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SCARAB BEETLES (COLEOPTERA: SCARABAEIDAE) ASSOCIATED WITH POCKET GOPHERS IN WISCONSIN

Nadine Kriska¹ and Kerry Katovich²

ABSTRACT

A survey of nonparasitic arthropods inhabiting pocket gopher burrows in Wisconsin was undertaken from 1998 through 2002, representing the first survey of its kind for the Great Lakes region. Six scarab species were collected during this survey, all of which represented new state records at the time of collection. Observations for each species, including diagnostic remarks, seasonality, distribution, and natural history information are provided. Background information on pocket gophers, with an emphasis on the Wisconsin species, *Geomys bursarius*, is also provided.

Since the late 1930s entomologists have studied the insect fauna of various burrowing animals, particularly pocket gophers (Hubbell and Goff 1939, Hubbell 1940, Cartwright 1944, Ross 1944a, 1944b, Blume and Aga 1975, 1979, Blume and Summerlin 1988). Although these early studies were narrowly focused in Texas and Florida, data on several previously undescribed or rarely-encountered arthropod species were collected. In the mid-1980s researchers started collecting beetles in burrows, including those of pocket gophers, and several new species were discovered (Skelley and Woodruff 1991, Skelley and Gordon 1995, 2001). This drew the interest of coleopterists in other parts of the United States and ultimately led to more intensive surveying of nonparasitic arthropods living in pocket gopher burrows in other regions (Skelley and Gordon 2001).

From 1997 to 2000, a survey of Wisconsin scarabaeoid beetles was conducted (Kriska and Young 2002). This survey focused on less sampled areas of the state, unique habitats, and unique microhabitats, including pocket gopher burrows. The scarabaeoid survey was undertaken at the same time as the surveys in Florida and the southeastern United States. We realized we had a unique opportunity to contribute to the pocket gopher studies, especially since there have been relatively few papers published regarding the overall pocket gopher fauna in the U.S. (Skelley and Gordon 2001), and nothing is known about the Midwestern fauna, save for a survey of the lice associated with the Midwestern *Geomys bursarius* complex (Timm and Price 1980). The results of the Wisconsin study contribute to our understanding of pocket gopher fauna as well as contribute to our knowledge of Wisconsin's arthropod fauna.

Pocket Gophers. Geomyidae (pocket gophers) are found in North and Central America. The family consists of about 35 species in five genera, three of which occur in the United States: *Geomys* (eastern pocket gophers), *Pappogeomys* (southern pocket gophers), and *Thomomys* (western pocket gophers) (Myers et al. 2005). In the Midwest north of Texas, there are three species of *Geomys*, one of which, *G. bursarius* (Shaw), occurs in Wisconsin. *Geomys bursarius* is comprised of three subspecies, two of which occur in Wisconsin (Fig. 1): *Geomys bursarius wisconsinensis* Jackson occurs in the southwest corner of Wisconsin just north of the Wisconsin River, and *Geomys bursarius bursarius* (Shaw) occurs in west central and northwest Wisconsin (Heaney and Timm 1983).

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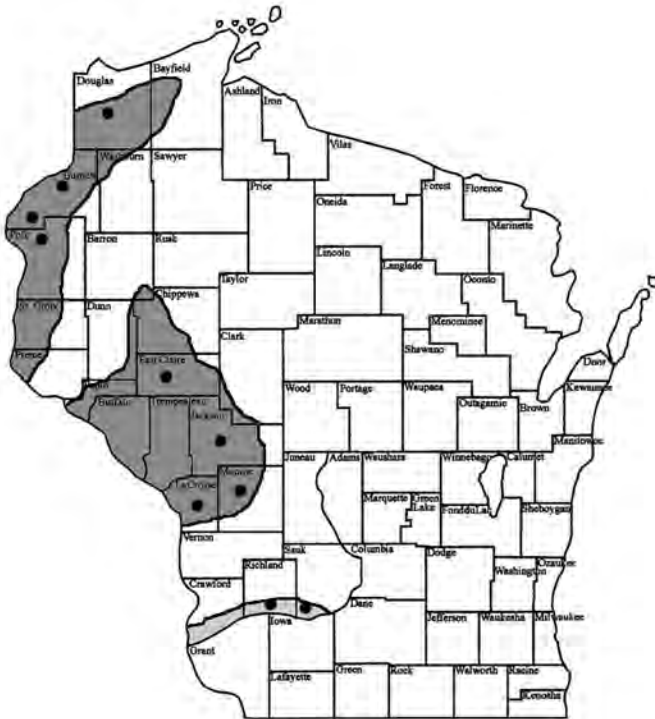


Figure 1: Ranges of *Geomys bursarius wisconsinensis* (light shade) and *Geomys bursarius bursarius* (dark shade). Dots indicate sample locations.

