

ON THE BIOLOGY AND THE NYMPHAL TAXONOMY OF *PHLAEOPA INFUMATA* BRUNNER (ACRIDIDAE) UNDER LABORATORY CONDITION

S. K. Mandal, A. K. Hazra and S. K. Tandon

Zoological Survey of India
Calcutta

INTRODUCTION

The biology of different orthopteran pests have been studied in India and abroad by workers like Lefroy (1909); Coleman and Kannan (1911); Roonwal (1945, '46, '47 and '76); Albrecht (1955), Jago (1963); Gupta and Kushwaha (1965, 68) and Parihar (1974).

Kushwaha and Bharadwaj (1977) has recognised *Phlaeopa infumata* as the pest of crops and vegetables. But so far the biology of this grasshopper species has not been attempted. The aim of the present paper is to give in some detail of its biology and to provide the identifying characters of the nymphs for easy recognition in the field and laboratory.

MATERIALS AND METHODS

Gravid females have been collected directly from the fields and kept in wooden cages (25 cm. x 15 cm.), two sides of which are fitted with zinc wire net for ventilation, other two sides with glass and top with sliding glass for smooth operation.

The floor of the wooden cages were provided with some false floor for insertion of glass tubes measuring (8 cm. height and 3 cm. in diameter) containing sterilised moist loamy soil (50% sand and 50% clay) for facilitating deposition of eggs. For observing the development and duration of hoppers, the nymphs were reared in isolated condition in separate cylindrical zinc wire net cages measuring 14 cm. height and 6 cm. in diameter, the top of which are covered with muslin cloth secured by rubber band. The appearance of fresh exuvae confirms the presence of newly moulted nymphs. The rearing cages were placed in B. O. D. incubator under controlled temperature $33^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and 70% to 85% relative humidity. During day time the cages were exposed to sunlight for 5 to 6 hours. Every day in the morning at 10.30 hours fresh *Cyperus rotundus* (grass) was placed in the rearing cages as food.

RESULTS

1) *Deposition of eggs and the formation of egg pods :*

The tip of the abdomen of *Phlaeoba infumata* during oviposition reaches up to the desired depth of 2.4 to 6.0 cm. and then secretes a kind of silvery-white secretion through the tip of the abdomen. After that the eggs, (light yellow in colour) were laid with a foamy substances. The female secretes some extra substances after completion of egg laying then withdraw its abdomen and sealed the hole with a plug made up of a soil and forthy material. The time taken for drilling operation till the abdomen removed ranges from 20 to 45 minutes. This species lays 1 to 3 egg pods in her life time. The interval between the deposition of one egg pod to other was recorded from 3 to 7 days. Each egg-pod contains 8 to 25 eggs. (Table 1).

The freshly laid eggs of *Phlaeoba infumata* is bright yellow in colour but after two hours, it becomes deep brown. It is cylindrical and blunt at both the sides. Each egg measures 5.5 to 5.9 mm. in length and 1.5 to 1.65 mm. in breadth.

2) *Hatching of eggs from the pods.*

From table 2 it is evident that the incubation period of egg of *Phlaeoba infumata* is from 17 to 23 days (Mean 20.26 days). The hatching starts from 20.26 the tip of the egg-pod ; a rupture appears at the upper end of the egg pod and through this orifice the "Vermiform larvae" comes out with head directed upwards. The larvae is enclosed within a thick transparent membrane, a separate "sleeves" for the legs, the distal part of the antennae and the cerci. The cuticle of vermiform larvae is ruptured after reaching the soil surface along the dorsum of the head then thorax and lastly the membrane from the hind legs. This shedding of skin is known as intermediate moult, hatching took place within 12 to 35 minutes or may extend upto 10 hours. The percentage of male and female were 53.62% and 46.38% respectively. it was calculated from 276 examples of laboratory reared specimens hatched from 15 egg pods ;

3) *Developmental stages and their duration :*

The nymphs of *Phlaeoba infumata* were found to pass through 5 moults to become adult male and 6 moults for adult female. It is evident from the table that the duration of the nymphal stages ranges from 32 to 44 days in male and 38 to 45 days in female.

Table 3. Duration of nymphal life (days) of *Phlaeoba infumata*. Isolated hoppers reared for development in the laboratory in B. O. D. incubator at $33 \pm 2^{\circ}\text{C}$ (Number of observations-30)

No. of instars	1	2	3	4	5	6	Mean total days
----------------	---	---	---	---	---	---	-----------------

Male :

Mean (days) 6.5 7.0 7.6 7.0 9.4 — 36.2

Ranges

(days) 5-8 5-8 6-9 7-9 8-12 — 32-44

Female :

