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A new species of stag beetle from sand dunes in west Texas, and a synopsis of the genus *Nicagus* (Coleoptera: Lucanidae: Aesalinae: Nicagini)

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Abstract

A new species of stag beetle, *Nicagus occultus* **n. sp.**, is described from the Monahans Sandhills of western Texas. Previously, the genus *Nicagus* contained only two species: *N. obscurus* (LeConte) from the eastern and central United States and southern Canada, and *N. japonicus* Nagel from Japan. The discovery of *N. occultus* represents both an unexpected range extension and an unusual habitat (unvegetated sand dunes) for the family Lucanidae. A synopsis (diagnosis and distribution) for each *Nicagus* species is given, including detailed distributional information for *N. obscurus*.

Key words: Lucanidae, *Nicagus*, Texas, United States, Japan, sand dunes

Introduction

The family Lucanidae is a well-known and avidly collected family of beetles. Although there are approximately 1000 species of stag beetles worldwide (Krajcik 2001), the Nearctic region is home to only 23 species in eight genera (Smith 2003). The last new species of Nearctic lucanid was described by Benesh (1942) over sixty years ago. Stag beetles are generally found in forested habitats, where the larvae feed on decaying wood (Ratcliffe 2002). Some stag beetles are known from sandy habitats along bodies of water, such as the eastern North American *Nicagus obscurus* (LeConte) (see Discussion). However, only one Nearctic species, *Lucanus mazama* (LeConte), has been previously reported from sand dunes (Hardy & Andrews 1974), and then only from the dune periphery near dead vegetation. Here we report the discovery of an undescribed species of *Nicagus* (Aesalinae: Nicagini, Fig. 1) found on active, unvegetated sand dunes in west

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Texas. We provide our observations on biology and probable life history of this new species with respect to its unique habitat and discuss characters that distinguish the two North American species of *Nicagus*. The distribution of *N. obscurus* has not been previously reported in detail. It is included here to emphasize the disjunct distribution of the new species.

Previously, the genus *Nicagus* was known from two species, one from eastern North America (*N. obscurus*) and another found in Japan (*N. japonicus* Nagel). Species of *Nicagus* are atypical stag beetles, and at first glance they do not seem to belong to Lucanidae. None of the characters that are generally used to distinguish the Lucanidae apply to the genus: enlarged male mandibles, geniculate antennae, and an elongate first antennal segment are all lacking. Furthermore, species of *Nicagus* have a strongly asymmetrical, closeable club that approaches the club found in scarabs to a greater degree than does that of any other lucanid antennae. However, because the club segments are not lamellate, the club in *Nicagus* is loose when closed and not as compact as in the Scarabaeidae. Based on their aberrant morphology, grayish coloration, and oval, convex body form, the genus has in the past been included in the Trogidae or Scarabaeidae by some authors (LeConte 1847, 1861; Kikuta 1986). The genus was transferred to the Lucanidae from Scarabaeidae by Deyrolle (1873).

More recent studies examining adult and larval characters have reaffirmed the placement of *Nicagus* within Lucanidae (Tabana & Okuda 1992; Katovich & Kriska 2002). Howden & Lawrence (1974) erected the subfamily Nicaginae for *Nicagus* and *Ceratognathus* Westwood of Australia, New Zealand, and southern South America. We follow the classification of Holloway (1969, 1997) based on convincing morphological analyses that places these genera within the Aesalinae. Molecular analyses currently in progress further support placement of *Nicagus* as an aesaline lucanid (D.C. Hawks, University of California-Riverside & M.J. Paulsen, unpublished data).

Materials and Methods

Specimens and Taxonomic Material

A total of 480 specimens were examined during this study, including specimens of *N. obscurus* and *N. japonicus*. Specimens or distributional data were provided by 17 institutions and private collections. Acronyms for institutions are from Samuelson *et al.* (2001), when available.

ADSC Aaron D. Smith collection, Austin, TX
CMNC Canadian Museum of Nature, Ottawa, Canada (Andrew Smith)
CMNH Carnegie Museum of Natural History, Pittsburgh, PA (Robert Androw)
CNC Canadian National Collection, Ottawa, Canada (Patrice Bouchard)
CUAC Clemson University, Clemson, SC (Phillip Harpootlian)

FMNH Field Museum of Natural History, Chicago, IL (Alfred Newton)
FSCA Florida State Collection of Arthropods, Gainesville, FL (Paul Skelley)
GMPC G. Mynhardt collection, College Station, TX
INHS Illinois Natural History Survey, Urbana, IL (Colin Favret)
KDKC K.D. Karns collection, Lancaster, OH
MJPC M.J. Paulsen collection, Lincoln, NE
MLJC M.L. Jameson collection, Lincoln, NE
MSUC A.J. Cook Arthropod Research Collection at Michigan State University, East Lansing, MI (Gary Parsons)
RAAC R.A. Androw collection, Gibsonia, PA
UGCA Georgia Museum of Natural History, Athens, GA (Cecil Smith)
UMMZ University of Michigan Museum of Zoology, Ann Arbor, MI (Barry OConnor)
UNSM University of Nebraska State Museum, Lincoln, NE (Federico Ocampo and Brett Ratcliffe)
USNM National Museum of Natural History, Washington, D.C. (Gary Hevel)

