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Arthropods infesting small mammals (Insectivora and Rodentia)
near Cedar Point Biological Station in southwestern Nebraska

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Abstract. Cedar Point Biological Station (CPBS) is located in the mixed grass prairie of the central Great Plains, at the transition between the subregions known as the “tall grass” and “short grass” prairies. Adding to the habitat diversity, there are wetlands and riparian habitats associated with the North Platte River and the edge of the Sandhills region of north central Nebraska. This concurrence of habitats supports a diverse small mammal community. The purpose of this paper is to assemble all published information on ectoparasites associated with small mammals (Insectivora, Rodentia) of southwestern Nebraska, and to report the results of an intensive survey carried out by students of the Parasitology field course during two summers at CPBS. In 2012 and 2013, 27 species of mammal-associated arthropods were collected, including five species of sucking lice (Anoplura), a chewing louse (Ischnocera), six species of fleas (Siphonaptera), thirteen species of mesostigmatic mites (Laelapidae, Macronyssidae, Macrochelidae), and two species of metastigmatic ticks (Ixodidae). These specimens were brushed from the pelage of 11 species of small mammals that were captured in a variety of habitats around CPBS. The arthropod list includes 17 new records for the State of Nebraska. This collection is housed in the Harold W. Manter Laboratory of Parasitology (HWML), University of Nebraska State Museum, at the University of Nebraska-Lincoln, and serves as a taxonomic base for our continued efforts to establish a long-term catalog of parasites associated with small mammals in southwestern Nebraska.

Key Words. Anoplura, ectoparasite, Ischnocera, Ixodidae, Laelapidae, Macrochelidae, Macronyssidae, Siphonaptera.

Introduction

The landscape of Nebraska has been classified into four categories – upland and lowland prairies, deciduous forests of the east, the geographically restricted ponderosa pine forests of the northwest, and the wetlands from the marshes, rivers, and lakes within the Sandhills region (Weaver 1965). At the southern edge of the Sandhills, the North Platte River pours into Lake McConaughy, a massive, man-made reservoir of water 35 kilometers in length by 5 kilometers in width held back by Kingsley Dam. Water spews from the dam into the smaller detention basin, Lake Ogallala, where Cedar Point Biological Station (CPBS), a field station of the University of Nebraska-Lincoln, is located. Each summer, students in the Field Parasitology class collect small mammals around CPBS, and examine them for their parasites. Through these efforts, it is possible to observe and describe the biodiversity of the area.

Arthropods have evolved a complex range of association with small mammals, from facultative to obligate, temporary to permanent, and commensal to parasitic; they can also serve as vectors transmitting parasites and pathogens, not only among their wild mammal hosts, but also to man and his domestic animals (Kim 1985). As natural habitats are destroyed and ecosystems altered by human development, many eastern species of small mammals are known to be expanding their ranges westward into Nebraska (Benedict et al. 2000). To understand these changes in the biotic systems of the central Great Plains, and the epidemiological threat posed by the merging of eastern and western small mammal species (Jones et al. 1983), we must have reliable data on both hosts and parasites. This catalog of ectoparasitic arthropods collected around CPBS in Keith County, Nebraska will form a working foundation upon which we can build a more extensive inventory of parasites associated with mammals in the Great Plains.

Another objective of this study was to gather the literature on ectoparasites associated with Nebraska rodents and insectivores. The foundation of our knowledge on the subject in Nebraska was established by Doris B. Gates (Nebraska State Teachers College, Chadron, NE) and William Rapp (Doane College, Crete, NE). Rapp and Gates (1957) published a valuable, specimen-based checklist of 28 species of Nebraska fleas, based on a master's thesis in Entomology by Doris B. Gates (1947) at the University of Nebraska. Her valuable collection of Nebraska Siphonaptera is still available for scientific study in the Division of Entomology, University of Nebraska State Museum. William Rapp had more of an interest in acarology, and published important papers on parasitic mites (1962) and ticks (1955, 1960) while serving as the Entomologist for the Nebraska State Department of Health. Since that time, very few studies have addressed the subject of native Nebraska mammals and their ectoparasites (but see Timm 1972; Cortinas and Spomer 2013).

Materials and Methods

From mid-July to mid-August 2012 and 2013, small mammals of several different species were collected from six different locations in west-central Nebraska. The names of the trapping sites are Cedar Point Biological Station (Station Grounds), Grama Grass, Double Tank, Breen's Flyway, and Ackley Valley (Ackley) in Keith County, and Arapahoe Prairie (Arapahoe) in Arthur County. Station Grounds (41.21°N, 101.65°W) is considered Great Plains-grassland/woodland and wetland habitat. Grama Grass (41.19°N, 101.65°W) is a fallow pasture that is deemed Great Plains-grassland habitat. Double Tank (41.20°N, 101.64°W) is also considered to be Great Plains-grassland habitat. Breen's Flyway (41.18°N, 101.36°W) is considered riparian-wetland habitat as it consists of a large pond in a marshy area on the edge of the North Platte River. Ackley (41.33°N, 101.73°W) is a horse pasture located in the Sandhills and is deemed Sandhills-short grass habitat. Arapahoe (41.49°N, 101.86°W) is also considered Sandhills-short grass habitat (Bailey 1982).

Collection procedures followed the methods of Gardner (1996) and Gardner and Jiménez-Ruiz (2009). Sherman™ live traps were used to collect specimens. Traps were checked twice daily, in the early morning and late afternoon. Each small mammal that was captured was placed into a separate plastic bag and labeled with location, trap line, and trap number. Each animal was assigned a Nebraska Parasite (NP) number, killed with chloroform, brushed for ectoparasites, and searched for endoparasites. Arthro-

Pods were identified with the primary literature and by comparing specimens with identified material in the HWML collections. Endoparasites will be reported in a separate contribution. All research was conducted under Institutional Animal Care and Use No. 652.