The majority of pocket gopher species occur west of the Mississippi River and occupy mountain tops, prairies, and deserts (Skelley and Gordon 2001). Pocket gophers in the Midwest inhabit grasslands with good drainage in either prairie or savanna (Jackson 1961). In Wisconsin, both subspecies are found in sandy or loose, loamy soil in semi- to completely open habitat (pastures, dry meadows, cultivated fields, burned cutover, undisturbed railway and highway roadsides).

Geomys bursarius spends its life underground. It is active in the winter and does not hibernate. During the winter it resides in tunnels dug below the frost line. According to Jackson (1961), the pocket gopher is a solitary, animal that will fight viciously with any intruder, including another pocket gopher, it encounters in its burrow. The exception to this is during the mating season, which is usually from late March into April or May. Females have one litter of 2-6 young per year. Once weaned, each youngster digs its own tunnel and begins its solitary life; this usually occurs in late summer.

Individual gophers make extensive tunnel systems linking several chambers. Chambers serve specific purposes, such as nesting, food storage, and defecation. These tunnel systems may be used for several years and extend up to 150 m in length and 30-90 cm deep (Kurta 1995). Pocket gophers rarely leave their burrows. Burrow entrances are sealed during the day preventing entrance

of diurnal terrestrial arthropods. The sealed nature of the gopher burrow provides a fairly consistent temperature and humidity range (Kennerly Jr., 1964). In Wisconsin, fire suppression and urbanization have fragmented many gopher populations. The nature of these isolated populations in relation to the unique arthropod fauna suggests the destruction of a gopher population in one region may result in the loss of a unique arthropod fauna.

Arthropod Fauna. The predominate arthropods associated with pocket gopher burrows are insects. The beetle families most prevalent are hister beetles (Histeridae), dung beetles (Scarabaeidae), and rove beetles (Staphylinidae). Camel crickets (Orthoptera: Gryllacrididae) and dung flies (Diptera: Sphaeroceridae) comprise the majority of non-beetle diversity. Insect parasites, such as lice and fleas, are also intimately associated with pocket gophers to the extent that individual species and subspecies of pocket gophers host their own unique parasite species. Timm and Price (1980) investigated the lice (Phthiraptera: Trichodectidae) parasitic on the *G. bursarius* species complex occurring in the Midwest. Fleas (Siphonaptera) associated with pocket gophers remain unstudied.

Insect Dispersal. Pocket gopher burrows are essentially moving caves which occasionally allow for movement into and between burrow systems, particularly during the mating season when male pocket gophers tunnel into females' burrow systems. Because true cave-dwelling insects have a fairly even allocation of resources and no need to disperse, unique adaptations are often seen, such as reduced eyes and wings, longer appendages, and pale body color (Skelley and Gordon 2001). This is not generally the case for pocket gopher fauna, since insects living in burrows need to move with them and be able to disperse. Camel crickets tend to show the most complete range of cavernicolous characteristics: they are all secondarily wingless with long legs, somewhat reduced eyes, and pale body coloration. Evidence strongly indicates that camel crickets endemic to pocket gopher burrows have a strictly subterranean dispersal pattern, including the fact that they have never been collected above ground outside of the burrow system (Skelley and Gordon 2001).

The remaining burrow fauna, except the parasites, may exhibit slightly reduced eyes or wings, or may have slightly longer legs but not to the extent seen in camel crickets. In fact, most of the fauna, including flies, rove beetles, and scarabs has been observed exiting freshly opened burrows and flying diurnally (Skelley and Gordon 2001, Kriska and Katovich, personal observations). Evidence for above-ground dispersal for many elements of the burrow fauna, particularly beetle species, includes capture in flight intercept traps and pitfall traps established in areas containing pocket gophers, collection at blacklight, and collection of specimens just under the surface of a fresh soil mound (Skelley and Gordon 2001, Kriska and Katovich, personal observations). What is intriguing about above-ground dispersal, as opposed to the subterranean dispersal of some faunal members, is that pocket gopher burrows are closed systems, rarely open to the surface. So why would some of these species risk above-ground dispersal? One possible explanation (Skelley and Gordon 2001) relates to the fact that immature stages of the beetles are relatively immobile and risk getting buried and left behind in an abandoned part of the burrow filled in by the gopher. So some adult beetles disperse above ground and look for active burrows in which to lay their eggs. Once active burrows are located, the beetles may find a temporary opening to the surface left by the gopher, often after a heavy rain, foraging, or dispersal of the young gophers. Another possibility is that the beetles may gain access to the burrow via a fresh mound that leads to the burrow through the backfilled tunnel that created the mound (Skelley and Gordon 2001). Some hypotheses as to how the beetles locate fresh mounds involve the use of chemical or visual cues, water content in fresh mounds, thermal differences of the mounds versus the surrounding ground, and others (Skelley and Gordon 2001).

