# A Key to the Forensically important sap beetles (Coleoptera: Nitidulidae) of North America

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Editor:
Section labels:

**Abstract**

The forensically relevant taxa of the family Nitidulidae (Insecta: Coleoptera) are examined and diagnosed. Specifically, the genera *Nitidula* and *Omosita* are known to be forensically important based on the shared feeding behavior on carrion. Eight species are reported from North America (excluding Mexico), including a **new country record** for *Omosita funesta* Reitter. Distribution maps for each species were generated from collection records compiled from 25 institutions with major holdings from the USA and Canada. The validity of *Omosita nearctica* Kirejtshuk was upheld by genetic distances of COI DNA barcode data from four species of *Omosita*. Finally, a dichotomous key is provided for the *Nitidula* and *Omosita* species, supplemented with dorsal habitus photographs of each species.

**Keywords**

*Omosita*, *Nitidula*, carrion, Nitidulinae

Nitidulidae, or sap beetles, are small (1 mm–15mm long) oval to elongate beetles with clubbed antennae with a global distribution (Jelínek et al. 2010). There are estimated to be approximately 4000 species worldwide, with approximately 200 of these species occurring within the United States and Canada (Habeck 2002). Members of this family are much more ecologically diverse than the common name might suggest. This family contains species that are fungivorous, frugivorous, anthophilous, predatory, and necrophagous in addition to some exhibiting saprophagy (Parsons 1943, Powell et al. 2020). Necrophagy is exhibited by two genera, *Nitidula* and *Omosita* (Parsons 1943). Despite this well–known feeding strategy, they are often overlooked in forensic systems, possibly due to their small size (not collected) or not easily identifiable (identified to family).

Nitidulids have been collected during the later stages of decomposition across all seasons (Anderson and VanLaerhoven 1996, Watson and Carlton 2005) from a variety of vertebrate remains including dogs (Reed 1958), swine (Adair and Kondratieff 1996), rats (DeJong and Hoback 2006) various wildlife (bears, alligators, deer, turtles, and gulls; Abdell et al. 1982, Lord and Burger 1984, Watson and Carlton 2003, 2005) and humans (Rodriguez 1982). Even though they are frequently encountered, little work has been completed on life histories in a forensic context. Zanetti et al. (2013) provided an overview of larval morphology and development of *Nitidula carnaria* (Schaller) and Wang et al. (2020) examined the development of *Omosita colon* (L.) at a range of temperatures and provides insight to their thermal maximum threshold, which aids in estimating the minimum Post–Mortem Interval (mPMI) of remains in a more advanced stage of decay.

*Omosita colon* was the most frequent species of this family collected (when identified down to species) from decomposition studies (Reed 1958, Rodriguez 1982, Watson and Carlton 2003, 2005). Shubeck et al. (1981) noted that *O. colon* was the dominant beetle species collected (35% of all beetles collected, 99.71% of all nitidulids) from baited traps in New Jersey. However, nitidulids are not always recorded during decomposition studies, or they are identified only to family (McLeod 2015) or genus (Abdell et al. 1982, Monthei 2009). The further into decomposition remains are, the more challenging it becomes to provide an accurate mPMI estimation. Understanding the species composition of the insect communities in these advanced stages of decomposition is the first step to determine which insects should be studied in greater detail. Here we present an overview of the forensically relevant species of Nitidulidae for North America north of Mexico with distribution maps for each species and a diagnostic key in an attempt to increase the utilization of these important species in forensic studies.

## Materials and Methods

### Specimens examined

The following public and private collections contain specimens that were physically examined for the present study.

ARCC Andrew R. Cline Private Collection (Sacramento, CA)

AEC Arthur Evans Private Collection (Richmond, VA)

BYU Monte L. Bean Museum, Brigham Young University (Provo, UT)

CNC Canadian National Insect Collection (Ottawa, CAN)

CMN Canadian Museum of Nature (Ottawa, CAN)

CUAC Clemson University Arthropod Collection (Clemson, SC)

CSCA California States Collection of Arthropods (Sacramento, CA)

FMNH Field Museum of Natural History (Chicago, IL)

FSCA Florida State Collection of Arthropods (Gainesville, FL)

GSPC Gareth S. Powell Private Collection (Lafayette, IN)

INHS Illinois Natural History Survey (Champaign, IL)

KESC Kyle E. Schnepp Private Collection (Gainesville, FL)

