

Original Research Article

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Diagnostics of Major White Grub Species Associated with Potato Crop Ecosystem in Himachal Pradesh, India

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ABSTRACT

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The major white grub species associated with potato crop were surveyed in Himachal Pradesh, India during April to August, 2015. Adults were collected in the vicinity of potato ecosystem by using light traps with black, mercury light sources and manual collection from trees on which they settled for feeding and mating. The survey revealed nine major species of Scarabaeidae of which, four species are melolonthines viz., *Brahmina coriacea* (Hope, 1837), *Holotrichia longipennis* (Blanchard, 1850), *Holotrichia sikkimensis* (Brenske, 1892), *Holotrichia seticollis* Moser, 1912, four species are rutelines viz., *Anomala polita* (Blanchard, 1851), *Anomala lineatopennis* Blanchard, 1851, *Anomala dimidiata* (Hope, 1831), *Anomala propinqua* Arrow, 1912 and one species of Dynastinae i.e *Phyllognathus dionysius* (Fabricius, 1792). Of these, *Anomala propinqua* Arrow, 1912 is reported for the first time in potato ecosystem. Present studies have brought out illustrative diagnostic keys of white grub species associated with potato crop ecosystem that can be used at field level, where the identification of the species is very important from management point of view.

Introduction

Scarabaeoidea is one of the largest superfamilies of Coleoptera that include largest family Scarabaeidae. Scarabaeoidea includes approximately 31,000 species worldwide of which the family Scarabaeidae is comprised of 27,800 species (Jameson and Ratcliffe, 2001). Scarabaeidae consist of 13 subfamilies, of which Melolonthinae and Rutelinae are the largest that are widely distributed throughout the world. These beetles are universally known as May beetles or June beetles or cockchafers in their adult stage due to coincidence of their emergence during the month of May/June and the habit of feeding on leaves of plants.

The larvae of these beetles are called white grubs or root grubs as they are subterranean feeders on roots and underground stems of living plants. Lefroy (1906) gave an account on white grubs infesting bajra and other millets in his monumental work 'Indian Insect Pests' and later in 1909 reported that larval stages of *Phyllognathus dionysius* (F.) (Scarabaeidae: Dynastinae) were destructive to rice crop in his 'Indian Insect Life'. Stebbing (1914) recorded the damage to crops by white grubs from Punjab in India, subsequently Fletcher (1919) reported *Serica* and *Maladera* species (Scarabaeidae: Melolonthinae) as serious pests of tea, coffee, cherry, roses. More than 2000 species of

white grubs are known from the Indian subcontinent, of which over 40 species cause severe damage to a wide range of crop plants (Veeresh *et al.*, 1991).

White grubs are serious pests of various crops such as sugarcane, groundnut, chillies, potato, maize, wheat, barley, jowar, bajra, sesame, sunflower, cotton, tobacco, soybean, brinjal, cucurbit, and bhendi including turf, meadows, lawns and forest trees (Fujiie and Yolojama, 1996).

The first record of white grubs causing damage to potato in India was from Himachal Pradesh by Sharma and Bhalla (1964). They mentioned two species viz., *Brahmina coriacea* and *Lachnosterna (Holotrichia) longipennis* causing damage to several crops including potato in Himachal Pradesh. Misra (1992) recorded 5.7 to 26.5 per cent damage of potato tubers and ginger rhizomes at harvest due to feeding by white grubs that leave large, deep circular holes. Chandel (1992) reported that the tuber damage in potato due to white grubs often exceeds 50 per cent in endemic areas in mid hills of Himachal Pradesh. The problem of white grubs is quite serious in hilly states of India where potatoes are grown during summer season as rainfed crop under long day conditions. Thakur *et al.*, (2008) recorded up to 62.0 per cent tuber damage in potato at Shillaroo in Shimla hills due to *B. coriacea*. The damage to potato tubers has been reported to vary from 8.5 to 75.0 per cent especially in hilly regions of the country (Chandel *et al.*, 2015). In spite of the seriousness of the problem, the consolidated and systematic work has not been carried out with respect to illustrated identification keys of white grub species associated with potato crop. So, the present study focused on documentation of major white grub species and developing taxonomic descriptions supplemented with illustrations of

distinguishing characters that are essential for correct identification of the species to adopt appropriate management strategies.

