

Studies on Morphology and Ecology of Grasshopper, *Hieroglyphus oryzivorus* Carl, 1916 (Acrididae: Orthoptera)*

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Abstract.- *Hieroglyphus oryzivorus* Carl is recognized as more severe pest of rice in Pakistan. However, millets, wheat, sugarcane and maize are also reported its alternate hosts. Pronotum in *H. oryzivorus* crossed by three deep transverse sulci while the hind sulcus bow-shaped at center. Male cercus appendiculate and same length of supra-anal plate, the face and mouthpart green-yellowish in ♂ or dark green in ♀. Moreover, significant differences are studied in *H. oryzivorus* on the basis of morphological traits as well as on genitalia components compared with *H. daganensis*. This pest occurred in two forms i-e brachypterous (short-winged) and macropterous (long-winged) but the macropterous form have tendency to produce swarm. Hoppers usually emerge in the field from August to September after a fortnight they enter in paddy field. The adults preferred to feed on fresh new leaves of the rice plant while hoppers vigorously feed on *Cynodon dactylon*. Population of adults was at its peak from September to November after this its population rapidly decreased in field.

Key words: *Oryza sativa*, macropterous, brachypterous, swarm tendency, genitalia, *Cynodon dactylon*.

INTRODUCTION

Oryza sativa (L.) is one of the world's most important crop providing staple food for nearly half of the global population, almost 90% of rice is grown and consumed in Asia. It feeds more than two billion people in the developing countries of Asia (Khuhro, 1988). Rice is subjected to considerable damage by a number of *Hieroglyphus* species among them, *H. oryzivorus* Carl is reported to cause massive losses to the crop particularly in the province of Sindh (Wagan and Riffat, 2006). In addition to rice, millets, wheat, sugarcane, and maize are also recorded alternate hosts of this pest (Riffat and Wagan, 2007a).

Hieroglyphus species have been the subject of investigation with reference to the distribution of *H. nigrorepletus* and *H. banian* (Roonwal, 1945; 1976a,b, 1978; Srivastava, 1956; Janjua, 1957; Pradhan and Peshwani, 1961; Ghouri and Ahmed, 1960; Mason, 1973; Alam and Alam, 1977; Irshad *et al.*, 1977; Hashmi, 1994; Karim and Riazuddin, 1999; Riffat *et al.*, 2007) and systematic position of *H. oryzivorus* (Uvarov, 1922), but the

information has been inadequate. Mason (1973) restricted her studies mostly on Indian insects and did not provide complete perspective of this pest from Pakistan.

Although, Wagan and Riffat (2006) and Riffat and Wagan (2007b, 2008a,b) have highlighted different aspects such as oviposition, mating behavior, feeding habit on different host plants and incidence of *H. oryzivorus*, the taxonomic status of this important pest is still scanty, scattered and unsatisfactory. The present research was therefore undertaken to explore the *H. oryzivorus* fauna along with its ecology from Pakistan.

The results obtained from the present study would aid in acquiring a better understanding of the economic importance of this pest and the knowledge attained on the current pest status and ecology of this species will be valuable in planning more appropriate and effective control measures in future.

MATERIALS AND METHODS

Collection, killing and preservation of grasshoppers

The stock of *H. oryzivorus* was collected from the paddy 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 2005-2006 in the months of July-

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November from Sindh and Punjab 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's boxes with labels showing locality, date and collector's name.

Dissection of phallic complex

For the study of male genitalia the method described by 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 out the whole phallic complex. The phallic complex was then immersed in 10% hot KOH 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 of Dirsh (1956, 1957) with regard to the phallic complex and female genitalia was adopted. Identification of specimen was carried out under the dissecting stereoscopic microscope. All the measurements are given in millimeter.

Material examined

The specimens examined for this study were collected from Dadu, K.N. Shah Goth Mubrak Burghari, Larkana, nr, Badah from the province of Sindh, and Rawalpindi Seray-Kharboza from the province of Punjab.