Morphological Characters

The following conventions were used during the collection of morphological data. Specimens were viewed under a dissecting microscope at 6.3 to 40.0x under fiber optic illumination. Our description parallels that for *N. obscurus* provided by Holloway (1969). ***Length*** was measured from the apex of the clypeus to the apex of the elytra. ***Width*** was measured at the widest point of the elytra. ***Color*** was determined under fiber optic illumination and magnification. The appearance of ***vestiture*** was described as seen under light magnification and is defined as either ***setae*** (simple, circular in cross section, hair-like) or ***bristles*** (thickened, flattened, or scale-like). ***Puncture size*** was defined as either large, moderate, or fine. Under 40x magnification, large punctures appear as pits over 0.06 mm in diameter with a visible floor, usually containing a single scale/seta. Moderate punctures (0.03–0.06 mm) may contain a scale or seta visible at 40x. Fine punctures are small (less than 0.03 mm) and lack structure or vestiture at a magnification of 40x. ***Puncture density*** was defined as contiguous, dense (punctures separated by less than 2 puncture diameters), moderate (punctures separated by 2–4 puncture diameters), sparse (separated by more than 4 puncture diameters), or impunctate.

Species Recognition

A modified phylogenetic species concept is applied in this study. Species are defined as the smallest aggregation of populations diagnosable by a unique combination of character states (Wheeler & Platnick 2000). However, to apply a consistent criterion for species taxa the robustness of the characters involved must be evaluated. Defining consistent species taxa within the Lucanidae requires the use of robust characters

(including especially the form of the genitalia) that have demonstrated importance in species-level recognition, rather than relying on small differences in few characters (such as the form of the male mandibles) that may result from geographic variation or allometry.

Nicagus LeConte, 1861: 130

Generic description. Total body length 5.5–9.5 mm. Sexual dimorphism present in the following characters: shape, color, dorsal vestiture, pronotal shape, size of antennal club, metatarsus length, claw size. Color light to dark brown, females usually darker, males of some species occasionally covered with a grayish accretion. Dorsum punctate, punctures large, each bearing a setae or bristle, vestiture shorter and finer in female. Head with an anteocular process. Eye larger in males, entire (not divided by an anterior ocular canthus). Antennae 10-segmented, clavate, not geniculate; scape short, nearly 1/2 as wide as long, anterior and dorsal faces covered with bristles; club 3-segmented, strongly asymmetrical, segments subcylindrical (not lamellate), capable of being closed (but not tightly), club larger in male. Mandibles short, apex acute, internal edge densely setose, not sexually dimorphic. Pronotum convex (males or females) or explanate (some males), lateral margin angulate to broadly rounded, usually crenulate (sometimes feebly so). Procoxae contiguous. Prosternal process narrow, carinate, not produced anteriorly. Mesocoxal cavity open laterally. Trochantin not exposed. Protibia with 1 apical spur, apex of spur curved inward in male. Anterior tarsomeres 1–4 subequal in length, less than 1/3 length of tarsomere 5. Mesotibia with 2 simple apical spurs. Metatibia with 2 more or less spatulate spurs. Metatibia with external tooth variably developed, occasionally appearing carinate. Mesotarsus and metatarsus with tarsomeres 1–4 decreasing in size, metatarsus and all claws shorter in female. Arolium short but visible, apex with 2 bristles. Abdomen with 5 visible ventrites, apex of last ventrite rounded. Male genitalia symmetrical. Internal sac eversible (not permanently everted). Median lobe without paired struts at base, ventral surface concave or not. Parameres tapering or elongate, apices curved dorsally, longer than basal piece. Female genitalia with coxites densely setose; styli simple, not hooked; apex of ninth tergite rounded. Wings fully developed in both sexes.

Nicagus occultus Paulsen & Smith, new species (Figs. 1–2, 3a, 4a, 5, 7–9)

Type specimens. Male holotype, female allotype, 100 male and 20 female paratypes. Holotype and allotype deposited at FMNH, labeled: a) “USA: TX: WARD Co. / Monahans Sandhills State / Park, N of campground on / active dunes N 31.637 W / 102.817, morning, 855 m / 5–6 JUN 2005, M.J. Paulsen”; b) “*Nicagus occultus* / PAULSEN & SMITH 2005 /”, “HOLOTYPE” or “ALLOTYPE”. Male (63) and female (10) paratypes labeled: a) labeled as holotype; b) paratype label: “*Nicagus occultus* / PAULSEN & SMITH 2005 /

PARATYPE". Male (21) and female (4) paratypes labeled a) "USA: TX: WARD Co. / 4 mi NE Monahans, / Monahans Sandhills SP / N 31.5731 W 102.8953 / 30 MAY 2005; AD Smith"; b) paratype label as above. Male (5) and female (4) paratypes labeled: a) "USA: TX: Ward County / Monahans Sandhills; 4.8 mi / NE of Monahans 30.V.2005 / N 31.5731 W 102.8953, on / sand dunes, Glene Mynhardt"; b) paratype label as above. Male (3) paratypes labeled: a) "USA: TX: WARD Co. / Monahans Sandhills State / Park, N of campground on / active dunes N 31.637 W / 102.817, pre-dusk, 855 m / 4 JUN 2005, M.J. Paulsen"; b) paratype label as above. Male (6) and female (1) paratypes labeled: a) "USA: TX: WARD Co. / Monahans Sandhills State / Park, N of campground on / active dunes N 31.637 W / 102.817, pre-dusk, 855 m / 5 JUN 2005, M.J. Paulsen"; b) paratype label as above. Male (2) and female (1) paratypes labeled: "USA: TX: WINKLER Co. / 8 mi. NE Kermit, N 31 56' / 24.6" W 102 58'41.3", elev. 928 m /active dunes, morning; / 6 JUN 2005; M.J. Paulsen"; b) paratype label as above. Paratypes deposited in the FMNH, CMNC, FSCA, USNM, UNSM and in the collections of J.C. Abbott (Austin, TX), L. Bartolozzi (Firenze, Italy), D.C. Hawks (Riverside, CA), S. Kawai (Tokyo, Japan), E.G. Riley & Texas A&M University (College Station, TX), P.E. Skelley (Gainesville, FL), and the authors.

