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A Study of the Seasonal Incidence of the Arthropod & Helminth Parasites of the Prairie Vole, Microtus Ochrogaster, & the Wood Mouse, Peromyscus Leucopus, in an Area of Warren County, Kentucky

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ABSTRACT

One-hundred and fifty Microtus ochrogaster and one-hundred and fifty-five Peromyscus leucopus were examined for arthropod and helminth parasites during a study from November, 1970 through November, 1971. The mean monthly burdens, per host, of each species of parasite and observations on the seasonal incidence of each species are reported.

Nineteen species of arthropod parasites were found; these include eight species of mites, two of chiggers, one of ticks, two of lice, five of fleas, and one of bots. Most of these species exhibited very little host specificity, although there was a definite host preference. Heavier ectoparasite burdens were found on M. ochrogaster than P. leucopus. The majority of the ectoparasites of M. ochrogaster were mites, with the predominate species being Dermacarus hypudaei and Listrophorus leukorti. Chiggers comprised the largest portion of the ectoparasite burden of P. leucopus. The species found were Euschoengastia peromysci and Neotrombicula caviola.

Three species of cestodes and three species of nematodes were found in M. ochrogaster. The most common helminth parasites were the cestode species Paranoplocephala variabilis and Aprostatandrya macrocephala.

Four species of nematodes were found in P. leucopus. The most common species was Syphacia peromysci. Immature Thelazia sp. were found under the eyelids of six P. leucopus. This nematode has not been previously reported for the genus Peromyscus.

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INTRODUCTION

Species of cricetid rodents belonging to the genera Microtus and Peromyscus are widespread throughout the United States. In southcentral Kentucky, the prairie vole, Microtus ochrogaster (Wagner), and the wood mouse, Peromyscus leucopus (Rafinesque), are the most abundant cricetid rodents. Helminth and arthropod parasites of these two species of rodents have been studied only sporadically, even though the hosts are abundant.

Most of the previous studies of the parasites of M. ochrogaster and P. leucopus have been compilations of lists of parasite species, especially arthropod ectoparasites. Whitaker (1968) has brought together an extensive listing of both arthropod and helminth parasites and a literature review for the genus Peromyscus. Hall and Sonnenberg (1955) have provided a list of the helminths of P. leucopus from the Fort Knox area of Kentucky. There is no single summary source for parasites of M. ochrogaster. The most comprehensive study of the helminths of species of Microtus has been conducted by Rausch and Tiner (1949). These authors provide a species list and information on the seasonal incidence of these species of parasites. Information concerning the arthropod parasites of the prairie vole is available from scat-

tered sources, the principle ones being Jameson (1947), Verts (1961), and Whitaker and Wilson (1968). Batson (1965) lists some of the arthropod parasites of M. ochrogaster in central Kentucky.

The prairie vole occurs in the north central part of the Mississippi Valley. It inhabits open grassy areas where it constructs a network of paths through the grass. Succulent plants serve as the main food item for voles with seeds and small woody plant material occasionally being eaten. The prairie vole is not strictly nocturnal, but often moves about during the day. Voles are very prolific, and it is thought that they breed throughout the year (Caras, 1967; Jameson, 1947).

The wood mouse is widespread in distribution throughout the United States. This strictly nocturnal mouse prefers woody areas with vine-entangled underbrush. Wood mice eat a variety of foods, primarily insects and seeds. Breeding activity reportedly takes place in spring, summer, and fall (Caras, 1967).

The primary objectives of this study were to obtain a species list of the helminth and arthropod parasites of the prairie vole, M. ochrogaster, and the wood mouse, P. leucopus, in an area of abandoned fields and woodlots and to determine if the numbers of these parasites on or in the two host species vary with the season.

METHODS AND MATERIALS

The study area was located in Warren County, Kentucky, approximately 0.5 mile south of Bowling Green, east of U. S. Highway 31W. The trapping area comprised about 300 acres of abandoned pastures and woodlots south of the Lost River Road and in the vertex of an angle formed by the junction of that road with Highway 31W. The study area was large enough to allow variance of trapping sites to prevent overtrapping. The terrain was gently rolling with numerous sinkholes and caves. There was little surface water.

Ten animals of each species were trapped and autopsied each month for one year. Within the study area, traps were set at those sites most likely to yield high ratios of catches per number of traps. They were set in runs in deep grass of abandoned pastures to trap voles. These areas provided good cover and abundant food. Wood mice were trapped in a variety of habitats, but seldom in open fields. They were most frequently caught in fencerows overgrown with vines and bordering woodlots. These mice were occasionally taken from trash heaps and on ledges at the entrance of a cave.

The two types of traps used during the study were Museum Special snap traps and Hav-a-heart live traps. The former was used throughout the study, while the latter was used dur-

ing the months of October and November of 1971 to compare the ectoparasite burden of animals live-trapped versus those caught in snap traps. Traps were baited with a mixture of peanut butter and oatmeal. During the warm months of June through September, 2,2-bis-(parachlorophenyl)-1,1,1-trichloroethane (DDT) was added to the bait at a ratio of 6 grams of 50% DDT per 100 grams of bait after the method of Coleman (1950). This treatment successfully prevented the loss of bait to ants. Traps were set in the evening and checked for animals the following morning. Traps were usually left in the same places for two to four nights. This often resulted in more animals being caught on the second or third night of the set. In the field, each animal was placed in a separate plastic bag to prevent the loss of ectoparasites. Those that had been trapped alive were first killed by cervical dislocation and then immediately placed in the plastic bags. If the animals were not to be examined on the day of collection, the bags containing the animals were placed in a freezer and the animals kept frozen until they could be examined.

In the laboratory, the individual rodents were identified as to species, and the sex, weight, and standard length measurements determined.

Ectoparasites were removed from each animal by washing the animal in detergent and filtering the wash through coarse filter paper. The plastic collecting bag of each animal was rinsed with water and the rinse filtered with the wash of the animal from that bag, in order to collect any ectoparasites

that had dropped from the animal while in the bag. Each animal was checked for attached forms under a 7-25 power dissecting microscope. Ectoparasites were removed from the filter paper and preserved in 70% ethanol (ETOH). For purposes of identification, slides were made of a representative sample of each of the various forms. Specimens were mounted in Polyvinyl alcohol-lactophenol (PVA-LP, App. I). Ectoparasites were identified to species and the number of individuals per species, excluding chiggers, was recorded. Counts for each species of chigger were not made, but rather the specimens were counted collectively as chiggers. The difference between the species of chiggers was so minute as to make specific determination for all specimens impractical. A sample collection of the ectoparasites from each animal was preserved in 70% ETOH.

To check for endoparasitic helminths, the animals were eviscerated and the internal organs placed in individual petri dishes containing 0.9% NaCl solution. The organs were then dissected under a dissecting microscope and the helminths removed. Cestodes were relaxed overnight in the refrigerator (6°C) in tap water and then fixed in Alcohol-formalin-acetic acid (AFA) heated to a temperature of 70°C. For identification, cestodes were stained with Harris' haematoxylin and permanent mounts made following the procedure outlined by Meyer and Olsen (1971). Nematodes were placed directly in AFA, heated to 70°C, for fixation. The specimens were later transferred to 70% ETOH for preservation. For identification

of nematodes, temporary mounts were made with lactophenol clearing agent.

Helminths were initially identified by Dr. Larry N. Gleason, using the keys of Wardle and McLeod (1952) and Yamaguti (1959, 1961). The work of Rausch (1952) aided in specific determinations of cestodes. The works of Kruidenier et al. (1961) and Tiner (1948) were useful in specific determination of nematodes belonging to the genus Syphacia.

Arthropods were initially identified by Dr. Nixon Wilson at the University of Northern Iowa and Dr. William J. Wrenn at the University of North Dakota.

Average parasite burdens of male and female rodents for the entire study period were tested with the chi square test. Results, where significant, are reported. The t-test was used to analyze the ectoparasite burden of animals caught in snap traps versus those trapped alive. All statistical procedures follow those outlined by Steel and Torrie (1960).

RESULTS

During the thirteen month period of study, 305 rodents were examined for arthropod and helminth parasites (Table I). One-hundred and fifty prairie voles were examined, ranging from nine to seventeen per month. Of this total, 77 were males and 73 were females. One-hundred and fifty-five wood mice were examined, from ten to fourteen per month. Of this total, 77 were males and 78 were females.

There was no significant difference between the total average ectoparasite burden of animals trapped in snap traps and those trapped alive, as determined by the t-test.

Microtus ochrogaster

Phylum Arthropoda

Class Arachnida

Order Parasitiformes

Suborder Mesostigmata

Ornithonyssus bacoti (Hirst) was found to be most abundant during July, August, and September (Fig. 1, App. II). A high mean burden of 120(0-516) occurred in July. This mite was rare from November, 1970 through April, 1971 and again in

Table I. The number of Microtus ochrogaster and Peromyscus leucopus examined for arthropod and helminth parasites during each month of a study from November, 1970 through November, 1971.

	Microtus ochrogaster			Peromyscus leucopus		
	males	females	totals	males	females	totals
Nov	7	10	17	8	5	13
Dec	2	9	11	4	8	12
Jan	6	5	11	7	10	17
Feb	5	5	10	8	5	13
Mar	4	8	12	5	5	10
Apr	5	7	12	5	5	10
May	5	5	10	8	5	13
Jun	9	1	10	5	7	12
Jul	7	5	12	6	9	15
Aug	7	3	10	3	7	10
Sep	6	4	10	4	6	10
Oct	5	4	9	8	2	10
Nov	9	7	16	6	4	10
totals	77	73	150	77	78	155

November, 1971. Specimens were not taken in January or February of 1971.

No significant difference was found between the average number of O. bacoti on male and female voles for the entire study period. There was, however, a noticeable difference in the monthly mean burdens of males and females (Fig. 2). The peak monthly burden for females occurred two months earlier than for males. The high mean for females was 214(11-516) in July, whereas the high for males was 90(8-257) in September.

Androlaelaps fahrenholzi (Berlese) occurred in low numbers throughout the study (Fig. 1, App. II). A high monthly mean burden of 10(0-31) occurred in August. This mite did not occur regularly during the months of November, 1970 through February, 1971. The mean burdens did not exceed one during December, 1970; January; or February, 1971.

No significant difference between the average burden of this mite on male and female voles was found. There appeared to be a monthly difference in the mean burdens of male and female voles (Fig. 3). Males showed a high mean burden of 15(1-50) in April. The peak burden of females was 13 in June and 11(0-19) in August. Only one female was collected in June.

Laelaps microti (Ewing) was found throughout the study (Fig. 1, App. II). The mean burden, 18(0-119), occurred in March with low mean burdens of 0.6(0-3) and 1(0-4) in July and

Figure 1. Mean monthly burdens of mites belonging to the suborder Mesostigmata found on Microtus ochrogaster from November, 1970 through November, 1971.

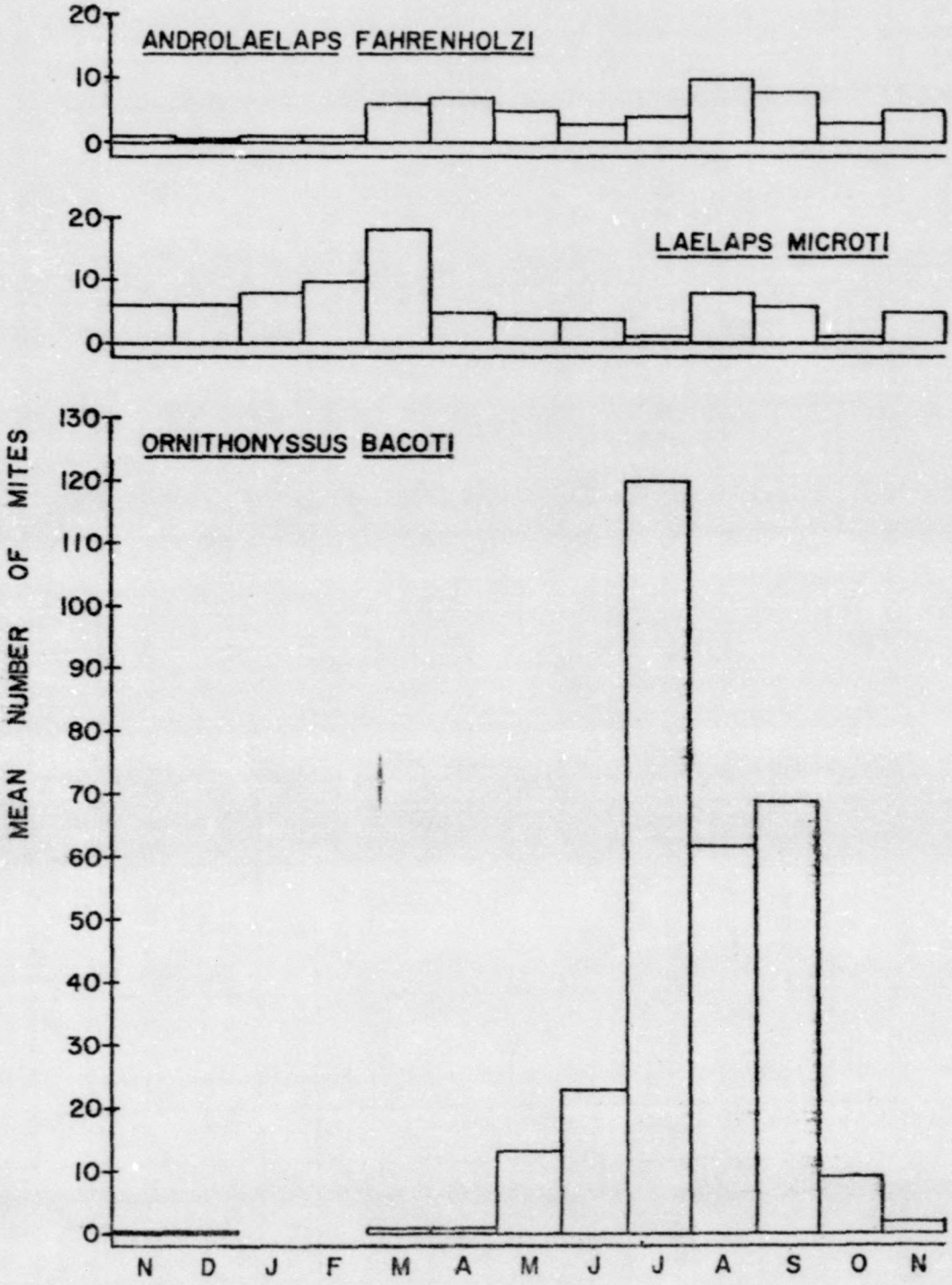

ANDROLAELAPS FAHRENHOLZI
20
10
0
LAELAPS MICROTI
20
10
0
ORNITHONYSSUS BACOTI
MEAN NUMBER OF MITES
130
120
110
100
90
80
70
60
50
40
30
20
10
0
N
D
J
F
M
A
M
J
J
A
S
O
N

Figure 2. Mean monthly burdens of Ornithonyssus bacoti found on male and female Microtus ochrogaster from November, 1970 through November, 1971.