MPM Milwaukee Public Museum (Milwaukee, WI)

MSU A.J. Cook Collection, Michigan State University (East Lansing, MI)

NHM Natural History Museum (London, UK)

NZAC New Zealand Arthropod Collection (Auckland, NZ)

PERC Purdue Entomological Research Collection (West Lafayette, IN)

PSUC Frost Museum, Penn State University (State College, PA)

RMBC R. Michael Brattain Private Collection (Lafayette, IN)

TAMC Texas A&M University Insect Collection (College Station, TX)

UAF University of Alaska Insect Collection (Fairbanks, AK)

UCFC University of Central Florida Collection (Orlando, FL)

UMSP University of Minnesota Insect Collection (St. Paul, MN)

USNM United States National Museum, Smithsonian (Washington, D.C.)

WIRC University of Wisconsin Research Collection (Madison, WI)

**Distributions**

State or province level presence data were recorded for the USA and Canada from more than 4,000 physical specimens from the collections listed above. Additional records were also compiled from published literature (Connell 1984, Dodge 1937, Downie and Arnett 1996, Dury 1902, Majka and Cline 2006, Powell 2015, Price and Young 2006, Vogt 1950, Williams et al. 1997). Coarse (state/province–level) distribution maps were produced in QGIS Essen v2.14.0 (QGIS Development Team, 2020).

**Key development**

Couplets were in part adapted and combined from several previous works (Parsons 1943; Audisio 1993) and then modified and illustrated here. Additional diagnostic tools have recently been presented for the Palearctic (Lee and Lee, 2015) and for South Africa (Williams et al., 2021). Character images were acquired using a Leica DFC450 camera mounted onto a M165C stereomicroscope or a Vision Digital Passport imaging system with a Canon EOS 6D camera with a 65mm lens.

**DNA–based species confirmation**

Representative DNA barcodes (cytochrome c oxidase subunit 1 “CO1”) were acquired from NCBI GenBank for four species of *Omosita* (Genbank Accession numbers given after each taxon); *O. colon* 1 (MT653618), *O. colon* 2 (KM452482), *O. colon* 3 (KM441201), *O. colon* 4 (KM446224), *O. depressa* (KU916617), *O. depressa* 2 (KM439454), *O. discoidea* 1 (KU912774), *O. discoidea* 2 (HQ953668), *O. discoidea* 3 (KM445991), *O. discoidea* 4 (KU919455) and *O. nearctica* 1 (MT371766), *O. nearctica* 2 (MG054067), *O. nearctica* 3 (MG058703). *Nitidula bipunctata* (KU918404) was included as an outgroup. Sequences were aligned following default conditions using MAFFT v.7.45 (Katoh and Standley 2013) implemented in Geneious Prime v.2021.0.1 (Kearse et al. 2012). Genetic distances were also generated in Geneious Prime.

## Results and Discussion

### Taxonomic notes

*Nitidula nigra* Schaeffer, 1911, is treated here as a synonym of *N. rufipes*. Audisio (1993) argued for this nomenclatural change based on a combination of shared characters (*i.e.,* elytra with narrowly flattened margins, lacking clear elytral patterning, and aedeagal structure) and lack of reliable morphological differences between the two taxa. *Omosita colon* (Linnaeus, 1758) was by far the most prevalent name used for the morphospecies that is the most commonly collected in the United States and Canada with a lighter apex of the elytra. Kirejtshuk (1987) described *O. nearctica,* to which most of these records are referring but stated that a few confirmed specimens of *O. colon* were seen from parts of Canada. None of those records were able to be confirmed for the present work and remain rare historic records that are not included as part of this practical application to forensic entomology in North America.

### Barcode confirmation of *Omosita neartica*

DNA barcodes were used to generate a genetic distance matrix (Table 1) to assess the validity of four species of *Omosita*. Genetic similarity is given as a percentage (Table 1). Two species, *O. discoidea* and *O. nearctica*, were each represented by multiple individuals and those individuals were shown to be >98% identical across the barcode region of CO1.

