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Notes on major white grub species associated with groundnut crop ecosystem in Rajasthan, Andhra Pradesh, India

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Abstract

The major white grub species associated with groundnut crop were surveyed in Andhra Pradesh and Rajasthan, India during May to August, 2015. Adults were collected in the vicinities of the groundnut ecosystem by utilizing light traps with mercury light bulb as source and manual scouting from trees on which they settled for feeding and mating. The survey revealed 12 major species of Scarabaeidae. Of these, six species belonged to Melolonthinae viz., *Holotrichia serrata* (Fabricius), *Holotrichia consanguinea* (Blanchard), *Holotrichia reynaudi* (Blanchard), *Holotrichia fissa* Brenske, *Maladera insanabilis* (Brenske), *Schizonycha ruficollis* (Fabricius), five species to Rutelinae viz., *Anomala bengalensis* (Blanchard), *Anomala dorsalis* (Fabricius), *Adoretus lasiopygus* Burmester, *Adoretus testaceus* (Hope), *Adoretus versutus* Harold and one species to Dynastinae viz., *Phyllognathus dionysius* (Fabricius) that were predominant. *Adoretus testaceus* was recorded for the first time from Rajasthan. Present studies have brought out illustrative diagnostic keys of major white grub species associated with groundnut crop ecosystem that can be used at field level, where the identification of the species is very important from management point of view.

Key words: Melolonthinae, Rutelinae, Dynastinae, Scarabaeidae, groundnut

Introduction

Scarabaeoidea is one of the largest superfamilies of Coleoptera that comprises of 12 families, 43 subfamilies, 118 tribes and 94 subtribes [1] with around 35,000 species worldwide. Of these, Scarabaeidae is one of the major families that constitutes 27,800 species around the world [2]. Scarabaeidae comprise of 13 subfamilies, of which Melolonthinae and Rutelinae are the largest subfamilies that are widely spread all over the world.

These are generally known as May/June beetles or cockchafer because of their coincidence of their emergence during the month of May/June and the adults feed on leaves of plants such as neem, acacia, ber, *Prosopis*, drumstick etc. The larvae of these beetles are called white grubs or root grubs and these feed on underground roots and stems of living plants. Around more than 2000 species of white grubs are known to occur in Indian subcontinent, of which more than 40 species cause serious injury to an extensive variety of crop plants [3]. White grubs are serious pests of various cereal crops such as maize, wheat, barley, jowar, bajra, oil seed crops like groundnut, sesame, sunflower, soyabean, vegetable crops like brinjal, cucurbit and bhendi and other commercial crops like sugarcane, cotton, tobacco etc [4].

A First major epidemic of white grubs in sugarcane and in groundnut was reported in 1950s [5]. *Holotrichia consanguinea* was the dominant species that appeared in severe form and caused substantial damage to groundnut and jowar in localized pockets of Amerli district of Gujrat [6]. Fourteen species of white grubs were reported from groundnut crop in eastern Uttar Pradesh, of which *Apogonia* spp., *Schizonycha ruficollis* and *Anomala ruficapilla* being the most predominant [7]. A total of 22 species from 9 genera were collected from groundnut ecosystem in South India [8]. 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 groundnut crop. 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 groundnut 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.

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Materials and methods

Surveys were conducted in Dausa, Tonk and Jaipur districts of Rajasthan, YSR Kadapa and Chittoor districts of Andhra Pradesh for the collection of adult white grub species in a groundnut ecosystem during May - August, 2015. Collection of adult beetles was made during the night between 6:30 to 10:00 pm by using light traps with black and mercury light sources. Hand collection of adults was also made from the nearby host trees by scouting using the powerful light torches, where they settled for feeding and mating after emergence. Usually white grub adults emerge from the soil after the first shower of monsoon and it is continued up to August. 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. 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 the species level with available keys [9, 10, 11, 12]. 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 groundnut ecosystems to document the distinguishing characters. The following morphological characters viz., number of segments in an 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 the legs and phallobase and paramers of male genitalia were documented. The images of all the diagnostic characters were taken with the help of a Leica EZ24HD stereozoom microscope connected to Leica Application Suite (LAS).

Measurements like length, width of full body and head were taken by using the stage and an ocular micrometer in the horizontal plane. Full body length was measured from the tip of the clypeus to the posterior margin of the elytra and width was measured from both side margins of elytra. Similarly, length and width of the head were measured from the tip of the clypeus to posterior margin of the vertex and from both sides of frons, respectively.