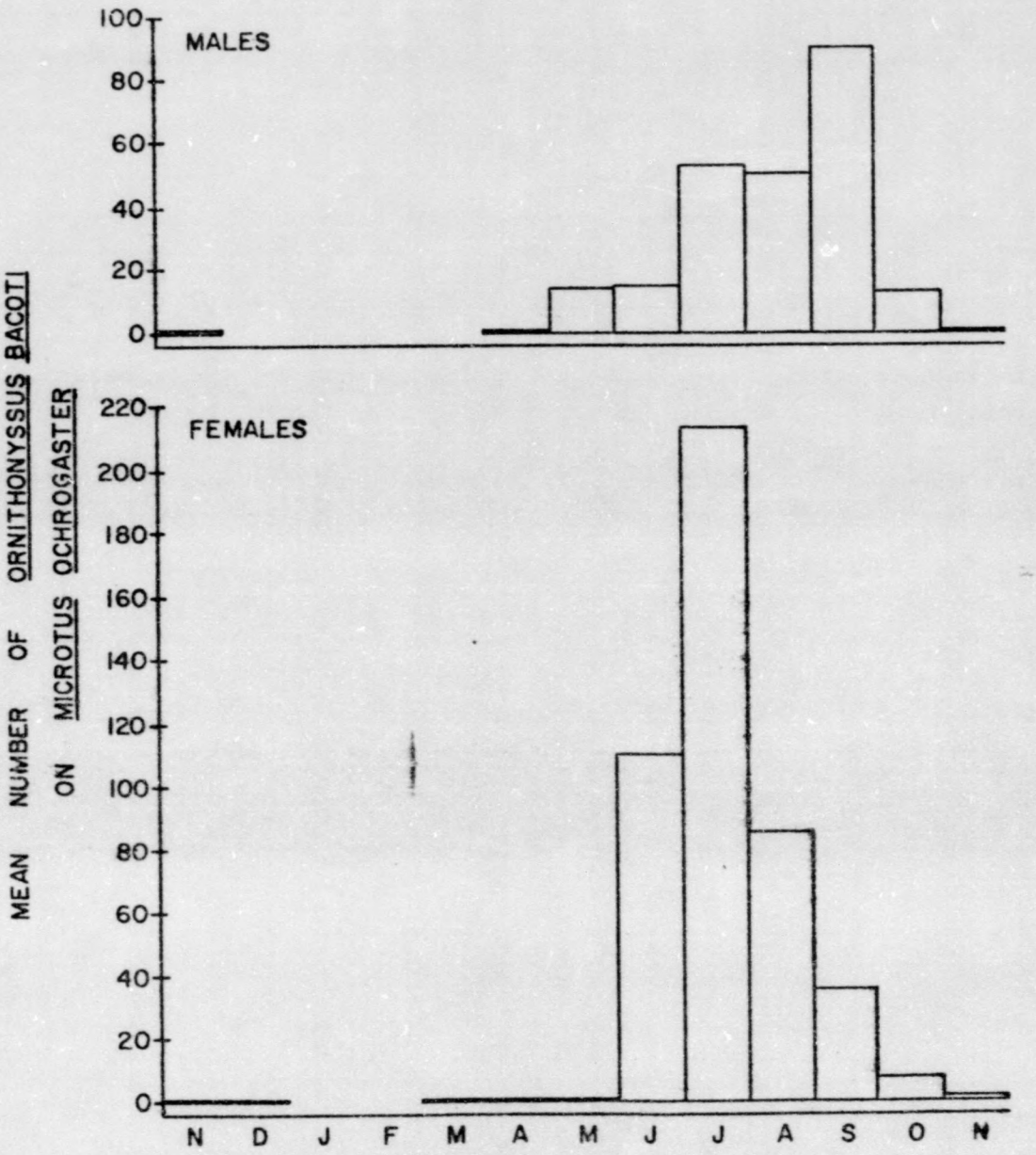
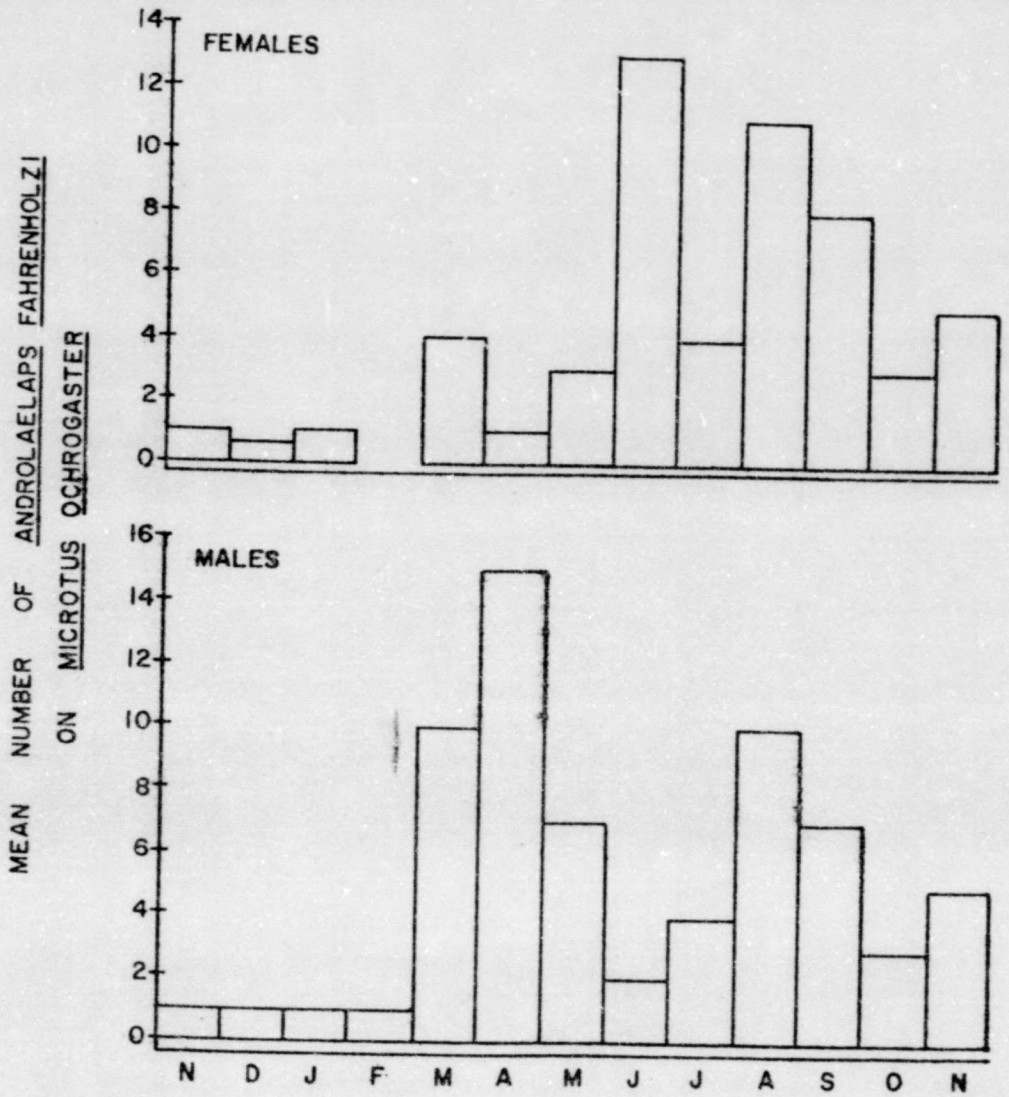

MEAN NUMBER OF ORNITHONYSSUS BACOTI ON MICROTUS OCHROGASTER
MALES
100
80
60
40
20
0
FEMALES
220
200
180
160
140
120
100
80
60
40
20
0
N D J F M A M J J A S O N

Figure 3. Mean monthly burdens of Androlaelaps fahrenholzi found on male and female Microtus ochrogaster from November, 1970 through November, 1971.


MEAN NUMBER OF ANDROLAELAPS FAHRENHOLZI ON MICROTUS OCHROGASTER
FEMALES
MALES
0
2
4
6
8
10
12
14
16
N
D
J
F
M
A
M
J
J
A
S
O
N

October.

Suborder Metastigmata

Dermacentor variabilis (Say) was not a common parasite. The monthly mean burdens never exceeded one (Fig. 4, App. III). A high mean burden of 0.8(0-9) occurred in March. This tick was not found during January, February, or April.

Order Acariformes

Suborder Prostigmata

Radfordia lemnina (Koch) was rare. A total of eight was found during the entire study period: one each in the months of November, 1970 and 1971, and two and four in June and September, 1971, respectively.

Trombiculidae - A minimum of two species of chiggers was found: Euschoengastia peromysci (Ewing) and Neotrombicula caviola (Ewing). Chiggers were common during the months of December, 1970, and January, March, April, and November of 1971 (Fig. 5, App. IV). The highest mean burden was 38(4-102), occurring in April. These mites were rare from May through October. The mean burdens for these months did not exceed one. No specimens were taken during May or October.

Chiggers were commonly found in the ears and in stylosomes on the belly and legs of the host. The location of chiggers on other parts of the body could not be determined

Figure 4. Mean monthly burdens of Dermacentor variabilis found on Microtus ochrogaster from November, 1970 through November, 1971.

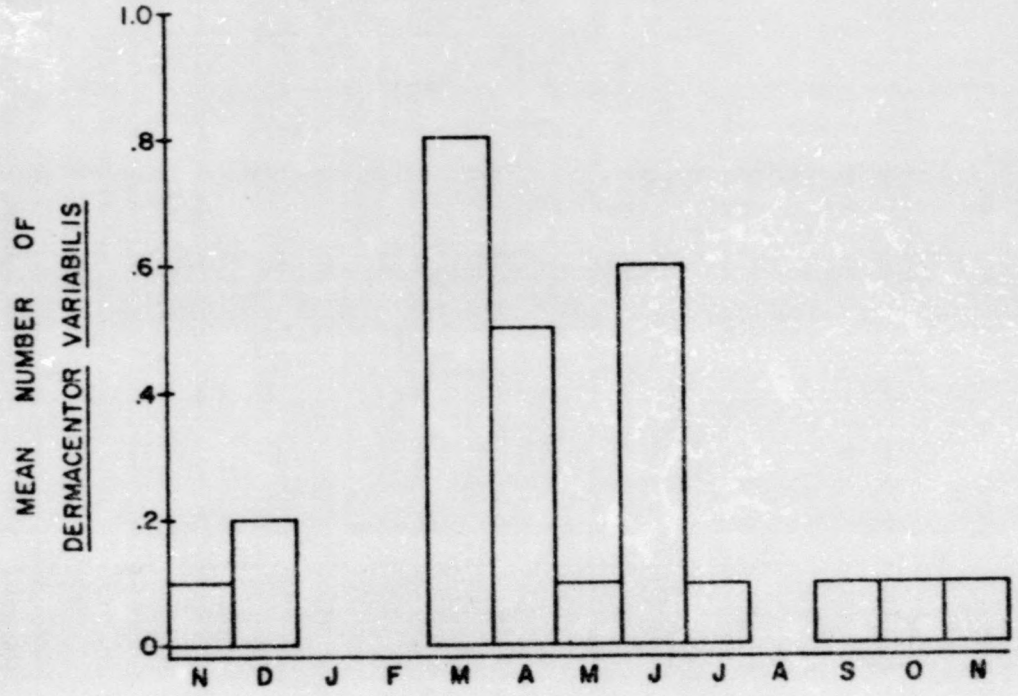
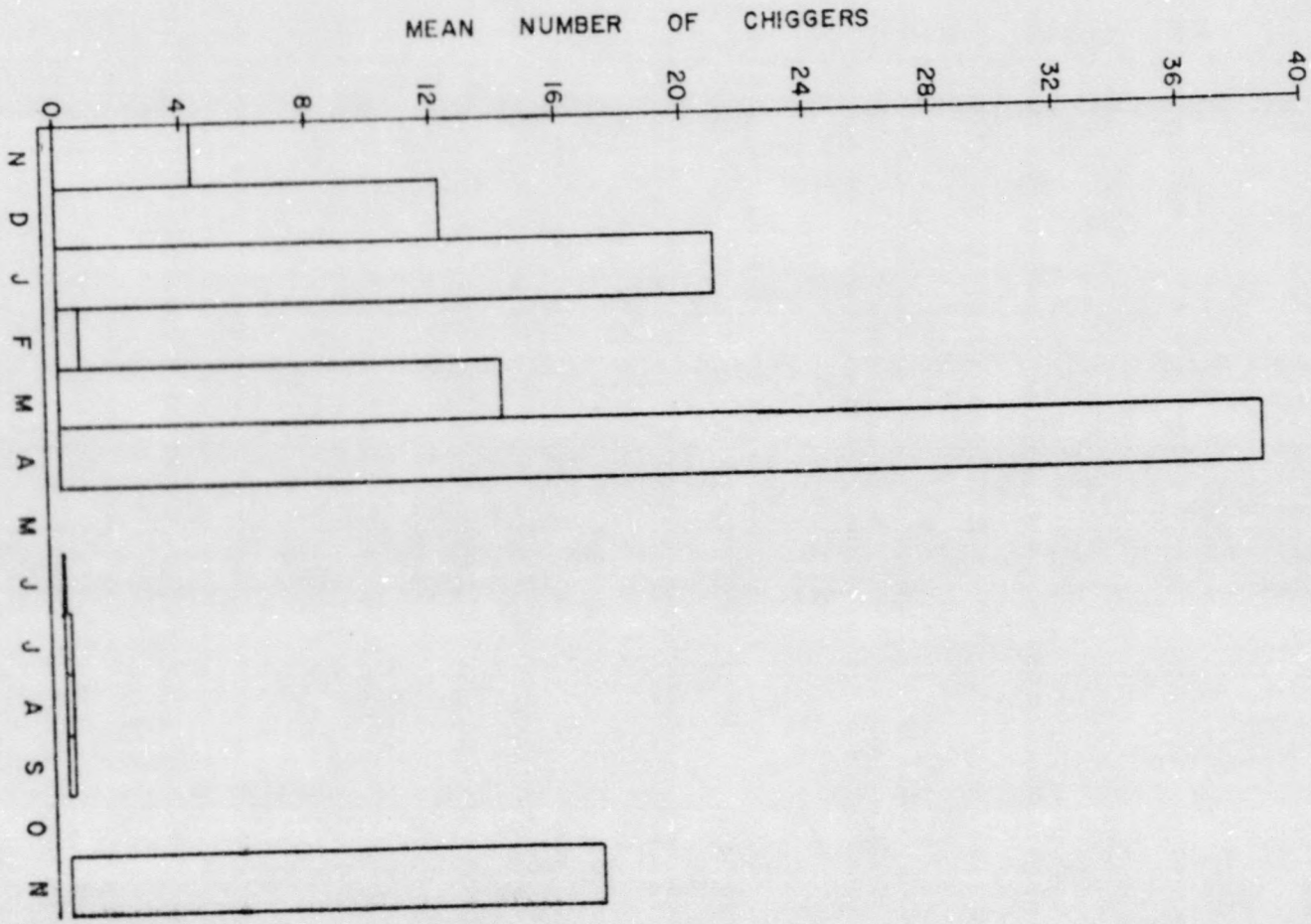

MEAN NUMBER OF
DERMACENTOR VARIABILIS
1.0
.8
.6
.4
.2
0
N
D
J
F
M
A
M
J
J
A
S
O
N

Figure 5. Mean monthly burdens of chiggers found on Microtus ochrogaster from November, 1970 through November, 1971.


MEAN NUMBER OF CHIGGERS
0
4
8
12
16
20
24
28
32
36
40
N
D
J
F
M
A
M
J
J
A
S
O
N

because of the collecting technique.

Suborder Astigmata

Dermacarus hypudaei (Koch) was one of the most common and numerous ectoparasites found. All specimens found were of the hypopial stage. This mite was present during all months (Fig. 6, App. V). A peak burden of 515(0-1621) occurred in March, 1971. The low burden was 25(0-250) in November, 1970.

Listrophorus leukorti Pagenstrecher was the most numerous ectoparasite found (Fig. 6, App. V). One vole, examined in November, 1970, had a burden of 2,169 L. leukorti. This mite was present in the greatest numbers during the months of November and December of 1970 and from August through November of 1971. The mean burden for each of these months exceeded 250, reaching 698(6-1515) in October. The mean monthly burden did not exceed 110 from January through July, with a low of 0.4(0-1) occurring in May.

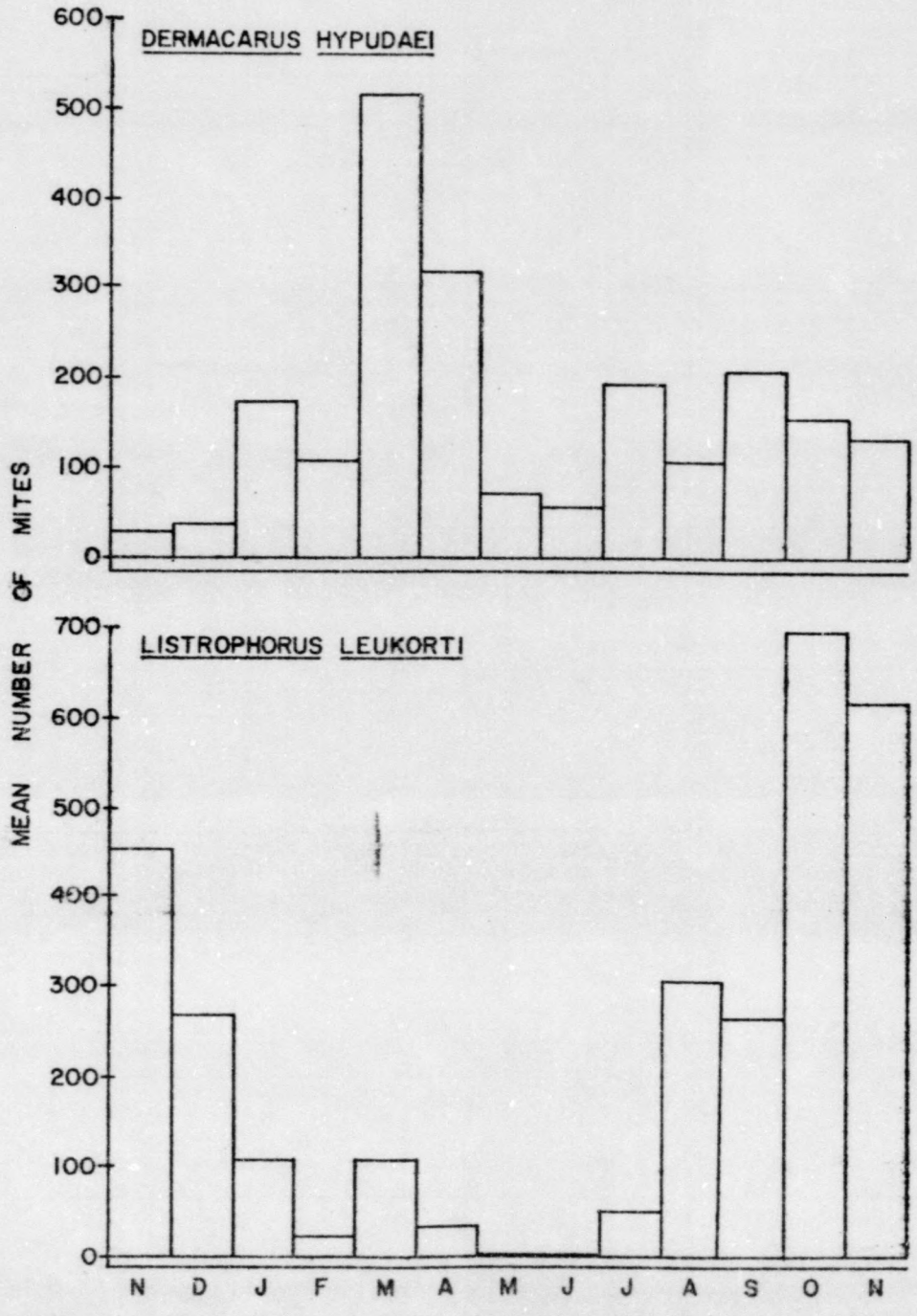
Mycoptes sp. occurred infrequently and in small numbers (App. V). The highest mean monthly burden was 4(0-27), occurring in April.

Class Insecta

Order Anoplura

Hoplopleura acanthopus (Burmeister) was almost exclusively

Figure 6. Mean monthly burdens of Dermacarus hypudaei and Listrophorus leukorti found on Microtus ochrogaster from November, 1970 through November, 1971.


