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Carol O. Mohr  
*University of California, Berkeley*

D Elden Beck  
*Brigham Young University*

Elias P Brinton  
*Brigham Young University*

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OBSERVATIONS ON HOST-PARASITE RELATIONSHIPS AND SEASONAL HISTORY OF TICKS IN SAN MATEO COUNTY, CALIFORNIA

Carol O. Mohr, D Elden Beck, and Elias P. Brinton

During the course of an investigation into the interrelationships of parasite and host populations in San Mateo County, California, data came to hand concerning populations of ticks on a number of species of small mammals, lizards, and birds. Since no studies appear to have been published concerning ticks in climates and faunal areas characteristic of the coastal zone, we believe it worthwhile to provide the following data.

STUDY AREA AND PROCEDURE

The study area consisted of a meadow and an adjoining hillside approximately three miles east of the Pacific coast. It was about two acres in size at an elevation of from 450 to 600 feet above sea level. A ridge about 1,250 feet in elevation shields the area somewhat from coastal fog which frequently covers the meadow. Killing frosts occur late in December and end early in February. Average temperatures for January are 50° F, and 68° F for July. Precipitation averages 6 inches in January and 0.01 inches in July, with 22 inches per year.

The area is within the San Francisco Wildlife Refuge and is well populated by mule deer, Odocoileus hemionus. Dogs from nearby residential areas frequently entered the refuge. Grey foxes, Urocyon cinereoargenteus, also were common. No domestic stock has been pastured in the area for scores of years, except three horses which were present for a few weeks during the summer of 1961.

Kartman et al (1962) described the same general area in some detail when they studied its cricetid fauna and flea consortes in relation to an outbreak of plague. Our study area is the southernmost part of their location, designated by them as Area 5. In their publication, Figure 4 shows the fluctuations in populations at that time for meadow mice, Microtus californicus; harvest mice, Reithrodon-

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2. Division of Parasitology, University of California, Berkeley, California.
3. Department of Zoology and Entomology, Brigham Young University, Provo, Utah.
tomys megalotis; and deer mice, Peromyscus maniculatus in this and adjoining areas.

For the most part in our study, mice and birds were live-trapped. Most of the lizards were caught by hand. Some of the mice and birds were caught during afternoons of the day on which traps were set; others were taken from traps early the next morning.

The ticks on the hosts were counted by use of a hand lens so far as possible. When the clusters of ticks were so numerous that counting became uncertain, the host was killed, wrapped, and brought to the laboratory for a more accurate count. Otherwise, a sample collection of parasites was removed from the live host for species identification. The host was then released to permit further study of its home range and relation to home ranges of other individuals and species.

The field work was done by William A. Stumpf. We are grateful to him for diligence and care in trapping, collecting, and preparation of field observational records.

**Observations**

The numbers and kinds of the more commonly collected hosts are shown in Table I. Other hosts less commonly collected are California white-footed mouse, Peromyscus californicus; brush rabbit, Sylvilagus bachmani; shrew, Sorex vagrans; wood rat, Neotoma fuscipes; spotted towhee, Papilio erythropthalum; brown towhee, P. fuscus; Bewick wren, Thryomanes bewickii; California jay, Aphelocoma coerulescens; white-crowned sparrow, Zonotrichia leucopephrys; alligator lizard, Gerrhonotus multicarinatus and the fence lizard Sceloporus occidentalis. California ground squirrels, Citellus beecheyi, were absent. They originally occupied the area, but have been eliminated by a concentrated poisoning program.

Table II shows a monthly record of tick infestation from March through October as found on the meadow mouse.

Nymphs of *Ixodes angustus* were found on one meadow mouse and one harvest mouse.

*Ixodes spinipalpis* was found on the California jay, spotted towhee, meadow mouse, deer mouse, and the brush rabbit as follows: One larva on a deer mouse, 1 June; five on brush rabbits between 27 June and 14 July; and three on the spotted towhee, 4 August.
Table II: Records of ticks (all species) from meadow mice: per cent of hosts infested, numbers examined and per cent of ticks which were nymphs and larvae.

