Siphonaptera (fleas) of the Nevada Test Site

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by
D ELDEN BECK
and
DORALD M. ALLRED

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MAY 1966
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SIPHONAPTERA (FLEAS) OF THE NEVADA TEST SITE

by

D Elden Beck and Donald M. Allred

INTRODUCTION

Ecological studies at the Nevada Test Site near Mercury, Nevada, were begun in 1959 as a cooperative project between the United States Atomic Energy Commission and the Brigham Young University Department of Zoology and Entomology. Initial research was directed to mammals, birds and reptiles (Jorgensen & Hayward, 1965; Hayward, Killpack & Richards, 1963; Tanner & Jorgensen, 1963). As the investigations continued, however, parasites and other eonsortes were collected. Reports on some of these collections have been published (Goates, 1963; Beck, Allred & Brinton, 1963; Allred, 1963; Allred & Beck, 1963, 1964; and others—see list of references).

This report deals with data on the fleas collected at the Nevada Test Site. Geographical and ecological distribution, host relationships, and seasonal occurrence are emphasized. The biotic communities and areas of study were designated by Allred, et al. (1963 a & b), and our references generally follow their classification (Figs. 1 and 2).

LITERATURE REVIEW

Previous records of fleas from the Nevada Test Site are unknown, although there are reports for the state of Nevada. Every record from Nevada is not made here, but some general ones are worthy of mention.

Most reports of fleas for Nevada are the result of the extensive work by C. A. Hubbard (1947). Practically all references made by him are for collections made in the northern half of the state near or above the 39th parallel although there are some collections from southern Nevada. For example, *Hoplopsyllus anomalus* was taken from the White-tailed Antelope Squirrel (*Annosperrnophilus leucurus*), and *Malara-cus sinomus* from the Deer Mouse (*Peromyscus maniculatus*) at Searchlight. *Hystrichopsylla gigas dippiei* (most likely *H. dippiei dippiei*) was collected from the Sonoran Deer Mouse (*P. maniculatus sonoriensis*) at Charleston Park on Charleston Mountain near Las Vegas. *Orch oepeas sexdentatus nevadensis* was taken from the Desert Wood Rat (*Neotoma lepida*) from Clark County. Hopkins and Rothschild (1962) reported a contribution to the British Museum of *Anomiopsyllus amphibolus* taken from the White-throated Wood Rat (*Neotoma albignula*—most likely *N. lepida*) in Nye County. All localities are in the southeastern corner of Nevada, relatively near the test site.

METHODS AND PROCEDURES

Most of the fleas were taken from the bodies of host animals which were trapped or shot specifically for the purpose of collecting ecto-parasites or selected from mammals and birds which were collected for other purposes. In each case the host was placed immediately into a paper sack which was then sealed, data written on it, and returned to the laboratory.

In some instances nests were removed from the houses or other recesses of the Desert Wood Rat, and the eonsortes extracted by the use of a modified Berlese funnel. Data contained with each collection included date, host or source, and the biotic community where found. These were coded for computer analysis.

Fleas were retrieved by brushing the fur of the host which was held under a 75-watt lamp

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1 BYU–AEC publication No. COO-1355-14 This work was supported (in part) by funds from the United States Atomic Energy Commission.
2 Department of Zoology and Entomology, Brigham Young University, Provo, Utah.
Fig. 1. Map of the southeastern corner of Nevada showing the regional location of the Nevada Test Site.
in a deep, white enamelware pan. All con-
sorts were preserved in 70% ethyl alcohol un-
til they were mounted individually on micro-
slides to which were applied the collection data.

Specimens were identified from the slide pre-
parations, all data then placed on collection rec-
ord forms, and IBM punch cards prepared to
enable computer analysis.

ACKNOWLEDGMENTS

Many technicians were involved in the field
collection and laboratory preparation of hosts
and parasites. Without their careful work this
study would not have been as readily accom-
plished. We are most grateful for their unself-
ish, enthusiastic participation.

Dr. William L. Jellison, Rocky Mountain
Laboratory, Hamilton, Montana, corroborated
and assisted in most of the flea determinations.
Dr. Robert Traub, School of Medicine, Univer-
sity of Maryland, also helped to untangle some
specific problems in flea determinations. This
was likewise the case with Frank M. Prince,
Communicable Disease Center, U. S. Public
Health Service, San Francisco, California. Dr.
C. Lynn Hayward, Department of Zoology and
Entomology, Brigham Young University, Provo,
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mammal and bird hosts.

We are especially grateful for the excellent
laboratory services and transportation facilities
which were provided by the Civil Effects Test
Operations (CETO), Division of the Atomic
Energy Commission, at Mercury, Nevada. We
are likewise grateful for similar conveniences
provided by Brigham Young University, Provo,
Utah.

SCHEME OF CLASSIFICATION

In general we have followed the taxonomic
and phyllogenetic arrangement described by Hop-
kins and Rothschild (1953, 1956, 1962). Where
special taxonomic studies have recently been
made on specific groups, such as the genus
Thrassis discussed by Stark (1958) and unpub-
lished information on Malaracus by Frank M.
Prince, information as deemed appropriate has
been judiciously inserted in the Hopkins-Roth-
schild arrangement. The species of fleas from
the Nevada Test Site are listed below.

For the hosts we used the "Vernacular Names
for North American Mammals North of Mexico"
as approved by the American Society of Mammal-
ologists (Hall, 1957).