Genetic similarity between the four species of *Omosita* was shown to be 84.91-91.21% 85.52–89.97%. The historically confused *O. colon* and *O. nearctica* exhibit the upper end of that range, with 89.97% similarity. While barcodes alone are a contentious method of defining or diagnosing species (Brower 2006, Rubinoff et al. 2006), they can be valuable tools and, in this case, clearly support the validity of *O. nearctica* as morphologically described by Kirejtshuk (1987)

**Table 1. Genetic similarity (%) matrix between several species of *Omosita* based on the barcode region of COI.**

| | *N_bipunctata* | *O_colon_1* | *O_colon_2* | *O_colon_3* | *O_colon_4* | *O_colon_2* | *O_depressa_2* | *O_depressa* | *O_discoidea_2* | *O_discoidea_3* | *O_discoidea_* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *N_bipunctata* | X | | | | | | | | | | |
| *O_colon_1* | 87.08 | X | | | | | | | | | |
| *O_colon_2* | 85.71 | 87.99 | X | | | | | | | | |
| *O_colon_3* | 85.87 | 87.99 | 99.85 | X | | | | | | | |
| *O_colon_4* | 85.71 | 87.99 | 100.00 | 99.85 | X | | | | | | |
| *O_colon_2* | 85.87 | 87.99 | 99.85 | 100.00 | 99.85 | X | | | | | |
| *O_depressa_2* | 84.35 | 86.32 | 86.17 | 86.02 | 86.17 | 86.02 | X | | | | |
| *O_depressa* | 84.80 | 86.63 | 86.32 | 86.47 | 86.32 | 86.47 | 99.24 | X | | | |
| *O_discoidea_2* | 86.17 | 88.75 | 88.30 | 88.30 | 88.30 | 88.30 | 86.47 | 86.47 | X | | |
| *O_discoidea_3* | 86.17 | 88.75 | 88.30 | 88.30 | 88.30 | 88.30 | 86.47 | 86.47 | 100.00 | X | |
| *O_discoidea_4* | 86.17 | 88.75 | 88.30 | 88.30 | 88.30 | 88.30 | 86.47 | 86.47 | 100.00 | 100.00 | X |
| *O_discoidea_5* | 86.17 | 88.75 | 88.30 | 88.30 | 88.30 | 88.30 | 86.47 | 86.47 | 100.00 | 100.00 | 100.00 |
| *O_discoidea_1* | 86.17 | 88.75 | 88.30 | 88.30 | 88.30 | 88.30 | 86.47 | 86.47 | 100.00 | 100.00 | 100.00 |
| *O_nearctica_3* | 85.02 | 91.21 | 90.23 | 90.23 | 90.23 | 90.23 | 87.30 | 87.62 | 90.55 | 90.55 | 90.55 |
| *O_nearctica_2* | 85.11 | 89.97 | 89.06 | 89.21 | 89.06 | 89.21 | 84.95 | 85.56 | 87.84 | 87.84 | 87.84 |
| *O_nearctica_1* | 85.21 | 89.94 | 89.02 | 89.18 | 89.02 | 89.18 | 84.91 | 85.52 | 87.96 | 87.96 | 87.96 |

## Range Expansions

General distributions are given for each species (Fig 2A–E, Fig. 3A-C). Many of the included taxa are not thought to be native to North America and have instead been moved by humans (Parsons, 1943). This means that several of the known distributions are disjunct and should be considered tentative. *Nitidula flavomaculata* for example was not known to occur in the area prior to the middle of the 20th century but we now report from a much larger range. Parsons (1943) reported *N. flavomaculata* from California and a second introduction near Washington, D.C. We now report *N. flavomaculata* from over a dozen states/provinces. *Omosita funesta* is added to the fauna of the United States as two specimens were studied from southern Texas that clearly match this name (deposited in FMNH). The species was known from northern Mexico prior to this study and so this only represents a minor range expansion in published distribution for this species.