Result and discussion

The species diversity of groundnut ecosystem revealed 12 species under six genera viz., *Holotrichia*, *Maladera*, *Schizonycha* representing Melolonthinae, *Anomala* and *Adoretus* representing Rutelinae and *Phyllognathus* representing Dynastinae. *Holotrichia* comprised of four species viz., *H. serrata* (Plate 1.1), *H. consanguinea* (Plate 1.2), *H. reynaudi* (Plate 1.3), *H. fissa* (Plate 1.4), *Maladera* and *Schizonycha* comprised of single species each such as *M. insanabilis* (Plate 1.5), *S. ruficollis* (Plate 1.6), *Anomala* comprised of two species viz., *A. bengalensis* (Plate 1.7), *A. dorsalis* (Plate 1.8), *Adoretus* comprised of three species such as *A. lasiopygus* (Plate 1.9), *A. testaceus* (Plate 1.10), *A. versutus* (Plate 1.11), while *Phyllognathus* represented by single species viz., *P. dionysius* (Plate 1.12). Of 12 species in groundnut ecosystem, *H. consanguinea* was the predominant species occurring in all surveyed areas of Rajasthan, India followed by *M. insanabilis*. *Holotrichia reynaudi* was predominant in Andhra Pradesh. This was followed by *Anomala dorsalis* and *H. serrata* dominance in Rajasthan and Andhra Pradesh, respectively. Other species were present in considerable numbers but can be rated as less serious in groundnut ecosystem. *Adoretus testaceus* was recorded for the first time from Rajasthan [13]. Many melolonthine species are associated with groundnut. *Holotrichia serrata* and *H.*

consanguinea, which are severe pests occurs in many parts of South and North India especially in plains [14]. *Holotrichia reynaudi* and *H. serrata* were the major species associated with groundnut, where *H. reynaudi* found to be predominated in the central Deccan area, while *H. serrata* was most abundant in areas to the South and West India and also ruteline species viz., *Adoretus bicolor*, *A. decanus*, *A. versutus*, *Anomala dorsalis*, *A. ruficapilla* reported from groundnut fields of Andhra Pradesh [15]. Earlier fourteen species of white grubs were reported from groundnut fields of Saurashtra region, Gujarat viz., *Phyllognathus* sp., *Apogonia rauca*, *Holotrichia consanguinea*, *H. fissa*, *H. serrata*, *Maladera* sp., *Schizonycha ruficollis*, *Adoretus bicolor*, *A. deccanus*, *A. versutus*, *Adoretus* sp., *Anomala bengalensis*, *A. dorsalis* and *A. varicolor* [16].

The important characters for distinguishing the species have been documented and furnished here with for easy identification of the white grub species associated with groundnut ecosystem. The diagnostic keys furnished aids in differentiating the subfamilies and further generic and species level. Subfamilies of Scarabeidae can be distinguished based on position of mandibles and equal and unequal tarsal claws. Further the melolonthines were distinguished based on tibial spurs, where the tibial spur on the either side of the tarsal segments in case of *M. insanabilis* (Plate 4.5), clypeal carina and nature of claw, where the tarsal claws clefted or bifid, clypeal and frontal carina present in case of *S. ruficollis* (Plate 4.7), claws with first and second tooth widely and closely separate in *H. consanguinea* (Plate 4.11), and *H. fissa* (Plate 4.12), respectively, pronotal punctations and serrations, where pronotal serrations distinct and prominent with thick bristles in *H. serrata* (Plate 4.9), pronotal serrations moderate incase of *H. reynaudi* (Plate 4.10). Rutelines were distinguished based on position of the labrum beneath the clypeus, labrum horizontal, not produced downwards in genus *Anomala* (Plate 4.13), but incase of genus *Adoretus* labrum produced downwards to the clypeus ventrally (Plate 4.14), emarginations of clypeus, shape of the clypeus, where clypeal front margin gently excised in *An. bengalensis* (Plate 4.15), not incase of *An. dorsalis* (Plate 4.16), fore tibia serration and dentations, where fore tibia serrated in basal part at the outer edge in *Adoretus testsceus* (Plate 4.17) and based on pronotal punctations, where punctations on pronotum dense at sides in *Adoretus lasiopygus* (Plate 4.19), and dense at middle in case of *Adoretus versutus* (Plate 4.20). The developed diagnostic keys will be useful to identify the major species of white grubs associated with groundnut ecosystem.