FIGURE 1. Dorsal habitus of *N. occultus:* a) male and b) female.

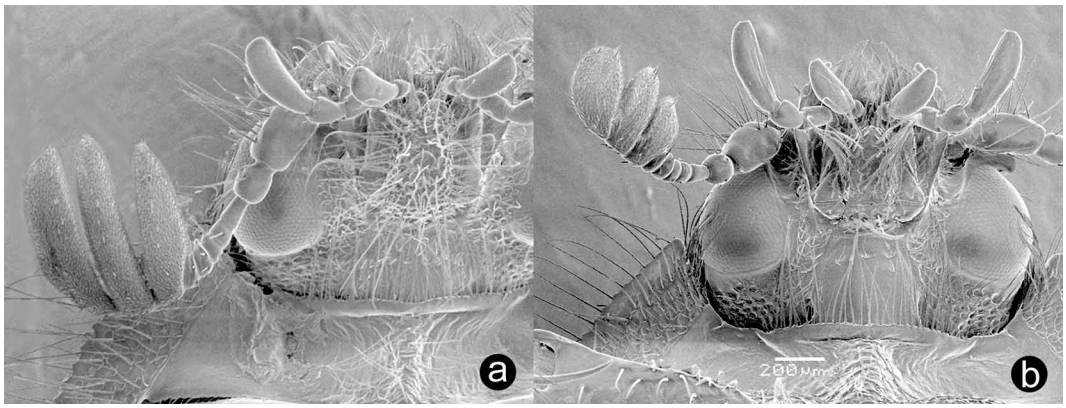


FIGURE 2. Head and right antenna of *N. occultus* (ventral view) of: a) male and b) female.

Male holotype description. ***Length:*** 7.8 mm. ***Width:*** 3.5 mm. ***Color:*** Head, pronotum, legs dark brown; elytra, tarsi, antennae slightly lighter, reddish brown. ***Head:*** Eye large, entire. Anteocular margin with rounded process protruding in front of eye. Vertex tumid, in lateral view appearing subtuberculate. Frons weakly depressed behind anterior margin, margin rounded apically and produced near antennal insertions, not strongly reflexed. Clypeus (inter-mandibular projection) nearly vertical, one-third as long as broad, emarginate anteroventrally to receive labrum. Labrum semi-circular, projecting anteroventrally. Mandibles short, broad, densely setose internally, not obscured by setae, acute apically, apices prominent in dorsal view. Antennae not geniculate; scape short, not longer than combined length of segments 2–7; club closeable, elongate lamellae fitting together loosely when closed, lamellae distinctly longer than last segment of maxillary palpus (Fig. 2a). Surface setose, densely punctate; punctures large, contiguous. ***Pronotum***: Lateral margins not explanate, weakly crenulate, subangulate behind middle, nearly straight from anterior margin to angulation, emarginate from angulation to acute posterior angle. Margins fimbriate with setae longer than scutellum. Surface densely punctate except at midline; punctures large, each bearing 1 long, fine seta; setae pale-colored (almost colorless), erect (Fig. 3a). ***Scutellum:*** Surface medially and apically glabrous, punctate and setose basally. ***Elytra:*** Lateral margins crenulate, fimbriate; setae longest at base, basal setae subequal in length to scutellum. Surface punctate; punctures large, each bearing 1 long, fine seta at anterior end; setae mostly more than 2 times longer than puncture diameter, pale-colored (almost colorless), erect. ***Legs:*** Protibia quadridentate 2 basal teeth small, apical 2 teeth strongly developed, acute; spur unciform, inwardly curved. Protarsus with last tarsomere subequal in length to tarsomeres 1–4 combined. Mesotibia with weak, oblique carina at basal third; spurs both longer than basal tarsomere, acute. Metatibia robust, in lateral view gradually widening towards apex (Fig. 5), apex 1/3 as wide as long, oblique; posterior face expanded (Fig. 7); inferior spur subequal in length to basal tarsomere, longer superior spur subequal in length to tarsomeres 1 and 2 combined, spatulate after middle, both spurs with spatulate faces

coplanar with oblique apex. External tooth of metatibia reduced to weak carina. Metatarsus plus claw length as long as metatibia. Claws long, weakly curved, subequal in length to last tarsal segment. ***Genitalia:*** (Fig. 8). Median lobe short, not reaching apex of parameres, apex broadly rounded (not acuminate), apical margin continuous with ventral concavity. Parameres strongly curved dorsally.

