Key to the forensically important beetle (Insecta: Coleoptera) families of North America

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Abstract: Beetles (Coleoptera) are one of the most common insect orders associated with remains making them useful in forensic investigations. Reliably identifying the insect composition throughout the decomposition process is vital to accurately using insect succession data. To date, there are no pictorial keys to identify families of forensically important beetles in North America. Here we present a dichotomous pictorial key for beetles that can be associated with carrion, encompassing beetles commonly encountered on decomposing remains and other families that occur less frequently, totaling 21 families. This key is specifically designed to be utilized by professionals and students without the need for specific morphology training.

Keywords: beetles, carrion, dichotomous, Nearctic

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Introduction

Flies (Diptera) and beetles (Coleoptera) are two of the most often used orders of insects in the field of forensic entomology. Forensic entomologists utilize developmental data, faunal succession patterns, and habitat preferences of these insects to aid in criminal investigations (1-3). Blow flies (Diptera: Calliphoridae) and flesh flies (Diptera: Sarcophagidae) are typically the initial colonizers of vertebrate remains and can arrive to a corpse within minutes, making them a valuable resource for estimating time since death (3-5). However, in more advanced stages of decomposition, beetles become important indicators of time since death.

Forensically relevant beetles are attracted to remains based on varying chemical cues released throughout the decomposition process (6-8). Some beetles, such as rove beetles (Coleoptera: Staphylinidae), are predaceous on fly larvae and will arrive early in the decomposition process, while this food source is still abundant, whereas others, such as skin beetles (Coleoptera: Dermestidae) and hide beetles (Coleoptera: Trogidae) will arrive later in decomposition to feed on dried remains. Due to their early arrival, more focus is given to flies in the forensic entomology literature but understanding the behavior and ecology of beetles associated with remains is a critical step in strengthening this field of study. Despite the importance of Coleoptera in forensic entomology, there remains very few diagnostic resources to aid in reliable determination of these taxa. This paper provides a pictorial dichotomous key to the forensically relevant beetle families found throughout North America. This publication aims to increase the use of forensic entomology, specifically beetle identification in a classroom setting and for students conducting decomposition research.

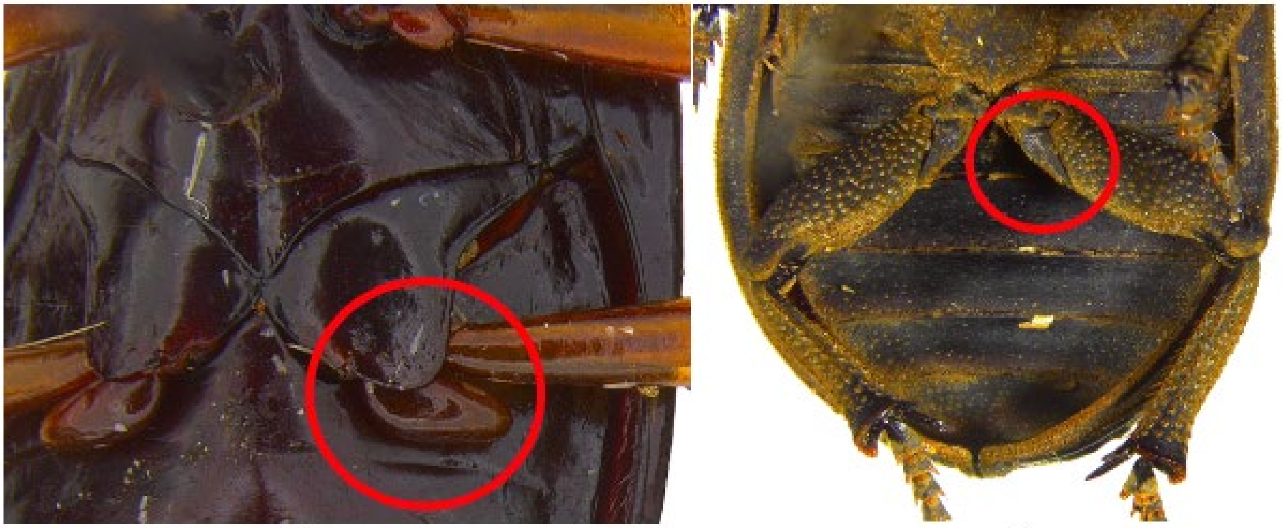
Methods

Couplets for the provided dichotomous key were adapted from multiple sources (9-10) and reworded without taxonomic jargon in an effort to make the tool more accessible to those that may not have formal entomology training.

High-resolution images were taken using either a Leica DFC450 camera mounted onto a Leica M165C stereomicroscope or a Vision Digital Passport Imaging System. Montaged habitus images were created using Leica Application Suite version 4.2 software for the former, and Zerene Stacker 1.04 for the later system. Images are specifically edited and cropped to show diagnostic features and are not meant as standalone identification tools **(FIGURES 1-21)**.

