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Two new species of bumblebee scarabs (Coleoptera: Glaphyridae: *Lichnanthe* Burmeister) from the central United States; a new discovery in Wyoming resolves a century-old puzzle from the Nebraska Sand Hills

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Two new species of bumblebee scarabs (Coleoptera: Glaphyridae: *Lichnanthe* Burmeister) from the central United States; a new discovery in Wyoming resolves a century-old puzzle from the Nebraska Sand Hills

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Abstract. The genus *Lichnanthe* Burmeister (Coleoptera: Scarabaeoidea: Glaphyridae) has been comprised of eight Nearctic species and contains the only New World members of their family. Here, two new species of arenicolous bumblebee scarabs are described from the central United States. The recent discovery of an undescribed Wyoming species led to the reevaluation of a dubious 134-year-old Nebraska *Lichnanthe* specimen, indicating that it also was an undescribed species. These two species, *Lichnanthe brusti* **new species** from central Wyoming and *L. bruneri* **new species** from central Nebraska are immediately distinguishable from all existing species of the genus by their square mandibles.

Key words. Taxonomy, pollinators, blowout penstemon, xerophilic, Seminoe Dune, Ferris Dunes, Nebraska Sand Hills.

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Introduction

The bumblebee scarabs (Scarabaeoidea: Glaphyridae) are a small family of beetles that consist of six genera and around 200 species in the Holarctic region and Southeast Asia (Carlson 1980; Nikodym and Bezdek 2006). The sole component of the family in the Americas is the genus *Lichnanthe* Burmeister, with eight previously recognized extant species in North America (Carlson 1980). The common name suggests that these scarabs are mimics of bumble bees, however, most mimic other types of bees in color and the name bee scarabs would be more apt.

Carlson (1980) last revised the genus *Lichnanthe*, indicating the distribution was "mainly restricted to far eastern and western states". As such, five species were treated as endemic to California, one is widespread in the West, and two species are found east of the Appalachians. One of these, the cranberry root grub, *L. vulpina* (Hentz), is an economically significant pest of cranberries in the East (Robbins et al. 2006), with larvae feeding on the plant roots. Only one species, *L. rathvoni* (LeConte), enjoys a wider distribution from British Columbia, Canada through the west coast U.S. states to Sinaloa, Mexico and east to Idaho, Utah, and Arizona in the United States (Carlson 1980). Cursory examination of specimens from across this range indicates that this may be an unresolved species complex.

Recently, my colleague and former graduate schoolmate Dr. Mathew Brust of Chadron State College in Chadron, Nebraska, discovered *Lichnanthe* in an unexpected location. In the Ferris Dunes of central Wyoming, Brust found four specimens of a glaphyrid species in July 2022. Since Wyoming is quite far from the known distribution of Glaphyridae, Brust sent the specimens which I determined to be an undescribed species. Encouraged by its evident uniqueness, Brust returned to the area and found over one hundred additional specimens at the nearby Seminoe Dune in July 2023 (Cook 2023). This new species is described below, and its diagnostic characters and placement with regards to the key to *Lichnanthe* species in Carlson (1980) discussed.

Brust's collection of this new species has helped solve the century-long puzzle of a problematic specimen of *Lichnanthe* in the UNSM collection. The specimen was included in Dawson's synopsis of Nebraska scarabs (Dawson 1922), as the New England/Appalachian species at that time known as *Amphicoma vulpina,* without further discussion. The specimen, however, clearly is not *L. vulpina.* The locality label of the specimen indicated only "Dismal River, Neb. July". I attempted to collect the species along the Dismal River in July almost yearly from 2002 to 2006, without success. After being unable to confirm its presence, in the Scarabaeoid Beetles of Nebraska (Ratcliffe and Paulsen 2008), we chose to consider the label dubious and exclude the specimen because: 1) the genus is more or less coastal and was not known to occur from anywhere in the vicinity, 2) it resembled some specimens from Utah sitting under *L. rathvoni* (although that is likely a species complex); and 3) the specimen had such scant collecting information we felt it was likely mislabeled.

The arrival of the large series from Wyoming led to a reassessment of the Nebraska specimen. Large series always make recognizing important characters much easier, and the uniqueness of the square mandibles of the Wyoming species became apparent. Initially, because the Nebraska specimen also possessed square mandibles it seemed possible that the specimen was a mislabeled Wyoming specimen of *L. brusti*, requiring validation of the label in question. Specimens of other insects with identical labels were located in the collection, UNSM entomology collection database, and through literature searches. Specimens in the UNSM collection bearing identical typeset labels are especially prevalent in Orthoptera (Hauke 1953), and the pin corresponds to those used in the UNSM in the late 1800s. This suggested that University of Nebraska professor Lawrence Bruner, famed orthopterist and ornithologist of that era, may have been the collector.

Literature searches revealed two important details. In 1889, a graduate student at the University of Nebraska at the time, botanist H.L. Webber (who, incidentally, later coined the word "clone"), published in two-parts an account of that summer's collecting trip to Plummer Ford on the Dismal River in the Nebraska Sand Hills (Webber 1889, 1890). Importantly, on this trip he was accompanied by Bruner, who was reportedly "burned to a blister by the hot sun" on the expedition (Webber 1889). This raised the possibility that the many grasshoppers, dragonflies, and scarab beetles, including the *Lichnanthe* specimen, with this Dismal River label at the UNSM were collected by Bruner on this trip. The second piece of the puzzle was provided by Bruner's contemporary and later field assistant J.T. Zimmer, who listed a paratype of his species *Euschistus latimarginatus* Zimmer (Hemiptera: Pentatomidae) bearing the same pin and locality label; with the additional parenthetical information of the collector and year: L. Bruner, 1889 (Zimmer 1910).