Mean (days) 6.0 6.5 7.3 8.4 8.6 10.5 41.5

Ranges

(days) 5-8 5-8 6-9 7-11 7-10 10-14 38-45

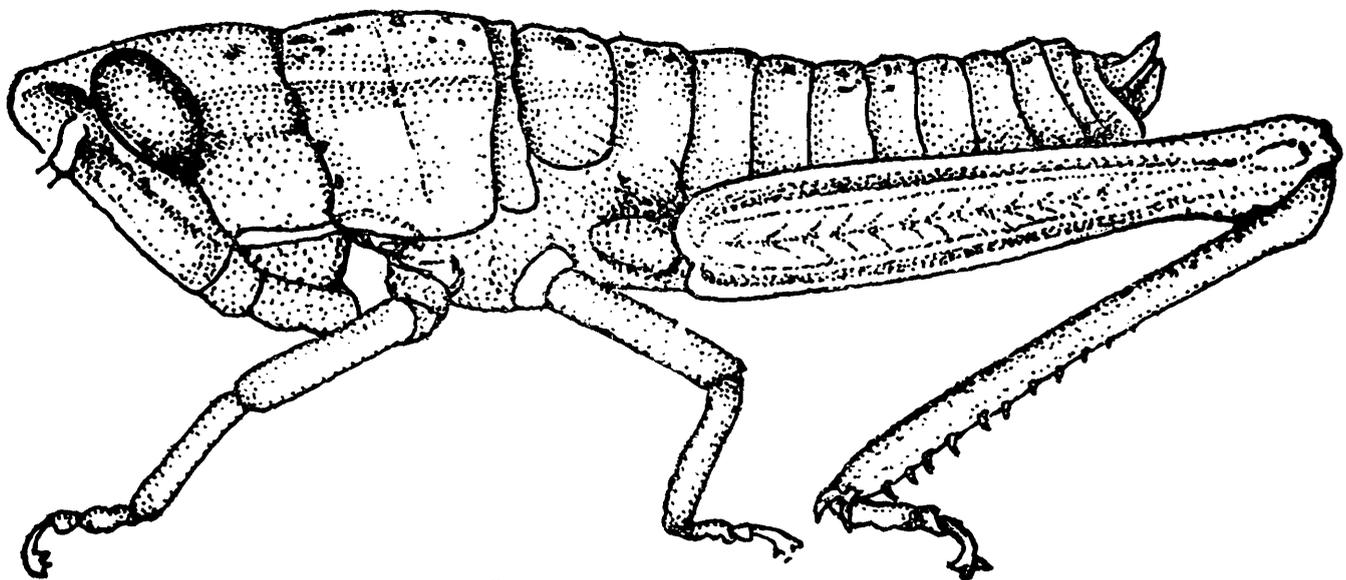
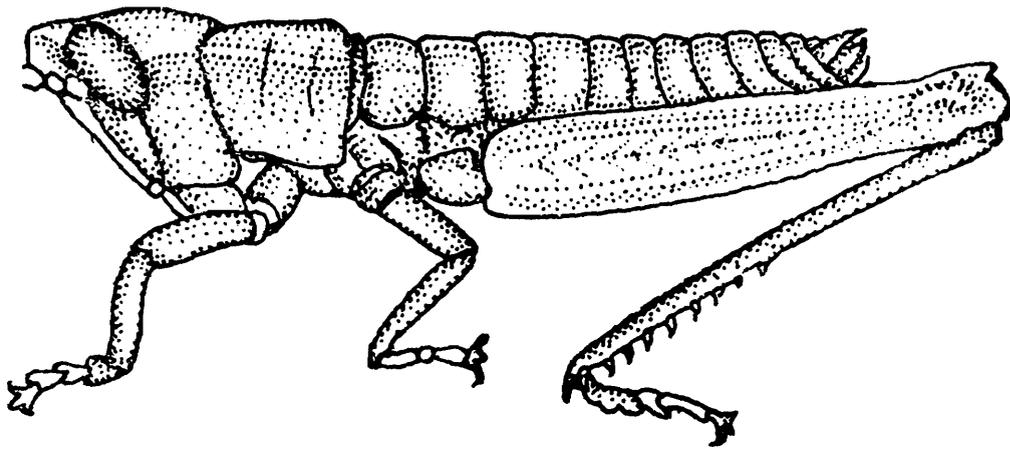


Fig. 1. First instar nymph of *Phlaeoba infumata* (male)

Fig. 2. Second instar nymph of *Phlaeoba infumata* (Female)

4) *Morphology of different instars of Phlaeoba infumata* :*First-instar* (Fig. 1)

Colour : Freshly emerged nymph of first instar was whitish yellow in colour but within 2 hours it changed to light brown colour with deep brown spots. *Head* : Relatively robust in comparison to the posterior part of the body and length measures 1.55 mm. *Antennae* : Ensiform, segments 12 ; comprises of scape, pedicel, and a flagellum of 10 annuli, measures from 2.3 to 2.7 mm. in length (Fig. 2) *Pronotum* : Posterior margin deeply incurved or concave and measures 1.06 mm. in length along the median carina. *Wing pads* Rudiments of hind margin of mesonotum or fore wing pad and metanotum or hind wing pad were directed vertically downward, blunt rounded at apex and without clear indication of trachiation. Fore wing pad measures from 1.8 to 2.0 mm. in length. *Hind femur* : Lower basal lobe longer than upper one and measures from 3.0 to 3.3 mm. in length and 0.7 to 0.8 mm. in breadth. *External genitalia Male* : (Fig. 10) Subgenital plate small deeply emarginate at apex, *Female* : (Fig. 11) : Sternite 8th (Fig. 1) bears a pair of small and truncate valve which later develops into anterior ovipositor valves, sternite 9th of abdomen bears another pair of small, triangular valves, which later develops into posterior ovipositor valves. (Fig. 1)

Second instar (Fig. 2)

Colour : General body colour same as first instar *Head*, : Less robust in comparison to the posterior part of the body and measures from 1.9 to 2.2 mm. in length ; *Antennae* (Fig. 22) : Segments 11 to 12 in number and comprises scape, pedicel, and a flagellum, measures 3.18 (3.10 to 3.2) mm. in length. *Pronotum* : Shape same as in 1st instar, posterior margin slightly incurve or concave and measures from 1.5 to 1.67 mm. in length. *Wing pads* : Presence of steaky pattern of trachiation, hind margin of mesonotum or fore wing pad or metanotum or hind wing pad same as in 1st instar. *Hind femur* : Lower basal lobe slightly longer than upper basal lobe and measures from 4.0 to 4.1 mm. in length. *External genitalia Male* (Fig. 12) : Subgenital plate narrowed with less emarginate at apex, *Female* (Fig. 13) : Anterior ovipositor valves or lower valves clearly developed posterior ovipositor or upper valves slightly angular and elongate in shape, inner margin deeply separated.