DERMACARUS HYPUDAEI
600
500
400
300
200
100
0
LISTROPHORUS LEUKORTI
700
600
500
400
300
200
100
0
MEAN NUMBER OF MITES
N
D
J
F
M
A
M
J
J
A
S
O
N

found during the months of February through May, with a peak burden of 15(2-72) occurring in April (Fig. 7, App. VI). During the remaining months no lice were found except in November of 1970 and 1971, when mean burdens were 0.6(0-21) and 0.8(0-7), respectively.

Order Siphonaptera

A total of five species of fleas was found: Epitedia wenmanni (Rothschild), Orchopeas leucopus (Baker), Peromyscopsylla scotti I. Fox, Stenoponia americana (Baker), and Ctenophthalmus pseudagyrtes Baker. The first four occurred infrequently. The last was the most common, occurring regularly from July through November of 1971 (Fig. 8). The mean monthly burdens for each of the species of fleas are as follows:

E. wenmanni - November, 1970 $\bar{x}$ = 0.1(0-1).

O. leucopus - February, 1971 $\bar{x}$ = 0.1(0-1).

P. scotti - June $\bar{x}$ = 0.1(0-1); November, 1971 $\bar{x}$ = 0.1(0-1).

S. americana - November $\bar{x}$ = 0.1(0-1); December, 1970 $\bar{x}$ = 0.1 (0-1); March $\bar{x}$ = 1.0(0-7); November, 1971 $\bar{x}$ = 0.3(0-4).

C. pseudagyrtes - November, 1970 $\bar{x}$ = 0.1(0-1); April $\bar{x}$ = 0.9 (0-3); July $\bar{x}$ = 0.1(0-1); August $\bar{x}$ = 0.7(0-3); September $\bar{x}$ = 0.4(0-2); October $\bar{x}$ = 1.0(0-4); November, 1971 $\bar{x}$ = 1.0(0-3).

Figure 7. Mean monthly burdens of Hoplopleura acanthopus found on Microtus ochrogaster from November, 1970 through November, 1971.

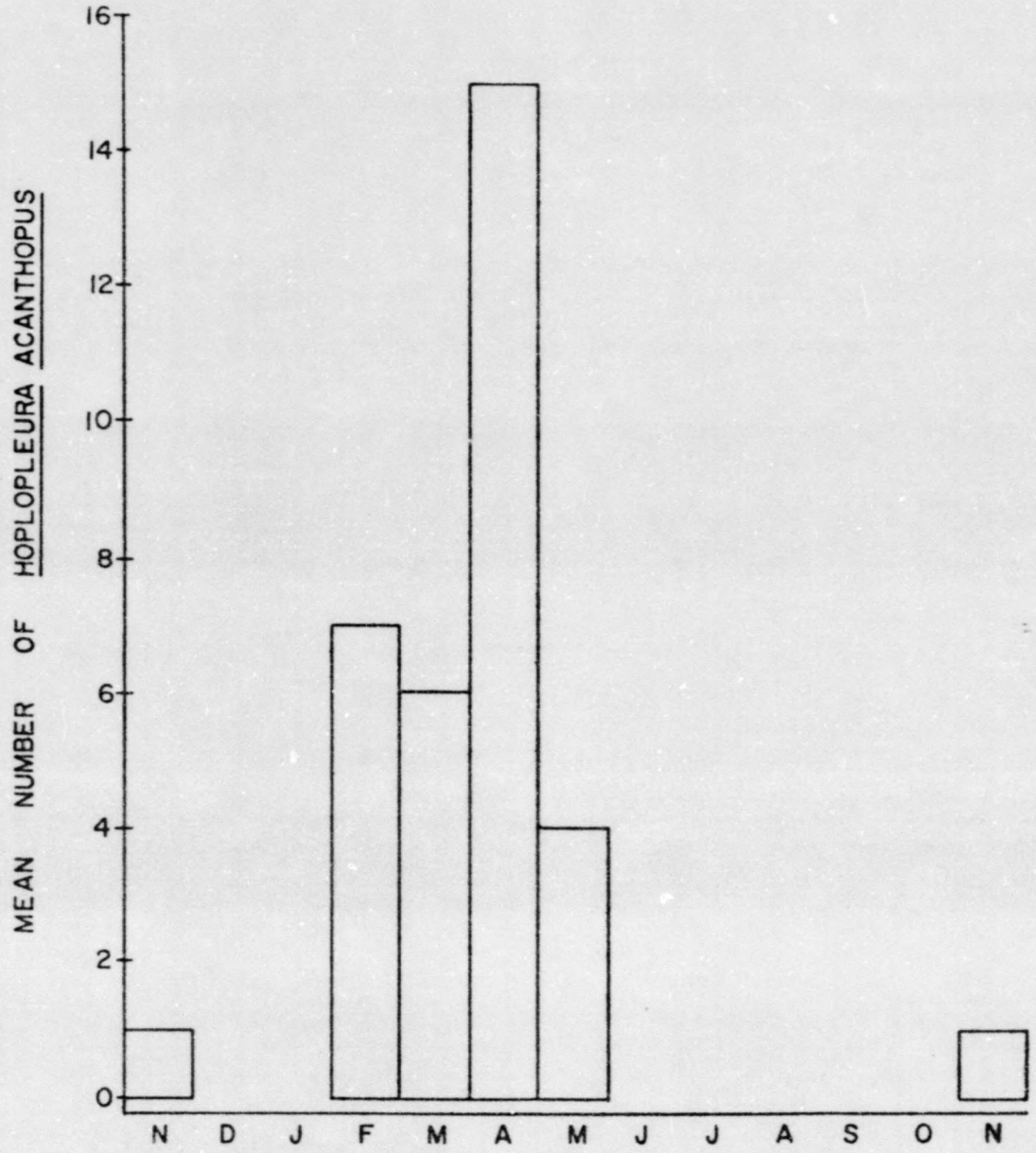
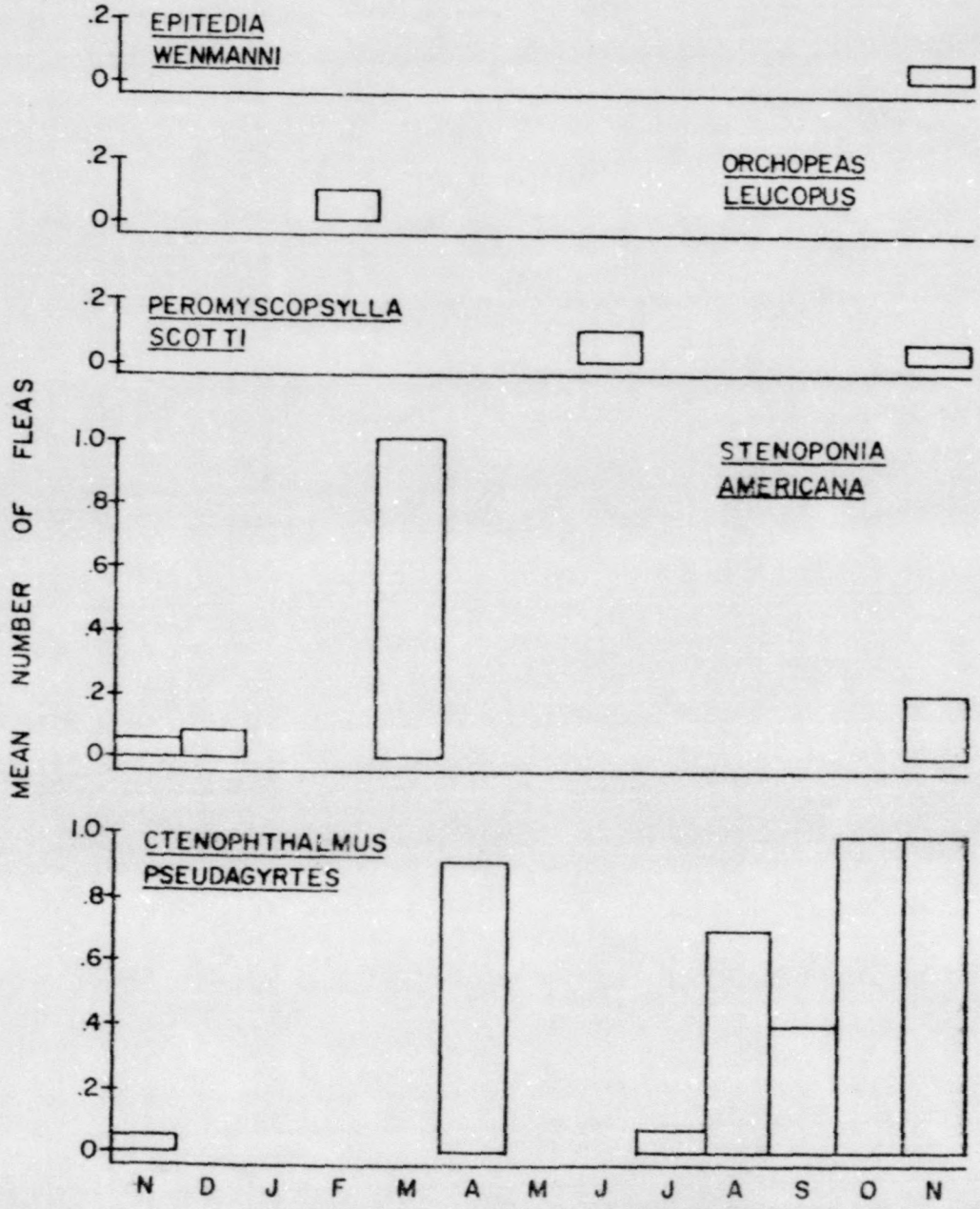

MEAN NUMBER OF HOPLOPLEURA ACANTHOPUS
16
14
12
10
8
6
4
2
0
N
D
J
F
M
A
M
J
J
A
S
O
N

Figure 8. Mean monthly burdens of fleas found on Microtus ochrogaster from November, 1970 through November, 1971.


EPITEDIA WENMANNI
ORCHOPEAS LEUCOPUS
PEROMYSCOPSYLLA SCOTTI
STENOPONIA AMERICANA
CTENOPHTHALMUS PSEUDAGYRTES
MEAN NUMBER OF FLEAS
.2
0
1.0
.8
.6
.4
N D J F M A M J J A S O N

Phylum Platyhelminthes

Class Cestoda

Family Anoplocephaladae

Aprostatandrya macrocephala (Douthitt, 1915) Spasky, 1951 was present throughout the study period (Fig. 9, App. VII). The mean monthly burdens ranged from 0.64(0-2) in January to 0.06(0-1) in November of 1971.

No significant difference was found in the total average burden of male and female voles. When the mean monthly burdens of males and females were graphically illustrated, a monthly difference was discernible (Fig. 10). The monthly burden of males was greater than 0.50 during January, February, March, and May with a peak of 0.83(0-2) during January. The mean burdens were less than 0.50 during November, 1970; June; and October, 1971. No A. macrocephala were found during the remaining six months. The monthly burden of females was greater than 0.50 only during April and August when it reached 0.75(0-4) and 0.67(0-2), respectively. During the remaining months, the burdens were less than 0.50, with none found in February, May, or June.

This species was rarely found attached anterior to the mid-point of the small intestine. Mature worms were very long, extending almost to the iliocecal junction. Often, proglottids near the posterior end of the worms were found to be without eggs.

Figure 9. Mean monthly burdens of Anoplocephalid cestodes found in Microtus ochrogaster from November, 1970 through November, 1971.

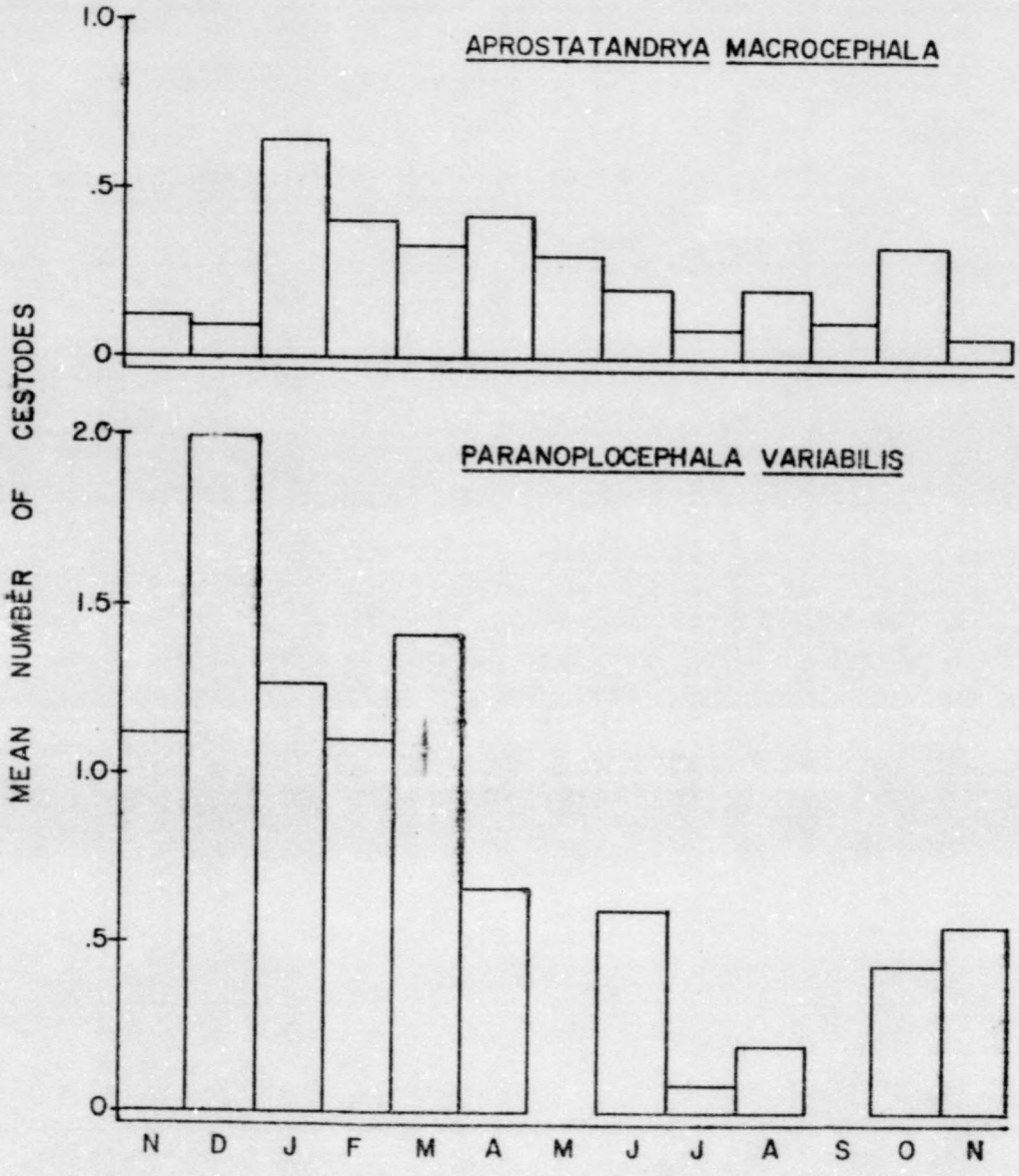
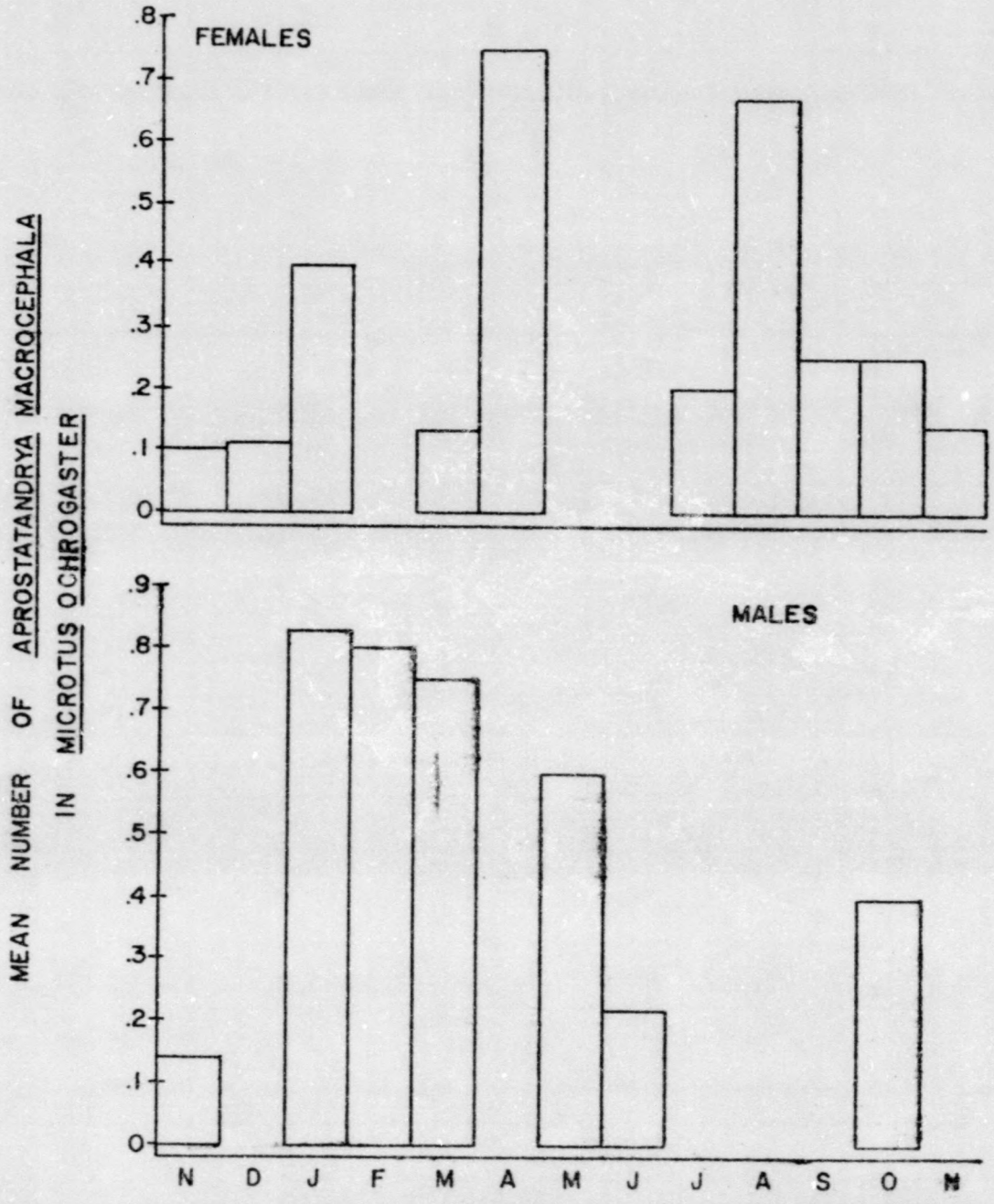

APROSTATANDRYA MACROCEPHALA
1.0
.5
0
PARANOPLOCEPHALA VARIABILIS
2.0
1.5
1.0
.5
0
MEAN NUMBER OF CESTODES
N D J F M A M J J A S O N

Figure 10. Mean monthly burdens of Aprostatandrya macrocephala found in male and female Microtus ochrogaster from November, 1970 through November, 1971.