<table>
<thead>
<tr>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Average or Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per cent mice infested</td>
<td>2</td>
<td>9</td>
<td>17</td>
<td>39</td>
<td>27</td>
<td>34</td>
<td>21</td>
<td>0.7</td>
</tr>
<tr>
<td>Aver. per infested mouse*</td>
<td>1.0</td>
<td>2.8</td>
<td>1.4</td>
<td>3.2+</td>
<td>4.2</td>
<td>11+</td>
<td>2.1+</td>
<td>6.0</td>
</tr>
<tr>
<td>Greatest no. per mouse*</td>
<td>1.0</td>
<td>10</td>
<td>3</td>
<td>11</td>
<td>21</td>
<td>49</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Per cent nymphs</td>
<td>100</td>
<td>76</td>
<td>23</td>
<td>7</td>
<td>43</td>
<td>36</td>
<td>57</td>
<td>14</td>
</tr>
<tr>
<td>Per cent larvae</td>
<td>0</td>
<td>24</td>
<td>77</td>
<td>93</td>
<td>54</td>
<td>64</td>
<td>43</td>
<td>86</td>
</tr>
<tr>
<td>Nrs. hosts examined</td>
<td>49</td>
<td>53</td>
<td>30</td>
<td>79</td>
<td>113</td>
<td>108</td>
<td>153</td>
<td>145</td>
</tr>
<tr>
<td>Nrs. ticks identified</td>
<td>1</td>
<td>7</td>
<td>7</td>
<td>74</td>
<td>141</td>
<td>268</td>
<td>52</td>
<td>7</td>
</tr>
</tbody>
</table>

*Excluding counts on 3 mice in June, 2 in August and 1 in September on which ticks were so numerous or hidden in the ears as to preclude a complete count. The largest count (49) was made in August from a mouse killed and brought to the laboratory.

Nymphs were collected from the California jay and meadow mice, 20 March through 14 July. Adults were found on brush rabbits between 25 May and 20 June.

* * * * * 

*Ixodes pacificus* was the only species of tick found on the fence and alligator lizards. Larvae were collected 4 August to 20 September; nymphs from 7 April to 28 June; some adults were collected 27 June. Larvae and nymphs were found on meadow mice, larvae only on harvest mice, deer mice, and a shrew. The adult specimens were from alligator lizards, man, and horses. The peak of population occurred in June. Only 0.4 percent of the 557 ticks removed for identification from meadow mice were this species.

*Haemaphysalis leporispalustris* were commonly encountered on brush rabbits as larvae, nymphs, and adults. Larvae and nymphs also were found on the spotted and brown towhees and the Bewick wren.

Larval *Dermacentor occidentalis* were observed on meadow mice, harvest mice, deer mice, California white-footed mice, and the brush rabbit. The first larvae were observed on 23 April and the latest on 10 October. The first nymph observed was on 31 March, and the last nymphal collection was on 4 October. *D. occidentalis* was the most common tick taken from the meadow mice. It constituted 99 per cent of the sample of 557 ticks taken from Microtus for identification. This is shown in Table II. A peak population on meadow mice was indicated for July and August. In July, 19 per cent of the meadow mice bore larvae and 20 per cent bore nymphs, and in August, 20 per cent bear larvae and 23 per cent bore nymphs. During this same period, 8 per cent of the harvest mice and 11 per cent of the deer mice were infested. All of the brush rabbits examined were infested.
Discussion

*Ixodes angustus*: According to Gregson (1956) this “is the commonest species of tick on British Columbian coast squirrels. *Tamiasciurus douglasi mollipilosus,*” and “one of the commonest species of *Ixodes* in British Columbia.” It is surprising in our studies to have only collected larvae, and these only from one meadow and one harvest mouse. Adults and nymphs as observed by Bishop and Trembly (1945), and Cooley and Kohls (1945) showed them to appear a score or more of times on other rodents and shrews in the studied localities. It is presumed that the kind of habitat and possibly the fact that some key hosts were not collected may be partly responsible for the scarcity in numbers of individuals and other developmental stages. Ground squirrels were virtually absent and wood rats rarely entered the study area. Lagomorpha have not been listed as hosts.

