

Comparative Studies on the Ovipositional Behaviour of *Hieroglyphus* Species (Hemiacridinae: Acrididae: Orthoptera) from Pakistan

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Abstract.- Observation on sexual reproductive activities of three grasshopper species *Hieroglyphus perpolita*, *Hieroglyphus oryzivorus* and *Hieroglyphus nigrorepletus* were made under laboratory conditions. Oviposition generally occurred during daytime: Females of *H. perpolita*, *H. oryzivorus* and *H. nigrorepletus* dig burrows of 8.4 ± 0.92 cm ($r=0.95$), 7.4 ± 0.95 cm ($r=0.94$) and 5.13 ± 0.71 cm ($r=0.97$), respectively below the sand surface. The duration of pre-oviposition in isolated females was calculated as 8.86 ± 3.0 , 23.46 ± 14.0 and 21.06 ± 8.5 days for *H. perpolita*, *H. oryzivorus* and *H. nigrorepletus*, respectively. Females laid only one egg-pod in each oviposition. The average number of egg-pods laid by each female reared in isolated medium was 2.2 ± 0.7 for *H. perpolita*, 3.26 ± 1.12 *H. oryzivorus* and 3.6 ± 1.40 for *H. nigrorepletus* compared with the females. When housed in crowded condition the females mostly laid significantly less number of egg-pod per female (1.58 ± 0.7 , 1.28 ± 0.50 and 1.46 ± 0.6 *H. perpolita*, *H. oryzivorus* and *H. nigrorepletus*, respectively). In addition to this, the average number of eggs per pod was significantly higher in the *H. oryzivorus* (35.65 ± 14.64) followed by the *H. perpolita* (28.96 ± 10.70). *H. nigrorepletus*, however, deposited significantly lesser number of eggs per pod (23.64 ± 7.7). It was also found that the average number of eggs in respective pods gradually decreased with the increase in oviposition number.

Key words: *Hieroglyphus*, oviposition, Acrididae, Orthoptera.

INTRODUCTION

The species of genus *Hieroglyphus* Krauss are well known in Pakistan and India as serious pests of rice (*Oryza sativa*), sugarcane (*Saccharum officinarum*), wheat (*Triticum aestivum*), maize (*Zea mays*), Sorghum jowar (*Sorghum vulgare*) and minor pest of millets (*Setaria italua*), bajar (*Penniselum typhoideum*) and fodder crops (Roonwal, 1978). The genus *Hieroglyphus* comprises a number of species. Of these three species namely *H. perpolita* (Uvarov), *H. oryzivorus* Carl and *H. nigrorepletus* I. Bolivar are found in Pakistan. The research so far conducted on *Hieroglyphus* species has mainly concentrated on the taxonomic status.

Inadequate descriptions of breeding habits have been given by several workers (Fletcher 1920; Roonwal 1945; 1976a, b, 1978; Chaturvdi, 1946; Srivastava, 1956; Janjua, 1957; Paradhan and Peshwani 1961; Uvarov 1966; Jotwani and Butani 1978; Siddiqui, 1986, 1989).

0030-9923/2007/0005-0321 \$ 8.00/0
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It is a fact that despite numerous studies on many aspects of biology, little is known about the reproductive activity of *Hieroglyphus* species. The present study deals with ovipositional behaviour in detail, which might be helpful in effective control of insect.

MATERIALS AND METHODS

Collection and rearing

Present study covered the period from June 2003 to September 2005. The nymphs of *Hieroglyphus* species were randomly captured from various agricultural fields having rice, wheat, maize, sugarcane, millets, fodder crops, and certain surrounding vegetation. Culture was maintained under laboratory condition on single host plant *Zea mays*.

