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Short Communication

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Description of life stages of dung beetle *Scaptodera rhadamistus* (Fabricius, 1775) (Coleoptera: Scarabaeidae: Scarabaeinae) with notes on nesting and biology

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Abstract: Immature stages of *Scaptodera rhadamistus* (Fabricius) are described for the first time along with notes on nidification and biology. The larvae differ from other Scarabaeinae species in the structure of raster on tenth sternum with two irregular bunches of serrations ventrally one on either half. Pupae with pronotum transverse having rounded margins resemble adults, and consist of four lateral, single caudal and single pteronotal support projection. Adult males and females differ in coloration, structure of pronotum, presence of spine like process on mesosternum and, in the structure of male and female genitalia.

Keywords: Description, immatures, nesting, scarab beetle, *Scaptodera rhadamistus.*

Beetles belonging to family Scarabaeidae are commonly called as 'Scarabs' and their larvae are known as white grubs. Arrow (1931) provided detailed account of Indian Scarabaeidae. The monotypic *Scaptodera rhadamistus* (Fabricius, 1775), was previously cited as *Liatongus* (*Paraliatongus*) Reitter under tribe Oniticellini of subfamily Scarabaeinae (Hanski & Cambefort 1991; Philips 2016). Larvae of different stages and adults forage by clearing excrement (Arrow 1931). Adult males of *S. rhadamistus* are attractive owing to the coloration and structure of pronotum.

Much of the literature available relating to scarab beetles are on adult taxonomy. Information regarding their immature forms and nest-building behaviour is deficient (Ritcher 1966; Veeresh 1980; Sreedevi & Tyagi 2014). Studies on natural history of dung beetles of the subfamily Scarabaeinae lack the information on *S. rhadamistus* (Halffter & Matthews 1966). The objective of this study is to present an account of larval morphology and nest-building behavior of *S. rhadamistus*, a commonly found scarab in central Indian region, based on a study conducted in and around Nagpur-Wardha forest areas.

Species diagnosis: In life, adults are yellowish-orange with metallic green colored patches present on dorsal and lateral regions, elongate, oval; 13–15 mm in length and 6–8 mm in width. Males have a prominent pronotum with elevated margins forming deep cavity at

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middle, anteriorly forming a short process that reflexes backwards distinguishing this species from other species of the same genus. Males and females differ in size and structure of pronotum, and in structure of spine-like process on mesosternum. Females are smaller, with simple pronotum.

The species is native to Oriental region (India, Laos, Sri Lanka, and Thailand) (Schoolmeesters 2017). In India, the species occurs in the states of Gujarat, Madhya Pradesh, Maharashtra and Tamil Nadu (Chandra & Ahirwar 2005; Chandra et al. 2011; Mittal & Jain 2015).

Materials and Methods

Adults and brood balls of *S. rhadamistus* from open grazing fields of Kavdas Village and nearby areas of Wardha District, Maharashtra were collected. This region lies on the periphery of Bor Wildlife Sanctuary. Field-collected brood balls were maintained in the laboratory at temperature and relative humidity of 27^0C ± 2^0C and 65–75 %, respectively (Hayes 1929). Morphology was described from five specimens, each of III Instar larvae, pupae, and adult males and females. Larvae were kept in boiling water for about three minutes, followed by cooling, and preservation in 70% alcohol or glycerol to prevent shrinking (Ritcher 1966). Leica S8APO stereoscopic microscope was used to study the morphological characters, for photography, and for morphometry. Terminology of Edmonds & Haffler (1978) was followed. Adult specimens were washed in soap water to clear dirt, rinsed in clear water, air-dried to remove the moisture, oven-dried for about two hours, labeled, and studied. Arrow (1931) was followed for morphological characterization.

Male genitalia were dissected out from the adults under stereoscopic microscope. Individual male genitalia was further boiled in 10% KOH solution, washed in water, treated with glacial acetic acid for two to three minutes, and rinsed in distilled water. The dissected genitalia were stored in 1ml eppendorf filled with glycerol for future reference.

Results

Brood Balls

A pair of adults construct nest in cow dung pats with an average diameter of 25–30 cm, and 5-10 cm thick. Each nest contains 3–7 brood balls per brood chamber with an average size of 4.7±1.41 cm and usually guarded by females. Each brood ball has a diameter of 18.9±0.74 mm (*n* = 20, range 18– 20 mm) (Images 1 & 2).

