A STUDY OF ECTOPARASITES OF THE BLACK-TAILED JACKRABBIT (*LEPUS CALIFORNICUS MELANOTIS* MEARNS.) IN WESTERN KANSAS

by

BANDER MOHAMMED EL-RAWI

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INTRODUCTION

The work reported in this paper was undertaken in an effort to collect and identify the ectoparasites infesting the Black-tailed Jackrabbit in Western Kansas.

In Kansas, Hall (1955) stated that Lepus californicus prefers open grassland of Western Kansas and tends to avoid the more heavily wooded area characteristic of the eastern border of the state. The population of the Black-tailed Jackrabbit has shown wide fluctuation, increasing year after year for several years and then decreasing rapidly in a period of only a few months.

The first report of parasites in rabbits was by Leeuwenhoek (1674). He described the oocyst of Eimeria stiedae, a coccidian, from the bile duct. Ectoparasites of rabbits were first reported by Nelson (1909). Following that, many authors have reported some ectoparasites of rabbits (Ferris 1916, Burnett 1926, Roberts 1932, Hall 1951, Philip, et. al. 1955, and many others).

The ectoparasites that infest the Black-tailed Jackrabbit are from two classes of Arthropoda, the Arachnida and Insecta. There are three orders of Insecta infesting the Black-tailed Jackrabbits that may carry disease organisms to man. These are fleas (Siphonaptera), sucking lice (Anoplura), and myiasis-producing Diptera [Diptera causing myiasis]. The literature shows many important disease-producing organisms are transmitted from the rabbit. Fleas transmit the plague from the wild animals (Rodents) to man. This disease once killed many millions a year, especially in the Old World. Fleas also are intermediate hosts for Dipylidium caninum which parasitizes cats and dogs, but also, incidentally, infects man. The Arachnida (ticks and mites) that infest Black-tailed Jackrabbits and which may transmit

disease organisms to man are Haemaphysalis leporis-palustris, Dermacentor andersoni, Dermacentor variabilis, and Dermacentor parumapertus var. marginatus.

The Black-tailed Jackrabbit is one of the largest of the rabbits and hares. It may be extremely destructive to farm crops, fruit trees, and forest seedlings. It may also destroy grapevines, and even garden crops. Rabbits have been economically important to man for many years because they serve as a source of food and sport. It has been reported that more than 20,000 Black-tailed Jackrabbits have been sold in the market in one year (Wall, 1955). The fur of young rabbits is very useful for fur coats and for felt.

DISTRIBUTION

The order Lagomorpha is relatively old in the geological sense. Fossilized bones and teeth of rabbits are known from deposits of the Oligocene age.

The principal characteristic of this order is the presence of four upper incisor teeth, placed one pair behind the other, instead of only one pair, as in the Rodentia. The order Lagomorpha includes two families. They are:

1. Family Ochotonidae, characterized by the hind legs scarcely larger than fore legs, nasals widest anteriorly, no supraorbital process on frontal, and five cheek teeth on each side above. It includes one genus, Ochotona.

2. Family Leporidae, characterized by hind legs notably larger than front legs, nasals widest posteriorly, supraorbital process on frontal, and six cheek teeth on each side above.

The family Leporidae (order Lagomorpha) has practically a worldwide distribution, but its members are not native in Australia. The family is

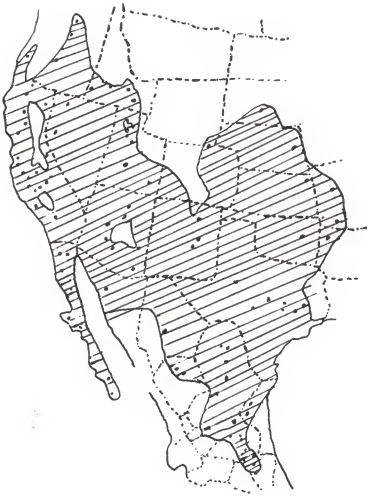


Fig. 1. Distribution map of *Lepus californicus* in North America. Redrawn from Hall (1951).

divided at the present time into nine recognized genera. Of these, only one, the circumpolar genus Lepus, inhabits parts of both the Old and New World.

In all the Old World there are six recognised generic types. Of these, Lepus and Oryctolagus are wide ranging. The others, Pronolagus (South Africa), Nesolagus (Sumatra), Caprolagus (Southern Himalaya), and Pentalagus (Lin Kiu Island of Japan) are widely separated and comparatively local. The number and variety of forms of the Leporidae appear to be greater in North America and fewer in South America than in any other continental areas.

