

## **Research Article**

### **Taxonomic Studies and Ecological Observations of *Hieroglyphus nigrorepletus* (Hemiacridinae: Acrididae: Orthoptera) as a Pest of Paddy in Uttar Pradesh, India**

M.H. Akhtar, M.K. Usmani, M.R. Nayeem

Department of Zoology, Aligarh Muslim University, Aligarh- 202002, Uttar Pradesh, India

#### **\*Corresponding author**

Md Humayoon Akhtar

**Email:** [humayoon1982@gmail.com](mailto:humayoon1982@gmail.com)

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**Abstract:** Grasshoppers of the subfamily Hemiacridinae are polyphagous cause heavy damage to our cash crops and play havoc with almost every type of vegetation. *Hieroglyphus nigrorepletus* is the pest of rice, millet, maize and sugarcane in India. Both macropterous and brachypterous forms of the species are found. Maximum number of the species has been recorded from the rice followed by maize, grass and least number of the grasshoppers collected from the pigeon pea and fodder sorghum. The macropterous form seems to be far less common than the brachypterous form. In both the forms female are larger than male, thus showing intraspecific variation in morphological characteristics.

**Keywords:** Hemiacridinae, Brachypterous, macropterous, paddy, pest, Uttar Pradesh

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#### **INTRODUCTION**

Acridoidea is one of the most important superfamily of sub order Caelifera and order Orthoptera which comprises the family Acrididae, widely distributed in India. Members of Acrididae are commonly known as locusts and grasshoppers. Grasshoppers are the most diverse group of insects and of great economic importance, because they constitute an important group of pests and pose a constant threat to grassland and forest plantations all over the world [24] and also cause significant damage to tree seedlings and agricultural crops [11]. Most grasshoppers are oligophagous and may be classified as graminivorous, forbivorous and ambivorous or mixed feeders [15].

Grasshoppers of the subfamily Hemiacridinae are polyphagous, damaging crops and vegetations all over the world and have been studied [13,5,6,9,25,7]. *Hieroglyphus nigrorepletus* is one of the important pest causes sporadic damage to paddy crops and also injurious to maize, millet, sorghum and sugarcane all over the country through severe defoliation and sorghum is most preferred among all [14]. Outbreak of this grasshopper has been recorded in Gujarat [10], Rajasthan [1] and Himachal Pradesh [26]. Recently taxonomy and ecology of the group has been studied [28,2,3,30,31,32,29] from Uttar Pradesh, Jharkhand and Bihar respectively.

Uttar Pradesh is the fifth largest state of India, situated between 23°52'N and 31°28'N latitudes and 77°3' and 84°39'E longitudes and can be divided into three regions by different geographical conditions:

North- Himalayan region, Middle- Gangetic plains and South- Vindhyan hills and plateau. It shares Nepal and Tibet in northeast, Himachal Pradesh in northwest, Haryana, Rajasthan & Delhi in West, Madhya Pradesh in south and Bihar in southeast. The climate varies from moderately temperate in the Himalayan region to tropical monsoon in the central plains and southern upland regions. In the plains, the average temperatures vary from 12.5°C to 17.5°C in January and 27.5°C to 32.5°C in May and June. Rainfall in the state ranges from 40-80 inches in the east to 24-40 inches in the west. The western region of the state is more advanced in terms of agriculture. Majority of the population depends upon farming as its main occupation. Wheat, rice, sugar cane, pulses, oil seeds and potatoes are its main products.

Asian rice (*Oryza sativa*) is the most important staple food of half of the world's population especially in Asia and the West Indies. India is one of the world's largest producers of white rice, accounting 20% of all world rice production. Rice is India's preeminent crop, and is the staple food of the people of the eastern and southern parts of the country. Paddy fields are a common sight throughout India. Paddy is cultivated twice a year in most parts of India, the two seasons being known as Rabi and Kharif respectively. The former cultivation is dependent on irrigation, while the latter depends on Monsoon. The paddy cultivation plays a major role in socio-cultural life of rural India.

#### **MATERIALS AND METHODS**

##### **I. Collection**

Authors surveyed paddy fields of Uttar Pradesh to collect the grasshopper *Hieroglyphus nigrorepletus* during the period of 2010- 2012. They were caught by the ordinary aerial insect net and through hand picking as well. The collected specimens were killed in bottles having soaked cotton with ethyl acetate.