FAMILIES AND SPECIES

Pulicidae

Echidnophaga gallinacea (Westwood)
Pulex irritans Linné
Cediopsylla inaequalis (Baker)
Hoplopsyllus anomalus (Baker)

Hystrichopsyllidae

Atyphloceras echis Jordan & Rothschild
Epitedia wenneanni (Rothschild)
Cattallagia decipiens Rothschild
Meringis dipodonys Kohls
Meringis parkeri Jordan
Meringis hubbardii Kohls
Jordanopsylla allredi Traub & Tipton
Stenistomera alpina (Baker)
Callistopsyllus dueterus Jordan

Megarthroglossus procerus Jordan & Rothschild
Anomiopsyllus amphibolus Wagner
Rhadinopsylla heiseri (McCoy)
Rhadinopsylla sectilis Jordan & Rothschild
Carteretta carteri Fox

Ceratophyllidae

Thrassis bacchi (Rothschild)
Thrassis aridis Prince
Dactylopsylla bluei (Fox)
Foxella ignota (Baker)
Diamanus montanus (Baker)
Orchopeas sexdentatus (Rothschild)
Monopsyllus wagneri (Baker)
Monopsyllus cumolpi (Rothschild)
Malaracus teeliniurn (Rothschild)
Malaraceus sinuosus (Jordan)
Malaraceus euphorbi (Rothschild)

Amphipsyllidae

Amphipsylla neotomaec Fox
Odontopsyllus dentatus (Baker)

SPECIES PRESENTATION

For each species listed, the following sequence in presentation of information was followed: (a) specific and subspecific identity and other pertinent taxonomic data; (b) ecological and geographical distribution with maps; (c) host association; and (d) seasonal occurrence accompanied by graphs where sufficient populations made such presentation worthwhile. Seasonal occurrence was interpreted on the basis that a collection of fleas from a single host constituted an encounter, regardless of the number of fleas taken. For those species for which data are minimal, the presentations are given as summary statements without headings.

Some hosts at the test site were collected in greater numbers than others which were taken only occasionally during a particular season of the year. Although it is most unfortunate that all hosts at the test site were not collected on a daily schedule, it was considered not economically or conservationally feasible to do so.

Echidnophaga gallinacea
(13estwood), 1875

Distribution. A total of 56 specimens was collected at widely separate parts of the site (Fig. 3). Too few specimens were collected to indicate a community predominance.

Host Associations. The Black-tailed Jack Rabbit (Lepus californicus) and the Kit Fox (Vulpes macrotis) were the only animals on which fleas of this species were found. The fleas were about equally distributed among those hosts collected.

Seasonal Occurrence. All specimens were found in August and December.

Comments. Sufficient data are not available to accurately delimit geographic boundaries. Extensive rabbit collections were made over several years at various seasons, yet only four rabbits were found infested, and then only with a single flea of this species on each rabbit.

According to Stark (1958) and Wheeler and Douglas (1945), E. gallinacea has been found naturally infected with plague organisms and demonstrated a high vector efficiency.

Pulex irritans Linné, 1758

Distribution. The greatest numbers of fleas collected were in the Graya-Lycium community. This is one of several communities in the valleys where the most common host, the Kit Fox was collected. Geographically, the hosts and their fleas were widely distributed, especially along the foothills and in the valleys (Fig. 3).

Host Associations. Most of the 73 specimens obtained were collected from the Kit Fox. Other hosts were the Black-tailed Jack Rabbit, the Coyote (Canis latrans), and the Western Pipistrelle Bat (Pipistrellus hesperus) which represents an unusual collection. Fleas of this species have been taken in most abundance from burrowing animals, which may explain the greatest number found on the Kit Fox.

Seasonal Occurrence. Apparently fleas of this species are not restricted seasonally, but may be found at any month of the year when their host is active. Fleas were collected in January, February, May, August, and December.

Comments. To better understand the distribution and seasonal occurrence of P. irritans at the test site, a larger series of predators such as the Kit Fox, Coyote, and Bob Cat (Lynx rufus) need to be collected. Their dens also should be carefully examined. The records from the bat and rabbit most likely were accidental encounters.

Cediopsylla inaequalis (Baker), 1895

The male fleas collected indicate that the subspecies is C. inaequalis interrupta Jordan (1925).

Distribution. Most of the fleas (45 of 59) were taken from hosts from the Pinyon-Juniper
Fig. 3. Geographic distribution of *Echidnophaga gallinacea* ★ *Pulex irritans* ● and *Cediopsylla inaequalis* ▲
community on Rainier Mesa. Thirteen were taken from the vicinity of Cane and Tippipah Springs which are in mixed vegetational communities. One collection was made in a Coleogyne community (Fig. 3).

Host Associations. The Rainier Mesa collections were from Nuttall’s Cottontail Rabbit (Sylvilagus nuttallii). Thirteen specimens were collected from the Desert Cottontail Rabbit (Sylvilagus auduboni) and one from the White-tailed Antelope Squirrel.

Seasonal Occurrence. The greatest number of specimens was from a Nuttall’s Cottontail Rabbit collected in April on Rainier Mesa. All others were collected in November from the Desert Cottontail Rabbit at lower elevations.

Comments. Extensive collections of mammals at the test site have not been made at the higher elevations, and collections at lower elevations have been limited in some instances. Although studies of the abundant mammalian fauna in the valleys and foothills have been carefully made, collections of cottontail rabbits living in the vicinity of springs on the desert have been limited to avoid their elimination by trapping and shooting. The vast areas of desert highland clothed with sage brush (Artemisia tridentata) in the western and northwestern part of the test site, and the extensive Pinyon-Juniper woodland to the north and northwest could well afford a close natural history scrutiny. These undoubtedly provide for an extended range for rabbits as well as other mammals and their ectoparasites.