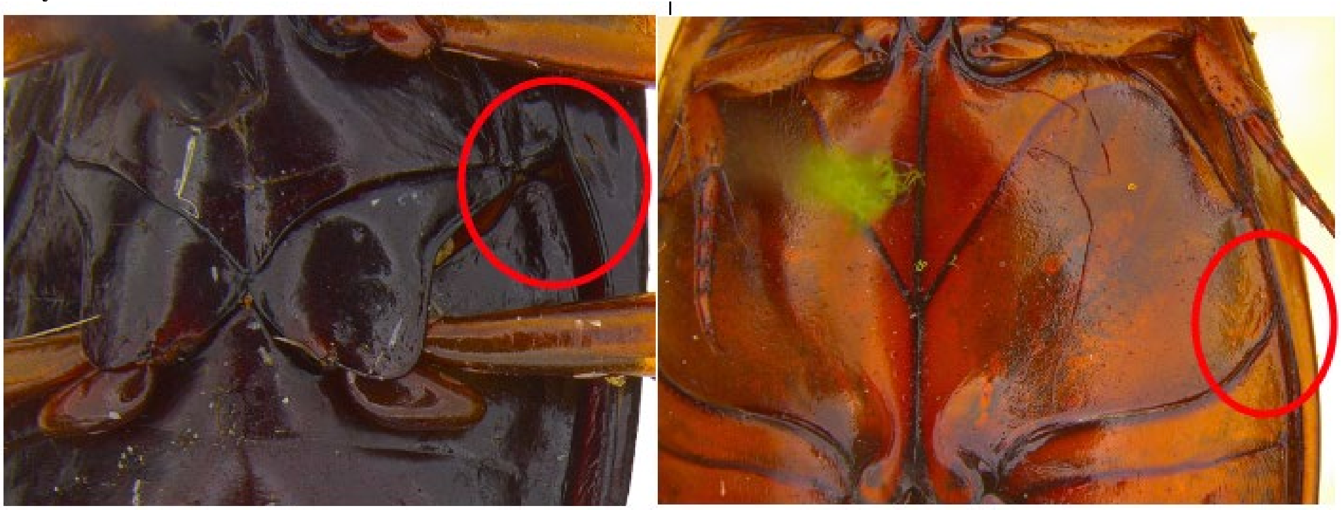
Key to adult beetle families of forensic importance

FIGURE1a Free trochanters; First abdominal sternite interrupted by hind coxae (A)……………………………………..…**2**
FIGURE 1b First abdominal sternite complete (B)………………………………………………...…………………**3**



A B

FIGURE 2a Metacoxa not reaching elytron laterally, last maxillary palpomere distinctly narrower than penultimate (A) …**Carabidae**
FIGURE 2b Metacoxa reaching elytron laterally, last maxillary palpomere not distinctly narrower than penultimate (B) …**Dytiscidae**



A B

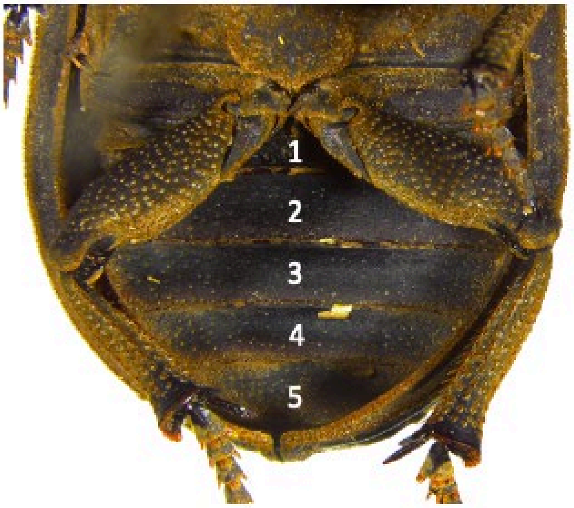
FIGURE 3a Antennae with strongly asymmetrical, usually lamellate club of 3-8 antennomeres; procoxae large, strongly transverse or conical and projecting below prosternum (A)……………………………………………………………..**4**
FIGURE 3b Antennae not lamellate, or coxae not as above (B)……………………………………………………..…….**6**

A **B**

FIGURE 4a Antennae with 11 antennomeres (A) **Geotrupidae**
FIGURE 4b Antennae with fewer than 11 antennomeres (B)………………………………………………………………**5**

A **B**

FIGURE 5a Abdomen with 5 ventrites (A) **Trogidae**
FIGURE 5b Abdomen with 6 ventrites (B) **Scarabaeidae**