There are four genera inhabiting North America: (1) Lepus is circumpolar; (2) Brachylagus and (3) Romerolagus, are peculiar to this continent and the other, (4) Sylvilagus, is common to both North and South America. In North America, the genus Lepus is represented by two subgenera, Macrotolagus, restricted to North America, and the subgenus Tapeti, belonging mainly to tropical America. Sylvilagus differs from Lepus in shape and size and in the structure of the skull. There are four genera in North America in the family Leporidae:

(1) Lepus (Linnaeus 1758); this genus includes the hares and jackrabbits. In North America there are eleven species in this genus, but only two species are found in Kansas, the White-tailed Jackrabbit (Lepus townsendii Backmann), and the Black-tailed Jackrabbit (Lepus californicus Gray) (Fig. 1).

(2) Sylvilagus (Gray 1867) included 12 species, three of which are present in Kansas: Eastern Cottontail (Sylvilagus floridanus Allen); the Swamp Rabbit (Sylvilagus aquaticus Backmann); and the Desert Cottontail (Sylvilagus audubonii Baird).

(3) Romerolagus (Merrian, 1896) includes one species.

(4) Brachylagus (Miller, 1900). Some authors include this as a subgenus. The last two genera are not represented in Kansas.

GENERAL REVIEW OF LITERATURE

The ectoparasites found on the rabbits; namely, ticks, mites, the causative organisms of myiasis, and fleas are potentially very important in carrying the disease-producing organisms to man or to his domestic animals. Therefore, the work in the field of parasites of rabbits has attracted many research workers during the last century.

Ferris (1916) found a high incidence of Haemadisrus ventricosus infesting Lepus californicus in Arizona and California.

Burnett (1926) examined hundreds of Lepus californicus in eastern Colorado and found the following ectoparasites: Dermacentor parumapertus var. marginatus (Banks); Dermacentor andersoni (Stiles); and Haemaphysalis leporis-palustris (Packard). He also found less infestation of fleas on White and Black-tailed Jackrabbits in July and August and comparatively more in the months of May and June. He reported three genera of fleas, Hoplopsyllus affinis (Baker), Spilopsyllus inaequalis (Baker), and Pulex spp. (Linn.) on Lepus californicus melanotis (Mearns) and Lepus townsendii campanius (Hallister).

Schwartz (1928), while working on different rabbits of the United States reported the louse Haemodisrus ventricosus, and ear mange caused by mites. He reported also the following fleas from the rabbits he had collected: the cat flea Ctenocephalides felis; the rabbit flea Spilopsyllus cuniculi; the human flea Pulex irritans; and Echidnophaga gallinacea. The last named is mostly parasitic on poultry and especially attacks chickens. In the same year he reported the warble (bot fly) Cuterebra cuniculi, having found these larvae of Diptera in wild rabbits. Warbles also occur on domestic rabbits.

Roberts (1932) frequently found screw worm infestation in Lepus californicus texianus, the common Texas Jackrabbit. In his view blow fly attacks

follow many non-fatal gunshot wounds.

Culbertson (1953) found itch mites, Psoroptes communis var. cuniculi, as a common parasite of rabbits. They were found in large numbers on the surface of the skin and deep within the folds of the outer ear.

Philip (1938), in Alaska, collected 172 hares (Lepus americanus macfarlani) from various localities. He reported occasional occurrence of the rabbit tick Haemaphysalis leporis-palustris, a carrier of Rocky Mountain spotted fever.

Hearle (1938), in his survey of British Columbia, collected thousands of ticks belonging to two families, Argasidae and Ixodidae, from game and domestic animals and birds. He found two genera of Argasidae, Ornithodorus and Argus. Of the Ixodidae he reported the following five species: Ixodes dentatus spinipalpis; Haemaphysalis leporis-palustris; Ixodes angustus; Dermacentor andersoni; and Haemaphsalis cinnabarinae.

Kohls (1939) found six species of fleas infesting the wild hares and rabbits; Hoplopsyllus glacialis; Hoplopsyllus glacialis lynx; H. affinis; H. foxi; H. powersi; and Hoplopsyllus minatus.

Green et al (1939), while studying the ectoparasites of the snowshoe hare (Lepus americanus) in Minnesota throughout the year, found rabbit ticks, Haemaphysalis leporis-palustris, to be the most common parasite. In one sample they collected as many as 4911 rabbit ticks and only two fleas (Spilopsyllus cuniculi) in the month of September.

Morgan and Waller (1940) collected and examined 210 cottontail rabbits from different counties in Iowa and found three species of fleas belonging to the family Pulicidae: Cediopsylla simplex; Hoplopsyllus affinis; and Ctenocephalides canis. They also found Haemaphysalis leporis-palustris in the ears of two rabbits.