Hoplopsis anomalus (Baker), 1904

Distribution. Fleas were taken from hosts in the valleys and foothills, and to a limited extent on Rainier Mesa. They were most frequently encountered in Crassia-Lycium, Larrea-Franseria, and Coleogyne biotic communities. Nevertheless, they were taken in all of the plant communities except Atriplex-Kochia. This is unusual, for the most common host, A. leucurus, was frequently collected from this latter community (Fig. 4).

Host Associations. Only a few Rock Squirrels (Spermophilus variegatus) were taken on Rainier Mesa in the Pinyon-Juniper community, but all possessed fleas. A Round-tailed Squirrel (Spermophilus tereticaudus) was collected in west Frenchman Flat, and two fleas were obtained. One flea was removed from the Little Pocket Mouse (Perognathus longimembris), and eight specimens from several Chisel-toothed Rats (Dipodomys microps). Most specimens (260 of 286) of H. anomalus were obtained from the White-tailed Antelope Squirrel.

Seasonal Occurrence. Most flea collections were made in June, with fewer encounters in April, May, and August. Two collections were made in September and one in December.

Comments. Collections of H. anomalus show them to occur in June, with a total absence in July, and reoccurrence in August. This was true regardless of elevation or host. These data should not be interpreted as conclusive, for there is a difference in the seasonal activity of the hosts from which fleas of this species have been taken. For example, one should not compare the seasonal occurrence for a species of flea on the Rock Squirrel with the same species on the White-tailed Antelope Squirrel. While the latter host is active during the winter in the valleys, the former may be hibernating in talus covered by snow at a much higher elevation. All specimens of S. variegatus were taken during April, May, and June, with the exception of one collection in August at the west side of Frenchman Flat along the foothills.

According to Stark (1958), fleas of this species in New Mexico have been found naturally infected with plague organisms.

Atypiloevras echis
Jordan and Rothschild, 1915

The subspecies of our collections is A. echis echis.

Distribution. Hosts and their parasites were confined primarily to the Coleogyne community. One specimen was taken in a mixed vegetational situation and one in a Pinyon-Juniper community (Fig. 5).

Host Association. Eleven fleas of this species were taken from the Desert Wood Rat.

Seasonal Occurrence. Collections were made in January and March, with most encounters in December.

Comments. Fleas of several species are known to live on N. lepida and in its nests. The natural history of the Desert Wood Rat and its parasites at the test site should be carefully studied, for the rats have a wide range of distribution at the site.

Epitedia wenmani (Rothschild), 1904

Only two specimens were collected, a male and a female. On the basis of the male, this
Fig. 4. Geographic distribution of *Hoplopsyllus anomalus.*
Fig. 5. Geographic distribution of *Atypaloceras echis* ○ *Epitedia wernmanni* △ and *Catallagia decipiens* ★
is most likely of the subspecies *E. wenmanni wenmanni*.

**Distribution.** The two fleas were taken at Tippipah Spring, a mixed type of biotic community (Fig. 5).

**Host Association.** Both specimens were collected from a Western Pipistrelle Bat.

**Seasonal Occurrence.** The fleas were collected in November.

**Comments.** Many specimens of *Peromyscus* spp. and *N. lepida* were collected during this survey. It is unusual that we did not collect fleas of this species from these hosts. More unusual is that the only specimens taken were from a bat. In the original descriptions made in 1904, the male was taken from a White-footed Mouse (*Peromyscus leucopus*) and the female from a Bushy-tailed Wood Rat (*Neotoma cinerea*). Most published records show fleas of this species to occur on species of *Peromyscus* and *Neotoma*.

*Catallagia decipiens* Rothschild, 1915

**Distribution.** Hosts of two different species were collected, and one flea was collected from each. One was in a mountainous vicinity, the other in the Pinyon-Juniper community on Rainier Mesa (Fig. 5).

**Host Associations.** One host animal, a Pinyon Mouse (*Peromyscus truei*) was from Rainier Mesa; the other, a Desert Wood Rat, was in the vicinity of Tippipah Spring.

**Seasonal Occurrence.** The collection from *P. truei* was made in March, and from *N. lepida* in December.

**Comments.** The few collections of this species perhaps can be explained on the basis that fewer hosts have been collected at higher elevations at the test site compared to the number made in the valleys and foothills. In other surveys during the past 20 years and in literature references, the Deer Mouse has been the main host. Others mentioned in the literature are mainly mammals whose habitats are at high elevations or in cool environments. *Peromyscus maniculatus* at the test site is most abundant in the Pinyon-Juniper community which has not been extensively surveyed by us.

*Meringis dipodomys* Kohls, 1938

**Distribution.** Fleas of this species were the ones most commonly encountered at the test site. This is due to the wide distribution and abundance of their common hosts, kangaroo rats. These mammals were under continuous study for several years, primarily in the valleys and foothills where they are most usually found. From the standpoint of biotic community distribution, many collections were from Larrea-Franseria with about equal numbers from Coleogyne and Grayia-Lycium. The next ranking community was Salsola, with few collections from mixed vegetative communities. Two collections were in Pinyon-Juniper, and one was in Atriplex-Kokoa (Fig. 6).

**Host Associations.** As the specific name of the flea indicates, the most common hosts are species of *Dipodomys*. The Chisel-toothed Kangaroo Rat is the species on which these fleas were most often encountered. The next was Merriam’s Kangaroo Rat (*Dipodomys merriami*). Only two collections were taken from the large Desert Kangaroo Rat (*Dipodomys deserti*) which is so restricted in its distribution that not many collections were expected. A single collection was made from Ord’s Kangaroo Rat (*Dipodomys ordii*). Other animals from which fleas were taken, in order of abundance, are the White-tailed Antelope Squirrel, the Southern Grasshopper Mouse (*Onychomys torridus*), the Desert Wood Rat, the Great Basin Pocket Mouse (*Perognathus parvus*), the Deer Mouse and the Kit Fox.