METHODS

Ten sites in nine counties were surveyed (Fig.1). Burrows were located by the characteristic mounding of soil, and tunnels were located by probing around the soil mounds with a thin metal rod. Once located, a small excavation exposed the tunnel and a dung-baited pitfall trap (Fig. 2) was established in the tunnel. The bait was composed of a mixture of pig dung, malt and molasses. It was held in a small cup which was secured with a thick wire cup holder and suspended over a larger plastic cup buried flush with the tunnel floor. The larger cup contained a small amount of propylene glycol for preservative. The tunnel roof was covered over with a small piece of plywood, which was remounded and flagged for later retrieval. Remounding prevented terrestrial arthropods from entering the burrows.

Sites were sampled during three time periods: spring (March-April), summer (June-August), and fall (October-December). During these times sites were sampled twice a week. Traps were retrieved and the contents strained and preserved in 80% EtOH. At each site, multiple burrows were sampled to provide a representation of arthropods present. At sites where gopher populations were low, fewer pitfall traps were established. At several sites, more extensive excavations of the tunnel system and chambers were conducted.

Voucher specimens of gophers taken at the Ft. McCoy site (Monroe County) and from Douglas Public Hunting Grounds (Douglas County) were deposited in the University of Wisconsin Zoology Museum. Removal of the gophers was accomplished by setting Victor's E-Z Set traps® in both approach tunnels where the pitfall trap was established. Although gopher traps were established at all of the sample sites, no other gophers were collected. Vouchers of arthropod specimens were deposited in the University of Wisconsin Insect Research Collection (IRC).

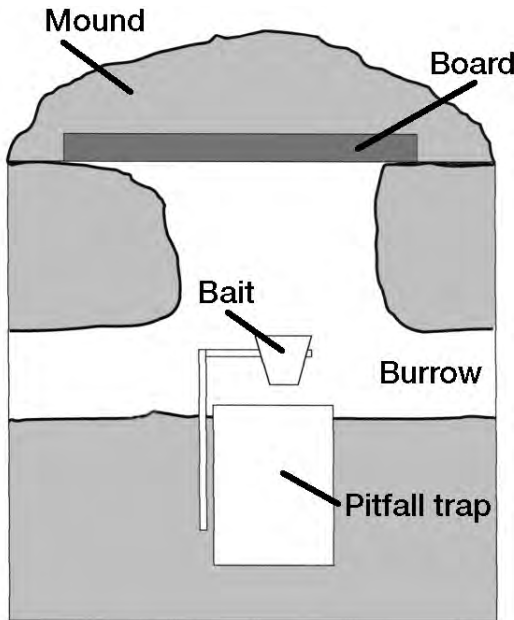


Figure 2: Baited pitfall trap placed in the burrow and sealed with a board and remounded.

RESULTS

Six of the largest known gopher populations in Wisconsin were sampled. Six species and 425 specimens of Scarabaeidae were collected from the burrow systems, and all constituted new state records at the time of capture (Kriska and Young 2002). All of the sampled sites except Eau Claire County produced beetles. The number of species collected at each site varied from two to five, but only *Aphodius insolitus* showed up consistently at every site. Additional insect and non-insect arthropods were collected and vouchered as noted above but are not discussed in this paper. The following are abbreviated profiles for each species. Diagnostic remarks are included because currently, no regional key to *Aphodius* exists that includes these six species.

Family Scarabaeidae

***Aphodius insolitus* Brown.** Specimens examined: 135. Diagnostic Remarks: This species is distinguished from the other pocket gopher species by its completely, coarsely punctate pronotum. It is 4.0-5.7 mm long, with a brown pronotum and orangish-brown to darker brown elytra. Distribution: *Aphodius insolitus* occurs in burrow systems of the plains pocket gopher, *G. bursarius*, which occurs in the Midwest from Wisconsin south to Texas and east into Indiana. It was collected in the following counties: Burnett, Douglas, Jackson, LaCrosse, Monroe, Polk, Richland, Sauk. It is active from early fall into winter (August-December). Natural History: *A. insolitus* is endemic to pocket gopher burrows and is a dung-feeder. It was collected in large series in dung-baited pitfall traps established in the pocket gopher tunnel system. The larva is unknown.

