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Research Paper

ABUNDANCE, DISTRIBUTION AND TAXONOMIC STUDIES ON HEMIACRIDINAE (ACRIDIDAE: ACRIDOIDEA: ORTHOPTERA) IN UTTAR PRADESH, INDIA

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Abstract

Members of the subfamily are large sized and generally called rice grasshoppers. They are polyphagous, causes heavy damage to paddy, maize, millet, sugarcane, sorghum and pulses through defoliation. Two species of grasshoppers i.e., *Hieroglyphus nigrorepletus* and *Hieroglyphus banian* of the subfamily Hemiacridinae have been reported from Uttar Pradesh of India. Total 281 males and 274 females of *Hieroglyphus nigrorepletus* and 201 males and 207 females of *Hieroglyphus banian* have been recorded. Maximum number of specimens recorded from pulses followed by grasses, maize, millet, sorghum whereas least number recorded from sugarcane and pigeon pea.

Key words: Abundance, taxonomy, Hemiacridinae, Acrididae.

INTRODUCTION

Orthoptera is one of the largest order of insect comprising 26,550 valid species found throughout the world (<http://orthoptera.speciesfile.org>, dated 11/10/2014). The order is divided into two suborders i.e. Caelifera called short horned grasshoppers and ensifera called long horned grasshoppers. Acridoidea is the largest super family comprising 11,000 species worldwide and out of that 290 species representing 138 genera reported from India (Shishodia et al., 2010). Family Acrididae shows maximum diversity, comprising 8,000 species and out of that 285 species belonging to 135 genera are found in India and out of that 136 species and 28 genera are endemic (Chandra and Gupta, 2013). Members of the family Acrididae are called grasshoppers, having antennae usually shorter than the body (about one-half body length, with less than 30 segments), three-valved ovipositor and three segmented tarsi.

Hemiacridinae sometimes called rice grasshoppers. Grasshoppers of the subfamily Hemiacridinae are polyphagous, causes heavy damage to our cash crops and play havoc with almost every type of vegetation all over the world. Preferred habitat of these large sized grasshoppers is tall grasses and paddy. After harvesting the paddy they move to the

grasses ecosystem and lay eggs in undisturbed area. Grasshopper belong to this subfamily are larger in size and are major pest of paddy causes heavy damage through defoliation and also reported from maize, millet, sugarcane, sorghum and pulses. The leaves are completely eaten by nymphs and adults, leaving the midrib and stalk. Plant growth is arrested and the stems become thin and do not produce grains.

For the first time this subfamily has been studied by Kirby (1914), Bie- Bienko and Mischenko (1951) and Mason (1978) from Indian Sub-Continent. Usmani *et al.*, (2012) also reported from pulses and paddy in Bihar and Jharkhand, Kumar and Usmani (2014) explored from Rajasthan, Chitra *et al.*, (2000) from paddy of Coimbatore, Kandibane *et al.*, (2004a,b), grasshopper from irrigated rice ecosystem from Madurai and Tamil Nadu while Chitra *et al.*, (2001) from rice field of South India respectively. *Hieroglyphus banian* confirmed pest of paddy in Maharashtra (Jadho and Khurad, 2011) and West Bengal (Das *et al.*, 2002) whereas *Hieroglyphus nigrorepletus* recorded from grasses in Rajasthan (Bhatia *et al.*, 1965) and Gujarat (Singh, 1972) respectively. Outbreak of *Hieroglyphus nigrorepletus* has been recorded in Gujarat (Jhala, 2004) and Rajasthan (Acharya, 2010). Riffat and Wagan (2007, 2008) confirmed the *Hieroglyphus nigrorepletus* as a pest of paddy in Pakistan. Studies in biology and ecology of different species of the *Hieroglyphus* have been done by Uvarov (1922), Katiyar (1957), Roonwal (1978) in the old world which is in continuation with the study of Julka *et al.*, (1982). Dev and Hazra, (2003), Joshi *et al.*, (1999), Riffat and Wagan (2007), Akhtar *et al.*, (2012), Usmani and Nayeem (2012) Usmani *et al.*, (2012) and Rafi *et al.*, (2013) respectively.

