

# Review of the Genus *Hieroglyphus* Krauss 1877 (Hemiacridinae: Acrididae: Orthoptera) with Description of One New Species From Pakistan

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**Abstract.** - The genus *Hieroglyphus* Krauss 1877 comprises a numbers of species. Of these, the occurrence of three species *H. perpolita* (Uvarov), *H. oryzivorus* Carl and *H. nigrorepletus* I. Bolivar in Pakistan was revised. In these species the significant taxonomic variations have been reported. The phallic complex of these species is discussed and taxonomic key for identification of species is presented. The natural history and geographical distribution of the genus is reviewed. It occurs mostly east, south-east and west region of Pakistan. The *H. oryzivorus* is largely disjunct geographically; it is only restricted in Dadu and Larkana district of Sindh, while *H. perpolita* and *H. nigrorepletus* have been recorded through out the country. In addition to this, one new species *H. akbari* has been added. In this new species the lobes of female subgenital plate are elongated and pointed and the lateral lobes are rounded and the posterior margin of the pronotum is obtuse angular. This character led to the diverse systemic position for this species in relation to the other species of this genus studied. This manuscript presents result of an expedition conducted for the collection of grasshopper during the year 2005-2007 in various provinces of Pakistan.

**Key words:** *Hieroglyphus*, geographical distribution, subgenital plate.

## INTRODUCTION

The representative of the genus *Hieroglyphus* are major pest of rice, wheat, sugarcane and maize and minor pests of millets and fodder crops in Pakistan including Bangladesh, India, China and Africa (Janjua, 1957; Mason, 1973; Roonwal, 1976 a,b; Alam and Alam, 1977; Wagan and Riffat, 2006). The systematic position of this genus has been studied by a numbers of authors over a considerable period of time (Uvarov, 1922, 1932; Roonwal, 1945; 1976a, b, 1978; Singh, 1972; Mason, 1973). The information available so far for this part of the world was insufficient. It was therefore, felt necessary to revise this genus from this region. Further, taxonomic key has been presented. However, bionomics and ecological account has also been briefly discussed. Mason's key contained ten species. We have described one more new species *H. akbari* and added to the list. Now this genus has 11 species. Present study might be helpful in filling certain gaps and facilitate our knowledge of *Hieroglyphus* fauna of Pakistan and bring the information up to date.

## MATERIALS AND METHODS

### *Collection, killing and preservation of grasshoppers*

The stock of *Hieroglyphus* was collected from the paddy, maize and sugarcane fields surrounded by vegetation of grasses with the help of traditional insect hand-net (8.89 cms in diameter and 50.8 cms in length) as well as by hand picking. The collection was made during the year 2005-2007 in the months of June-November from various provinces of Pakistan. The collected material was transferred to the laboratory in polythene bags and killed in standard entomological bottles containing KCN. The specimens were stretched on a stretching board till they dried. Later the insects were stored in insect boxes with labels showing locality, date and collector's name.

### *Dissection of phallic complex*

For the study of male genitalia the method described by McE Kevan *et al.* (1969) was adapted. The method of softening the abdominal terminalia was not followed by immersing these in hot water, but by relaxing the whole insect for 24 hours over water in a small desiccator to which a few drops of phenol/70% alcohol was added to prevent fungal growth. The supra-anal plate of the specimen was, later raised with a needle and cut laterally to take

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out the whole phallic complex. The phallic complex was then immersed in 10% hot KOH for 5-10 hours in order to remove unsclerotized and non-chitinous tissues before being transferred to microvials for storage. The microvials were pinned through their rubber stoppers beneath the insects from which the phallic structure had originally been extracted. Difficulty in maintaining proper orientation of the specimens was overcome by supporting them in the required position with small pieces of absorbent cotton fiber.

To study female genitalia the method described by Randell (1963) was followed. After relaxing the insect as per method mentioned above, with the help of fine scissors an incision was made on each side of the abdomen where the tergum meets the subgenital plate, and was continued just far enough anteriorly to allow easy removal of the extra plate. The spermatheca, which lies just above the vagina, was also removed. The dissected subgenital plate and spermatheca was then washed with 10% KOH and examined in water.