Third instar (Figs. 3, 4)

Colour General body colour more or less like second instar except the colour becomes more bright. *Head* : Now proportionate to the abdomen and measures from 2.4 to 2.6 mm. in length. *Antennae* (Figs. 23, 24) : Number of segments 16, occasionally 15 segments at the right side and 16 at left, and measures from 3.4 to 3.6 mm. in length. *Pronotum* : Posterior margin slightly concave or incurved

and measures from 2.0 to 2.2 mm. in length. *Wing pads*: Lower posterior angles of mesonotum or fore wing pad and metanotum or hind wing pad begins to project and more or less triangular in shape. *Male*: Fore wing pad reaches at least one third length along the costal border of hind wing pad. *Female*: Fore wing pad extend at least one fourth of length along the costal margin of hind wing pad. *Hind femur* Upper and lower basal lobe equal and measures from 5.9 to 6.5 mm. in length.

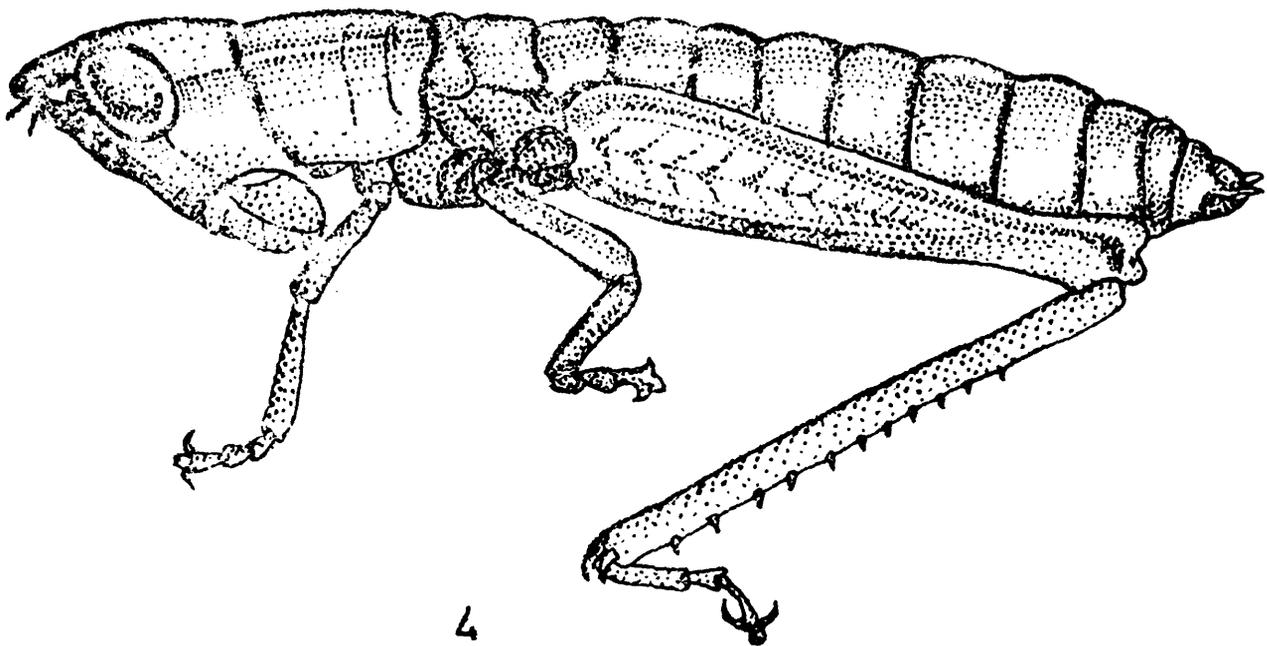
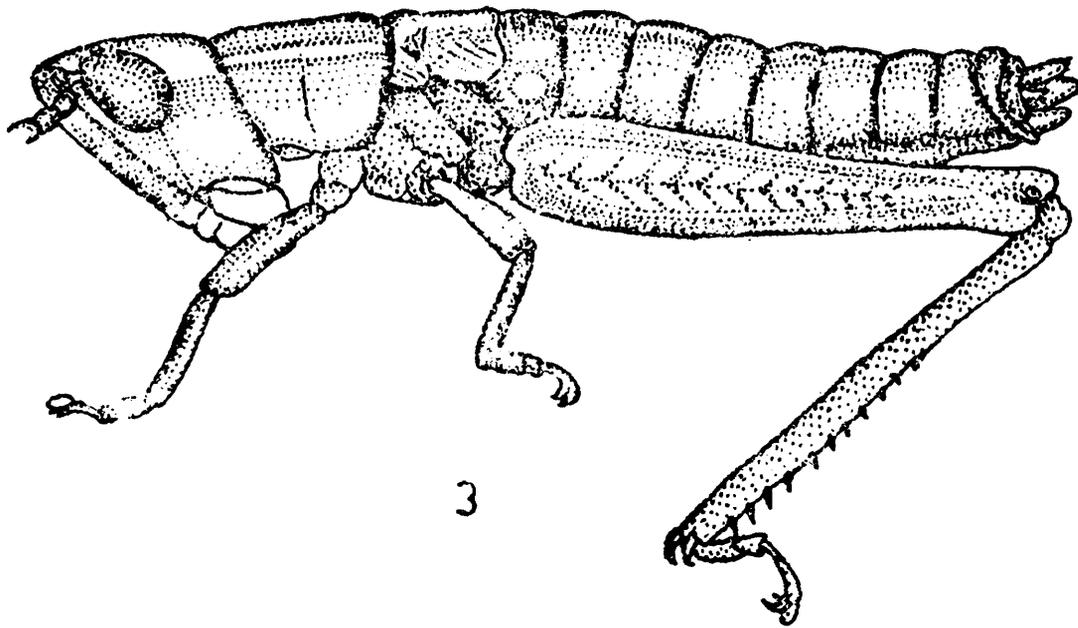


Fig. 3. Third instar nymph of *Phlaeoba infumata* (male)
 Fig. 4. Third instar nymph of *Phlaeoba infumata* (female)

External genitalia : *Male* (Fig. 14) : Apex of subgenital plate out curved and reaches up to the end of paraprocts. *Female* (Fig. 15) : Anterior ovipositor valves reaches at the base of posterior ovipositor valves, posterior ovipositor valves or lower valves reaches upto one third length of the paraprocts, inner margin of posterior ovipositor valves slowly divergent from each other, inner valves also developed in between the posterior ovipositor valves.