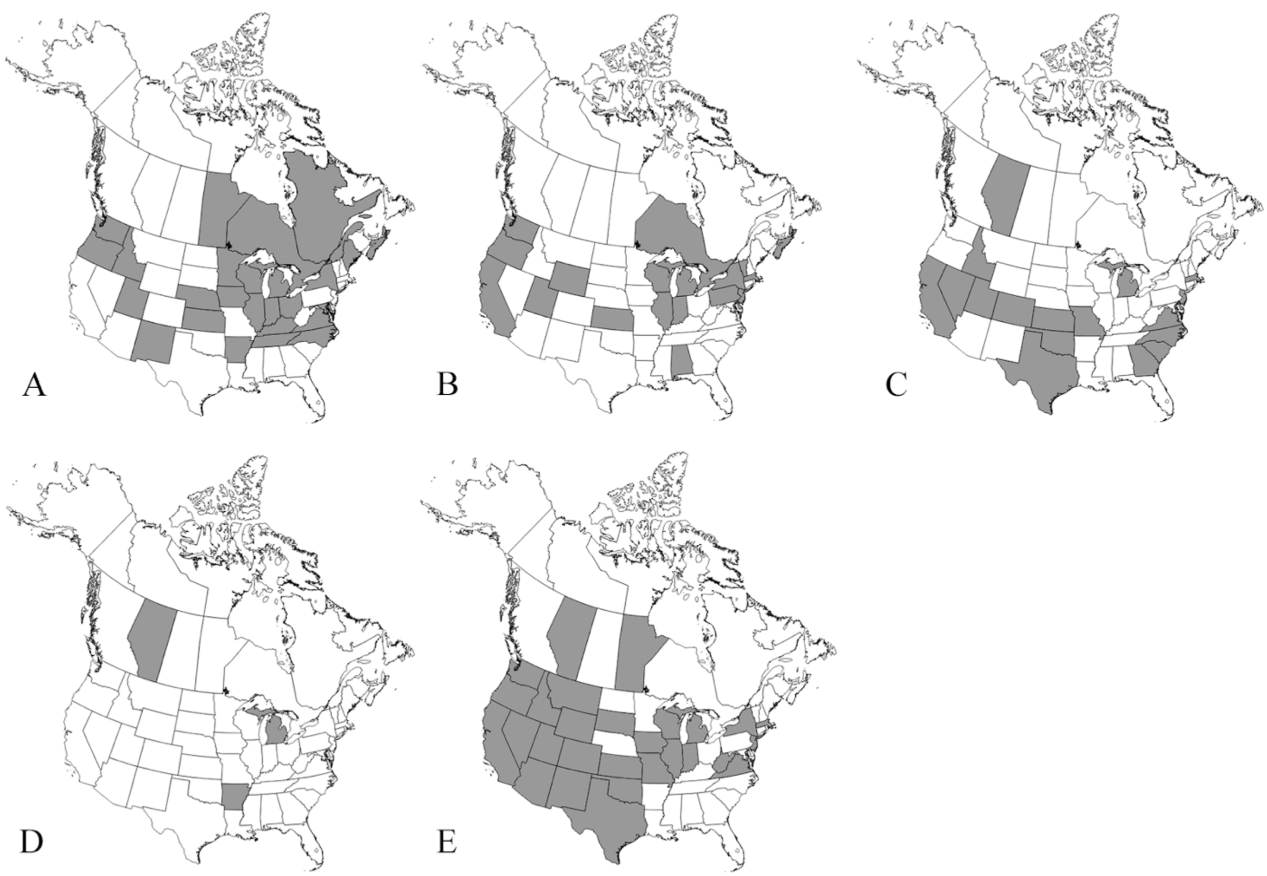


**Fig. 2.** North American north of Mexico distributions for each species of forensically important Nitidulidae. (A) *Nitidula bipunctata,* (B) *Nitidula carinaria,* (C) *Nitidula flavomaculata,* (D) *Nitidula rufipes,* (E) *Nitidula ziczac.*


**Fig. 3.** North American north of Mexico distributions for each species of forensically important Nitidulidae. (A) *Omosita discoidea,* (B) *Omosita funesta,* (C) *Omosita neartica*.

**Checklist of *Nitidula* and *Omosita* for North America north of Mexico**

*Nitidula bipunctata* (Linnaeus, 1758)

*Nitidula carnaria* (Schaller, 1783)

*Nitidula flavomaculata* (Rossi, 1790)

*Nitidula rufipes* (Linnaeus, 1767)

*Nitidula ziczac* Say, 1824

*Omosita discoidea* (Fabricius, 1775)

*Omosita funesta* Reitter, 1873 **new country record**

*Omosita neartica* Kirejtshuk, 1987

Dorsal habitus photos (Figs. 5-6) are provided for all eight species to assist the key below.