Kohls and Cooley (1940) reported one species of tick, Ixodes ricinus californicus, on jackrabbits from some counties of Oregon. They reported their occurrence on the coyote, domestic cat, and horse in Oregon and California.

Eddy (1943) examined 176 cottontail rabbits obtained by trapping in Oklahoma for fleas and other ectoparasites. He collected the ectoparasites by using paradichlorobenzene crystals. His collection included six species of fleas: Hoplopsyllus affinis; Pediopsylla simplex; Echidnophaga gallinacea; Pulex irritans; Orchopeas leucopus; and Ctenocephalides felis.

Green et al (1943) studied the area close to Lake Alexander near Little Falls, Minnesota, for ten years and found the rabbit tick Haemaphysalis leporis-palustris to be the most important ectoparasite of the snowshoe hare. They also found this tick on quail, meadow larks, and meadow mice.

Joyce (1941) reported negative observations on the occurrence of rabbit ticks, but found two other parasites on the rabbit, namely Ixodiphagus texanus, and Hunterellus hookeri. However, in the year 1942, Joyce and Eddy found Haemaphysalis leporis-palustris to be the second most abundant tick occuring on different animals and birds of Iowa.

Bell and Chalgren (1943) found about 50 per cent of the rabbits of their collection tick infested, with an average of 25 ticks per rabbit. They found most commonly two species of ticks, Haemaphysalis leporis-palustris, and Ixodes dentatus in the states of West Virginia, Pennsylvania and New York. They also collected 3107 fleas from cottontail rabbits representing eleven species, the important ones being Cediopsylla simplex, Odontopsyllus multispinosus, and Hoplopsyllus affinis.

Portman (1944) reported Haemaphysalis leporis-palustris and Dermacentor variabilis on cottontail rabbits collected in Missouri. He also reported finding five species of fleas, namely Cediopsylla simplex; Hoplopsyllus

affinis; Odontopsyllus multispinosus; Ctenophthalmus felis; and Nosopsyllus fasciatus.

Brown (1945) reported the rabbit tick Haemaphysalis leporis-palustris from a laborer near Camrose, Canada, which he believed the laborer got from a rabbit killed by a train.

Llewllyn and Handley (1945) found practically all rabbits of the species Sylvilagus floridanus and Sylvilagus transitionalis collected in Virginia and New England respectively, to be infested with fleas. The winter specimens showed ticks in varying numbers. The most abundant fleas were Cediopsylla simplex, Odontopsyllus multispinosus, and Ctenocephalides canis. Of ticks, they found both the rabbit tick Haemaphysalis leporis-palustris, and Ixodes dentatus, the former one being the most common. They also found the cottontail to be an important host for the chigger Eutrombicula affreddueesi.

Cooper (1946) reported the mite Cheyletiella parasitivorax, from several rabbits in different places in the United States.

Collins et al (1949), while studying ectoparasites on different mammals and birds from Long Island, found seven species of ticks from eastern rabbits, namely Dermacentor variabilis, Haemaphysalis leporis-palustris, Ixodes cookei, I. dentatus, I. marxi, I. muris and Ixodes scapularis.

Philip et al (1955), in their studies on ticks and the transmission of Brucella and Rickettsia diseases, found Dermacentor andersoni and D. parumapertus var. marginatus from Black-tailed Jackrabbits from northern Nevada to be naturally infected by Rickettsia rickettsi. They also found a soft tick, Otobius lagophilus, and several bot flies from a number of Black-tailed Jackrabbits.

The literature has so far revealed seven genera with 15 species of ticks, nine genera with 15 species of fleas, three species of mites, one species of lice, two chalcidoids and three species of bot flies on Black-tailed and White-tailed Jackrabbits, cottontail rabbits, and snowshoe hares. These ectoparasites have been reported from at least fifteen states, parts of New England and Alaska.

MATERIALS AND METHODS

Black-tailed Jackrabbits were obtained for investigation from western Kansas. The area where the Black-tailed Jackrabbits were shot, is represented by a range of sand-hills as in Fig. 2. The area extends from southeastern Colorado eastward into Kansas through Hamilton, Kearny, Finney and Gray Counties, and into the western part of Ford County. The area varies in elevation from 2,955 feet on the river valley to 3,020 feet on sand-hill pastures. The area where the hunting was done contained about 965 square miles. The soil is sandy with some areas subject to blowing because of lack of vegetation.