## II. Morphological Studies

Dry mounts were prepared for better understanding the certain characters like size, colour, texture etc. For this purpose, the specimens were first relaxed, stretched, later pinned and labeled. Complete records were also maintained indicating the reference number, locality, date of collection and name of host plants.

## III. Genital Studies

For detailed study, permanent slide of their genital structures (Supra anal plate, Sub genital plate, Epiphallus, Aedeagus, Ovipositor and Spermatheca) were prepared. For genitalic studies apical parts of male and female were cut off and boiled in 10% KOH to remove unsclerotized and non chitinous tissues. They were then thoroughly washed in tap water for complete removal of KOH and examined in 70 percent ethyl alcohol on a cavity slide. The normal process of dehydration was adopted and clearing was done in clove oil and were mounted separately on cavity slides in Canada balsam. A 22 mm square cover-glass over the cavity of the slide was normally used to prevent them from curling upwards and inwards at the edges. Slides were examined under the microscope and drawings were made with the help of Camera Lucida. Details were filled in by conventional microscope examination.

## IV. Morphometry

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 using methodology used by Uvarov (1966). Mean value, Standard Deviation of male and female of both macropterous and brachypterous forms are calculated to show the differentiation and intraspecific variation.

## V. Preservation

Permanent collections of pinned specimens were kept in store boxes and cabinets for further studies

on their morphological structures. To prevent decomposition of dry specimens, naphthalene balls were kept in boxes and for wet preservation specimens are stored in plastic vials using 70 % ethyl alcohol.

## RESULTS

Two forms of *Hieroglyphus nigrorepletus* i.e., Brachypterous (short-winged) and Macropterous (long-winged) has been reported from paddy fields of Uttar Pradesh, India. Brachypterous forms are more common and dangerous constitutes about 70% than macropterous form imparting 30%. Resurgence of the species takes place in July and disappears in December of each year.

Mean value (brachypterous forms) of male body parts, pronotum, tegmina & hind femur (35.77, 8.18, 14.69 & 17.41) are lesser than female parts (39.22, 8.79, 18.15 & 18.72) showing larger size of female and smaller size of male. Value of standard deviation of male incase of body parts (2.01) and tegmina (1.52) shows more deviation as compared to female body parts (1.84 & 4.69) and tegmina (0.91) respectively, where as it is less deviated incase of pronotum (0.48) & hind femur (0.73) than female pronotum (0.63) and hind femur (0.77) respectively. The differences within the male and female brachypterous forms reveals the significant intersex variation (Table 1).

Incase of macropterous forms Mean value of male body parts, pronotum, tegmina & hind femur (39.30, 8.52, 29.14 & 19.25) are also lesser than female parts (42.93, 8.87, 31.27 & 20.62) showing larger size of female and smaller size of male. But the value of standard deviation of female incase of body parts (2.16), hind femur (0.77) and tegmina (2.28) shows more deviation as compared to male body parts (1.79) hind femur (0.42) and tegmina (1.99) respectively, where as it is less deviated incase of pronotum (0.40) than male pronotum (0.57) only. The differences within the male and female macropterous forms reveals the intersex variation in size (Table 2).

Result of present study regarding the morphometric differentiation of the grasshoppers of two different forms collected from thirty six districts of Uttar Pradesh, India revealed intraspecific variation of brachypterous and macropterous forms of *Hieroglyphus nigrorepletus*.

**Table 1. Morphometric variation of brachypterous form of *Hieroglyphus nigrorepletus***

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

Table 2. Morphometric variation of macropterous form of *Hieroglyphus nigrorepletus*

Measurement (mm)	Male	Female	Mean $\pm$ SD	
			Male	Female
Body length	36.35-41.86	39.98- 45.89	39.30 $\pm$ 1.79	42.93 $\pm$ 2.16
Pronotum	7.55 - 9.10	8.36 - 9.43	8.52 $\pm$ 0.57	8.87 $\pm$ 0.40
Tegmina	26.74-31.66	28.62 -34.67	29.14 $\pm$ 1.99	31.27 $\pm$ 2.28
Hind Femur	18.71-19.83	19.47- 21.64	19.25 $\pm$ 0.42	20.62 $\pm$ 0.77

