

## Siphonaptera from Western North American Chipmunks

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**ABSTRACT:** Several species of western North American chipmunks (Rodentia: *Tamias*) are distributed in overlapping ranges. Field-collected specimens of 9 species of chipmunks from 8 U.S. states were examined externally for fleas (Siphonaptera). We document flea infestations and 1 new range extension. This work demonstrates that ongoing field collection can shed light on host and parasite distributions over large geographical areas.

**KEY WORDS:** chipmunks, *Tamias*, Siphonaptera, fleas, plague, *Yersinia pestis*, museum collection, western United States.

Western American chipmunks, *Tamias* spp. (or *Neotamias* spp.; see Patterson and Norris, 2015), are found primarily throughout the western Nearctic region from northern Mexico to the Yukon (Canada) in a variety of habitats (Hall, 1981). A diverse group with 23 recognized species (Wilson and Reeder, 2005), many species of chipmunks occupy large geographical areas whereas others have more limited distributions. In many areas throughout western North America, multiple species may be sympatric or share narrow zones of parapatry (Heller, 1971; Hall, 1981; Bergstrom, 1992). For example, the broad distribution of the least chipmunk, *Tamias minimus*, includes 16 U.S. states and 8 Canadian provinces and overlaps with as many as 16 other species of chipmunk throughout its range (Hall, 1981). In addition, significant overlap in distributions of some species, in part driven by secondary contact, has led to interspecific gene flow (Sullivan et al., 2014).

Chipmunks, along with other rodents, are hosts for a variety of ectoparasites, including ticks, mites (personal observation), sucking lice (Phthiraptera; Bell et al., 2015), and fleas (Siphonaptera; Lewis and Jameson, 2002), and have been proposed as enzootic and epizootic hosts for *Yersinia pestis*, the causative agent of plague (Gage and Kosoy, 2005; Jameson, 1999). Hubbard (1947) and Holland (1949) described fleas from large geographical areas as well as their hosts, and Howell (1957), Stark (1958), Poorbaugh and Gier (1961), Campos (1971, unpublished thesis, Colorado State University, Fort Collins, Colorado), and Cam-

pos et al. (1985) concentrated on fleas in individual states or on individual hosts. We are aware of few more recent studies addressing several species of fleas on 1 or several related host species across a wide geographical distribution since the work of Galloway and Christie (1990), Haas et al. (2004), and Haas et al. (2005). Our purpose was to concentrate on fleas of 1 particular group of related hosts, the western chipmunks (*Tamias* spp.). Our objective was to document the fleas of western chipmunks, especially with respect to host specificity, and to identify possible new distribution and host records.

As part of a larger study on chipmunks, fleas were collected from 9 species of western *Tamias* spp. and deposited in the collection of the Denver Museum of Nature & Science (DMNS). A list of the Denver Museum of Nature & Science catalog numbers for chipmunk hosts from which each flea species was collected followed by parasite catalog numbers is provided in the Appendix. Chipmunks were collected and examined for ectoparasites following approved mammal handling and collecting protocols (Sikes et al., 2011). Chipmunks were collected between June 2004 and August 2014 from numerous sites in 8 U.S. states (Arizona [6 counties], Colorado [25 counties], Idaho [3 counties], Nevada [4 counties], New Mexico [11 counties], Utah [4 counties], and Wyoming [10 counties]). Collected fleas were stored in 100% ethanol and later hydrated, clarified in 10% KOH, dehydrated in ethanol, cleared in xylol, and mounted in Canada balsam on microscope slides for identification and inclusion in the Museum's collections. Processing and identification of fleas were done at the University of Colorado Colorado Springs, and specimens were returned to DMNS.

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**Table 1.** Chipmunk (*Tamias* spp.) hosts of *Eumolpianus eumolpi* in the collection of the Denver Museum of Science & Nature from the western United States with state and county locations from 2004 through 2014.