**Key to adult *Nitidula* and *Omosita* in the USA and Canada**

1a. Labrum bilobed (Fig.4A) and the presence of paramedial pronotal depressions………..2 (*Omosita*)

b. Labrum emarginate (Fig. 4B) and a lack of paramedial pronotal depressions.…...4 (*Nitidula*)

2a. Elytra nearly parallel, pronotum with long, golden setae along basal third of margin………

…………………..……………..*Omosita funesta*

b. Elytra narrowing posteriorly, with nearly indistinct silver setae…………………….……3

3a. Base of elytra distinctly darker than apex ……………………………...*Omosita neartica*

b. Apex of elytra distinctly darker than base, disc of pronotum also darker …...…*Omosita discoidea*

4a. Elytra unicolorous …………*Nitidula rufipes*

b. Elytra with distinct maculations ……………5

5a. Each elytron with single pale spot (often orange) ……………………..*Nitidula bipunctata*

b. Elytra lacking well defined single spots……6

6a. Pronotum broadly explanate with margins lighter……………………*Nitidula flavomaculata*

b. Pronotum not explanate…. ………………7

7a. Body length shorter, 1.5–3.0mm……………

………………….………........… *Nitidula carnaria*

b. Body length longer, 3.0–5.0mm..……………………….…..*Nitidula ziczac*

**Acknowledgements**

We thank the many curators and collections staff that provided loan material or hosted museum visits facilitating access to vital specimens: Maxwell Barclay (NHM), Craig Brabant (WIRC), Michael Brattain, Yves Bousquet (CNC), Michael Caterino (CUAC), Shawn Clark (BYU), Andrew Cline (CDFA), Anthony Cognato (MSU), Anthony Davies (CNC), Andrew Deans (PSUC), Arthur Evans, Michael Ferro (CUAC), Michael Geiser (NHM), François Génier (CMN), Richard Leschen (NZAC), Eugenio Nearns (PERC), Crystal Maier (FMNH), Thomas McElrath (INHS), Sandor Kelly (UCFC), Edward Riley (TAMU), Kyle Schnepp (FSCA), Floyd Shockley (USNM), Derek Sikes (UAF), Paul Skelley (FSCA), Robin Tompson (UMSP), Dan Young (WIRC), Jennifer Zaspel (MPM). We thank Natalie Saxton for assistance taking dorsal habitus photos and Laura Sutherland for assistance generating several of the distribution maps. Lastly, we would like to thank reviewers and editorial staff that helped improve the manuscript at each stage.