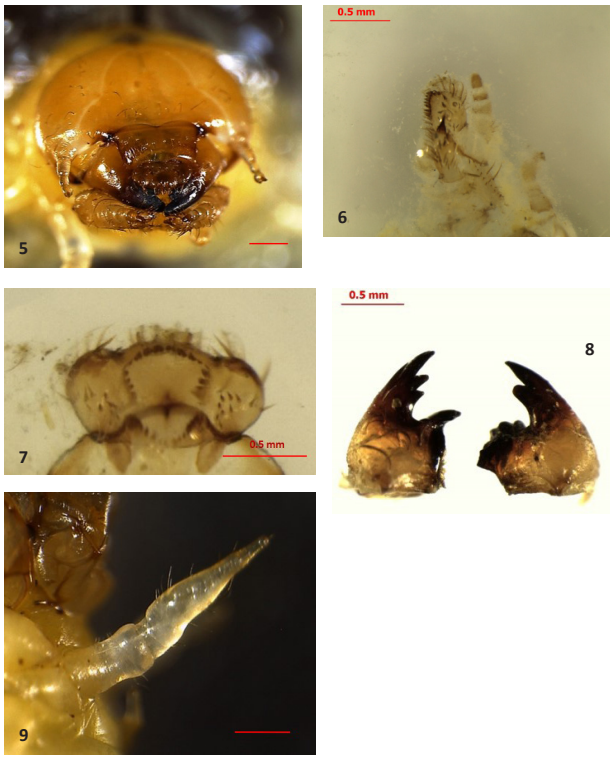
A. Eggs: Lemon yellow when freshly laid, oblong, average length 4.5 ± 0.1 mm (*n* = 10, range 4.4 to 4.6 mm); average maximum width in the middle 2.3 ± 0.11 mm (*n* = 10, range 2.3–2.5 mm); one egg is laid per brood ball, the egg is held vertically and attached to the substratum at the basal end with apical end bearing a small hump (Image 3).

B. Larva (III Instar): Larvae translucent in appearance; body covered with very fine setae; humped in the middle giving a 'V' shaped appearance to the body; average length 19 ± 0.20 mm (*n* = 5, range 18.8–19.3 mm), average width at abdominal hump 7 ± 0.15 mm (*n* = 5, range 6.8– 7.2 mm) (Image 4). Clypeus wider than long, rectangular, lateral margins straight, posterior margin bilobed; irregular row of seven to nine setae in middle; cranium surface smooth; frons with one seta each at anterior angle to the dorsal surface of head, three to four anterior frontal setae on each side, posterior frontal setae absent; remaining cranial surface with two para-ocellar setae, and with a row of eight dorso-epicranial setae (Image 5); antennae four segmented each; labrum symmetrical, trilobed, broadly oval; maxillary stridulatory area with a row of 8–10 teeth; epipharynx chaetoparie each with 9–11 setae (Image 7); mandibles stout, with single median seta, incisor lobes with three teeth on left mandible and two on right mandible (Image 8). Three pairs of thoracic legs, each two segmented, with 10–12 fine setae, claws absent (Image 9). Raster on 10^{th} sternum with two irregular bunches of serrations ventrally one on either half distinct.

C. Pupa: Pupa exarate; pronotum transverse with rounded margins resembling adults; four thumb like tergal support projections, one per segment present laterally on abdominal segments three to six (Image 10). Pronotal support projection absent. One pteronotal support projection present. Caudal projection callus-like (Image 11).

D. Adult: Male - body yellowish-orange, with metallic green patches; elongate, oval; length 14–15 mm with an average of 14.46 ± 0.4 mm, width 7 to 8 mm with an average of 7.52 ± 0.3 mm (Image 12); head semicircular, elevated area between eyes, clypeus metallic green, lateral margins blackish; antenna eight segmented; pronotum with elevated margins forming deep cavity at middle, anteriorly forming a short process that reflexes backwards, laterally blunt and angular downward, with circular black spots (Image 13); scutellum very small, finely punctuated; a large spine-like process with broad base and rounded on sides present on meso-sternum (Image 14); elytra striate with a broad black central median suture and a central dark spot shared by both sides of elytra, with one ventral spherical dark spot and two oval median