The following mammal species were sampled, prepared as voucher host specimens, and deposited in the mammal collection of the University of Nebraska State Museum (UNSM): *Sorex cinereus* Kerr, 1792; *Geomys lutescens* Merriam, 1890; *Dipodomys ordii* Woodhouse, 1853; *Chaetodipus hispidus* Baird, 1858; *Perognathus flavescens* Merriam, 1889; *Zapus hudsonius* (Zimmermann, 1780); *Microtus ochrogaster* (Wagner, 1842); *Onychomys leucogaster* (Wied-Neuwied, 1841); *Peromyscus leucopus* (Rafinesque, 1818); *Peromyscus maniculatus* (Wagner, 1845); and *Reithrodontomys megalotis* (Baird, 1858). Ectoparasites were brushed following Gardner (1996) and Gardner and Jiménez-Ruiz (2009).

Ectoparasites were preserved in plastic Whirl-Pak™ bags with 70% ethanol pending further examination. Each bag was later inspected individually and sorted by type (mite, flea, tick, or louse) into vials of 95% ethanol. Permanent mounts were made of fleas, mites, and lice on glass microscope slides using both a water-based (Hoyer's) and resin-based medium (Damar Gum). Ticks were studied and preserved in the vials of ethanol. Arthropods collected by the Field Parasitology students were maintained as voucher specimens, either preserved in vials of ethanol or mounted on slides. These vouchers were labeled with a unique number under the codon HWML, and formally deposited in the general collection of the Harold W. Manter Laboratory of Parasitology, University of Nebraska - Lincoln. All ectoparasite records are supported by voucher specimens of the host mammal, as formal skins and/or skeleton preparations, including frozen organ tissue samples. The skins and skeletons were deposited at the Zoology Division of the University of Nebraska State Museum (UNSM) at the University of Nebraska-Lincoln; tissues are in the HWML Parasite Genomic Research Facility at the University of Nebraska-Lincoln. Records for mammal specimens are available online in the Zoology Division of the UNSM database. The parasite specimen records are available online within the HWML database.

Results

Twenty-seven species of arthropods were collected from 11 species of small mammals (Rodentia, Insectivora), including insects (Phthiraptera, six spp.; Siphonaptera, six spp.) and mites (Metastigmata, two spp.; Mesostigmata, thirteen spp.). Phthiraptera: *Geomydoecus nebrathkensis**, *Hoplopleura acanthopus*, *Hoplopleura onychomydis**, *Hoplopleura hesperomydis*, *Fahrenholzia boleni**, *Fahrenholzia zacatecae**. Siphonaptera: *Orchopeas leucopus*, *Pleochaetis exilis**, *Aetheca wagneri**, *Megabothris asio**, *Foxella ignota*, *Corrodopsylla curvata*. Metastigmata: *Dermacentor variabilis*, *Ixodes sculptus**. Mesostigmata: *Hyperlaelaps microti*, *Androlaelaps circularis**, *Androlaelaps crowei**, *Androlaelaps fahrenholzi*, *Androlaelaps geomys*, *Echinonyssus geomys*, *Echinonyssus hilli**, *Echinonyssus incompitis**, *Echinonyssus perognathi**, *Ornithonyssus bacoti**. New state species records (14) are marked with an asterisk. Also, three species of nest-associated macrochelid mites were collected (all new records for Nebraska).

An account of each ectoparasite species follows, including current scientific name, list of catalog numbers for identified specimens of both arthropods and host mammals, and a brief summary of distribution and ecology. Host and ectoparasite sample sizes were insufficient for yielding much information on host associations or ectoparasite infrapopulation, but ectoparasites infesting each species of small mammal host are listed (Table 1).

Insecta: Psocodea: Phthiraptera: Ischnocera: Trichodectidae

***Geomydoecus nebrathkensis* Timm and Price**

Type host: *Geomys bursarius lutescens* Merriam from Lincoln Co., Nebraska.

Deposition, host records, and locality: HWML 92016, *G. lutescens*/Ackley 2013; HWML 92035, *G. lutescens*/Ackley 2013; HWML 101756, *G. lutescens*/Ackley 2013; HWML 92047, *G. lutescens*/Ackley 2013; HWML 92054, *G. lutescens*/Ackley 2013.

Remarks: Chewing lice are permanent ectoparasites, passing their entire life cycle on the body of the host. Lice of the genus *Geomydoecus* are exclusively associated with pocket gophers, and are strongly host species specific. *Geomydoecus nebrathkensis* is easily separated from closely related *Geomydoecus oklahomensis* Price and Emerson, 1971, to the south, by the lack of a distinct antennal thumb in the male, and from *Geomydoecus geomydis* (Osborn, 1891), to the east, by general size characters (Timm and Price 1980). These ectoparasites are generally abundant on the host gopher, with all stages (adults, nymphs, and eggs) infesting the pelage of the host.

Insecta: Psocodea: Phthiraptera: Anoplura: Hoplopleuridae

***Hoplopleura acanthopus* (Burmeister)**

Type host: *Microtus arvalis* (Pallas) from Europe.

Deposition, host records, and locality: HWML 101667, *M. ochrogaster*/Station Grounds 2012.