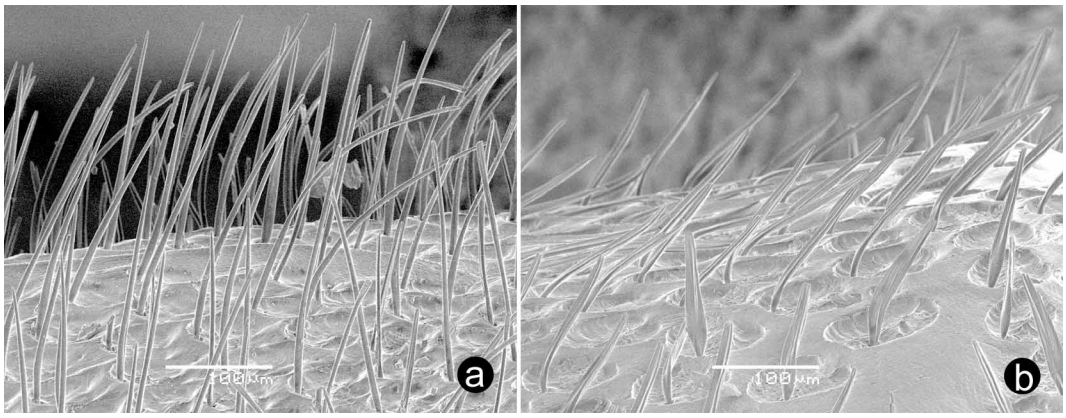


FIGURE 3. Vestiture of pronotum (lateral view) in male a) *N. occultus* and b) *N. obscurus.*

Female allotype description. ***Length:*** 7.8 mm. ***Width:*** 3.9 mm. As holotype except in the following respects: ***Head:*** Color darker, entirely dark brown except tarsi, antennae lighter reddish brown. Eye smaller than in male. Anteocular margin with subtriangular process protruding in front of eye. Vertex tumid, in lateral view appearing subtuberculate. Antennal club oval, small, lamellae subequal in length with last segment of maxillary palpus (Fig. 2b). ***Pronotum***: Lateral margin weakly crenulate, crenulation lacking behind median angulation. ***Elytra:*** Surface setose, setae fine, short, most shorter than 2 puncture diameters. ***Legs:*** Protibia quadridentate, 2 basal teeth small, 2 apical teeth more strongly developed than in male; spur simple, short, acute. All claws curved, shorter than in male. Mesotibiae with 1–2 weak external teeth; spurs both longer than basal tarsomere, acute. Metatibia robust, in lateral view gradually widening towards apex, at apex nearly 1/2 as wide as long, with external oblique carina at basal third, weakly developed; spurs broader than in male, inferior spur longer than basal tarsomere, superior spur abruptly expanded at middle, broadly rounded apically, spatulate. Metatarsus shortened, length including claw shorter than metatibia. ***Genitalia:*** Sclerotized structures similar to those of *N. obscurus* (see Holloway 1969) except coxites with longer setae, hemisternite of ninth segment curved internally at base, and ninth pleurite approximately 2 times wider than in *N. obscurus.*

Variation. Males (n=100). Male paratypes differ from the holotype in the following characters: ***Length****:* 5.8–7.9 mm. ***Width:*** 2.5–3.5 mm. ***Color:*** light brown (teneral) to dark brown. ***Head:*** Anteocular process more or less strongly developed. Frons with weak to strong excavation behind anterior margin. Vertex with median elevation variably

developed from simply tumid to tuberculate. ***Pronotum***: Lateral margin rarely with crenulations reduced to absent behind middle. ***Legs:*** Anterior tibia with basal 1–2 teeth reduced or absent. Metatibia with external tooth usually absent or present as a reduced carina.

Females (n= 20). Female paratypes differ from the allotype in the following characters: ***Length***: 6.6–9.4 mm. ***Width***: 3.3–4.7 mm. ***Color:*** light brown (teneral) to dark brown. ***Head:*** Anteocular margin with process subtriangular to rounded. ***Pronotum***: Lateral margins with crenulation weak to absent. Posterior angle produced, subacute to acute. Surface with glabrous impunctate spot variably enlarged along midline. ***Legs:*** Protibia tridentate or quadridentate, 1–2 basal teeth variably reduced or absent. External oblique carina at basal third variably produced, but never toothlike.

Sexual Dimorphism. Species of *Nicagus* show a high degree of sexual dimorphism. Females are generally larger, darker, and more oval (Fig. 1). This is accentuated in *N. obscurus* and *N. japonicus* because the dorsal punctures of males are often filled with a grayish exudate or debris. This coating was not found in any male specimens of *N. occultus*, but males are generally still lighter in color than females. A more useful character for determining the sexes is the size of the antennal club. In females, the antennal club is small and round with segments about equal in length to the last segment of the maxillary palpus (Fig. 2b). Males have a much larger club with more elongate club segments, each distinctly longer than the last segment of the maxillary palpus (Fig. 2a). Females also have more robust metatibiae and shorter metatarsus than do males.

