MORPHOLOGY OF IMMATURES OF *APHODIUS (NEOCALAPHODIUS) MOESTUS* (FABRICIUS, 1801) (COLEOPTERA: SCARABAEIDAE: APHODINAE)

Suvarna S. Khadakkar*, Ashish D. Tiple and Arun M. Khurad***

* Centre for Sericulture and Biological Pest Management Research (CSBR), Amba Vihar, North Ambazari Road, Nagpur, – 440 022, INDIA. E-mail: suvarnask17@gmail.com
** Department of Zoology, Vidhyabharti College, Seloo, Wardha 442 104, INDIA.

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ABSTRACT: Immatures of *Aphodius (Neocalaphodius) moestus* (Fabricius, 1801) were studied and compared with *A arenarius, A. nanus, A. hyxos* and *A. granaries*. The IIIrd Instar larva of *A. moestus* differs in presence of prominent slit on the ventral anal lobe, 1st antennal segment 2 times the length of 2nd antennal segment, presence of 36 to 41 setae on raster and mandible with 1st tooth blunt compared to *A. arenarius, A. nanus, A. hyxos* and *A. granaries*. Eggs are laid freely in dung. As the larval development gets completed, pupation occurs inside the pupal chamber. Pupal chamber is irregularly oblong with pupa on one side of the chamber. Pupa of male differs from that of female in presence of gonopore. The ratio of adult emergence during March and April 2017 was 2f#:1m#.

KEY WORDS: Coprophagous, beetles, white grubs, Maharashtra

Aphodius (Neocalaphodius) moestus (Fabricius, 1801) is widely distributed in Afrotropical, Madagascan, Palaearctic, and Oriental region (Schoolmeesters, 2017).

Immature stages of dung beetle have been studied in temperate countries. But the studies from Asiatic region, Indian subcontinent are restricted to few species only. Adults of dung beetle are always in focus in taxonomy studies. However, immatures can play major role in taxonomy and identification of species. Literature survey lack any description on immature stages of genus *Aphodius* from Indian subcontinent. The endocoprid beetle *Aphodius moestus* is very common in central India but little is known about the immature stages of this species. Description of the immature stages of *Aphodius moestus* is unavailable. This study has been started with a view to study the immature stages of this species. However, *Aphodius hyxos* (Verdu et al., 1997), *Aphodius (Plagiogonus) nanus*, *Aphodius (Plagiogonus) arenarius* (Verdu & Galante, 2000) are some of the Aphodiines whose immatures were documented by earlier authors which were found to be morphologically related.

MATERIAL AND METHODS

Study site. The study was done during March and April months of 2017 in Zilpi village of Wardha district of Maharashtra (India). Zilpi is situated at 21.0658° N, 78.8666° E and approximately 312 m above sea level. The study area is a typical village with ample cattle sheds. Usually, the villagers collect and deposit the cattle dung on pile near the cattle shed.

Sampling. Immatures of *Aphodius moestus* were collected from this area and reared in laboratory till adult to confirm the species identity. Beetles and larvae were removed from dung with blunt forceps.

Rearing. 10 pairs of male and female adults were reared in plastic tumbler covered with gauze. Tumblers were filled with bottom layer of moist sand, mid layer of soil, and upper layer of excrement from which the adults and larvae were collected. Eggs were singly laid on upper portion of excrement in 48 - 72 hours of release of adults.

Morphological characterization. For morphological characterization, 5 third instar larvae collected from field were washed with lukewarm water and studied under microscope using keys by Ritcher (1967). Methodology of Verdu et al. (1997) and Frolov (2009) is followed. Pupae with gonopore were marked as males and kept separately from females till emergence. All the morphological characters were compared with the available literature on *A. arenarius, A. nanus, A. hyxos* and *A. granaries.* The examined material is deposited in the Entomology section of Centre for Sericulture and Biological Pest Management Research (CSBR), Nagpur University for future reference.