MEAN NUMBER OF APROSTATANDRYA MACROCEPHALA IN MICROTUS OCHROGASTER
FEMALES
.8
.7
.6
.5
.4
.3
.2
.1
0
MALES
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
N
D
J
F
M
A
M
J
J
A
S
O
N

Paranoplocephala variabilis (Douthitt, 1915) was commonly found during the months of November, 1970 through March, 1971 (Fig. 9, App. VII). The mean monthly burden for each of these months was greater than one, with a high of 2.00(0-4) occurring in December, 1970. This cestode was infrequently taken from April through November, 1971. The mean burden for each of these months never exceeded 0.70. No worms were found during May or September.

This cestode was found exclusively in the anterior one-third of the small intestine. The attachment point was usually just below the stomach.

Family Taeniidae

Taenia taeniaeformes (Batsch, 1786), found as a strobilocercus larva, was occasionally taken from the liver. A total of six was found, one per month, during the months of November; December, 1970; March; April; August; and October, 1971.

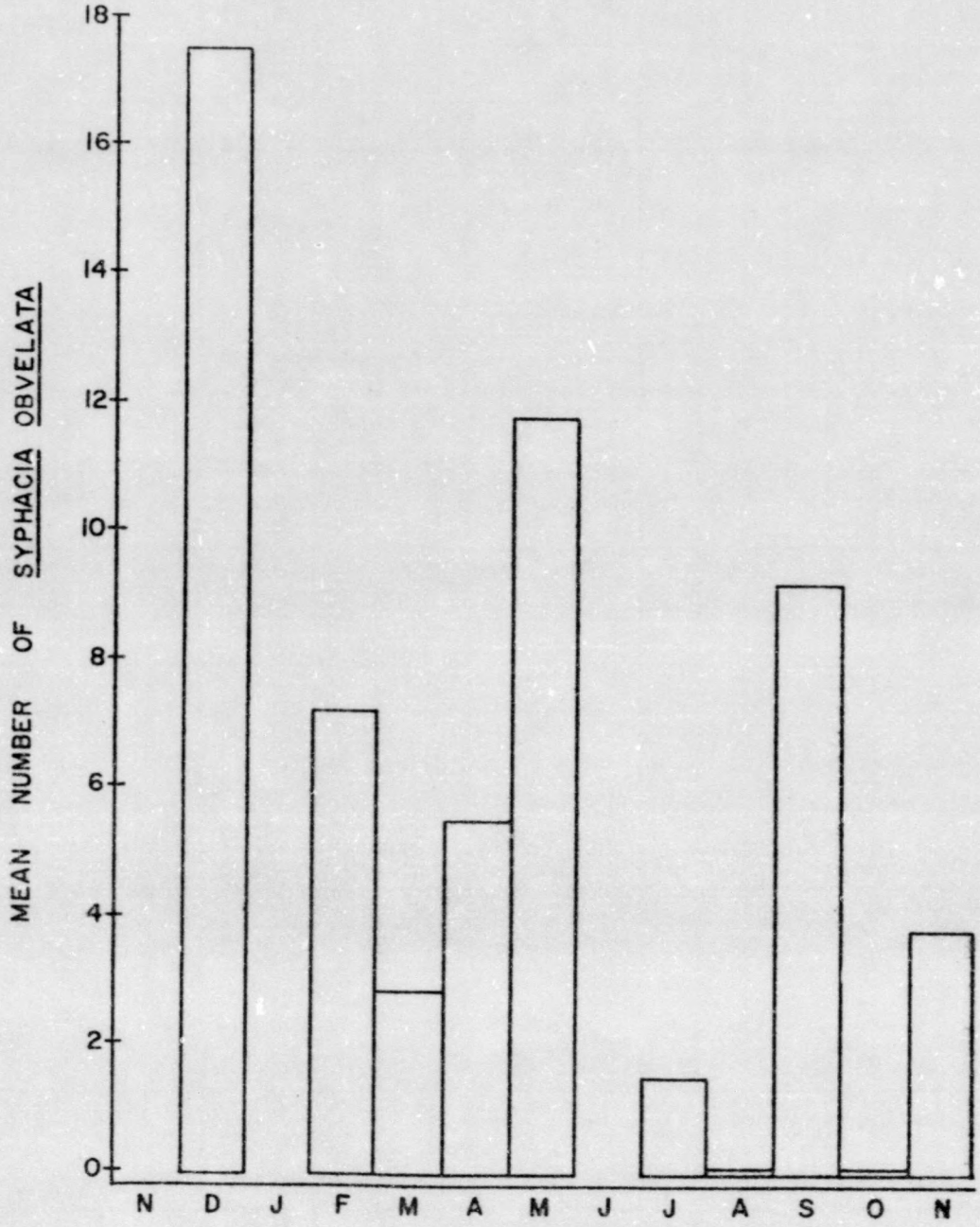
Phylum Aschelminthes

Class Nematoda

Family Oxyuridae

Syphacia obvelata (Rud., 1802) occurred infrequently (Fig. 11, App. VIII). The peak mean monthly burden was 17.5(0-194) in December, 1970. No worms were found in November, 1970; January; and June, 1971.

Figure 11. Mean monthly burdens of Syphacia obvelata found in Microtus ochrogaster from November, 1970 through November, 1971.


MEAN NUMBER OF SYPHACIA OBVELATA
18
16
14
12
10
8
6
4
2
0
N
D
J
F
M
A
M
J
J
A
S
O
N

Family Physalopteridae

One small specimen of Physaloptera sp. was found in the stomach of a male vole caught in November, 1970.

Family Trichostrongylidae

Longistriatus sp. occurred infrequently. The mean monthly burdens were: 5.2(0-41) in November and 9.8(0-64) in December of 1970 and 0.1(0-2) in March, 19.1(0-161) in October, and 0.8(0-6) in November of 1971.

Peromyscus leucopus

Phylum Arthropoda

Class Arachnida

Order Parasitiformes

Suborder Mesostigmata

Three species of mites belonging to this suborder were taken. These mites occurred in very low numbers (Fig. 12, App. IX).

Ornithonyssus bacoti occurred at a peak burden of 6(0-53) in May and 4(0-12) in July. During the remaining months the mean burden never exceeded one. This mite was not found in March, April, or October.

Androlaelaps fahrenholzi occurred during all months. The mean monthly burdens were very low, equaling or exceeding one only during December, 1970; April; May; and October, 1971. The highest mean burden was 2(0-17) in December, 1970.

Laelaps microti occurred irregularly. The highest mean burdens were 2(0-19) in March, 1(0-11) in May, and 1(0-9) in June. During the remaining months the mean burdens were less than 0.5. This mite was not found in December, 1970; January; July; or August, 1971.

Suborder Metastigmata

Dermacentor variabilis was found at an average burden of greater than 1.5 during March, April, and May (Fig. 13, App. X). A peak burden of 2(0-10) occurred in May. During the remaining months, the burdens were less than one, with none being found in November, 1970; January; February; or November, 1971.

Order Acariformes

Suborder Prostigmata

Radfordia subuliger (Ewing) was very rare. A total of five specimens was found: one each in the months of November, 1970; January; and November, 1971; and two in September, 1971.

Trombiculidae - A minimum of two species of chiggers was

Figure 12. Mean monthly burdens of mites belonging to the suborder Mesostigmata found on Peromyscus leucopus from November, 1970 through November, 1971.

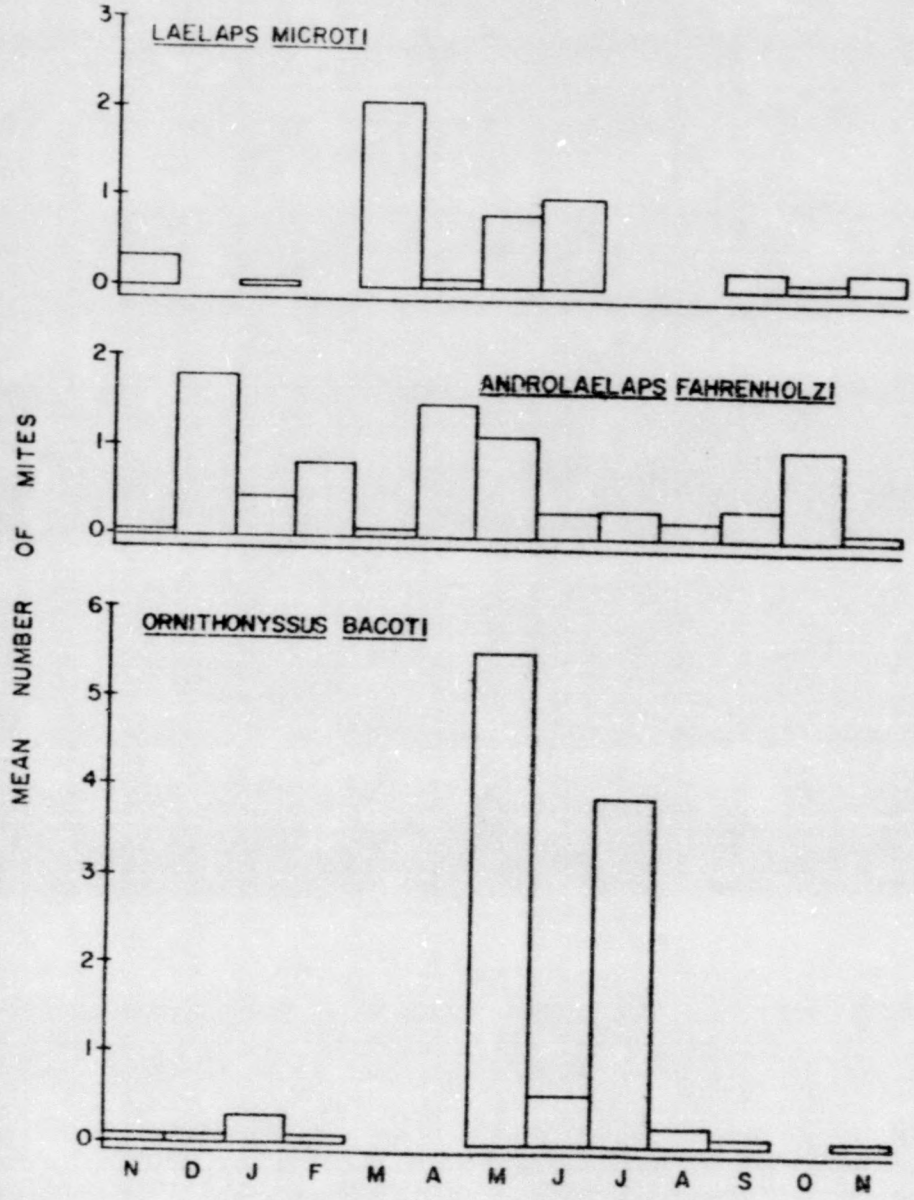
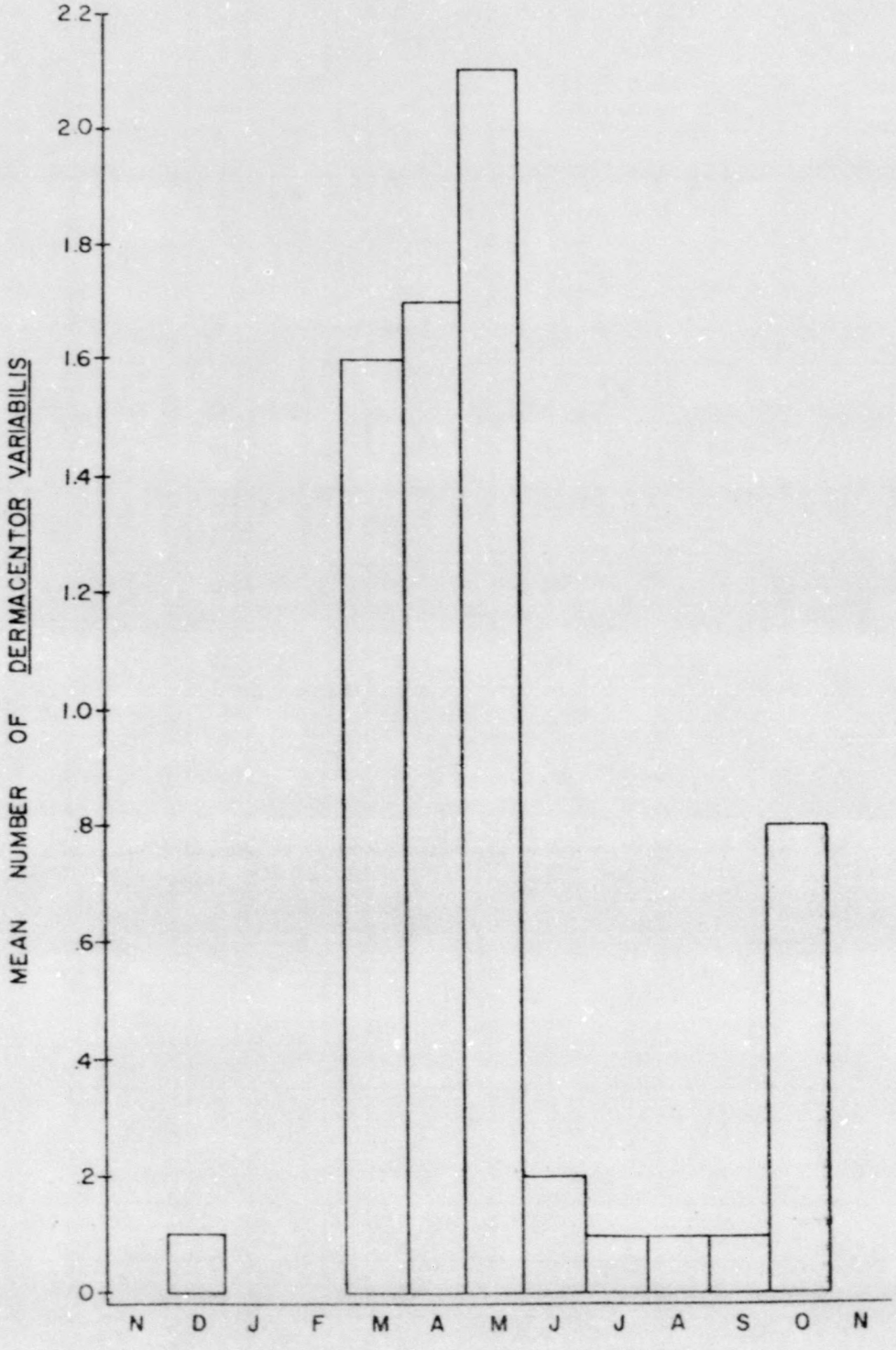

LAELAPS MICROTI
ANDROLAELAPS FAHRENHOLZI
ORNITHONYSSUS BACOTI
MEAN NUMBER OF MITES
0
1
2
3
4
5
6
N
D
J
F
M
A
M
J
J
A
S
O
N

Figure 13. Mean monthly burdens of *Dermacentor variabilis* found on *Peromyscus leucopus* from November, 1970 through November, 1971.


MEAN NUMBER OF DERMACENTOR VARIABILIS
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
N
D
J
F
M
A
M
J
J
A
S
O
N

found: Euschoengastia peromysci and Neotrombicula caviola. Chiggers were most abundant during the months of November, 1970 through April, 1971 and again in October and November, 1971 (Fig. 14, App. XI). A peak burden of 31(0-71) occurred in February. From May through September the mean burden did not exceed five. A low burden of 0.5(0-3) occurred in September.

Suborder Astigmata

Dermacarus hypudaei, all hypopi, was present throughout the study period (Fig. 15, App. XII). A high mean burden of 43 (0-424) occurred in March. This burden far surpassed the second highest mean burden of 6(0-15) occurring in April. During the remaining months the mean burdens did not exceed 3.5. The low burden was 0.2(0-1) in June.

A significant difference in the total average D. hypudaei burden on male and female mice was shown by the chi square test, ($X^2 = 4.004$). The average for females was 7(0-424). The average for males was 1(0-11). One female, collected in March, had a burden of 424 mites of this species. The second highest individual burden for the entire study period was only 19. Another chi square test was run, excluding the female having 424 mites, and no significant difference was found. The average burden for females, excluding the female with 424 mites, was 2(0-19).

Listrophorus leukorti was rarely found (Fig. 15, App. XII).

Figure 14. Mean monthly burdens of chiggers found on Peromyscus leucopus from November, 1970 through November, 1971.