<i>Tamias</i> host species	State	County	<i>Eumolpianus eumolpi</i> n = 219		
			Male	Female	
<i>T. amoenus</i> (n = 28)	Idaho	Custer	2	1	
	Utah	Box Elder	1	2	
<i>T. canipes</i> (n = 7)	New Mexico	Lincoln	1	1	
<i>T. cinereicollis</i> (n = 24)	Arizona	Coconino	1	5	
		Greenlee	0	1	
	New Mexico	Catron	0	1	
<i>T. dorsalis</i> (n = 35)	Arizona	Graham	2	3	
	New Mexico	Grant	1	5	
<i>T. minimus</i> (n = 271)	Colorado	Archuleta	0	1	
		Boulder	3	5	
		Chaffee	1	0	
		Conejos	2	8	
		Delta	0	3	
		Douglas	0	1	
		Eagle	0	1	
		Garfield	1	2	
		Gunnison	1	2	
		Jefferson	0	1	
		Larimer	4	15	
		Montezuma	3	3	
		Montrose	0	2	
		Saguache	4	11	
		Idaho	Butte	3	1
		New Mexico	San Miguel	1	0
			Taos	3	4
		South Dakota	Lawrence	4	3
		Utah	Sanpete	0	1
		Wyoming	Albany	2	0
			Carbon	0	1
			Crook	0	2
			Fremont	2	1
		Johnson	1	4	
		Sweetwater	1	0	
		Washakie	1	0	
<i>T. quadrivittatus</i> (n = 71)	Colorado	Conejos	1	3	
		Gunnison	1	12	
		Jefferson	2	3	
		Saguache	7	14	
		New Mexico	Cibola	0	6
		Rio Arriba	2	2	
<i>T. rufus</i> (n = 11)	Colorado	Eagle	3	1	
<i>T. umbrinus</i> (n = 72)	Arizona	Coconino	0	2	
	Colorado	Boulder	0	1	
		Jackson	1	1	
		Lake	3	0	
		Larimer	0	1	
		Nevada	Elko	2	6
			White Pine	0	1
		Utah	Rich	0	1
			Summit	1	2
		Wyoming	Fremont	1	3
	<i>Totals</i>			69	150

**Table 2.** Fleas other than *Eumolpianus eumolpi* collected from 8 species of western chipmunks (*Tamias* spp.) from the Denver Museum of Nature & Science collected from 2004 through 2014.

Flea (family/subfamily/species)	<i>Tamias</i> (host) species	County	U.S.A. state	Male	Female
Hystrichopsyllidae					
Hystrichopsyllinae					
<i>Hystrichopsylla dippei</i> (n = 9)	<i>T. minimus</i>	Conejos	Colorado	1	1
	<i>T. minimus</i>	Gunnison	Colorado	0	1
	<i>T. minimus</i>	Saguache	Colorado	0	1
	<i>T. minimus</i>	Taos	New Mexico	0	1
	<i>T. minimus</i>	Sanpete	Utah	0	1
	<i>T. minimus</i>	Washakie	Wyoming	0	1
	<i>T. quadrivittatus</i>	Conejos	Colorado	0	2
<i>Atyphlocerus</i> sp. (n = 1)	<i>T. quadrivittatus</i>	Las Animas	Colorado	0	1
Neopsyllinae					
<i>Catallagia</i> sp. (n = 3)	<i>T. minimus</i>	Conejos	Colorado	0	1
	<i>T. quadrivittatus</i>	Saguache	Colorado	0	2
<i>Eptedia stanfordi</i> (n = 1)	<i>T. minimus</i>	Fall River	South Dakota	0	1
Anomiopsyllinae					
<i>Megarhthroglossus divisus</i> (n = 2)	<i>T. umbrinus</i>	Summit	Utah	1	0
	<i>T. umbrinus</i>	Park	Wyoming	0	1
Ceratophyllidae					
<i>Aetheca wagneri</i> (n = 5)	<i>T. minimus</i>	Butte	Idaho	0	1
	<i>T. minimus</i>	Sweetwater	Wyoming	0	1
	<i>T. quadrivittatus</i>	Las Animas	Colorado	0	3
<i>Eumolpianus cyrturus</i> (n = 1)	<i>T. dorsalis</i>	Grant	New Mexico	1	0
<i>Orchopeas leucopus</i> (n = 3)	<i>T. minimus</i>	Boulder	Colorado	1	0
	<i>T. quadrivittatus</i>	Las Animas	Colorado	1	1
<i>Oropsylla idahoensis</i> (n = 3)	<i>T. minimus</i>	Montezuma	Colorado	0	1
	<i>T. minimus</i>	Park	Colorado	0	1
	<i>T. quadrivittatus</i>	Conejos	Colorado	0	1
Total				5	23

Five hundred nineteen chipmunks representing 9 species were collected (Table 1). All species except *Tamias panamintinus* were infested with fleas for a total of 247 fleas representing 9 genera in 2 families (Tables 1 and 2). The most common flea (219/247 or 88.7%) and the one with the widest distribution was *Eumolpianus eumolpi*, which was found on 8 species of chipmunks. Below we discuss the species of fleas in alphabetical order under each family and subfamily.