Webber (1890) describes the collecting locality in detail: on the morning of 13 July, 1889, he and Bruner investigated the blowouts on the edge of the bluffs on the south side of the Dismal River at Plummer Ford. This collecting event is important as the type locality for both the syntypes of the endangered blowout penstemon (*Penstemon haydenii* Wats., Plantaginaceae) in the UNSM and the holotype of the new *Lichnanthe* described below. However, this placename is not recorded on any 20th century map and proved difficult to pinpoint. Ultimately, a map that put Plummer Ford in Section 33, T.22N. R.30W., or 41.838°, -100.787°, was located in Rydberg (1895), see Fig. 1.

Given the abundant evidence of additional insect taxa with the same label that are all common species of the Nebraska Sand Hills and herbarium specimens that also represent the same well-documented collecting event it is most parsimonious to hypothesize that this *Lichnanthe* specimen was collected in Nebraska at Plummer Ford by Bruner on the morning of 13 July 1889, corresponding to the date indicated by Webber (1890). Although sharing the square mandibles, other characters are too morphologically distinctive for it to be considered conspecific with the new Wyoming species, thus it is described and these distinguishing characters discussed below.

These species of *Lichnanthe* are distributed exactly where the blowout penstemon now occurs (Heidel 2005) or is known to have occurred historically (Sutherland 1988; Kaul et al. 2006), in what must be considered a relictual distribution of a geologically rather young habitat. Webber (1889, 1890) mentioned *Penstemon* in the Plummer Ford blowout. These specimens are present in the UNSM and confirmed to be *P. haydenii.* Although the co-occurrence of two beetle species of the same genus with a single plant species did seem questionable initially, Heidel (2022) reported that preliminary analyses of the Nebraska and Wyoming populations of blowout penstemon revealed a molecular divergence between them equal or greater to that seen between other *Penstemon*

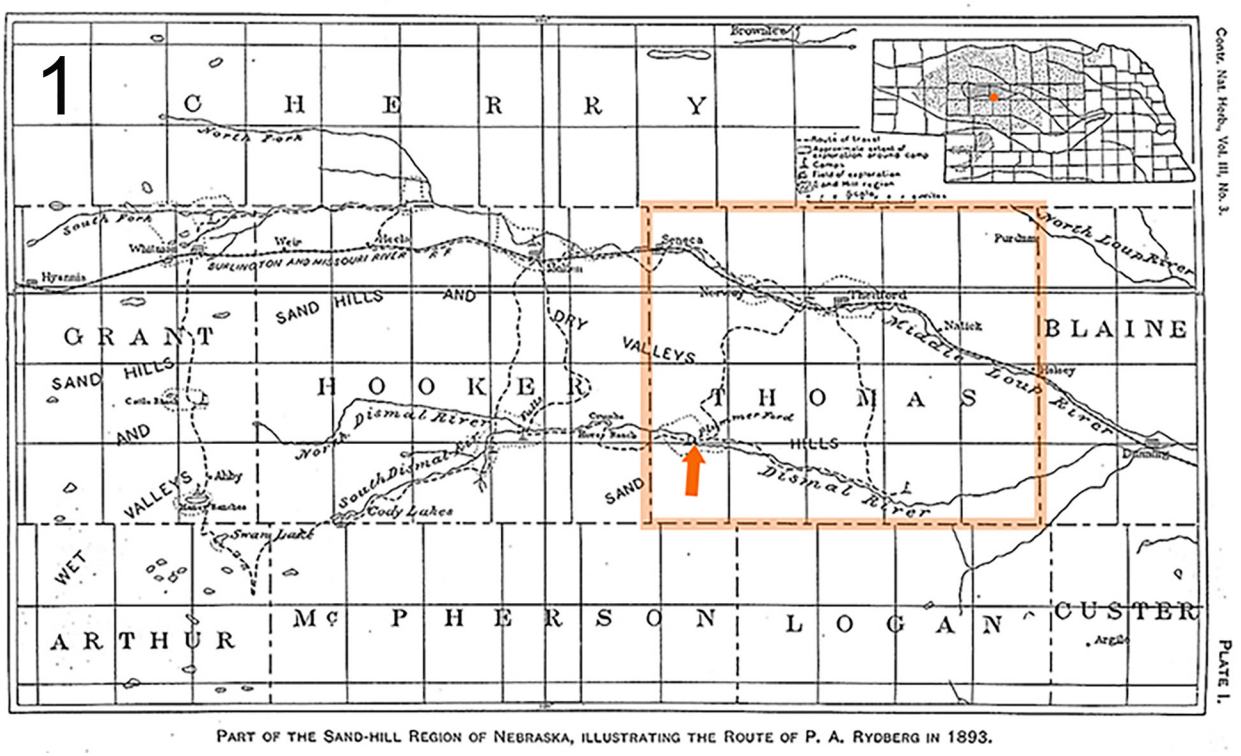


Figure 1. Location of Plummer Ford, Thomas County, Nebraska. Map modified from Rydberg (1895) to indicate the locality (arrow) and county (highlighting).

full species. Although that work is described as ongoing, this suggests that these habitats have been isolated for a sufficient amount of time for speciation to have occurred in *Penstemon,* or in *Lichnanthe*, as hypothesized here.