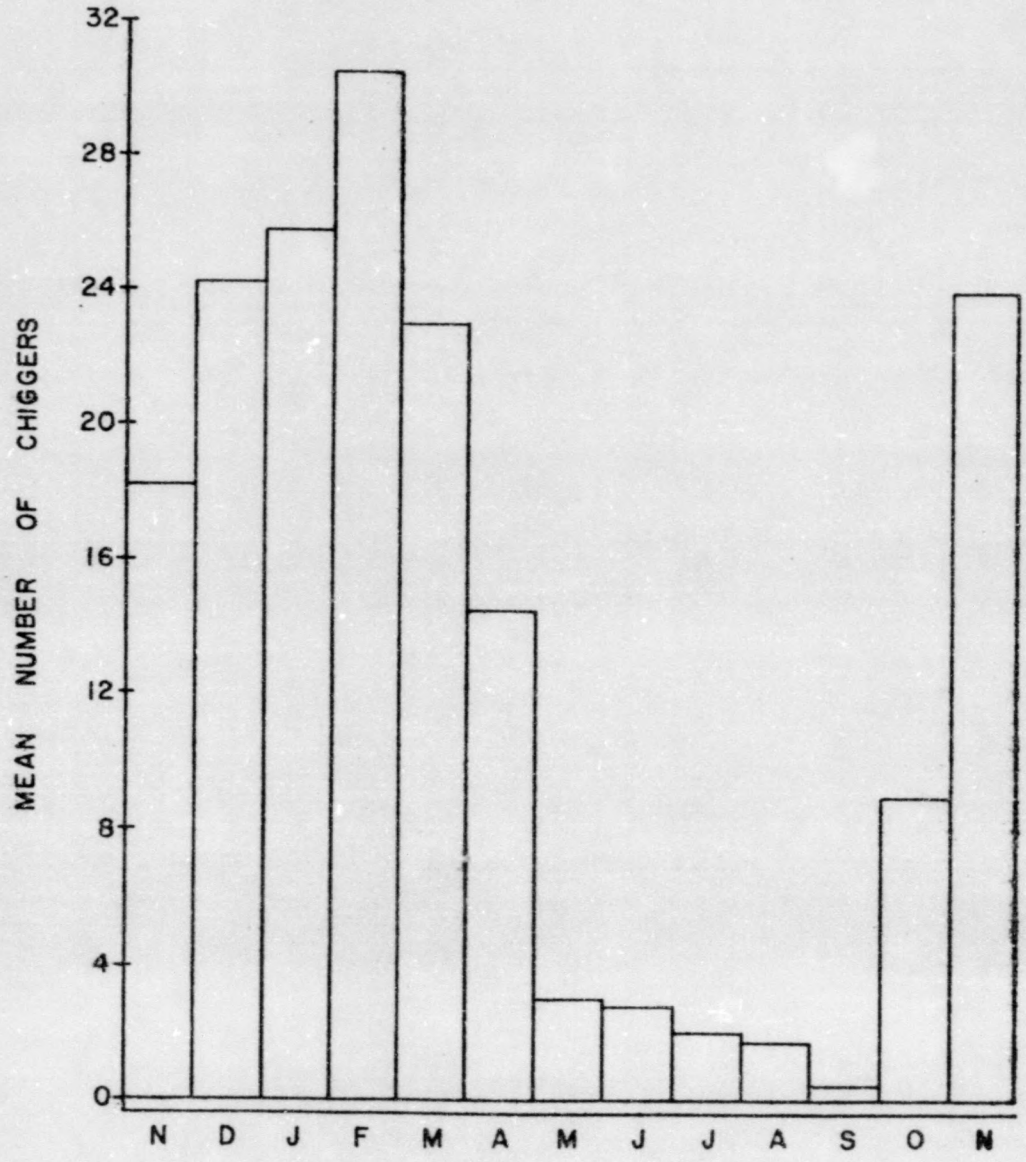
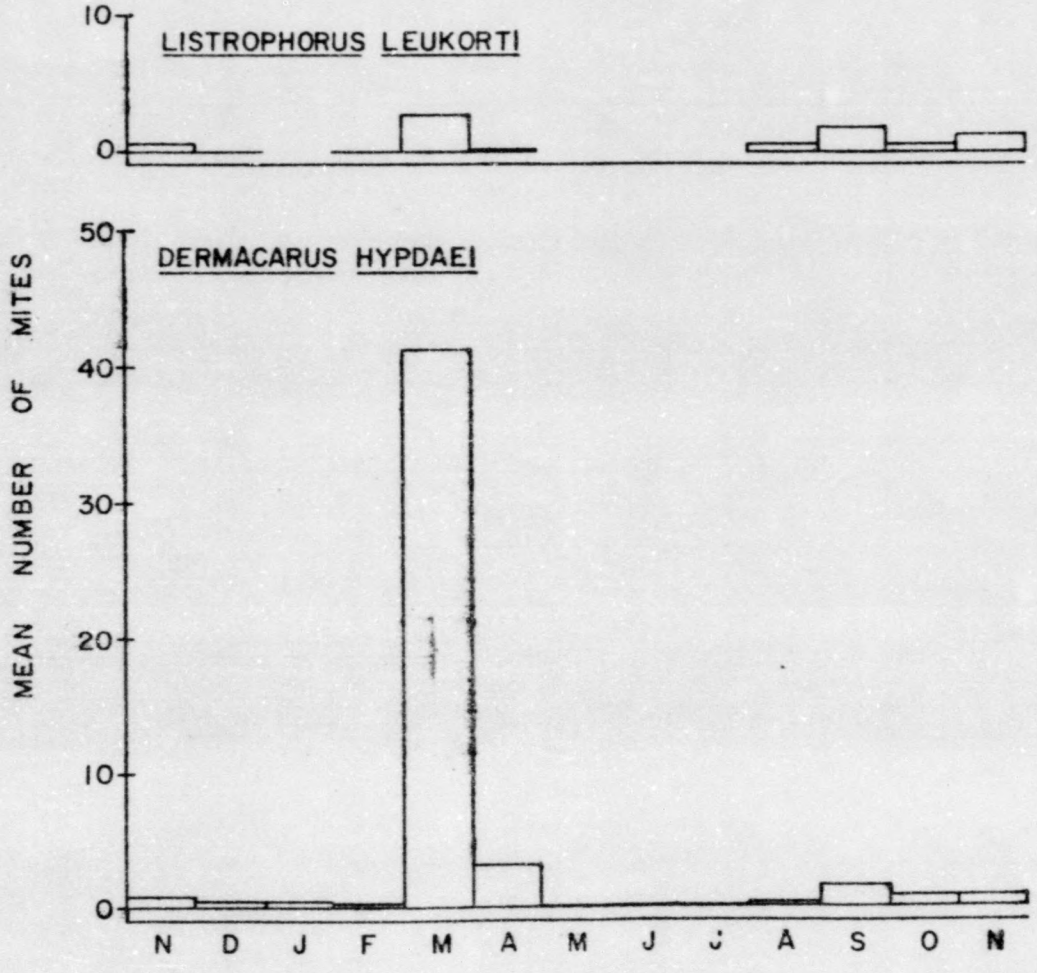

MEAN NUMBER OF CHIGGERS
32
28
24
20
16
12
8
4
0
N
D
J
F
M
A
M
J
J
A
S
O
N

Figure 15. Mean monthly burdens of Dermacarus hypudaei and Listrophorus leukorti found on Peromyscus leucopus from November, 1970 through November, 1971.


LISTROPHORUS LEUKORTI
10
0
DERMACARUS HYPDAEI
50
40
30
20
10
0
MEAN NUMBER OF MITES
N D J F M A M J J A S O N

A high mean burden of 6(0-55) occurred in March. No mites were found during January, May, June, or July.

Mycoptes sp. did not commonly occur (App. XII). The largest mean burden was 1(0-8) in October. This mite was not found in December, 1970; May; or September, 1971.

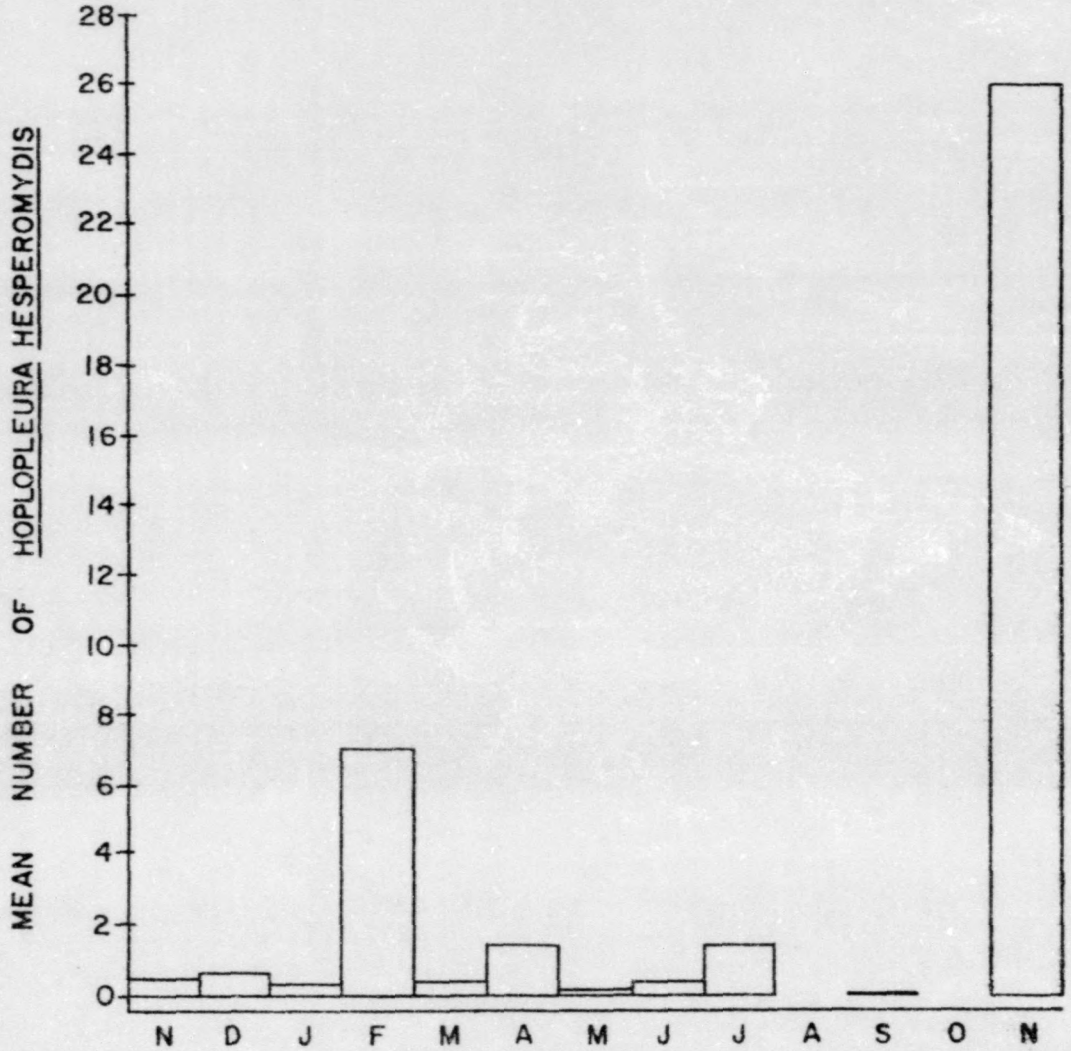
Class Insecta

Order Anoplura

Hoplopleura hesperomydis (Osborn) was taken in low numbers throughout most of the study period (Fig. 16, App. XIII). The peak burdens of 7(0-25) and 25(0-252) occurred in February and November, 1971. During the remaining months the burden did not exceed two. No lice were found in August or October.

A significant difference in the total average burden of male and female mice was shown by a chi square test, (X^2 = 4.085). The average burden of 5(0-252) for males was significantly larger than the average burden of 0.4(0-8) for females. One male, collected in November of 1971, had a burden of 252 lice. The second highest individual burden for the entire study period was only 25. Another chi square test was run, excluding the male with 252 lice, and no significant difference was found. The average burden for males, excluding the one male with 252 lice, was 2(0-25).

Figure 16. Mean monthly burdens of Hoplopleura hesperomydis found on Peromyscus leucopus from November, 1970 through November, 1971.


MEAN NUMBER OF HOPLOPLEURA HESPEROMYDIS
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
N
D
J
F
M
A
M
J
J
A
S
O
N

Order Siphonaptera

Five species of fleas were taken: Peromyscopsylla scotti, Epitedia wenmanni, Ctenophthalmus pseudagyrtes, Orchopeas leucopus, and Stenoponia americana. The first four occurred infrequently. The latter was the most common. It was frequently taken from December, 1970 through April, 1971 and again in November, 1971 (Fig. 17). The mean monthly burdens for each of the species of fleas are as follows:

P. scotti - November, 1970 $\bar{x}$ = 0.1(0-1).

E. wenmanni - January $\bar{x}$ = 0.1(0-1); February $\bar{x}$ = 0.3(0-4); June $\bar{x}$ = 0.3(0-3); August $\bar{x}$ = 0.1(0-1); October, 1971 $\bar{x}$ = 0.1(0-1).

C. pseudagyrtes - January $\bar{x}$ = 0.1(0-1); April $\bar{x}$ = 0.2(0-1); June $\bar{x}$ = 0.4(0-5); August, 1971 $\bar{x}$ = 0.1(0-1).

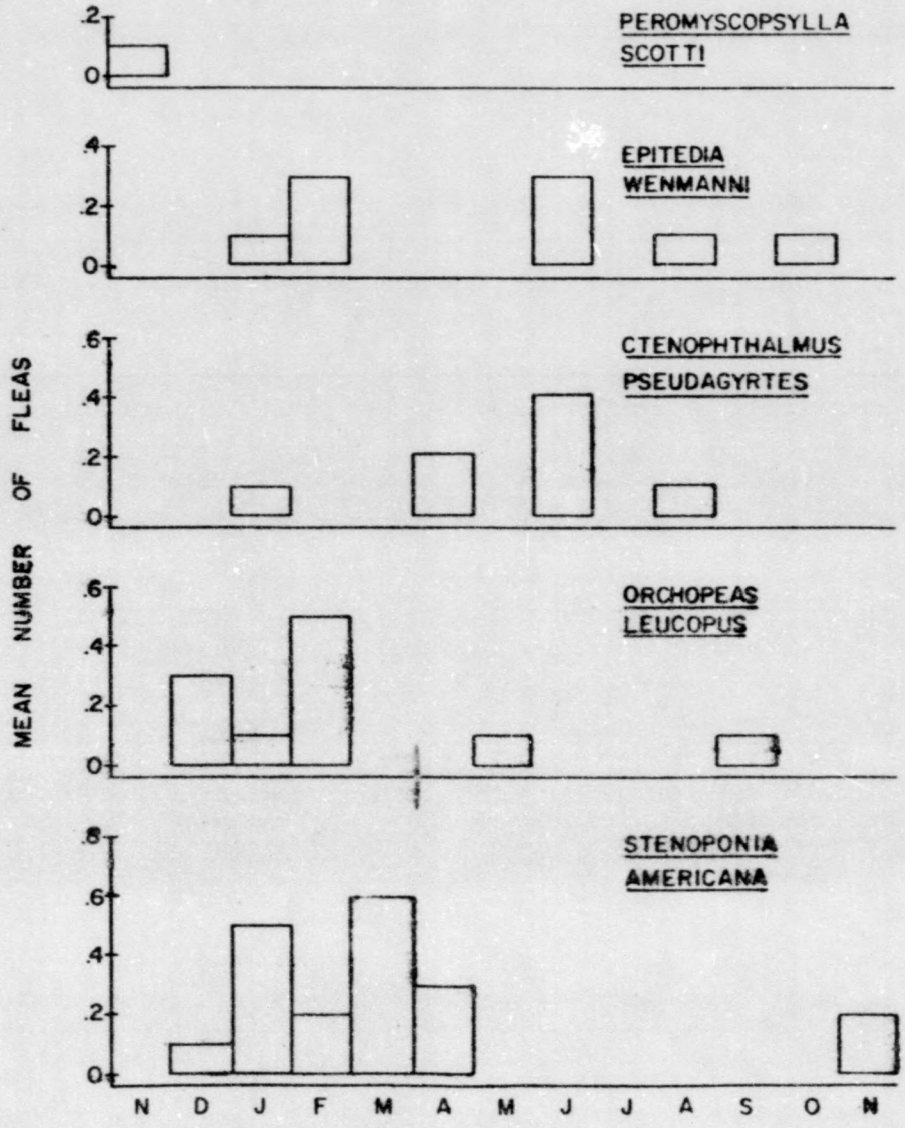
O. leucopus - December, 1970 $\bar{x}$ = 0.3(0-1); January $\bar{x}$ = 0.1(0-2); February $\bar{x}$ = 0.5(0-4); May $\bar{x}$ = 0.1(0-1); September, 1971 $\bar{x}$ = 0.1(0-1).

S. americana - December, 1970 $\bar{x}$ = 0.1(0-1); January $\bar{x}$ = 0.5 (0-6); February $\bar{x}$ = 0.2(0-2); March $\bar{x}$ = 0.6(0-4); April $\bar{x}$ = 0.3(0-2); November, 1971 $\bar{x}$ = 0.2(0-2).

Order Diptera

A total of two Cuterebra sp. was found, one in July and one in November of 1971. These bot larvae were removed from under the skin of the inguinal region.

Figure 17. Mean monthly burdens of fleas found on *Peromyscus leucopus* from November, 1970 through November, 1971.


MEAN NUMBER OF FLEAS
PEROMYSCOPSYLLA SCOTTI
EPITEDIA WENMANNI
CTENOPHTHALMUS PSEUDAGYRTES
ORCHOPEAS LEUCOPUS
STENOPONIA AMERICANA
.2
0
.4
.2
0
.6
.4
.2
0
.6
.4
.2
0
.8
.6
.4
.2
0
N D J F M A M J J A S O N

Phylum Aschelminthes

Class Nematoda

Family Oxyuridae

Syphacia peromysci Harkema, 1936 was most abundant from November, 1970 through February, 1971 and in April and November of 1971 (Fig. 18, App. XIV). The peak burden was 101(0-969) occurring in February. No worms were found during March, May, June, or October.