Remarks: This louse occurs exclusively on arvicoline rodents (voles and lemmings). Durden and Musser (1994) list this species from 24 species of *Microtus*, including both *Microtus pennsylvanicus* (Ord, 1815) and *M. ochrogaster*.

***Hoplopleura hesperomydis* (Osborn)**

Type host: *Peromyscus leucopus* (Rafinesque) from Ames, Iowa.

Deposition, host records, and locality: HWML 91981, *Pm. maniculatus*/Station Grounds 2012; HWML 101683, *Pm. leucopus*/Grama Grass 2012; HWML 92023, *R. megalotis*/Ackley 2013; HWML 101734, *Pm. maniculatus*/Ackley 2013; HWML 92046, *Pm. leucopus*/Ackley 2013; HWML 92057, *Pm. maniculatus*/Grama Grass 2013.

Remarks: This species name is applied to lice infesting a wide range of deer mice (*Peromyscus* spp.), and this nominal louse is strongly associated with both *Pm. maniculatus* and *Pm. leucopus*. Studies in New Mexico (Morlan and Hoff 1957) and Minnesota (Cook and Beer 1955) demonstrate that prevalence and intensity of infestation can vary widely, both seasonally and geographically. In Indiana, *H. hesperomydis* has been reported from both *Pm. leucopus* and *Pm. maniculatus* (Wilson 1961).

***Hoplopleura onychomydis* Cook and Beer**

Type host: *Onychomys torridus* (Coues, 1874), Portal, Arizona.

Deposition, host records, and locality: HWML 92026, *O. leucogaster*/Ackley 2013; HWML 101720, *O. leucogaster*/Ackley 2013; HWML 101726, *O. leucogaster*/Ackley 2013.

Remarks: This sucking louse species is oligoxenous, infesting *Onychomys torridus* and the northern grasshopper mouse, *O. leucogaster* throughout their ranges in the western U.S. and Mexico (Durden and Musser 1994).

Insecta: Psocodea: Phthiraptera: Anoplura: Polyplacidae

***Fahrenheitzia boleni* McDaniel**

Type host: *Perognathus merriami merriami* J.A. Allen, 1892, 10 mi. S. of Riviera, Kenedy Co., Texas.

Deposition, host records, and locality: HWML 91979, *Pg. flavescens*/Arapahoe 2012.

Remarks: The type host, *Perognathus merriami*, is closely related phylogenetically to *Pg. flavus* Baird, 1855, and the two species are thought to hybridize at several localities in southeastern New Mexico (Williams et al. 1993). *Perognathus flavescens* is also a closely related species. This louse species needs careful study to assess the true species boundaries.

***Fahrenholzia zacatecae* Ferris**

Type host: *Chaetodipus hispidus zacatecae* Osgood, 1900, Valparaiso, Zacatecas, Mexico.

Deposition, host records, and locality: HWML 91984, *C. hispidus*/Grama Grass 2012; HWML 101678, *C. hispidus*/Grama Grass 2012; HWML 101682, *C. hispidus*/Grama Grass 2012.

Remarks: This species is a permanent associate with the Hispid Pocket Mouse, *C. hispidus*, and probably infests this host throughout its geographic range, including Mexico, Arizona, and Texas (Kim et al. 1986). Light and Hafner (2007) report a vouchered *C. hispidus* infested with this louse species in Hidalgo County, Texas. In Oklahoma, however, Ellis (1955) reports *Fahrenholzia tribulosa* Ferris, 1922, as the louse from *C. hispidus*.

Insecta: Siphonaptera: Ceratophyllidae

***Orchopeas leucopus* (Baker)**

Type host: *Peromyscus leucopus* from Madison Co., New York.

Deposition, host records, and locality: HWML 91985, *O. leucogaster*/Grama Grass 2012; HWML 101674, *O. leucogaster*/Station Grounds 2012; HWML 92042, *O. leucogaster*/Grama Grass 2013; HWML 101697, *Pm. maniculatus*/Station Grounds 2013; HWML 101767 and 101768, *Pm. leucopus*/Ackley 2013; HWML 92058, *Pm. maniculatus*/Ackley 2013.

Remarks: This is a common *Peromyscus* flea in North America, and is known to occur in Nebraska infesting both *Pm. maniculatus* and *Pm. leucopus* (Rapp and Gates 1957). We have collected this flea species from *O. leucogaster* and both *Pm. leucopus* and *Pm. maniculatus*.

***Pleochaetis exilis* (Jordan)**

Type host: *Onychomys leucogaster* from Powder River and Beaverhead Counties, Montana.

Deposition, host records, and locality: HWML 91991, *O. leucogaster*/Grama Grass 2012; HWML 92013, *Pm. leucopus*/Station Grounds 2013; HWML 92019, *O. leucogaster*/Ackley 2013; HWML 92028, *O. leucogaster*/Ackley 2013; HWML 101759, *O. leucogaster*/Grama Grass 2013; HWML 101792, 101793, and 92055, *O. leucogaster*/Grama Grass 2013.

Remarks: The primary host of *P. exilis* is the grasshopper mouse, *O. leucogaster*. It was the dominant flea collected from *O. leucogaster* in New Mexico, and is thought to be quite specific to the grasshopper mouse (Pfaffenberger and de Bruin 1986).

***Aetheca wagneri* (Baker)**

Type Host: unknown; from Moscow, Idaho.