The diagrams were all drawn with the help of ocular square reticule. The terminology followed here is basically that adopted by Dirsh (1956, 1957) with regard to the phallic complex and female genitalia.

## RESULTS

### KEY TO SPECIES OF *HIEROGLYPHUS* OCCURRING IN PAKISTAN

1. Dorsum of pronotum crossed by four broad black sulci, (Fig.1) prosternal process bifurcate (Fig.F), apex of male cercus straight (Fig.G) Ancorae of epiphallus straight, turning outward lophi elongate (Fig.E) median lobe of female subgenital plate broad with two spiny ridges (Fig. H) ..... *perpolita* (Uvarov)
- Dorsum of pronotum crossed by three sulci, prosternal process pointed (Fig.F) Ancorae of epiphallus curved, lophi lobe-shaped (Fig.E) male cercus obliquely truncated (Fig.H) or appendiculate (Fig.I), subgenital plate without ridges ..... **2**
2. Pronotum with sides markedly expanded in metazona dorsum with characteristic black pattern connecting all sulci by two irregular stripes (Fig.2) female subgenital plate trilobate with well developed lateral lobes and large median lobes (Fig.I) ..... *nigrorepletus* Bolivar
- Posterior margin of pronotum rounded (Fig.3) apex of male cercus pointed (Fig.B) female subgenital plate trilobate with very small lateral lobes and small median lobes (Fig.C) ..... **3**
3. Posterior margin of metazona rounded prosternal process conical ..... *oryzivorus* Carl
- Posterior margin of pronotum obtuse angula (Fig.4) the median lobe of female subgenital plate is elongated and pointed and the lateral lobes are rounded (Fig.B) ..... **4**
4. Posterior margin of metazona obtusely angular. Prosternal process conical ..... *akbari* sp.n

### *Hieroglyphus perpolita* (Uvarov, 1932) (Fig. 1)

#### Description

Size medium to large. Moderately robust. Antenna (25-28) segmented shorter than head and pronotum together. Pronotum cylindrical dorsum crossed by four wide sulci, metazona shorter than prozona, its posterior margin widely obtuse angular. Prosternal process bifurcate. Mesosternal interspace narrowly opens; metasternal interspace closed. Hind femora organ-colored on the outer side and reddish below, hind tibia bluish-grey with black band at base, with external 9 and internal 8 spines buff with blackish tips apical half and hind tarsus bluish.

#### Description of phallic complex

Epiphallus's size small, ancorae of medium length, turning outwards; lophi elongate, not lobe-shaped pointed inwards, with subacute apices. Zygoma of cingulum narrow; rami broad; apodemes slightly shorter than basal valves of penis moderately broad with obtuse apices. Arch of cingulum with small denticle in the anterior part. Apical valves of penis narrow, shorter than valves of cingulum, narrowing at apex; valves of cingulum slightly upcurved, with subacute apex; basal valves of penis robust, slenderly expended at end; dorsal ridge of valves smooth at basal end; gonopore process elongate, narrowing towards truncate apex. Spermatheca with preapical diverticulum straight or curved at distal end, apical diverticulum half the length of preapical diverticulum.

#### Distribution

This species was collected from the following districts Jacobabad, Shikarpur, Sukkur Ghotki, Mirpur Khairpur, Larkana, Thatta, Karachi, Malir, Badin, Mati, Sanghar, Mirpurkhas, Umerkot, Hyderabad: Dadu, Jamshoro, Kotri and Nawabshah