Materials and Methods

Surveys were conducted in Solan, Shimla and Shillaroo districts of Himachal Pradesh for the collection of adult white grub species in potato ecosystem during April - August, 2015. Collection of adult beetles was made during the night by using light traps with black and mercury light sources. Since the beetles settle on the leaves of nearby shrubs for feeding and mating after emergence, adults were also collected from the nearby host trees by scouting using the powerful light torches. Generally white grub adults emerge from soil after the first shower of monsoon and it is continued up to August. Hence, the collection of adults was done during the months of April - August, 2015 at fortnightly intervals in the selected locations of the survey areas. The beetles attracted towards the light source were trapped in the collection bucket, placed beneath the light source that contain cotton swab sprinkled with ethyl acetate. Light traps were operated from 6:30 to 10:00 pm. The beetles trapped in the collection bucket were sorted out and transferred to small insect boxes for further processing.

After processing, the specimens were identified up to species level with available keys (Brenske, 1899; Arrow, 1910, 1917; Khan, 1975). Five to ten specimens were studied for each species based on the availability of specimens for the diagnostic characters. The male specimens were studied for all the species collected from potato ecosystems to document the distinguishing characters. The following morphological characters viz., number of segments in antenna, punctations and front margin shape of clypeus; serrations, punctations, anterior

and posterior angles of pronotum; Striations of elytra; tibial spurs and tarsal claws of legs and phallobase and Parameters of male genitalia were documented. The images of all the diagnostic characters were taken with the help of Leica EZ24HD stereo zoom microscope connected to Leica Application Suite (LAS).

Measurements like length, width of full body and head were taken by using stage and ocular micrometer, after fixing the specimen in horizontal plane. Full body length was measured from tip of the clypeus to the posterior margin of elytra and width was measured at the broadest region of elytra from one margin to other. Similarly, length and width of head was measured from tip of the clypeus to posterior margin of vertex and from both sides of frons, respectively.

Results and Discussion

The species diversity from potato ecosystem revealed nine major species of white grubs, of which four species of melolonthines viz., *Brahmina coriacea* (Hope) (Plate 1.1), *Holotrichia longipennis* (Blanchard) (Plate 1.2), *Holotrichia sikkimensis* Brenske (Plate 1.3), *Holotrichia seticollis* Moser (Plate 1.4), four species of rutelines viz., *Anomala polita* Blanchard (Plate 1.5), *Anomala lineatopennis* Blanchard (Plate 1.6), *Anomala dimidiata* (Hope) (Plate 1.7), *Anomala propinqua* Arrow (Plate 1.8) and one species of Dynastinae viz., *Phyllognathus dionysius* (F.) (Plate 1.9) were recorded. Among these, *A. propinqua* is reported for the first time in potato ecosystem. Misra and Chandla (1989) described eight species of white grubs, of which *A. dimidiata*, *A. polita*, *A. rugosa*, *H. longipennis* and *B. coriacea* were the predominant species in hilly tracts where potatoes are grown during summer season as rainfed crop. Chandel *et al.*, (2013) reported destructive species such as *B. coriacea*, *B. flavosericea*, *A. dimidiata*, *Melolontha indica*

Hope, *H. sikkimensis*, *H. longipennis*, *H. seticollis*, *P. dionysius* from the potato habitat. Mandeep *et al.*, (2015) recorded five most common species viz., *B. coriacea*, *Adoretus lasiopygus* Burmeister, *A. lineatopennis*, *Maladera insanabilis* (Brenske) and *H. longipennis* occurring in potato habitat besides apple, pear, walnut, which are in conformity with present studies. The present study furnishes the diagnostic keys to delineate the species for easy identification of the white grub species associated with potato ecosystem, which is important from management point of view.

