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A new species and new records of *Aphodius* Illiger
(Coleoptera: Scarabaeidae: Aphodiinae)
from mammal burrows in Nebraska

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Abstract: Direct sampling of rodent burrows in Nebraska resulted in the collection of 16 species of *Aphodius* Illiger previously unknown from the state, including specimens of four undescribed species. One of these species is described here as new: *Aphodius viceversus* **new species** recorded from Nebraska and Kansas. Other *Aphodius* species recorded from Nebraska for the first time include *A. acuminatus* Cartwright, *A. anomaliceps* Brown, *A. carri* Brown, *A. criddlei* Brown, *A. kirni* Cartwright, *A. kiowensis* Gordon and Salsbury, *A. magnificens* Robinson, *A. neodistinctus* Brown, *A. peculiarus* Schmidt, *A. punctissimus* Brown, *A. thomomysi* Brown, and *A. leptotarsis* Brown. Collecting information is summarized for each species.

Introduction

Rodent burrows afford a unique habitat to which many insects are adapted, including many rarely collected beetles (Cartwright 1944; Ross 1944; Skelley and Kovarik 2001). Although many areas of eastern North America have been heavily sampled with traditional sampling techniques, specialized collecting from small mammal burrows has resulted in the recent description of ten new species of *Aphodius* (Coleoptera: Scarabaeidae: Aphodiinae) from Florida, Alabama, and Georgia (Skelley and Woodruff 1991; Skelley and Gordon 1995, 2001), and Kansas and Texas (Gordon and Salsbury 1999).

Two Nebraska rodent species that host numerous inquiline insects are the black-tailed prairie dog, *Cynomys ludovicianus* (Ord) and the Plains pocket gopher, *Geomys bursarius* (Shaw). Many species of *Aphodius* are known from the burrows of these rodents in neighboring states (Gordon and Salsbury 1999; Skelley and Gordon 2001). In Nebraska, rodent burrows have remained virtually unsampled for insects. Seven *Aphodius* species that utilize small mammal burrows are known from Nebraska (Ratliffe 1991). Of these species, only *Aphodius concavus* Say has been collected frequently. Small series of three species associated with prairie dogs known from Nebraska (*A. dentigerulus* Brown, *A. explanatus* LeConte, and *A. pseudabusus* Cartwright) were probably collected directly from this habitat, although *A. dentigerulus* is sometimes taken at lights. The remaining three species previously recorded from the state (*A. brevicollis* LeConte, *A. iowensis* Wickham,

and *A. russeus* Brown) are pocket gopher associates. The first two species are probably not attracted to light and have rarely been collected in the state. The few Nebraska specimens were probably taken by netting in late afternoon during presumed fall dispersal flights. The latter species is apparently collected at light in September, a time of year that is rarely sampled.

Beginning in the fall of 2004, I sampled pocket gopher burrows in Greeley and Arthur counties in central and western Nebraska, respectively, using subterranean dung-baited pitfall traps. I also used a custom-made telescoping burrow scoop (Rose Entomology, Benson, AZ) to sample from prairie dog burrows in Greeley County and Keith County (western Nebraska). In addition, some mammal-associated *Aphodius* species were collected with an aerial net in late afternoon flights during the autumn months in several counties across the state. This research resulted in the collection of 16 species of *Aphodius* not previously recorded from Nebraska, including four undescribed species. One of these is described below; the other three are being described by Gordon and Warner and Skelley in this issue.

Materials and Methods

Morphological Characters. The following conventions were used for morphological data. Specimens were viewed under a dissecting microscope from 6.3x to 40.0x under fiber optic illumination. 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. 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. Moderate punctures (0.03 - 0.06 mm) have a visible floor at 40x. Fine punctures are small (less than 0.03 mm) and lack definition at a magnification of 40x. Puncture density was defined as either contiguous (punctures separated by <1 puncture diameter), or by the approximate number of puncture diameters between punctures (e.g., punctures separated by 2-4 times their diameter).

Data Transcription. Labels described are typeset on white or natural paper unless otherwise noted. Each label is denoted with a letter designation (a, b, c), and the beginning of each new line of text is designated with “/” (slash symbol). Collections where specimens are deposited include: Florida State Collection of Arthropods, Gainesville, FL (FSCA); Glenn A. Salsbury, Greensburg, KS (GASC); Snow Entomological Museum, University of Kansas (KSEM); M.J. Paulsen, Lincoln, NE (MJPC); Paul E. Skelley, Gainesville, FL (PESC); University of Nebraska State Museum, Lincoln, NE (UNSM), United States National Museum, Washington, DC (USNM), William B. Warner, Chandler, AZ (WBWC).