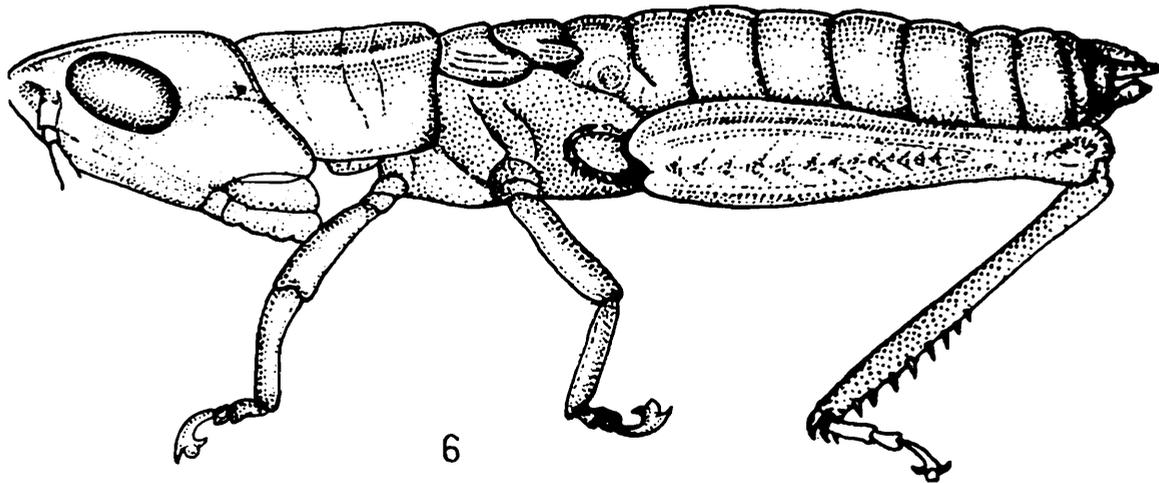
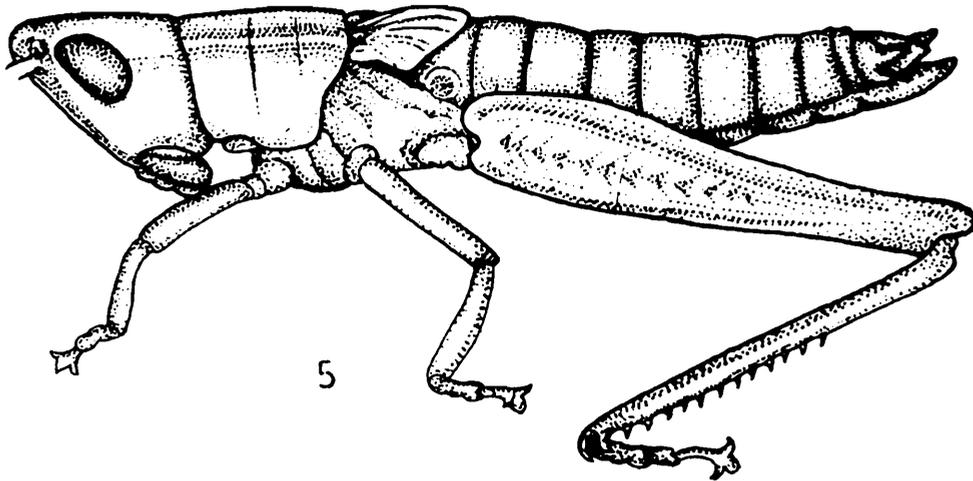


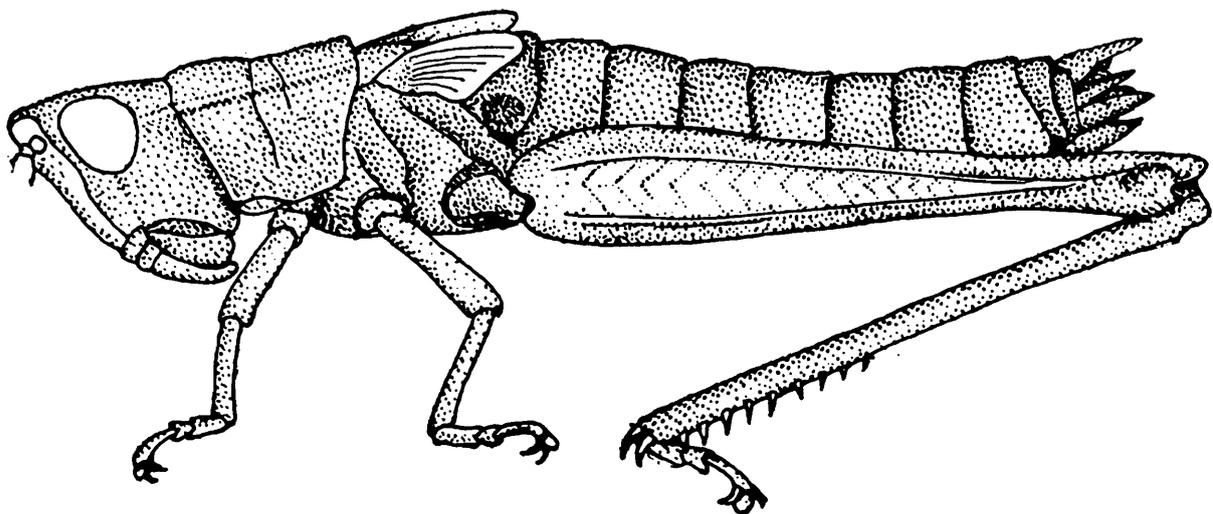
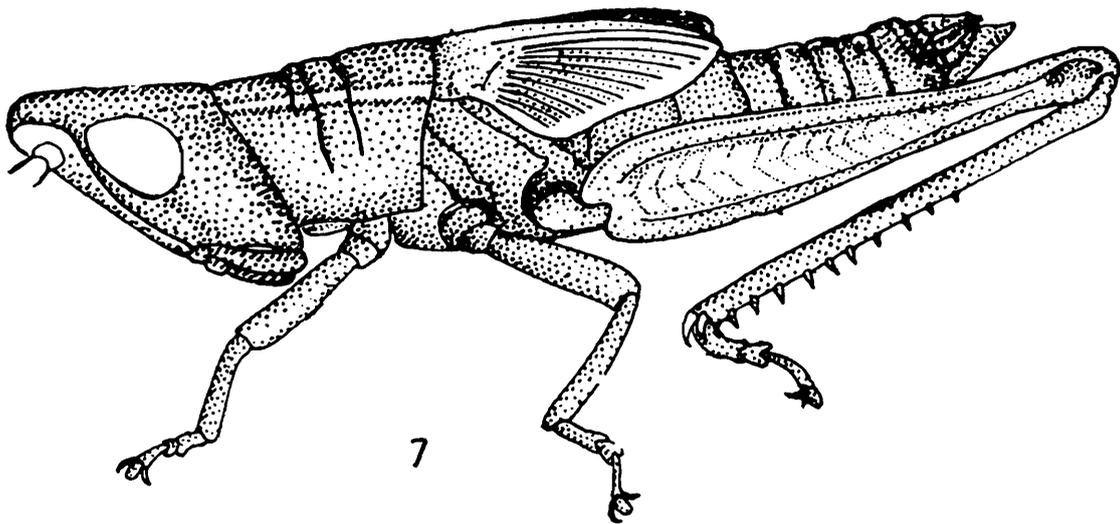
Fig. 5. Fourth instar nymph of *Phalaeoba infumata* (male)