The antennal and clypeal characters are given below.

Antenna: Antenna ten segmented with three lamellate club, shorter than the funicular segments in *H. serrata* (Plate 2.1), *H. consanguinea* (Plate 2.2), *H. reynaudi* (Plate 2.3), *H. fissa* (Plate 2.4), *S. ruficollis* (Plate 2.6), lamellate club longer than funicular segments in *M. insanabilis* (Plate 2.5). In *Adoretus lasiopygus* (Plate 2.9) and *A. versutus* (Plate 2.11), the lamellar club is longer than funicular segments while club relatively equal to the funicular segments in *A. testaceus* (Plate 2.10). Antenna nine segmented with three segmented

club in *Anomala* species, where club longer than the funicular segments in *A. bengalensis* (Plate 2.7) and as long as funicular segments in *A. dorsalis* (Plate 2.8).

Clypeus: clypeus wider than long, front margin emarginate, sides rounded in *H. serrata* (Plate. 2.13), slightly emarginated in *H. consanguinea* (Plate 2.14), *H. reynaudi* (Plate 2.15), *H. fissa* (Plate 2.16), clypeus wider than long, lateral margins rounded, front margin slightly rounded, without emargination *A. lasiopygus* (Plate 2.21), *A. testaceus* (Plate 2.24), *A. versutus* (Plate 2.23), clypeal carina sharp and distinct, straight in middle obliterated at base in *S. ruficollis* (Plate 2.18), clypeus wider than long, finely, uniformly and deeply punctate, median longitudinal carina present in *M. insanabilis* (Plate 2.17), clypeus broadly and transversely rectangular, lateral margins straight, front margin of strongly reflexed and straight, gently excised at angles in *A. bengalensis* (Plate 2.19), not excised in *A. dorsalis* (Plate 2.20), clypeus rounded, mandibles expanded sideways to clypeus in *P. dionysius* (Plate 2.24).

The details of male genitalia, which is an easy and recognizable distinguishing character among the different scarab species are herewith furnished.

Male genitalia

***Holotrichia serrata* (Fabricius)**

Phallobase broad and elongated, expanded towards apex with conical depression at anterior margin. Parameres symmetrical, immovable, broad and separate, each paramere with a pair of sclerotized structures with blunt rounded head like structures at the end (Plate 3.1).

***Holotrichia consanguinea* Blanchard**

Phallobase slender extended broader at apex with conical depression at anterior margin Parameres immovable, symmetrical, elongated, broad at base, inner margins gradually narrowed and rounded at tip, each paramere with a symmetrical chitinized processes ending in a shoe-shaped tip (Plate 3.2).

***Holotrichia reynaudi* (Blanchard)**

Phallobase elongated, narrowed and round at base, distinct constriction near base, broad at apex, deep median depression along anterior margin. Parameres symmetrical immovable, separate broad at base, outer margin straight, inner margin uniformly broad till mid then bent inwardly, each paramere with a short chitinized processes with slightly clefted broad tip (plate 3.3).

***Holotrichia fissa* Brenske**

Phallobase narrow at base, wider anterior, a pair of symmetrical parameres broader at base and narrowed towards apex, ventral processes triangular shaped, each paramere with a chitinized process broader throughout (Plate 3.4).

***Maladera insanabilis* (Brenske)**

Phallobase extended, narrowed basally, broad anteriorly, parameres simple, movably articulated, asymmetrical, right paramere long, enlarged at base, progressively tapering towards the end with a curved pointed apical tooth, left paramere short, bilobed at base, narrowing towards the end with an apical curved tooth (Plate 3.5).

***Schizonycha ruficollis* (Fabricius)**

Phallobase and parameres blindly united, phallobase conical at base basal attachment with small depression Parameres symmetrical, short, directed posteriorly, slanting, tip flat without any sclerotised processes, endophallus with spines medially (Plate 3.6).

***Anomala bengalensis* (Blanchard)**

Phallobase elongated, length more than parameres, broad at base, slightly narrow towards apex, attachment between phallobase and parameres distinct, parameres symmetrical curved inside, pointed at apex distinct small process on each paramere, a spine like process arise ventrally from base of parameres (Plate 3.7).