Materials and Methods

Specimens and taxonomic material. The following institutions and private collections provided specimens or are designated as the repository for specimens examined in this study. Species descriptions are based on Carlson (1980) for ease of comparison. Label data for primary and secondary types are listed verbatim with each label indicated by letter and a forward slash (/) between data on separate lines within a label.

CMNC Canadian Museum of Nature, Ottawa, ON, Canada
CSCA California State Collection of Arthropods, Sacramento, CA, USA
CSCI Chadron State College Insect Collection, Chadron, NE, USA
DCCC David C. Carlson Collection, Fair Oaks, CA, USA
FSCA Florida State Collection of Arthropods, Gainesville, FL, USA
NMNH National Museum of Natural History (Smithsonian), Washington, DC, USA
UNSM University of Nebraska State Museum, Lincoln, NE, USA
UWIM University of Wyoming Insect Museum, Laramie, WY, USA

Taxonomic Treatment

Lichnanthe brusti Paulsen, new species

Brust's bee scarab; Fig. 2–7, 11, 14–18.

Type material. Holotype male (Fig. 2), labeled (Fig. 3): a) "**USA:** WYOMING: / Carbon Co.: 25 mi NNE / Sinclair, Seminoe Dunes / 42.1039°, –106.9379° / 11.vii.2023; M.L. Brust"; b) on orange paper, "*Lichnanthe* / *brusti* ♂ / Paulsen / HOLOTYPE"; c) "U of Nebraska / State Museum / entomology / UNSMe / 9453". Holotype deposited at UNSM. Allotype female (Fig. 5) labeled (Fig. 6): a) as holotype; b) on orange paper, "*Lichnanthe* / *brusti* ♀ / Paulsen / ALLOTYPE" ; c) "U of Nebraska / State Museum / entomology / UNSMe / 9454". Allotype deposited at UNSM.

Two paratype females (CSCI, UNSM), 107 paratype males (5 CSCA, 20 CSCI, 5 CMNC, 10 DCCC, 7 FSCA, 10 NMNH, 25 UNSM, 5 UWIM, and 20 to be distributed in the future as needed) labeled: a) as holotype; b) on yellow paper, "*Lichnanthe* / *brusti* [♂ or ♀] / Paulsen / PARATYPE".

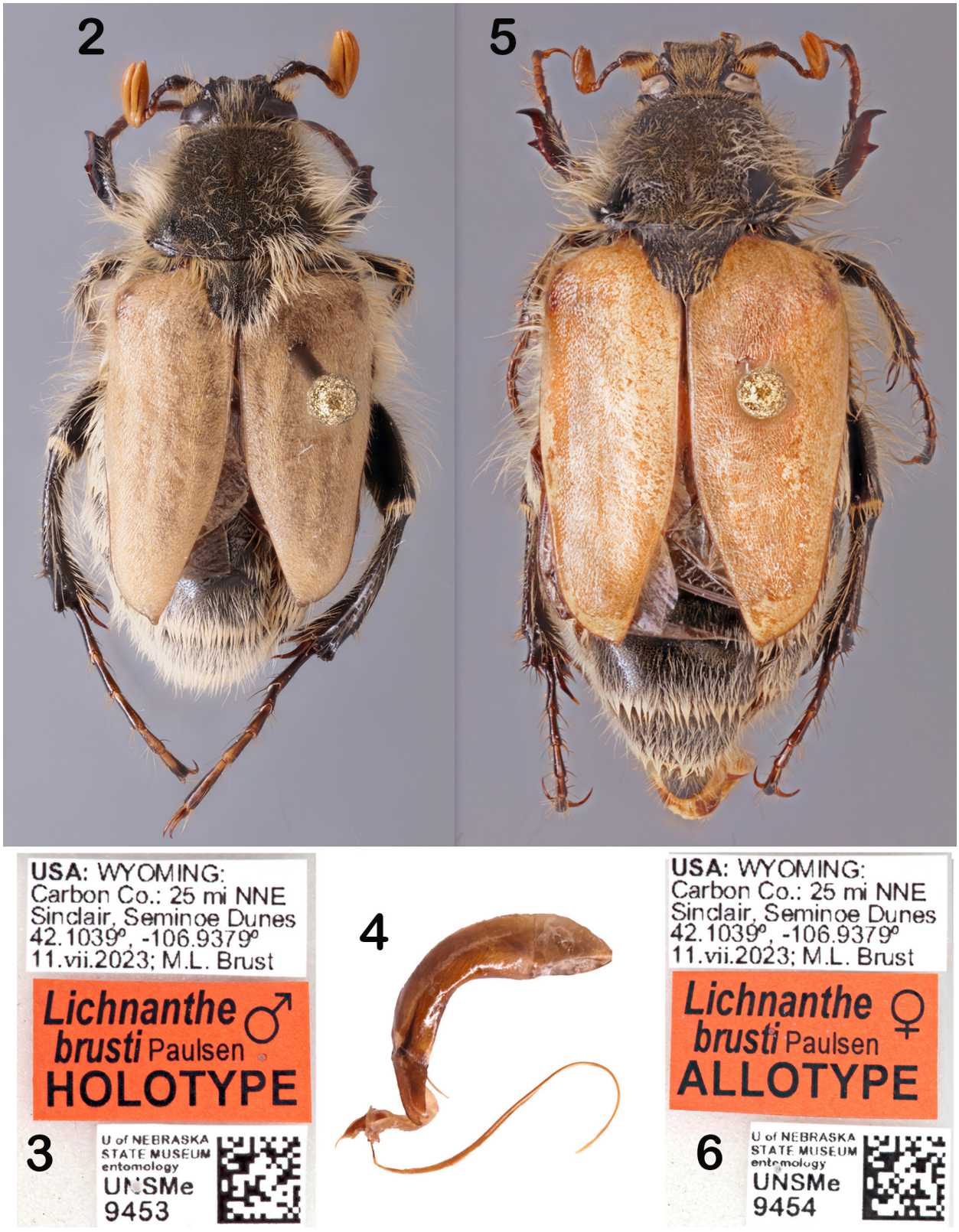
Five paratype males (3 CSCI, 2 UNSM) labeled: a) "**USA:** WYOMING / Carbon Co.: 14.2 mi. E / of Lamont; Ferris Dunes / 42.19474°, –107.19905° / 16.vii.2022; M.L. Brust"; b) on yellow paper, "*Lichnanthe* / *brusti* ♂ / Paulsen / PARATYPE".