***Aphodius iowensis* Wickham.** Specimens examined: 148. Diagnostic Remarks: The best diagnostic character for *A. iowensis* is its granulate or sometimes verrucose clypeus. It may be confused with specimens of *Aphodius punctissimus* Brown or larger specimens of *A. insolitus*, but it has only one to two slight scallops along the posterior face of its prothoracic tibiae (*A. punctissimus* has a completely scalloped surface all the way to its basal tooth), and *A. iowensis* lacks a completely punctate pronotum. It is 7.0-8.5 mm long. Distribution: This species occurs from Manitoba, Canada, south to Nebraska, Kansas, Iowa, and east to Wisconsin, Illinois, and Indiana. It was collected in the following counties: Burnett, Jackson, Monroe, Polk, Richland, Sauk. It is active from fall into winter (late September-December) and in the spring (April). Natural History: *Aphodius iowensis* is another species comprising the insect fauna endemic to plains pocket gopher burrows. Most Wisconsin specimens were caught in dung-baited pitfall traps established in the gopher tunnel system. A single specimen from Douglas County was collected in a malaise trap in the mid-1970s. It appears that while most of the burrow fauna disperses to new tunnel systems subterraneously, occasionally a few *Aphodius* disperse via flight. *A. iowensis* might be more abundant in flight intercept traps if they were established during the late fall when the beetle is active in areas containing pocket gophers. The larval stage is unknown.

***Aphodius kirni* Cartwright.** Specimens examined: 66. Diagnostic Remarks: This species is distinct from the other pocket gopher species in that it is uniformly dull red to reddish-brown. It is 6.4-10.1 mm long. This species closely resembles a potential Wisconsin pocket gopher species, *Aphodius concavus* Say. They can be distinguished by features of their metathoracic legs. *A. concavus* has an inner row of setae on its metathoracic tibia that is uniform in length and extending the full length of the tibia. Males also have a row of stout, straight metathoracic trochanter hair. *Aphodius kirni* has a non uniform inner row of setae on its metathoracic tibia (basal setae are shorter than the apical setae) and the row extends only $\frac{1}{2}$ to $\frac{3}{4}$ the length of the tibia. Males have a row of longer, outwardly curved hair on their metathoracic trochanters. More importantly it

appears that unlike *A. kirni*, *A. concavus* prefers richer prairie soil as opposed to sandy, loamy soil found in all of our trapping localities (P. Skelley, personal communication). Distribution: *A. kirni* occurs in plains pocket gopher burrows, from Wisconsin south to Texas and east to Indiana. It was collected in the following counties: Burnett, Douglas, Jackson, Monroe, Polk, Richland, Sauk. Its habitat overlaps with that of *A. concavus*, which is found slightly further west to Iowa, Nebraska, Kansas and the Dakotas but also as far east as Indiana. It is active from April through December but tends to be more abundant in the spring and summer. Natural History: *A. kirni* is endemic to plains pocket gopher burrows. Most Wisconsin specimens were caught in dung-baited pitfall traps established in the gopher tunnel system. Several specimens were also caught in flight intercept traps that had been established in areas containing, or adjacent to, pocket gophers, suggesting this beetle does use flight to disperse to new burrow systems. The larva is unknown.

***Aphodius magnificens* Robinson.** Specimens examined: 48. Diagnostic Remarks: This species is distinctive. Its large size (8-10 mm) and shiny, light brown and dark brown color are diagnostic. Distribution: *A. magnificens* occurs in plains pocket gopher burrows in the Midwestern states, from Wisconsin south to Oklahoma and Texas. It was collected in the following counties: LaCrosse, Jackson, Monroe, Polk, Richland, Sauk. It is active in the fall through winter (August-December). Natural History: This species is endemic to plains pocket gopher burrows. Wisconsin specimens were caught in dung-baited pitfall traps established in the gopher tunnel system. No specimens have been collected in flight intercept traps, either because it disperses underground or because traps were not established during the beetle's peak activity period (winter). The larva is unknown.

***Aphodius peculiaris* Schmidt.** Specimens examined: 4. Diagnostic Remarks: Its small size (4.3-4.5 mm), rugo-tuberculate clypeus, and pale yellow elytra easily distinguish *A. peculiaris* from the other pocket gopher species. Distribution: This species occurs in plains pocket gopher burrows in the Midwest from Wisconsin south to Texas. It was collected in Monroe County. It is active from fall through early spring. Natural History: *A. peculiaris* is an uncommon species found below the soil surface of the dirt mounds pushed up by pocket gophers as they construct their tunnels (R. Gordon, personal communication). Several larvae and adults were sifted from a pocket gopher mound in Monroe County in early spring; larvae were reared in the lab to confirm their identity and are being described by the authors in a separate paper.

