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Mites on kangaroo rats at the Nevada Test Site

Morris A. Goates

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MITES ON KANGAROO RATS AT THE NEVADA TEST SITE

by

Morris A. Goates

Biological Series - Volume III, Number 4
October, 1963
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MITES ON KANGAROO RATS AT THE NEVADA TEST SITE

INTRODUCTION

In August 1959 Brigham Young University began an ecological survey of the native animals at the Nevada Test Site near Mercury, Nye County, Nevada. The objective was a comparative study to determine the reaction of the animals to exposure of nuclear effects. The phase of the project reported herein covered the period from August 1959 to December 1961. The intent was to determine the kinds of mites found on kangaroo rats of two species, Dipodomys merriami merriami Mearns and Dipodomys microps occidentalis Hall and Dale, (1) where both hosts occupied the same habitat in about equal numbers, (2) where one host was predominantly more abundant than the other, (3) living in nuclear disturbed areas and contiguous undisturbed areas, (4) from the standpoint of seasonal occurrence, and (5) to determine the microhabitat of the mites.

As far as is known, this was the first systematic study of its kind dealing with parasitic mites of kangaroo rats. A seasonal study of the ectoparasites of D. ordii ssp., and D. microps bonnevillei Goldman was made by personnel of the University of Utah Institute of Environmental Biological Research at Dugway, Utah, but their data on mites have not been published. Brennan and Beck (1955) listed five species of chigger mites from D. ordii and D. merriami in Utah as part of a study of the ectoparasites of Utah. Gould (1956) listed eight species of chiggers found on kangaroo rats in California, and Loomis (1956) reported nine species of chiggers on kangaroo rats in Kansas. Other published records of mites from kangaroo rats are very few and are from collections incidental to other studies.

Acknowledgment is made of United States Atomic Energy Commission Research Grant AT (11-1)786 to Brigham Young University which assisted this research. I express gratitude to Drs. Donald M. Allred and D Elden Beck, principal and associate investigators, for permission to use the data in this study, and for suggestions for analysis. To my associates at the Nevada Test Site and Brigham Young University who helped in the collection and preparation of specimens, I extend thanks. Acknowledgment is made especially for the help of Carole McLain and Reed Preston, technicians associated with this project, in mounting many of the mites on microslides.

Identification and verification of some of the mites were kindly made by Dr. James M. Brennan, Rocky Mountain Laboratory, Hamilton, Montana; Dr. Russell W. Strandtmann, Texas Technological College, Lubbock; and Dr. Donald A. Chant, Canada Department of Agriculture Research Laboratory, St. Catharines, Ontario.

STUDY AREAS AND PROCEDURES

The Nevada Test Site is situated in southeastern Nye County, adjacent to the western boundaries of Clark and Lincoln counties. Study areas were established in the three major valleys of Jackass, Yucca, and Frenchman flats, although most collections were made in the latter two areas. Frenchman and Yucca flats each have a large playa supporting little or no vegetation, whereas Jackass Flats has an open drainage system and lacks a playa. The valleys lie at elevations between 940 and 1,125 meters. The test site presents an interesting ecological situation in having communities typical of both the Mojave and Great Basin influences. Allred, Beck and Jorgensen (1963) discussed the geographic and vegetative features of the test site and study areas.

The plant communities from which animals were trapped were designated on the basis of the predominant plant species present. These were (1) Artemisia tridentata Nutt., (2) Atriplex confertifolia (Torr. and Frem.) Wats. and Kochia americana Wats., (3) Coleogyne ramosissima Torr., (4) Gratiola spinosa (Hook.) Moq. and Lycium andersonii A. Gray, (5) Larrea divaricata Cov. and Franseria dumosa Gray,
(6) Lycium pallidum Miers., (7) Salsola kali L., and (8) Mixed. The Mixed designation consists of complexes of both northern and southern desert shrubs. These do not fit clearly into the other plant community types, and it is difficult to designate a predominant plant type because of the relative numbers of the numerous species present. In designating the major plant communities at the Nevada Test Site, Allred, Beck and Jorgensen (1963) listed Artemisia tridentata as part of the Coleogyne community, and Lycium pallidum as part of the Larrea-Franseria community. These two plant species occur in relatively pure stands but cover only small areas. Because each may have its own species of animals, each is considered as a separate community in this paper.

The vegetation in all the areas studied shows no physical disturbance from the effects of nuclear detonations except at one study site in the Grayia-Lycium community where plants were damaged by wind and thermal forces. This site was designated as “Grayia-Lycium disturbed” as contrasted to the Grayia-Lycium (undisturbed). In several areas where nuclear detonations occurred, the native vegetation was eliminated and Salsola was the predominant invasive plant.