The diagnostic keys furnished aids in differentiating the subfamilies and further generic and species level. The subfamilies of phytophagous Scarabaeidae can be distinguished based on position of mandibles, labrum, lamellar club, tarsal claws. The species delineation is largely based on antennal characters, clypeal and male genitalia characters. Among melolonthines, three belong to genus *Holotrichia*, where *H. longipennis* and *H. sikkimensis* are very similar externally and one can distinguish both based on metallic/dull elytra and punctations. Here, male genitalia forms strong basis to differentiate both *H. longipennis* and *H. sikkimensis*, where Parameteres are produced into flap like structures at shoulders in case of *H. sikkimensis* and normal rounded in *H. longipennis*. On the other hand, *H. seticollis* is easily distinguishable from other two species of *Holotrichia* with distinct black colour body. Similarly rutelines are distinguished based on emarginations of clypeus, pronotal and elytral structures. Hence, the antennal, clypeal and male genitalia characters of species studied are detailed below.

Antenna

Ten segmented with three segmented lamellate club in Melolonthinae, where length

of the club is relatively smaller than funicular segments in *B. coriacea* (Plate 2.1), *H. longipennis* (Plate 2.2), *H. sikkimensis* (Plate 2.3) and *H. seticollis* (Plate 2.4), Antenna nine segmented with three segmented club in Rutelinae, relatively longer than funicular segments in species, *A. polita* (Plate 2.5), *A. lineatopennis* (Plate 2.6), *A. dimidiata* (Plate 2.7), *A. propinqua* (Plate 2.8) and in *P. dionysius* antennal club is equal to the funicular segments in length (Plate 2.9).

Clypeus

Clypeus deeply emarginated in *B. coriacea* (Plate 2.10), slightly in *H. longipennis* (Plate 2.11), *H. sikkimensis* (Plate 2.12) and *H. seticollis* (Plate 2.13), transversely rectangular, margins strongly reflexed and angles round in *A. polita* (Plate 2.14), broad and almost straight in the middle, lateral margins straight, front angles, front margins slightly raised in *A. lineatopennis* (Plate 2.15), slightly rectangular in *A. dimidiata* (Plate 2.16), transverse with front margin slightly rounded, front angles rectangular in *A. propinqua* (Plate 2.17), rounded, mandibles expanded sideways to clypeus in *P. dionysius* (Plate 2.18).

Male genitalia

Brahmina coriacea

Phallobase elongated, constricted medially on both sides. Parameteres symmetrical, elongated, immovable, broad at base, curved at apex with blunt tip (Plate 3.1).

Holotrichia longipennis

Phallobase extended round at base expanded outwardly. Parameters symmetrical, immovable, elongated and strongly bent downwards at apex, united and broad at base, strong chitinized process arise at apical region of phallobase (Plate 3.2).

Holotrichia sikkimensis

Phallobase broad at base, elongated. Parameteres symmetrical, immovable, elongated and strongly bent downwards and pointed at apex, produced into flap like structures at shoulders. At apex of phallobase an elongated, blunt, chitinized process extended up to apex of Parameteres (Plate 3.3).

Holotrichia seticollis

Phallobase broad, extended, small depression at apex, attachment between phallobase and Parameteres distinct. Parameteres symmetrical, immovable, each with a chitinized processes, wide apart with two distinct spines at its apex (Plate 3.4).

Anomala polita

Phallobase wider at base, narrowed towards apex, the attachment between phallobase and Parameteres distinct, slightly curved in middle.

Parameteres are symmetrical separated in middle with distinct spines either side (Plate 3.5).

Anomala lineatopennis

Phallobase uniform width throughout length, curved. Parameteres asymmetrical, left Parameteres broad, right Parameteres narrow and elongated, sickle like chitinized process at junction of phallobase and Parameteres (Plate 3.6).