Deposition, host records, and locality: HWML 91992, *R. megalotis*/Grama Grass 2012; HWML 91993, *Pm. maniculatus*/Double Tank 2012; HWML 91995, *Pm. maniculatus*/Double Tank 2012; HWML 92000, *Pm. maniculatus*/Arapahoe 2012; HWML101689, *Pm. leucopus*/Station Grounds 2013; HWML 101690, *Pm. leucopus*/Station Grounds 2013; HWML 101691, *Pm. leucopus*/Station Grounds 2013; HWML 92008, *Pm. leucopus*/Station Grounds 2013; HWML 92009, *Pm. leucopus*/Station Grounds 2013; HWML 101802 and 101803, *Pm. leucopus*/Breen's Flyway 2013; HWML 101819, *R. megalotis*/Breen's Flyway 2013.

Remarks: *Aetheca wagneri* is a common flea of deer mice of the genus *Peromyscus* (Holland 1985). The male is easily recognized by the moveable process that is long and triangular, armed at posterior apex with three blunt spiniforms (two are short, stud-like, and clustered, the other is about five times as long as the upper two). The females have a distinctive, vermiform spermatheca with hilla broader than bulga. Haas et al. (2004) report the species from *Peromyscus gratus* Merriam in southwestern New Mexico. This flea was also collected in Arizona from *Pm. maniculatus*, but only at higher altitudes of 8-9,000 feet (Beer et al. 1959).

***Megabothris asio* (Baker)**

Type host: *Megascops asio* (Linnaeus, 1758) from Norfolk Co., Massachusetts.

Deposition, host records, and locality: HWML 101658, *M. ochrogaster*/Station Grounds 2012; HWML 101811, 101812, 101813, and 101817, *M. ochrogaster*/Station Grounds 2013.

Remarks: This is a common flea of the meadow vole, *M. pennsylvanicus*, in eastern North America. Although this flea has been reported from *M. ochrogaster* in Illinois (Verts 1961), this is not a common association, so these are important new records. Wilson (1961), collecting from *M. pennsylvanicus*, makes it clear that *M. asio* is a nest flea, rarely found in high numbers on the body of the host. *Megabothris asio* was the only flea collected from voles.

***Foxella ignota* (Baker)**

Type host: unknown, from Story Co., Iowa.

Deposition, host records, and locality: HWML 101694, 101695, and 101696, *G. lutescens*/Ackley 2013; HWML 101701, *G. lutescens*/Ackley 2013; HWML 101709 and 101710, *G. lutescens*/Ackley 2013; HWML 92037, 101739, 101740, 101741, 101742, 101743, and 101744, *G. lutescens*/Ackley 2013; HWML 101753, 101754, and 101755, *G. lutescens*/Ackley 2013; HWML 101769 and 101770, *G. lutescens*/Ackley 2013; HWML 101771, 101772, 101773, 101774, 101775, 101776, 101777, 101778, 101779, 101780, 101781, 101782, 101783, and 101784, *G. lutescens*/Ackley 2013.

Remarks: This flea is primarily an ectoparasite of the pocket gopher genera, *Geomys* and *Thomomys*. Although Fox (1940) indicated that *Ctenophthalmus pseudagyrtis* Baker was the most common flea from gophers in the eastern United States, he noted that *F. ignota* was very common on these hosts in the western states. Holdenried & Morlan (1956) reported heavy infections of *F. ignota* on pocket gophers in northern New Mexico. McAllister et al. (2013) reported *F. ignota* from *G. lutescens* in northwestern Oklahoma. At CPBS, *F. ignota* was the only flea collected from *G. lutescens*.

Insecta: Siphonaptera: Hystrichopsyllidae

***Corrodopsylla curvata* (Rothschild)**

Type host: *Blarina brevicauda* Elliot, from Johnson Co., Iowa.

Deposition, host records, and locality: HWML 101798, *S. cinereus*/Breen's Flyway 2013.

Remarks: This is one of the most common fleas on shrews (Insectivora) in North America, and occurs on both *Sorex* and *Blarina* spp. (Holland 1985). Rapp and Gates (1957) report specimens of *C. curvata* from *Blarina brevicauda* collected in Knox County, Nebraska. Wilson (1961) also reported this flea from *B. brevicauda* in southwestern Indiana.

Acari: Metastigmata: Ixodidae

In Nebraska, William F. Rapp with the State Department of Health made important contributions on the presence of ticks statewide (Rapp 1955, 1960), and this organization has continued to carefully document statewide information on ticks and tick-borne diseases. Our field studies of ectoparasites serve as surveillance for two important vectors, *Amblyomma americanum* (Linnaeus, 1758) and *Ixodes scapularis* Say, 1821, which are not presently established in western Nebraska. The Lone Star Tick (*A. americanum*), an extremely anthropophilous species, began to become a common tick in southeastern Nebraska about 25 years ago, and appears to be expanding westward (Cortinas and Spomer 2013). The corridor along Interstate 80 near CPBS could be a point of introduction for engorged females detaching from domestic dogs from the southeastern United States. Two species of ticks listed in Nebraska by Bishopp and Trembley (1945), but not by Rapp (1960, 1962), are *Ixodes kingi* Bishopp, and the Spinose Ear Tick, *Otobius megnini* (Dugès, 1884). Bishopp and Trembley (1945) also shows records of *Dermacentor parumapertus* Neumann, 1901 from areas adjacent to Keith County, in Kansas and Colorado. This tick is common, infests *Lepus californicus* Gray, 1837, and may infest this host around CPBS.

***Dermacentor variabilis* (Say)**

Type host: unknown.