**Seasonal Occurrence.** Fleas of this species were not taken in May, July, or August, and only one collection was made in June when three males were taken from *D. microps*. Most collections were made in October and November. The common hosts, *Dipodomys* spp., were present during these months, and many were trapped and examined during May, June, July, and August as well as in other months. Two collections were made in September, 32 in October, and 86 in November. A relatively high incidence was maintained throughout the fall, winter, and early spring until May (Fig. 7).

**Comments.** Kangaroo rats of several species and the White-tailed Antelope Squirrel were studied extensively at the test site. This provided an opportunity to examine their ectoparasite fauna on a year-round basis.

The disappearance of adult flea populations during May, June, July, and August is an enigma. The host is active during the summer months, but fleas were not found on those examined during that period. One might surmise that fleas of this species are sensitive to the high temperatures during the hot summer
Fig. 6. Geographic distribution of *Meringis dipodomys* ○ and *Meringis parkeri* ★
Fleas of the Nevada Test Site

Fig. 7. Seasonal occurrence of Meringis dipodomys. The figures on incidence do not represent total numbers of specimens taken during the month, but indicate the total number of collections (encounters) wherein fleas were found.

period and perhaps exist in the nests as an immature stage—egg, larva, or pupa—until cooler temperatures occur.

Meringis parkeri Jordan, 1937

Distribution. All collections were made from hosts taken on the high mesas or along the foothills. Collections came from the Coleogyne, Pinyon-Juniper, and mixed biotic communities, as well as Artemisia associations. Most encounters were from mixed vegetative situations (Fig. 6).

Host Associations. With the exception of one collection from the Deer Mouse, the remainder were about equally encountered from the Great Basin Pocket Mouse, Merriam’s Kangaroo Rat, the Chisel-toothed Kangaroo Rat, and Southern Grasshopper Mouse.

Seasonal Occurrence. The 16 specimens taken occurred in the same pattern as M. dipodomys. Collections were taken in September, December, March, and April with no encounters in other months, although the usual hosts were collected during all months of the year.

Comments. This species was originally described from specimens from Dipodomys sp. taken at Powderville, Montana. From literature references and twenty years of field studies of fleas, one may assume that the most likely host is Ord’s Kangaroo Rat. This is especially true for the Great Basin Province. Dipodomys ordii has a scattered distribution at the test site—northward it is predominant, but southward it is replaced by D. merriami. Nevertheless, D. ordii that were collected did not produce a specimen of M. parkeri.

Meringis hubbardi Kohls, 1938

Distribution. All specimens were taken at higher elevations, principally on Rainier Mesa in the northwestern portion of the test site. All were in the Pinyon-Juniper biotic community, except one from the Gold Meadow area north of Rainier Mesa, a region predominantly vegetated by the sage brush, Artemisia tridentata (Fig. 8).

Host Associations. Three collections were from the Great Basin Pocket Mouse, two from the Chisel-toothed Kangaroo Rat, and one from the Little Pocket Mouse.

Seasonal Occurrence. All collections were made in September except one in April.

Comments. The lack in numbers and breadth of distribution of this species may be related to the higher elevations where its hosts more commonly occur, areas not so extensively surveyed by us.

Jordanopsylla alredi
Traub and Tipton, 1951

Fleas of this genus and species were described by Traub and Tipton (1951) from females taken from the Cactus Mouse (Peromyscus cлемicus) at Grafton, Washington County, Utah, the western gateway to Zion National Park.

In our investigations three males and two females of J. alredi were collected.

Distribution. All specimens of fleas were collected from N. lepida at the southern boundary of the test site. Hosts were taken from rocky ledges in a mixed vegetative biotic community in each instance (Fig. 8).

Host Associations. Although the first collection was from the Cactus Mouse in Southern Utah, it seems probable that the principal host will eventually be shown to be the Desert Wood Rat. We collected the type specimens of this genus and species and are well acquainted with the habitats where both the initial and later collections were made. It is on these observations that we make the tentative host-preference designation.

Seasonal Occurrence. Fleas were taken in October and November.

Comments. Many specimens of N. lepida and their nests at the test site were examined during
Fig. 8. Geographic distribution of *Meringis hubbardii* ▲ *Jordanopsylla allredii* ★ and *Stenistomera alpina* ●
the summer of 1965 without obtaining a single flea of this species. Collections of nests were
made in the same locality where fleas of this species previously had been collected. The study
of Howell (1955) revealed a very low population of all species of fleas in the nests of N. lepida in Utah during the summer periods. The specimens from which the original descriptions were made were collected in December and November.

*Stenistomera alpina* (Baker), 1895

**Distribution.** Fleas of this species have been considered by some workers as rare in occurrence. In our studies at the Nevada Test Site, they occurred commonly on the Desert Wood Rat at some seasons of the year. This host is not restricted to any one biotic community at the test site, but is found in the Pinyon-Juniper, Coleogyne, Salsola, Larrea-Fraseria, and Grayia-Lycium communities. About the only restrictive influence affecting its distribution is the absence of house-building materials, rocky ledges, or large shrubs in which a house may be constructed with appropriate situations for nest ing either in the house or in close association with it. Most of the fleas were collected from hosts trapped in the mixed biotic communities (Fig. 8).