Taxonomic Treatment

Aphodius viceversus Paulsen

new species

Figs. 1-3, 5, 7, 9

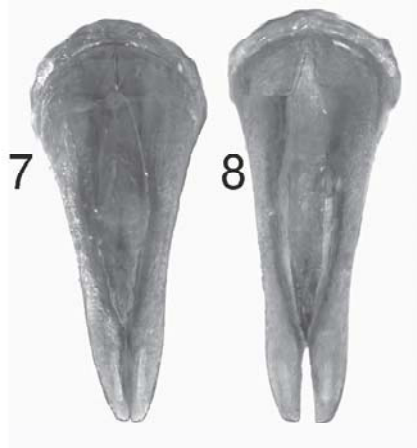
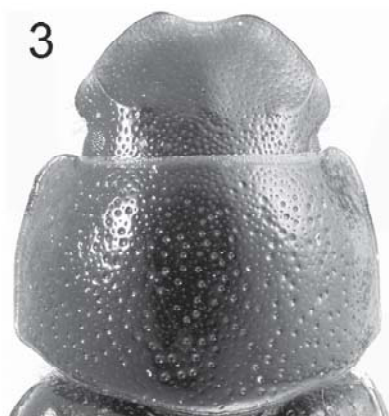
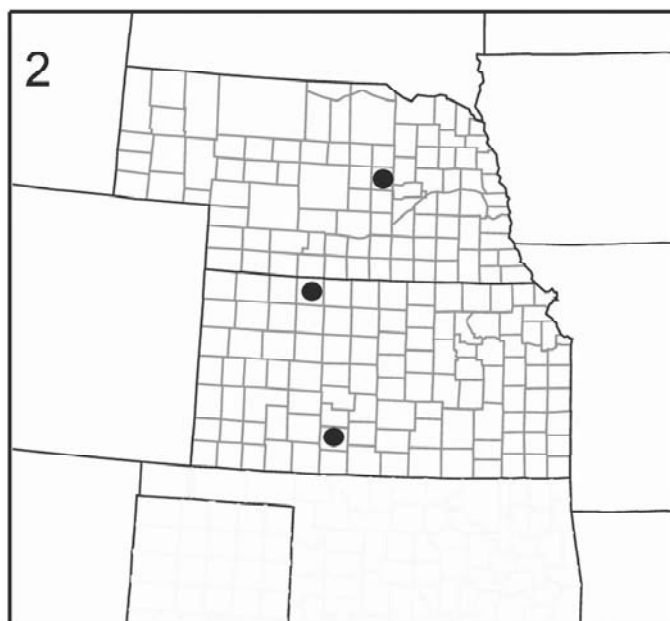
Type material. Holotype male (deposited at UNSM) labeled as: a) “NEBR: GREELEY CO. / 7.3 mi S of Greeley / E. of HWY 281; prairie / dog colony; 3 APR 2005/ coll. MJ Paulsen”; b) in or near prairie / dog *Cynomys ludovicianus* (Ord) / burrow or mound”; c) holotype label (red paper) “*Aphodius viceversus* / Paulsen/HOLOTYPE”. Allotype female (deposited at UNSM) labeled: a) and b) same as holotype; c) allotype label (red paper) “*Aphodius viceversus* / Paulsen / ALLOTYPE”. Paratypes (2 male, 2 female) same data as holotype. Paratypes (34) from Kansas, Kiowa Co., 13 mi S. Greensburg, G. Salsbury, prairie dog burrow with dates as follows: 17 Febr. 1996 (3 males, 13 females), 25 Febr. 1996 (2 males, 4 females), 7 Apr. 1996 (1 male), 2 Jan. 1997 (1 female), 1 Febr. 1997 (3 males, 5 females), 28 Febr. 1999 (1 male), and 14 Mar. 2000 (1 female). Paratypes (11) from Kansas, Kiowa Co., 10 mi NW Mullinville, G. Salsbury, prairie dog

burrow with dates as follows: 2 Mar. 1996 (1 male, 3 females), 15 Mar. 1996 (2 females), 17 Apr. 1996 (2 females), 30 Mar. 1997 (1 male, 1 female), 19 Apr. 1997 (1 male). Paratype (male) labeled: “USA: Kansas, Norton Co/6mi W Norton, 14 Mar. / 2001, prairie dog burrow / G.A. Salsbury”.