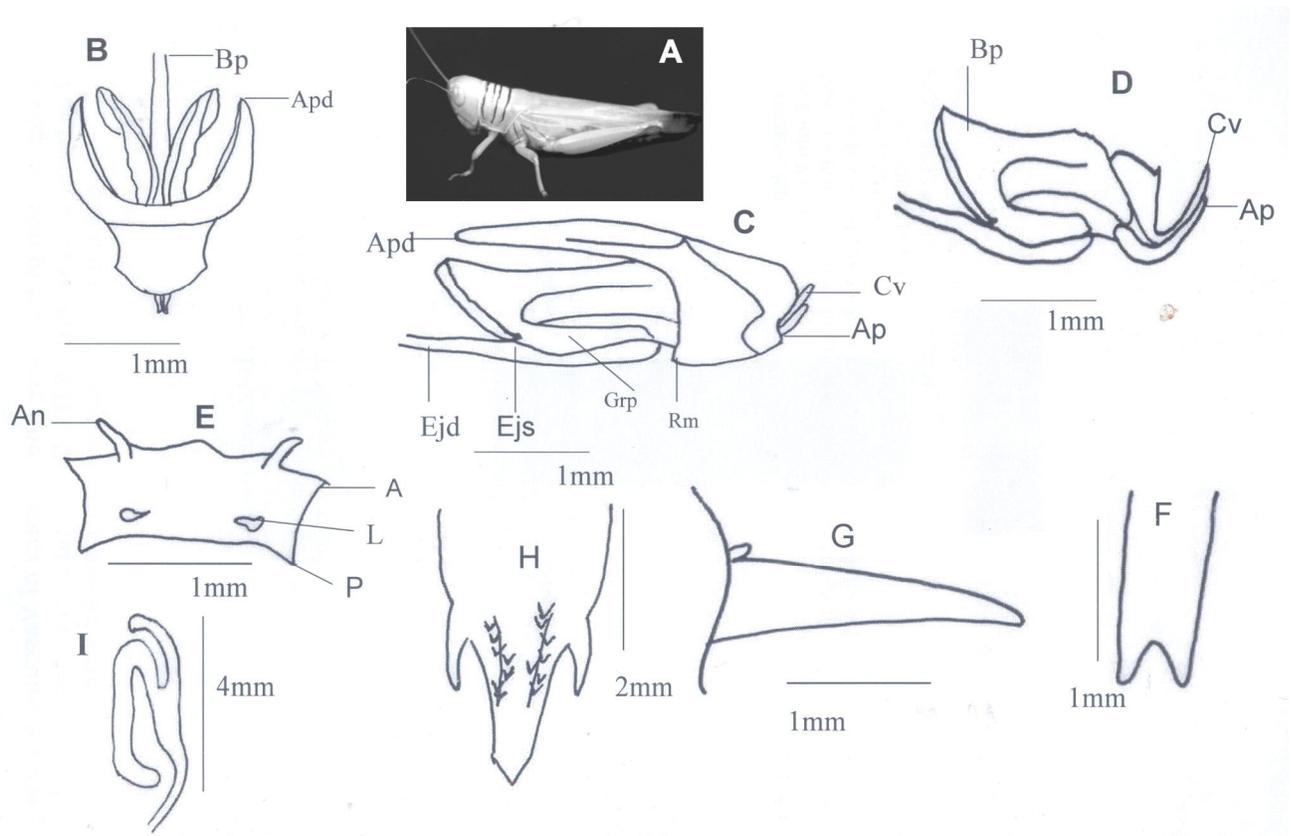


Fig. 1. *Hieroglyphus perpolita* (Uvarov) A, Female; B, Phallic complex with epiphallus and ectophallic membrane removed; C, Same lateral view; D, Endophallus lateral view; E, Epiphallus, Dorsal view; F, Proseternal process; G, Cercus, Lateral View; H, Subgenital plate, Ventral view; I, spermatheca.

from Sindh province, Chakwal, Rawalpindi, Islamabad, Multan, Lahore, Gujrat, D.G.Khan Bahawal Nagar, Rahim Yar Khan from Punjab, Mansehra, Abbotabad, Haripur, Swat from N.W.F.P and Barkhan, Lasbela, Uthal, Loralai from Balochistan province.

**Bionomics**

The first authentic information on the life history of *H.perpolita* was provided by Wagan and Riffat (2006). There is one generation per year. The hoppers hatch in mid June and go through six nymphal stages before becoming adults. The total nymphal duration was reported 35.83±7.72 days. The population of adult reached maximum levels in field by the middle of July, adults mature by the first week of August then copulation and oviposition

takes place. The number of egg per female reported was 29.07±6.73 and total number of egg pods during the entire life was 1.58±0.7 by per female. The total survival period recorded was 26.46±12.13 days for male and 21.13±4.62 days for female.