**Host Associations.** The Desert Wood Rat is the principal host. Six fleas were taken from a Canyon Mouse (*Peromyscus crinitis*), and three from a White-tailed Antelope Squirrel.

**Seasonal Occurrence.** Extensive collections of the Desert Wood Rat were not made continually throughout any one year. A collecting schedule set up to include the months of October, November, December, and January resulted in thirty collections in December compared to only four encounters each for January, October, and November. During the summer months of 1965 (June, July, August), collection of N. lepida and its nests was emphasized. Seven fleas of this species were taken from one nest in June. None was found in 58 other nests collected during the summer.

**Comments.** Although the principal host, the Desert Wood Rat, is widely distributed, there seems to be some relationship between the presence of fleas of this species and the seasonal occurrence of the rat.

*Callistopsyllus deuterus* Jordan, 1937

The only specimen of this species taken is a male from a Canyon Mouse. Hubbard (1947: 251) stated: "The two species (of *Callistopsyllus*) come consistently off deer mice, occasionally off other rodents." This has been our experience in many years of collecting in Utah. The host, *P. crinitis*, has been collected in most months of the year and at widely-separated parts of the test site, mainly along the foothills in mixed communities; yet this is the only flea of this species we have taken (Fig. 9).

*Megarthroglossus procus* Jordan and Rothschild, 1915

Insofar as we can determine, our single specimen belongs to the subspecies *M. procus procus*. The male was collected from a Desert Wood Rat in the vicinity of Tippipah Spring in a Coleogyne biotic community in November (Fig. 9).

*Anomiopsyllus amphibolus* Wagner, 1935

**Distribution.** This species was taken at widely-separated points at the test site, but most frequently at the northwestern part along the foothills or at higher elevations. The biotic community association was mainly with Pinyon-Juniper, Grayia-Lycium, and in mixed vegetative types (Fig. 9).

**Host Associations.** One collection each was made from a pocket mouse, Deer Mouse, Pinyon Mouse, and Cactus Mouse. Five separate encounters were with the Desert Wood Rat.

**Seasonal Occurrence.** Two collections were made in March, one in April, six in October, and one in December.

**Comments.** In Utah studies, hundreds of specimens of *A. amphibolus* were found in the nests of *N. lepida*, whereas few were taken from the host's body (Beck et al., 1953; Howell, 1955). During June, July, August, and September collections in Utah, nests were relatively free of fleas of this species compared to other months of the year. Nests were not examined during fall, winter, and spring months at the test site.

The collection of this flea from the host's body indicates a similarity of occurrence at the test site and in collections made in Utah. Additional support to this view are our studies during the summer of 1965. More than fifty nests of *N. lepida* were collected, but not a single flea of any species was found. We did take seven specimens of *Stenistomera alpina* from one host, but *A. amphibolus* was not encountered.
Fig. 9. Geographic distribution of Callistopsyllus deuterus ▲ Anomiopsyllus amphibolus ★ Megarthroglossus procerus ♦ and Rhadinopsylla heiseri ●
Rhadinopsylla heiseri (McCoy), 1911

This species has been listed as Actenophthalmus heiseri in some publications. We follow the taxonomic placement by Hopkins and Rothschild (1962) in which Actenophthalmus is listed as a subgenus and the generic status is Rhadinopsylla. According to Jellison (personal correspondence), there is a close relationship between heiseri and multidenticulata of Morlan and Prince (1954). Nevertheless, we feel these specimens more closely fit the description for heiseri.

Distribution. Most of the 127 fleas collected of this species were taken from hosts found in mixed vegetation communities in Jackass Flats at the southwestern part of the test site. The next most often encountered collections were in Larrea-Franseria communities in the southeastern section. Another community with about equal encounters is the Coleogyne community in the northeastern part. All other communities except the Pinyon-Juniper produced occasional collections (Fig. 9).

Host Associations. The host on which most fleas of this species were taken is the White-tailed Antelope Squirrel. Occasional collections were also made from the Desert Kangaroo Rat, Chisel-toothed Kangaroo Rat, Southern Grasshopper Mouse, and Southern Pocket Gopher (Thomomys umbrinus). Onychomys torridus is a predator and thus may be expected to have fleas from various rodent victims.

Seasonal Occurrence. Most collections were in January, with December, November, and February ranking in relative sequence for other collections. Only one collection was made in March, one in April, and one in October. Fleas were not found in other months of the year.

Comments. The original description of this species made by McCoy (1911) was of a female taken at Mojave, California. The host is unknown for that collection, but in later collections by several workers, the most common host encountered was the White-tailed Antelope Squirrel. Hubbard contributed a male and female of this species which he had collected in December of 1949 at Carson City, Nevada, to the British Museum in 1950. These were from A. leucurus. The great majority of our collections were likewise from this same host. No doubt the instances of occurrence on hosts other than A. leucurus are accidental, for several species of animals live in close association with this squirrel.

Rhadinopsylla sectilis
Jordan and Rothschild, 1923

Rhadinopsylla sectilis was listed by Hubbard (1947) and Holland (1949) as Micropsylla sectilis. Hopkins and Rothschild (1962) listed Micropsylla as a subgenus of Rhadinopsylla. As far as we can determine, our specimens are of the subspecies R. sectilis sectilis.

Distribution. Most hosts were taken in the Gravua-Lycium community. A few encounters were from Larrea-Franseria and Coleogyne. The geographical distribution was generally in Yucca and Frenchman Flats (Fig. 10).

Host Associations. The Chisel-toothed Kangaroo Rat is the host on which fleas of this species were most commonly encountered. The next most common host is the White-tailed Antelope Squirrel. One specimen was removed from O. torridus, and three were from Merriam’s Kangaroo Rats.