All paratypes with label (on yellow paper): “*Aphodius viceversus* / Paulsen/PARATYPE”. Paratypes deposited in the FSCA, GASC, KSEM, MJPC, PESC, UNSM, USNM, and WBWC.

Description. Holotype male. *Length:* 4.5 mm. *Width:* 1.6 mm. Form elongate, widest behind middle of elytra (see Fig. 1). *Color:* Head, pronotum, elytra, venter dark brown; clypeal margin, lateral margin of pronotum, elytral suture, legs, antennae lighter brown. *Head:* Clypeus obtusely angulate either side of narrow, median emargination (Fig. 3), angulations weakly reflexed, margin thickened at angulations in anterior view, not fimbriate laterally, surface punctate; punctures fine and moderate in size, separated by 1-2 puncture diameters. Frontoclypeal suture obsolete medially, lacking tubercles. Frons punctate; punctures fine to moderate in size, dense, separated by 0.5 - 1.0 puncture diameters. Gena fimbriate. *Pronotum:* Form (Fig. 3) subrectangular, sides parallel in basal third, converging anteriorly. Lateral margin not fimbriate, weakly explanate, impressed at anterior and posterior angles. Base with marginal bead. Surface densely punctate; punctures everywhere mixed fine and large, fine punctures separated by 1-2 diameters, large punctures separated by 0.5-2.0 diameters. *Scutellum:* Shape triangular. Size small (less than 1/6 length of elytra). *Elytra:* Surface alutaceous, weakly shining. Intervals irregularly punctate; punctures fine, shallow, separated by 2-5 diameters. Striae moderately impressed, moderately punctate; punctures as wide as stria, separated by 2-3 diameters. *Legs:* Protibia impunctate, tridentate. Protibial spur modified, long, robust, bent externally at apex (Fig.

Figures 1-10. 1) Dorsal habitus of *Aphodius viceversus*, n.sp. (male); 2) Distribution of *A. viceversus*; 3) Head and pronotum of *A. viceversus* showing clypeal angulations and weakly explanate pronotal shape; 4) Head and pronotum of *A. leptotarsis* Brown showing broadly rounded clypeal margin and more strongly explanate pronotal shape; 5) Dorsal view of protibia of *A. viceversus* with protibial spur curved externally; 6) Dorsal view of protibia of *A. leptotarsis* with protibial spur curved internally; 7) En-face view of male genitalia of *A. viceversus* with parameres contiguous along apices; 8) En-face view of male genitalia of *A. leptotarsis* with parameres separated at apices; 9) Lateral view of male genitalia of *A. viceversus* with parameres bent in apical third; 10) Lateral view of male genitalia of *A. leptotarsis* with parameres nearly straight.



5). Inferior mesotibial spur modified, length less than 1/3 length of superior spur, internal surface with small tooth. Metatrochanter setose; setae long, straight, pale. Metafemur with dense patch of similar setae near metatrochanter, scattered setae to near apex. Metatibial apex fringed with conspicuously unequal spinules (short spinules alternating with spinules 3 times longer). Metatarsus with basal segment longer than superior spur, length of entire tarsus subequal to metatibia. *Genitalia*: Parameres elongate, acute, apices contiguous (Fig. 7), in lateral view bent in apical third (Fig. 9), lacking membranous apical appendage.

Allotype female. Length: 5.1 mm. Width: 1.9 mm. Externally similar to holotype male except in the following: Pronotum: Lateral margins more parallel, less convergent anteriorly. Legs: Anterior spur not modified, gradually curving ventrally, acute. Inferior mesotibial spur not modified, acute, 1/2 as long as superior spur. Metatrochanter and metafemur with fewer, shorter setae; metafemur lacking dense setal patch.

Variation. Male paratypes (n = 16). Length: 4.4 to 5.4 mm. Width: 1.8 to 3.1 mm. Female paratypes (n = 34). Length: 4.5 to 5.5 mm. Width: 2.0 to 2.5 mm. Specimens differ from the holotype in the following characters: Some specimens with the frontoclypeal suture more strongly indicated and three tubercles indicated by weakly raised, impunctate areas.