There is no consolidated record of Hemiicridinae in Uttar Pradesh except some sporadic report. Akhtar *et al.*, (2012) confirmed the pest status of paddy in Uttar Pradesh of the two species *Hieroglyphus nigrorepletus* and *Hieroglyphus banian* respectively. Usmani *et al.*, (2010) reported both the species from Western Uttar Pradesh while Singh and Singh (2014) reported only *Hieroglyphus banian* from Eastern Uttar Pradesh and Akhtar *et al.*, (2012) reported only *Hieroglyphus nigrorepletus* from Aligarh Fort of Western Uttar Pradesh. Authors tried to find out these pests from different ecosystem of Uttar Pradesh.

MATERIALS AND METHODS

A. Study area (Uttar Pradesh)

Uttar Pradesh located in northern India, is the top-ranking state in the country in terms of population more than 199.5 million people as per the census 2011. If the state were considered as a distinct nation, it would have ranked as the fifth most populated country in the globe, just after Indonesia, USA, India and China. The state is bordered by Rajasthan to the west, Haryana and Delhi to the northwest, Uttarakhand and the country of Nepal to the north, Bihar to the east, Jharkhand to the southeast, and Madhya Pradesh to the southwest. This is located at 26.8500° N, 80.9100° E has a humid temperate climate, spread across a land area of 2,43,286 square kilometers and demarcated into three distinct regions: the Himalayan region in the north, the Gangetic plains in the centre and the Vindhya hills and plateau to the south. It is the second largest Indian state by economy and holds the third largest economy (2011-12) in India, with a GDP of 708,000 crore rupees. The leading sector is agriculture and majority of the population depends upon farming as its main occupation. It is the largest wheat producing state of the country while second largest producer of rice as well.

B. Collection and mounting

During survey of Uttar Pradesh two species of grasshopper *Hieroglyphus nigrorepletus* and *Hieroglyphus banian* collected by authors for the period of 2012 and 2013. Collection was made through ordinary aerial insect net. At the time of collection

specimens were killed in bottles having soaked cotton with cyanide. Later on specimens were first relaxed, stretched and pinned. This dry mounts left for 72 hours to dry. Specimen identifies the with the help of binocular stereoscopic microscope upto species level on the basis of characters like size, colour and texture, running with available literature and keys.

C. Morphometry and preservation

Morphometry or measurement in mm of four important differentiating parts of body (Body length, pronotum, tegmina and hind femur) has been done with the help of Vernier Calliper. Mean value, Standard Deviation of male and female of both the species were calculated to show the interspecific variation. Pinned specimens labeled with complete records like locality, date of collection and name of host plants, were kept in store boxes and cabinets for further studies or for the record. Naphthalene balls were kept in boxes to prevent decomposition of dry specimens and 70 % ethyl alcohol was used to store the specimens as a wet preservation in plastic vials.

RESULTS

Two species of grasshoppers of subfamily Hemiacridinae i.e., *Hieroglyphus nigrorepletus* and *Hieroglyphus banian* have been reported from different habitats of one of the largest state (Uttar Pradesh) of India. Total 555 (male-281and female 274) specimens are found of *Hieroglyphus nigrorepletus* and 408 (male-201and female 207) of *Hieroglyphus banian* respectively Table 1. This is not in conformity with the result of Rafi and Usmani (2013), they described five species of *Hieroglyphus* from Eastern Uttar Pradesh only, whereas it is correlated with Shishodia et al., (2010), they described only two species from Uttar Pradesh in Orthopteran checklist of India.