RESULTS AND DISCUSSION

Genus *Aphodius* belong to endocoprid beetle fauna. *Aphodius (Neocalaphodius) moestus* (Fabricius, 1801) is found to be commonly distributed in study area. Adults feed on the liquid portion of the dung while the larvae feed on coarse dung. During collection not a single larva was found in the liquid portion of the dung pad. Larvae and pupae were observed in somewhat drier portion of dung pad (Figs. A-C). Adults make tunnels inside the semi liquid as well as drier portion of dung pads. The dung pads are found to be shared by *Onthophagus* species, larvae of diptera, mites along with other parasitic worms. Female lay eggs singly in the drier portion of the dung pad. Egg stage is followed by three larval instars and a pupa. The period from egg to adult stage require 40 – 55 days in *Aphodius fossor* (Owen et al., 2006). Under laboratory conditions *A. moestus* completed the life cycle in 40-45 days. Third instar larva constructs a pupation chamber around itself and pupates inside. The pupation chamber is made up of dung excrement, oblong in shape. Pupa resides on one end of the pupation chamber. Pupa of male differs from that of female in presence of gonopore on the last abdominal segment. The ratio of adult emergence during March and April was 2f#:1m#.

Egg: Creamish white in appearance, oblong in shape. 1.39±0.03 mm in length and 0.79± 0.03 mm in width (Fig. D). Eggs are laid singly on the drier portion of excrement.

Larva: Description of Third instar larva of *Aphodius (Neocalaphodius) moestus* (Fabricius, 1801). Body C shaped. Transparent at the abdomen and whitish at thorax. Head, clypeus light brown. Mandibles dark brown to black. Antennal segments with brownish patches. Length 6.83±0.04 mm and 2.57±0.02 mm in width (abdomen) (Fig. E).

Head. Head capsule is 1.64±0.04 mm in width. Light brown. 1 Anterior Frontal Angle Setae (AA) on each frontal angle; 1 External Frontal Setae (EFS); 1 very minute Anterior Frontal Setae (AFS); 1 Internal Posterior Frontal Setae (IPFS); 2-3 Dorso Epicranial Setae (DES). Epicranial suture present surpassing the frontal suture (Figs. G-H).

Antenna. 4 segmented, 1st antennal segment twice the length of second and curved in the middle. 4th antennal segment very short (Fig. K).

Mandibles. Triangular, dark brown with black edges. Left and right mandibles are asymmetrical in structure. Left mandible with 3 teeth. 2nd tooth clefted. Third

tooth separated from 1st and 2nd by a groove curved at sides and straight in middle. Right mandible with 1st and 2nd teeth fused. 3rd tooth separated from 1st and 2nd by a semicircular groove (Figs. I-J).

Abdomen. Arched with median, tranverse row of setae per abdominal segment. The setae are short at the middle of abdomen and elongated towards the head and last abdominal segments. Ventral anal lobe bears a prominent slit. Raster with one patch of 36-41(39) setae. External angles of superior anal lobe are slightly extended to ventral anal lobe (Figs. M, O, P).

Legs. 4 segmented. 4th segment bears claws and spines (Figs. F, L).

Pupa. Exarate. Glabrous. Length of pupa is 2.32± 0.02 mm and is 1.14± 0.04 mm wide. Off white in appearance. Pupal support projections absent. Male pupa has a cylindrical projection 'gonopore' on the last ventral sternite (Figs. R-U).

Third instar larva of *A. moestus* was compared with the available literature on *A. nanus, A. arenarius, A. hyxos* and *A. granaries* (Verdu & Galante, 2000; Verdu et al., 1997).

Key to *Aphodius moestus* based on description of third larval instar

1. Ventral anal lobe without slit.....2
-. Ventral anal lobe with slit.....3
2. 1st antennal segment 2.2 times the length of 2nd .....*A. nanus*
3. Ventral anal lobe with a prominent slit in middle; 1st antennal segment 2 times the length of 2nd ; raster with 36-41 setae.....*A. moestus*
-. Ventral anal lobe with a shallow slit; 1st antennal segment 1.7 times the length of 2nd ; raster with 29 - 37 setae.....*A. arenarius*