**Ceratophyllidae**  
**Ceratophyllinae**  
***Aetheca wagneri***  
**Baker 1904**

This flea is commonly found on *Peromyscus* spp. as well as other small mammals and their predators and is widely distributed in western North America (Lewis et al., 1988). Campos et al. (1985) reported many specimens of *A. wagneri* from *Peromyscus maniculatus*, *Peromyscus nasutus* and *Neotoma* spp. taken in Colorado. We also examined a total of 115 specimens (41 males, 74 females) from *Peromyscus* spp.

***Eumolpianus cyrturus***  
**Jordan, 1929**

This flea has been found on chipmunks and occasionally on other species of squirrels and on mice (Lewis and Jameson, 2002).

***Eumolpianus eumolpi***  
**Rothschild, 1905**

This is the most commonly reported flea of western chipmunks (*Tamias* spp.), its primary host, and has an extensive range in the western United States from the Great Lakes west to California and south into New Mexico (Lewis, 1975). Smith et al. (2010) reported that *E. eumolpi* was 1 of 2 species of fleas from chipmunks in California most commonly infected with the plague bacillus, *Y. pestis*.

Lewis and Jameson (2002) considered the genus *Eumolpianus* “poorly defined” due to lack of sufficient samples of species other than *E. eumolpi* and *E. cyrturus*. Only the most well-known members of the genus were collected in our work. This genus warrants further investigation using molecular techniques to investigate interspecific relationships.

**Orchopeas leucopus****Jordan, 1933**

Although mainly a flea of *P. leucopus* and *P. maniculatus* (Lewis, 2000), *O. leucopus* is occasionally found on other cricetids, such as *Reithrodontomys* spp., *Dipodomys* spp., *Onychomys* spp., and *Neotoma* spp. Benton and Kelly (1975) reported it on *T. striatus* in New York state. *Orchopeas leucopus* is found in the contiguous United States and Canada, with at least 1 record from the state of Alaska (Lewis, 2000). Several researchers (Holdenreid and Morlan, 1956; Fagerland et al., 2001) have reported that *O. leucopus* can carry *Y. pestis*.

**Oropsylla idahoensis****Wagner and Ioff, 1926**

*Oropsylla idahoensis* is considered a flea of the golden mantle ground squirrel, *Callospermophilus lateralis*; however, it has been reported from 54 host species, 5 of which were birds (Lewis, 2002). This flea was also mentioned by Smith et al. (2010) as testing positive for the plague bacillus in California. The genus *Oropsylla*, like the genus *Orchopeas*, has undergone much revision in recent years, most notably by Lewis (2000, 2002). Very little is known, however, about the biology of this species (Lewis, 2002).

**Hystrichopsyllidae****Hystrichopsyllinae****Atyphloceras sp.**

This genus is usually found on *Microtus* spp., *P. maniculatus*, *Rattus* spp., and *Spilogale* spp. (Holland, 1949; Stark, 1958; Lewis and Lewis, 1994). Further identification was not possible, because no males were collected.

**Hystrichopsylla dippiei dippiei****Rothschild, 1902**

Members of the genus *Hystrichopsylla* are widely distributed throughout the United States. These very large fleas are usually associated with the nests of microtines, wood rats, and *Peromyscus* spp. (Friggens et al., 2010).

**Hystrichopsyllidae****Neopsyllinae****Catallagia sp.**

Female fleas of this genus are variable within populations, making identification difficult unless males are present (Lewis et al., 1988). In previous work we recorded 2 male fleas of *C. decipiens* from specimens of *P. maniculatus*, 1 each from Park and Pueblo Counties, Colorado, giving us confidence that the identification was reasonable. In Utah, Stark (1958) reported

*Catallagia decipiens* from a number of small rodents including *T. minimus* and *T. quadrivittatus*. Hubbard (1947) did not include Colorado in the locations for this flea.

**Epitedia stanfordi****Traub, 1944**

We collected 1 specimen of *E. stanfordi* from Fall River County, South Dakota, considerably farther east than expected. The distribution of *E. stanfordi*, as described by Lewis et al. (1988) does not extend further inland than Utah and New Mexico; however, Campos et al. (1985) collected several *E. stanfordi* in Larimer County, Colorado from *N. mexicana*, *P. maniculatus* and *P. nasutus*. Neither Easton (1982) nor Larson et al. (2011) collected *E. stanfordi* in their studies of fleas in South Dakota, thus our observation represents a range extension and a new state record.