**Ecology**

This species was collected mostly from the *Saccharum bengalense* locally called Sarkanda (these plants having thick and coarse (thorny) leaves) near the cultivated fields of *Zea mays* (Maize) and *Arachis hypogaea* (Peanut). While Mazhar (1993) Yousuf (1996) and Riffat *et al.* (2002) recorded this species from wheat, rice and maize fields. This species occurred in only macropterous form.

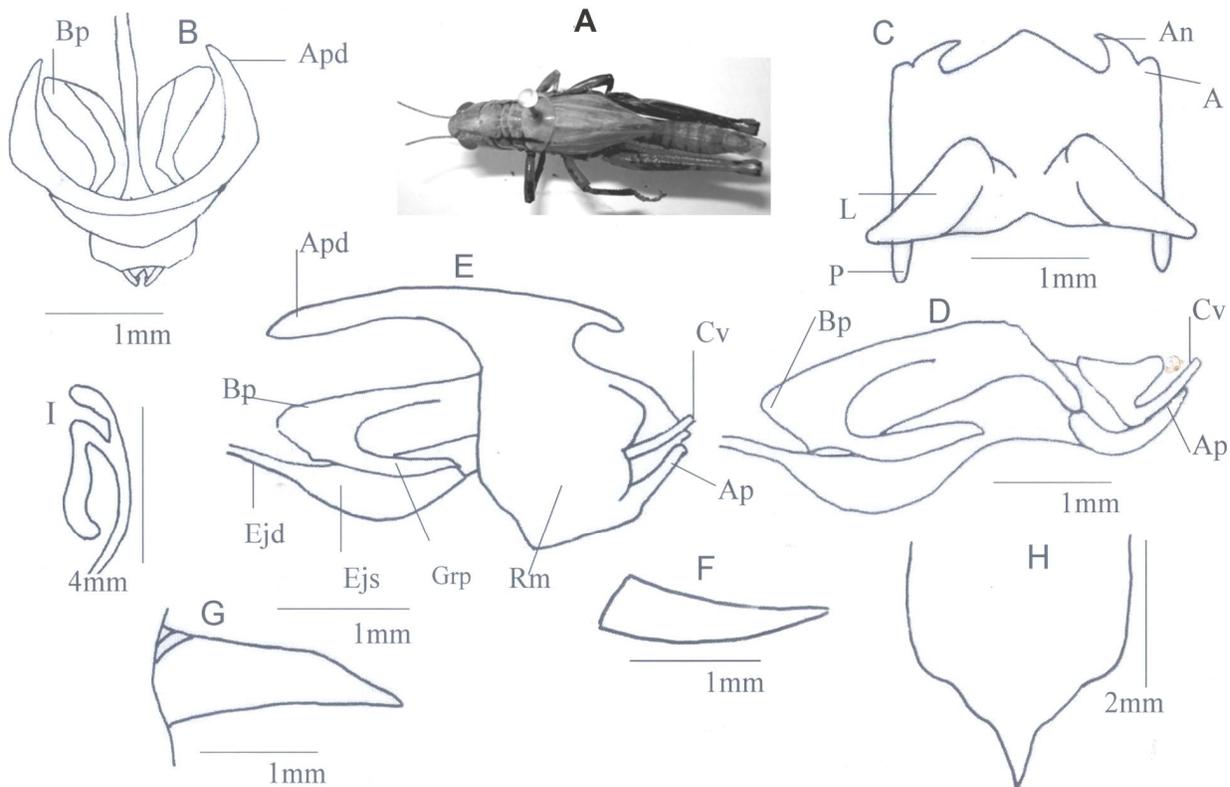


Fig. 2. *Hieroglyphus nigrorepletus* I. Bolivar, A, Female; B, Phallic complex with epiphallus and ectophallic membrane removed; C, Same lateral view; D, Endophallus lateral view; E, Epiphallus dorsal view; F, Prosternal process; G, Cercus, Lateral view; H, Subgenital plate, ventral view; I, Spermatheca.