Many rats were collected during mammal population and home range studies. Young-type, live-catch traps and Museum Special, break-back traps baited with oatmeal were used for trapping rats. Trapping designs with live-catch traps consisted of eight transects radiating from a central point in Grayia-Lycium, four similarly arranged transects in Atriplex-Kochia, and four in Larrea-Franseria. Traps were spaced at 30 ft. intervals with 10 traps per transect. Trapping designs with break-back traps were arranged as single transects or two parallel transects with traps spaced at 30 ft. intervals. Single transects had 100 traps per transect; parallel transects had 50 traps each.

Traps were operated once each month for a sufficient number of nights to catch a minimum of five rats in each community. Captured rats were placed in white paper bags as soon as they were removed from the traps, and rats still alive were immediately killed. The bags were tightly closed to prevent escape of ectoparasites. The bags containing rats were placed in a refrigerator for several hours to chill the body of the host. The rats were then removed from the refrigerator, allowed to warm to room temperature, and the detached mites were brushed from the fur into a large, white enamelware pan. Examination for attached mites was made by parting the hairs of the hosts.

Mites were preserved in 70 percent ethyl alcohol until they were mounted on glass slides in polyvinyl alcohol medium. They were identified with the use of a phase-contrast microscope.

RESULTS

General Infestation of Rats

*Dipodomys merriami*

Totals of 252 males, 259 females, and 17 rats not identified to sex were examined. From 28 to 94 rats were examined each month except in March and May when only 13 and 11, respectively, were examined (Table 1).

About equal numbers of male and female rats from each plant community were examined. More rats from the Mixed and disturbed Grayia-Lycium communities were examined than from other communities (Table 2). Relatively few from Coleogyne and none from Atriplex-Kochia were examined inasmuch as this species is not common in these communities.

Twenty-six percent of the rats from all areas together were infested with mites. Rates of infestation of rats by all species of mites in each of the plant types were: Larrea-Franseria, 54%; Grayia-Lycium, 33%; Salsola, 32%; Artemisia, 30%; Grayia-Lycium (disturbed), 28%; Lycium, 20%; and Mixed, 18%.

In January only one species of mite was found on this host. In February and May three species were found, and in the remaining months the number varied from five to seven.

In Grayia-Lycium the average number of mites on male rats was double the number found on females, whereas in Salsola the situation was reversed. In other communities males and females were about equally infested. Mite numbers were highest in February, July, August and October, and lowest in January, May, and September. The greatest number of mites on a host was 174 on a male in Grayia-Lycium in August. In all but Lycium and Salsola the greatest number was found on males.

In the presentation that follows these communities are referred to by their general and common names only.
TABLE 1
NUMBER OF KANGAROO RATS EXAMINED EACH MONTH

<table>
<thead>
<tr>
<th>Host</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>D. merriami</em></td>
<td>40</td>
<td>35</td>
<td>13</td>
<td>31</td>
<td>11</td>
<td>63</td>
<td>61</td>
<td>94</td>
<td>58</td>
<td>28</td>
<td>55</td>
<td>39</td>
<td>528</td>
</tr>
<tr>
<td><em>D. microps</em></td>
<td>40</td>
<td>29</td>
<td>27</td>
<td>65</td>
<td>16</td>
<td>131</td>
<td>59</td>
<td>52</td>
<td>87</td>
<td>106</td>
<td>81</td>
<td>35</td>
<td>728</td>
</tr>
</tbody>
</table>

*Dipodomys microps*

Totals of 378 males, 301 females and 49 rats not identified to sex were examined. From 27 to 131 rats were examined each month except in May when only 16 were examined (Table 1).

About equal numbers of male and female rats from each plant community were examined. Relatively fewer rats from Artemisia, Larrea, Franseria, Lycium, and Salsola were examined than from other communities because of their infrequent occurrence in these areas (Table 2).

Thirty-four percent of the rats from all areas together were infested with mites. Rates of infestation by all species of mites in each of the plant types were: Grayaia-Lycium, 55%; Grayaia-Lycium (disturbed), 36%; Lycium, 33%; Coleogyne, 32%; Atriplex-Kochia, 31%; Mixed, 25%; and Salsola, 20%.

In March only two species of mites were found on this host. Nine species were found in June, and eight in July, September and December. During the remaining months the number varied from five to six.

In Atriplex-Kochia male rats possessed four times as many mites as females, although in other communities males and females were about equally infested. There was no significant difference between the degree of infestation of the two rat species where both occurred in the same plant community. Highest mite numbers were observed in February and July, and lowest in January and May. The greatest number of mites on a host was 156 on a female in Grayia-Lycium in July. In all but Grayia-Lycium (disturbed) the greatest number was found on females.