Description. Holotype male (Fig. 2). **Length:** 14.5 mm. **Width:** 5.8 mm at elytral humeri. **Color:** Integument piceous, nearly black, densely clothed with long, fine, pale yellowish-white setae. Pronotum, clypeus and scutellum with bronze metallic reflection. Antennal clubs and 3 distal abdominal segments orange-brown. Antennal funicle (antennomeres 2–7) light brown ventrally, and dark brown dorsally; tarsi bicolored with the antennal coloration inverted; elytral surface testaceous, macroscopically appearing striped from alternating longitudinal areas of testaceous or dark brown setae; setae fine, sparse, never forming spots or clumps. Elytral humeri with variably sized dark brown humeral spot. **Head:** Mandibles square, moderately angulate externally and truncate apically from above (Fig. 7). Labrum deeply emarginate anteriorly, punctate, sparsely and finely setose. Maxilla with terminal palpomere subparallel, width less than ½ length, apical sensory area wider than base of same palpomere. Clypeus subparallel, sides converging weakly at anterior ⅓, longer than wide, lateral margins elevated anteriorly; clypeal surface rugose, densely punctate, weakly setose; setae sparse and short. Frontoclypeal suture indistinct but with raised bump medially. Frons with moderately short setae (<⅓ length of antennal club); setae erect. Ocular canthi punctate, setose; setae longer than on frons. Antennal club elongate, distinctly longer than scape (antennomere 1). **Thorax:** Pronotum convex but impressed in apical half along midline; marginal bead almost entire but obsolete near scutellum; pronotal disc densely punctate, densely setose with long, fine setae; posterolateral angles with small, smooth impunctate areas. Scutellum densely setose, punctate. Elytra contiguous along median suture for about ½ distance from scutellum to elytral apices, elytra gradually but distinctly dehiscent apically, sutural angle with rounded protuberance (see Fig. 2), elytral apices otherwise gradually rounded, broad. **Legs:** Secondary tooth of protibia large, strongly developed. First protarsomere subequal in length to next 2 collectively. Tarsal claws on all legs lacking basal tooth. Terminal oblique carina on mesotibia almost obsolete, corbels indistinct. Apex of hind tibia as in figure 31 of Carlson (1980); metatibial spurs more or less equal; dorsal channel for tarsi strongly developed. **Abdomen:** Genitalia (Fig. 4) not demonstrably distinct from those of other species studied, internal sac with a median spine and bird-skull shaped sclerite immediately preceding the terminal flagellum, as shown in figure 41 of Carlson (1980). The parameres of all *L. brusti* specimens dissected are not contiguous along the suture (Fig. 11).