Diagnosis. This species is readily separated from its only North American congener (*N. obscurus*) by its dorsal vestiture, weakly crenulate lateral pronotal margins, and shape of the metatibiae. In *N. occultus* the dorsum of males bears mostly long, pale-colored setae (Fig. 3a). This differs from the short, flattened bristles of male *N. obscurus* (Fig. 3b). Although the dorsal vestiture of females of both species consists of fine, pale-colored setae, that of *N. occultus* females is relatively longer and more prominent. The crenulations of the lateral pronotal margins in *N. occultus* are poorly developed, being weak in males and virtually absent in some females. In contrast, the crenulations are stronger and always apparent in *N. obscurus.* Both sexes of *N. occultus* possess relatively short, conical metatibiae that gradually widen towards the apex (Fig. 5). The metatibiae of *N. obscurus* are slender in males (Fig. 6), and in females are abruptly expanded after the distal third. In addition, both sexes of *N. occultus* have more prominent, acute mandibles, and the apical protibial teeth are stronger and more acute (Fig. 4a–b). The median lobe of the male genitalia is rounded (Fig. 8) and not acuminate as in males of *N. obscurus*, and the parameres are more strongly curved dorsally.

Both Nearctic species differ from *N. japonicus*, which has an evenly rounded lateral margin of the pronotum (not angulate as in the Nearctic species) with stronger tooth-like crenulations. In addition, *N. japonicus* has the anterior margin of the clypeus subtriangular and not rounded, the claws are relatively short and subequal in length to tarsomeres 3–4

together, and males have a bidentate protibial apex (Fig. 4c), rather than an apex with a single large tooth.

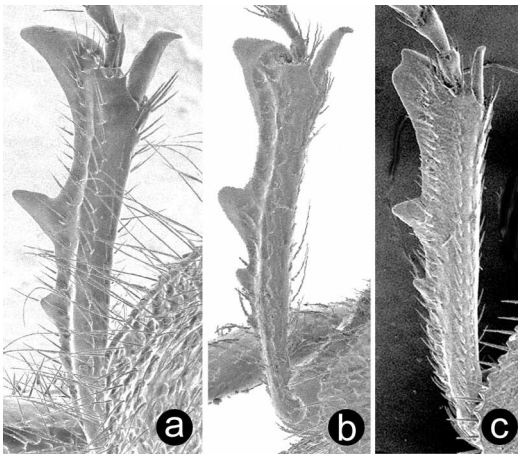


FIGURE 4. Protibial dentation (dorsal view) of male: a) *N. occultus*, b) *N. obscurus*, and c) *N. japonicus.*

Species of *Nicagus* can be immediately separated from members of the Trogidae, with which they might be confused, by the presence in *Nicagus* of a bisetose arolium between the claws. An arolium is not present in members of the Trogidae.

Etymology. The specific epithet is derived from the Latin *"occultus"*, meaning hidden, concealed, or secret, in reference to the elusive nature of the species that has evaded discovery by entomologists for decades in an ostensibly well-studied locality. In addition, many males were observed to remain hidden under the sand with only their antennae exposed.

Distribution. (Fig. 9). United States, Texas, Monahans Sandhills.

Locality Data. UNITED STATES: TEXAS: WARD (113): Monahans Sandhills State Park (4 mi NE of Monahans); WINKLER (4): 8 mi NE of Kermit.

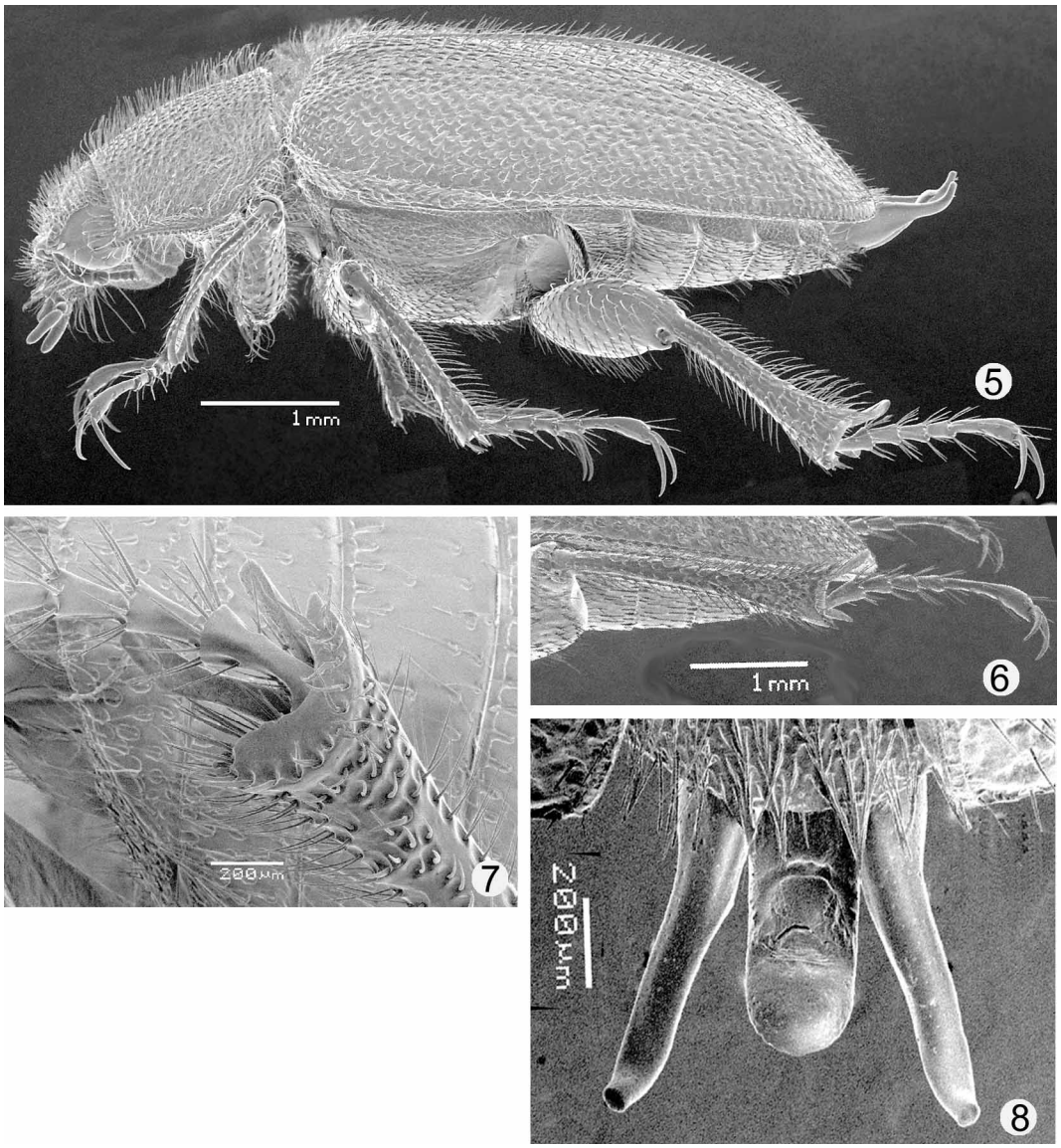
Temporal Data. May (28), June (89).