A

B

FIGURE 6a Elytra very short leaving 3 or more abdominal tergites exposed (A)……………………………………………..**7**
FIGURE 6b Elytra longer, leaving no more than 1 or 2 abdominal tergites exposed (B)…………………………..……..**10**

A **B**

FIGURE 7a Antennae with distinct club (A)……………………………………………………………..……………………**8**
FIGURE 7b Antennae not clubbed (B) **Staphylinidae**

A **B**

FIGURE 8a Antennae with 4 apical antennomeres expanded into asymmetrical club(A) **Silphidae**
FIGURE 8b Antennae not as above (B*)*……………………………………………………………………………………….***9***

A **B**

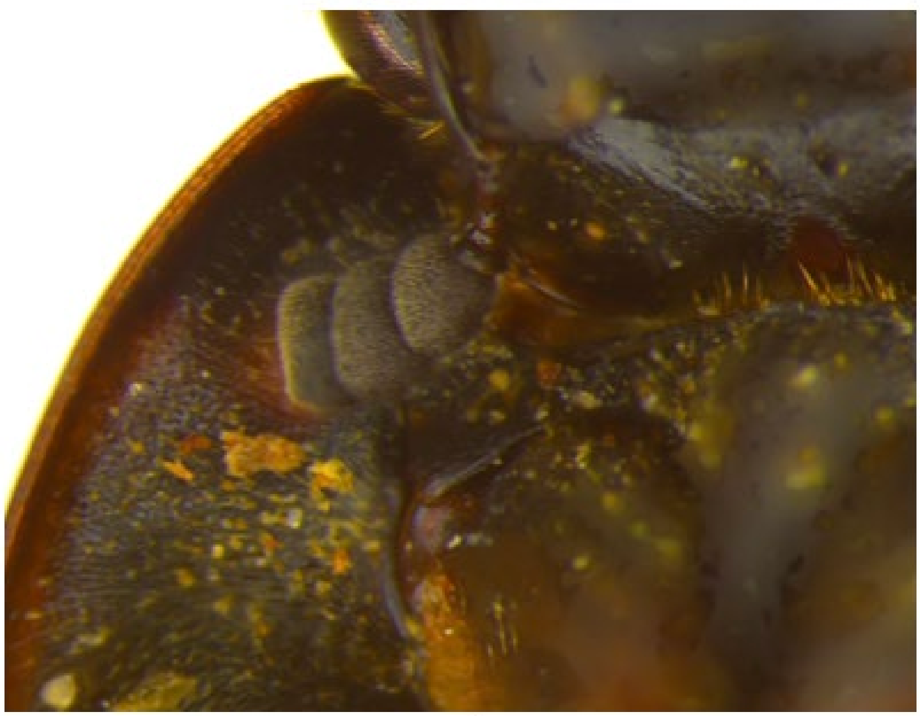
FIGURE 9a Procoxal cavities open (A) **Staphylinidae**
FIGURE 9b Procoxal cavities closed (B) **Nitidulidae**

A **B**

FIGURE 10a Antennomere 8 smaller than 7 or 9 (A) **Leiodidae**
FIGURE 10b Antennomere 8 never smaller than 7 and 9 (B)………………………………………………………………...**11**

A B

FIGURE 11a Antennae with 7-9 antennomeres, antennomeres 7-9 usually forming loose, tomentose club, antennomere 6 often forming a cupule at base of club (A) **Hydrophilidae**
FIGURE 11b Antennae variable but not as below (not shown)……………………………………………………………….**12**



A

FIGURE 12a Metacoxa with distinct posterior face (at least medially) set off from ventral surface by carina of flange (A)..**13**
FIGURE 12b Metacoxa without distinct posterior face, ventral surface of metacoxa more or less continuous with first ventrite (B)……………………………..…………………………………………………………………………….**15**