Fig. 6. Fourth instar nymph of *Phalaeoba infumata* (female)

Fourth Instar (Figs. 5,6)

Colour General body colour straw yellow to deep brown, numerous deep brown dots scattered all over the body and legs. *Head* : *Male* Measures from 2.8 to 2.9 mm. in length. *Female* : Measures from 2.8 to 3.0 mm. in length. *Antennae* (Figs. 25, 26) : In both the sexes the number of segments were 18 measures from 4.5 to 4.8 mm. in length. *Pronotum* : Posterior margin of pronotum transverse ; *Male* : Measures from 2.8 to 2.9 mm. in length ; *Female* : Measures 3.8 to 3.0

mm. in length. *Wing pads* : Male : Wing pads reversed in direction, outer surface becomes the inner and develops numerous unbranched veins ; hind wing pad not touching the margin of first abdominal tergite ; *Female* : Lower posterior angle of meso and metanotum formed the definite lobe for future tegmina and wings, trachiation more distinct, fore wing pad backwardly directed about one third of length along the costal margin of hind wing pad. *Hind femur* : Upper basal lobe slightly longer than lower basal lobe. Measures 8.1 to 8.5 mm. in length. *External genitalia-Male* (Fig. 16) : Apex of subgenital plate acutely conical and extends beyond the paraproct. *Female* (Fig. 17) : Anterior ovipositor valves or lower valves crossed the base of the posterior ovipositor valves, inner margin of posterior ovipositor valves not touching along each other, inner valves more prominently developed.



8

Fig. 7. Fifth instar nymph of *Phlaeoba infumata* (male)

Fig. 8. Fifth instar nymph of *Phlaeoba infumata* (female)

Fifth instar (Figs. 7, 8)

Colour : No remarkable changes in colour pattern than the previous instars. *Head* : In both sexes measures from 3.2 to 3.5 mm. in length. *Antennae* (Figs. 27, 28) : Number of segments 20 and measures from 6.0 to 7.2 mm. in length in both the sexes. *Pronotum* Posterior margin of pronotum convex or out curved and measures from 3.4 to 3.9 mm. in length in case of both the sexes. *Wing pads* : *Male* : Wing pads, triangular in shape and pointing upwards, hind wing pad not touching the abdominal tergite 3, *Female* : Wing pads reversed as in the fourth instar of female hopper, hind wing pad extends just above the 1st abdominal tergite. *Hind femur* : Upper basal lobe longer than lower basal lobe and measures from 10.5 to 12 mm. in length. *External genitalia* : *Male* (Fig. 18) : Apex of subgenital plate more acutely conical and extends more beyond the paraproct. *Female* (Fig. 19) : A triangular projection appeared in between the base of anterior ovipositor valves. Anterior ovipositor valves covers more than half of the posterior ovipositor valves. Posterior ovipositor valves extends upto the end of paraproct, inner valves overlaped.

Sixth instar (female) (Fig. 9)

Colour : General body colour of fresh hopper is straw yellow, wing pads light green just after moulting but after half an hour the colour of the wing pads changes to brown. *Head* : Measures from 3.9 to 4.0 mm. in length. *Antennae* (Fig. 29) : Number of segments 20 to 23, measures from 7.3 to 8.0 mm. in length. *Pronotum* : Posterior margin convex and obtusely pointed at the posterior margin and measures from 6.1 to 6.2 mm. in length. *Hind femur* : Upper basal lobe more longer than the lower basal lobe and measures from 13.0 to 14 mm. in length.