Images 1–4. Brood balls of *Scaptodera rhadamistus*.
1 - hatched brood balls; 2 - unhatched brood balls; 3 - egg; 4 - IIIrd instar larva. (Scale 1 & 2 = 1cm; 3 & 4 = 1mm). © Suvarna S Khadakkar



Images 5–9. Head and mouth parts of IIIrd instar larva of *Scaptodera rhadamistus*.
5 - cranium; 6 - maxilla; 7 - epiphrynx; 8 - mandibles; 9 - prothoracic leg (Scale 5 & 9 = 1mm; 6 & 8 = 0.5mm). © Suvarna S Khadakkar

dark spots present transversally; femora of fore-, mid- and hind legs orange; fore-tibia setose, tridentate, with elongate tooth; tibia, tarsi and claws of fore-, mid- and hind legs brownish-black; abdominal sclerites metallic greenish-black, pygidium dark, with fine, evenly spread punctuations.

Male genitalia: It consists of parameres and phallobase. Phallobase is broad and curved at the apical end, and about 2.5 times the length of parameres. Parameres bend at the junction of phallobase and parameres (Image 15).

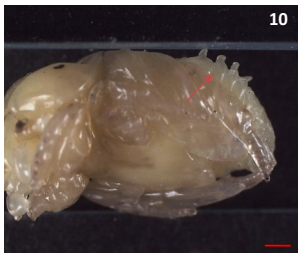
Specimens examined: Col/47/M, 04.iv.2017, 03 ex., Kavdas, Hingna, Nagpur, Maharashtra, Suvarna Khadakkar (location: 21.06^{0}N & 78.86^{0}E, elevation: 310m); Col/47/M/(a), 17.iii.2017, 01 ex., Seloo, Wardha, Maharashtra, Suvarna Khadakkar (location: 20.83^{0}N & 78.70^{0}E, elevation: 265m); Col/47/M/(b), 10.ii.2017, 01 ex., Zilpi, Hingna, Nagpur, Suvarna Khadakkar (location: 21.06^{0}N & 78.86^{0}E, elevation: 366m)

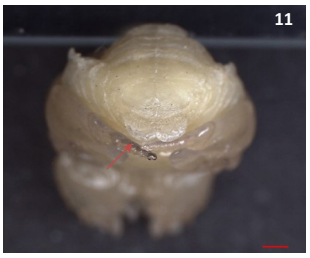
Female - body yellowish-orange, oval; head: clypeus dark metallic green, black on margins; length, 13–14 mm; width, 6–7 mm (Image 16); antenna eight segmented; head semicircular; pronotum (Image 17) yellowish-orange with irregular central metallic green patch, wider than long, narrowed towards head and broader towards base, with single dark metallic green spots laterally, without any process, bare, with lateral margins rounded than angular; with a large spine-like process, slender compared with males with broad base, present on meso-sternum (Image 18); elytra with a broad black central median suture and a dark spot shared by both sides of elytra at the middle; each half of elytra with one ventral spherical dark spot and two oval median dark spots present transversally; abdominal sclerites metallic greenish-black; femora of fore-, mid- and hind legs orange; tibia, tarsi and claws of fore-, mid- and hind legs brownish-black; pygidium dark; otherwise similar to males.

Specimens examined: Col/47/F, 17.iii.2017, 03 ex., Kavdas, Hingna, Nagpur Maharashtra, Suvarna Khadakkar (location: 21.06^{0}N & 78.86^{0}E, elevation: 310m); Col/47/F/(a), 17.iii.2017, 01 ex., Seloo, Wardha, Maharashtra, Suvarna Khadakkar (location: 20.83^{0}N & 78.70^{0}E, elevation: 265m); Col/47/F/(b), 10.ii.2017, 01 ex., Zilpi, Hingna, Nagpur, Suvarna Khadakkar (location: 21.06^{0}N & 78.86^{0}E, elevation: 366m).