***Nicagus obscurus* (LeConte)** (Figs. 3b, 4b, 6, 9)

Nicagus obscurus (LeConte, 1847: 86) (*Ochodaeus*).

Diagnosis. This species possesses several characters intermediate between *N. japonicus* and *N. occultus.* In males, the lateral margins of the pronotum are moderately crenulate and subangulate; not as strongly angulate as in *N. occultus*, nor as broadly rounded as in *N. japonicus*. The apical protibial teeth (Fig. 4b) are smaller and more rounded than in *N. occultus*, but more strongly developed than in *N. japonicus.* However, the explanate

lateral margins of the pronotum are more strongly developed in *N. obscurus* than in either of the remaining species. In male *N. obscurus*, the antennal club segments are relatively longer, and the dorsum bears short, flattened bristles (Fig. 3b). The metatibiae of *N. obscurus* are elongate in males (Fig. 6) and straight internally (in dorsal view), and in females are abruptly expanded after the distal third (lateral view). The median lobe of the male genitalia has a small acuminate process at the apex (Fig. 8) not a broadly rounded apex as in *N. occultus* or *N. japonicus.*



FIGURES 5–8. **5.** Lateral view of male *N. occultus*, illustrating diagnostic characters: short, conical metatibia; weakly curved claws; and dorsally curved parameres. **6.** Lateral view of elongate male metatibia of *N. obscurus.* **7.** Apex of metatibiae of male *N. occultus.* **8.** Male genitalia of *N. occultus* (dorsal view), showing rounded apex of median lobe.

Distribution. Eastern North America (Fig. 9).

Locality Data. 338 specimens examined (294 male, 44 female).
CANADA: **ONTARIO**: GREATER TORONTO AREA: Toronto (CMNC, FMNH, UMMZ, USNM); LAMBTON: Grand Bend (CNC, FSCA); MANITOULIN: Billings (CNC); NIAGARA: Grimsby (MSUC); NORFOLK: Long Point (CMNC, CNC). **QUEBEC:** BROME-MISSISQUOI: Brome (CNC); no locality (Katovich & Kriska 2002).