RESULTS

Hieroglyphus oryzivorus Carl, 1916

(Fig. 1)

Description of male (Fig. 1B)

Body moderately slender, elongated. Antennae with 27-28 segments longer than head and pronotum together. Fastigium of vertex twice as broad as long. 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. Tegmina and hind wings surpassing tip of abdomen. Hind femora moderately slender. Hind tibia slightly expanded apically, almost straight with 9 external and 7 internal spines male cercus appendiculate (Fig. 1G) and same length of supra-anal plate.

Phallic complex

Epiphallus (Figs. 1C,D) of medium size, upper margin slightly curved and inner margin slightly curved with a dent upper in the center. Ancorae moderately pointed and slightly curved inwards. Lophi (Fig. 1F) rounded with second small lobe facing inwards, lobe of lophi rounded with second small lobe facing inwards. Apodemes U-shaped, slightly longer than basal valves of penis, and slightly expanded 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 (Fig. 1E); basal valves of penis robust, expanded at end, dorsal ridge of valves smooth; gonopore process elongate, narrowing to subacute apex; rami broad.

Coloration

Pale-green or buff with slight yellowish brown patches. Antennae yellowish to reddish

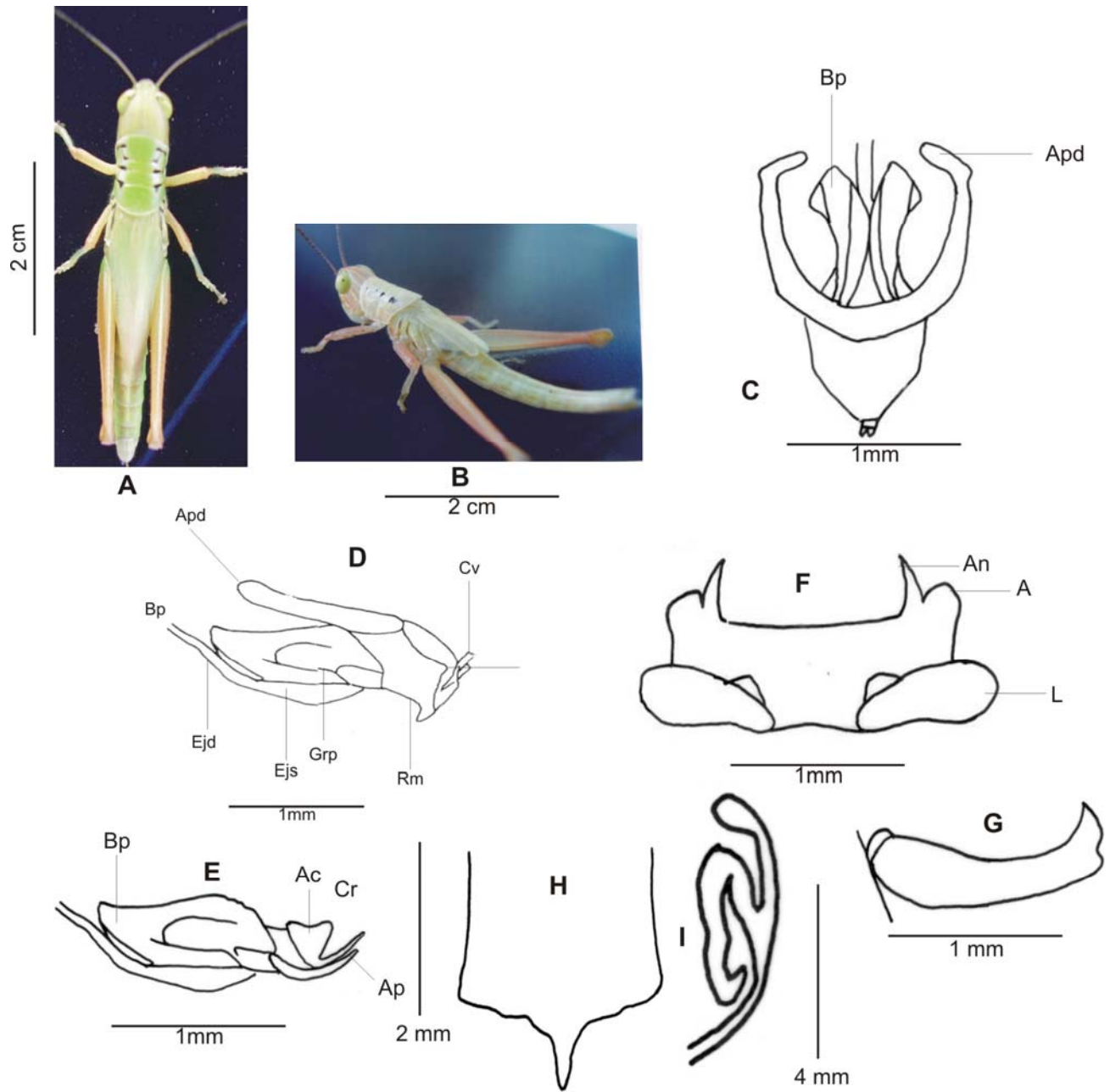


Fig. 1. *Hieroglyphus oryzivorus* Carl, 1916. A, female, B, male; C, phallic complex from above, with epiphallus and ectophallic membrane removed; D, same lateral view; E, endophallus, lateral view; F, epiphallus, dorsal view; G, cercus of *H. oryzivorus*; H, subgenital plate ventral view; I, spermatheca.

A, ancorae; Ac, arch of cingulum; An, anterior process of epiphallus; Ap, apical valves of penis; Apd, apodemes; Bp, basal valves of penis; Cv, valve of cingulum; Ejd, ejaculatory duct; Ejs, ejaculatory sac; Grp, gonopore process; P, posterior process; L, lophus; Rm, ramus of cingulum.

brown, darker at apex (in fresh specimen). Face and mouthpart green-yellowish in ♂ or dark green in ♀.

Vertex and occiput reddish. Brownish patches on the lateral side of pronotum. Abdominal sterna

yellowish brown with an interrupted, dark yellowish, median line. Wings almost hyaline with pale greenish buff or brownish veins. Hind femur buff with reddish tinge. Hind tibia gray, spines with black tips. Tips of cercus black.