Deposition, host records, and locality: HWML 92007, *Pm. leucopus*/Station Grounds 2013; HWML 92010 and 101692, *Pm. leucopus*/Station Grounds 2013; HWML 92011, *Pm. leucopus*/Station Grounds 2013; HWML 92012, *Pm. leucopus*/Station Grounds 2013; HWML 92059, *Pm. maniculatus*/Breen's Flyway 2013; HWML 92060, *R. megalotis*/Breen's Flyway 2013; HWML 92061, *Pm. leucopus*/Breen's Flyway 2013; HWML 92062, *R. megalotis*/Breen's Flyway 2013; HWML 92066, *Pm. leucopus*/Breen's Flyway 2013.

Remarks: *Dermacentor variabilis* is the most common tick on dogs and humans in Nebraska, known from all regions but the northwest panhandle, with larvae and nymphs occurring in high numbers on deer mice, *Peromyscus*, especially in "river bottom woodlands," and can be found in association with other tick species on the same host individual (Rapp 1955). We collected 14 adults from humans, and nymphs from many small mammals, especially *Peromyscus* spp., *O. leucogaster*, and *M. ochrogaster*. The raccoon (*Procyon lotor* (Linnaeus, 1758)) and Virginia opossum (*Didelphis virginiana* Kerr, 1792) are the principal hosts of the adult stage of the tick in Missouri (Kollars et al. 2000). The type host and original locality of this species are not known (Cooley 1938).

***Ixodes sculptus* Neumann**

Type host: unknown.

Deposition, host records, and locality: HWML 92017, *G. lutescens*/Ackley 2013; HWML 92031, 92036, 101735, 101745, and 101747, *G. lutescens*/Ackley 2013; HWML 92038 and 92039, *G. lutescens*/Ackley 2013; HWML 92053, *G. lutescens*/Ackley 2013.

Remarks: This tick is most commonly associated with burrowing mammals, especially ground squirrels, and their predators throughout the central and western United States and Canada (Miller and

Ward 1960; Spicka 1981; Brillhart et al. 1994; Salkeld et al. 2006). Keirans and Clifford (1978) note its presence in Nebraska, and at Ackley Valley a single adult female and 45 larvae were collected from four *G. lutescens*. Salkeld et al. 2006 examined the host associations of *I. sculptus* among the small mammals of a prairie community in northern Colorado, about 200 miles west of CPBS. Although they report *I. sculptus* from four species of semi-fossorial rodents, they were collecting with Sherman live traps and did not sample gophers. However, Miller and Ward (1960) collected this tick from both *Geomys* and *Thomomys* in Colorado. Salkeld et al. 2006 summarized the published records of *I. sculptus*, revealing a very wide host range, including humans and their domestic animals, rodents, lagomorphs, and many carnivores. Because of its broad host-range, the potential role of *I. sculptus* as a vector of enzootic diseases is very high (Salkeld et al. 2006). The type host and original locality of this species are not known (Keirans and Clifford 1978).

Acari: Mesostigmata: Laelapidae: Laelapinae

Mesostigmatic mites of the subfamily Laelapinae are thought to be nidicolous, or nest-mites, although all instars are commonly collected from host pelage. They are probably not truly haematophagous, but are occasionally collected with blood in their gut (Radovsky 1969).

***Androlaelaps circularis* (Ewing)**

Type host: *Peromyscus truei* (Shufeldt, 1885); Type locality: Salina, Utah.

Deposition, host records, and locality: HWML 101731, 101732, and 101733, *Pm. maniculatus*/Ackley 2013.

Remarks: *Androlaelaps* (subgenus *Eubrachylaelaps*) spp. are distinctive, highly sclerotized, circular-shaped mites associated primarily with peromyscine rodents in North and Central America, and with Akodontine and Abrotrichine rodents in South America (Gettinger and Gardner 2015). *Androlaelaps circularis* has been reported from a long list of neotomine rodents in North and Central America (Furman 1955). The wide range of morphological variation across closely related host species and a wide geographic range has never been studied critically. Although the implication in the literature points toward intraspecific geographic variation (see Furman 1955), in South America, a morphometric analysis of the congeneric species *Androlaelaps rotundus* (Fonseca, 1936) concluded that this nominal form is a composite of cryptic species, each associated with a separate host species (Gettinger and Owen 2000). The subgenus *Eubrachylaelaps* is in great need of revision to evaluate this variation, and to assess the monophyly of these mites infesting different host groups in the Nearctic (Neotominae) and Neotropical (Sigmodontinae) regions.

***Androlaelaps crowei* Jameson**

Type host: *Onychomys leucogaster arcticeps* (Rhoades) from Meade Co., Kansas.

Deposition, host records, and locality: HWML 101687 and 91998, *O. leucogaster*/Arapahoe 2012; HWML 91999, *O. leucogaster*/Arapahoe 2012; HWML 92002, *O. leucogaster*/Arapahoe 2012; HWML 92003, *O. leucogaster*/Arapahoe 2012; HWML 92004, *O. leucogaster*/Arapahoe 2012; HWML 92020 and 101700, *O. leucogaster*/Ackley 2013; HWML 101713, 101714, 101715, 101717, 101718, and 92027, *O. leucogaster*/Ackley 2013; HWML 101721, *O. leucogaster*/Ackley 2013; HWML 92044, *O. leucogaster*/Grama Grass 2013.

Remarks: *Androlaelaps crowei* was collected in relatively high numbers, infesting the grasshopper mouse, *O. leucogaster*. Our specimens are morphologically similar, but slightly smaller than the holotype described and illustrated by Jameson (1947a). All of the mites of this species appear to be specifically associated with neotomine rodents of the genus *Onychomys*.

***Hyperlaelaps microti* (Ewing)**

Type host: *Microtus californicus* Merriam, 1880; from Los Angeles, CA.