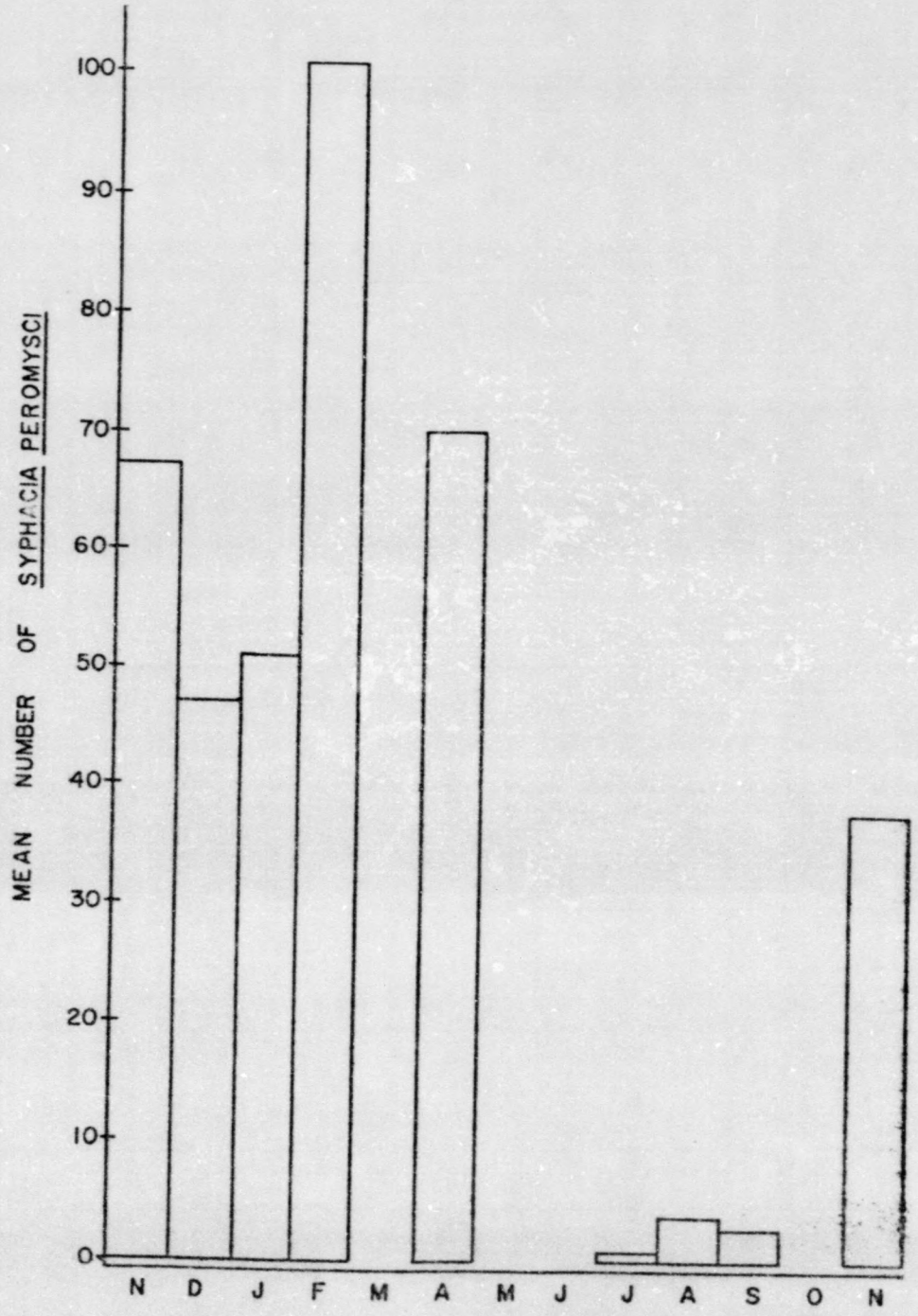
Family Rictularidae

Rictularia coloradensis Hall, 1916 was found infrequently during the study. The mean monthly burdens were: 0.3(0-4) in November and 0.2(0-2) in December of 1970 and 0.1(0-1) in January, 0.2(0-2) in April, 0.7(0-8) in June, 0.3(0-2) in July, and 0.4(0-2) in August of 1971.

Family Thelaziidae

Immature specimens of Thelazia sp. were found in a total of six mice during the entire study. The average number of worms per infected mouse was 14(2-34). This nematode was found under the eyelids.

Figure 18. Mean monthly burdens of Syphacia peromysci found in Peromyscus leucopus from November, 1970 through November, 1971.


MEAN NUMBER OF SYPHACIA PEROMYSCI
100
90
80
70
60
50
40
30
20
10
0
N
D
J
F
M
A
M
J
J
A
S
O
N

Family Trichostrongylidae

Four specimens of Longistriatus sp. were taken from the small intestine of one male mouse in November of 1970.

Table II. Species of arthropod and helminth parasites found on or in *Microtus ochrogaster* and *Peromyscus leucopus* from November, 1970 through November, 1971 and their average densities per animal for the period.

Parasites	Density	
	M. ochrogaster	*P. leucopus*
Arthropods		
Mites		
Ornithonyssus bacoti	23.12(0-516)	0.82(0-53)
Androlaelaps fahrenholzi	4.19(0-50)	0.65(0-17)
Laelaps microti	6.31(0-119)	0.38(0-19)
Radfordia subuliger	----	0.03(0-2)
R. lemnina	0.05(0-1)	----
Dermacarus hypudaei	161.00(0-1695)	4.87(0-424)
Listrophorus leukorti	225.49(0-2169)	1.26(0-55)
Mycoptes sp.	1.56(0-27)	0.23(0-8)
Chiggers		
Euschoengastia peromysci	8.33(0-102)	13.76(0-75)
Neotrombicula caviola		
Ticks		
Dermacentor variabilis	0.21(0-9)	0.52(0-12)
Lice		
Hoplopleura acanthopus	2.62(0-72)	----
H. hesperomydis	----	2.98(0-252)

Table II. Continued.

Parasites	Density	
	M. ochrogaster	*P. leucopus*
Fleas		
Ctenophthalmus pseudagyrtes	0.32(0-4)	0.06(0-5)
Epitedia wenmanni	0.01(0-1)	0.07(0-4)
Orchopeas leucopus	0.01(0-1)	0.08(0-4)
Peromyscopsylla scotti	0.02(0-1)	0.01(0-1)
Stenoponia americana	0.12(0-7)	0.15(0-6)
Bots		
Cuterebra sp.	----	0.001(0-1)
Helminths		
Cestodes		
Aprostatandrya macrocephala	0.25(0-4)	----
Paranoplocephala variabilis	0.78(0-8)	----
Taenia taeniaeformes	0.04(0-1)	----
Nematodes		
Longistriatus sp.	2.69(0-161)	0.03(0-4)
Physaloptera sp.	0.01(0-1)	----
Rictularia coloradensis	----	0.17(0-8)
Syphacia obvelata	4.58(0-194)	----
S. peromysci	----	29.38(0-969)
Thelazia sp.	----	0.55(0-34)

DISCUSSION

Phylum Arthropoda

There appeared to be little host specificity among the ectoparasites, although there was a definite host preference. A total of 19 species was found, of which host specificity was exhibited only by mites of the genus Radfordia and lice of the genus Hoplopleura. Ectoparasites were more numerous on M. ochrogaster than P. leucopus. This difference in burden is probably the result of the heavier pelage of voles.

Suborder Mesostigmata

Three species of mites belonging to this suborder were found: Laelaps microti, Androlaelaps fahrenholzi, and Ornithonyssus bacoti. These mites were more commonly associated with voles, on which they occurred in greater numbers and exhibited a more continuous incidence pattern. The densities of these three respective mites were 4.19, 6.31, and 23.12 on voles and 0.65, 0.38, and 0.82 on wood mice. Whitaker and Wilson (1968) in a three year study of mites in Indiana reported lower densities: 0.17, 0.19, and 0 for M. ochrogaster and 0.62, 0.003, and 0.01 for P. leucopus.

Androlaelaps fahrenholzi is a common rodent mite with widespread distribution. It shows little host specificity, for it is known to occur on almost all small mammals and some birds (Strandtmann, 1949). Batson (1965) found this mite to be a common species on M. ochrogaster in central Kentucky.

This mite showed no distinct seasonal incidence pattern on either host, although it appeared to be less common on M. ochrogaster from November, 1970 through February, 1971. A similar lack of definite seasonal cycle for this species was reported by Morlan (1952) and Worth (1950).

The mite Laelaps microti also exhibited no definite seasonal incidence pattern on either host. The literature offers little information on this mite. Jameson (1950) states that L. microti is a holoartic parasite of voles. In the present study, it was associated with both hosts, but occurred more commonly on M. ochrogaster.

Ornithonyssus bacoti is a common parasite of rats, but it is also associated with many other rodents. It is widely distributed but most abundant in the southern part of the United States (Pratt and Good, 1954). This mite displayed a distinct seasonal incidence pattern on voles. It occurred almost exclusively during the months of May through October with a peak occurring in July. Cross and Wharton (1968), in studying environmental preferences for feeding, found that more O. bacoti fed at warmer temperatures (102-107°F) than at cooler temperatures. This could possibily account for their peak during the summer. No temperature preferences

were observed for the genera Laelaps or Haemolaelaps. Worth (1950) reported a seasonal incidence pattern with maximum numbers observed during March, April, and May and minimum numbers in October and November. His study was conducted in Florida where the optimum temperature may occur earlier than in Kentucky.

When the burdens of these three species of mites found on male and female voles were compared, an interesting pattern was observed for two species. Androlaelaps fahrenholzi appeared to be more abundant on males during early spring and late summer while on females the peak burden came only in late summer. The sharp increase on females in June represents a collection from only one female and therefore cannot be considered indicative of an average for the month. With O. bacoti, females had a sharper increase in burden than males. The peak burden for females came in July, two months earlier than the September peak for males.

Suborder Metastigmata

The only member of this suborder found was the common American dog tick, Dermacentor variabilis. This tick is one of the most widely distributed species. It has a two-host life cycle. Small rodents, preferably Microtus sp., serve as host for the immature stages. Adults are found primarily on dogs (Bishopp and Trembley, 1945; Smith et al., 1946). In the present study this tick was found more often on P.

leucopus than on M. ochrogaster.

Dermacentor variabilis was most abundant in early spring, beginning in March and continuing through May on wood mice and through June on voles. This follows the life-cycle pattern reported by Smith et al. (1946). They found the activity of the immature forms reached a peak during the months of March, April, and May, after which these forms became rare or absent. The decrease resulted from the nymphs molting to adults and subsequently leaving the rodents for the adult host. Bishopp and Trembley (1945) reported a tendency for the adults to become attached to the dog host during the spring in the central and northern states.

Suborder Prostigmata

Four species belonging to this suborder were fcund: Radfordia lemnina, R. subuliger, Euschoengastia peromysci, and Neotrombicula caviola.

The genus Radfordia is one of the most specialized and modified myobid mites, occurring only on rodents. A total of eight R. lemnina was found on M. ochrogaster. This mite is a parasite of the genus Microtus. A total of five R. subuliger was found on P. leucopus. This mite is a parasite of the genus Peromyscus (Jameson, 1955). Both species are very small and cling tenaciously to hairs. This may account for the low densities of 0.05 and 0.03 respectively. However, these densities are slightly higher than the density of 0.02 reported

for both species by Whitaker and Wilson (1968). An insufficient number of specimens was found to allow speculation on their seasonal incidence patterns. These mites were an insignificant part of the ectoparasite burden of these hosts.

A minimum of two species of trombiculid mites, chiggers, was found: E. peromysci and N. caviola. The first is primarily a parasite of P. leucopus (Whitaker, 1968). During the present study chiggers were more regularly associated with P. leucopus, in fact, they comprised the major portion of this host's ectoparasite burden.

A definite seasonal incidence pattern was observed for chiggers occuring on wood mice. They were most common during the cooler months of October through April. During the warmer months their numbers greatly decreased. The prevalence of the larvae in winter place these chiggers into what is termed a winter group. In spring the larvae leave the host and molt to the free-living stages. This type of incidence pattern has been described by Farrell (1956) and Suyemoto (1954). A similar trend, though more erratic, was observed for chiggers on voles.

Suborder Astigmata

Three species of mites belonging to this suborder were found: Dermacarus hypudaei, Listrophorus leukorti, and Mycoptes sp. The first two species of mites comprised the largest portion of the ectoparasite burden of voles but were found in

small numbers on wood mice. These are small fur mites. They cling to hair and probably feed on sebacious secretions at the base of the hair. This may explain their predominance on voles because of their heavier pelage. The literature provides little information on these mites. Because of their affinity for clinging to hair, making them difficult to remove, and the fact that they often occur in the hundreds, most workers simply make conservative estimates and do not bother to count them. In this study an attempt was made to collect and count all specimens, and numbers far exceeded reported densities.

All D. hypudaei found were hypopi, a second nymphal stage with specialized claspers. In this species the hypopial stage is parasitic on rodents while the adults are free-living in the nest of the rodent (Drummond, 1957).

This mite was common on voles. It frequently numbered several hundred, with a maximum of 1,695 taken from one vole in March. They were abundant on this host throughout the study but were most numerous during March and April, 1971 and least numerous during November and December, 1970. There is no information on the seasonal incidence of this mite. One possible explanation for this incidence pattern may be as follows. First let us assume that there is a more or less equal proportion of young hypopi moving on the host from the nest and old hypopi leaving the host for the nest, as suggested by the pattern from July to November. With the approach of cold weather, perhaps more hypopi are stimulated to leave

the host and molt to adults. In conjunction with this there is possibly an inhibitory effect on the hatching of eggs, thus reducing the number of replacement hypopi. This would decrease the mite burden of the host, as suggested by the low burdens in November and December, 1970. It should be noted that November of 1971 was much warmer than November of 1970, possibly accounting for the difference in burdens. The inhibitory effect on the hatching of eggs would result in an increase of eggs in the nest. The slight rise in temperature in March at the onset of spring may stimulate hatching of the backlog of eggs, resulting in movement of many more replacement hypopi onto the host. This would greatly increase the burden, as observed in March and April. If the hypopi mature in six or eight weeks, the burden would drop to a normal range after a few months.

This mite occurred on wood mice in low densities throughout the study. There was a sharp increase during March, but numbers were very low during the remaining months.

A difference in the burden of this mite on male and female wood mice was observed. This difference was likely the result of taking one female in March having an abnormally high burden. This would also explain the sharp increase in mean monthly burden during March.

This mite was observed to be very tolerant to low temperature. Occasionally it was necessary to leave some animals frozen several days before examining them. When they were thawed and their ectoparasites collected most D. hypu-

daei were found to be still alive and active. One specimen of D. hypudaei was found alive and actively moving about on a vole that had been frozen three months.

The genus Listrophorus is more or less restricted to rodents (Krantz, 1971). In the present study Listrophorus leukorti was the most abundant species found on M. ochrogaster. Several hundred of these mites were usually present. During November of 1970 one vole had a burden of 2,169 L. leukorti. On P. leucopus, they occurred in much lower numbers.

This mite exhibited a marked seasonal incidence pattern on voles. It was most abundant in late summer and fall with peaks in October and November, 1971. From January through July this mite occurred in much lower numbers. The occurrence of this mite on the wood mouse was very erratic, showing no definite pattern.

There is little information available on the seasonal incidence of L. leukorti. If one considers the climatic factors of moisture and temperature, it appears that this mite is most abundant during the warm dry months of late summer and fall and least abundant during the cool moist months of winter and spring. The limiting factor for this mite may be temperature or moisture, or an interaction of the two.

Mites of the genus Mycoptes were found in low densities on both host. This genus made up only a small portion of the ectoparasite burden of either host. No seasonal incidence pattern was indicated by the mean monthly burdens.

Order Anoplura

Two species of lice were found: Hoplopleura acanthopus on M. ochrogaster and H. hesperomydis on P. leucopus. The first louse is a parasite of the genus Microtus, the second a parasite of the genus Peromyscus. Batson (1965) found H. acanthopus to be the most abundant ectoparasite of M. ochrogaster in central Kentucky. The most comprehensive study of these two species of lice was conducted by Cook and Beer (1958). They studied the occurrence of these lice on 979 meadow voles, Microtus pennsylvanicus, and 1,904 deer mice, Peromyscus maniculatus. They found voles to have a higher infestation than deer mice. It was found that, on voles, the males had a higher infestation of lice than females, and males also had an increased infestation with age. This male-female and age difference was not observed on deer mice. The average burden was found to change with the seasons. The number of lice per vole showed a peak during April. On deer mice the peaks came in March-April, May-June, and November.

The results of the present study differ somewhat from that described above. This difference may be due in part to the examination of a smaller number of hosts and the study of different host species. The present data shows P. leucopus to have a slightly larger burden than M. ochrogaster. This is probably the result of having collected one male wood mouse in November, 1971, with an unusually high burden. This may also be responsible for the significant difference in the bur-

den of male and female wood mice.

In the present study, a similar seasonal incidence pattern was exhibited by H. acanthopus. This species of louse was most abundant from February through May with the peak in April. From June through October no lice were found. Wood mice appeared to maintain a low burden of H. hesperomydis throughout most of the study, with peaks occurring in February and November, 1971.