Experimental method

Present studies were carried out to know

about the comparative behaviour of oviposition in different species of the genus *Hieroglyphus*. For this purpose two ordinary jam jars and cages (length 16½, width 13½ cms) were set at room temperature 28±2°C and 39±2°C with the relative humidity 26%±5% to 61% ±5%. Fifteen pairs of each species were singly reared in glass jars. Similarly, the same number of pairs of each species was housed in crowded condition in three cages. For oviposition, the egg trays filled with moist sand were placed in all the cages and the rearing jars were also filled with moist sand to one-fifth. Insects were frequently observed feeding on *Zea mays*. The host plant cuttings were immersed in water and replaced daily.

All the experimental insects were maintained till their death. Pre-oviposition and oviposition period, longevity of female, egg pods per female and number of eggs per-pod by each female of each species were recorded.

Statistical analysis

Data obtained from experimental groups were subjected to one-way analysis of variance (ANOVA) with repeated measures and significant means were determined using Duncan's New Multiple Range Test (DNMRT). This test was used to compare the means of the various treatments.

RESULTS

The mechanism of oviposition by the females was like that of majority of grasshopper and locusts. It was initiated by digging a burrow of 8.4±0.92 cm ($r=0.95$) by *H. perpolita*, 7.4±0.95cm ($r=0.94$) by *H. oryzivorus* and 5.13±0.71 cm ($r=0.97$) by *H. nigrorepletus*. The depth of burrow was related with the number of eggs in the respective egg-pods.

Reproductive activity was at its maximum from second week of August to September in *H. perpolita*, mid September to November in *H. oryzivorus*, and August to middle of October in *H. nigrorepletus*. The eggs in all the cases were cylindrical and whitish yellow when laid, turning deep brown within half an hour after oviposition. The froth mass was whitish yellow when fresh but gradually turned brownish. The female, however,

under unusual circumstance oviposits even without digging a hole.

The pre-oviposition period of *H. nigrorepletus* was significantly higher comparable with *H. oryzivorus* and *H. perpolita* though *H. perpolita* took significantly less days. The interval between successive pods was significantly higher in *H. oryzivorus* compared with *H. nigrorepletus* and *H. perpolita* (Table I). It was also observed that oviposition generally occurred during the daytime mostly early in the morning.

Present investigation showed that *H. oryzivorus* took on an average 47.26±6.0 minutes for the oviposition, which was significantly higher than in other two species. However, there was no significant difference in the duration for secretion of foamy mass in these species except for the difference of about 1-2 minutes in each species (Table I).

The mean number of egg-pods per female in isolated reared insects was significantly higher viz., 3.6±1.40 for *H. nigrorepletus*, 3.26±1.12 for *H. oryzivorus* and 2.2±0.7 for *H. perpolita* comparable with those housed in crowded condition, which laid significantly lesser number of egg-pods (1.58±0.7, 1.28±0.50 and 1.46±0.6 for *H. perpolita*, *H. oryzivorus* and *H. nigrorepletus*, respectively). It was also observed that females of *H. nigrorepletus* deposited significantly higher number of egg-pods during entire life.

Table II shows no significant difference in the average number of eggs per pod laid by the females reared either in isolated or crowded condition. However, there was significantly higher number of eggs per pod laid by *H. oryzivorus* followed by *H. perpolita* and *H. nigrorepletus*. *H. nigrorepletus* laid significantly lesser number of eggs per pod. During the present study it was also observed that number of eggs remarkably reduced with increase in the frequencies of oviposition. Oviposition and fecundity of *H. perpolita* has been studied for the first time.

The longevity of females was calculated as 21.13±4.62, 38.13±14.77 and 35.93±16.48 days for *H. perpolita*, *H. oryzivorus* and *H. nigrorepletus* respectively. Likewise in the males it was 26.46±12.13, 46.86±21.34 and 40.4±16.10 days, respectively. These findings suggested that there

was significant difference between the survival rate of the females of *H. perpolita* and other two species.