Deposition, host records, and locality: HWML 101660, *M. ochrogaster*/Station Grounds 2012; HWML 101671, *M. ochrogaster*/Station Grounds 2012.

Remarks: There are multiple records for *H. microti* in Nebraska. Rapp (1962) reported this mite from *M. ochrogaster* near Chadron, in Dawes County. Later, Timm (1973) collected *H. microti* from *M. pennsylvanicus* in Kearney County, and from *M. ochrogaster* in Saline County. Jameson (1947b) reports *H. microti* as common on *M. ochrogaster* in Kansas, on *M. pennsylvanicus* in New York, and on *Microtus californicus* (Peale, 1848) in Alameda County, California. This species is collected primarily from voles of the genus *Microtus* (Evans and Till 1966; Timm 1972).

***Androlaelaps fahrenheitzi* (Berlese)**

Type host: unknown; from Germany, Europe.

Deposition, host records, and locality: HWML 101657, *D. ordii*/Station Grounds 2012; HWML 101664, *M. ochrogaster*/Station Grounds 2012; HWML 101669 and 101670, *M. ochrogaster*/Station Grounds 2012; HWML 101677, *C. hispidus*/Grama Grass 2012; HWML 91986, *O. leucogaster*/Grama Grass 2012; HWML 91987, *O. leucogaster*/Grama Grass 2012; HWML 91990, *O. leucogaster*/Grama Grass 2012; HWML 101688, *Pg. flavescens*/Arapahoe 2012; HWML 92006, *Pm. maniculatus*/Station Grounds 2013; HWML 101699 and 92021, *O. leucogaster*/Ackley 2013; HWML 101716 and 101719, *O. leucogaster*/Ackley 2013; HWML 101723 and 92030, *O. leucogaster*/Ackley 2013; HWML 101711, *Pg. flavescens*/Ackley 2013; HWML 101757, 101758, and 92043, *O. leucogaster*/Grama Grass 2013; HWML 92056, *O. leucogaster*/Grama Grass 2013; HWML 101791, *Pg. flavescens*/Grama Grass 2013; HWML 101797, *S. cinereus*/Breen's Flyway 2013; HWML 101804, *R. megalotis*/Breen's Flyway 2013; HWML 101805, *Z. hudsonius*/Breen's Flyway 2013; HWML 101807, *Z. hudsonius*/Breen's Flyway 2013; HWML 101808, *Z. hudsonius*/Breen's Flyway 2013; HWML 92067, *Pm. leucopus*/Breen's Flyway 2013; HWML 101814, *M. ochrogaster*/Station Grounds 2013.

Remarks: The genus *Androlaelaps* s.l. is problematical and unsettled taxonomically. Historically, a wide range of morphologically variable mite populations have been identified under the names *A. fahrenheitzi* and *Androlaelaps glasgowi* (Ewing). Furman (1966) placed *A. glasgowi* in synonymy with *A. fahrenheitzi*, so for the purposes of this paper we have chosen to continue using this epithet for these mites, even though they occur on multiple host species around CPBS. More research is needed to assess whether this species is truly polyxenous, or a composite of more host specific, but cryptic species. In just two collecting periods, we have collected *A. fahrenheitzi* from nine different genera of hosts (*Sorex*, *Onychomys*, *Peromyscus*, *Reithrodontomys*, *Microtus*, *Zapus*, *Chaetodipus*, *Dipodomys*, and *Perognathus*). Rapp (1962) recorded the occurrence of *A. glasgowi* on several species of small mammal hosts in Nebraska, and noted that the "specimens show intraspecific variations depending upon their host".

***Androlaelaps geomys* (Strandtmann)**

Type host: *Geomys* sp. from Brooks Co., Georgia.

Deposition, host records, and locality: HWML 92014, *G. lutescens*/Ackley 2013; HWML 101702, 101704, 101705, and 101708, *G. lutescens*/Ackley 2013; HWML 92022, *G. lutescens*/Ackley 2013; HWML 92032, 101737, 101746, and 101750, *G. lutescens*/Ackley 2013; HWML 92041, *G. lutescens*/Ackley 2013; HWML 92048, *G. lutescens*/Ackley 2013; HWML 101786, 101787, 101788, 101790, and 92051, *G. lutescens*/Ackley 2013.

Remarks: *Androlaelaps geomys* is a pleioxenous ectoparasite reported exclusively from fossorial rodents (Geomyidae). It appears to infest all geomyid species, including *Thomomys*, *Geomys*, and *Cratogeomys* (Miller and Ward 1960; Rust 1973; Whitaker et al. 2007; Wilkins and Houck 2001). This association was first recorded in Nebraska by Rapp (1962) from *G. lutescens*, near Chadron, in Dawes County. The mite is easily distinguished from other *Androlaelaps* infesting small mammals by the gnathosome with a distinct labial-brush.

Acari: Mesostigmata: Laelapidae: Hirstionyssinae

We record the presence of four species of hirstionyssine mites on small mammals. These mites are very small (< 500 micrometers), haematophagous, and probably nidicolous (Radovsky 1969). However, we have found no references to their common occurrence in nest substrates, and all active stages were collected by brushing host pelage. Because of their small body size, these mites are difficult to identify to species from material in alcohol, and must be mounted on slides and examined with a compound microscope for positive identification.

***Echinonyssus geomydis* (Keegan)**

Type host: *Geomys bursarius* (Shaw) from Leavenworth Co., Kansas.