Order Siphonaptera

Fleas show little host specificity. Any species may be more common on a particular host, but it will also be found on a wide range of other hosts (Herms, 1961). This is the case for the five species of fleas taken in this study. Of the five species, the only one occurring on voles with any regularity was Ctenophthalmus pseudagyrtes. This was by far the most predominate flea. The other four species occurred sporadically and in low numbers. This flea was most abundant in April and from August through November. Jameson (1947, 1950) reports this species to be the most common flea on the genus Microtus and to have no marked seasonal distribution. Holland and Benton (1968) found this species to be most numerous in spring. Verts (1961) reports this flea to be most numerous during the warmer months. The most comprenhensive study of C. pseudagyrtes was conducted by Benton and Kelly (1969). They found little host specificity, but this species

of flea was most prevalent on insectivores and microtine rodents. They reported that this species exhibited a peak abundance in early spring, March-April, with a second peak in late summer. This closely follows the seasonal incidence pattern of C. pseudagyrtes observed in the present study. Benton and Kelly (1969) attributed the spring peak to the resumption of breeding activity of the main hosts, Microtus and Pitymys. In their study the reproductive activity of these hosts was greatly reduced from November through February. However, in the present study many pregnant female voles were taken during these months.

The occurrence of fleas on P. leucopus was not as limited to one species as on M. ochrogaster. On voles, there was a relatively large number of C. pseudagyrtes, with comparatively few specimens of the other four species. On wood mice there was no one predominant species but rather a small number of all five species. The only species occurring with any regularity were Stenoponia americana and Orchopeas leucopus.

Stenoponia americana was the most abundant flea on wood mice. It was commonly found during the months of January through April. This flea has a low host specificity (Holland and Benton, 1968). It is considered to be a winter flea (N. Wilson, personal communication). Benton and Altmann (1964) state that P. leucopus is a secondary host for S. americana.

The genus Peromyscus is the most common host for Orchopeas leucopus (Holland and Benton, 1968; Jameson, 1950). It has been suggested that O. leucopus has a definite preference for

P. leucopus (Benton and Altmann, 1964). In the present study it ranked second in abundance. It was most commonly found during December, January, and February. Benton and Altmann (1964) found this flea to occur throughout the year, with no significant seasonal incidence pattern. However, Verts (1961) reported it to be more common in the spring.

An insufficient number of specimens of each of the five species of fleas was taken, with the possible exception of C. pseudagyrtes on voles, to accurately depict their seasonal incidence patterns.

Order Diptera

Two specimens of Cuterebra sp. were taken from P. leucopus. These fly larvae are found underneath the skin, usually in the inguinal region. They do little damage to the host. Cuterebra sp. is commonly associated with the genus Peromyscus (Dunaway et al., 1967; Wecker, 1962).

Phylum Platyhelminthes

Class Cestoda

In this study the occurrence of cestodes was limited to prairie voles. No specimens were taken from wood mice. The species found belong to the families Anoplocephalidae and Taeniidae. The prevalence of the anoplocephalid cestodes in voles is probably a function of the feeding habits of these

hosts. Voles feed on tender grass shoots, whereas wood mice feed primarily on seeds and arthropods. Cestodes belonging to the family Anoplocephalidae are common parasites of herbivores. All known life cycles for members of this family utilize oribatid mites as intermediate hosts (Kates and Runkel, 1948). This mode of transmission has been suggested for the cestodes of voles (Rausch and Tiner, 1949). It has only recently been confirmed for the species taken in the present study (Gleason and Buckner, unpublished data). Oribatid mites are found in ground litter and on grass, and thus are readily accessable to feeding voles but not to wood mice.

Family Anoplocephalidae

Cestodes of this family are common parasites of species of Microtus (Rausch and Tiner, 1949). Two species belonging to this family were found: Aprostatandrya macrocephala and Paranoplocephala variabilis.

Rausch (1952) states that Paranoplocephala borealis is a synonym of P. variabilis, concluding that the former is a growth stage of the latter. This cestode was the most common species found. This species was not listed by Rausch and Tiner (1949), although they reported finding a large species of Paranoplocephala just below the stomach in the duodenum. This description resembles the P. variabilis of the present study. The above authors found P. troeschi, an inhabitant of the cecum, to be the most common cestode of voles. In the

present study P. variabilis was most abundant from November through March, with a peak occurring in December. This seasonal incidence pattern is similar to that of P. troeschi, reported by Rausch and Tiner (1949). To explain this incidence pattern the above authors suggested that P. troeschi was a rapidly maturing, short-lived species. This explanation seems equally plausible for P. variabilis.

Yamaguti (1959) has separated the genus Andrya into the genera Andrya and Aprostatandrya. Aprostatandrya macrocephala is therefore synonymous with Andrya macrocephala commonly used in earlier literature. Rausch and Schiller (1949) have suggested that A. caucasica, A. microti, and A. ondatrae are synonyms of A. macrocephala.

This species is a common parasite of the genus Microtus. Rausch and Tiner (1949) found it to be most abundant during the summer months, with a peak infection in August, and least abundant during the winter. The results of the present study show no definite seasonal incidence pattern, although it appeared that A. macrocephala was more common during the months of January through May, with a peak in January. It was suggested by the above authors that the intermediate host, assumed to be oribatid mites, would rarely be available during the winter. This was not the case in the area of the present study. Oribatid mites were commonly found throughout the winter. Rausch and Tiner collected their seasonal incidence data from areas in Michigan which are subjected to more severe winters than the area of the present study, and this could possibly

account for the lack of intermediate host. One explanation for the incidence pattern observed in the present study may be that A. macrocephala is a long-lived slow-maturing species. This coupled with the year-round availability of an intermediate host would give this cestode a more continuous incidence pattern.

A graph of the mean monthly burdens of male and female voles revealed an interesting pattern. From the data females appeared to have comparatively larger burdens during fewer months of the study than males, for which the burdens were generally smaller but more continuous. The reasons for this pattern are not understood. Perhaps it is the result of inadequate sample size.

Family Taeniidae

Strobilocerci larvae of Taenia taeniaeformes were found in the liver of voles. Rodents are common intermediate hosts for this cestode, with cats serving as definitive hosts (Wardle and McLeod, 1952). A total of six larvae was found during the study.

Phylum Aschelminthes

Class Nematoda

Six species of nematodes were found. Three of these species probably represent accidental or rare associations.

These include immature Thelazia sp. taken from P. leucopus which has not been previously reported for the genus Peromyscus, a single Physaloptera sp. taken from one vole, and the four Longistriatus sp. from one wood mouse. The most abundant nematodes were pinworms of the genus Syphacia.

Syphacia obvelata occurred in voles. This is a widely distributed species commonly associated with voles. Rausch and Tiner (1949) reported this nematode to be the most common helminth parasite of voles and to occur throughout the year. Syphacia obvelata was found sporadically and in low numbers throughout the study.

Syphacia peromysci occurred in wood mice and was found to be the most prevalent helminth parasite of this host. It showed a marked seasonal incidence pattern, being most abundant during the months of November through April with a peak of 101 in February. It was least abundant from May through October. Harkema (1936) reported a similar incidence pattern with a peak in February, but at a much lower mean burden of 18.85.

The remaining nematode species are Longistriatus sp., occurring in voles, and Rictularia coloradensis, found in wood mice. Longistriatus sp. belongs to the family Trichostrongylidae. Members of this family are reported to be uncommon parasites of voles (Rausch and Tiner, 1949). Rictularia coloradensis is a common parasite of wood mice (Oswald, 1958). Harkema (1936) found the highest burdens occurred from June through November. In the present study these two

species of nematodes occurred sporadically and in low numbers, suggesting no definite seasonal incidence pattern.

Appendix I. Formula and preparation of PVA-LP mounting medium.

Lactic acid ----- 22cc.

Phenol (pure, clear crystals) ----- 22cc.

Add crystals to the 22cc. of lactic acid in a graduate cylinder, bringing the level of mixture to 44cc. Phenol will dissolve slowly in the acid while paste in the next step of the procedure is being prepared.

Prepare the paste as follows, at room temperature.

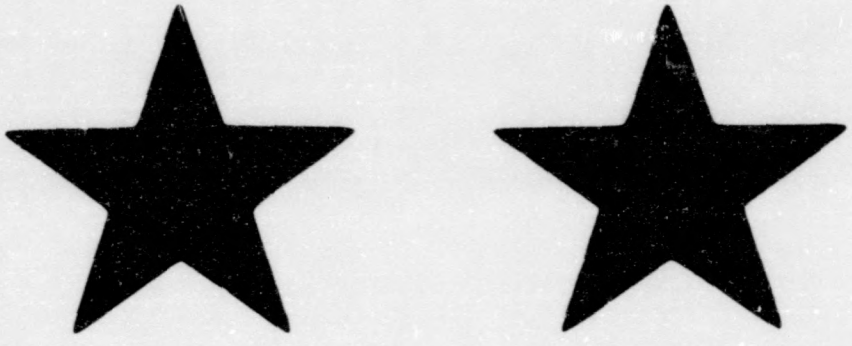
Distilled water ----- 50cc.

Delkote Polyvinyl Alcohol powder

Add this powder slowly, from a sifter, to water, agitating from time to time. Continue adding until a thick paste is formed.

Add lacto-phenol to the paste and stir gently for a few moments, not attempting to homogenize ingredients. Cover the beaker and allow to stand for 24 hours. Mounting medium is now ready for use. If stored in a clear glass container it will darken, brown, but this is not undesirable. Specimens may be mounted directly from life, water, or alcohol. To reclaim specimens, soak slide for 24 hours in warm water.

CORRECTION



PRECEDING IMAGE HAS BEEN REFILMED TO ASSURE LEGIBILITY OR TO CORRECT A POSSIBLE ERROR

Appendix II. Mean monthly burdens of mites belonging to the suborder Mesostigmata found on Microtus ochrogaster from November, 1970 through November, 1971.

	Ornithonyssus bacoti			Androlaelaps fahrenholzi		
	males	females	total	males	females	total
Nov	0.6(0-2)	0.3(0-1)	0.4(0-2)	1.3(0-5)	1.2(0-7)	1.2(0-7)
Dec	----	0.1(0-1)	0.1(0-1)	1.0(0-2)	0.6(0-2)	0.5(0-2)
Jan	----	----	----	1.0(0-3)	0.6(0-3)	0.8(0-3)
Feb	----	----	----	1.0(0-4)	----	0.5(0-4)
Mar	----	1.3(0-4)	0.8(0-4)	9.8(0-25)	4.1(0-17)	6.0(0-25)
Apr	0.8(1-3)	0.5(0-3)	0.7(0-3)	14.6(1-50)	0.8(0-4)	6.6(0-50)
May	14.4(0-42)	10.8(0-25)	12.6(0-42)	6.8(0-19)	3.2(0-7)	5.0(0-19)
Jun	15.0(0-62)	90(90)	22.5(0-90)	2.1(0-8)	13(13)	3.2(0-13)
Jul	53.0(0-182)	214.0(11-516)	120.1(0-516)	3.6(0-11)	3.6(0-15)	3.6(0-15)
Aug	51.4(8-119)	86.0(14-123)	61.8(0-123)	9.9(0-31)	10.6(0-19)	10.1(0-31)
Sep	89.5(8-257)	38.3(10-119)	69.0(0-257)	7.3(2-22)	8.3(1-26)	7.7(0-26)
Oct	12.6(0-27)	7.5(2-20)	9.2(0-27)	3.0(0-6)	3.0(1-7)	3.0(0-7)
Nov	1.0(0-4)	2.2(0-9)	1.5(0-9)	4.6(0-13)	4.8(0-12)	4.8(0-13)

Appendix II. Continued.

	Laelaps microti		
	males	females	total
Nov	9.7(0-34)	3.7(0-10)	6.2(0-34)
Dec	12.5(11-14)	4.6(0-18)	5.6(0-18)
Jan	9.3(0-19)	6.4(2-13)	8.0(0-19)
Feb	15.6(0-41)	4.8(1-8)	10.2(0-41)
Mar	47.8(7-119)	3.5(0-16)	18.3(0-119)
Apr	9.2(0-33)	1.9(0-5)	5.2(0-33)
May	4.4(0-10)	3.6(0-5)	4.0(0-10)
Jun	3.9(0-12)	2(2)	3.6(0-12)
Jul	0.3(0-1)	1.0(0-3)	0.6(0-3)
Aug	10.4(0-35)	2.0(0-6)	7.9(0-35)
Sep	8.1(0-33)	2.3(0-7)	5.8(0-33)
Oct	1.8(0-4)	----	1.0(0-4)
Nov	5.6(0-11)	3.9(1-7)	4.8(0-11)

Appendix III. Mean monthly burdens of Dermacentor variabilis found on Microtus ochrogaster from November, 1970 through November, 1971.

	males	females	total
Nov	0.2(0-1)	----	0.1(0-1)
Dec	----	0.2(0-2)	0.2(0-2)
Jan	----	----	----
Feb	----	----	----
Mar	0.3(0-1)	1.1(0-9)	0.8(0-9)
Apr	----	0.9(0-5)	0.5(0-5)
May	0.2(0-1)	----	0.1(0-1)
Jun	0.7(0-5)	----	0.6(0-5)
Jul	0.2(0-1)	----	0.1(0-1)
Aug	----	----	----
Sep	0.2(0-1)	----	0.1(0-1)
Oct	0.2(0-1)	----	0.1(0-1)
Nov	----	0.2(0-1)	0.1(0-1)

Appendix IV. Mean monthly burdens of chiggers found on *Microtus ochrogaster* from November, 1970 through November, 1971.

	males	females	total
Nov	4.6(0-12)	4.3(0-13)	4.4(0-13)
Dec	33.5(33-34)	7.6(0-29)	12.3(0-34)
Jan	26.3(7-90)	14.8(0-33)	21.1(0-90)
Feb	0.6(0-3)	0.8(0-3)	0.7(0-3)
Mar	23.0(0-76)	7.8(0-35)	13.1(0-76)
Apr	19.6(4-47)	52.2(7-102)	38.6(4-102)
May	----	----	----
Jun	0.1(0-1)	----	0.1(0-1)
Jul	0.4(0-2)	----	0.3(0-2)
Aug	0.4(0-3)	----	0.3(0-3)
Sep	0.3(0-2)	0.3(0-1)	0.3(0-2)
Oct	----	----	----
Nov	10.1(0-33)	26.0(0-94)	18.1(0-94)

Appendix V. Mean monthly burdens of mites belonging to the suborder Astigmata found on Microtus ochrogaster from November, 1970 through November, 1971.

	Dermacarus hypudaei			Listrophorus leukorti		
	males	females	total	males	females	total
Nov	13.6(0-43)	32.4(1-250)	25.2(0-250)	472.7(77-2169)	445.3(7-1355)	456.6(7-2169)
Dec	3.0(0-3)	41.1(0-90)	34.2(0-90)	116.5(4-229)	304.9(2-1279)	270.6(2-1279)
Jan	55.3(2-99)	320.6(13-1061)	175.9(2-1061)	119.7(3-600)	92.8(9-174)	107.5(3-600)
Feb	151.6(6-386)	67.2(0-321)	109.5(0-386)	15.4(2-41)	26.2(0-97)	20.8(0-97)
Mar	683.0(28-1621)	430.5(0-1695)	514.7(0-1695)	63.5(12-118)	128.8(0-778)	107.0(0-778)
Apr	524.4(13-1219)	108.7(10-615)	316.9(10-1219)	70.0(0-347)	5.6(0-15)	32.4(0-347)
May	21.2(0-54)	126.8(41-279)	74.0(0-279)	0.4(0-1)	0.4(0-1)	0.4(0-1)
Jun	37.7(7-93)	179(179)	50.0(7-179)	0.2(0-2)	25(25)	2.7(0-25)
Jul	158.4(23-441)	249.0(35-769)	196.2(23-769)	67.6(3-269)	15.0(0-58)	45.7(0-269)
Aug	84.6(35-159)	155.0(41-222)	105.7(35-222)	256.7(4-690)	420.0(27-816)	308.5(4-816)
Sep	240.0(94-597)	159.0(22-350)	207.6(22-597)	267.0(0-1069)	257.5(1-983)	263.2(0-1069)
Oct	98.0(3-336)	212.5(42-586)	148.9(3-586)	843.2(78-1515)	516.8(6-1292)	698.1(6-1515)
Nov	133.1(63-319)	132.1(3-478)	132.7(3-478)	512.1(64-1205)	752.6(6-1927)	617.3(6-1927)

Appendix V. Continued.

	Mycoptes sp.		
	males	females	total
Nov	----	0.1(0-1)	0.1(0-1)
Dec	0.5(0-1)	4.4(0-27)	3.7(0-27)
Jan	0.2(0-1)	0.2(0-1)	0.2(0-1)
Feb	2.8(0-14)	1.2(0-6)	2.0(0-14)
Mar	1.0(0-4)	3.1(0-16)	2.4(0-16)
Apr	5.6(0-8)	2.6(0-27)	4.3(0-27)
May	1.2(0-5)	1.0(0-5)	1.1(0-5)
Jun	0.1(0-1)	----	0.1(0-1)
Jul	1.0(0-5)	0.02(0-1)	0.7(0-5)
Aug	1.6(0-10)	----	1.1(0-10)
Sep	0.3(0-2)	1.0(0-4)	0.6(0-4)
Oct	0.3(0-1)	----	0.1(0-1)
Nov	1.9(0-7)	3.6(0-13)	2.5(0-13)

Appendix VI. Mean monthly burdens of Hoplopleura acanthopus found on Microtus ochrogaster from November, 1970 through November, 1971.

	males	females	total
Nov	0.6(0-3)	2.3(0-21)	0.6(0-21)
Dec	----	----	----
Jan	----	----	----
Feb	8.2(0-15)	6.0(0-12)	7.1(0-15)
Mar	5.3(0-13)	6.4(0-21)	5.8(0-21)
Apr	17.6(2-72)	14.3(4-36)	14.5(2-72)
May	6.8(0-27)	0.6(0-1)	4.0(0-27)
Jun	----	----	----
Jul	----	----	----
Aug	----	----	----
Sep	----	----	----
Oct	----	----	----
Nov	0.9(0-7)	----	0.8(0-7)

Appendix VII. Mean monthly burdens of cestodes in the family Anoplocephalidae found in Microtus ochrogaster from November, 1970 through November, 1971.