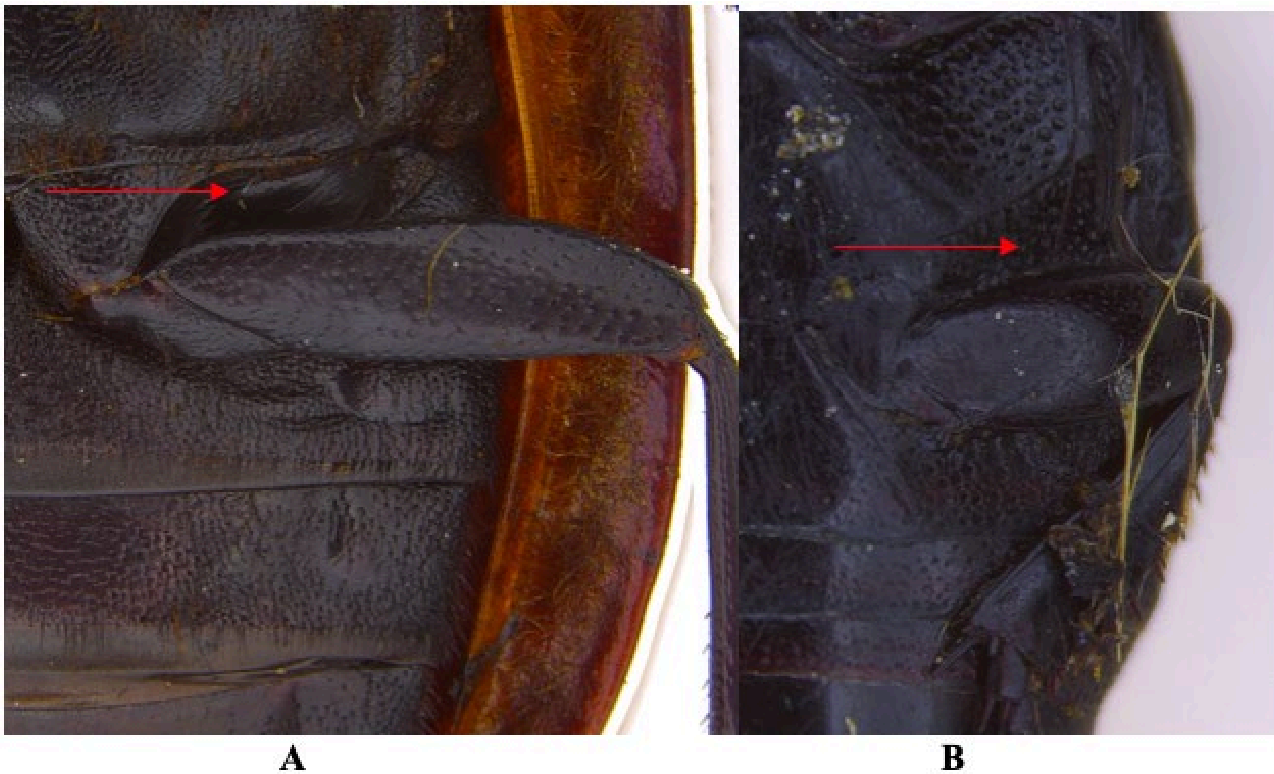


FIGURE 13a Dorsal surface of elytra setose, though often patchy (A) **Dermestidae**
FIGURE 13b Dorsal surface of elytra smooth and without setae (B)…………………………………………………………**14**