Table I.- Reproductive activities in *Hieroglyphus* species.

| Treatments | <i>H.perpolita</i> | <i>H.oryzivorus</i> | <i>H.nigrorepletus</i> | F _(.0.05) |
|---|-------------------------|-------------------------|-------------------------|-----------------------------|
| Depth of Sand (cm) | 8.4±0.92 ^c | 7.4±0.95 ^b | 5.13±0.71 ^a | (6.97) 13.09 ^{ns} |
| Pre-oviposition Period (days±SD) | 11.06±2.7 ^a | 15.66±3.82 ^b | 16.33±6.97 ^b | (14.35) 25.31 ^{ns} |
| Oviposition period (days±SD) | 8.86±3.0 ^a | 23.46±14.0 ^c | 21.06±8.5 ^b | (17.79) 32.29* |
| Interval between each oviposition (Mins±SD) | 6.83±1.04 ^a | 9.78±3.2 ^c | 7.57±1.51 ^b | (8.06) 14.84 ^{ns} |
| Duration of oviposition (Mins±SD) | 38.8±5.14 ^b | 47.26±6.0 ^c | 31.53±3.62 ^a | (39.19) 68.94* |
| Secretion of foam mass (Mins±SD) | 15.66±4.13 ^c | 14.53±3.39 ^b | 13.0±3.0 ^a | (14.39) 25.31 ^{ns} |

Means in the same column followed by the same letters are not significantly different from one another at 5% level of probability (DNMRT)

*=p< 0.05; ns =not significant p= 0.05

Table II.- The comparison of oviposition and fecundity of females in mass-rearing and isolated rearing.

| Treatments | Mass-reared | | Isolated -reared | |
|------------------------|------------------------|-----------------------------|------------------------|-----------------------------|
| | Pods per female | Eggs per pod | Pods per female | Eggs per pod |
| <i>H.perpolita</i> | 1.58±0.7 ^b | 29.07±6.73 ^b | 2.2±0.70 ^a | 28.96±10.70 ^b |
| <i>H.oryzivorus</i> | 1.28±0.50 ^a | 36.12±13.75 ^c | 3.26±0.96 ^b | 35.65±14.64 ^c |
| <i>H.nigrorepletus</i> | 1.46±0.6 ^a | 24.88±7.33 ^a | 3.6±1.4 ^c | 23.64±7.71 ^a |
| F _(.0.05) | (1.44) 2.62 * | (30.02) 53.23 ^{ns} | (3.0) 6.11 * | (29.11) 51.49 ^{ns} |

Means in the same column followed by the same letters are not significantly different from one another at 5% level of probability (DNMRT)

*=p< 0.05; ns =not significant p= 0.05

DISCUSSION

If females do not have sand for the oviposition they also laid egg on the leaves or bottom. This indicated that actual oviposition was not merely a reflex brought about by some stimulus which acts only when the hole is ready for egg-laying, but by some internal physiological state of readiness for oviposition and if it is reached the female could not delay egg-laying for any considerable length of time or for the availability of particular external condition.

Present observations on the pre-oviposition, restlessness movement of female and finding the suitable place for oviposition by maxillary palpi and antennae were co-related with the findings of Srivastava (1956) and Siddiqui (1986). The depth of egg-pods in the sand was also significantly different in these three species. Present study suggests that this difference may be due to difference in

ovipositor of these species. Present figures confirmed the findings of Siddiqui (1986) that the depth of the burrow was related with the number of eggs laid in the respective egg-pod. Moreover, Janjua (1957) reported that *H. oryzivorus* digs the burrow of 2 to 5 inches in soil but no other details were given regarding the number of egg-pods and eggs.

The duration of the pre-oviposition period in isolated females was calculated from the day of first mating to the collection of first egg-pod. It is interesting to note that among these three species that of pre-oviposition period of *H. perpolita* was comparatively much shorter than that of the other two species. This could be because of shorter mating period in *H. perpolita* whereas it was prolonged and lasted more than two and three days in *H. oryzivorus* and *H. nigrorepletus*, respectively.