***Anomala dorsalis* (Fabricius)**

Phallobase broad at base, elongated, slightly narrow towards the apex, attachment between phallobase and parameres clear. Parameres symmetrical, distinct, slightly expanded at sides, nearly square shaped at apex (Plate 3.8).

***Adoretus lasiopygus* Burmeister**

Phallobase enlarged articulation between phallobase and parameres clearly visible. A pair of symmetrical parameres curved at junction, fused medially with shallow depression and inverted 'v' shape at apex (Plate 3.9).

***Adoretus testaceus* (Hope)**

Phallobase slightly broad at base, symmetrical parameres right angles to the phallobase, wider at base narrowed towards apex united medially with deep 'U' shape notch at apex (Plate 3.10).

***Adoretus versutus* Harold**

Phallobase slightly broad at base, curved in middle. Parameres asymmetrical, right paramere larger, slightly curved and pointed at apex, left paramere shorter blunt at end (Plate 3.11).

***Phyllognathus dionysius* (Fabricius)**

Phallobase broader at base narrow towards middle, curved at middle, symmetrical parameres arch like in the middle, slightly pointed at apex (Plate 3.12).

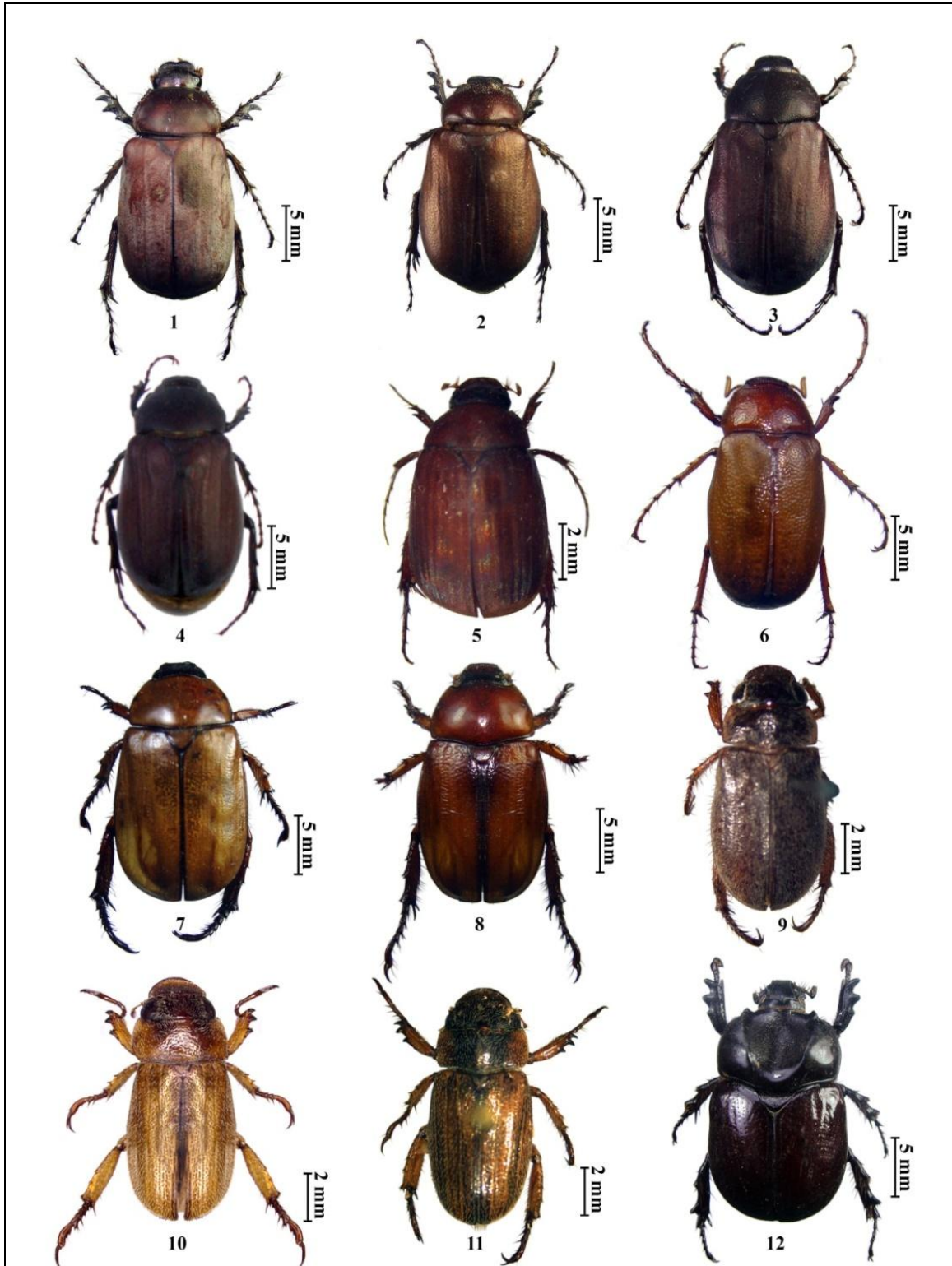


Plate 1: 1-12 Habitus. 1. *H. serrata*, 2. *H. consanguinea*, 3. *H. reynaudi*, 4. *H. fissa*, 5. *M. in sanabilis*, 6. *S. ruficollis*, 7. *A. bengalensis*, 8. *A. dorsalis*, 9. *A. lasiopygus*, 10. *A. testaceus*, 11. *A. versutus*, 12. *P. dionysius*