This region was originally a tall grass region with the climax vegetation represented by little bluestem (Andropogon scarparius), together with lesser and big bluestem (Andropogon hallii) (Plate I). The principal plants present are:

A. Grasses: Red three-awn (Aristida longiseta); grama grasses (Boutelona sp.); and buffalo grass (Buchloe dactyloides).

B. Weeds: Russian thistle (Salsoma pestifer); and milkweed (Asclepias sp.).

C. Brush: Sand sagebrush (Artemisia filifelia); and Yucca (Yucca glauca).

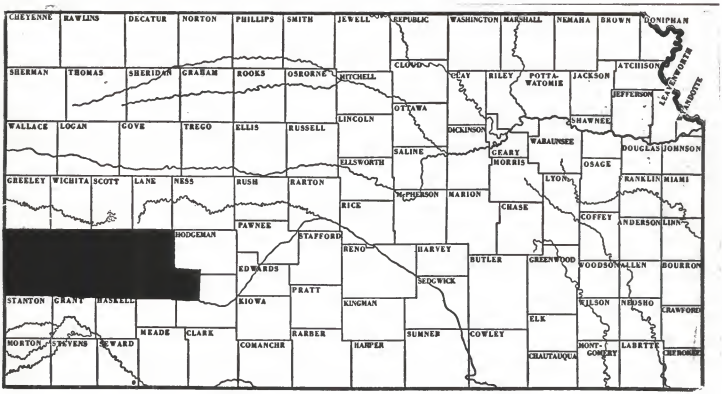


Fig. 2. Kansas map showing hunting area.

EXPLANATION OF PLATE X

A Black-tailed Jackrabbit in its native habitat in western Kansas.

PLATE I

Shooting the Black-tailed Jackrabbits was done by using a .22 caliber rifle or a 16 gauge shotgun. Hunting was done between 3:30 p.m. and midnight, sometimes as late as 3 a.m.

The rabbits were placed in plastic sacks as soon as possible after shooting, and taken to Manhattan, where the ectoparasites were collected. The rabbits were kept in the Zoology Department quarters before being checked. During the cold winter the dead rabbits were kept in a ventilated room at about freezing temperature, and later in the spring they were kept in a refrigerator until checked for ectoparasites. Each specimen was checked separately from others and the arthropods recovered kept in properly labelled vials in 70 per cent alcohol. A large lens was used in searching for the minute arthropods.

Several methods for recovering the ectoparasites were attempted. They are as follows:

Washing Method

This method makes use of a large size can, filling the can about one quarter full with warm water with an added teaspoonful of detergent. Each Black-tailed Jackrabbit was individually soaked about 40 minutes. The can was then carefully covered and shaken very hard about 15 minutes. The jackrabbit was then removed from the can and checked for ectoparasites. The washing water was transferred to a 500 c.c. cylinder and left to stand 30-40 minutes after adding a few drops of 85 per cent alcohol. The ectoparasites by that time usually precipitate to the bottom. The water in the cylinder was checked in different levels but the important material is that at the bottom. This method was used for several Black-tailed Jackrabbits but the results were not thought to be satisfactory.

Freezing and Heating Method

The Black-tailed Jackrabbits had been kept for one to two hours in a refrigerator. Because of the chilling, the ectoparasites became sluggish. When the Black-tailed Jackrabbit was removed from the refrigerator it was placed on a large white sheet of paper, and one or more 500 watt lamps were hung above the rabbit to activate the ectoparasites. Soon they started crawling over the hairs and were easily picked off. This method was used the first time by Morgan and Waller (1940) for collecting the ectoparasites from the Cottontail, Sylvilagus floridanus, in Missouri.

Paradichlorobenzene Method

This method was developed by Wallace in 1946 at Carnegie Museum and is described by Neil (1951). The method is used on small to medium sized mammals such as Black-tailed Jackrabbits. The rabbit is placed in a bag of paper or nylon, adding one or two teaspoonsful of paradichlorobenzene crystals to the animal in the bag (the amount depends on the size of the animal). In about 20 minutes the rabbit is removed, leaving the ticks and fleas in the bag, but the small ectoparasites, such as mites and lice, usually stay attached to the skin. In order to get all ectoparasites, the rabbit must be brushed over a white paper or a white pan. Only two rabbits were examined by this method, the result being poor, which probably is due to the long and thick hairs of the Black-tailed Jackrabbit.

Pyrethrins in Ethylene Tetrachloride Method

The method was used by Dr. H. T. Gier in his work of collecting the ectoparasites of coyotes. By this method good results, compared to the other methods, were obtained. In the pyrethins method the Black-tailed

Jackrabbit is put on a white pan, then pyrethrins in ethylene tetrachloride is sprayed on the rabbit by machine pump, after which the rabbit is covered by a large sheet of nylon for 15–20 minutes. The ectoparasites are then collected from the surface of the hairs.