Deposition, host records, and locality:

Slides: HWML 101703, 101706, and 101707, *G. lutescens*/Ackley 2013; HWML 101789, *G. lutescens*/Ackley 2013; HWML 92033, 92034, 101736, 101748, 101749, 101751, and 101752, *G. lutescens*/Ackley 2013. *Vials:* HWML 92040, *G. lutescens*/Ackley 2013; HWML 92049, *G. lutescens*/Ackley 2013; HWML 92052, *G. lutescens*/Ackley 2013.

Remarks: *Echinonyssus geomydis* was included within a morphometrically-based “geomyid host group” (Herrin (1970)), and has been reported infesting all three genera (*Geomys*, *Thomomys*, *Cratogeomys*) of the subterranean rodent family Geomyidae. Herrin (1970) reports this species from Clay County, Nebraska, ex. *G. bursarius* and *Spermophilus tridecemlineatus* (Mitchill, 1821). There is some evidence that these small mites are commonly congregated within the cheek-pouches of the host gopher (Ubelaker and Downhower 1965), but this was not confirmed by Spicka (1981) in gophers collected in Illinois and Missouri.

***Echinonyssus hilli* (Jameson)**

Type host: *Perognathus parvus* (Peale) from Washoe Co., Nevada.

Deposition, host records, and locality:

Slides: HWML 101712, *Pg. flavescens*/Ackley 2013; HWML 101728, 101729, and 101730, *Pg. flavescens*/Ackley 2013; HWML 101760, 101761, 101762, 101763, 101764, and 101765, *Pg. flavescens*/Ackley 2013; HWML 101794, 101795, and 101796, *Pg. flavescens*/Ackley 2013. *Vials:* HWML 92001, *Pg. flavescens*/Arapahoe 2012; HWML 92005, *Pg. flavescens*/Arapahoe 2012; HWML 92024 and 92025, *Pg. flavescens*/Ackley 2013; HWML 92045, *Pg. flavescens*/Ackley 2013.

Remarks: Herrin (1970) classified this species within the “heteromyid host group,” yet listed *Peromyscus* spp. as hosts in Utah and Idaho. In the original description (Jameson 1950), paratypes are reported from *C. hispidus* in Meade County, Kansas. We collected *E. hilli* only from *Pg. flavescens*, although we have also captured other heteromyid rodents, including *C. hispidus*. It will be interesting to continue to monitor the host associations of this mite.

***Echinonyssus incomptis* (Eads and Hightower)**

Type host: *Dipodomys ordii* Woodhouse from Terry Co., Texas.

Deposition, host records, and locality:

Slides: HWML 101654, 101655, and 101656, *D. ordii*/Station Grounds 2012; HWML 101661, 101662, and 101663, *M. ochrogaster*/Station Grounds 2012; HWML 101800, *R. megalotis*/Breen's Flyway 2013. *Vials:* HWML 91980, *M. ochrogaster*/Station Grounds 2012; HWML 91978, *R. megalotis*/Breen's Flyway 2013; HWML 92050, *R. megalotis*/Grama Grass 2013.

Remarks: This mite is commonly reported from kangaroo rats, including *D. ordii* (Reisen and Best 1973; Herrin 1970). The mite was described from specimens collected from *D. ordii* in Terry County, Texas, during studies of plague by the Center for Disease Control and Texas State Department of Health (Eads and Hightower 1952).

***Echinonyssus perognathi* Herrin**

Type host: *Chaetodipus formosus* (Merriam) from Nye Co., Nevada.

Deposition, host records, and locality:

Slides: HWML 101679, 101680, and 101681, *C. hispidus*/Grama Grass 2012; HWML 101676, *C. hispidus*/Grama Grass 2012; HWML 91994, 101684, 101685, and 101686, *C. hispidus*/Double Tank 2012. *Vials:* HWML 91983, *C. hispidus*/Grama Grass 2012; HWML 91989, *C. hispidus*/Grama Grass 2012; HWML 91994, *C. hispidus*/Double Tank 2012; HWML 91996, *C. hispidus*/Double Tank 2012.

Remarks: Herrin (1970) reported the holotype from *Chaetodipus formosus* (Merriam, 1889) in Nevada, but he lists a paratype from *C. hispidus* in Meade County, Kansas. The specimens from CPBS support the placement of this species in the "heteromyid host group" (Herrin 1970), as oligoxenous ectoparasites of pocket mice of the genus *Chaetodipus*.

Acari: Mesostigmata: Macronyssidae***Ornithonyssus bacoti* (Hirst)**

Type host: unknown.

Deposition, host records, and locality: HWML 101659, *M. ochrogaster*/Station Grounds 2012; HWML 101665 and 101666, *M. ochrogaster*/Station Grounds 2012; HWML 101668, *M. ochrogaster*/Station Grounds 2012; HWML 101673, *Pm. maniculatus*/Station Grounds 2012; HWML 91988, *Pm. leucopus*/Grama Grass 2012; HWML 101675, *C. hispidus*/Grama Grass 2012; HWML 101801, *Pm. maniculatus*/Breen's Flyway 2013; HWML 101809, *Z. hudsonius*/Breen's Flyway 2013; HWML 101815, *M. ochrogaster*/Station Grounds 2013; HWML 101818, *R. megalotis*/Breen's Flyway 2013; HWML 101820 and 101821, *R. megalotis*/Breen's Flyway 2013.