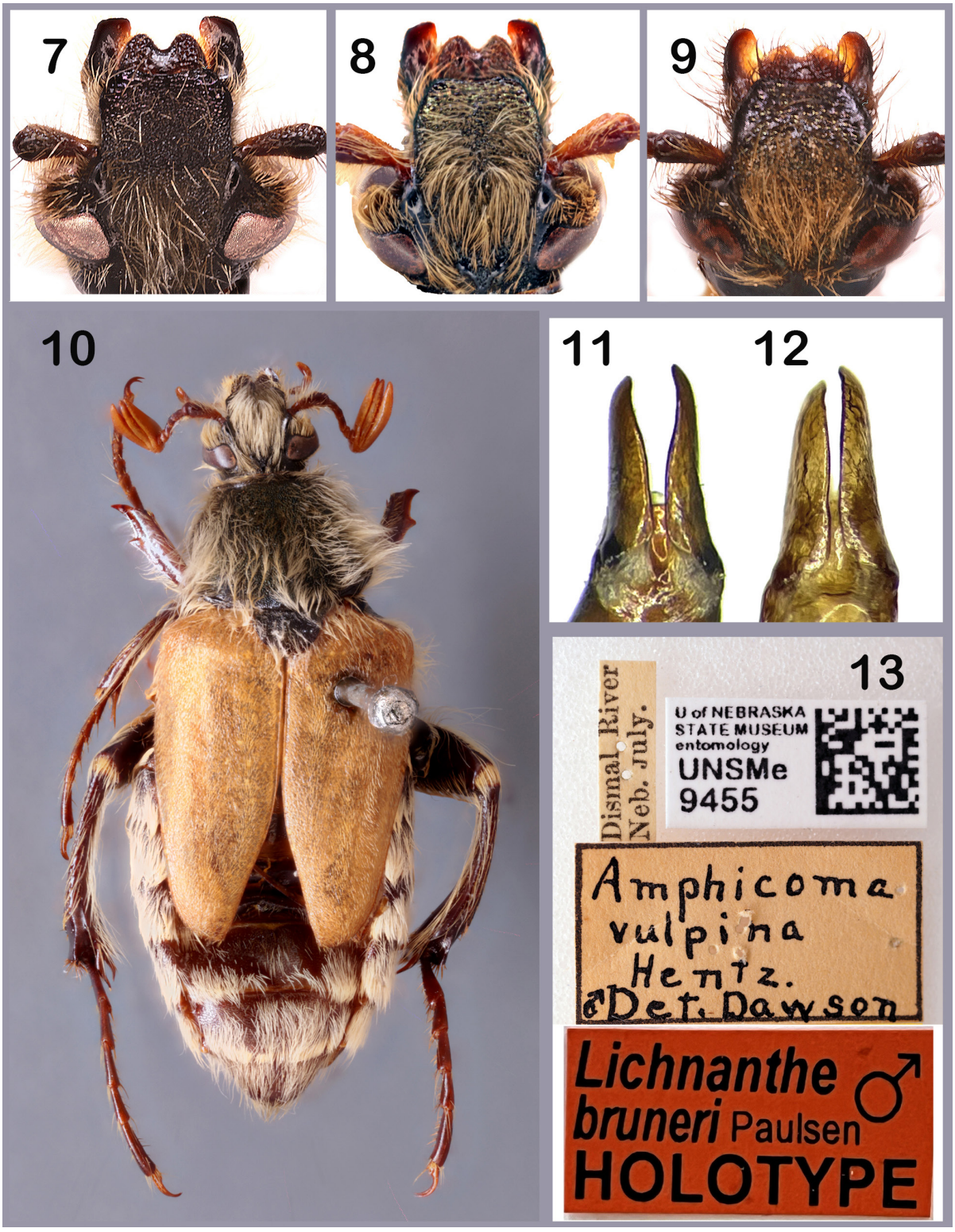
Description. Allotype female (Fig. 5). **Length:** 16.8 mm. **Width:** 6.8 mm at elytral humeri.

Coloration and setation as holotype male except setation on head and pronotum relatively shorter; and abdomen distally with reddish-brown coloration reduced. The body overall appears to be more robust, especially the shorter and rounder metafemora. The antennal club is much shorter than in the male, just slightly longer than scape. On the pronotum the impunctate areas near posterior-lateral corners are markedly larger, and the marginal bead is apparently entire near the scutellum. The elytra of the allotype female display discoloration from being stored in isopropyl alcohol.

Variation in males. Paratype males (n = 111) differ from the holotype as follows. **Length:** 12.0–16.5 mm. **Width:** 5.1–6.3 mm. Coloration and setation as holotype male except 31% of males have a large humeral spot on the



Figures 2–6. *Lichnanthe brusti* Paulsen, new species. **2)** Holotype male, habitus. **3)** Labels. **4)** Lateral view of male genitalia, similar to other *Lichnanthe* sp. studied. **5)** Allotype female. **6)** Labels.



Figures 7–13. Comparative images of *Lichnanthe* spp. **7–9)** Heads of *Lichnanthe* spp. **7)** *Lichnanthe brusti* Paulsen, new species. **8)** *L. bruneri* Paulsen, new species. **9)** *L. rathvoni* (LeConte), showing oval mandibles. **10)** *L. bruneri* Paulsen, new species, holotype male, habitus. **11–12)** Paramera of male genitalia, distal view. **11)** *L. brusti.* **12)** *L. bruneri.* **13)** *L. bruneri* Paulsen, new species, holotype male, labels.

elytron, while 67% have small spots, and spot size was not consistently symmetrical. Two specimens had 4 spots due to the presence of an additional spot on each elytron nearer to the scutellum. The development of the sutural apex also exhibited interesting variation. In 58% of males the apex was produced into a bulbous rounded process as in the holotype, but the remaining 42% lacked the process and the apices were simply rounded.