Seasonal Occurrence. About equal numbers were collected during January, February, March, and December. One specimen each was taken in October and November.

Comments. Apparently fleas of this species are not abundant on a variety of hosts. Collections of such hosts as P. maniculatus at higher elevations may produce a greater number of specimens.

Carretetta carteri Fox, 1927

Dr. William L. Jellison (personal correspondence) is of the opinion that these fleas are of the subspecies C. carteri clavata.

Distribution. The geographical and ecological distribution is throughout Frenchman and Yucca Flats. Most encounters were in the Larrea-Franseria community, followed by Coleogyne and mixed vegetative communities (Fig. 10).

Host Associations. Three collections (total of seven fleas) were taken from the Long-tailed Pocket Mouse (Perognathus formosus). One specimen each was from a Merriam’s Kangaroo Rat, a Canyon Mouse, and a White-tailed Antelope Squirrel.

Seasonal Occurrence. Specimens were taken in March, April, October and November.

Comments. The occasional appearance of this flea on Merriam’s Kangaroo Rat and the White-tailed Antelope Squirrel may be accidental, for only a few of several hundred of these hosts that were examined were infested with
Fig. 10. Geographic distribution of *Rhadinopsylla sectilis* • and *Carteretta carteri* ★
Fig. 11. Geographic distribution of *Thrassis bacchi*
Fleas of this species. Of the many mice examined during the five-year period, only six specimens of C. carteri flavata were taken. It is possible that fleas of this species occur in low density.

_Thrassis bacchi_ (Rothschild), 1905

A total of 1,491 specimens of this species was collected during the period of this study, making it the most abundant flea at the test site. Using Stark's (1958) publication on Utah Siphonaptera as a guide, we conclude that the subspecies is _T. bacchi gladiolus._

_Distribution._ The hosts from which the fleas were taken are principally valley and foothill inhabitants. They were found in all communities relegated to these elevations (Fig. 11).

_Host Associations._ The White-tailed Antelope Squirrel was most often encountered as the host. The Southern Grasshopper Mouse was the next most prominent host, with the Chisel-toothed Kangaroo Rat about equal in host preference. Other hosts on which specimens were infrequently taken are Merriam's Kangaroo Rat, the Desert Kangaroo Rat, Little Pocket Mouse, Canyon Mouse, Pinyon Mouse, and Coyote.

_Seasonal Occurrence._ There were about equal numbers of collections made during most of the months of the year except the summer months of July and August (Fig. 12). There was an absence of fleas in July, and only one specimen was taken in August. White-tailed Antelope Squirrels were collected during the summer, but they did not possess fleas.

_Comments._ Fleas of this species reflect the general pattern of seasonal distribution of other fleas at the lower elevations of the test site where the incidence of occurrence is greatly reduced during the summer months. Burrow examination and nesting site collections would be a worthwhile endeavor, for they might help determine what happens to the adult flea populations during the summer months.

_Thrassis aridis_ Prince, 1944

According to Stark's keys and descriptions (1958), our specimens are _T. aridis hoffmani._ This species ranks next to _T. bacchi gladiolus_ in abundance at the test site.

_Distribution._ There was widespread distribution at the test site in the biotic communities of the valleys and foothills. Most of the fleas came from the Gravia-Lycium, Coleogyne, Larrea-Fraseria, and Salsola communities (Fig. 13).

_Host Associations._ _Thrassis aridis hoffmani_ was most often encountered on the Chisel-toothed Kangaroo Rat. Merriam's Kangaroo Rat was the next most frequently infested, with the White-tailed Antelope Squirrel producing occasional specimens. One to five encounters were made with the Southern Grasshopper Mouse, Kit Fox, Canyon Mouse, Southern Pocket Gopher, Long-tailed Pocket Mouse, and Rock Squirrel.

_Seasonal Occurrence._ The greatest numbers were collected in November, followed by October, December, and January. Incidental collections made at other times of the year were one each in June and August (Fig. 14).

_Comments._ The same picture for seasonal distribution as seen in others is also reflected in this species. Summer incidence is low or lacking, with the highest being late fall to midwinter.

_Dactylopsylla bluei_ (Fox), 1909

F sạch and _Dactylopsylla_ are variously used by workers in generic designation for pocket gopher fleas. There is sufficient difference in genital anatomy alone to separate them as two distinct genera, and we follow Prince (1945) and Holland (1949) in this arrangement. Specimens of _D. bluei_ were submitted to Dr. W. L. Jeffison who recommended the subspecific designation of _D. bluei psilos_.
Fig. 13. Geographic distribution of *Thrussis aridis* ○ *Foxella ignota* ⬠ *Dactylopsylla bluei* ▲ and *Diamanus montanus* ★
Distribution. Most of the specimens were from gophers trapped in Grayia-Lycium communities. A few were from Coleogyne and some from mixed vegetational types. One flea was collected from an area of much gopher activity in the west-central area of the test site which is at a higher elevation in an Artemisia association (Fig. 13).

Host Associations. The Southern Pocket Gopher was the principal host. Collections were also made from the Southern Grasshopper Mouse and from an unknown species of pocket mouse.

Seasonal Occurrence. Collections were made during January, February, March, May, June, July, and September. Most of them were encountered in March.

Comments. The principal host for this flea is T. umbrinus, although it is occasionally found on other mammals living in the same vicinity. Before a true picture on host relationships, seasonal occurrence, and distribution may be seen, more concentrated surveys will have to be made in all of the biotic communities, especially in the western half and at higher elevations of the test site.