Diagnosis. This species is most similar to *Aphodius leptotarsis* Brown, a rodent-associated species with a broad distribution in North America that has been recently collected in Nebraska (see below). The two species can be distinguished by the angulate clypeal margin of *A. viceversus* (Fig. 3) as compared with the broadly rounded clypeal margin of *A. leptotarsis* (Fig. 4). In addition, the anterior protibial spur of male *A. viceversus* is turned to the outside (Fig. 5), but the spur is hooked to the inside on male *A. leptotarsis* (Fig. 6). The parameres of the male genitalia are bent abruptly in lateral view in *A. viceversus* (Fig. 9) but nearly straight in *A. leptotarsis* (Fig. 10). In addition, the apices of the parameres are contiguous in *A. viceversus* (Fig. 7) but separated at the apices in *A. leptotarsis* (Fig. 8). Because of the explanate pronotum and margined pronotal base, *A. leptotarsis* would key to *A. russeus* in Ratcliffe (1991). The latter species, however, is 5.7 – 6.5 mm in length and distinctly reddish in color.

Geographic distribution (Fig. 2). KANSAS: Kiowa Co.: 13 mi S Greensburg, 10 Mi N Mullinville; Norton Co.: 6 mi W Norton. NEBRASKA: Greeley Co.: 7.3 mi S Greeley.

Temporal distribution. January (1 specimen), February (31 specimens), March (10 specimens), April (10 specimens).

Remarks. *Aphodius viceversus* is recorded from Kansas and Nebraska. All specimens in the type series were collected from the burrows of the black-tailed prairie dog, *Cynomys ludovicianus*.

Etymology. The specific epithet is derived from *vice versa*, Latin for 'turned about', because the male protibial spur is turned the other way when compared to *A. leptotarsis*.

Other New *Aphodius* Records

In addition to the species described above, I collected the following 11 species of rodent-associated *Aphodius* not previously known from Nebraska. Three other species of *Aphodius* collected from prairie dog and pocket gopher burrows belong to species currently being described by Gordon and Warner and Skelley in this number.

Aphodius acuminatus Cartwright new state record

Most of the 84 specimens of this distinctive species (it is the only species in Nebraska with a tapered elytral apex) from 2004 were collected from pocket gopher burrow pitfalls in northern Greeley County in the Nebraska Sandhills. Several specimens were also taken in flight before dusk at that locality. In 2004, specimens were collected between 3 October and 11 November. In 2005, 83 specimens were collected in flight along the border of Garden and Sheridan counties (south of Lakeside, NE) in mid-October. Additional specimens were taken in flight in Greeley County (35), Dundy County (35), and Sioux County (15). Two specimens were found washed-up along the shore of Lake McConaughy in Keith County.

Aphodius carri Brown new state record

A single specimen of this small (3.8 – 5.0 mm), brown species was netted in flight over sandhills

prairie on 6 June 2004 in northern Greeley County. Subsequently on 14-15 May 2005 south of Paxton in Keith County, sifting black-tailed prairie dog mounds and loose substrate from the burrows resulted in the collection of over one hundred specimens. This is the only small *Aphodius* species in Nebraska with a strongly dentate humeral angle.

Aphodius criddlei Brown
new state record

A single specimen of this relatively large (~8 mm) species was netted in flight over prairie in October 2005 in northern Sioux County. The species was previously known from North Dakota and Wyoming in the United States and from Canada (R. Gordon, personal communication) and has been taken in burrows of pocket gophers in the genus *Thomomys*, which are present in northern Sioux County.

Aphodius kiowensis Gordon & Salsbury
new state record

A total of ten specimens of this species were taken in Arthur, Greeley, and Keith counties from 8 October to 7 November 2004. The single Keith County specimen was taken in a prairie dog burrow. One Greeley County specimen was collected in a pitfall trap in the burrow of the pocket gopher, *G. bursarius*. The remaining specimens were netted in flight at dusk over sandhills prairie. One specimen was collected 16 October 2005 in flight before sunset in Dundy County. This yellowish-brown species is distinctive among Nebraska *Aphodius* due to its deeply emarginate clypeus that is produced into obtuse teeth on the anterior angles.