All the ectoparasites recovered from 64 Black-tailed Jackrabbits were kept in properly marked vials in 70 per cent alcohol. The following tables (Tables 1 and 2) represent the number of rabbits taken, dates of hunting, and the number of ectoparasites recovered.

Identification of two out of seven lots of the ectoparasites was made by Dr. F. C. Bishopp of the United States Department of Agriculture.

RESULTS

The ectoparasites recovered from 64 Black-tailed Jackrabbits were separated to three orders as identified. Four-hundred eighty-five specimens were recovered during the survey which was started in late November and ended in late May. These ectoparasites were identified as the following:

I. Acarina (ticks). Four-hundred fifty-six specimens represented by two genera. Four hundred and fifty specimens were Dermacentor parumapertus var. marginatus (Banks) (Plate III). Of these, 87 were nymphs, and 199 females and 204 male adults. In addition, 6 Amblyomma sp. specimens also were recovered.

II. Siphonaptera (fleas). Twenty four specimens of fleas, identified as two species, 4 Pulex irritans (Linn) (Plate IV) and 20 specimens of Hoplopsyllus glacialis affinis (Baker) (Plate IV).

III. Diptera. Five larvae of flies (bot flies) were identified as Cuterebra spp.

Table 1. Data on collecting date, number of hosts taken, and number of ectoparasites recovered.

Rabbit Number	Date	Sex	Age	Weight: pounds	Weight: ounces	Length: mm	Number of ectoparasites
1	11-24-56	male	juv.	5	9	506	2
2	11-24-56	male	juv.	5	9	534	18
3	11-24-56	female	juv.	5	15	536	4
4	11-24-56	female	adult	6	6	—	—
5	11-24-56	female	adult	6	11	550	9
6	11-24-56	male	adult	6	—	553	5
7	11-24-56	male	juv.	5	8	521	2
8	11-24-56	female	juv.	5	13	511	1
9	11-24-56	female	juv.	5	10	511	2
10	11-24-56	female	juv.	6	—	553	2
11	11-24-56	female	juv.	5	11	559	9
12	11-24-56	female	juv.	6	8	587	1
13	12-21-56	male	juv.	5	3	520	1
14	12-21-56	male	juv.	5	6	516	3
15	12-21-56	male	juv.	5	12	522	3
16	12-21-56	male	juv.	4	0	563	3
17	12-21-56	female	juv.	5	12	541	2
18	12-21-56	female	juv.	5	10	478	11
19	12-21-56	male	juv.	5	8	514	6
20	12-21-56	male	juv.	5	8	510	5
21	12-21-56	female	juv.	5	8	525	5
22	12-21-56	male	juv.	6	3	522	—
23	1-25-57	male	adult	5	13	531	4
24	1-25-57	male	adult	5	12	539	4
25	1-25-57	male	adult	6	9	573	1
26	1-25-57	male	adult	5	7	502	4
27	1-25-57	female	adult	7	—	555	3
28	1-25-57	male	adult	5	6	539	—
29	1-25-57	female	juv.	6	8	571	—
30	1-25-57	male	juv.	5	8	520	—
31	1-25-57	male	adult	5	7	503	4
32	1-25-57	female	juv.	5	—	522	8
33	2-16-57	female	adult	6	11	510	7
34	2-16-57	female	adult	6	3	590	—
35	2-16-57	male	juv.	6	5	554	10
36	2-16-57	male	juv.	6	1	—	2
37	2-16-57	female	juv.	6	2	512	—
38	2-16-57	female	juv.	5	—	555	1
39	3-27-57	male	adult	5	10	551	28
40	3-27-57	female	juv.	6	10	590	3
41	3-27-57	female	juv.	4	7	522	8
42	3-27-57	male	adult	5	10	594	10
43	3-27-57	male	adult	5	6	544	22
44	3-27-57	female	adult	5	7	534	1
45	4-20-57	female	adult	5	7	540	14

Table 1. Concl.

Rabbit Number	Date	Sex	Age*	Weight: pounds	Weight: ounces	Length: mm	Number of ectoparasites
46	4-20-57	male	adult	6	8	523	8
47	4-20-57	female	adult	4	12	514	10
48	4-20-57	female	adult	6	3	514	15
49	4-20-57	female	adult	6	8	545	11
50	4-20-57	male	adult	5	8	508	17
51	4-20-57	male	adult	5	8	531	21
52	4-20-57	female	adult	6	—	543	13
53	4-20-57	male	adult	5	2	500	7
54	4-20-57	female	adult	6	8	526	10
55	4-20-57	male	adult	5	—	496	9
56	4-20-57	male	adult	5	11	554	7
57	5-24-57	male	adult	6	—	525	57
58	5-24-57	male	adult	8	5	598	14
59	5-24-57	female	juv.	2	1	358	13
60	5-24-57	female	adult	7	4	533	9
61	5-24-57	male	adult	5	5	519	14
62	5-24-57	female	adult	5	6	504	7
63	5-24-57	male	adult	5	11	612	8
64	5-24-57	male	adult	6	7	565	15

*Age determination made by Mr. Franklin Bronson, on the basis of size and/or condition of gonads.