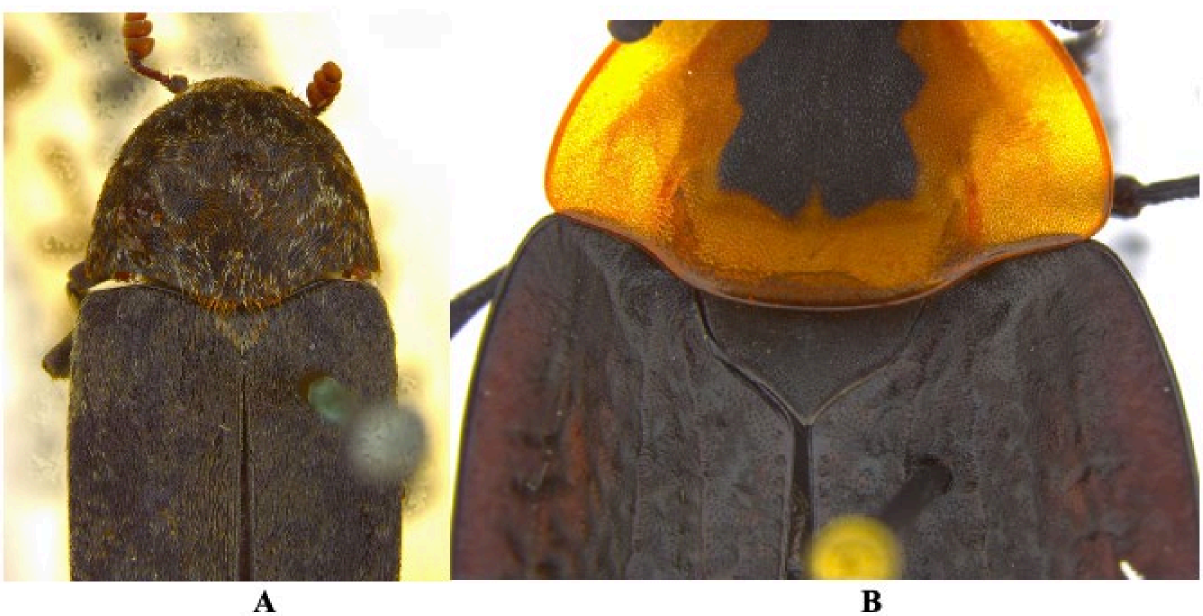
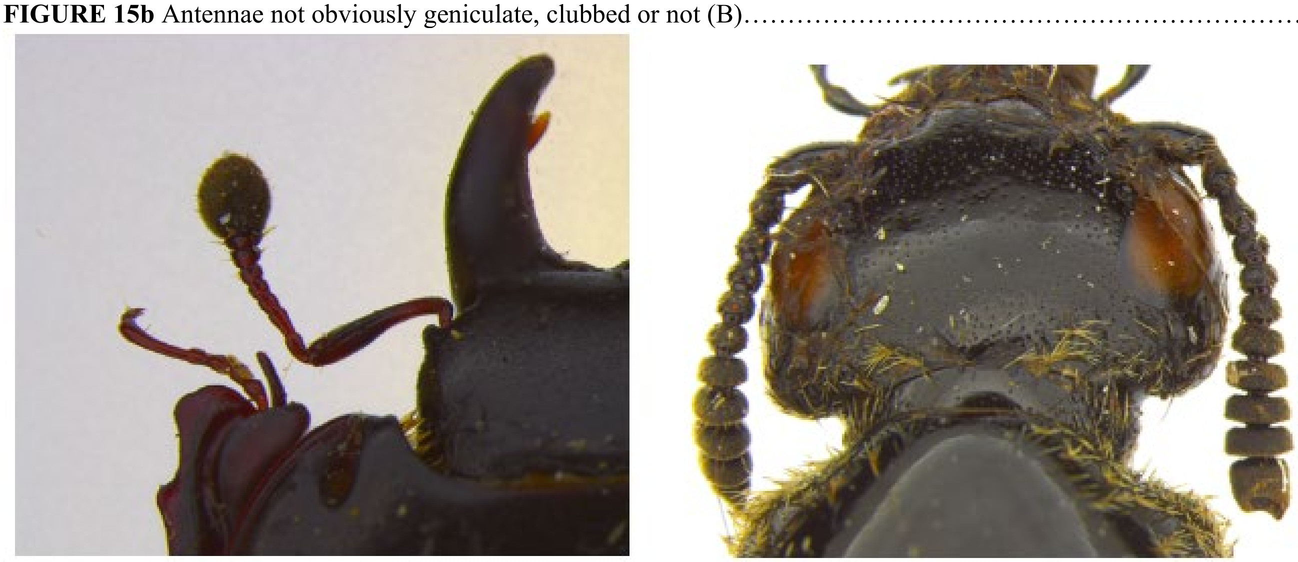


FIGURE 14a Each elytra with 9 or 10 punctate striae (A) **Agyrtidae**
FIGURE 14b Elytra without punctate striae (B) **Silphidae**

A B

FIGURE 15a Antennae geniculate, club usually of 3 antennomeres (A) **Histeridae**
FIGURE 15b Antennae not obviously geniculate, clubbed or not (B)……………………………………………………….**16**



A B

FIGURE 16a Metacoxa extending laterally to reach elytral, epipleuron, or side of body (A)…………………..………………**17**
FIGURE 16b Metacoxa not reaching elytron (B)……………………………………………………………………………..…18