Aphodius kirni Cartwright
new state record

This large, red species is one of the most commonly collected *Aphodius* species in Nebraska and is represented in the UNSM by hundreds of specimens from across the state. Previously, the *A. kirni* in the UNSM collection were misidentified as *A. concavus*. Although both species may be found together in some localities, *A. kirni* generally occurs in sandier soils. The majority of records for *A. concavus* from the Nebraska Sandhills in Ratcliffe (1991) actually refer to *A. kirni*. In Nebraska, the two species can be distinguished immediately by the first tarsal segment of the middle leg having two rows of setae in *A. concavus* but only one row in *A. kirni*. Two factors

likely contribute to the frequency of these two species in collections. First, unlike the other inquiline species, both *A. concavus* and *A. kirni* are active in summer (as are most insect collectors). Also, unlike the fall and spring rodent-associated *Aphodius* species, both *A. concavus* and *A. kirni* are attracted to light.

Aphodius leptotarsis Brown
new state record

In April, 2006, I collected a single female specimen of this species in Keith County. The specimen was found in nest materials excavated from a shallow rodent burrow. Based on mammals present in the area, the burrow was probably that of a thirteen-lined ground squirrel, *Spermophilus tridecemlineatus* (Mitchill). However, other species of ground squirrel are also reported from the area. *Aphodius leptotarsis* is similar to *A. viceversus* n.sp., but can be distinguished from it by the characters discussed under the latter species' description.

Aphodius magnificens Robinson
new state record

Eight specimens of this large (8.0 – 10.0 mm), reddish-brown, shining species were taken in northern Greeley County in mid-October 2004. Five specimens were collected in pitfall traps in the burrows of pocket gophers, *G. bursarius*. The remaining three specimens were caught in flight in late afternoon. In October 2005, 17 specimens were taken in flight in Dundy, Garden, and Sheridan counties.

Aphodius neodistinctus Brown
new state record

From 27 March to 17 April 2005, ten specimens of this small (4.0 – 5.5 mm) species were collected by scooping prairie dog burrows in southern Greeley County. The mottled elytral pattern of this species is somewhat similar to that of *A. distinctus* Müller, an adaptable and abundant adventive European species that has become established in North America and is found in many habitats including (perhaps unfortunately for native beetle species) prairie dog burrows. These species can be distinguished in dorsal view by the lateral margin of the elytra appearing glabrous in *A. neodistinctus* but conspicuously fimbriate in *A. distinctus*.

Aphodius peculiosus Schmidt
new state record

Between 3 October and 7 November 2004, over 60 specimens of this small (3.0 – 5.0 mm), bicolored species were collected in Greeley and Arthur counties. In October 2005, a total of 49 specimens were collected in Dundy, Garden, and Sheridan counties. This species is similar to *A. scabriceps* LeConte, but the clypeus of *A. peculiosus* is densely pubescent and not glabrous as in *A. scabriceps*. Specimens of *A. peculiosus* were taken with every method attempted, including netting in flight at dusk, pitfall traps, scooping prairie dog burrows, and in baited pitfall traps in pocket gopher burrows.

Aphodius punctissimus Brown
new state record

In 2004, four specimens of *A. punctissimus* were collected in flight in Keith and Arthur counties in western Nebraska. In 2005, one specimen was netted before sunset in Garden County. Two other specimens from Nebraska (PESC) were collected from pocket gopher burrows in eastern Nebraska (Nine-mile Prairie, Lancaster Co., June 1997). This species keys roughly to *A. brevicollis* in Ratcliffe (1991) but can be separated from that species by the clearly punctate elytral intervals and smaller size (4.5–6.0 mm vs. 7.0–9.0 mm).

Aphodius thomomysi Brown
new state record

Three specimens of this species were collected in Keith and Arthur counties in 2004. The single Keith County specimen was found dead in a mouse nest at Cedar Point Biological Station in July. The Arthur County specimens were taken in a *G. bursarius* burrow pitfall trap on 6 November 2004. In October 2005, 24 additional specimens were taken in flight in Dundy, Garden, Sioux, and Sheridan counties. This species is similar to *A. viceversus* and *A. leptotarsis* but is light brown in color and has the meso- and metatarsi noticeably longer than their respective tibiae.

Discussion

This research addresses a conspicuous gap in our knowledge of the dung beetle diversity of the Great Plains. Further sampling of rodent burrows in rarely sampled regions of the state (e.g., the Pine Ridge) would likely result in the collection of additional records and potentially new species. Furthermore, the burrows of other rodent hosts, such as packrats (*Neotoma* spp.) and ground squirrels (*Spermophilus*

spp.), have not been sampled in the state and generally contain their own unique *Aphodius* species. Although future sampling is needed, this research is a first step towards identifying insect species that may be adversely impacted by a decline of burrowing rodents in Nebraska resulting from current land management practices.

Acknowledgments

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