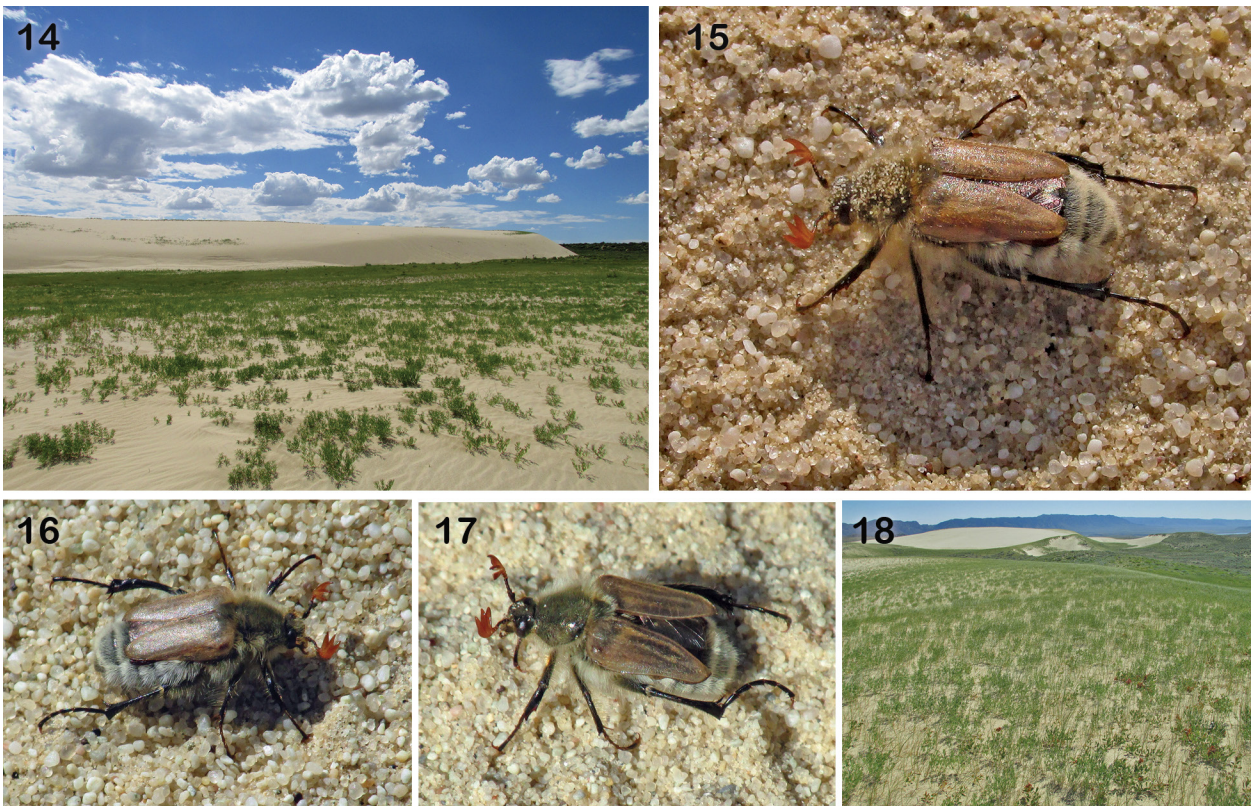
Variation in females. Paratype females ($n = 2$) differ from the allotype as follows. **Length:** 12.8–15.8. mm. **Width:** 5.7–7.0 mm. With only two examples, the only significant difference from the allotype appears to be adult size.

Remarks. This species is light-colored and densely setose, adaptations to living in sand as seen in the coastal California species *L. albipilosa* Carlson and *L. ursina* (LeConte). However, its distribution and square mandibles make confusion with these species impossible. Specimens of *L. brusti* have faint but distinct longitudinal striping on the elytra formed from variation in the color of the elytral setae (see Fig. 17), and a humeral spot on the elytra.

Etymology. Brust's bee scarab is named for Dr. Mathew Brust, professor at Chadron State College who collected the entire type series and recognized the uniqueness of the material. He is one of the most keen and dedicated collectors I know, and without his entomological knowledge and collecting expertise the species would have remained unknown and undescribed.

Distribution. The species is known from two locations in Carbon County, Wyoming, Seminoe Dune and the Ferris Dunes (Fig. 14, 18, 19).

Discussion. Brust first discovered the species in 2022, flying amid sparse vegetation in the morning at the Ferris Dunes (Fig. 14–15), although none were found there in a late afternoon visit to the same spot a year later. However, additional specimens were found flying at the nearby Seminoe Dune (Fig. 16– 18) the following morning between 8:30 and 10 a.m. (Cook 2023). Some specimens were also seen on the sand, but a focus on netting flying



Figures 14–18. Habitat and live adult images of *L. brusti*, new species. Images taken at the time of collection by M.L. Brust. **14)** Ferris Dunes. **15)** Live adult male at Ferris Dunes. **16)** Live adult male at Seminoe Dune. **17)** Live adult male at Seminoe Dune, showing elytral pattern. **18)** Seminoe Dune.

specimens may account for the skewed sex ratio and support a previous study that found that females fly only infrequently. A three-year study of *Lichnanthe rathvoni* sex ratios by Carlson (1977) found that a large sample (*n* = 2660) of flying adults was skewed to 93% males, while the sex ratio of pupa excavated from the sandy substrate did not differ from 50:50. Although the mouthparts (especially the brushy maxillae) appear functional, dissection of the abdomen showed an atrophied digestive tract and no evidence of pollen or other food (David Hawks, pers. comm.)

With respect to the key to *Lichnanthe* species in Carlson (1980), males of this new species progress through couplet six due to the impunctate areas near the posterolateral corners of the pronotum, which may be minute but are always present. The unicolorous hind femora lead to couplet 8, there reaching a dead end as neither the characters of *L. rathvoni* or *L. brachyselis* Carlson pertain to this species. Females would skip to couplet 11 due to their strong pronotal anterolateral bead, to couplet 12 with abruptly dehiscent elytra. Couplet 13 cannot be passed, as the combination of a wide terminal maxillary palpomere and deeply emarginate labrum is not presented.