Foxella ignota (Baker), 1895

Only two hosts were found infested with fleas of this species. A Desert Cottontail collected in a Larrea-Franseria community yielded sixteen fleas. An unusual record was the extraction of 121 fleas from a Southern Pocket Gopher which was collected from a Pinyon-Juniper community (Fig. 13).

Collections were made in January and July.

Foxella ignota should be further studied, especially in the Pinyon-Juniper community and the Artemisia associations found at higher elevations.

Diamanus montanus (Baker), 1895

In our surveys in Utah we found the Rock Squirrel to be a common host for this flea. Stark (1958) likewise reports this host preference. Literature records for other hosts indicate their habitats as foothills and median montane elevations. At the test site, S. cariegatus was collected in the Pinyon-Juniper community on Rainier Mesa (Fig. 13). In our studies over the years, especially in Utah, the usual case was to find the host heavily infested, but at the test site only twelve fleas were collected. These were taken during April, May, and June.

Obviously a more extensive survey is needed, especially at higher elevations, to determine the extent of distribution and seasonal occurrence of this flea.

The flea is of public health importance in that it has been considered moderately effective in plague transmission (Stark, 1958).

Orchopeas sexdentatus (Roethschild), 1905

We consider this flea to be of the subspecies O. sexdentatus agilis. The taxonomic characters which have been used to distinguish the subspecies of O. sexdentatus are variously interpreted by different workers. A rather careful study needs to be made of this species over a wide geographical range. On the basis of literature descriptions and accompanying illustrations, our specimens are nearer agilis than a closely related form, nevadensis. Hubbard (1957) stated: “During 1938 this flea, nevadensis, was found to be a constant parasite on Neotoma desertorum (Wood Rat) in Clark County, Nevada, and Kane County, Utah.”

Distribution. Hosts and their fleas were about equally distributed in Coleogyne and Larrea-Franseria communities. Other communities include Pinyon-Juniper, Salsola, Grayia-Lycium, and several mixed vegetative types (Fig. 13).

Host Associations. Four of S5 separate collections were from the Canyon Mouse. The re-
Fig. 15. Geographic distribution of *Orchopeas sexdentatus*
Seasonal Occurrence. Twenty-three collections were made in January, 20 in November, 14 in December, 9 in October, and 9 in March. During February, April, June, and September, one to three encounters were made in each of the months.

Comments. Fleas of O. sexdentatus (no subspecific designation) have been found to harbor plague in nature and are considered efficient vectors of the disease (Eskey & Haas, 1939 & 1940).

During the 1965 summer surveys of wood rat habitats at the test site, we were impressed by the similarity of conditions encountered in surveys in other parts of the western United States. We found situations in which whole colonies of wood rats apparently had died. Nests and houses showed varying degrees of recent use, and dead bodies were found in the houses. As stated by Beck (1955), "... the disappearance of once abundant rodent populations has been too consistent to be happenstance. These extreme fluctuations in rodent populations may be due in part to man’s interference with environmental conditions, or perhaps it is a reflection of inherent population rhythm... It is possible that the almost, and, in some cases, complete disappearance is due to a disease agent and the vectors involved."

Monopsyllus wagneri (Baker), 1904

Our specimens are of the subspecies M. wagneri wagneri.

Distribution. All specimens were taken from hosts located along the foothills or at higher elevations. The majority were from the Pinyon-Juniper biotic community (Fig. 16).

Host Associations. In our extensive surveys in Utah and in surveys by other workers, specimens of M. wagneri wagneri are considered to be the most frequently collected fleas. They have been collected at elevations much higher than those of the desert valleys and lowlands at the test site. Most published data list the Deer Mouse as the preferred host. At the test site P. maniculatus has been found mainly at higher elevations in the Pinyon-Juniper community, and has provided some specimens of M. wagneri wagneri. Additional collections were made from the Pinyon Mouse, Southern Grasshopper Mouse, and Chisel-toothed Kangaroo Rat.

Seasonal Occurrence. Specimens were collected about equally during April and November. Two encounters were in July, and one each in August and October.

Comments. Extensive year-round surveys need to be made in the Pinyon-Juniper and Artemisia associations in the western and northwestern parts of the test site.

Monopsyllus cumolpi (Rothschild), 1905

Distribution. All specimens were collected in the north-central part of the test site in a Pinyon-Juniper community (Fig. 16).

Host Associations. This flea is commonly termed the "chipmunk" flea. Most collections at the test site were from the Cliff Chipmunk (Eutamias dorsalis). Additional fleas were taken from the Deer Mouse and Great Basin Pocket Mouse.

Seasonal Occurrence. Most collections were in April with minor occurrences in July and November.

Comments. Eighty-three specimens were collected. Although this may be considered comparatively few, all collections were in the Pinyon-Juniper community, a biotic situation where we have done relatively little survey work with the vertebrate fauna.

Malaracus tachinum (Rothschild), 1905

Only two specimens of this species were collected at the test site. One was taken from the Chisel-toothed Kangaroo Rat, and the other from the Deer Mouse. Both were in a Pinyon-Juniper community during October and November (Fig. 16).

Malaracus sinomus (Jordan), 1925

One of the principal characteristics used to separate M. sinomus from M. eremicus is the comparative length of the first metatarsal segment. In eremicus it is longer than the combined 2nd, 3rd, and 4th tarsal segments, whereas in sinomus it is shorter. The majority of our specimens fit sinomus, but there are borderline cases. Nevertheless, the structure of the ninth sternite of the male is unmistakably that of M. sinomus. It may be that specimens at the test site are at the meeting place of eremicus populations from the southeast and the sinomus populations from the north and southwest.