TABLE 2
NUMBER OF KANGAROO RATS EXAMINED IN THE PLANT COMMUNITIES

<table>
<thead>
<tr>
<th>Plant Community</th>
<th><em>D. merriami</em></th>
<th><em>D. microps</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Artemisia</td>
<td>10</td>
<td>*</td>
</tr>
<tr>
<td>Atriplex-Kochia</td>
<td>*</td>
<td>65</td>
</tr>
<tr>
<td>Coleogyne</td>
<td></td>
<td>115</td>
</tr>
<tr>
<td>Grayaia-Lycium</td>
<td>48</td>
<td>127</td>
</tr>
<tr>
<td>Grayaia-Lycium (disturbed)</td>
<td>102</td>
<td>85</td>
</tr>
<tr>
<td>Larrea-Franseria</td>
<td>37</td>
<td>*</td>
</tr>
<tr>
<td>Lycium</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Salsola</td>
<td>57</td>
<td>25</td>
</tr>
<tr>
<td>Mixed</td>
<td>238</td>
<td>253</td>
</tr>
<tr>
<td>Unknown</td>
<td>18</td>
<td>40</td>
</tr>
</tbody>
</table>

*Rats did not occur in sufficient numbers in this plant community to yield an adequate sample.*

As a result of this study 6,208 mites representing 16 species were collected. Greatest numbers were 4,919 chigger mites of which 2,109 were *Odontacarus linsdalei*, 1,604 *Trombicula arenicola*, 320 *Euschoengastia decipiens*, 233 *Euschoengastia radfordi*, 52 *Euschoengastia laccerta*, 42 *Trombicula jessiciens*, and 499 belonging to a species tentatively referred to as *Sasacarus* sp. "W."

Of the remaining mites 394 were *Ischyropoda armatus*, 372 *Haemolaelaps glasgowi*, 76 *Hirstonyssus triacanthus*, 31 *Listrophorus dipodomius*, 12 *Androlaelaps leviculus*, and 373 *Kleemannia* spp. Specimens of the genus *Kleemannia* were sent to Dr. Donald A. Chant, Canada Department of Agriculture, who stated (personal correspondence) that the material included at least four undescribed species. These have been retained by him for description. In this paper these will be discussed as one group designated as *Kleemannia* spp.

Twelve species of mites were found on both male and female rats. These were *H. glasgowi*, *H. triacanthus*, *I. armatus*, *Kleemannia* spp., *O. linsdalei*, *T. arenicola*, *E. radfordi*, *E. decipiens*, and *Sasacarus* sp. "W." Two species, *A. leviculus* and *E. laccerta*, were not found on *merriani*. *Listrophorus dipodomius* was not found on male rats of either species, and *T. jessiciens* was not found on male *microps*.

Twice as many *merriani* were infested with chigger mites than with mesostigmatid mites, and twice as many rats of this species were in-
fested with one species of chigger, *O. linsdalei*, than with any other mite. Considerably more *microps* were infested with chigger mites than with mesostigmatid mites, but the difference in degree of infestation was not so great as with *merriami*. Twice as many rats of *microps* were infested with *O. linsdalei*, *T. arcticola* and *Kleemania* spp. than with any other mites.

In the discussions that follow, ecological data (when available) will be presented for each species of mite in the following sequence: general comments on previously known host relationships, frequency and degree of infestation, acarine symbioses, microhabitat, plant community and seasonal realtionships as they relate to mite populations and rates of infestation.

*Haemolaelaps glasgowi* (Ewing) 1925

Mites have been reported from numerous birds and mammals including *D. microps* (Strandtmmann, 1949; Strandtmann and Wharton, 1958). They have not been reported heretofore from *D. merriami*.

In my study 333 females, two males and 37 deutonymsphs were collected. There was no significant difference between the number of male rats infested when compared with the number of females. However, the average and largest numbers of mites were greater on female rats. Over twice as many mites were found on female as on male *merriami*, whereas only 50% more mites were found on female as on male *microps*. In both rat species the largest number of mites on a rat was six times greater on females.

This mite was the only species found on its host 57% of the time that it was collected (Table 3). It occurred 22% of the time in combination with chiggers and mesostigmatids. Its most frequent associates were *Kleemania* spp.

Numbers of mites on *merriami* were three times higher in the Mixed community than in Grayia-Lycium (disturbed) and Salsola, and six times higher than in Lycium and Larrea-Franseria. Numbers on *microps* were 60% higher in Coleogyne and Grayia-Lycium (disturbed) than in the Mixed and Grayia-Lycium, and 80% higher than in Salsola.

More *merriami* were infested in Lycium, and more *microps* were infested in Salsola than in any other community. In areas where both rat species were infested with this mite there were some significant differences. Nearly five times as many *merriami* were infested in Lycium than were *microps*, twice as many *microps* were infested in Salsola, and 40% more *microps* were infested in Grayia-Lycium (disturbed) than were *merriami*.

Twice as many *merriami* were infested in December than any other month, although the numbers of mites on *merriami* were eight times greater during June. More *microps* were infested in January than in any other month, but numbers on *microps* were highest in February and March.

*Androclacaps leviculus* Eads 1951

Mites are known from *Perognathus hispidus*, *Onychomys leucogaster*, and *Sigmodon hispidus* (Eads, 1951), but have not previously been reported from kangaroo rats.