Description of female (Fig.1A)

Similar to the male, but larger, differences in fastigium of vertex being three times as border as long. Mesosternal interspace open. ♀ subgenital plate trilobite (Fig. 1H) with very small lateral lobes and small median pointed lobes ovipositor short, robust lower valves with a obtuse, external projection small. Spermatheca (Fig.1I) short, apical diverticulum long, preapical diverticulum elongated somewhat half length of apical diverticulum.

Measurements of different body parts

Table I shows a significant difference in the measurement of macropterous and brachypterous forms. In the male all the body parameters were significantly higher in macropterous form except that the antennal segments were equal in both cases. In the female, there was no marked statistical difference between the macropterous and brachypterous forms and all the parameters were similar except that total body length was recorded as being higher in the macropterous female.

Comparative account

According to Uvarov (1922) and Mason (1973) this species is very closely related to *H. daganensis* and it is very similar in appearance and difficult to differentiate. It has been retained as a species distinct from *H. daganensis* because of the following characters. The body is smaller. The apex of the male cercus is not elongate, and the apex of the subgenital plate is truncate, not emarginated as in *H. daganensis* (though this character is not always constant in *H. daganensis*) the female subgenital plate is of different shape; in *H. oryzivorus* the lateral lobes are very small and rounded; the medium lobe is also small. The phallic complex also gives good character. The valves of the cingulum are elongate and narrow, while in *H. daganensis* they are shorter and thicker. The

epiphallus possesses an extra lobe on the lophi, which face inwards; this is absent in *H. daganensis*. Like *H. daganensis* this species occurred in both macropterous and brachypterous forms. In the specimen studied by Mason (1973) the male were macropterous and the females with only one exception brachypterous. Our study based on the large number of specimens having equal ratio of macropterous and brachypterous confirmed the above findings of Uvarov (1922) and Mason (1973).