*Ixodes spinipalpis* was found in larval and nymphal development on a variety of hosts. There seemed to be no restriction of the larvae and nymphs to smaller hosts for larvae were found on both brush rabbits and deer mice. Adults however were found only on the brush rabbit.

*Ixodes pacificus* has been commonly collected in the larval and nymphal stages from the alligator lizard along the Pacific coastal region (Cooley and Kohls, 1945; Gregson, 1956). It was natural to find it infesting this and the fence lizard at the San Mateo locale. It is however interesting that in studies by Beck (1955), Allred, Beck, and White (1960) for Utah, Beck, Allred, and Brinton (1963) for Nevada, this species was not found on any species of lizard. It also was uncommon on mice in our study.

Our collections indicate the larvae and nymphs tend to occur mostly on small mammals and lizards. Larger and medium-sized mammals, and lizards are most often reported hosts of adults (Cooley and Kohls, 1945), and (Bishop and Trembly, 1945). However, it is interesting to note in the observations by Linsdale and Tevis (1951) in their study of the dusky-footed wood rat made at a location about eighty miles south of our location that, “In Monterey County. 11 per cent of the wood rats *Neotoma fuscipes* were infested by larval *Ixodes pacificus* at the height of the season (in May). One was infested by a nymph. In August, 14 per cent were infested by nymphs and larvae of *Dermacentor occidentalis.*”

Although our sample of specimens is too small to be conclusive, there did seem to be a greater tendency for *I. pacificus* to infest cricetine mice compared to meadow mice. Seventeen per cent of 193 ticks identified from 209 cricetine mice were this species. From a general review of the literature and our observations in the present study, one could postulate that host association of ticks in San Mateo County is related to choice of habitat by the mice: the cricetine species occur most commonly in open areas inhabited by fence lizards and the microtine under heavy vegetative cover and at a higher humidity. There is evidence also that the size of a host’s home range
effects the percentage infested by certain ticks and other ectoparasites (Mohr and Stumpf, 1962).

According to Cooley (1946), Beck (1955), and Gregson (1956) adult *Haemaphysalis leporispalustris* are predominantly parasites of brush rabbits, cotton tails, and other rabbits and hares. Larvae and nymphs occur on rabbits, and ground-inhabiting birds for which Bishop and Trembley (1945), Peters (1936), and Nibley (1962) report almost 100 species. Larvae were found on the Bewick wren and larvae and nymphs on the spotted and brown towhees. It is not uncommon to find the larval, nymphal, and adult stages at the same time on a single lagomorph host (Green et al, 1943; Beck, 1955; and Gregson, 1956). In our study, the brush rabbit was the only leporid observed. In all instances, they were heavily infested by all developmental stages.

*Dermacentor occidentalis*: Our observations show this species of tick to have its highest seasonal population in the San Mateo study area during August. It was the most abundant of the tick species observed in the area. No adult ticks were found on the rodents examined. Adults commonly attack the larger vertebrates such as ungulates, dogs, and man (Cooley, 1938; Bishop and Trembley, 1945).

**Conclusions**

Five species of ticks were found on the reptiles, birds, and mammals in a small study area of approximately two acres. *Dermacentor occidentalis* was the most common of the ticks observed. Its peak population of larvae occurred about June when 39 per cent of the meadow mice were infested; and of nymphs in August when 34 per cent of these mice were infested. *Ixodes pacificus* was the only species found on reptiles. Larvae and nymphs were also collected from a small percentage of meadow mice and others. Adults of *Haemaphysalis leporispalustris* were found only on the brush rabbits and ground-inhabiting birds. A few *Ixodes angustus* were found on mice, and *I. spinipalpis* on birds, mice and rabbits.

**References**