	Aprostatandrya macrocephala			Paranoplocephala variabilis		
	males	females	total	males	females	total
Nov	0.14(0-1)	0.10(0-1)	0.12(0-1)	1.29(0-6)	1.00(0-8)	1.12(0-8)
Dec	----	0.11(0-1)	0.09(0-1)	----	2.44(0-4)	2.00(0-4)
Jan	0.83(0-2)	0.40(0-2)	0.64(0-2)	1.33(0-5)	1.00(0-3)	1.27(0-5)
Feb	0.80(0-2)	----	0.40(0-2)	1.00(0-5)	1.20(0-4)	1.10(0-5)
Mar	0.75(0-3)	0.13(0-1)	0.33(0-3)	0.50(0-1)	1.88(0-4)	1.42(0-4)
Apr	----	0.75(0-4)	0.42(0-4)	1.00(0-2)	0.43(0-3)	0.67(0-3)
May	0.60(0-3)	----	0.30(0-3)	----	----	----
Jun	0.22(0-1)	----	0.20(0-1)	0.56(0-3)	1.00(1)	0.60(0-3)
Jul	----	0.20(0-1)	0.08(0-1)	----	0.20(0-1)	0.08(0-1)
Aug	----	0.67(0-2)	0.20(0-2)	0.29(0-1)	----	0.20(0-1)
Sep	----	0.25(0-1)	0.10(0-1)	----	----	----
Oct	0.40(0-1)	0.25(0-1)	0.33(0-1)	0.60(0-2)	0.25(0-1)	0.44(0-2)
Nov	----	0.14(0-1)	0.06(0-1)	0.67(0-2)	0.43(0-1)	0.56(0-2)

Appendix VIII. Mean monthly burdens of *Syphacia obvelata* found in *Microtus ochrogaster* from November, 1970 through November, 1971.

	males	females	total
Nov	----	----	----
Dec	97.0(0-194)	----	17.5(0-194)
Jan	----	----	----
Feb	6.2(0-29)	10.2(0-26)	7.2(0-29)
Mar	2.5(0-5)	3.0(0-13)	2.8(0-13)
Apr	3.2(0-9)	6.6(0-22)	5.5(0-22)
May	12.8(0-31)	12.8(0-57)	11.8(0-57)
Jun	----	----	----
Jul	1.4(0-6)	1.6(0-8)	1.5(0-8)
Aug	0.1(0-1)	----	0.1(0-1)
Sep	5.2(0-21)	15.3(0-61)	9.2(0-61)
Oct	0.2(0-1)	----	0.1(0-1)
Nov	6.8(0-38)	----	3.8(0-38)

Appendix IX. Mean monthly burdens of mites belonging to the suborder Mesostigmata found on *Peromyscus leucopus* from November, 1970 through November, 1971.

	Ornithonyssus bacoti			*Androlaelaps fahrenholzi*		
	males	females	total	males	females	total
Nov	0.1(0-1)	----	0.1(0-1)	0.9(0-6)	0.4(0-2)	0.7(0-6)
Dec	0.3(0-1)	----	0.1(0-1)	4.5(0-17)	0.4(0-1)	1.8(0-17)
Jan	0.7(0-5)	----	0.3(0-5)	0.3(0-2)	0.5(0-3)	0.4(0-3)
Feb	----	0.2(0-1)	0.1(0-1)	0.8(0-3)	0.8(0-2)	0.8(0-3)
Mar	----	----	----	----	0.2(0-1)	0.1(0-1)
Apr	----	----	----	2.0(0-5)	0.8(0-2)	1.4(0-5)
May	2.3(0-11)	10.8(0-53)	5.5(0-53)	1.2(0-4)	1.0(0-3)	1.2(0-4)
Jun	0.2(0-1)	0.6(0-4)	0.4(0-4)	0.6(0-2)	0.1(0-1)	0.3(0-2)
Jul	4.2(0-12)	3.6(0-8)	3.8(0-12)	0.2(0-1)	0.3(0-2)	0.3(0-2)
Aug	----	0.3(0-2)	0.2(0-2)	----	0.3(0-2)	0.2(0-2)
Sep	0.3(0-1)	----	0.1(0-1)	0.3(0-1)	0.5(0-2)	0.3(0-2)
Oct	----	----	----	1.1(0-6)	0.5(0-2)	1.0(0-6)
Nov	0.2(0-1)	----	0.1(0-1)	0.2(0-1)	----	0.1(0-1)

Appendix IX. Continued.

	Laelaps microti		
	males	females	total
Nov	0.3(0-1)	0.4(0-1)	0.3(0-1)
Dec	----	----	----
Jan	----	0.1(0-1)	0.1(0-1)
Feb	----	----	----
Mar	0.4(0-2)	3.8(0-19)	2.1(0-19)
Apr	----	0.2(0-1)	0.1(0-1)
May	1.4(0-11)	----	0.9(0-11)
Jun	2.0(0-9)	0.3(0-2)	1.0(0-9)
Jul	----	----	----
Aug	----	----	----
Sep	----	0.2(0-1)	0.2(0-1)
Oct	0.1(0-1)	----	0.1(0-1)
Nov	0.2(0-1)	0.3(0-1)	0.2(0-1)

Appendix X. Mean monthly burdens of Dermacentor variabilis found on Peromyscus leucopus from November, 1970 through November, 1971.

	males	females	total
Nov	----	----	----
Dec	----	0.1(0-1)	0.1(0-1)
Jan	----	----	----
Feb	----	----	----
Mar	2.0(0-7)	1.2(0-3)	1.6(0-7)
Apr	----	3.4(0-12)	1.7(0-12)
May	3.4(0-10)	----	2.1(0-10)
Jun	0.4(0-2)	----	0.2(0-2)
Jul	0.2(0-1)	----	0.1(0-1)
Aug	----	0.2(0-1)	0.1(0-1)
Sep	0.3(0-1)	----	0.1(0-1)
Oct	0.8(0-3)	1.0(0-2)	0.8(0-3)
Nov	----	----	----

Appendix XI. Mean monthly burdens of chiggers found on *Peromyscus leucopus* from November, 1970 through November, 1971.

	males	females	total
Nov	16.3(8-28)	19.0(2-43)	17.3(2-43)
Dec	13.5(6-20)	29.6(4-75)	24.3(6-75)
Jan	25.6(7-46)	26.1(4-74)	25.8(4-74)
Feb	32.4(9-57)	27.4(0-71)	30.5(0-71)
Mar	35.6(11-75)	10.6(1-26)	23.1(1-75)
Apr	4.2(1-11)	25.0(2-67)	14.6(1-67)
May	3.8(0-13)	1.8(0-6)	3.0(0-13)
Jun	5.7(1-12)	1.0(0-5)	2.9(0-12)
Jul	3.8(0-22)	0.9(0-4)	2.0(0-22)
Aug	0.3(0-1)	2.7(0-15)	1.8(0-15)
Sep	1.3(0-3)	0.5(0-2)	0.5(0-3)
Oct	8.1(0-21)	13.0(0-26)	9.1(0-26)
Nov	19.7(3-72)	32.0(17-63)	24.0(3-72)

Appendix XII. Mean monthly burdens of mites belonging to the suborder Astigmata found on Peromyscus leucopus from November, 1970 through November, 1971.

	Dermacarus hypudaei			Listrophorus leukorti		
	males	females	total	males	females	total
Nov	3.7(0-11)	0.8(0-4)	1.9(0-11)	0.6(0-4)	2.4(0-8)	1.3(0-8)
Dec	----	2.0(0-7)	1.3(0-7)	0.5(0-1)	----	0.2(0-1)
Jan	0.6(0-2)	1.9(0-19)	1.4(0-19)	----	----	----
Feb	1.9(0-5)	0.2(0-1)	1.2(0-5)	0.3(0-1)	----	0.2(0-1)
Mar	0.2(0-1)	84.8(0-424)	42.5(0-424)	0.4(0-2)	11.0(0-55)	5.7(0-55)
Apr	4.0(0-15)	9.0(0-17)	6.4(0-17)	0.6(0-3)	----	0.3(0-3)
May	0.3(0-1)	0.4(0-2)	0.3(0-2)	----	----	----
Jun	0.4(0-1)	----	0.2(0-1)	----	----	----
Jul	0.3(0-2)	0.3(0-1)	0.3(0-2)	----	----	----
Aug	1.0(0-2)	0.7(0-3)	0.8(0-3)	1.0(0-2)	1.0(0-3)	1.0(0-3)
Sep	3.3(0-9)	3.1(0-7)	3.5(0-9)	----	5.3(0-30)	3.1(0-30)
Oct	2.0(0-10)	1.0(0-1)	1.8(0-10)	1.1(0-8)	0.5(0-1)	1.0(0-8)
Nov	1.7(0-2)	4.3(0-8)	1.8(0-8)	1.3(0-5)	4.0(0-9)	2.4(0-9)

Appendix XII. Continued.

	Mycoptes sp.		
	males	females	total
Nov	0.1(0-1)	----	0.1(0-1)
Dec	----	----	----
Jan	----	0.1(0-1)	0.1(0-1)
Feb	0.3(0-2)	0.8(0-3)	0.5(0-3)
Mar	0.2(0-1)	----	0.1(0-1)
Apr	0.4(0-1)	----	0.2(0-1)
May	----	----	----
Jun	----	0.1(0-1)	0.1(0-1)
Jul	0.2(0-1)	----	0.1(0-1)
Aug	0.7(0-2)	0.3(0-2)	0.4(0-2)
Sep	----	----	----
Oct	0.6(0-3)	0.4(0-8)	1.3(0-8)
Nov	0.3(0-1)	----	0.2(0-1)

Appendix XIII. Mean monthly burdens of Hoplopleura hesperomydis found on Peromyscus leucopus from November, 1970 through November, 1971.

	males	females	total
Nov	----	1.2(0-6)	0.5(0-6)
Dec	----	1.0(0-9)	0.7(0-9)
Jan	0.3(0-2)	0.4(0-4)	0.4(0-4)
Feb	10.6(0-25)	1.2(0-3)	7.1(0-25)
Mar	0.6(0-3)	0.2(0-1)	0.4(0-3)
Apr	2.5(0-12)	0.4(0-2)	1.5(0-12)
May	0.3(0-2)	----	0.2(0-2)
Jun	----	0.7(0-4)	0.4(0-4)
Jul	3.3(0-19)	0.2(0-1)	1.5(0-19)
Aug	----	----	----
Sep	----	0.2(0-1)	0.1(0-1)
Oct	----	----	----
Nov	42.7(0-252)	0.3(0-1)	26.0(0-252)

Appendix XIV. Mean monthly burdens of Syphacia peromysci found in Peromyscus leucopus from November, 1970 through November, 1971.

	males	females	total
Nov	76.3(0-280)	52.0(0-92)	67.0(0-280)
Dec	42.5(0-119)	48.8(0-205)	46.8(0-205)
Jan	34.1(0-138)	66.8(0-448)	51.4(0-448)
Feb	159.3(0-969)	8.0(0-38)	101.1(0-969)
Mar	----	----	----
Apr	87.0(2-127)	52.0(0-116)	69.5(0-127)
May	----	----	----
Jun	----	----	----
Jul	0.3(0-2)	2.1(0-11)	1.4(0-11)
Aug	8.7(0-26)	1.3(0-9)	3.5(0-26)
Sep	7.0(0-28)	----	2.8(0-28)
Oct	----	----	----
Nov	15.7(0-83)	72.0(0-131)	38.2(0-131)

LITERATURE CITED

Batson, J. 1965. Studies on the prairie vole, Microtus ochrogaster, in central Kentucky. Trans. Ky. Acad. Sci. 25: 129-137.

Benton, A. H. and H. J. Altmann. 1964. A study of fleas found on Peromyscus in New York. J. Mamm. 45: 31-36.

----- and D. L. Kelly. 1969. Notes on the biology of Ctenophthalmus p. pseudagyrtes Baker in the northeast (Siphonaptera: Hystrichopsyllidae). Jour. N. Y. Ent. Soc. 77: 70-74.

Bishopp, F. C. and H. L. Trembley. 1945. Distribution and host of certain North American ticks. J. Parasit. 31: 1-54.

Caras, R. A. 1967. North American Mammals. Meredith Press, New York. 578 pages.

Coleman, R. W. 1950. DDT protects baits from ants. J. Mamm. 31: 199.

Cook, E. F. and J. R. Beer. 1958. A study of louse populations on the meadow vole and deer mouse. Ecology 39: 645-659.

Cross, H. F. and G. W. Wharton. 1964. A comparison on the number of tropical rat mites and tropical fowl mites that fed at different temperatures. J. Econom. Ent. 57: 439-443.

Drummond, R. O. 1957. Observations on fluctuations of acarine populations from nests of Peromyscus leucopus. Ecol. Mon. 27: 137-152.

Dunaway, P. B., J. A. Payne, L. L. Lewis, and J. D. Story. 1967. Incidence and effects of Cuterebra in Peromyscus. J. Mamm. 48: 38-51.

Farrell, C. E. 1956. Chiggers of the genus Euschoengastia (Acarina: Trombiculidae) in North America. Proc. U. S. Natl. Mus. 106: 85-235.

Hall, J. E. and B. Sonnenberg. 1955. Some helminth parasites of rodents from localities in Maryland and Kentucky. J. Parasit. 41: 640-641.

Harkema, R. 1936. The parasites of some North Carolina rodents. Ecol. Mon. 6: 151-232.

Herms, W. W. 1961. Medical Entomology. revised by M. T. James. The MacMillan Co., New York. 616 pages.

Holland, G. P. and A. H. Benton. 1968. Siphonaptera from Pennsylvania mammals. Amer. Mid. Nat. 80: 252-261.

Jameson, E. W., Jr. 1947. Natural history of the prairie vole. Univ. Kans. Publ. Mus. Nat. Hist. 1: 125-151.

----- 1950. External parasites of the short-tailed shrew, Blarina brevicauda. J. Mamm. 31: 138-145.

----- 1955. A summary of the genera of Myobiidae (Acarina). J. Parasit. 41: 407-416.

Kates, K. C. and C. E. Runkel. 1948. Observations on oribatid mite vectors of Moniezia expansa on pastures, with a report of several new vectors from the United States.

Helm. Soc. Wash. 15: 18-33.

Krantz, G. W. 1971. A Manual of Acarology. O. S. U. Book Stores, Inc., Corvalis, Oregon. 335 pages.

Kruidenier, F. J., K. N. Mehra, and R. Harkema. 1961. Comparative studies of Syphacia peromysci and S. samoradini (Nematoda: Oxyuridae). J. Parasit. 47: 47-52.

Meyer, M. C. and O. W. Olsen. 1971. Essentials of Parasitology. Wm. C. Brown Co., Dubuque, Iowa. pages 263-271.

Morlan, H. B. 1952. Host relationships and seasonal abundances of some southwest Georgia ectoparasites. Amer. Mid. Nat. 48: 74-93.

Oswald, V. H. 1958. Studies on Rictularia coloradensis Hall, 1916 (Nematoda: Thelaziidae). II. Development in the definitive host. Trans. Amer. Micr. Soc. 77: 413-422.

Pratt, H. D. and N. E. Good. 1954. Distribution of some domestic rat ectoparasites in the United States. J. Parasit. 40: 113-129.

Rausch, R. 1952. Studies on the helminth fauna of Alaska. XI. Helminth parasites of microtine rodents - taxonomic considerations. J. Parasit. 38: 415-444.

----- and E. L. Schiller. 1949. A critical study of North American cestodes of the genus Andrya with special reference to A. macrocephala Douthitt, 1915 (Cestoda: Anoplocephalidae). J. Parasit. 35: 306-314.

----- and J. D. Tiner. 1949. Studies on the parasitic helminths of the north central states. II. Helminths of voles (Microtus spp.) preliminary report. Amer. Mid.

Nat. 41: 665-694.

Smith, C. N., M. M. Cole, and H. K. Gouck. 1946. Biology and control of the American dog tick. U. S. Dept. Agric. Tech. Bull. 905: 1-74.

Suyemoto, W., J. E. Scanlon, and T. C. Sicay. 1954. Ectoparasite fauna of small mammals and birds in the Fuji Maneuver area, Honshu, Japan. J. Parasit. 40: 632-637.

Steel, R. G. D. and J. H. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Co. Inc., New York. 481 pages.

Strandtmann, R. W. 1949. The blood sucking mites of the genus Haemolaelaps (Acarina: Laelaptidae) in the United States. J. Parasit. 35: 325-352.

Tiner, J. D. 1948. Syphacia eutami n. sp. from the least chipmunk, Eutamias minimus, with a key to the genus (Nematoda: Oxyuridae). J. Parasit. 34: 87-92.

Verts, B. J. 1961. Observations on the fleas (Siphonaptera) of some small mammals in northwestern Illinois. Amer. Mid. Nat. 66: 471-476.

Wardle, R. A. and J. A. McLeod. 1952. The Zoology of Tapeworms. Univ. Minn. Press, Minneapolis. 780 pages.

Wecker, S. C. 1962. The effects of bot fly parasitism on a local population of the white-footed mouse. Ecology 43: 561-565.

Whitaker, J. O., Jr. 1968. Parasites. in Biology of Peromyscus (Rodentia). Spec. Publ. Amer. Soc. Mamm. 2: 254-311.

Whitaker, J. O., Jr. and N. Wilson. 1968. Mites of small mammals of Vigo County, Indiana. Amer. Mid. Nat. 80: 537-542.

Worth, C. B. 1950. Observations on ectoparasites of some small mammals in Everglades National Park and Hillsborough County, Florida. J. Parasit. 36: 326-335.

Yamaguti, S. 1959. Systema Helminthum. Vol. II. The Cestodes of Vertebrates. Interscience Publ., Inc., New York. 860 pages.

----- 1961. Systema Helminthum. Vol. III. The Nematodes of Vertebrates, Part I. and II. Interscience Publ., Inc., New York. 1261 pages.