The 12 female mites collected in my study were found on four *microps*. The average number of mites per infested host was five on males and one on females. The greatest number of mites on one host was six on a male and one on a female.

One of the four times that it was found *A. leviculus* was the only mite found on its host. It occurred in combination with chigger mites twice, and with chiggers and mesostigmatid mites once.

These mites were found only in the Grayia-Lycium and Mixed communities during the months of June, July, and August.

*Hirstionyssus triacanthus* Jameson 1950

Mites have previously been reported only from *D. merriami* (Strandtmmann and Wharton, 1958).

Totals of 73 female and three male mites were collected in my study. There was no significant difference between the number of male rats infested when compared with the number of females. The average number of mites per infested rat varied from one to two, and the largest number of mites on a host was five on a female *merriami* and four on a male *microps*.

This mite was the only species found on its host 29% of the time (Table 3). It occurred 33% of the time in combination with other mesostigmatid mites, 33% with chigger mites, and 5% with combinations of chiggers and mesostigmatids. Its most frequent associates were *Kleemania* spp.

The number of mites on *merriami* in Grayia-Lycium was nearly two times higher than in the Mixed community, and five times higher than in Grayia-Lycium (disturbed), Larrea-Franseria, and Salsola. The number on *microps*
TABLE 3
SYMBIOTIC FREQUENCIES OF MESOSTIGMATID AND SARCOPTIFORM MITES ON KANGAROO RATS

<table>
<thead>
<tr>
<th></th>
<th>Percentage of times associated&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H. glasgowi</td>
</tr>
<tr>
<td>H. glasgowi</td>
<td>57</td>
</tr>
<tr>
<td>A. leviculus</td>
<td>25</td>
</tr>
<tr>
<td>H. triacanthus</td>
<td>8</td>
</tr>
<tr>
<td>I. armatus</td>
<td>25</td>
</tr>
<tr>
<td>Kleemania spp.</td>
<td>19</td>
</tr>
<tr>
<td>O. lindsadei</td>
<td>8</td>
</tr>
<tr>
<td>T. arenicola</td>
<td>7</td>
</tr>
<tr>
<td>E. radfordi</td>
<td>7</td>
</tr>
<tr>
<td>E. decipiens</td>
<td>7</td>
</tr>
<tr>
<td>L. dipodomius</td>
<td>7</td>
</tr>
</tbody>
</table>

<sup>1</sup>Only those associations which occurred more than 5 percent of the time were included.
<sup>2</sup>Based on the total times these species were collected.

in the Mixed community was twice as high as in any of the other communities.

More *merriami* and *microps* were infested in the Salsola than in any other community. In areas where both rat species were infested with this mite there were some significant differences. Six times as many *microps* in Grayia-Lycium (disturbed) and twice as many in Grayia-Lycium and Salsola were infested than were *merriami*, whereas in the Mixed community 50% more *merriami* were infested than were *microps*.

Nearly five times as many *merriami* were infested in March than any other month, although the number of mites on *merriami* was more than twice as high during June. Twice as many *microps* were infested in May than in any other month, and the numbers of mites on *microps* were highest in April and May.

*Ischyropoda armatus* Keegan 1951

Mites of this species have been reported from mammals of several species including *D. merriami* (Strandtmann and Wharton, 1958). They have not been reported heretofore from *D. microps*.

During this study 367 females, 10 males, and 17 nymphs were collected. There was no significant difference between the number of male rats infested when compared with the number of females. However, the average and largest numbers of mites on a host were three times greater on female than on male *merriami*, and 50% greater on male than on female *microps*.

This mite was the only species found on its host 54% of the time that it was collected (Table 3). It occurred 19% of the time with other mesostigmatid mites, 16% with chigger mites, and 11% with chiggers and mesostigmatids. Its most frequent associate was *T. arenicola*.

The number of mites on *merriami* in Salsola was seven times higher than in the Mixed community, and 14 times higher than in Lycium and Grayia-Lycium (disturbed). The number on *microps* in Salsola and Grayia-Lycium was 50% higher than in Coleogyne, and four times higher than in the Mixed, Lycium, and Grayia-Lycium (disturbed) communities.

More *merriami* were infested with mites in Salsola, and more *microps* infested in Lycium than in any other community. In areas where both rat species were infested with this mite there were some significant differences. Fifty percent more *merriami* were infested in Salsola than were *microps*, and twice as many *microps* were infested in the Lycium and Mixed communities than were *merriami*.

Twice as many *merriami* were infested in May as any other month, although the number of mites on *merriami* was twenty times greater during July and October. More *microps* were infested in May and June than in any other month, and the numbers on *microps* were highest during June, August, and September.

*Kleemania* spp.

Specimens of this genus represent at least four undescribed species. In this paper these are discussed as one group.
During this study 373 mites were collected. There was no significant difference between the number of male rats infested when compared with the number of females. There was also no significant difference between the average number of mites per infested male rat when compared with the average number of mites per infested female rat. The largest number of mites on a host was three times greater on male than on female *merriami*, and two times greater on female than on male *microps*.