It was also observed that oviposition generally occurred during the daytime, mostly early

in the morning with the exception of few cases. The females of *H. nigrorepletus* took, on an average, 31.53 ± 3.62 minutes to deposit the eggs in respective batches. Srivastava (1956) and Roonwal (1976a) recorded it $2\frac{1}{2}$ hours, whereas Siddiqui (1986) observed it for 21-47 minutes. The results of present study agreed with Siddiqui (1986) whose work is based on constant laboratory condition, whereas former authors carried this work in the field. The interval between successive pods was significantly higher in *H. oryzivorus*, which is because of long breaks after prolonged mating.

There is considerable variation in the numbers of egg per pod reported by previous workers in *H. nigrorepletus*. Roonwal reported 20-30 eggs per pod in 1945 and 1976 and 37-82 in 1978. Srivastava (1956) stated that female deposits 40-55, Pradhan and Peswani (1961) reported 23-53, Jotwani and Butani (1978) found 25-50 and Siddiqui (1986) collected 36.60 ± 1.42 eggs per pod. During the present finding we counted 23.64 ± 7.71 eggs per pod, which could be because of energetic feeding of female under control conditions. Moreover, the previous data was mostly associated with the field observations where the female could find different host plants varieties which definitely affected the production of eggs.

The variation in the number of eggs in other species of this genus is not unusual. For example, *H. concolor* Walk. egg-pods contain 62-84 eggs. Katiyar (1960), Gupta and Saxena (1963) collected 123 eggs per pod. In the case of *H. banian* F. Coleman and Kannan (1911) reported 29-49 eggs per pod and the female lays approximately four egg-pods during entire life. Chowdhury and Majid (1954) collected 50-60 eggs. Butani (1961) and Janjua (1957) reported 30-40 eggs per pod. Grist and Lever (1969) gave the number 35 per pod, whereas Gupta and Saxena (1963) observed the number of eggs per pod as 68-90.

The mean number of egg-pods per female was consistently higher in isolated females (Table II). The isolated insects lay more egg-pods in a given time and also lived longer so that the productions of egg-pods were considerably higher.

The comparative fecundity of these three species show that the egg-pod of *H. oryzivorus* contained significantly greater number of eggs

followed by the other two species although the same feeding and housing conditions were provided to all the experimental insects. Present study suggests that prolonged copulation in *H. oryzivorus* might be responsible for this.

Present investigation show that the rate of oviposition was significantly higher in *H. nigrorepletus*. Female oviposited approximately six times during her life, whereas *H. oryzivorus* deposited maximum five egg-pods and the females of *H. perpolita* dropped at least three egg-pods. (Table II).

According to Uvarov (1966) in Acrididae the total number of layings by a female primarily depends on the length of period during which the female continued its reproductive activities, and duration of survival period definitely affect the rate of fecundity in females. The results of present study are close to the above account. However, present study also confirmed the finding of Jotwani and Butani (1978) that *H. nigrorepletus* deposits maximum six egg-pods during its entire life.

During present study it was also noted that fecundity reduced with increased rate of oviposition. The chances of repeated mating were found to decrease. Present study suggests that aging female progressively became less energetic thus leading to reduced production of eggs in a batch.

The period of longevity of insects was calculated from the first day of maturation to death. Present finding suggests that males live longer than females because it is evident from the literature that reproductive activities affect the length of female life (Uvarov, 1966). The study indicates that the female of *H. perpolita* lived shorter than the other two species of this genus. Present study also suggests that the fecundity rate of this species was low and the insect died mostly after laying the last egg-pod. The information on the fertility, fecundity and longevity of female's life will definitely be helpful in estimating the exact outbreak in future.

ACKNOWLEDGMENTS

The authors are grateful to Mr. M. Irshad (NARC) Islamabad for critical review of this manuscript. Our thanks also extend to Prof. Dr. N.T.