**Hystrichopsyllidae****Anomiopsyllinae****Megarhroglossus divinus****Baker 1895**

This flea is usually associated with *Neotoma* spp., although it is often found on other rodents (Tipton et al., 1979). Widely distributed across the western United States, this flea has been reported from western Nebraska and southwestern South Dakota to California (Tipton et al., 1979; Larson et al., 2011).

We were unable to find any reference of ectoparasites of *T. panamintinus*, which was also noted by Best et al. (1994). *Eumolpianus* spp. are primarily parasites of western chipmunks, although they are occasionally found on other small mammals. Fox (1940) does not list *Eumolpianus* from *T. striatus*, nor do Holland (1949) or Snyder (1982), although the ranges of *T. striatus* and *T. minimus* overlap in Michigan, Minnesota, and Wisconsin.

The additional fleas we observed are primarily associated with rodents, particularly *Peromyscus* spp. Chipmunks are accidental hosts for these fleas, as they are found in the same habitats as the other host rodents. Additionally, we noted a range extension and new state record for *E. stanfordi* in South Dakota. All of the species of fleas we collected from chipmunks are considered to be capable of transmitting plague or have previously tested positive for *Y. pestis* (Allred, 1952; Fagerland et al., 2001; Eisen et al., 2009; Friggens et al., 2010).

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## APPENDIX

List of the Denver Museum of Nature & Science catalog numbers for chipmunk hosts (ZM.) from which each flea species was collected followed by parasite catalog numbers (ZP.) Parasite specimen records can be accessed through the on-line collections database Arctos ([http://arctos.database.museum/dmns\\_para](http://arctos.database.museum/dmns_para)).

*Tamias amoenus*: ZM.11172 (ZP.629); ZM.11173 (ZP.630); ZM.11174 (ZP.631); ZM.12133 (ZP.632, ZP.633); ZM.12280 (ZP.634).

*Tamias canipes*: ZM.11095 (ZP.635); ZM.11424 (ZP.636).

*Tamias cinereicollis*: ZM.11108 (ZP.637); ZM.11111 (ZP.638); ZM.11118 (ZP.639, ZP.640); ZM.11120 (ZP.641); ZM.11846 (ZP.642, ZP.643); ZM.11852 (ZP.644).

*Tamias dorsalis*: ZM.11823 (ZP.645, ZP.646, ZP.647, ZP.648, ZP.649); ZM.11824 (ZP.650); ZM.11825 (ZP.651); ZM.11838 (ZP.652); ZM.11840 (ZP.653); ZM.11841 (ZP.654); ZM.11842 (ZP.655); ZM.11844 (ZP.656).