Table 1: Abundance and distribution of *Hieroglyphus nigrorepletus* and *Hieroglyphus banian* in Uttar Pradesh

Districts	<i>Hieroglyphus nigrorepletus</i>			<i>Hieroglyphus banian</i>		
	♂	♀	Host Plant	♂	♀	Host Plant
Allahabad	4	5	Paddy, grasses	-	-	
Azamgarh	5	5	Paddy, grasses, pigeon pea	12	15	Paddy, grasses
Basti	6	4	Grasses	2	2	Sugarcane
Ballia	5	5	Grasses	5	5	Paddy, grasses
Balrampur	4	4	Grasses	5	6	Paddy, grasses
Bahraich	3	2	Grasses	4	6	Paddy, grasses
Deoria	5	6	Paddy, grasses, sugarcane	4	5	Paddy, grasses, sugarcane
Faizabad	8	6	Grasses, maize	6	5	Paddy, grasses
Gonda	3	1	Sugarcane	-	-	
Ghazipur	8	7	Paddy, grasses	6	8	Paddy, grasses
Jaunpur	4	4	Grasses	-	-	
Kaushambi	4	3	Grasses	2	2	Grasses
Kushinagar	10	12	Paddy, grasses, sugarcane	-	-	Grasses
Mirzapur	2	2	Grasses	-	-	
Mau	4	5	Grasses, pigeon pea	3	5	Paddy, grasses

Pratapgarh	13	14	Paddy, grasses	2	1	Grasses
Sultanpur	12	14	Paddy, grasses	6	5	Paddy, grasses
Varanasi	4	4	Grasses	-	-	
Auraiya	-	-		2	5	Paddy, grasses
Barabanki	5	6	Paddy, grasses	-	-	
Fatehpur	15	14	Paddy, grasses	8	7	Paddy, grasses
Hamirpur	5	8	Paddy, grasses, maize	7	8	Paddy, grasses, sorghum
Jhansi	10	10	Paddy, grasses	5	6	Paddy, grasses
Kannauj	5	7	Paddy, grasses	4	4	Paddy, grasses
Kanpur Dehat	8	9	Paddy, grasses	5	3	Paddy, grasses
Kanpur Nagar	5	2	Grasses	-	-	
Lucknow	3	3	Grasses	5	7	Paddy, Grasses
Raebareli	5	7	Grasses, maize	8	6	Paddy, Grasses
Sitapur	10	6	Paddy, grasses	7	7	Paddy, grasses, maize
Unnao	6	6	Grasses	4	2	Grasses
Aligarh	5	4	Paddy, grasses, maize, millet, sorghum	10	11	Paddy, grasses, maize, millet, sorghum
Bareilly	4	4	Grasses	3	2	Grasses
Badaun	-	-		5	7	Paddy
Bijnor	4	2	Grasses	5	3	Paddy
Bulandshahar	6	7	Paddy, grasses	4	4	Grasses
Etah	3	5	Grasses	5	7	Grasses
Etawah	4	5	Grasses	4	1	Grasses
Farrukhabad	6	2	Grasses	3	3	Grasses
Hathras	2	4	Grasses, maize	2	4	Grasses
Meerut	10	14	Grasses, sorghum	7	6	Paddy, grasses, sorghum
Muradabad	5	6	Paddy, grasses, maize	4	3	Paddy, grasses, sorghum
Muzaffarnagar	15	18	maize, millet, sorghum	12	14	maize, millet, sorghum
Pilibhit	4	2	Maize	3	4	Paddy, grasses
Rampur	6	7	Paddy, grasses	10	6	Paddy, grasses, sorghum
Shahjahanpur	8	5	Paddy, grasses	7	6	Paddy, grasses, sorghum
Saharanpur	8	8	Paddy, grasses, sorghum, maize	5	6	Paddy, grasses, maize, millet, sorghum
Total No.	281	274		201	207	