Anomala dimidiata

Phallobase elongated, broad at base, slightly narrowed towards apex, attachment between phallobase and Parameteres distinct. Parameteres symmetrical, slightly overlapped at base (Plate 3.7).

Plate.1 1-9 Habitus. 1. *B. coriacea*, 2. *H. longipennis*, 3. *H. sikkimensis*, 4. *H. seticollis*, 5. *A. polita*, 6. *A. lineatopennis*, 7. *A. dimidiata*, 8. *A. propinqua*, 9. *P. dionysius*

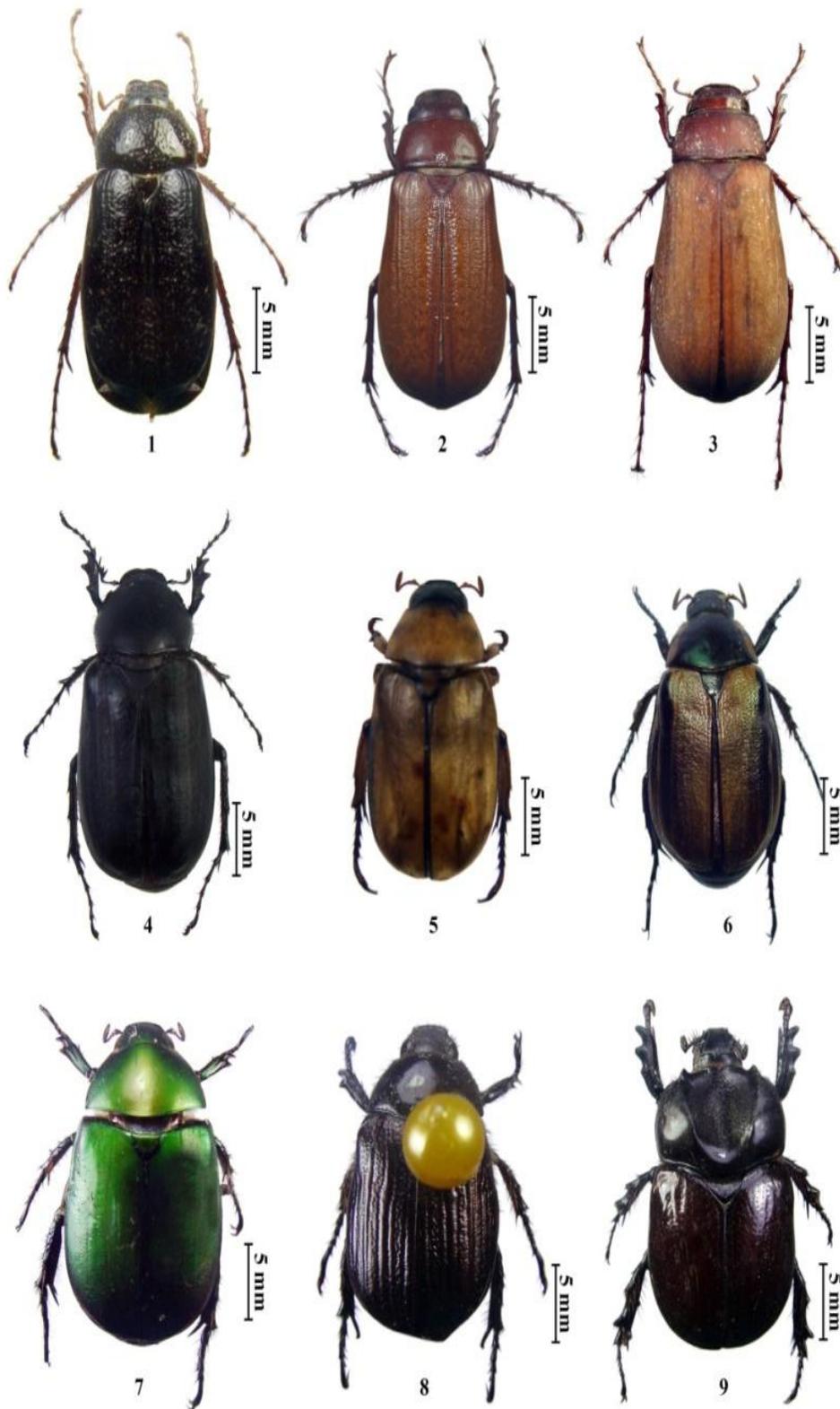


Plate.2 1-9 Left antenna. 1. *B. coriacea*, 2. *H. longipennis*, 3. *H. sikkimensis*, 4. *H. seticollis*, 5. *A. polita*, 6. *A. lineatopennis*, 7. *A. dimidiata*, 8. *A. propinqua*, 9. *P. dionysius* ; 9-18 Clypeus and frons. 10. *B. coriacea*, 11. *H. longipennis*, 12. *H. sikkimensis*, 13. *H. seticollis*, 14. *A. polita*, 15. *A. lineatopennis*, 16. *A. dimidiata*, 17. *A. propinqua*, 18. *P. Dionysius*