## TAXONOMIC ACCOUNT

### 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

### Material examined:

India, Uttar Pradesh. Allahabad, 4♂,5♀, 06-X-2010; Azamgarh, 5♂,5♀, 08-X-2010; Ghazipur, 8♂,7♀, 09-X-2010; Mau, 8♂,8♀, 10-X-2010; Ballia,10♂,10, 11-X-2010; Deoria, 15♂,16♀, 12-X-2010; Kushinagar, 10♂,12♀, 13-X-2010; Gorakhpur, 14♂,14♀, 14-X-2010; Siddhartha Nagar, 8♂,5♀, 16-X-2010; Basti, 10♂,14♀, 18-X-2010; Balrampur, 11♂,10♀, 19-X-2010; Gonda, 14♂,14♀, 20-X-2010; Bahraich, 10♂,7♀, 22-X-2010; Faizabad, 10♂,14♀, 24-X-2010; Sultanpur,12♂,14♀, 25-X-2010; Pratapgarh, 13♂,14♀, 26-X-2010; Jhansi, 10♂,10♀,01-IX-2011; Hamirpur, 15♂,18♀, 04-IX-2011; Kanpur Dehat, 8♂,9♀, 06-IX-2011; Kannauj, 15♂,17♀, 09-IX-2011; Auraiya, 10♂,10♀, 10-IX-2011; Fatehpur, 15♂,14♀, 11-IX-2011; Lucknow, 95♂,9♀, 14-IX-2011; Barabanki, 5♂,6♀, 15-IX-2011; Raebareli, 7♂,6♀, 16-IX-2011; Sitapur, 10♂,9♀, 17-IX-2011; Lakhimpur Kheri, 5♂,6♀, 18-IX-2011; Aligarh, 25♂,24♀, 01-VIII-2012; Firozabad, 10♂,14♀, 05-VIII-2012; Farrukhabad, 10♂,11♀, 06-VIII-2012; Mainpuri, 8♂,8♀, 07-VIII-2012; Etawah, 10♂,11♀, 08-VIII-2012; Agra, 8♂,7♀, 09-VIII-2012; Shahjahanpur, 8♂,5♀, 14-VIII-2012; Rampur, 6♂,7♀, 15-VIII-2012; Muradabad, 5♂,6♀, 16-VIII-2012; Bulandshahar, 6♂,7♀, 18-VIII-2012; Saharanpur, 8♂,8♀, 23-VIII-2012.

**Male:** Supra anal plate elongate angular abruptly narrowing at apex; male cercus with elongate acute apex, oblique on upper margin; subgenital plate wide with apex obtusely conical; epiphallus with ridges,

narrow and undivided, concave, ancorae small, turned inwards with acute apices, anterior projections small, apex obtuse and incurved, posterior projection small with rounded apex, lophi robust and large; Aedeagus flexure, apical valve narrow, curved, apex pointed and upcurved, narrow and shorter than basal valve with flexure, basal valve broad and narrowing its obtuse apex, gonopore process narrowing towards its truncated apex (Plate 1.A-D).

**Female:** supra anal plate elongate, broad basally, narrowing apically, longer than wide, apex rounded, cercus conical, shorter than supra anal plate, more than twice as long as wide, apex obtuse; Sub genital plate with posterior margin setose with an acutely conical projection medially with a lobe on each side basally, egg guide broad at base and slender apically; Spermatheca with apical diverticulum short, of uniform width, slightly curved apically, shorter than the pre apical diverticulum, pre apical diverticulum long, broader apically and curving back at basal end; Ovipositor valves long and broad, curved, shorter than lateral apodeme, dorsal valve broad, more than three times as long as wide, curved apically with acute apex, ventral valve narrow, curved apically with acute apex with well developed lateral tooth (Plate 1.E-H).

## ECOLOGICAL OBSERVATIONS:

### Life cycle:

Female grasshoppers lay eggs in egg pods 5-8 cm deep in the soil by inserting the abdomen in the bunds of paddy fields from September to November and then adults die soon after sometime. Eggs remain in the soil and hatch in June or in early July a few days after the first shower of the monsoon. Their population peak from August to October, start decreasing in November and become invisible in December.

### Mode of damage:

Hoppers immediately after emerging start feeding on leaves of paddy. Epidemic loss has been reported in the field. They can not move far away due to loss of functional wings, so vigorously feed on particular place and reported more loss in patches than adults which prefers fresh leaves hence move away resulting no loss in particular field. Over population of hoppers and adults cause severe foliar damage as the leaves are completely eaten by nymphs and adults, leaving the midrib and stalk. Loss of foliage and overcrowding leads movement of pests to upper softer plant parts and even immature grains.