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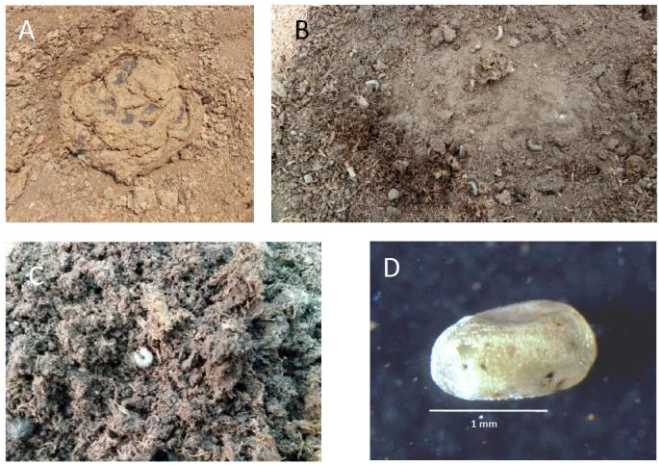
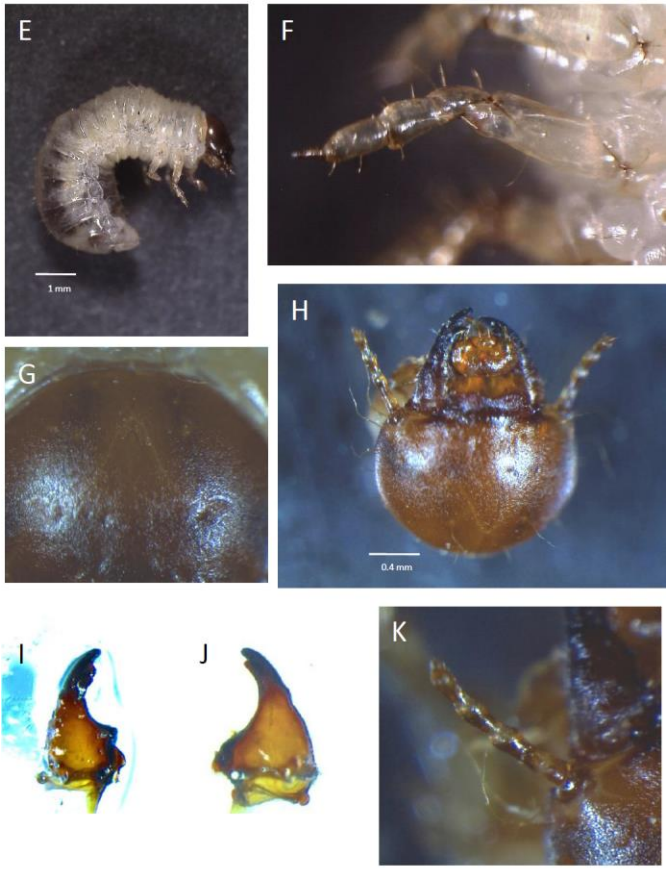
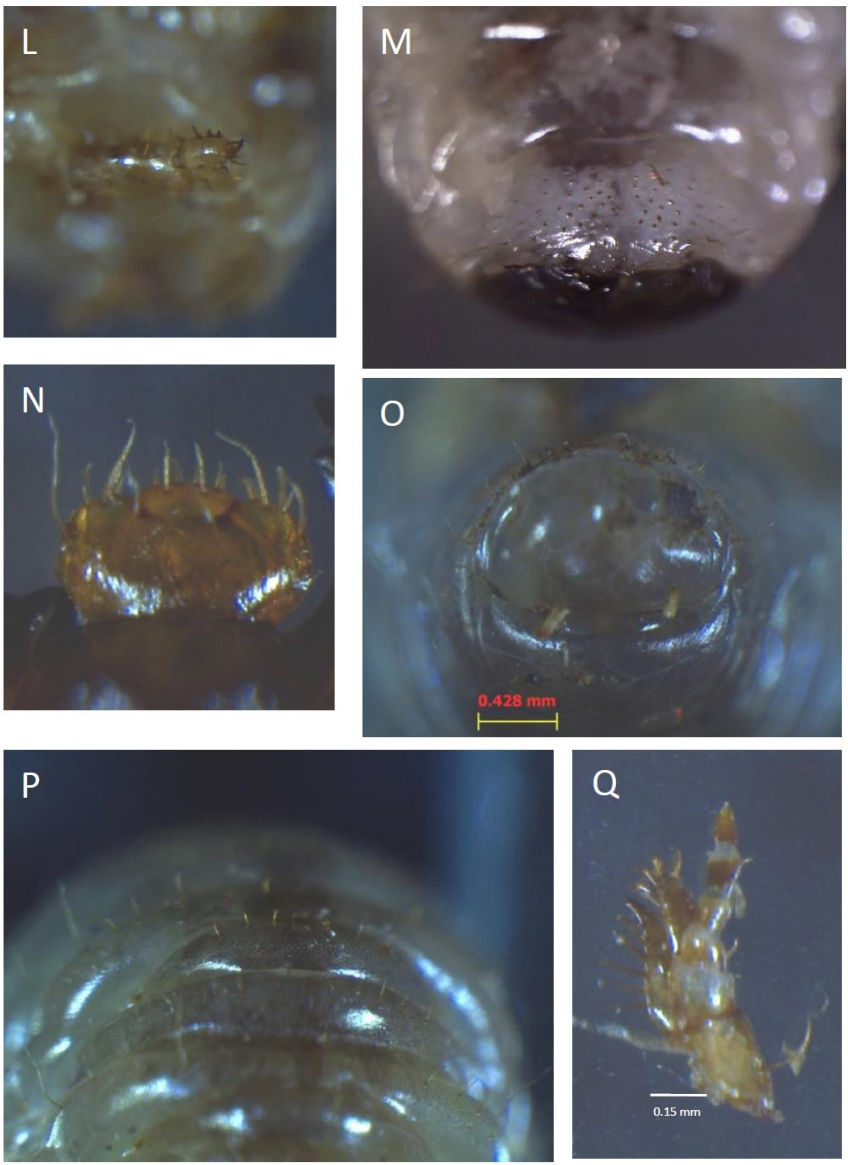