*Hieroglyphus nigrorepletus* I. Bolivar, 1912  
(Fig.2)

*Description*

Body size large moderately robust. Antenna filiform with (25-28) segments larger than head and pronotum together. Pronotum with weak median carina sulci on pronotum deeply placed. Distal abdominal sternites hairy. Mesosternal interspace slightly open; metasternal interspace closed. Hind tibia slightly expended apically almost straight with 11 external and 10 internal spines. Cercus simple longer than supra-anal plate, Subgenital plate subacute. Yellowish buff patches on the abdomen sulci on the pronotum broad blackish. Hind femora yellowish-colored on the outer side and reddish below. Tibia bluish buff with black tips of spines, tarsus brownish-green in colored.

*Description of phallic complex*

Epiphallus very large, upper margin extending upward and inner margin curved upper, lophi large robust, ancorae small pointed curved inwards. Apodemes slightly larger than the basal valves of penis, broad, narrowing to obtuse apices. Zygoma of cingulum narrow; rami broad. Arch of cingulum somewhat rectangular. Penis with apical valves narrowing at apex; shorter and broader than valves of cingulum. Valves of cingulum narrow, upcurved, basal valves of penis robust and broad, dorsal ridge of valves smooth; gonopore process narrowing towards acute apex. Spermatheca small, apical diverticulum long, narrow, curving back at basal end, preapical diverticulum elongate, half length of apical diverticulum.

*Distribution*

This species was collected from following districts Larkana; Shikarpur, Badin Golarchi, Hyderabad, Khairpur, Sukkur, Ghotki Jacobabad, Thatta; Sujawal Mirpur; Sukkaro Umerkot, Maati Tharparkar, Nawabshah, Karachi; Dadu and Jamshoro from Sindh, Rawalpindi, Islamabad Faisalabad Lahore and Behawalpur from Punjab, Mansehra Abbotabad, Haripur and Swat from N.W.F.P and Barkhan, Lasbela and Uthal from Balochistan province.

*Bionomics*

Life history of *H. nigrorépletus* studied by (Purthi, 1949; Roonwal, 1945, 1976a,b, 1978; Srivastava, 1956; Riffat and Wagan, 2007b). Hoppers appear in late June or earlier July soon after the monsoon rains. This species crossed six nymphal stages to become adult with exception of few authors *i.e.* (Purthi, 1949; Srivastava, 1956). The average nymphal duration was reported  $34.88 \pm 6.63$  days. The reproductive activity was at its maximum from the second week of August to the middle of October in *H. nigrorépletus*. A single female laid  $24.88 \pm 7.33$  eggs per pod and  $1.46 \pm 0.6$ -egg pod during her entire lifespan. The longevity of insect was calculated  $40.4 \pm 16.10$  days and  $35.93 \pm 16.48$  days for male and female respectively (Riffat and Wagan, 2007a).

*Ecology*

This species is more dominant and widely distributed throughout the Pakistan. They are found in field having mixed vegetation of herbs and grasses *i.e.* *Desmostachya bipinnata* as well as from agricultural fields of (*Oryza sativa*) sugarcane, (*Saccharum officinarum*) wheat (*Tritium aestivum*) maize (*Z. mays*), Sorghum jowar (*Sorghum vulgare*) and some specimens were collected from millets (*Setaria italua*) and bajar (*Pennisetum typhoideum*). *H. nigrorépletus* is most abundant in areas which have huge rainfall annually (Riffat and Wagan, 2007 b). The adults were collected during the months of July, August and September. Both macropterous (long-winged) and brachypterous (short-winged) forms were recorded.

*Hieroglyphus oryzivorus* Carl, 1916  
(Fig. 3)*Description*

Body moderately slender, elongated. Antennae with 28 segments longer than head and pronotum together. Dorsum of pronotum crossed by three deep transverse sulci. Posterior margin of pronotum rounded. The hind sulcus bow-shaped at center. Prosternal process conical, mesosternal and metasternal interspace closed. Hind femora moderately slender. Hind tibia slightly expanded apically, almost straight with 9 external and 7 internal spines. Hind femur buff with reddish tinge. Hind tibia gray, spines with black tips. Tips of cercus black.