*Tamias minimus*: ZM.11026 (ZP.501, ZP.502); ZM.11027 (ZP.500); ZM.11080 (ZP.503); ZM.11081 (ZP.504, ZP.505, ZP.506, ZP.507); ZM.11082 (ZP.508, ZP.509); ZM.11083 (ZP.510); ZM.11124 (ZP.623); ZM.11128 (ZP.624); ZM.11129 (ZP.625); ZM.11130 (ZP.6260); ZM.11132 (ZP.627, ZP.628); ZM.11155 (ZP.511); ZM.11157 (ZP.512); ZM.11202 (ZP.622); ZM.11398 (ZP.519); ZM.11404 (ZP.520, ZP.521, ZP.522, ZP.523, ZP.524, ZP.525, ZP.526, ZP.527, ZP.528); ZM.11416 (ZP.529); ZM.11417 (ZP.530, ZP.531, ZP.532); ZM.11418 (ZP.533); ZM.11420 (ZP.534, ZP.535, ZP.536); ZM.11429 (ZP.513, ZP.514); ZM.11431 (ZP.515, ZP.516); ZM.11432 (ZP.517); ZM.11437 (ZP.518); ZM.11544 (ZP.539); ZM.11546 (ZP.540, ZP.541); ZM.11578 (ZP.542); ZM.11583 (ZP.543, ZP.544); ZM.11600 (ZP.545); ZM.11611 (ZP.546); ZM.11649 (ZP.537); ZM.11652 (ZP.538); ZM.11695 (ZP.547); ZM.11698 (ZP.548); ZM.11829 (ZP.549); ZM.11876 (ZP.550, ZP.551, ZP.552, ZP.553); ZM.11878 (ZP.554); ZM.11880 (ZP.555, ZP.556, ZP.557); ZM.11914 (ZP.558); ZM.11917 (ZP.559); ZM.11935 (ZP.560); ZM.12027 (ZP.561, ZP.562); ZM.12028 (ZP.563); ZM.12040 (ZP.564); ZM.12042 (ZP.565); ZM.12044 (ZP.566, ZP.567); ZM.12069 (ZP.568); ZM.12129 (ZP.569); ZM.12137 (ZP.570); ZM.12152 (ZP.571); ZM.12160 (ZP.572, ZP.573); ZM.12162 (ZP.574); ZM.12170 (ZP.575, ZP.576, ZP.577, ZP.578, ZP.579, ZP.580); ZM.12174 (ZP.587); ZM.12175 (ZP.588, ZP.589); ZM.12176 (ZP.590, ZP.591); ZM.12181 (ZP.592); ZM.12195 (ZP.593, ZP.594); ZM.12196 (ZP.595, ZP.596); ZM.12197 (ZP.597); ZM.12198 (ZP.598); ZM.12200 (ZP.599, ZP.600); ZM.12201 (ZP.601); ZM.12202 (ZP.602, ZP.603); ZM.12206 (ZP.604, ZP.605); ZM.12214 (ZP.606); ZM.12232 (ZP.607, ZP.608); ZM.12234 (ZP.609, ZP.610, ZP.611); ZM.12281 (ZP.612); ZM.12282 (ZP.613, ZP.614, ZP.615, ZP.616); ZM.12286 (ZP.617); ZM.12288 (ZP.618); ZM.12289 (ZP.619); ZM.14307 (ZP.621).

*Tamias quadrivittatus*: ZM.11024 (ZP.659); ZM.11032 (ZP.658); ZM.11038 (ZP.657); ZM.11078 (ZP.660); ZM.11079 (ZP.661, ZP.662, ZP.663); ZM.11098 (ZP.664); ZM.11099 (ZP.665, ZP.666, ZP.667); ZM.11100 (ZP.668); ZM.11101 (ZP.669); ZM.11137 (ZP.670, ZP.671, ZP.672); ZM.11138 (ZP.673, ZP.674); ZM.11821 (ZP.675); ZM.11874 (ZP.676, ZP.677, ZP.678, ZP.679, ZP.680, ZP.681); ZM.11934 (ZP.683); ZM.11941 (ZP.684); ZM.12163 (ZP.685); ZM.12164 (ZP.687); ZM.12166 (ZP.686); ZM.12167 (ZP.688); ZM.12168 (ZP.689, ZP.690); ZM.12169 (ZP.691); ZM.12171 (ZP.692, ZP.693, ZP.694, ZP.695, ZP.696, ZP.697); ZM.12172 (ZP.698); ZM.12173 (ZP.699, ZP.700, ZP.701); ZM.12179 (ZP.702); ZM.12182 (ZP.703); ZM.12185 (ZP.704);

ZM.12187 (ZP.705); ZM.12191 (ZP.706); ZM.12193 (ZP.707, ZP.708); ZM.12903 (ZP.620); ZM.12904 (ZP.709); ZM.12905 (ZP.710); ZM.12907 (ZP.711, ZP.712, ZP.713, ZP.714, ZP.715, ZP.716); ZM.12908 (ZP.717, ZP.718, ZP.719) ZM.12909 (ZP.720); ZM.12910 (ZP.721).

*Tamias rufus*: ZM.11206 (ZP.722, ZP.723, ZP.724); ZM.11208 (ZP.725).

*Tamias umbrinus*: ZM.11148 (ZP.747); ZM.11160 (ZP.749); ZM.11161 (ZP.750); ZM.11162 (ZP.751); ZM.11163 (ZP.752); ZM.11188 (ZP.743, ZP.744); ZM.11190 (ZP.745); ZM.11380 (ZP.727, ZP.728); ZM.11433 (ZP.726); ZM.11669 (ZP.753); ZM.11686 (ZP.729, ZP.730, ZP.731, ZP.732, ZP.733, ZP.734); ZM.11687 (ZP.735); ZM.11688 (ZP.736); ZM.11792 (ZP.748); ZM.11881 (ZP.737); ZM.11924 (ZP.746); ZM.12088 (ZP.741); ZM.12108 (ZP.742); ZM.12208 (ZP.738); ZM.12209 (ZP.739); ZM.12210 (ZP.740).