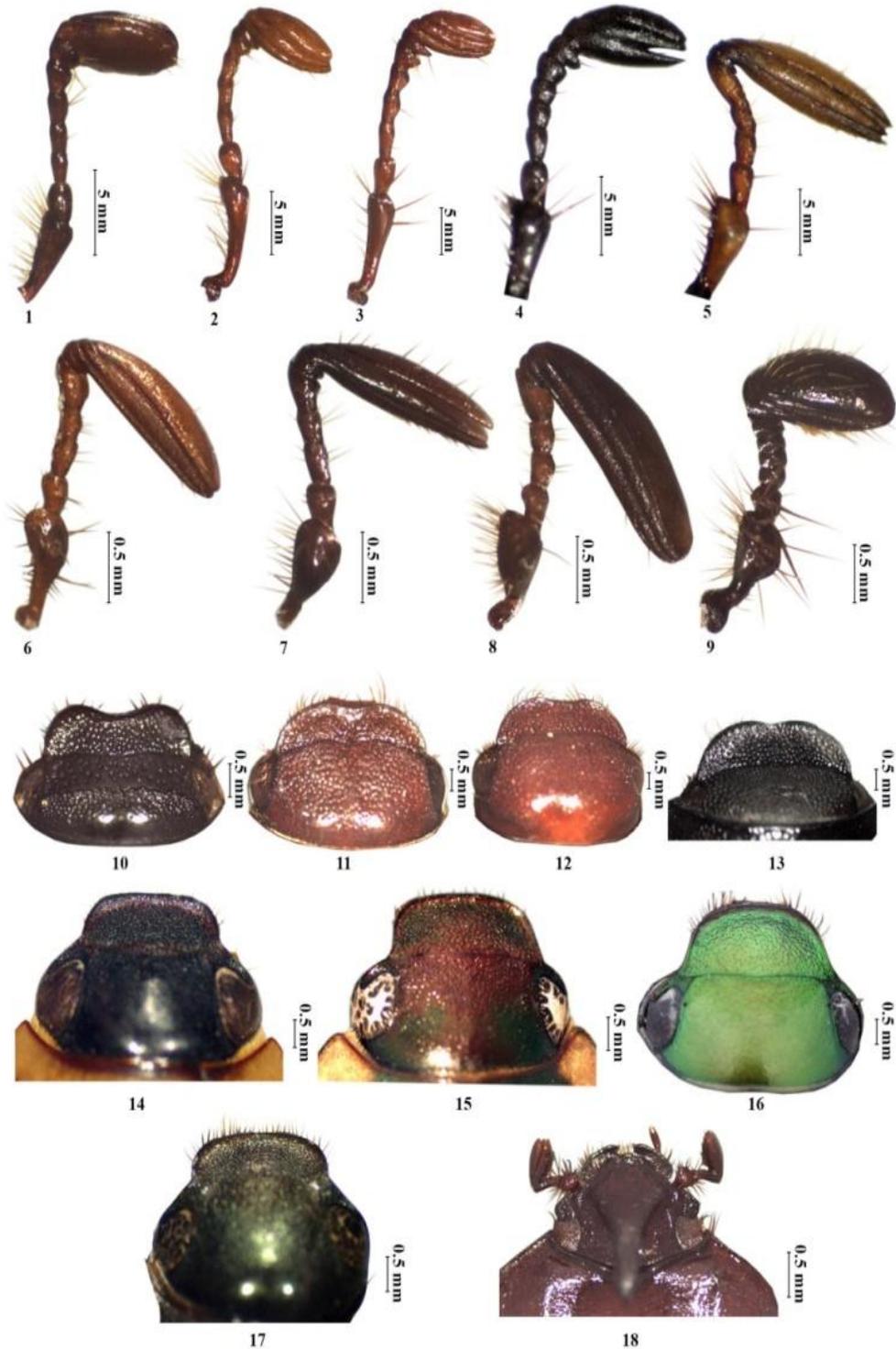


Plate.3 1-9 Male genitalia. 1. *B. coriacea*, 2. *H. longipennis*, 3. *H. sikkimensis*, 4. *H. seticollis*, 5. *A. polita*, 6. *A. lineatopennis*, 7. *A. dimidiata*, 8. *A. propinqua*, 9. *P. dionysius*