*Description of phallic complex*

Epiphallus of medium size, upper margin slightly curved and inner margin slightly curved with a dent upper in the center. Ancorae moderately pointed and slight curved inwards. Lophi rounded with second small lobe facing inwards. Apodemes U-shaped, slightly longer than basal valves of penis; and slightly expended before rounded apex. Arch of cingulum roughly square. Penis with apical valves subacute at apex stouter and shorter than valves of cingulum. Valves of cingulum narrow elongate with rounded apices; basal valves of penis robust, expended at end, dorsal ridge of valves smooth, gonopore process elongate, narrowing to subacute apex; rami broad. Spermatheca short, apical diverticulum long, preapical diverticulum elongated somewhat half length of apical diverticulum.

*Distribution*

This species was collected from rice producing areas of Dadu, Larkana and Jacobabad from the province of Sindh, while some were collected from district Rawalpindi from the province of Punjab.

*Bionomics*

Life history of this species is similar to that of *H. nigrorépletus*. Hoppers generally hatch out during the last week of August in Dadu and Larkana districts of Sindh. However, they emerge earlier during the second week of July in Rawalpindi

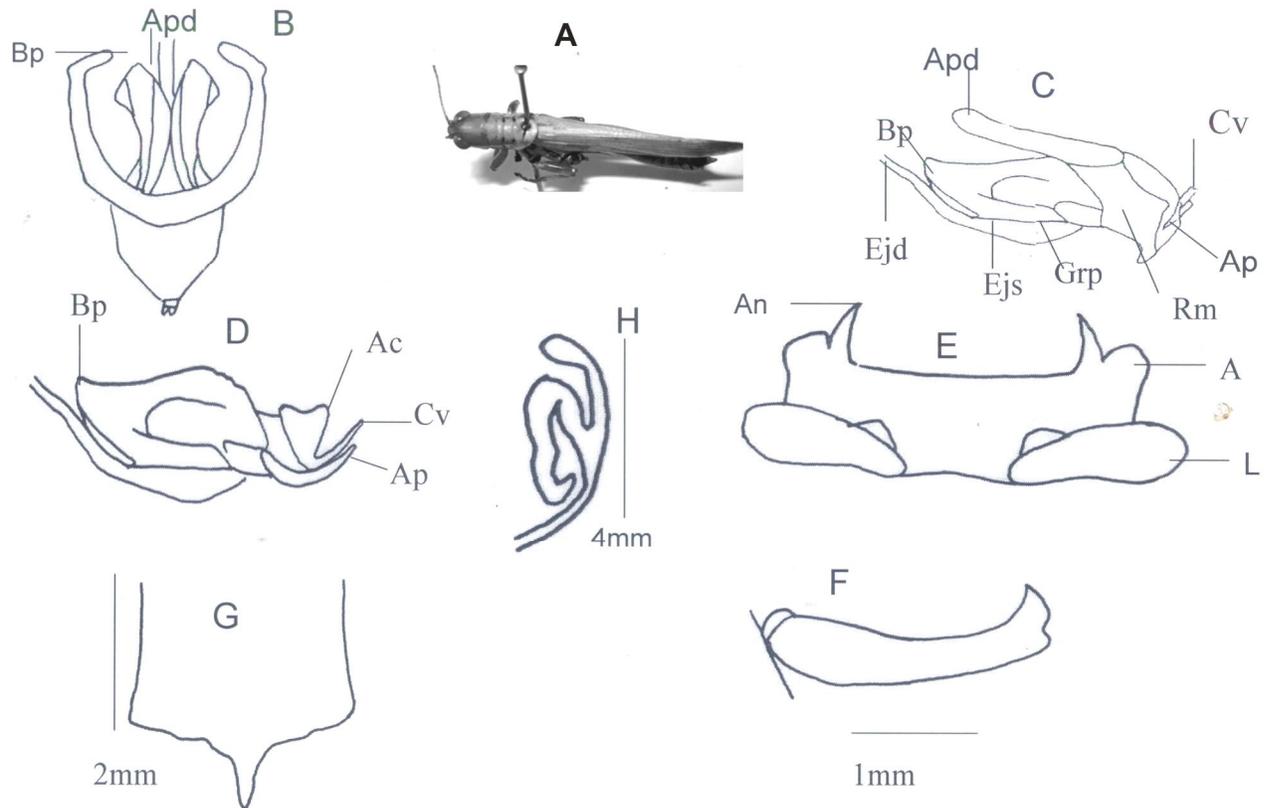


Fig. 3. *Hieroglyphus oryzivorus* A, Male; B, Phallic complex of with epiphallus and ectophallic membrane removed; C, Same lateral view; D, Endophallus lateral view; E, Epiphallus, dorsal view; F, Cercus; G, Subgenital plate ventral view; H, Spermatheca.