The key could be modified with a couplet at any point distinguishing square, apically truncate mandibles (*L. brusti* and the new species below) from oval mandibles with rounded apices (all other species), regardless of sex. The two new species could be distinguished from each other therein by the density and length of setae on the head (Fig. 7–8) and the presence of a dark humeral spot on the elytra in *L. brusti.*

Lichnanthe bruneri Paulsen, new species

Bruner's bee scarab; Fig. 8, 10, 12–13.

Type material. Holotype male (Fig. 10) labeled (Fig. 11): a) "Dismal River / Neb. July"; b) handwritten "*Amphicoma* / *vulpina* / Hentz / ♂ Det. Dawson"; c) on orange paper, "*Lichnanthe* / *bruneri* ♂ / Paulsen / HOLOTYPE"; c) "U of Nebraska / State Museum / entomology / UNSMe / 9455". Holotype deposited at UNSM.

Description. Holotype male (Fig. 10). **Length:** 15.0 mm. **Width:** 5.4 mm at elytral humeri. **Color:** Integument of head and thorax piceous, nearly black, body densely clothed with long, fine, pale yellowish white setae. Pronotum, clypeus and scutellum with bronze metallic reflection. Antennal clubs and 3 distal abdominal segments orange-brown, remainder of abdomen and legs brown to light reddish brown. Antennal funicle (antennomeres 2–7) light brown ventrally, gradually becoming dark brown dorsally; elytral surface testaceous, macroscopically appearing unicolorous, setose; setae mostly testaceous but with some dark brown setae at base and on disc; setae fine, sparse, never forming spots or clumps. Elytral humeri lacking dark humeral spot. **Head:** Mandibles square, strongly angulate externally and truncate apically from above (Fig. 8). Labrum deeply emarginate anteriorly, punctate, setose; setae moderate to long. Maxilla with terminal palpomere subparallel, width less than ½ length, apical sensory area wider than base of same palpomere. Clypeus widest at middle, longer than wide, lateral margins elevated anteriorly; clypeal surface rugose, densely punctate and setose; setae long. Frontoclypeal suture indistinct but with raised bump medially. Frons with long, hair-like setae (>½ length of antennal club); setae recumbent. Ocular canthi punctate, setose; setae shorter than on frons. Antennal club elongate, distinctly 2× longer than scape (antennomere 1). **Thorax:** Pronotum convex but impressed in apical half along midline; marginal bead entire, including near scutellum; pronotal disc densely punctate, densely setose with long, fine setae; posterolateral angles with small, smooth impunctate areas. Scutellum densely setose, punctate. Elytra contiguous along median suture for about ½ distance from scutellum to elytral apices, elytra gradually but distinctly dehiscent apically, sutural angle not produced, simply rounded, elytral apices broad. **Legs:** Secondary tooth of protibia large, strongly developed. First protarsomere subequal in length to next 2 collectively. Tarsal claws on all legs lacking basal tooth. Terminal oblique carina on mesotibia almost obsolete, corbels indistinct. Apex of meso- and metatibiae as in preceding species; metatibial spurs more or less equal; dorsal channel for tarsi strongly developed. **Abdomen:** Genitalia not demonstrably distinct from those of other species studied, however the parameral suture is straight in this species and the parameres nearly contiguous (Fig. 12), while in all males of *L. brusti* dissected the parameres are sinuous along the suture and distinctly separated near the apices (Fig. 11).

Remarks. This species is similar to *L. brusti* in overall coloration and the presence of square mandibles, a character unique to these two taxa within *Lichnanthe* as the remaining taxa have oval, externally rounded mandibles as in *L. rathvoni* (Fig. 9). However, I do not consider these two taxa to be conspecific due to the differences discussed

in the descriptions. The most striking difference is the long, dense, hair-like setae of the head of *L. bruneri* (Fig. 8), given that over 100 examples of *L. brusti* all had shorter, spikier, and much less dense setae (Fig. 7). This species has uniformly testaceous elytra, whereas the elytra in *L. brusti* appear longitudinally striped and have dark humeral spots.

Etymology. Bruner's bee scarab is named for Lawrence Bruner, University of Nebraska professor considered a pioneer of Nebraska entomology, and collector of the single known specimen in 1889. Although *Lichnanthe* have been called bumblebee scarabs, most appear to be mimicking halictids, anthophorines, and andrenids (D.C. Hawks, pers. comm.), so the common name 'bee scarab' is suggested.

Distribution. The species is known only from Thomas County, Nebraska near the Dismal River (Fig. 1, 19).

Discussion. Unfortunately, the species has eluded rediscovery for 134 years and may possibly be extinct, especially if it is in fact tied to the presence of open sand dunes. Nebraska has the largest dune field in North America (Muhs and Budahn 2019), and although the sand is currently grass-stabilized, the dunes were largely active 700 years ago (Mason et al. 2004; Miao et al. 2007;). Some were mobile during the last 250 years (Stokes and Swinehart 1997) and possibly into the mid-nineteenth century based on historical accounts (Muhs and Holliday 1995).