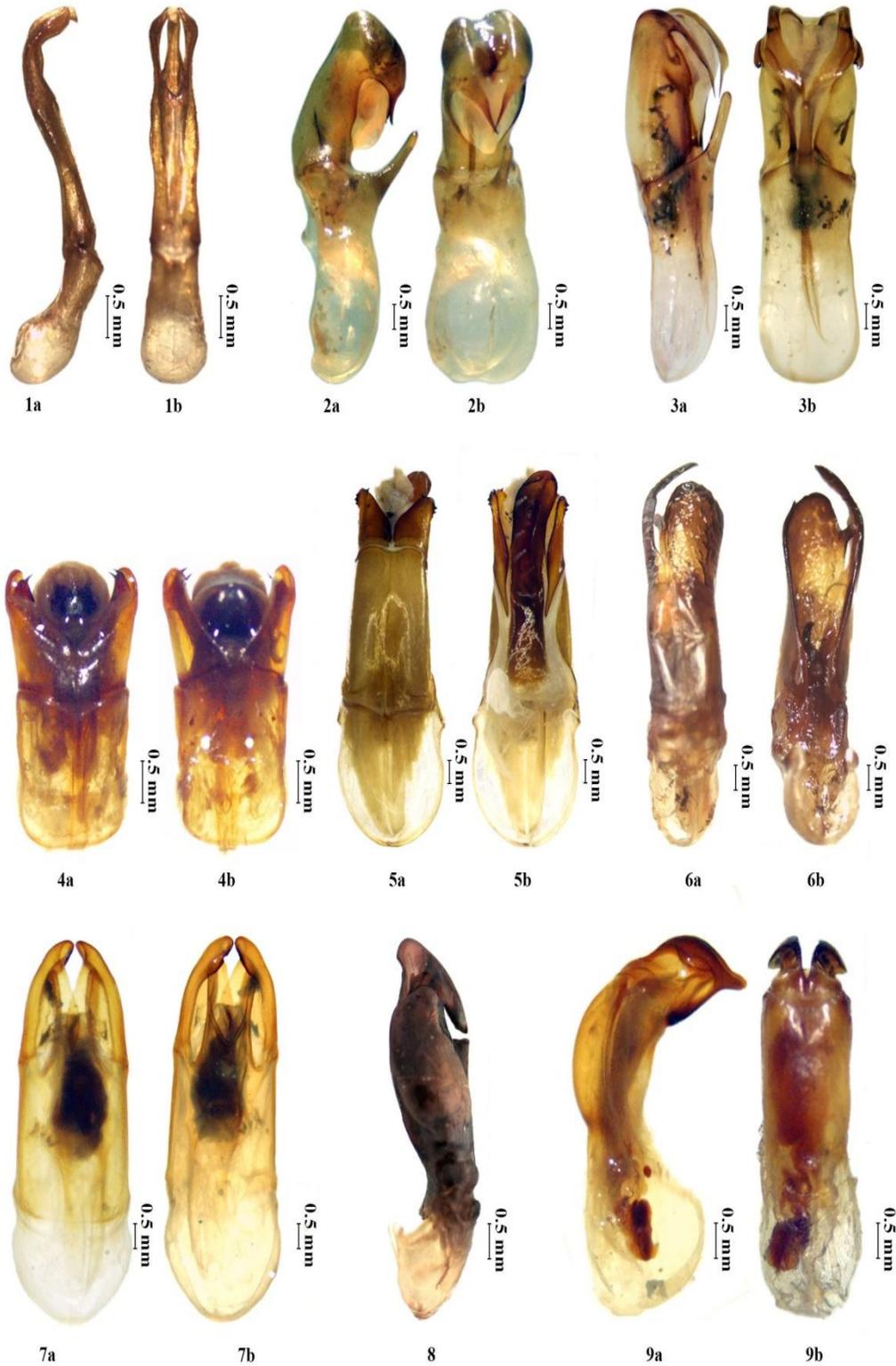
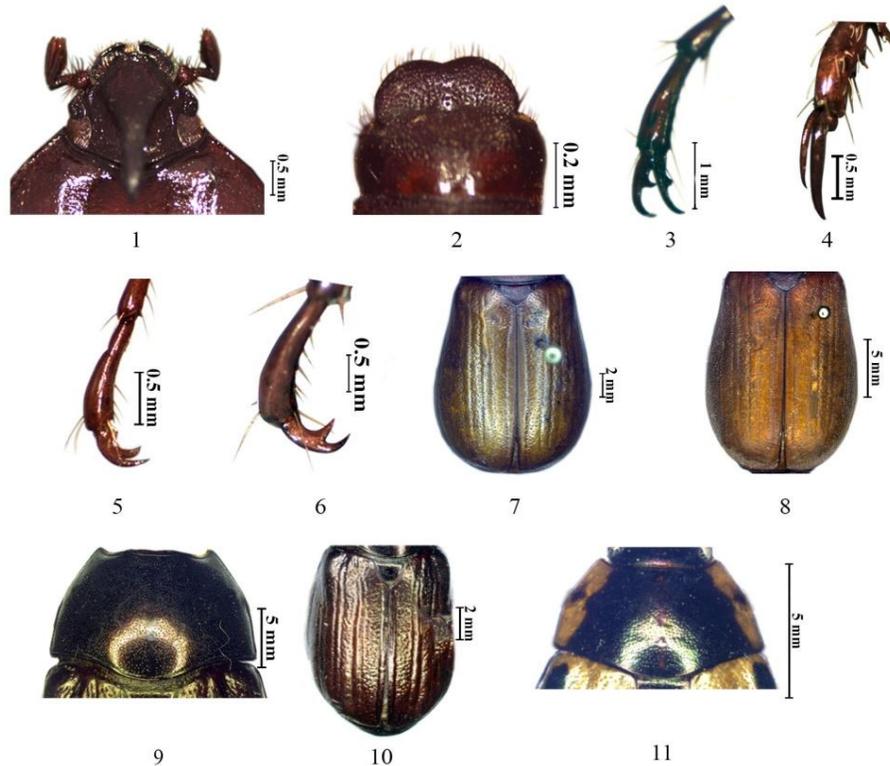


Plate.4 Distinguishing characters of white grub species associated with potato



Phyllognathus dionysius

Phallobase broader at base narrow towards middle, curved at middle, symmetrical Parameteres arch like in the middle, slightly pointed at apex (Plate 3.9).

Since *Anomala propinqua* is reported for the first time in potato ecosystem, brief description of this species furnished along with the diagnostic keys for major species associated with potato ecosystem.