*Kleemannia* spp. were the only mites found on their host 35% of the time they were collected (Table 3). They occurred 26% of the time with other mesostigmatid mites, 20% with chigger mites, and 9% with chiggers and mesostigmatids. Their most frequent associate was *T. arenicola*.

The number of mites on *merriami* in the Mixed community was twice as high as in Grayia-Lycium and Larrea-Franseria. The number of mites on *microps* in Coleogyne was 50% higher than in Grayia-Lycium, two times higher than in Lycium and Mixed, and four times higher than in Atriplex-Kochia and Grayia-Lycium (disturbed).

More *merriami* were infested with *Kleemannia* spp. in Larrea-Franseria, and more *microps* infested in Lycium than any other community. In the Mixed community four times as many *microps* were infested as *merriami*, whereas in Grayia-Lycium there was no difference in rate of infestation.

Three times as many *merriami* were infested in May and October than in any other month, although the number of *Kleemannia* spp. on *merriami* was nine times greater during June. Four times as many *microps* were infested in May than in any other month, but the number on *microps* was highest during June, with high numbers also found during May, August, October and November.

*Odontacarus linsdalei* (Brennan and Jones) 1954

Mites of this species are known from mammals of several species including *D. microps* (Brennan and Beck, 1955). They have not been reported heretofore from *D. merriami*.

During this study 2,169 larval mites of this species were collected. There was no significant difference between the numbers of male rats infested when compared with the number of females. The average number of mites was twice as high on male as on female *merriami*, and 13% higher on female than on male *microps*. The largest number of mites on a host was found on males of both rat species.

This mite was the only species found on its host 52% of the times that it was collected (Table 4). It occurred 34% of the time with other chigger mites, 7% with mesostigmatid mites, and 9% with chiggers and mesostigmatids. Its most frequent associate was *T. arenicola*. Mites were found in the ears of their hosts 80% of the time. The remainder of the time they were found on the underparts of the hind legs and near the genitalia.

The number of mites on *merriami* in the Mixed community was 40% higher than in Grayia-

### TABLE 4

<table>
<thead>
<tr>
<th>Symbiont</th>
<th>O. linsdalei</th>
<th>T. arenicola</th>
<th>T. jessicmac</th>
<th>E. lacerta</th>
<th>E. radfordi</th>
<th>E. decipiens</th>
<th>Sasacarus sp. “W”</th>
<th>Percentage of times associated²</th>
</tr>
</thead>
<tbody>
<tr>
<td>H. glasgowi</td>
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<tr>
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¹Only those associations which occurred more than 5 percent of the time were included.
²Based on the total times these species were collected.
Lycium (disturbed), 57% higher than in Grayia-Lycium, 66% higher than in Salsola, and 14 times higher than in Larrea-Franseria and Artemisia. The number on microps in Coleogyne was 81% higher than in Grayia-Lycium, over twice as high as in Grayia-Lycium (disturbed). Mixed, and Atriplex-Kochia, and five times as high as in Lycium.

More rats of both species were infested with O. linsdalei in the Grayia-Lycium than in any other community. In areas where both rat species were infested with this mite there were some significant differences. Fifty percent more merriami were infested in Grayia-Lycium (disturbed) than were microps, whereas 50% more microps than merriami were infested in Grayia-Lycium.

Twice as many merriami were infested in April and November than any other month. The number of mites on merriami was twice as high during April, May, October and November. More microps were infested in May and July than in any other months, but the number was highest in July.

_Trombicula arenicola_ Loomis 1954

Mites of this species have been reported from reptiles of two species and numerous mammals including D. microps (Brennan and Beck, 1955). They have not been heretofore reported from _D. merriami_.

In this study 1,604 larval mites of this species were collected. There was no significant difference between the number of male rats infested when compared with the number of females. The average number of mites was slightly higher on male rats, but the largest number of mites was twice as high on female _merriami_, and 30% higher on female _microps_.

This mite was the only species found on its host 29% of the times that it was collected (Table 4). It occurred 45% of the time with other chigger mites, 17% with mesostigmatid mites, and 9% with chiggers and mesostigmatids. Its most frequent associate was _O. linsdalei_. Ninety-two percent of the time they were found, mites were attached to the underparts of the hind legs. The remainder of the time they were found on the ears.

The number of mites on _merriami_ in Larrea-Franseria was three times higher than in Grayia-Lycium and four times higher than in the Mixed and Grayia-Lycium (disturbed) communities. The number on _microps_ in Atriplex-Kochia was two times higher than in Grayia-Lycium, three times higher than in Grayia-Lycium (disturbed), four times higher than in the Mixed community, and six times higher than in Coleogyne.

More _merriami_ were infested with _T. arenicola_ in Grayia-Lycium and Larrea-Franseria, and more _microps_ were infested in the Grayia-Lycium than in any other community. In areas where both rat species were infested with this mite, _microps_ was more heavily infested. Seven times as many _microps_ were infested in Grayia-Lycium (disturbed), three times as many in Mixed, and 50% more _microps_ were infested in Grayia-Lycium than were _merriami_.