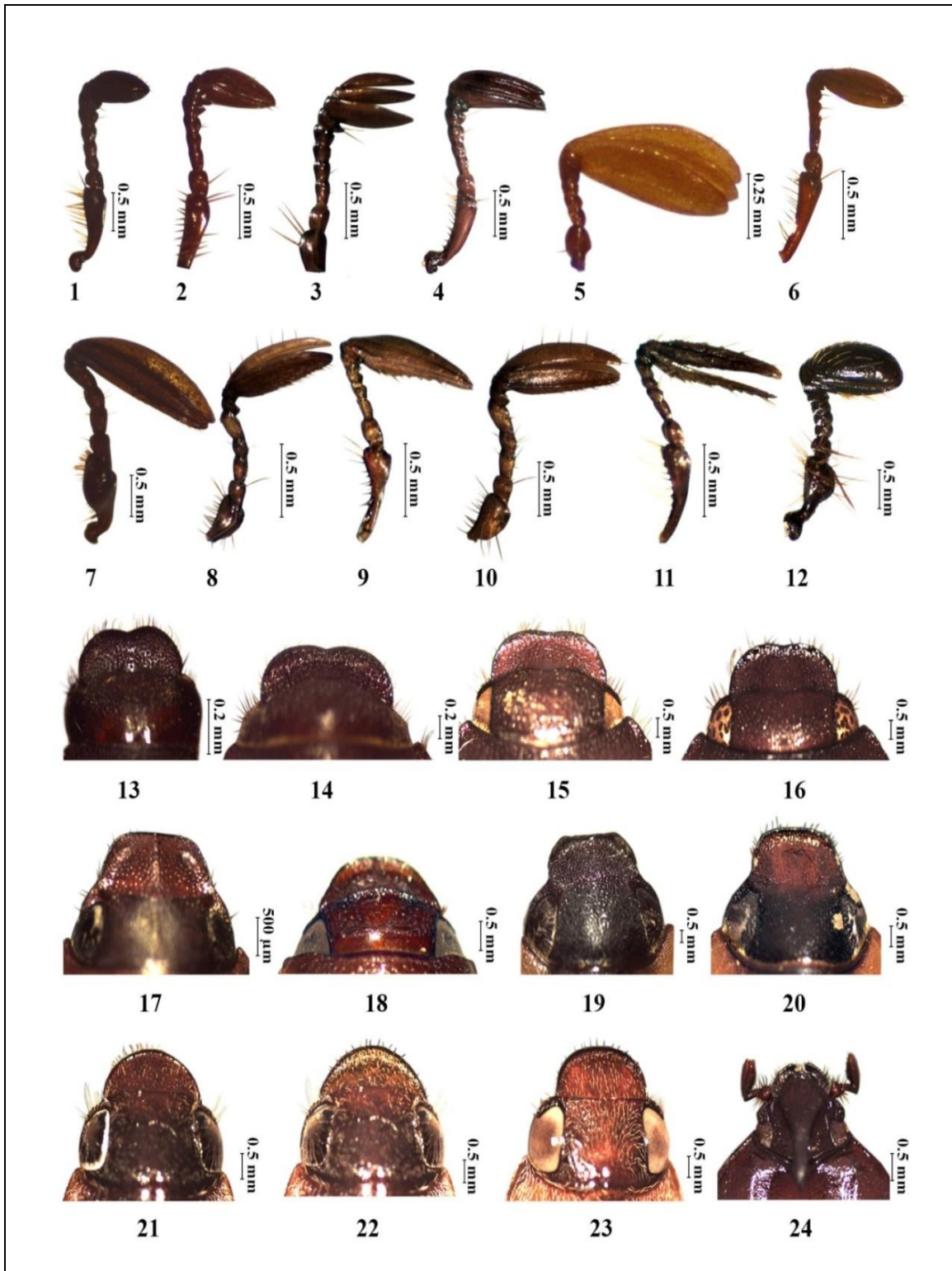


Plate 2: 1-12 Antenna. 1. *H. serrata*, 2. *H. consanguinea*, 3. *H. reynaudi*, 4. *H. fissa*, 5. *M. insanabilis*, 6. *S. ruficollis*, 7. *A. bengalensis*, 8. *A. dorsalis*, 9. *A. lasiopygus*, 10. *A. testaceus*, 11. *A. versutus*, 12. *P. dionysius*; 13-14. Clypeus and frons. 13. *H. serrata*, 14. *H. consanguinea*, 15. *H. reynaudi*, 16. *H. fissa*, 17. *M. insanabilis*, 18. *S. ruficollis*, 