***Anomala propinqua* Arrow, 1912**

Material examined

INDIA: Himachal Pradesh: Shimla-Kufri (31°05'52.06" N, 77°16'04.38" E), 12♂ 8, 12.V.2015, Coll. K. Sreedevi.

Male

Body slightly elongated and broadest at extremity and convex measuring 16 mm length, 9 mm breadth, frons and clypeus coppery, slightly metallic, elytra, legs coppery.

Head

Length 2 mm, breadth 3.4 mm, rugose and opaque. Clypeus transverse with front margin slightly rounded, front angles rectangular, dark brown, shiny appearance with fine shallow punctations (Plate 2, 17), vertex with dense punctations at sides, sparsely at posterior median line. Antenna nine segmented with three segmented club, longer than funicular segments (Plate 2, 8).

Thorax

Pronotum length 3.1 mm, breadth 6 mm, smooth at sides, anterior margin slightly curved in the middle, posterior margin bow shaped, anterior angles acute, posterior angles obtuse, minutely punctured, punctations sparse in the middle, dense at the side, base of the pronotum completely margined. Scutellum finely punctated, broad at anterior, acute at posterior and having short linear impression on both sides. Elytra with deep sutural stria and elevated costa and four paired stria enclosing elevated costa and intervening spaces flat and strongly, irregularly punctured, with deep and fine puncture, two hind tibial spurs on one side of first tarsal segment, front and middle leg

claws unequal, larger claw clefted, hind tarsal claws unequal, not clefted.

Male genitalia

Phallobase broad and less sclerotized at base, the attachment between Parameres and phallobase not clear, prameres symmetrical, one chitinized structure reflexed backward (Plate 3, 8).

Diagnostic keys for species delineation

The important characters for distinguishing the species have been documented and furnished here with for easy identification of the white grub species associated with potato ecosystem.

Diagnostic keys for species delineation

The important characters for distinguishing the species have been documented and furnished here with for easy identification of the white grub species associated with potato ecosystem.

1. Mandibles expanded sideways to clypeus, tarsal claws simple (Plate 4.1)
.....Dynastinae, *Phyllognathus dionysius* (F.)
- Mandibles not visible from above, fused with clypeus, tarsal claws variable (Plate 4.2)..... 2
2. The tarsal claws equal (Plate 4.3) Melolonthinae 3
- The tarsal claws unequal or asymmetrical (Plate 4.4) Rutelinae 6
3. The tarsal claws clefted, thoracic sternites more hairy (Plate 4.5)....*Brahmina coriacea* (Hope)
-The tarsal claws dentate, thoracic sternites less hairy (Plate 4.6).....4
4. Medium sized body, with distinct black colour*Holotrichia seticollis* Moser
- Medium to large size body with testaceous brown colour 5
5. Elytra shiny, striate with close punctations (Plate 4.7) ...*Holotrichia longipennis* (Blanchard)
-Elytra dull, striate with sparse punctations (Plate 4.8).....*Holotrichia sikkimensis* Bresnke
6. Hind legs not extremely massive, base of the pronotum completely margined (Plate 4.9)
.....7
- Hind legs extremely massive, base of the pronotum not completely margined.....8
7. Front margin of clypeus not excised, hind tibia and tarsus slender
..... *Anomala polita* Blanchard
- Metasternum clothed with thick hair, scutellum grooved on each side, brownish beetle, intervals of elytra dissimilar (Plate 4.10)..... *Anomala propinqua* Arrow
8. Green coloured beetle, large sized, legs on lower surface not uniform deep green, elytra broadest behind middle.....*Anomala dimidiata* (Hope)
- Metallic straw colour, pronotum with dark black patch, shoulders of elytra with black sutural line, vanishing posteriorly (Plate 4.11).....*Anomala lineatopennis* Blanchard

Potato is major staple crop grown in the hilly tracts of country and white grubs are becoming serious biotic stress limiting the yield of the crop in recent past. So, the present study documented the white grub species that are major pests of potato furnishing the distinguishing characters to enable the species identification, which is crucial for adoption of management strategies.

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