Over twice as many _merriami_ were infested in June than in any other month, although the number on _merriami_ was 20% higher in September. Sixty percent more _microps_ were infested in July than in any other month, and the number on _D. microps_ was over twice as high in July.

_Trombicula jessiema_ Gould 1956

Mites of this species are known from _Signodon hispidus_ and _Neotoma_ sp. (Gould, 1956). Forty-two larval mites were collected in my study from six male and one female _merriami_ and one female _microps_. The average number of mites was the same on both male and female _merriami_ but was three times higher on the _microps_ than on _merriami_. The largest number of mites on a rat was the same for male _merriami_ and female _microps_ but only one-half as high for female _merriami_.

In six of its eight collections, _T. jessiema_ was the only species found on its hosts (Table 4). They were taken from _merriami_ in the Larrea-Franseria and Mixed communities in July, August, September, and October and from _microps_ in the Mixed community in July.

_Euschongastia lacerta_ Brennan 1948

Mites have been collected from mammals of several species and one species of lizard (Loomis, 1956). They have not been reported heretofore from kangaroo rats.

During my study 39 larval mites were collected from three male and two female _microps_. Twice as many mites were found on male as on female _microps_, and the largest number of mites on a host was five times greater on male than on female _microps_.

This mite was the only species found on its host 20% of the times that it was collected (Table 4). The rest of the time it was collected in combination with other chigger mites. Its most frequent associate was _T. arenicola_. It was collected in the Atriplex-Kochia and Mixed communities during June, July, and August. Twice as
many rats were infested during July and the number of mites was three times higher also during July.

_Euschöngastia radfordi_ Brennan and Jones 1954

These mites have been reported from numerous birds and mammals including _Dipodomys_ spp. (Brennan and Beck, 1955; Gould, 1956). They have not been reported heretofore from _D. merriami_ or _D. microps._

A total of 233 larval mites was collected during my study. There was no significant difference between the number of male rats infested when compared with the number of females. However, the average and largest numbers of mites were greatest on female _merriami_ and on male _microps._ Fifty percent more mites of this species were found on female as on male _merriami_, whereas three times as many mites were found on male as on female _microps_. The largest number of mites on a host was twice as high on female as on male _merriami_, and six times higher on male than on female _microps_.

This mite was the only species found on its host 44% of the times that it was collected (Table 4). It occurred 25% of the time with chigger mites, 19% with mesostigmatid mites and 12% with chiggers and mesostigmatids.

The number of mites on _merriami_ in _Artemisia_ was four times higher than in the Mixed community and nine times higher than in _Grayia-Lycium_ (disturbed). The number on _microps_ in _Coleogyne_ and _Grayia-Lycium_ (disturbed) was twice as high as in _Grayia-Lycium_ and 14 times as high as in the Mixed community.

Ten times as many _merriami_ were infested in _Artemisia_, and 50% more _microps_ in _Coleogyne_ than in any other community. In areas where both rat species were infested with this mite, twice as many _microps_ were infested as were _merriami_.

Over three times as many _merriami_ were infested in March than any other month, although the population on _merriami_ was three times greater during February. Three times as many _microps_ were infested in February and May as in any other month, but the number on _microps_ was six times greater during February.

_Sasacarius_ sp. “W”

This represents a species whose taxonomic placement is debatable (Brennan, personal correspondence). It is tentatively assigned to this genus.

During this study 499 larval mites were collected. There was no significant difference between the number of male rats infested when compared with the number of females. Three times as many mites were found on male as on female _merriami_, but there was no difference between male and female _microps_. The largest number of mites on a rat was six times greater on male than on female _merriami_, and two times greater on female than on male _microps_.

This mite was the only species found on its host 36% of the times that it was collected (Table 4). It occurred 51% of the time with other chigger mites, and 13% with chigger and mesostigmatid mites. Its most frequent associates were _O. lins-
arenicola. Mites were found only in the ears of their hosts. The number of mites on merriami in Grayia-Lycium was three times higher than in Larrea-Franseria and Salsola. The number on microps in the Mixed community was four times higher than in Grayia-Lycium and Atriplex-Kochia.

More merriami were infested in Larrea-Franseria and more microps in Grayia-Lycium than in any other community. In areas where both rat species were infested with this mite, there was no difference in percentage of animals infested.

Fifty percent more merriami were infested in September than in July or August, although the number of Sasacarus sp. “W” on merriami was three times greater during August. Twice as many microps were infested during August as in July or September, but the number on microps was 30% higher during July.

Listrophorus dipodomius Radford 1953

Mites have been reported from Dipodomys spectabilis (Radford, 1953). They have not been reported heretofore from D. merriami or D. microps.

