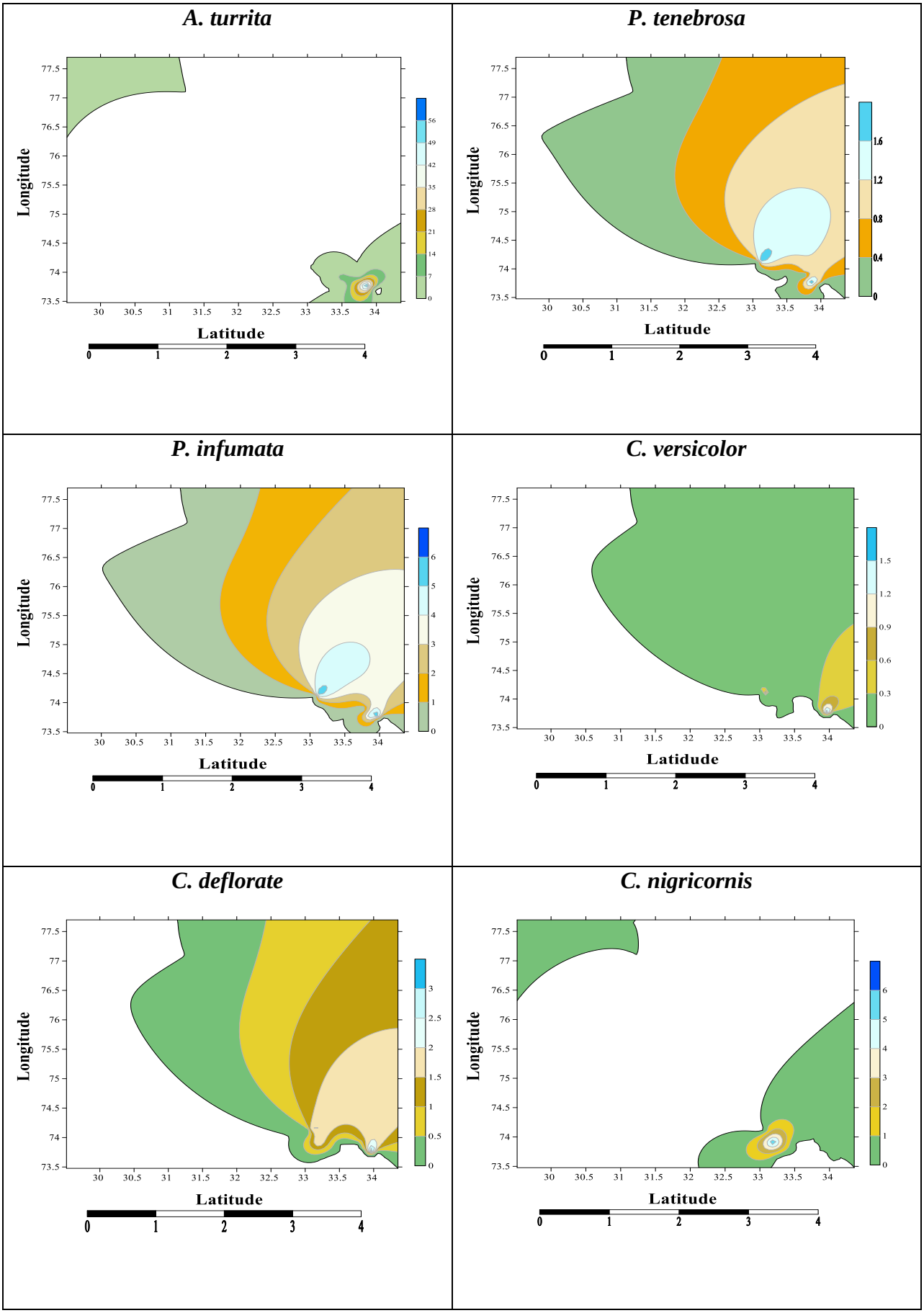

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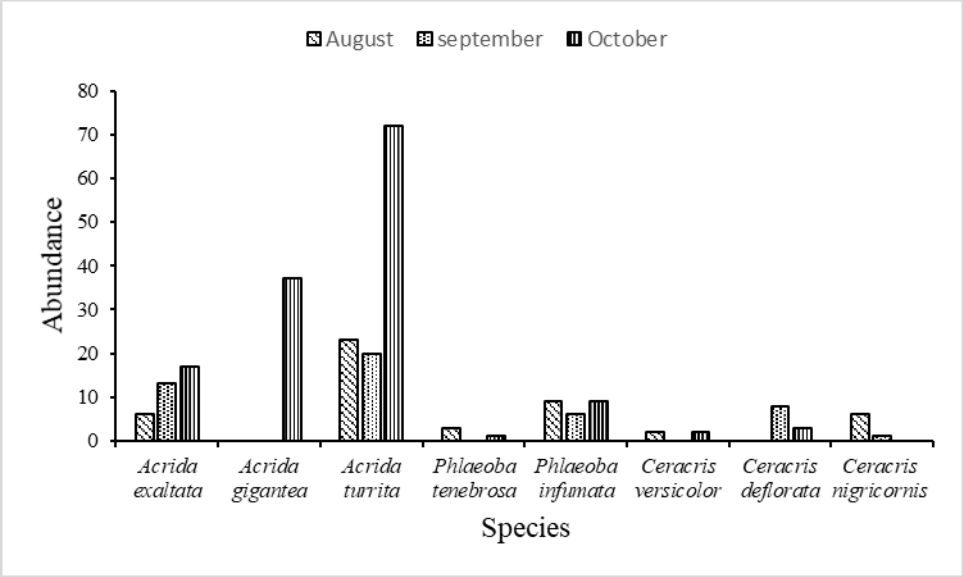