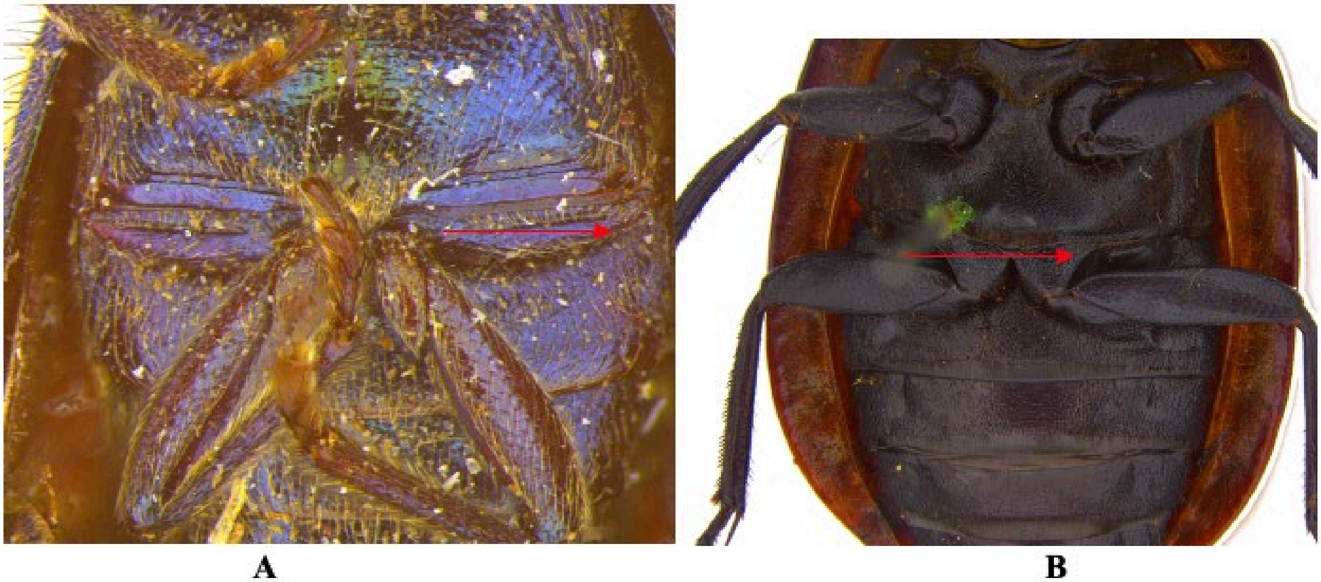


FIGURE 17a Body covered in bristly hairs (A) **Cleridae**
FIGURE 17b Body not covered in bristly hairs (B)……………………………………………………………………………**19**

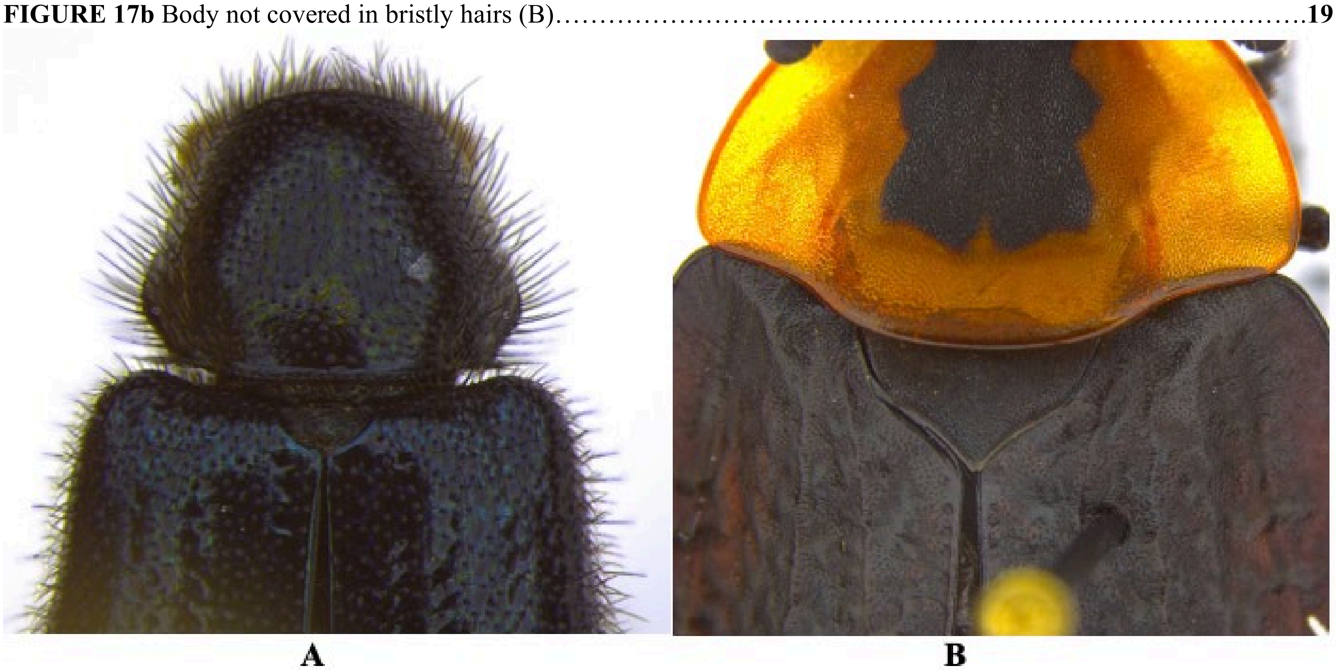


FIGURE 18a Meso- and meta-tarsi with equal numbers of tarsomeres (i.e. 5-5) (A) **Nitidulidae**
FIGURE 18b Metatarsus with one fewer tarsomere than mesotarsus (i.e. 5-4) (B)…………………………………………**19**