During this study 18 females and 13 males were collected from one female merriami and two female microps. Three mites were found on the single merriami, 27 on one microps, and one mite on the other. In one collection, this mite occurred as the only species on its host, once in combination with H. glasgowi, and once with Kleemannia spp. The infested merriami was collected in Salsola in August, and the microps were collected in December in Grayia-Lycium (disturbed).

Other Mites

Three specimens of fur mites of the family Myobidae were found on the kangaroo rats. These mites commonly occur on rodents and other mammals. Six specimens of the family Cheyletidae and ten of the family Glycyphagidae were collected. These mites are not commonly found on mammals.

DISCUSSION

According to Allred and Beck (1963) species and numbers of kangaroo rats at the Nevada Test Site vary with the plant community. Specifically, merriami was not abundant in Atriplex-Kochia and Coleogyne, whereas microps was rarely found in Larrea-Franseria. Consequently, in my study fewer rats were collected and examined from certain communities than from others.

Frequency of infestation of hosts. In areas where one of the two species of rats was greatly predominant in number, a greater percentage of the rats of the predominant species was infested with mites. Where both species of rats were found as associates in somewhat equal numbers, relatively more microps were infested than merriami. The rate of infestation of merriami was highest in Larrea-Franseria, and of microps in Grayia-Lycium. This phenomenon on merriami was due to a high rate of infestation by two species of chiggers, T. arenicola and Sasacarus sp. “W,” which occurred abundantly in Larrea-Franseria. In this community these two chiggers were never found together on the same individual rat, thereby potentially increasing the rate of rat infestation. With reference to microps in Grayia-Lycium, these two species of mites with a third abundant species, O. linsdalei, were usually found as symbionts on the same rat.

The average number of mites per infested host ranged as high as 18. The highest average on both rat species occurred in Grayia-Lycium and the lowest in Lycium. There was no significant difference between the average number of mites per infested merriami when compared with the average number of mites per infested microps in any community. In areas where the rates of infestation of rats with chiggers were low, the average number of mites per infested host also was low. Although there was no significant difference between the number of males infested when compared with the number of females infested with all mites, the average number of mites for infested males as compared with females was significantly different in some instances. In each case, however, the higher average was due to an infestation by chiggers. In all but one case where relatively high numbers of mites infested one host, chiggers were the principal mites involved. The single exception was a female merriami infested with 68 I. armatus.

The greatest number of mites found on a single rat was 174 on a merriami and 156 on a microps, both in Grayia-Lycium. Fewest numbers of mites on both species of rats were found on
animals in Lycium. Male merriani were generally more heavily infested than females, whereas female microps were generally more heavily infested than males.

Frequency of infestation by particular mite species. All species of mites collected were found on both rats except A. leviculatus and E. lacerta which were found only on microps. All species of mites were found on both sexes of host in about equal numbers, except L. dipodomius which was found only on females of both hosts and T. jessienae which was not found on male microps.

Odontacarus lindsdalei and T. arenicola infested relatively more rats than other species of mites. The next highest rate of infestation was with Kleemannia spp. which was one-half the rate of infestation of O. lindsdalei. Twice as many merriani were infested with O. lindsdalei than with any other mite species. Only one merriani was infested with L. dipodomius. Odontacarus lindsdalei and T. arenicola infested relatively more microps than did any other species of chiggers, and Kleemannia spp. and H. glasgowi infested twice as many microps as any other mesostigmatid.

The average number of each species of mite was generally the same on both host species except for Sasacarus sp. "W" which was predominantly greater on merriani than on microps. There were few differences between the average number of mites on the different sexes of hosts except for mites of E. decipiens which were eight times as abundant on male as on female microps. Almost three times as many E. radfordi were found on male as on female microps, and almost three times as many Sasacarus sp. "W" were found on male as on female merriani. Over three times as many I. armatus were found on female as on male merriani.

A significant difference between the greatest numbers of mites found on merriani and microps was noted with Sasacarus sp. "W" where the number was over six times greater on merriani. The number of I. armatus was three times greater on merriani than on microps, and L. dipodomius was nine times greater on microps than on merriani. A significant difference was also noted between the greatest numbers of mites on a single rat when males were compared with females. The numbers of O. lindsdalei and Sasacarus sp. "W" were greater on female merriani, whereas the number of T. arenicola was greater on female than on male microps. The numbers of E. lacerta, E. radfordi and E. decipiens were greater on male than on female microps.

Acarine symbiosis. Each species of mite that was collected occurred as the only species on its host in at least 20% of its collections. Three species of chiggers and two mesostigmatids occurred alone 50% or more of the time. One of the chiggers, T. jessienae, was found as the only mite species on its host 67% of the time. The remaining species occurred alone up to 45% of the time. Some mites occurred as symbionts in certain combinations more frequently than did others. Trombicula arenicola was found with O. lindsdalei nearly twice as often as it was alone. Sasacarus sp. "W" was associated with T. arenicola and O. lindsdalei nearly 50% of the time. Kleemannia spp. occurred with the chigger T. arenicola, and I. armatus with Kleemannia spp. one-fourth of the time. Other combinations were found, but not in significantly large numbers.