Narejo of Department of Freshwater Biology and Fisheries, University of Sindh, Jamshoro for his kind guidance on statistical analysis. This study was financially supported by Pakistan Science Foundation, Islamabad under a research grant (Project No. PSF S-SU/Bio 338).

REFERENCES

- BUTANI, D.K., 1961. Insect pests of maize and their control. *Indian Farm.*, **11**: 7-10.
- CHATURVADI, P.L., 1946. Oviposition in *Hieroglyphus nigrorepletus* Bol. *Indian Ent.*, **7**: 238-239.
- CHOWDHURY, S. AND MAJID, S., 1954. *A handbook of plant protection*, Shilong, pp. 117.
- COLEMAN, L.C. AND KANNAN, K.K., 1911. The rice grasshoppers (*Hieroglyphus banian*) Fabr. *Bull. Dep. Agric. (Ent.)*, **1**: 1-52.
- FLETCHER, T.B., 1920. Annotated list of Indian crop-pests. *Proceeding of third entomological meeting, Pusa*, pp. 33-314.
- GRIST, D.H. AND LEVER, R.J.A.W., 1969. *Pests of rice*. London, pp. 520.
- GUPTA, K.M. AND SAXENA, A.P., 1963. Control of grasshoppers on sugar cane in Uttar Pradesh. *Indian Sug.*, **13**: 509-511.
- JOTWANI M.G. AND BUTANI, D.K., 1978. Crop pests and their control: pearl millet *Pesticides (Bombay)*, **12**: 20-30.
- JUNJUA, N.A., 1957. Insect pests of paddy in Pakistan. *Agric. Pakistan*, **8**: 5-21.
- KATIYAR, K.N., 1960. Ecology of oviposition and the structure of egg-pods and eggs in some Indian Acrididae. *Rec. Indian Mus.*, **55**: 29-68.
- PRADHAN, S. AND PESHWANI, K.M., 1961. Studies on the ecology and control of *Hieroglyphus nigrorepletus* Bolivar. *Indian J. Ent.*, **23**: 79-105.
- ROONWAL, M.L., 1945. Notes on the bionomics of *Hieroglyphus nigrorepletus* Bolivar (Orthoptera: Acrididae) at Banaras, United Province, India. *Ent. Res.*, **36**: 339-341.
- ROONWAL, M.L., 1976a. Ecology and biology of the grasshoppers *Hieroglyphus nigrorepletus* Bolivar (Orthoptera: Acrididae) 1. Eggs pods, diapause, prolonged viability and annual hatching rhythm. *Zool. angew., Berlin*, **63**: 171-185.
- ROONWAL, M.L., 1976b. Ecology and biology of the grasshoppers *Hieroglyphus nigrorepletus* Bolivar (Orthoptera: Acrididae) Distribution, economic importance, life history, color forms and problems of control. *Zool. angew., Berlin*, **63**: 307- 323.
- ROONWAL, L., 1978. The phadka grasshopper and its control. *Indian Farm.*, **27**: 3-6.
- SIDDIQUI, J.I., 1986. Studies on reproduction IV. Oviposition in *Hieroglyphus nigrorepletus* Bolivar (Orthoptera: Acrididae). *Indian J. Ent.*, **48**: 169-182.
- SIDDIQUI, J.I., 1989. Studies on reproduction I. Mating in *Hieroglyphus nigrorepletus* Bolivar (Orthoptera: Acrididae). *Indian J. Ent.* **51**: 125-130.
- SRIVASTAVA, P.D., 1956. Studies on the copulatory and egg-laying habits of *Hieroglyphus nigrorepletus* Bol. (Orthoptera: Acrididae). *Ann. ent. Soc. Am.*, **49**: 167-170.
- UVAROV, B.P., 1966. *Grasshoppers and locust: A hand book of general acridology*. Cambridge University Press, vol. 1, pp. 1-481

(Received 16 August 2006, revised 4 May 2007)