Table 2. Data on numbers of ectoparasites recovered from Black-tailed Jackrabbits on the basis of month taken.

Month	No. of rabbits	Rabbits w/ticks	% rabbits w/ticks	Total ticks	Average No. of ticks per rabbit	No. of fleas	No. of cuterebra
November	12	10	83.3	52	4.3	3	—
December	10	8	80.0	24	2.4	15	—
January	10	7	70.0	28	2.8	—	1
February	6	4	66.6	20	2.0	—	1
March	6	5	83.3	69	11.5	3	3
April	12	12	100	139	11.7	3	—
May	8	8	100	124	15.5	—	—
Total	64	54	84.4	456	7.1	24	5

Table 2 presents the data on the numbers and kinds of ectoparasites recovered by the month of collection (Plate II).

DISCUSSION

To survey the ectoparasites of almost any animal, such as the Black-tailed Jackrabbit, presents a number of relatively complex problems. For example, it is difficult to make an accurate survey of the ectoparasites since some of them leave the animal soon after its death.

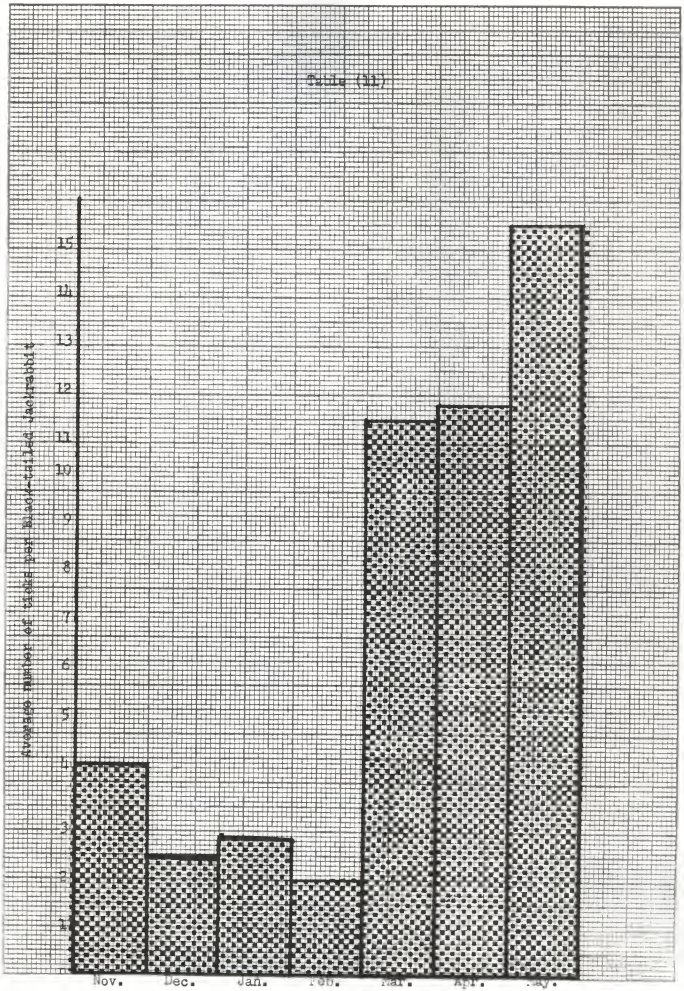
First interest in the ectoparasites of rabbits was expressed about one hundred years ago. Until the latter part of the nineteenth century, ticks were usually thought to be merely annoying parasites of domestic animals and occasionally of man. Theobald Smith and Kilbourne in 1889-1890 as reported by Bequaert (1945), showed ticks play an essential role in transmission of Texas or Southern cattle fever. This was the first occasion of a line of investigations away from that expressed above, and showing the real significance of ticks as ectoparasites. Since 1890 many similar discoveries have followed, concerning tick-borne diseases of man as well as of animals. These arthropods rank now with fleas, lice, and the Diptera causing myiasis which we find on the Black-tailed Jackrabbit, as among the most dangerous foes of mankind. Only a few species of ticks attack man. Three are known to do so to some extent: Dermacentor variabilis; Ixodes gookei; and Amblyomma americana (Bequaert, 1945). Even these are only accidental human parasites.