Distribution. Most collections at the test site were made along the foothills or in basins where
Fig. 16. Geographic distribution of Monopsyllus wagneri ★ Malaraeus telchinum ● Monopsyllus eumolpi ▲ and Malaraeus sinomus ○.
the elevation is little higher than Frenchman and Yuca Flat. About equal encounters were made in the Larrea-Franseria and Coleogyne communities, plus occasional collections from Gray- rat, Pinyon-Juniper, and mixed vegetative areas (Fig. 16).

Host Associations. Members of the genus Peromyscus are considered to be the preferred hosts. Most of our collections were from the Canyon Mouse, Deer Mouse, and Desert Wood Rat, with occasional collections from the White-tailed Antelope Squirrel, Southern Grasshopper Mouse, and Pinyon Mouse.

Seasonal Occurrence. Collections were made every month of the year except August and September, with most encounters in November, December, January, and February, successively. Only one or two encounters were made during the other months of the year.

Comments. This flea is associated with hosts living along the foothills.

Malarzuev euphorbi (Rothschild), 1905

Only one collection of fleas of this species was made. Two males and six females were removed from a Deer Mouse in November from a Pinyon-Juniper community on Rainier Mesa (Fig. 17).

Amphipsylla neotomaec Fox, 1940

A male and female specimen were taken from a Desert Wood Rat in the eastern end of Jackass Flats in a Larrea-Franseria community (Fig. 17).

Frank M. Prince (personal correspondence) indicated that A. neotomae should be listed as Malarzuev neotomae. Nothing has been published to this effect to date, so we are obligated to leave neotomae in its present generic allocation—Amphipsylla.

Odontopsyllus dentatus (Baker), 1904

Three fleas of this species were collected in April from Nuttall’s Cottontail Rabbit from a Pinyon-Juniper community on Rainier Mesa (Fig. 17).

Fleas of this species, although not found in great numbers on the preferred hosts of several species of Lepus and Sylvilagus (jackrabbits and cottontails, respectively), are considered common. Many specimens of the Black-tailed Jackrabbit were collected during the period of this study, and large numbers of cottontails were also taken and checked for ectoparasites. Only one collection of O. dentatus was encountered, fleas of this species likely are to be found on rabbits at higher elevations and northward into the Great Basin region. Collections of rabbits at higher elevations at the test site need to be made to corroborate this point of view. So far, most collections of rabbits have been made only in the valleys at the test site.

Peromyscopsylla hesperomys (Baker), 1904

According to keys and descriptions given by Johnson and Traub (1954), our specimens belong to the subspecies P. hesperomys adelptra.

Distribution. Most hosts and their fleas were taken along the foothills or at higher elevations. The biotic community most commonly represented was Coleogyne, followed by the mixed vegetative types, and to a lesser extent the Larrea-Franseria and Pinyon-Juniper communities (Fig. 17).

Host Associations. The Southern Grasshopper Mouse and Canyon Mouse were equally encountered with flea consorts. The next most often encountered was the Deer Mouse. Single encounters were made with the Pinyon Mouse, Great Basin Pocket Mouse, White-tailed Antelope Squirrel, and Southern Pocket Gopher.

Seasonal Occurrence. January, November, December, and April were the months of the year when most encounters were made. Single encounters were made in February, May, July, September, and October.

Comments. Records of this species emphasize the need for more intensive surveys along the foothills and at higher elevations of the test site.

According to Holdenried and Morlan (1955), fleas of this species have been found naturally infected with plague organisms.

Nycteridopsylla vancouverensis

Wagner, 1936

Both Hubbard (1947) and Holland (1949) listed this flea under the generic name, Eptesycopsylla. Following Hopkins and Rothschild (1953), we are using the generic name, Nycteridopsylla.

Five specimens were collected from a Western Pipistrelle Bat shot while flying in the vicinity of Tippipah Spring in November. This area is characterized as a mixed vegetative type of biotic community (Fig. 17).

The flea fauna of bats at the test site is relatively unknown, for few bats have been collected.
Fig. 17. Geographic distribution of Malaracuus euphorbi △, Odontopsyllus dentatus ▼, Nycteridopsylla (Eptesicusopsylla) vancouverensis ★, Amphipsylla neotomae ★, and Peromyscopsylla hesperomys ○.
CONCLUSIONS

Naturally the flea fauna is best known from those host animals which have been most frequently collected. Kangaroo rats and Whiletailed Antelope Squirrels were the animals most often collected. In those areas of the test site where studies were made over several years, a conspicuous reduction in numbers of fleas during the summer months was observed. Geographically, the fauna of Frenchman, Yucca, and Jackass Flats is best known, and animals of the foothills and mesas are least known.

Although thirty-three species are listed in this paper, this does not represent all that are expected to occur at the test site. The extensive stands of Artemisia tridentata in the western half of the test site are relatively unsurveyed biologically, and comparatively little has been done with the Pinyon-Juniper community on the mesas and elsewhere. To a certain extent this applies to the foothill environs. The test site does not contain high mountain ranges, and one would not expect to find hosts and their ectoparasites at the test site characteristic of high mountain elevations such as the Sheep Range to the east and the Charleston Mountains to the southeast.

About one-fourth of the species of fleas reported from the test site are from the Desert Wood Rat. Nevertheless, for the most part these records are not a result of year-round collecting in the various biotic communities where the rat is found. Such a study would assist in resolving some of the problems in the taxonomy of fleas of the genus Maláreas and related groups. There is a junction of the Great Basin and the Mojave biota at the test site, and the fleas characteristic of these two provinces may demonstrate an unusual distribution pattern once it is known.

LITERATURE CITED