(Punjab) and its adjoining areas (Riffat and Wagan, 2009). The total nymphal duration was recorded  $44.69 \pm 9.10$  days (Riffat and Wagan, 2007a). The female grasshopper after drilling a hole lays eggs in masses in deep soil from September to November after which the adults are not seen in field (Riffat and Wagan, 2009). The means numbers of egg pods per female in mass reared insects was recorded  $3.62 \pm 1.12$  and total number of eggs per pod was calculated  $36.12 \pm 13.75$ . The longevity of insects was recorded  $46.86 \pm 21.34$  days and  $38.13 \pm 14.77$  days for male and female respectively (Riffat and Wagan, 2007a).

#### Ecology

This species has been collected from the cultivate field of rice that is why this species is considered as severe rice pest in Sindh (Riffat and

Wagan, 2009) however, the young hoppers mostly remain confined to the bunds and mound for about a fortnight where they feed on *Cynodon dactylon*. Hoppers generally start hatching during the month of July in Punjab where as in the month of August in Sindh province. This species occurs in both macropterous and brachypterous forms.

#### *Hieroglyphus akbari*, new species (Fig. 4)

#### Diagnosis

This species is very closely related to *H.daganensis* Krauss and *H.oryzivorus* Carl. In this new specimen the posterior margin of the pronotum is obtuse angular whereas in *H.daganensis* and *H.oryzivorus* the posterior margin of the pronotum is rounded. In this specimen the median lobe of

female subgenital plate is elongated and pointed and the lateral lobes are rounded while in *H. daganensis* the median lobe of female sub-genital plate is shorter and the lateral lobes are rectangular whereas in *H. oryzivorus* the lateral lobes are small and rounded and the median lobe is also small.

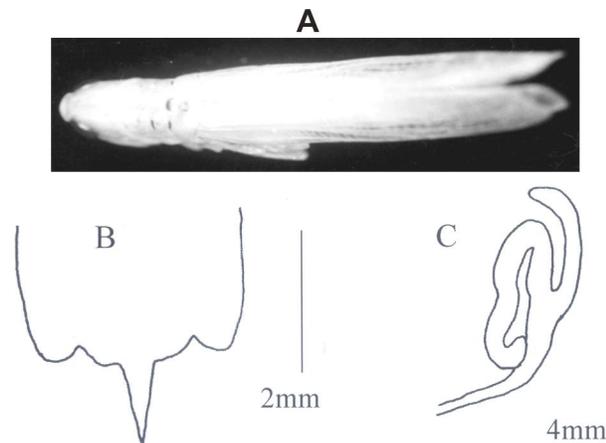


Fig. 4. *Hieroglyphus akbari*, new species, A, Female; B, Subgenital plate; C, spermatheca.

#### Description of female holotype

Large and graceful, integument coarsely pitted. Hairy on ventral surface. (Antenna missing). Fastigium of vertex nearly twice as broad as long; carinula of vertex absent, frontal ridge divergent downwards with moderately deep sulcus. Sulci on pronotum moderately deep, the posterior sulcus bow-shaped at centre, posterior margin of metazona obtusely angular. Prosternal process conical. Mesosternal interspace slightly open, metasternal interspace closed. Tegmina and wings extending beyond the end of abdomen. Hind femur moderately slender. Female subgenital plate (Fig. 4, B) trilobate with outer lobes rounded and much shorter than median lobe; median lobe much elongated and pointed; valves of ovipositor shorter and robust; external lateral projection of lower valves moderately large obtuse angular. Spermatheca (Fig. 4, C) with apical diverticulum long, narrow curving backs at basal end, preapical. diverticulum small, elongate half the length of apical diverticulum.

#### Coloration

General coloration yellowish green hind

femur straw colored on the outer side and more or less reddish below; hind tibia pale blue black marks on the lateral lobes of pronotum sharp the first and third sulcus being connected by black line while the sulci on the disc are unicolours.