Microhabitat. Inasmuch as the mesostigmatid mites were never found attached to their hosts, no data as to a preferred site of location on the animal were obtained. The chigger mites, which remain attached for prolonged periods, were found to prefer particular sites for attachment. Sasacarus sp. "W" was found only on the ears of its hosts, O. lindsdalei was found predominantly on the ears and occasionally on the underparts of the hind legs, and T. arenicola was found predominantly on the underparts of the hind legs and only occasionally on the ears. No data are available on the site of attachment of other species found.

Plant community relationships. In communities where numbers of kangaroo rats were high, the numbers of mite species on the rats were also high. For example, in Grayia-Lycium (disturbed) and Mixed communities where rat numbers were high, 10 to 12 species of mites were collected. In Artemisia where rat numbers were low only two species of mites were collected.

Total mites collected varied from one community to another. Slightly higher numbers were observed in Artemisia, Atriplex-Kochia, Coleogyne, Grayia-Lycium, and Larrea-Franseria plant types than in the others.

In Atriplex-Kochia, I. armatus, Kleemannia spp., and Sasacarus sp. "W" were least common, whereas T. arenicola and E. lacerta were most common. Odontacarus lindsdalei was least common in Artemisia, whereas E. decipiens was most abundant there. No species was particularly abundant in Lycium. In Larrea-Franseria T. jessienae was least abundant, whereas T. arenicola was very common. Euohungastria radfordi
was least abundant there. Most species were found in abundance only in one or two communities, whereas O. linsdalei and T. arenicola were abundant in several communities.

Seasonal occurrence. Seasonally there were three main peaks of mite activity with respect to those species which were active most of the year. These peaks occurred in February-March, July, and October-November when mite numbers were about equal. Numbers during these periods were about six times greater than the numbers which occurred in January and April. These differences likely resulted from high numbers of chiggers. Numbers of the mesostigmatid I. armatus reached a high peak in October. Mites which were not active most of the year were found principally during the period from June through September.

New host records. The new host records that were established are A. lepiculus, T. jessie-mae, E. radfordii and L. dipodomus merriami and microps; H. glasgowi, O. linsdalei and T. arenicola on merriami; and H. triacanthus, I. armatus, E. lacerta and E. decipiens on microps.

Effects of nuclear disturbance. Forty percent more animals in the undisturbed Grayia-Lycium were infested than in the nuclear disturbed Grayia-Lycium. Infested animals in the undisturbed areas had an average of three times as many mites as in disturbed areas. The maximum number of mites on any one host in the undisturbed was double the number in the disturbed. No significant difference in the number of species of mites was found between the two areas. About half of the species occurred in both areas in about equal numbers. Ischyropoda armatus and Sasacarus sp. "W" were considerably more abundant in undisturbed areas, whereas E. radfordii was most abundant in disturbed areas. Odontacarus linsdalei, T. arenicola, and Sasacarus sp. "W" infested more rats in undisturbed than in disturbed areas. Haemolaelaps glasgowi, E. decipiens, and E. radfordii infested more rats in disturbed than in undisturbed areas.

Morphological anomalies of chiggers. An occasional T. arenicola was found to have two anteromedial setae or an extra scutal seta. In many specimens the dorsal pattern of setae varied considerably. Dr. James M. Brennan stated (personal correspondence) that this variation was common for these chigger mites. An occasional O. linsdalei was found with three anteromedial setae instead of the common two. In each specimen other characteristics indicated it to be O. linsdalei.

One-hundred and nine T. arenicola possessed a stylostome which remained attached to the chigger when it was removed from its host’s tissue. Several stylostomes were much longer than the chigger itself.

SUMMARY

A systematic study of parasitic mites on kangaroo rats of two species at the Nevada Test Site was conducted from August 1959 to December 1961. The intent was to determine the kinds, numbers, seasonal occurrences and ecological relationships of mites in nuclear disturbed and contiguous undisturbed areas. A total of 1,256 rats from nine plant communities was examined.

The 6,208 mites collected represented 16 species including four undescribed. Fourteen were found on both kinds of rats. Considerably more rats were infested with chiggers than with mesostigmatids. Each species of mite occurred alone on its host at least 20% of the time, and one species was found alone as much as 67% of the time. Chiggers of two species occurred predominantly on the ears of their hosts, whereas mites of another species were found principally on the underparts of the hind legs. Although most mite species were found in all plant communities, they occurred in abundance in only one or two. However, two species were abundant in several communities. Seasonal peaks in numbers of mites occurred during the three periods of February-March, July, and October-November. Forty percent fewer rats in the nuclear disturbed areas were infested than in undisturbed areas, and only one-third as many mites were found on rats in the disturbed as in the undisturbed areas.
LITERATURE CITED


Fig. 1. Location of the Nevada Test Site.