Remarks: *Ornithonyssus bacoti* is primarily an ectoparasite of introduced rats (*Rattus*), and their nests (Radovsky 2010). It is unclear about whether this is truly an ectoparasitic mite that is capable of infesting a wide range of native small mammals, or a complex of morphologically similar species with host specific habits. However, the present belief is that *O. bacoti* commonly abandons its primary host to infest man and his domestic and/or laboratory animals (Cole et al. 2005). It is a blood-feeder and its bite can cause skin dermatitis, with the potential for transmission of zoonoses to man and his domestic animals (Easterbrook et al. 2008). For this reason, it is important to note its strong association with domestic *Rattus*. In discussing the broad host distribution of *O. bacoti*, Radovsky (2010) notes the probability that it has spread "from post-Columbian human transport of host animals."

Acari: Mesostigmata: Macrochelidae

Macrochelid mites are predators of small invertebrates, and many species are fimicolous and phoretic on dung-beetles, so it is not surprising that they are commonly found in association with small mammals and their nests (Krantz and Whitaker 1988). Several specimens were collected from *G. lutescens*, *O. leucogaster*, and *Pm. maniculatus*, but without a good series of specimens, we hesitate to attempt species identifications. All three mites are different species and they all clearly fit within the genus *Macrocheles*. Using Krantz and Whitaker (1988), the macrochelids associated with *O. leucogaster* key to *Macrocheles mammifer* Berlese, but our specimens are smaller (HWML 101724, 101725, and 92029); those on *Pm. maniculatus* (HWML 101823 and 101824) are near *Macrocheles nemerdarius* Krantz and Whitaker, but smaller in body size. Only a few specimens (larger than those on the neotomines) were collected from *G. lutescens* (HWML 101738 and 92015).

Discussion

The study areas surrounding CPBS are strongly anthropogenic and influenced by the placement of the station below Kingsley Dam and Lake McConaughy. Natural habitats have been converted into monocultures of grain and forage crops; domestic livestock have replaced the original native grazers on what is left of the mixed grasses and upland prairies; a corridor of second-growth deciduous forest lines the Platte River just south of the station. This modern landscape provides especially interesting and important areas for the study of parasitology. The mammalian ectoparasites of North America are not well known, and most of the field collecting and research was done many years ago (see Whitaker et al. 2007, for an extensive bibliography). We plan to continue to collect data at localities around CPBS to provide an intensive survey of the host-arthropod relationships, including full voucher specimens of both host mammals and arthropods.

The sampling methods employed in this study were designed for use in biodiversity survey work, where it is generally necessary to process host mammals quickly and efficiently, yet still get all the data possible (the “complete” specimen). The emphasis is on treating each host individual in a standardized manner, and most importantly, on avoiding the contamination of one host individual with the ectoparasites of another host individual (see Gettinger 1987; Gardner 1996). Much of the published research on North American ectoparasites is based on host records of questionable and highly variable reliability, inevitably underestimating host specificity. However, advantages and weaknesses come with any method the researcher may choose to employ. Our methods are excellent for sampling arthropods that move actively through the pelage of the host. In North America, this includes most ectoparasitic insects, including Phthiraptera, Hemiptera, Siphonaptera, Coleoptera, and Diptera, and many of the mesostigmatic mites (Laelapidae, Haemogamasidae, Macronyssidae, Dermanyssidae, Spinturnicidae). However, brushing techniques are poor at sampling the smaller arthropods that attach firmly to the host animal (Ixodidae, Argasidae, Trombiculidae, Myobiidae), or are found in follicles and internal cavities of the host (Halarachnidae, Listrophoridae, Sarcoptidae, Demodicidae, Psoregatiidae). An excellent coverage of alternative methodologies for the sampling of small mammal ectosymbionts was provided by Ritzi (2014).

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Table 1. A list of the mammalian host species collected at Cedar Point Biological Station, followed by the species of ectoparasitic arthropods sampled from their skin and pelage.***Sorex cinereus***

Corrodopsylla curvata
Androlaelaps fahrenheitzi

Perognathus flavescens

Fahrenheitzia boleni
Androlaelaps fahrenheitzi
Echinonyssus hilli

Chaetodipus hispidus

Fahrenheitzia zacatecae
Androlaelaps fahrenheitzi
Echinonyssus perognathi
Ornithonyssus bacoti

Dipodomys ordii

Androlaelaps fahrenheitzi
Echinonyssus incomptis

Geomys lutescens

Geomydoecus nebrathkensis
Foxella ignota
Ixodes sculptus
Androlaelaps geomys
Echinonyssus geomysidis
Macrocheles sp.

Zapus hudsonius

Androlaelaps fahrenheitzi
Ornithonyssus bacoti

Microtus ochrogaster

Hoplopleura acanthopus
Megabothris asio
Hyperlaelaps microti
Androlaelaps fahrenheitzi
Echinonyssus incomptis
Ornithonyssus bacoti

Onychomys leucogaster

Hoplopleura onychomydis
Orchopeas leucopus
Pleochaetis exilis
Androlaelaps crowei
Androlaelaps fahrenheitzi
Macrocheles sp.

Peromyscus leucopus

Hoplopleura hesperomydis
Orchopeas leucopus
Pleochaetis exilis
Aetheca wagneri
Dermacentor variabilis
Androlaelaps fahrenheitzi
Ornithonyssus bacoti

Peromyscus maniculatus

Hoplopleura hesperomydis
Orchopeas leucopus
Aetheca wagneri
Dermacentor variabilis
Androlaelaps circularis
Androlaelaps fahrenheitzi
Ornithonyssus bacoti
Macrocheles sp.

Reithrodontomys megalotis

Hoplopleura hesperomydis
Aetheca wagneri
Dermacentor variabilis
Androlaelaps fahrenheitzi
Echinonyssus incomptis
Ornithonyssus bacoti