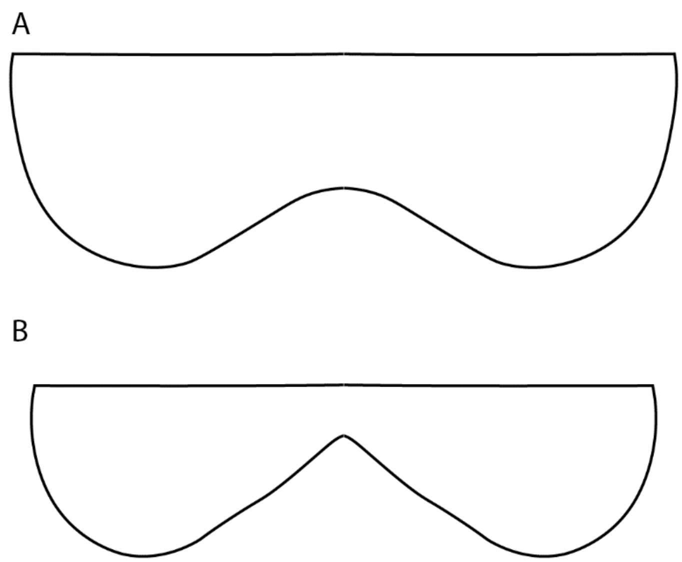


**Fig. 4.** Line drawings of the labrum of (A) *Omosita*, (B) *Nitidula.*

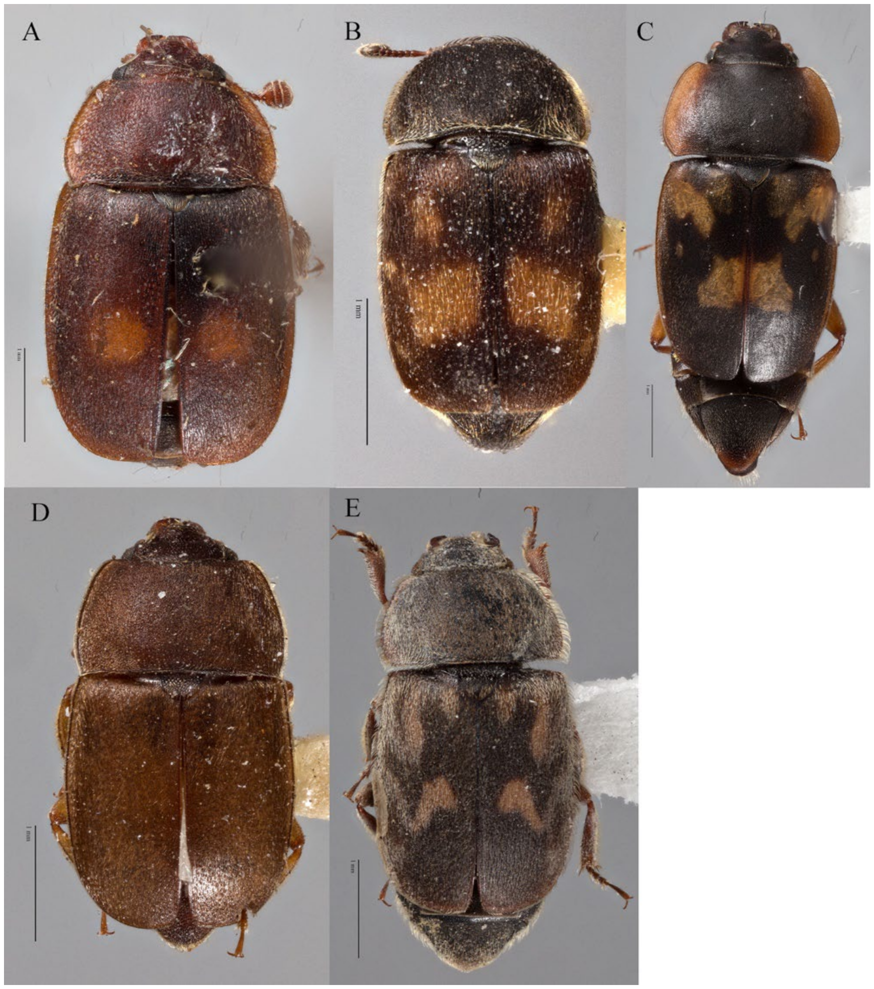


**Fig. 5.** Dorsal habitus photographs of the North American species of *Nitidula*. (A) *Nitidula bipunctata* (B) *Nitidula carnaria* (C) *Nitidula flavomaculata* (D) *Nitidula rufipes* (E) *Nitidula ziczac*

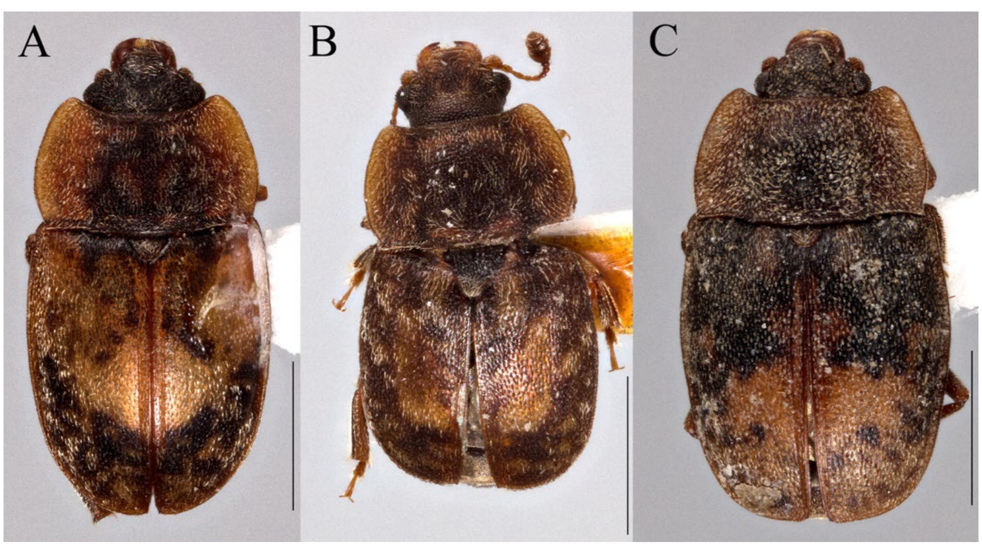


**Fig. 6.** Dorsal habitus photographs of the North American species of *Omosita.* (Scale bars = 1mm) **A)** *Omosita discoidea* **B)** *Omosita funestra* **C)** *Omosita neartica.*

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