Figure 01. Temporal trend graph of different species described from AJK

Discussion

The adult grasshoppers of subfamily Acridinae were collected from 11 different localities of study area. These collected specimens were identified in to 8 species under three genera. *Acrida exaltata, Acrida gigentea, A.crida turrita* under genus Acrida; *Phlaeoba tenebrosa, Phlaeoba infumata* under genus Phlaeoba; *Ceracris deflorata, Ceracris nigricornis, Ceracris versicolor* under genus Ceracris were reported from study area. The present work reveals that the genera and species of subfamily are widely distributed in different localities of Poonch, Mirpur and Muzaffrabad division of Azad Jammu and Kashmir. A limited record is available about this important fauna from the region of Azad Jammu & Kashmir. Previously (Mahmood *et al*.,2000)recorded seven species under three genera from this region, of those one species *Gelastorhinus begaensis*, under genus *Gelastorhinus* was new to science, whereas *Gelastorhinus filatus* (Walker) under genus *Gelastorhinus* was reported for the first time from study area.(Rajpar *et al*., 2014) reported seven species of subfamily Acridinae from Pakistan; all these species were first time reported from Sindh (Pakistan). In the present study eight species belonging to three genera of the subfamily Acridinae were recorded from different localities of state of Azad Jammu and Kashmir. The studies on the systematics of Acridinae are based on the external morphological characters like body size, length of head, pronotum, tegmina and femur etc. The state comprising three divisions and ten districts is the most important biodiversity hotspots in the world. This region is full of diversity of various insects. The genus Acrida having the most number of specimens, followed by genus Phlaeoba as well as the least number of specimens under genus Ceracrus were recorded as 185, 30 and 21 specimens respectively. During this study three species under genus Ceracris, Ceracris *vercicolor* (Brunner von Wattenwyl), *C. deflorata* (Brunner von Wattenwyl,) and *c.nigricornis* Walker, were first time reported from the region. Results showed that the population density of grasshopper's response to climate change as (Jonas and Joern., 2007) proved that weather influence the abundance and species composition.

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Conclusion

This research provided preliminary knowledge on the diversity and spatio-temporal population dynamics of grasshoppers. The diversity, richness and evenness of these species influenced through both biotic and abiotic factors as vegetation, temperature and humidity. The maximum diversity was recorded in the area with high vegetation. The gradient difference also influences the species distribution behavior. This research will assist the future studies to understand the ecological and evolutionary process in this region.

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Colour plates of 3 Genera along with three new record of genus Ceracris

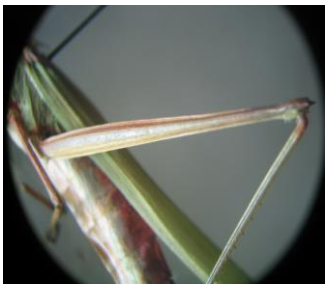

Fig.1. *Acrid exaltata* (Walker), Wings pinkish (dorsal view).

Fig.2. *Phlaeoba tenebrosa* (Walker), Lateral carina of pronotum straight,

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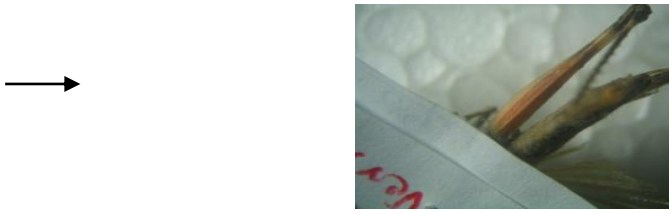

Fig.3. *Ceracris vercicolor* Brunner von Wattenwyl, Hind femur red on ventral side, (ventral view).

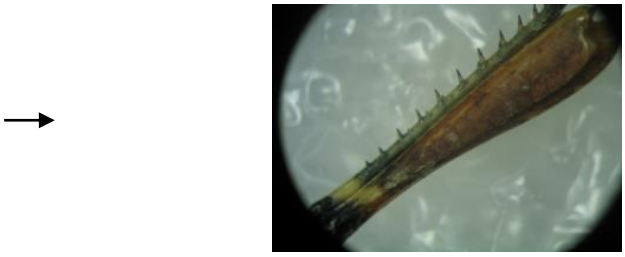

Fig.4. *Ceracris deflorata* Brunner von Wattenwyl, Hind tibia blue (ventral view).

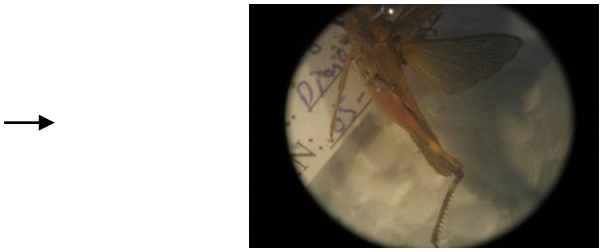

Fig.5. *Ceracris nigricornis* Brunner von Wattenwyl, Hind tibia black (lateral view).