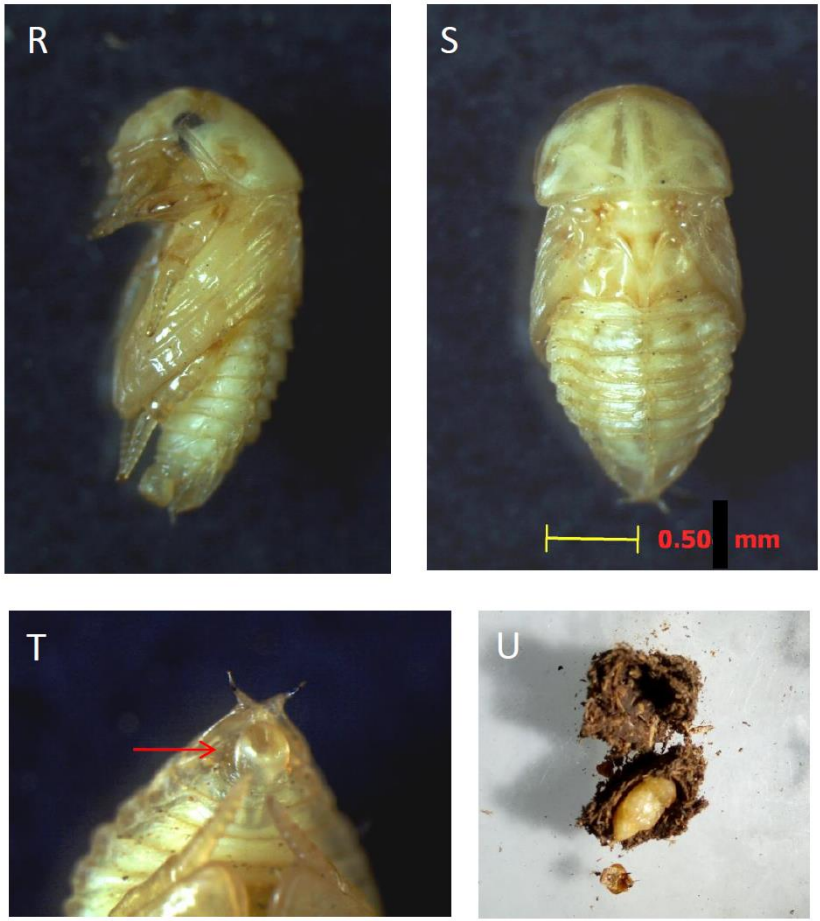
Figures A-C. Habitat of *Aphodius moestus,* D. Egg.



Figures E-K. Larvae of *Aphodius moestus*. E. Habitus, F. Foreleg, G. Clypeus (Frontal suture), H. Head, I. Left mandible, J. Right mandible, K. Antenna.



Figures L-Q. Larvae of *Aphodius moestus*. L. Claw of leg, M. Raster, N. Epipharynx, O. Caudal view of last abdominal segment, P. Abdominal segments, Q. Maxilla.



Figures R-U. Pupa of *Aphodius moestus*. R. Lateral view, S. Dorsal view, T. Ventral view showing gonopore, U. Pupal chamber.