**Coloration:**

Brown colour is more common and rarely green when feeds upon early green stage of crop. All sulci of dorsum of pronotum connected with two black parallel bands. Hind knee black.

**Host range:**

Paddy, wheat, sugarcane, sorghum, maize, millet, pigeonpea and grass. The leaves are completely eaten by nymphs and adults, leaving the midrib and stalk. Vigorous feeding arrested the plant growth and stem becomes thin resulting the heavy loss of grains.

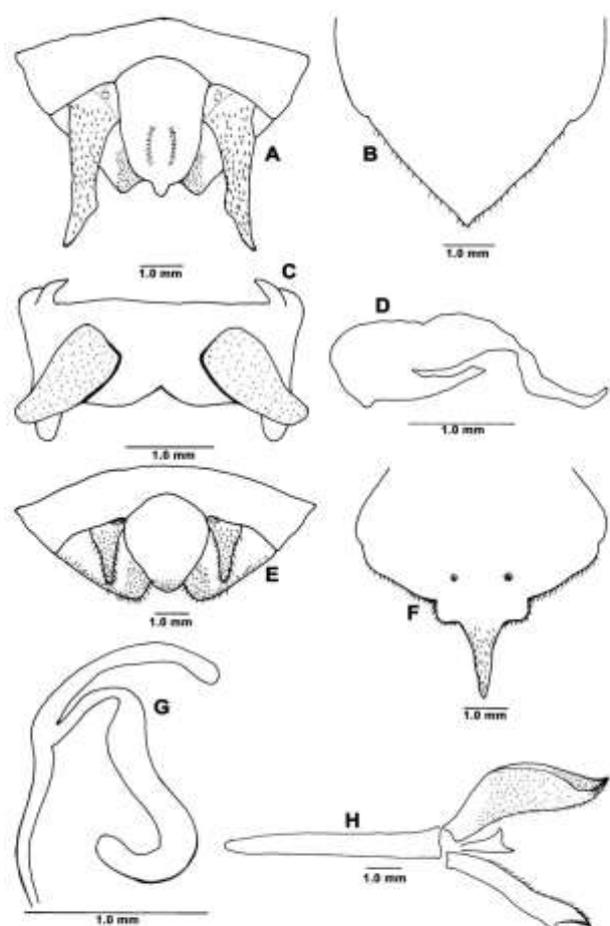


Plate 1: *Hieroglyphus nigrorepletus* A-D (male); E-H (female) A. Supra anal plate, B. Subgenital plate, C. Epiphallus, D. Aedeagus, E. Supra anal plate, F. Subgenital plate, G. Spermatheca, H. Ovipositor

**DISCUSSION**

The rice grasshopper *Hieroglyphus nigrorepletus* is more dominant and widely distributed species in paddy field of Uttar Pradesh and reported sporadic [3]. This species has been confirmed as pest of paddy in Rajasthan and Gujarat [4] and further incidence of this pest in Gujarat has been studied by [27]. It is a major pest of rice, wheat, maize, Sorghum and sugarcane in India and Pakistan [23,19] as well. Brachypterous form seems to be more common than the macropterous one [33] but swarming occurs by macropterous form only [8]. Life history and biological

study of this species has been done [16,20,21,22,17,18] and also confirmed the paddy pest in India and Pakistan respectively.

Present study reveals that the species is frequently distributed throughout the state in paddy fields because rice production is on top as provides staple food to major populations of Uttar Pradesh. Defoliation arrested growth and size of plants resulted in lean stem with few leaves resulting bad quality, low yield rice or no yield some times. As discussed earlier hoppers are more dangerous than adults and no more differences observed among them except wing and colour, hoppers are usually wingless and green which later transforms into developed wings and brown colour. Population of grasshoppers relatively becomes low with decreasing temperature from the month of November and appear healthy with increasing temperature and on first shower of monsoon in the month of June/July. Population also crashed due to extreme drought that results in exploitation of vegetations i.e., lack of food which bounces back on return vegetation.

**CONCLUSION**

There is no previous record of detailed study of this pest from Uttar Pradesh. In the present study emergence and peak period of development of this paddy pest has been shown including damaging level as well. So it should focused on control measure of this pest *Hieroglyphus nigrorepletus* for the sake of agricultural community. It is easier to control the pest if life cycle (hatching, development and mating) is known which is definitely helpful for plant protection agencies to implement control measures at appropriate time. Hatching and mating period is the most suitable time to adapt the control measure. Controlling of this pest would result in high yield and better quality of rice.

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