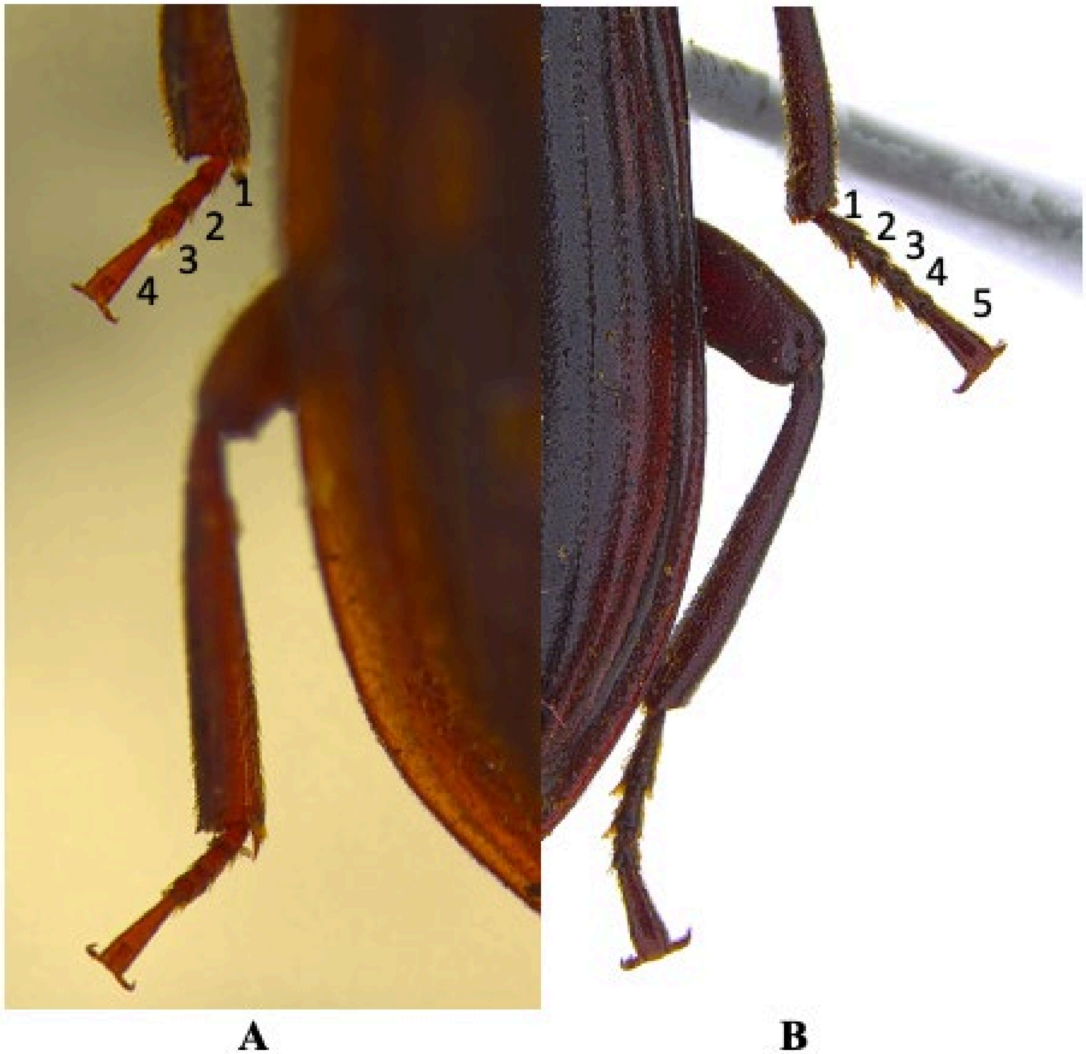


FIGURE 19a Tarsal formula (number of tarsal segments on each leg) 5-5-4 (A)…………………………………………..**20**
FIGURE 19b Tarsal formula not 5-5-4 (not shown)……………………………………..………………………………**21**