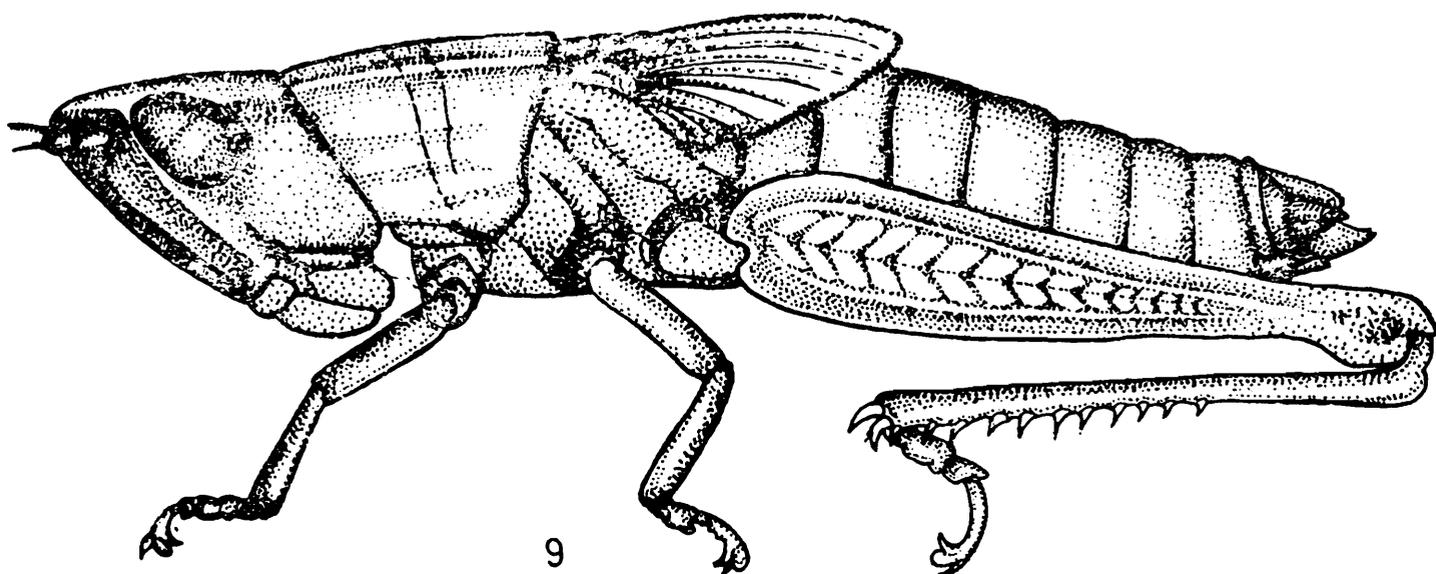


Fig. 9. Sixth instar nymph of *Phaleoba infumata* (female)

Wing pads : Hind wing pads touching the posterior margin to tergite 3. **External genitalia** (Fig. 20) : The triangular projection on eighth sternum more prominent ; anterior ovipositor valves extends three fourth length of posterior ovipositor valves and posterior ovipositor valves extended beyond the paraproct.

5) Key to the identification of different instars of *Phlaeoba infumata*.

1. Anterior ovipositor valves absent on eighth abdominal sternite ; subgenital plate present on ninth abdominal sternite Male (2)
 — Anterior valves of ovipositor and subgenital plate present on eighth abdominal sternite Female (6)
2. Upper and lower basal lobe of hind femur equal or lower basal lobe slightly longer than upper basal lobe ; length of subgenital plate shorter than breadth (3)
 — Upper basal lobe distinctly longer than lower basal lobe ; length of subgenital plate longer or equal (4)
3. Head width 2.4 to 2.5 mm. in length ; subgenital plate covers only base of the paraproct and tip of subgenital plate deeply emarginate... 1st instar ♂
 — Head width 3.0 to 3.1 mm. in length ; subgenital plate covers half of the paraprocts and tip less emarginate... .. 2nd instar ♂
4. Wing pads more or less triangular in shape ; apex of subgenital plate transverse not elevated in the middle and covered three fourth of the paraproct 3rd instar ♂
 — Wing pads clearly triangular in shape, apex of subgenital plate acutely conical, elongated, elevated in the middle, and extends beyond the paraproct (5)
5. Posterior margin of pronotum transverse hind wing pad reaches just above the hind margin of first tergite ; 4th instar ♂
 — Posterior margin of pronotum outcurved hind wing pad reaches before the posterior margin of 3rd tergite ; 5th instar ♂
6. Wing rudimentary, downwardly directed and blunt ; posterior margin of subgenital plate incurved (7)
 — Wing rudimentary obliquely backwardly directed and less blunt, posterior margin of subgenital plate transverse (8)
7. Antennae 10 segmented ; anterior ovipositor valves not clearly developed ;
 1st instar ♀
 — Antennae more than 12 segment anterior ovipositor valves more clearly

- developed ; posterior valve elongated 2nd instar ♀
8. Antennae 16 segmented ; anterior ovipositor valve touching the ninth sternum groove and apex more or less attenuated but not sclerotised ; posterior valves cover half of the paraproct 3rd instar ♀
 — Antennae more than 16 segments ; anterior ovipositor valves extended beyond the base of the posterior valves, apex more attenuated and sclerotised ; posterior valves cover more than half of the paraprocts ... (9)
9. Posterior margin of subgenital plate not indented ; inner line of posterior valves not touching along each other posteriorly 4th instar ♀