19. *A. bengalensis*, 20. *A. dorsalis*, 21. *A. lasiopygus*, 22. *A. testaceus*, 23. *A. versutus*, 24. *P. dionysius*.

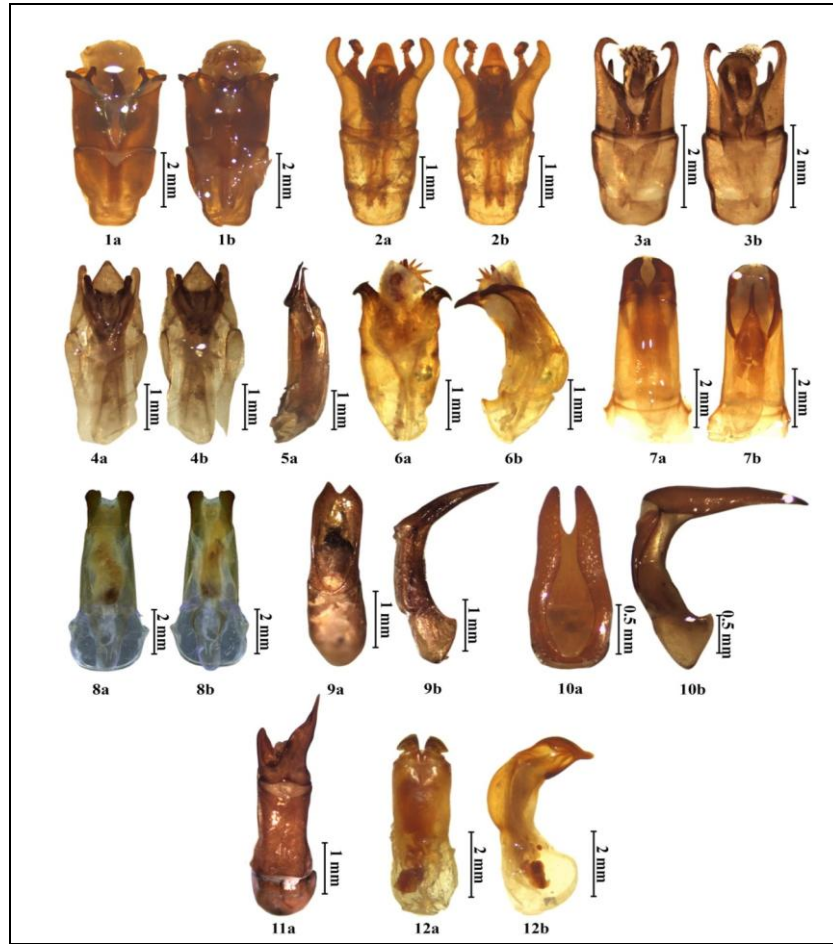


Plate 3: 1-12 Male genitalia. 1. *H. serrata*, 2. *H. consanguinea*, 3. *H. reynaudi*, 4. *H. fissa*, 5. *M. insanabilis*, 6. *S. ruficollis*, 7. *A. bengalensis*, 8. *A. dorsalis*, 9. *A. lasiopygus*, 10. *A. testaceus*, 11. *A. versutus*, 12. *P. Dionysius*