#### Measurement

The measurement of different body parts based on single female specimens are as follows: length of head, 3.0; distance between two compound eyes, 2.45; length of pronotum, 9.10; length of tegmina, 37.0; length of hind femur, 26.0; length of hind tibia, 22.0; and total body length, 45.0.

#### Material examined

The specimen examined was collected from Sindh Jacobabad nr, Jacobabad. 1 female holotype 02.ix.2006 (S. Riffat and M.S. Wagan).

#### Depository

The type material has been deposited in the Entomological Museum, Department of Zoology, University of Sindh.

#### Etymology

This species has been named in the honored of Prof. Dr. S.S.Akbar the Ex- Chairman Department of Zoology, University of Sindh for his innumerable contribution in the field of taxonomy.

#### Habitat

The specimen was collected from a rice field near Jacobabad (2817°N, 6826°E) city.

#### Remarks

The pronotum of this specimen exhibit an intermediate condition between the *Hieroglyphus daganensis*, *H. oryzivorus*, *H. indicus* and the rest of species of the *Hieroglyphus*. The male when described, will afford some more important characters.

## DISCUSSION

The systematic position of this taxon within the family Acrididae also appears to be disputed. Hemiacridinae subfamily was established by Dirsh (1956). Earlier Kirby (1914), Mishchenko (1952)

included the member of this subfamily in Catantopinae. McE Kevan and Knipper (1961) supported the subfamily status of Hemiacridinae. Since then it has been regarded as subfamily by Dirsh (1961) Uvarov (1966), Vickery and McE Kevan (1983) and Otte (1995). Dirsh (1975) raised the status of Hemiacridinae to family Hemiacrididae. He separated Hemiacrididae from Acrididae based on whether or not his basal and apical valves of penis were connected by a flexure. Eades (2000) studied the *Hieroglyphus banian* and found that basal and apical valves of the penis are connected by a flexure. Our study on *Hieroglyphus perpolita*, *H. nigrorepletus* and *H. oryzivorus* all show a thread like connection between basal and apical valves and thus supports Eades (2000) who consider Hemiacridinae under family Acrididae.

In *H. perpolita* zygoma of cingulum narrow; rami broad; apodemes slightly shorter than basal valves of penis moderately broad with obtuse apices. Arch of cingulum with small denticle in the anterior part. While in *H. nigrorepletus* apical valves of penis narrow, shorter than valves of cingulum, narrowing at apex; valves of cingulum slightly upcurved. Conversely to this, in *H. oryzivorus* zygoma of cingulum narrow; rami broad. Arch of cingulum somewhat rectangular. Penis with apical valves narrowing at apex; shorter and broader than valves of cingulum. The above differences in male genitalia also appear to be variations within the species. Ingrisch (1989) has pointed out that the phallic complex is due to individual variation. McE Kevan and Lee (1974) have even shown that its form can change in adult grasshopper with age. Small difference in shape, especially when compared drawing of other authors should not be overestimated Ingrisch. There are also other significant differences occur in the genital components of same and different species of *Hieroglyphus* which has already been expansively discussed in our previous papers (Riffat and Wagan, 2007a, 2009, 2010).

During the present study three species namely *H. perpolita*, *H. nigrorepletus* and *H. oryzivorus* were recorded from Pakistan. We did not find a single specimen of *H. banian*. This last species had been reported by Janjua (1957), Irshad (1977), Irshad *et al.* (1977) and Hashmi (1994). Yousuf

(1996) reported *H. concolor* (Walk.) from Pakistan, but this species does not occur in Pakistan. Present study recommends that if more extensive surveys are to be conducted in the country particularly in northern areas it will not only confirm the presence of *H. banian* but also lead to the addition of new diversity in this genus. Occurrence of previously recorded species had been confirmed and their distribution has been extended to new localities. It may be concluded that *H. perpolita* and *H. nigrorepletus* are abundant throughout the country while *H. oryzivorus* is only confined to Sindh Province (with exception of few specimens). The present study recommends that if frequent surveys are conducted in arid-regions of Pakistan it might be helpful to collect the *H. oryzivorus* in greater numbers.

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