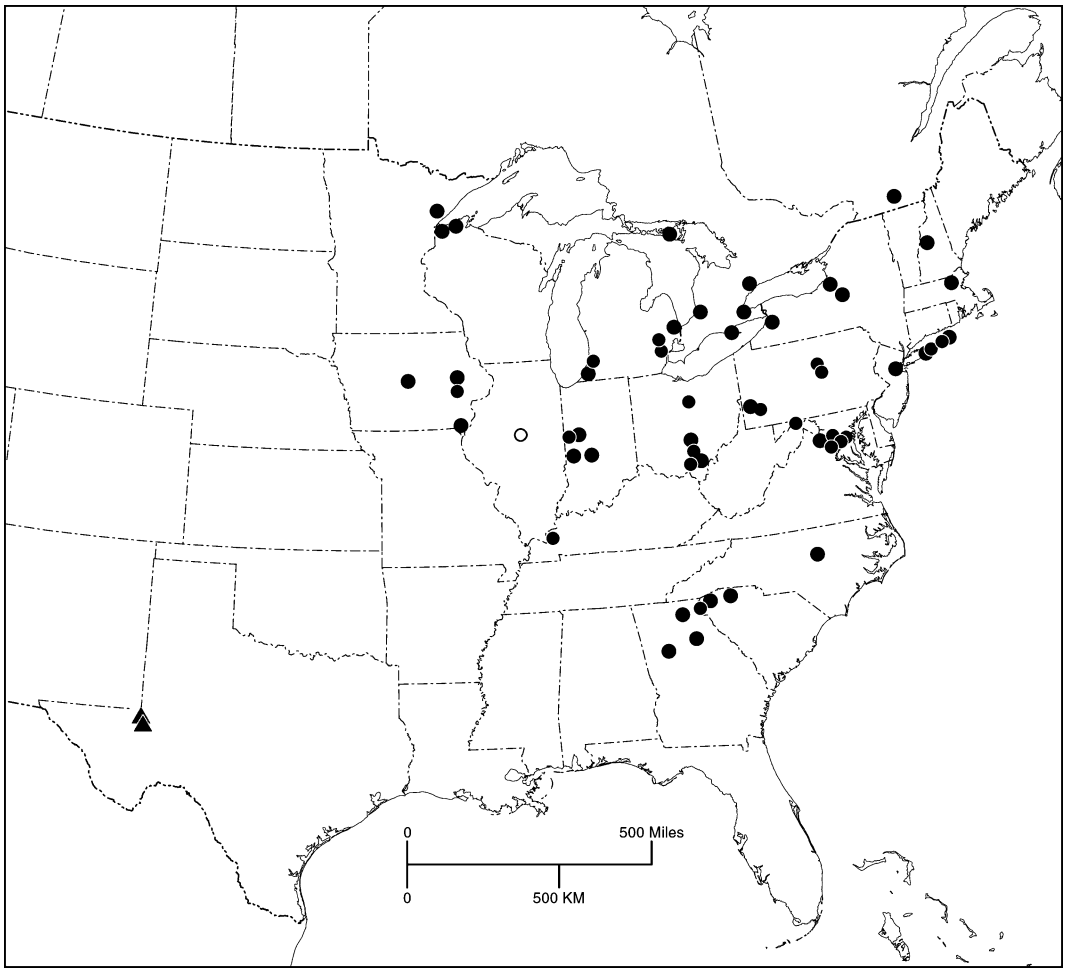


FIGURE 9. Distribution of Nearctic species of *Nicagus*, indicated by triangles (*N. occultus)*, or circles (*N. obscurus*). An open circle indicates a state record without specific locality data.

UNITED STATES: **GEORGIA**: CLARKE: no locality (UGCA); FULTON/ DEKALB: Atlanta (FMNH, USNM); WHITE: Helen (UGCA). **ILLINOIS**: no locality (FMNH, MSUC). **INDIANA**: HENDRICKS: Stilesville (USNM); PARKE: Shades SP

(FMNH, MJPC); TIPPECANOE: Wildcat Creek (FSCA), no locality (FMNH, MJPC, MSUC, UGCA, USNM); WARREN: no locality (FMNH). **IOWA**: JOHNSON: Iowa City (USNM); LEE: Shimek SF (MJPC); LINN: Indian Creek Nature Center (MJPC); STORY: Ames (CMNC, FMNH). **KENTUCKY**: LIVINGSTON: no locality (USNM). **MARYLAND**: ALLEGANY: Green Ridge SF, Oldtown (CMNH); ANNE ARUNDEL: Crofton (CMNH); MONTGOMERY: Plummers Island (USNM); PRINCE GEORGE'S: Berwyn (USNM), College Park (CMNC, USNM), Laurel (CMNH), Riverdale (USNM). **MASSACHUSETTS:** MIDDLESEX: Lowell (CNC); no locality (FMNH). **MICHIGAN**: BERRIEN: Warren Dunes (FMNH); OAKLAND: no locality (MSUC, UMMZ); ST. CLAIR: Port Huron (USNM); VAN BUREN: South Haven (CUAC); WAYNE: Detroit (USNM). **MINNESOTA**: ST. LOUIS: Duluth (INHS). **NEW HAMPSHIRE**: GRAFTON: Plymouth (CNC, FMNH, FSCA, UMMZ). **NEW JERSEY**: ESSEX: Newark (USNM). **NEW YORK**: ERIE: Buffalo (INHS); ONEIDA: Sylvan Beach (CNC); OSWEGO: Selkirk Beach (FMNH, MSUC, UNSM); SUFFOLK: Montauk (FMNH, FSCA), Napeague (INHS), Riverhead (CMNC), Wading River (CMNC, FMNH, FSCA, USNM). **NORTH CAROLINA**: WAKE: Raleigh (CMNC). **OHIO**: FAIRFIELD: Barnebey Center (CMNH, FSCA), Revenge (CMNH, MJPC); HOCKING: no locality (CMNC, FSCA, UNSM); PIKE: Liberty (KDKC, RAAC), Jackson Lake (CMNH); RICHLAND: Shelby (RAAC); VINTON: Lake Hope SP (CMNH, MLJC). **SOUTH CAROLINA**: OCONEE: Salem (CUAC); PICKENS: Clemson (FMNH, USNM); SPARTANBURG: Spartanburg (CUAC). **PENNSYLVANIA**: ALLEGHENY: Guyasuta Run (CMNH), no locality (USNM); LYCOMING: Loyalsock Creek (CMNH); NORTHUMBERLAND: Milton, Milton SP (CMNH); WESTMORELAND: Jeannette (CMNH). **VIRGINIA**: FAIRFAX: Black Pond, Dead Run, Great Falls (USNM), Springfield (CMNH). **WASHINGTON, D.C.**: Rock Creek (USNM). **WISCONSIN:** BAYFIELD, no locality (USNM), Quarry Point (Katovich & Kriska 2002); DOUGLAS: Brule Point (Katovich & Kriska 2002).

Nicagus japonicus Nagel (Fig. 4c)

Nicagus japonicus Nagel, 1928: 260.