Taxonomic Account

Key to Indian Species of the genus *Hieroglyphus* Krauss, 1877

1. Dorsum of pronotum with two broad black parallel bands connecting all sulci..... *H. nigrorepletus* Bolivar, 1912
- Dorsum of pronotum without bands connecting all sulci..... *H. banian* (Fabricius, 1798)

***Hieroglyphus nigrorepletus* Bolivar, 1912**

Hieroglyphus nigrorepletus Bolívar, I. 1912. *Trab. Mus. Cienc. nat., Madrid*. 6:56

Hieroglyphus bettoni Kirby, 1914. *Acrididae*, 203. Syn. by Bolívar, 1918. *Trab. Mus. Cienc. nat., Madrid (Ser. zool.)* 34:29

Hieroglyphus vastator Carl. 1916. *Revue Suisse de Zool.* 24(6):481. Syn. by Mason, J.B. 1973. *Bull. Br. Mus. (Nat. Hist.) Ent.* 28(7):526.

Hieroglyphus nigrorepletus Bolivar; Riffat & M.S. Wagan. 2010. *Pakistan J. Zool.* 42(6):809-816

Hieroglyphus nigrorepletus Bolivar; Nayeem & Usmani. 2012. *Munis Entomology & Zoology*, 7(1):398

Diagnostic characters: Medium to large sized; body robust and cylindrical; pronotum with sides markedly expanded in metazona; dorsum with characteristic black pattern connecting all sulci by two irregular stripes; first and third sulci joined by a black band; posterior margin of pronotum obtuse angular; frons oblique; fastigium of vertex trapezoidal; fastigial foveolae absent; frontal ridge broad, sulcate with lateral carina slightly reaching upto the clypeus, margins slightly diverging below; mesosternal lobes rounded and mesosternal space narrow.

Distribution: India: Andhra Pradesh, Assam, Bihar, Delhi, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttarakhand, Uttar Pradesh and West Bengal. Elsewhere: Bangladesh and Pakistan

Morphometry:

Measurement (mm)	Male	Female	Mean \pm SD	
			Male	Female
Body length	32.46-38.51	36.01- 41.52	35.77 \pm 2.01	39.22 \pm 1.84
Pronotum	7.49- 8.03	7.86- 9.32	8.18 \pm 0.48	8.79 \pm 0.63
Tegmina	12.35-16.67	16.53-19.16	14.69 \pm 1.52	18.15 \pm 0.91
Hind Femur	16.30-18.19	17.62- 19.78	17.41 \pm 0.73	18.72 \pm 0.77

Standard deviation of 0.48 in case of male pronotum and 0.61 in case of hind femur indicates that size of pronotum and hind femur are not of much variable whereas value of 1.52 and 2.01 in case of tegmina and body length shows much variation and may varies with large fractions among individuals of the species. Standard deviation of 0.63 in case of female pronotum, 0.91 in case of tegmina and 0.77 in case of hind femur indicates that size of pronotum, tegmina and hind femur are not of much variable but the body length may varies with little fractions among individuals of the species.

***Hieroglyphus banian* (Fabricius, 1798)**

Gryllus banian Fabricius, 1798. *Supplementum Entomologiae Systematicae Suppl.* 194.

Acridum furcifer Serville, 1838[1839]. *Histoire naturelle des insects. Orthopteres.* 677. Syn. by Bolivar, 1918. *Trab. Mus. Cienc. nat., Madrid (Ser. zool.)* 34: 28.

Hieroglyphus banian elongata Uvarov, 1922. *Bull. Ent. Res.* 13 (2): 238. Syn. by Mason, 1973. *Bull. Br. Mus. (Nat. Hist.) Ent.* 28 (7): 540.

Hieroglyphus banian (Fabricius); Nayeem & Usmani. 2012. *Munis Entomology & Zoology.* 7 (1): 398.