***Aphodius punctissimus* Brown.** Specimens examined: 24. Diagnostic Remarks: This species resembles some of the other pocket gopher species, particularly *A. insolitus* and *A. iowensis*. The length of *A. punctissimus* falls between larger specimens of *A. insolitus* and smaller specimens of *A. iowensis*. It is distinguished from *A. insolitus* by the large pronotal punctures: confined to the sides and base in *A. punctissimus*, and numerous and moderately dense over the entire surface in *A. insolitus*. It is distinguished from smaller, lighter colored specimens of *A. iowensis* by the basal region of the posterior face of the prothoracic tibiae: margin scalloped to serrate up to the basal tooth in *A. punctissimus*, margin smooth with occasionally one to two slight scallops up to basal tooth in *A. iowensis*. Distribution: *A. punctissimus* occurs in the west-central United States; Wisconsin represents the easternmost limit of its range. It is interesting to note that *A. punctissimus* was only collected in the northernmost locations, Burnett and Polk Counties. It is active from fall to winter (October-December). Natural History: Little biological information is available concerning this species other than its close affinity to *Aphodius oklahomensis* Brown, *Aphodius socialis* Brown, and *Aphodius talpoidesi* Brown. All are primarily west-central species ranging from South central Canada into Oklahoma and are associated with pocket gopher burrows. The larval stage is unknown.

DISCUSSION

Late spring and summer collection periods (May-July) proved to be the least productive and often conflicted with high gopher invasions from adjacent burrow systems, but the beetles were probably still active. During this time, gophers were active in their burrows mating and rearing young. Their increased activity resulted in their frequent encounters with the pitfall traps, which they would bury along with the bait cup and wire holder, blocking up that portion of their run. Peak arthropod collections occurred in late fall, two to three days after the traps were set, then tended to drop off significantly. This is could be due to the collapse of the tunnel systems (lacking maintenance by the gopher) or perhaps from the bait losing its effectiveness.

Four of the six species appear to be widespread throughout the ranges of both pocket gopher subspecies in Wisconsin, and they occurred in most if not all of the collection sites. The exceptions are *A. peculiarus* (collected only in Monroe County) and *A. punctissimus* which exhibits a distinctly northern distribution. *A. kirni* was collected primarily in the southern and central sites and rarely in the north, while *A. iowensis* generally showed an opposite trend. *A. magnificens* was fairly evenly distributed throughout all of the regions. The most common species was *A. insolitus* which was collected at every site except in Eau Claire County and in consistently moderate numbers (an average of six specimens per collecting event). It was often found in the same burrows as *A. iowensis*, *A. kirni* in the south or *A. magnificens* in the west central sites. *A. iowensis* was the second most abundant species averaging eight specimens per collecting event. The higher average than *A. insolitus* is due to one unusually large number (57) in a single collecting event from Sauk County in the spring of 2000. *A. iowensis* was often found in the same burrow with *A. insolitus* and *A. magnificens*. It is difficult to discern an overall pattern of species overlap in any given burrow other than the trends observed by *A. insolitus* and *A. iowensis*. However, it was generally the case that not more than two species would be collected together in the same collecting event.

The scarab fauna exhibited no distinct seasonal differences among the six species, except *A. kirni*, which was recovered consistently in small numbers throughout the spring into the fall, then dropped off. The remaining species, except *A. peculiarus* (collected just once in May), were collected in both early spring and fall/winter collecting periods. It appears that in Wisconsin, the numbers of specimens for the majority of *Aphodius* species peak in the late fall and winter, then drop off by late spring. In different regions of the country, these same species may exhibit more or less pronounced seasonal differences, depending on the climate (Skelley and Gordon 2001). *A. insolitus*, *A. kirni*, and *A. peculiarus* occur south into Texas, but there is no information to indicate what their seasonality is there.

The gophers' mounding activities, which increase more dramatically in the fall, may account for the increased beetle activity in the fall and winter (as opposed to the spring). Because the gophers are more active making mounds, the beetles that use above-ground dispersal would have the best opportunity to locate fresh, active burrows (Skelley and Gordon 2001).

The investigation of this novel habitat has demonstrated the importance of focusing on such areas when doing faunal surveys. In microhabitats such as burrow systems, endemic fauna may be found that would not be collected in any other habitat or by any other means. The loss of these microhabitats due to urbanization and management practices may result in a large reduction of species diversity.

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