Yet, after more than a century of confusion prolonged at least partially by my reluctance to entertain that a member of this mainly coastal group could occur in the middle of the continent, Nebraska boasts a native glaphyrid, and only its second endemic scarabaeoid. Although the state is approaching 300 species of scarabaeoid beetles, only one other species, the aphodiine *Flaviellus gordoni* (Ratcliffe), is endemic to Nebraska (Ratcliffe and Paulsen 2008). Both species are restricted to the Sand Hills.

My previous attempts to locate the species in Thomas County were unsuccessful, but the distribution of *L. bruneri* should be studied further and its conservation needs assessed. The blowouts near Plummer Ford could be seen in aerial photographs from the 1960s from the Thomas County soil survey (Sherfey et al. 1965), but they are now entirely vegetated. New sampling should focus on the extensive blowout systems in the Sand Hills near the Dismal River to the west. If the habits of the similar Wyoming species are any indication, adults may only be active during a short period in July, and then only during the morning.

Both of these *Lichnanthe* species are distributed in the same areas as the endangered plant *Penstemon haydenii* Wats. (blowout penstemon) in Wyoming (Heidel 2005) and in Nebraska. Perhaps the best chance to find extant populations of *L. bruneri* is where blowout penstemon currently survives (Fig. 19). Because some *Lichnanthe* larvae feed at least partially on roots there may be undiscovered links between these beetles and the blowout penstemon beyond sharing a small and very limited relictual habitat.

Acknowledgments

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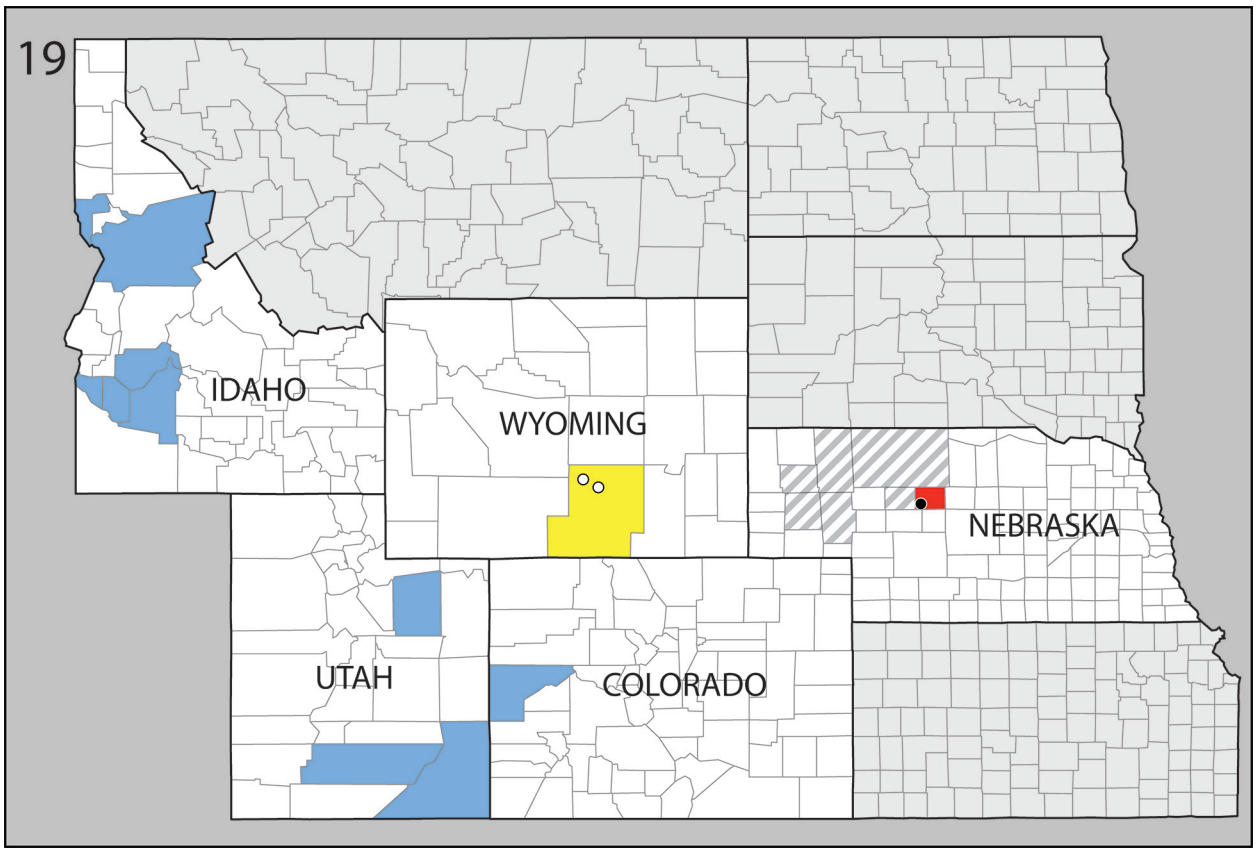

Figure 19. Map of *Lichnanthe* species in selected states. Red indicates Thomas County, Nebraska, with a black dot for *L. bruneri*. Crosshatching indicates Nebraska counties where blowout penstemon occurs that are possible sampling areas for *L. bruneri*. Yellow indicates Carbon County, Wyoming, with white dots representing the two localities for *L. brusti*. Blue indicates counties of Colorado, Idaho, and Utah where members of the *L. rathvoni* complex are present.

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