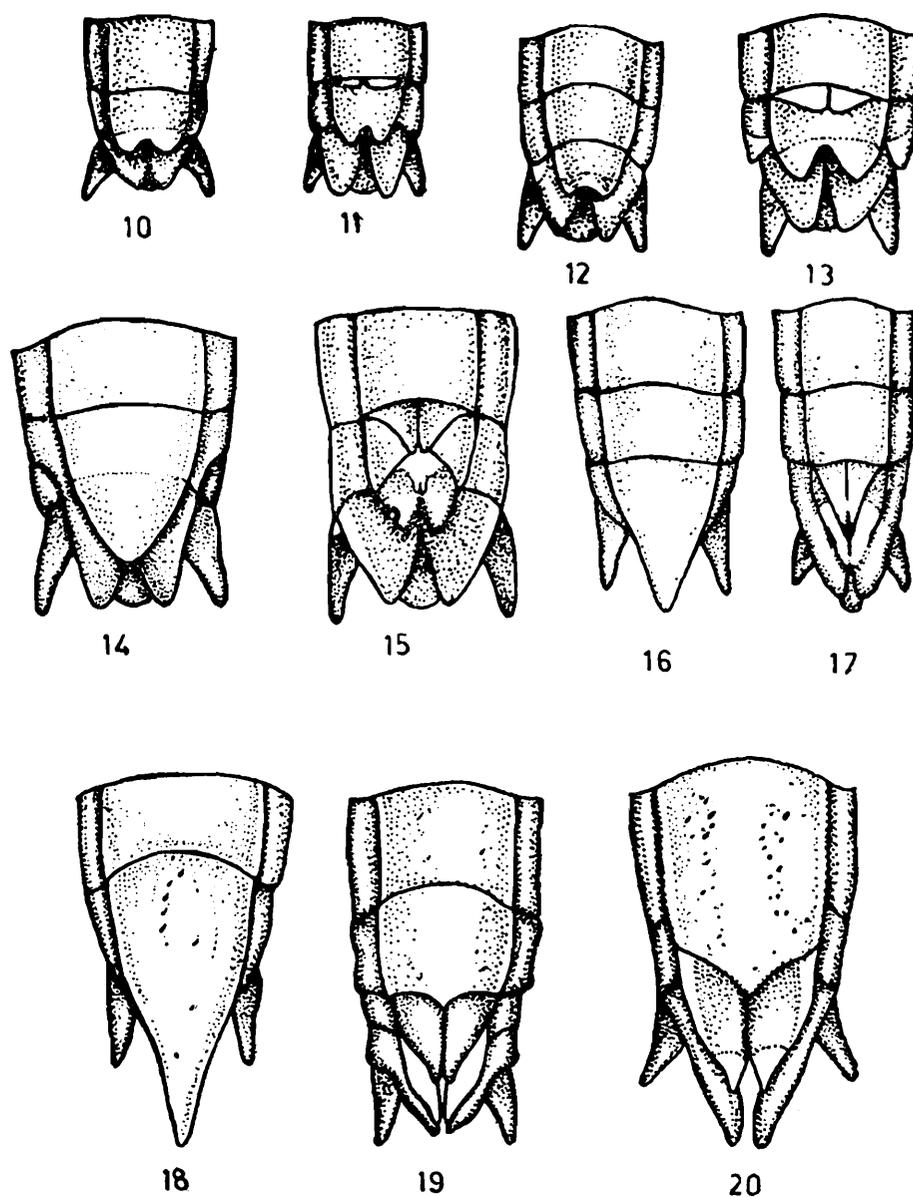
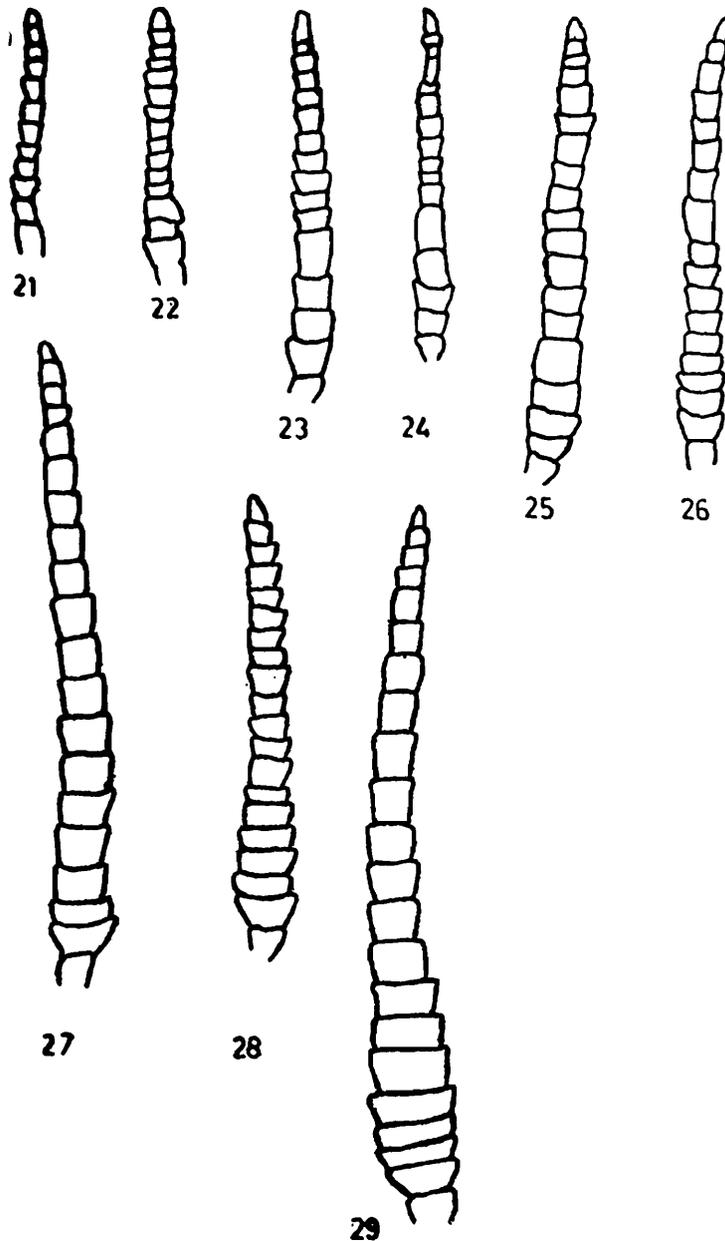


Fig. 10.-20. Genitalia of different instars of *Phaleoba infumata* figs. 10-11, first instar male and female ; figs. 12-13, second instar male and female ; figs. 14-15, third instar male and female ; figs. 16-17, fourth instar male and female ; figs. 18-19, fifth instar male and female ; fig. 20, sixth instar female.