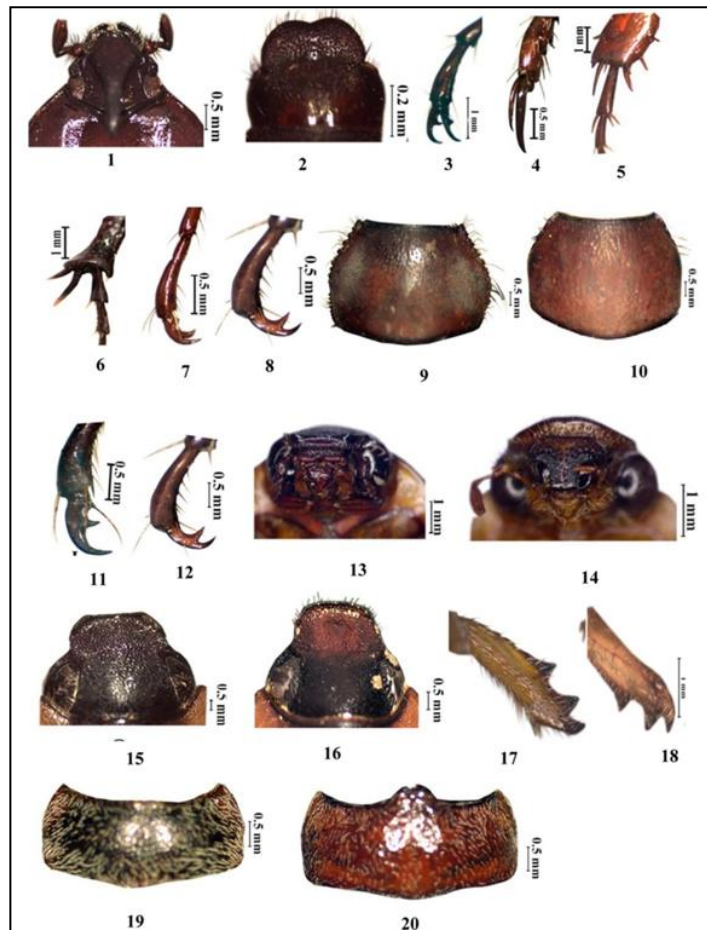


Plate 4: Distinguishing characters of white grub species associated with groundnut

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 groundnut ecosystem.

1. Mandibles expanded sideways to clypeus, tarsal claws simple, posteriorly produced cephalic horn like processes in males (Plate 4.1).....Dynastinae, *Phyllognathus dionysius*
- 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 8
3. The tibial spur on the either side of the tarsal segments (Plate 4.5)*Maladera insanabilis*
- The tibial spur on one side of the tarsal segments (Plate 4.6)..... 4
4. The tarsal claws clefted or bifid, clypeal and frontal carina present (Plate 4.7) *Schizonycha ruficollis*
- The tarsal claws dentate, carina absent on clypeus and frons (Plate 4.8) 5
5. Pronotum with moderate to distinct serrations 6
- Pronotal margins smooth without serrations7
6. The pronotal serrations distinct and prominent with thick bristles (Plate 4.9) *Holotrichia serrata*
- The pronotal serrations moderate, distinct anteriorly and fades away gradually towards posterior (Plate 4.10) *Holotrichia reynaudi*
7. Abdomen bulged ventrally, thoracic sternum densely hairy, claws with first and second tooth widely separate (Plate 4.11) *Holotrichia consanguinea*
- Abdomen flat ventrally, thoracic sternum less hairy, claws with first and second tooth closely placed (Plate 4.12)*Holotrichia fissa*
8. Labrum horizontal, not produced downwards (Plate 4.13) *Anomala* 9
- Labrum produced downwards to the clypeus ventrally (Plate 4.14) *Adoretus* 10
9. Clypeal front margin gently excised (Plate 4.15) *Anomala bengalensis*
- Clypeal front margin not excised (Plate 4.16) *Anomala dorsalis*
10. Fore tibia serrated in basal part at the outer edge (Plate 4.17) *Adoretus testaceus*
- Fore tibia not serrated in basal part at the outer edge (Plate 4.18) 11
11. Punctuations on pronotum dense at sides than in the middle (Plate 4.19) *Adoretus lasiopygus*
- Punctuations on pronotum densely at middle than the sides (Plate 4. 20) *Adoretus versutus*

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