Ticks transmit the disease organisms by biting, a purely mechanical injury caused by the action of chelicerae and the introduction of the hypostome. The "bite" is usually followed by an inflammatory reaction of skin tissues. Usually ticks inject in the bite a certain amount of saliva containing an anticoagulant which makes for a continued flow of blood into the

EXPLANATION OF PLATE II

Bar graph showing numbers of ticks recovered during certain months.

Table (11)


Average number of cases per month per physician
0
½
1
1½
2
2½
3
3½
4
4½
5
5½
6
6½
7
7½
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11½
12
12½
13
13½
14
14½
15
Nov.
Dec.
Jan.
Feb.
Mar.
Apr.
May.
Months.

EXPLANATION OF PLATE III

Fig. 1. Male *Dermacentor parumapertus* var. *marginatus*.

Fig. 2. Female *D. parumapertus* var. *marginatus*

PLATE III

Fig. 1.

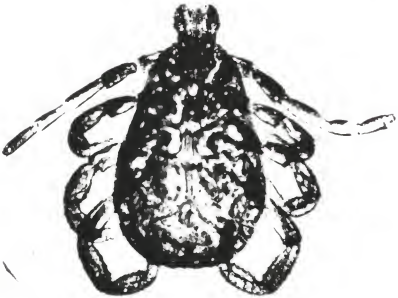

Fig. 2.

EXPLANATION OF PLATE IV

Fig. 1. Human flea, *Pulex irritans*, male

Fig. 2. Human flea, *Pulex irritans*, female.

Fig. 3. Rabbit flea, *Hoplopsyllus glacialis affinis*, female.

Fig. 4. Rabbit flea, *Hoplopsyllus glacialis affinis*, male.

PLATE IV

Fig. 1

Fig. 2

Fig. 3

Fig. 4

hypostome (Ewing 1931). In recent years it has been found that the ticks transmit the organisms of several types of diseases to man. The most important of these are Rocky Mountain spotted fever (Stiles 1905,[1] mentioned in Montana as early as 1872), and tularemia (Parker 1922).[1] These apparently are primarily diseases of wild animals, although man may acquire the infection. Ticks also transmit many other organisms causing diseases, including those of Texas cattle fever (Meanse 1814),[1] (Kilbourne and Theobold 1889),[1] spotted fever (Wilson and Chowning 1902),[1] Colorado tick fever (Parker 1937),[1] and Q fever (Derrick 1939).[1]

Four hundred and fifty six ticks were recovered from 64 specimens of Lepus californicus during this survey. Of these, 450 specimens were Dermacentor parumapertus var. marginatus. Some work has been done concerning the carrying and transmission of diseases from one animal to another. Mayer (1911)[1] in a series of experiments on D. parumapertus var. marginatus found that Rocky Mountain spotted fever organisms can be transmitted from an infected to a normal guinea pig by the adults of this tick. It has been reported that these ticks are infested naturally by the virus of Rocky Mountain spotted fever, which may be transmitted from larvae to adult (Mayer 1911). Parker (1937) has reported the virus of Rocky Mountain spotted fever may transmit continually from larvae to nymph stages and survive in the adult.

The six specimens identified as Amblyomma sp. were taken from four animals. Amblyomma sp. is a vector of Rocky Mountain spotted fever, Bullis fever (Matheson, 1950) and tularemia. Ticks show a decrease in number with the decreasing of the temperature (Fig. 4); the lowest number of ticks were

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[1]These names and dates are reported by Hermes (1956).

recovered during January and February, and the highest number during April and May. Some error is possible here because of the changability of the weather during the survey.

Twenty-four specimens of fleas (Siphonaptera) were recovered during the survey. The fleas are small insects with complete metamorphosis, parasitic in adult stages on warm-blooded vertebrates, without wings or vestgial wings, the body is greatly compressed and frequently one or more "combs" are present on the thorax. The two species that were recovered are assignable to the family Pulicidae; they are represented by four specimens of Pulex irritans (Linnaeus) and 20 specimens of Hoplopsyllus glacialis affinis (Baker).

Pulex irritans (Linn.), called the human flea, was the earliest described member of the order Siphonaptera (1695) and the best known species in the world. It is nearly cosmopolitan in the warmer climates and in the tropical region. It is a specific flea of human beings, but will readily live upon a variety of other animals as a transient parasite. This species is characterized by having no thoracic ctenidia (combs), and the inner side of the hind coxae are supplied distally with a comb of minute teeth.