Diagnosis. This species differs from both Nearctic species in possessing an evenly rounded lateral margin of the pronotum (not angulate as in the Nearctic species) with stronger, tooth-like crenulations. In addition, *N. japonicus* has the anterior margin of the clypeus subtriangular and not rounded, and the claws are relatively short and subequal in length to tarsomeres 3–4 together. Males have a bidentate protibial apex (Fig. 4c), rather than an apex with a single large tooth, and the inner margin of the metatibia is convex in dorsal view. Also in males, the first antennal club segment is not simply cylindrical, and instead is bulbous medially and narrows abruptly to the apex. The median lobe of the male

genitalia lacks the ventral concavity present in the Nearctic species and the parameres are less strongly curved, appearing almost straight in dorsal view.

Distribution. Fifteen specimens examined (11 male, 4 female).

JAPAN: AKITA: Mose-Hachimantai (CMNC). **HOKKAIDO**: Mena River north of Hakodate (FMNH). **NIIGATA**: Nakauonuma: Kawanishi (MJPC). A distributional map in Tabana & Okuda (1992) includes localities on the islands of Hokkaido and Honshu in the following prefectures: AKITA, FUKUI, FUKUSHIMA, GIFU, HOKKAIDO, HYOGO, KYOTO, MIE, NARA, NIIGATA, TOYAMA.

Discussion

Life history of *Nicagus* species and *N. occultus*

Species of *Nicagus* are more closely associated with sandy habitats than are most lucanids. Both *N. obscurus* and *N. japonicus* are known to inhabit sandy areas near large bodies of freshwater such as rivers and lakes (Katovich & Kriska 2002; Tabana & Okuda 1992; S. Kawai (Tokyo University of Agriculture & Technology, pers. comm.), but they are also found near small sandy streams (E. Freese [Waverly, IA] and D. Veal [Marion, IA], pers. comm.). Adults are frequently found either under driftwood and debris along the shore, or flying over sandbars in the late afternoon (Katovich & Kriska 2002, D. Veal, pers. comm.).

In contrast, most specimens of *N. occultus* we collected were found flying above or crawling on the tops of large, unvegetated sand dunes. Both sexes were active in the evening before sunset flying over and crawling up the northwestern, leeward faces of large dunes. The beetles were also active in the morning before 9:30 AM. Morning-active beetles were observed emerging from northwestern dune faces, climbing and flying up dune faces, and burrowing into the sand on the dune tops. Beetles were likely engaging in hilltopping behavior to locate mates. The majority of specimens collected were digging into dune crests of the tallest (~20 m) dunes. We observed only two mating pairs on the surface, indicating that mating may take place under the sand. The number of males collected outnumbered females at a ratio of greater than 5:1.

This environment differs dramatically from the riparian habitats of other *Nicagus* species, most notably in the apparent aridity and lack of obvious water. Monahans Sandhills State Park contains few permanent bodies of water, but temporary pools, some lasting several months, often form after periods of heavy rain (Machenberg 1984). Regardless of the seeming lack of surface water, the dunes retain a large amount of moisture in the spaces between sand grains just a few inches under the surface (Machenberg 1984).

Larvae of other *Nicagus* species have been found feeding on the underside of exposed branches and driftwood in relatively moist, sandy habitats. Katovich & Kriska (2002) reared larvae of *N. obscurus* collected feeding on aspen driftwood (*Populus sp.*,

Salicaceae). The larvae of *N. japonicus* are recorded from oak logs, *Quercus myrsinaefolia* Blume (Fagaceae) (Tabana & Okuda 1992). In the Monahans Sandhills, potential larval food for *N. occultus* includes the dead branches or roots of two trees, the sand shinnery oak (*Quercus havardii* Rydb., Fagaceae) and the desert willow (*Chilopsis linearis* (Cav.) Sweet, Bignoniaceae). However, we did not encounter beetles on oak-vegetated dunes or in interdunal depressions that support desert willow. The xeric habitat of *N. occultus* precludes the use of surface wood as in other *Nicagus* species, because any exposed wood in the Monahans Sandhills is too hot and dry for larvae to survive. We examined surface wood in both sunny and shaded conditions and found no evidence of larval feeding. Larvae of *N. occultus* may develop in wood that has been buried by dune movement or on dead tree roots under the sand. The roots of sand shinnery oak, which may reach over 20 meters, stabilize coppice dunes (Machenberg 1984) and may provide habitat for larval feeding.

The Monahans Sandhills is a belt of active and vegetated dunes approximately 110 km long and 32 km wide on the Pecos Plain running from extreme southeastern New Mexico to Crane County, Texas, in the south. The sandhills are a recent geologic feature formed within the last 12,000 years as the region became more arid (currently ~30 cm/yr precipitation) and windblown sands accumulated (Machenberg 1984). Monahans Sandhills State Park is situated near the middle of the dunes system in Winkler and Ward counties, Texas. Though the sandhills are relatively young, they are home to a variety of endemic psammophilous plants and animals. Endemic species of Coleoptera include: *Polyphylla monahansensis* Hardy, *Polyphylla pottsorum* Hardy, and *Anomala suavis* Potts (all Scarabaeidae); *Prionus arenarius* Hovore and *Prionus spinipennis* Hovore and Turnbow (both Cerambycidae); and *Trigonoscutoides texanus* O'Brien (Curculionidae). Collecting insects in Monahans Sandhills State Park requires a permit, which gives some degree of protection to the park's unique fauna. Given its restricted distribution and collecting pressure placed upon the Lucanidae worldwide, *N. occultus* may require additional protection.

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