Behaviour of larvae

Brood balls of smaller diameter and dried from outside contained malformed and/or dead larvae whereas those moist from outside contained healthy larvae and eggs. When a hole is made in moist brood





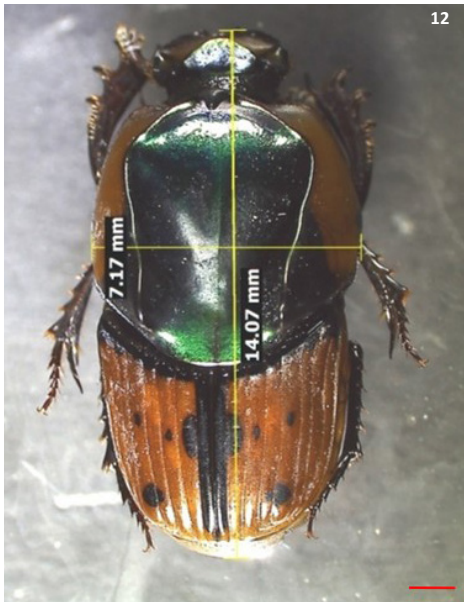
Images 10–11. Pupa of *Scaptodera rhadamistus.*
10 - lateral tergal projections on segments (3-6); 11 - caudal projection (Scale = 1mm). © Suvarna S Khadakkar

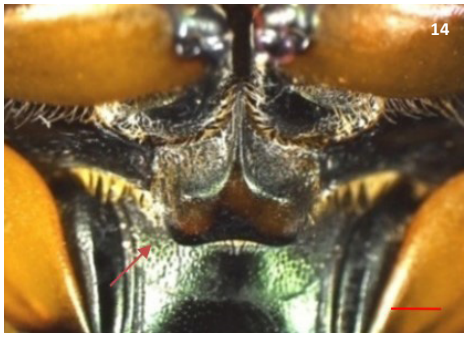
ball with the help of a needle, the larva present inside eat the dung present in ball and seal the hole with the excrement. Larvae were unable to fill the holes when the punctures were bigger. Centipedes were found to occupy the brood balls after the adult emergence.

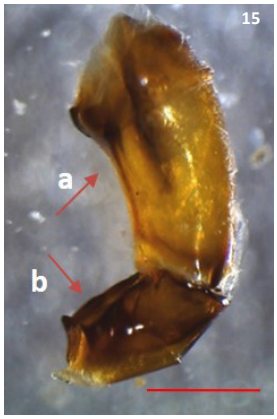
Discussion

Fully grown III instar larvae of *S. rhadamistus* can be characterized by the presence of a prominent hump in the middle of body, two segmented legs, and raster on 10th sternum with two irregular bunches of serrations ventrally one on either half distinct from ovate fields of stout setae. Pupal support projections present in scarabaeinae pupae play a major role in taxonomic studies. Four thumb-like tergal support projections, one per segment laterally on abdominal segments three to six, one pteronotal support projection, callus like caudal projection, and absence of pronotal support projection are other prominent characters of *S. rhadamistus.*

S. rhadamistus build nests in large undisturbed dung pats. Brood count of 3–7 brood balls at a time, per pair of adults of *S. rhadamistus* is considered less in comparison to other scarabs. Investment of energy in parental care may be a reason for smaller brood. Brood balls as well as females guarding the brood balls signifies the importance of parental care in this species. Diameter of the brood balls as well as the moisture







Images 12–15. *Scaptodera rhadamistus* (male)
12 - dorsal view;
13 - lateral view;
14 - large posterior process;
15 - aedegus with line
(Scale = 1mm).
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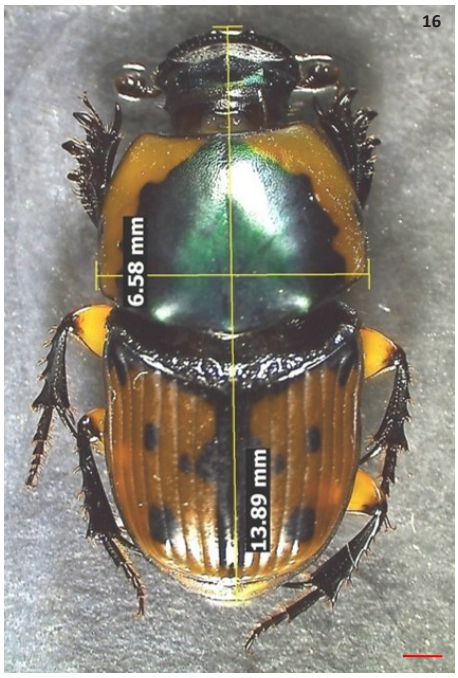

Images 16–18. *Scaptodera rhadamistus* (female)
16 - dorsal view; 17 - pronotum; 18 - large posterior process on mesosternum (Scale = 1mm).
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content plays important role in the development of *S. rhadamistus.* These aspects of life history are important for conservation of the species.

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