Fleas are very important in two ways: (1) By their direct attacks on man and his domestic animals they cause irritation and loss of blood; and (2) because of their blood sucking habit, they are important transmitters of certain internal parasites and disease organisms. Fleas transmit the bubonic plague organism; they are the usual transmitters of the cause of the murine form of typhus and of tularemia among rodents. Fleas serve as intermediate hosts for certain tape worms. Among them are Dipylidium caninum of dogs and cats which are occasional in children, Hymenolepis diminuta and H. nana of rats, mice, and man. It has been reported that the life cycle of Hymenolepis diminuta is completed in Pulex irritans and in the adult form

lives in the dog (Juan 1928).

Summers (1943) found that Pulex irritans is infected naturally by Dirofilaria immitis, and is highly susceptible to infection experimentally. The same author found that the larvae of D. immitis developed in the haemocoel cavity of Pulex irritans. It has been found in Madagascar that Pulex irritans plays a minor role in transmitting the plague organism to man. Blanc and Baltzard (1943) reported that Pulex irritans which he collected from a person dying of plague were able to infect guinea pigs. Chabaud (1947) stated that "Pulex irritans plays the principle role in the human cycle in carrying the plague from man to man".

Of the 20 specimens of Hoplopsyllus glacialis affinis, the greatest number recovered from one animal was four specimens. H. glacialis affinis was first described as such by Baker in 1905. The characteristics of this species are the postnotal ctenidium or comb with fourteen to eighteen spines, and the article of the hind tarsi with all the bristles shorter than their succeeding articles. This genus was included under the genus Pulex before 1905. The species is now known as the rabbit flea.

Hoplopsyllus glacialis affinis (Baker) generally infests rabbits and hares and also is common on rodents. It is not important from the medical point of view. The writer found no reports mentioning this flea as a transmitter of disease organisms, but it is reasonable to believe that this flea carries the plague organism from rodents to man and to other animals, because this flea commonly infests the rodents and rodents which are the reservoir of the plague. There is, however, no definite proof. The fleas reported were very few in number, related to the three or four drought years in that area, which prevented development of the larval stages since this stage needs some moisture to develop.

The third group of Arthropoda found during the survey was that of the rabbit warbles of the genus Cuterebra of Clark. It is the larva of an adult muscoid Diptera. Cuterebra, strictly American in distribution, parasitizes rodents and lagomorphs. Five larval specimens were recovered from three Black-tailed Jackrabbits during the survey. These larvae cause myiasis on the infested mammals.

Cuterebra specimens are found widely distributed over the United States. It has been reported from Lepus californicus texianus from Texas (Roberts 1932). The same author in 1931 reported several full grown larvae of Sarcophaga and one Brachymeria from common Texas Jackrabbits.

Vorhies and Taylor (1933) reported that warbles, Cuterebra princeps and C. americana, are common in the jackrabbits of Arizona.

Scharts (1928) reported the varble Cuterebra cuniculs from rabbits in different counties in the United States. Also Cuterebra specimens were reported from Black-tailed Jackrabbits in Nevada (Philip et al 1955).

SUMMARY

A study of the ectoparasites of 64 Black-tailed Jackrabbits (Lepus californicus) was made during November 1956 to May 1957. The jackrabbits were collected from western Kansas largely from Kearny County by shotgun.

The use of the pyrethrins in ethylene tetrachloride method of fumigation was found to be the best for recovering the ectoparasites.

A review of the literature revealed that ticks transmitted the causative organisms of Rocky Mountain spotted fever, tularemia, Q fever, Texas cattle fever and Colorado tick fever. The bubonic plague, murine typhus and certain types of helminths, such as Dirylidum caninum, Hymenolepis diminuta, H. nana, and Dirofilaria immitis are transmitted by fleas. These organisms are harmful to man and to his domestic animals.

Five different genera of ectoparasites were found: *Amblyomma* sp. and *Dermacentor parumapertus* var. *marginatus* belonging to order Acarina, *Pulex irritans* and *Hoplopsyllus glacialis affinis* of the order Siphonaptera and *Cuterebra* of the order Diptera.

Ninety per cent of the Black-tailed Jackrabbits were found to be infested with ectoparasites. The incidence of the different ectoparasites was as follows: *Amblyomma* sp. six per cent; *D. parumapertus* var. *marginatus* 84 per cent; *Pulex irritans* five per cent; *Hoplopsyllus glacialis affinis* 20 per cent; and *Cuterebra* five per cent.

The number of species of ectoparasites in each infested jackrabbit ranged from one to three. Among the infestations that by the rabbit tick *D. parumapertus* var. *marginatus* was the heaviest.

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by

BANDER MOHAMMED EL-RAWI

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1957

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