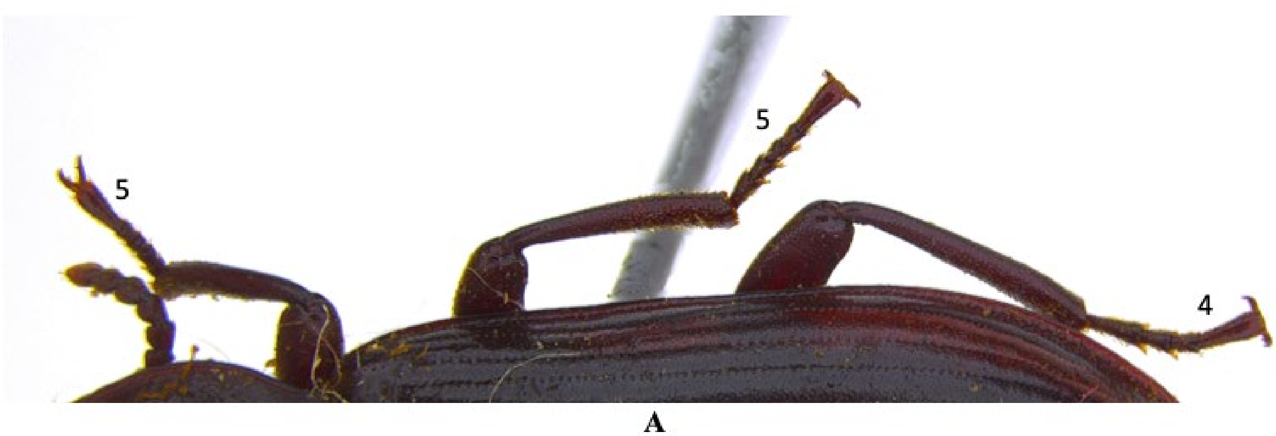
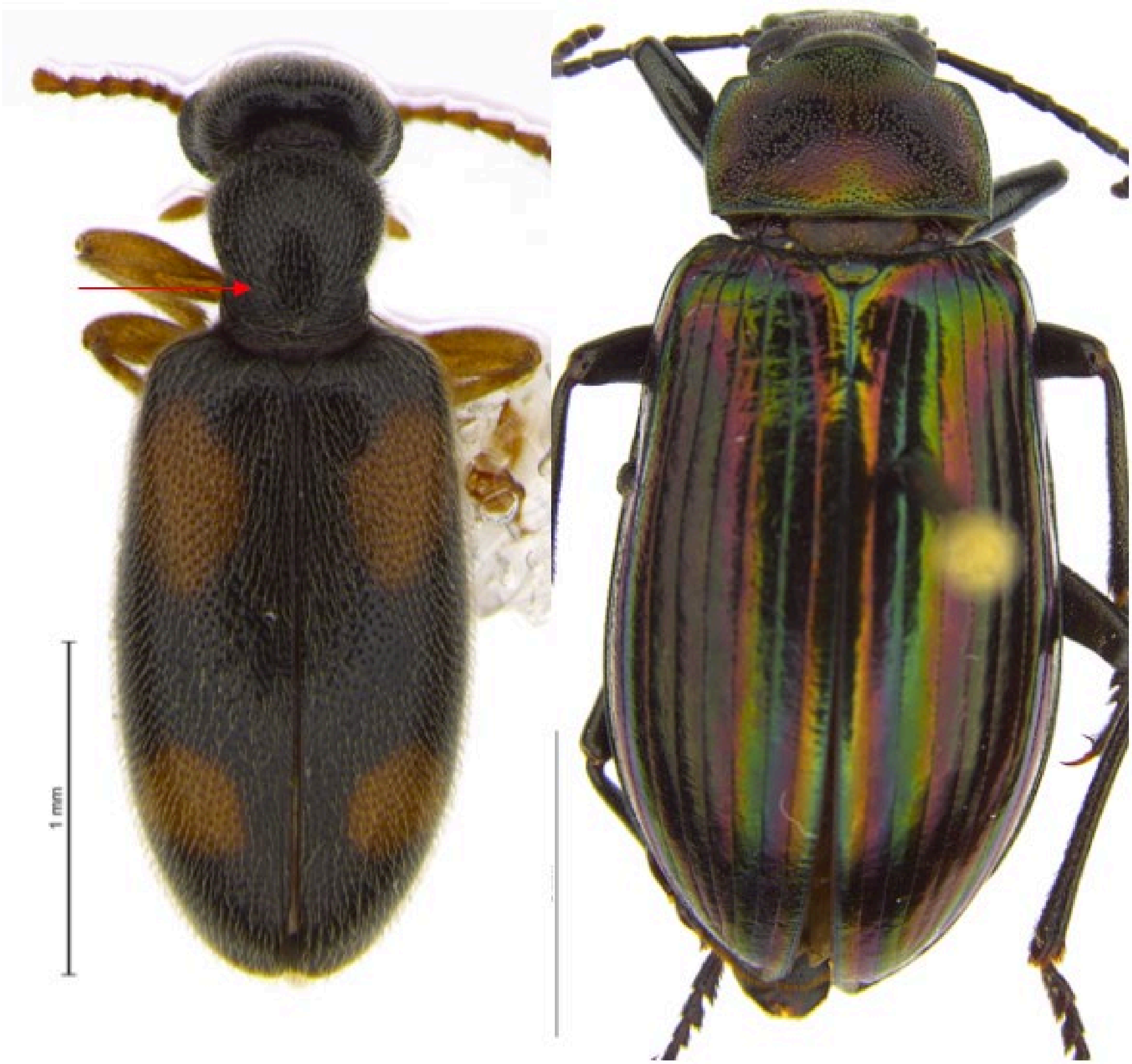


FIGURE 20a Base of pronotum with distinct constriction (A) **Anthicidae**
FIGURE 20b Base of pronotum lacking constriction (B) **Tenebrionidae**



A B

FIGURE 21a Abdomen with 6 ventrites (A) **Staphylinidae**
FIGURE 21b Abdomen with 4 or 5 ventrites (B) **Ptinidae**

A

B

Acknowledgements

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