Diagnostic characters: Body medium to large sized; antennae filiform, longer than head and pronotum together; head globular in profile; fastigium of vertex short, as long as wide in males while wider than long in females; frons oblique; frontal ridge smooth, shallowly sulcate; pronotum shiny, overall smooth with fine punctations in metazona and as band beneath anterior pronotal margin in prozona, lateral carinae absent,

dorsum cylindrical, slightly flattened in metazona, crossed by three transverse sulci, lateral pronotal lobe also with three sulci often filled with black, anterior most continues up to dorso-lateral region; prosternal process small in size, conical with sub-acute apex; mesosternal interspace open, narrow, lobes rounded, virtually as long as wide; metasternal pits closely placed; tegmina fully developed, equal to or slightly exceeding abdomen; wings hyaline, wingspan narrow; arolium large.

Distribution: India: Andhra Pradesh, Bihar, Himachal Pradesh, Maharashtra, Orissa, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh and West Bengal. **Elsewhere:** Afghanistan, Bangladesh, Bhutan, China, Myanmar, Nepal, Thailand and Vietnam.

Morphometry:

Measurement (mm)	Male	Female	Mean \pm SD	
			Male	Female
Body length	38.57– 42.54	47.68–53.72	40.63 \pm 1.98	50.96 \pm 3.05
Pronotum	7.24 –8.85	8.74 – 10.22	8.14 \pm 0.82	9.51 \pm 0.74
Tegmina	27.69 –30.57	34.53 –37.48	29.19 \pm 1.44	36.16 \pm 1.50
Hind Femur	18.45 –19.84	22.38 –25.22	19.21 \pm 0.70	23.99 \pm 1.45

Standard deviation of 0.82 in case of male pronotum and 0.70 in case of hind femur indicates that size of pronotum and hind femur are not of much variable whereas value of 1.44 and 1.98 in case of tegmina and body length shows much variation and may varies with large fractions among individuals of the species. Standard deviation of 0.74 in case of female pronotum indicates that size of pronotum is not of much variable while value of 1.50 in case of tegmina and 1.45 in case of hind femur and 3.05 in case of body length shows that tegmina, hind femur and body length shows much variation and these parts may varies with large fractions among individuals of the species.

DISCUSSION

Both the species of grasshopper *Hieroglyphus nigrorepletus* and *Hieroglyphus banian* are widely distributed in paddy field and grasses of Uttar Pradesh and sparsely distributed among maize, millet, sorghum and sugarcane. *Hieroglyphus nigrorepletus* has been a major pest of paddy in Rajasthan from old world (Bhatia et al., 1965) to new world (Acharya, 2010) and Gujarat (Singh, 1972; Muralidharan et al., 2007). *Hieroglyphus banian* also reported as major pest of paddy in West Bengal (Das et al., 2002), Uttar Pradesh (Akhtar et al., 2012), Maharashtra (Jadho and Khurad, 2011) and Tamil Nadu (Kandibane et al., 2004a,b). These grasshoppers have tough and hard mandibles which help in biting and chewing of food. Both nymphs and adults feed vigorously on leaves, leaving the bare stems and plant growth is arrested that affects the yield. Damage at early stage by newly hatched nymphs is hardly visible, but older nymphs feed on the crops voraciously. Adults cause maximum damage and it is estimated that one adult feeds as much as four to seven times the amount of food that it eats during nymphal stages. Mode of feeding is almost same in all host plants.

No detailed study of these pests under subfamily Hemiaceridinae has been done so far from one of the largest state of India. In the present study taxonomy, distribution, abundance and mode of feeding of these pests has been discussed for the first time. Taxonomy is the backbone of science without identification no one can conclude the result. Study reveals that the host plant of these grasshoppers and extensively found in paddy that clearly indicates paddy is the most preferred food of these grasshoppers

thus may be concluded that these grasshoppers are major pest of paddy. So it is a need to control these pests through environmentally safe methods to increase the production. Definitely this study will give an addition to the existing knowledge of the entomologist of India and abroad as well

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