— posterior margin of subgenital plate indented ; inner line of posterior valves touching along their posterior inner margin ... (10)

10. Antennae 19-20 segmented, tip of the anterior valves covered half of the posterior ovipositor valves, posterior valves extend up to the end of paraproct ... 5th instar ♀

— Antennae 21-22 segmented, tip of the anterior valves extend three-fourth of the posterior valves, both anterior and posterior valves cover the paraproct, ... 6th instar ♀



Figs. 21.-29. Antennae of different instars of *Phlaeoba infumata* figs. 21, first instar male ; fig. 22, second instar female ; figs. 25-26, third instar male and female ; figs. 27-28, fourth instar male and female ; figs. 29-30, fifth instar male and female ; Figs. 31, sixth instar female.

6. Adult Biology

Adult: Fledging or fresh adult of *Phlaeoba infumata* is straw or yellow in colour, very less active and do not take any food for 5 hours. It acquires the colour pattern of adult species nearly after 7 to 8 hours.

Copulation: The male of this species generally took 5 to 10 days for first copulation and the female took about 6 to 9 days. The mating lasts for about 20 to 50 minutes extending up to 3 hours in some cases. The number of copulation of a pair was observed 3 to 6 times.

Interval between pairing and oviposition

In female time from pairing to oviposition was from 8 to 15 days.

Longevity of adult

The average longevity of an adult male is from 19 to 32 days and an adult female 24 to 38 days.

DISCUSSION

So far no detail account on the life history and the nymphal taxonomy of *Phlaeoba infumata* have been recorded.

The period of incubation of eggs varies in different species, as Descamps (1965) recorded about 22-24 days in *Gastrimargus africanus* at variable temperature, whereas Parihar (1974) recorded the incubation period in case of *poekilocerus pictus* was 45-49 days at variable temperature. In the present study the time taken for incubation was 17-23 days at 33°C.

The duration of hopper stages in the present study was 36.2 days and 41.5 days respectively in male and female at 33°C. Khan and Aziz (1974) recorded in *Oedaleus abruptus* 53.5 days in case of male and 71 days in case of female at 30°C constant temperature, while in case of *Spathosternum pr. prasiniferum* Iq'bal and Aziz (1974) found that the duration of hopper stages were 37.58 days 44.25 days respectively for male and female.

It can be concluded from the present observation that throughout its development *Phlaeoba infumata* prefers a constant temperature of 33°C and single type of food plant under laboratory conditions. External genitalia starts to develop from 1st instar in both male and female. The duration of nymphal life was maximum for 6th instar female which lasts for about 10.5 days (Table 3). Moreover, the different instars of the species can easily be identified with the help of the given key.

ACKNOWLEDGEMENTS

We offer our grateful thanks to Prof. M. S. Jairajpuri, Director, Zoological Survey of India for providing laboratory facilities. Thanks are also due to Dr. S. K. Bhattacharya, Scientist 'SF' of the same organisation for helpful suggestions.

SUMMARY

The present paper deals with the biology and the taxonomy of nymphs of *Phlaeoba infumata*—a minor grasshopper pest of crops and vegetables of West Bengal. A detail study on all the instars have been made. The identifying characters and figures of the nymphs for easy recognition in the field have been provided. This species throughout its development period prefers a constant temperature of 33°C—2°C and single type of food plant under laboratory conditions.

REFERENCES

- Coleman, L. C. and Kannan, K. K. 1911. The rice grasshopper (*Hieroglyphus banian* Fabr.) *Bull. Dep. Agric. Mysore* (Ent.), no. 1 : 1-52.
- Descamps, M. 1961. Le cycle biologique de *Gastrimargus nigericus* Uvarov. (Orth. Acrididae) dans la vallee du Bani (Mali). *Rev. Pat. veget., Ent. Agric. France*, XL, no. 3 : 187-199.
- Gupta, H. C. and Kushwaha, K. S. 1968. Biology and external morphology of the grasshopper, *Oxya ebneri* Willemse (Acrididae : Orthoptera) *Res. Sind. Univ. Udaipur* 6 : 71-116.
- Iqbal, M. and Aziz, S. A. 1974. Life history of *Spathosternum prasiniferum* Walker (Orth. Acridoidea.) *Ind. J. zool.*, 2 (1) : 37-43.
- Khan, H. R. and Aziz, S. A. 1974. Influence of different levels of temperature and moisture on the development and hatching of eggs of *Oedaleus abruptus* Thunb. (Orth. : Acrididae) under controlled ecological conditions. *Indian J. Ent.* 36 : 142-144.
- Kushwaha, K. S. and Bhardwaj, S. C. 1977. Forage and pasture Insect pests of Rajasthan. *Indian Council of Agricultural Research, New Delhi*. PP. 1-186.
- Lefroy, H. M. 1909. *Indian Insect Life*, Vol. 1., Calcutta.
- Parihar, D. R. 1974. Some observations on the Life history of a grasshopper, *Poecilocerus pictus* (Acridoidea : Pyrgomorphidae) at Jodhpur, Rajasthan, India. *J. zool. Soc. India.*, 26 (1 & 2) : 99-129.

- Roonwal, M. L. 1945. Notes on the bionomics of *Hieroglyphus nigrorepletus* Bolivar (Orthoptera : Acrididae) at Benaras. United Provinces, India. *Bull. ent. Res.*, London, **36** (3) : 339-341.
- Roonwal, M. L. 1946. Studies in intraspecific variation. 11 New rules governing the correlation between normal and extra-moulting and directional reversal of elytron-Wing complex in the Desert Locust and other Acrididae (Orthoptera). *Indian J. Ent.*, New Delhi ; **7** (1-2) : 375-384.
- Roonwal, M. L. 1976. Ecology and biology of the Grasshopper, *Hieroglyphus nigrorepletus* Bolivar (Acrididae). *Z. Angew. zool.*, Berlin, **63** : 307-332.