Ecological account

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 (Punjab) and its adjoining areas. The young hoppers remain confined to the bunds and mound for about a fortnight where they feed on *Cynodon dactylon* locally called (common lawn grass/ Bahama grass). They then move to paddy fields where begin feeding dynamically on paddy leaves. When the attack is very severe, the leaves may be entirely eaten or reduced to mere midribs or stalks. Generally the lower leaves are attacked first and very often the extent of damage caused is not fully apparent at first sight as the hoppers have the habit of concentrating in the denser parts of the field where they hide themselves in closely set foliage and sideways under the leaves to get out of sight. The whole field may become conspicuously stunted in growth when attack of hoppers is severe during the early stages of the crop.

The later instars of the hoppers, after feeding on the leaves of paddy, begin cutting of the tops, thereby causing the ears to drop to the ground. The young hoppers can be trapped easily in the hundreds during a course of few hours by net sweeping on the bunds, mounds etc. The female grasshopper after drilling a hole lays eggs in masses in deep soil on the bunds of paddy fields from the last week of September to November after which the adults are not seen in field. The nymphs and adults move only short distances; the latter fly only when disturbed. The present study revealed that the grasshoppers are mostly abundant in areas with graminaceous vegetation and light rainfall during the hatching period.

Table I.- Measurements (Mean±SD) of different body parts of *H. oryzivorus* in millimeter.

	Male (n=30)		Female (n=30)	
	Macropterous	Brachypterous	Macropterous	Brachypterous)
Antennal segment	27.53±0.48	27.66±0.37	28.56±0.48	28.0±0.0
Antennal length	10.39±0.76	6.66±0.57	10.84±0.57	10.09±0.8
Length of head	3.52±0.24	2.1±0.11	6.02±0.28	5.18±0.61
Distance between two eyes	1.34±0.22	1.0±0.005	2.48±0.3	1.89±0.28
Length of pronotum	5.33±0.60	3.5±0.60	7.40±0.8	6.84±1.2
Length of tegmina	22.1±5.21	8.83±0.28	25.33±2.94	16.95±4.21
Length of femur	15.73±1.12	14.9±0.40	23.13±1.85	20.7±2.2
Total body length	32.66±4.50	26.7±0.25	48.43±3.59	39.8±4.90

DISCUSSION

Earlier Mason (1973) reported a single male of this species from Amree district Dadu, Sindh and one male from Mekran, Balochistan. Irshad *et al.* (1977), Ahmed (1980) and Yousuf (1996) did not record this species from Pakistan whereas Janjua (1957) reported its occurrence throughout Pakistan but, without mentioning localities.

According to Riffat and Wagan (2008b) collection of such greater number of *H. oryzivorus* in macropterous form would be a warning of a potential future plagues, because the reclamation of the desert in Pakistan is continuously extending the areas favorable for breeding of this species. The present study was also conducted in the arid region where both macropterous and brachypterous forms were present in the breeding place. The reclamation of desert in this region could also make the ecological conditions favorable for breeding and formation of swarms of this species. This fact is already pointed out by Uvarov (1922) and Ghouri and Ahmed (1960) this information led to early prediction for pest managements present study also agrees with it.

In *H. oryzivorus* the apodemes are slightly larger than the basal valves of the penis ancorae of epiphallus is slightly larger and slightly curved at apex and the upper margin of the bridge is almost straight whereas Mason (1973) mentioned that apodemes are slightly shorter than the basal valves of the penis ancorae of epiphallus is shorter and curved and the upper margin of the bridge is curved.

The above differences in male genitalia also appear to be variations within the species. Ingrisich

(1989) has pointed out that the difference in the phallic complex is due to individual variation. Kevan and Lee (1974) have even shown that its form can change in adult grasshopper with age. Small difference in shape, especially when comparing drawing of other authors should not be overestimated Ingrisich (1989). However, there was no significant difference in the phallic complex of macropterous and brachypterous forms except that slight difference occurred in measurement of different body parts.

The information obtained from this study on the ecology of this pest in paddy fields would facilitate us to forecast exact hatching dates, development of hoppers and reproductive activities of adults which would be helpful to plant protection agencies in making decisions to implement control measures at appropriate time in future.

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