

Parasites of Feral Housemice, *Mus musculus*, in Vigo County, Indiana

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Abstract

The major external parasites of the housemouse, *Mus musculus*, in Vigo County, Indiana, are *Myobia musculi*, *Radfordia affinis*, *Myocoptes musculus*, *Ornithonyssus bacoti*, *Androlaelaps fahrenheitsi*, and *Dermacarus heptneri* (all are mites), in approximate order of decreasing abundance. Among the internal parasites, *Heligmosomoides polygyrus* is the most abundant, followed by cestodes (presently unidentified and listed as a group), *Protospirura* sp., and *Syphacia* sp. Males and females harbored similar parasite infestations, but there was a definite increase in internal parasite load with increased age of the mouse. The same trend was apparent in one species of mite, *Radfordia affinis*, but was not evident in the rest of the species of ectoparasites. *Heligmosomoides* is primarily a spring and winter form and occurred at its greatest abundance in the single habitat present only at that time, winter wheat, while cestodes were most common during the summer and fall. The data are scanty, but suggest *Syphacia* to be a spring and summer form. *Myocoptes* was primarily a fall form. Most external parasites reached their greatest abundance in the fall and summer. *Myobia* was most abundant in winter wheat and corn, *Radfordia* in soybeans and corn, *Myocoptes* in corn and *Ornithonyssus bacoti* in sorghum. No relation was found between internal and external parasites; their distributions seemed independent of each other.

Introduction

A number of housemice, *Mus musculus*, were taken during studies of the mammals of Vigo County, Indiana (2). Of these, 470 from randomly selected plots were examined for external parasites, and 503 for internal parasites. The present study was initiated to determine if there were seasonal, sex, age or habitat differences in parasite infestations.

Some of the information has been presented previously, in a paper on the fleas of the mammals of Vigo County (3), in a paper on the mites of the small mammals of Vigo County (4), and in a paper on the Labidophorine mites of North America (1).

Donald Norris was kind enough to make the nematode identifications.

Methods

External parasites were obtained by searching the fur with dissecting needles and a 10 to 60X zoom binocular dissecting microscope. Mites were cleared and stained overnight in cold Nesbitt's Solution, mounted in Hoyer's Solution and ringed with asphaltum. Fleas were run through the alcohols and mounted in permount. Internal parasites were preserved in 70% alcohol or formal-acetic acid (FAA).

Data concerning incidence of parasitism were presented in terms of percentage of mice infested, with Chi-square being used to test for significant differences using the actual numbers of parasitized mice in the different categories. Abundance information was presented in terms of average number of parasites per mouse, but this number often seemed

of less value than the incidence values because of the great amount of variation in the numbers of parasites infesting individual mice, with a few individuals harboring large numbers. For this reason "t" tests were not run.

External parasites

Other than some of the species of mites, there were few external parasites on the housemouse. One mouse yielded about 15 larval ticks, 2 mice each had 1 flea, 1 had 2 lice, while 124 mice had mites (Table 1).

TABLE 1. Comparison of parasites of male and female *Mus musculus*.

| Parasites | 270 Males | | | | 219 Females | | | |
|------------------------------------|-------------|------|-----------|-------|-------------|-----|-----------|-------|
| | Infestation | | No./Mouse | | Infestation | | No./Mouse | |
| | No. | % | Total | Avg. | No. | % | Total | Avg. |
| Internal Parasites | | | | | | | | |
| <i>Heligmosomoides</i> | | | | | | | | |
| <i>polygyrus</i> | 35 | 13.0 | 482 | 1.79 | 21 | 9.5 | 171 | 0.78 |
| Cestodes | 21 | 7.8 | 93 | 0.34 | 22 | 9.6 | 94 | 0.43 |
| <i>Syphacia</i> | 5 | 1.9 | 27 | 0.10 | 3 | 1.4 | 49 | 0.22 |
| <i>Protospirura</i> | 5 | 1.9 | 6 | 0.02 | 6 | 2.7 | 9 | 0.04 |
| <i>Cuterebra</i> larvae | 1 | 0.4 | 1 | 0.004 | 0 | 0.0 | 0 | 0.0 |
| Ascarid larvae | 0 | 0.0 | 0 | 0.0 | 1 | 0.5 | 1 | 0.005 |
| <i>Heterakis</i> | 0 | 0.0 | 0 | 0.0 | 1 | 0.5 | 1 | 0.005 |
| <hr/> | | | | | | | | |
| | 253 Males | | | | 214 Females | | | |
| External Parasites | | | | | | | | |
| <i>Myobia musculi</i> | 24 | 9.5 | 132 | 0.52 | 12 | 5.6 | 29 | 0.14 |
| <i>Radfordia affinis</i> | 23 | 9.1 | 51 | 0.20 | 12 | 5.6 | 22 | 0.10 |
| <i>Ornithonyssus bacoti</i> | 16 | 6.3 | 35 | 0.14 | 2 | 0.9 | 3 | 0.01 |
| <i>Androlaelaps fahrenheitsi</i> | 11 | 4.3 | 25 | 0.10 | 3 | 1.4 | 3 | 0.01 |
| <i>Myocoptes musculus</i> | 7 | 2.8 | 10 | 0.04 | 9 | 4.2 | 27 | 0.13 |
| <i>Dermacarus heptneri</i> | 2 | 0.8 | 57 | 0.22 | 1 | 0.5 | 1 | 0.005 |
| <i>Dermacarus hypudaei</i> | 2 | 0.8 | 2 | 0.01 | 0 | 0.0 | 0 | 0.00 |
| <i>Hirstionyssus talpae</i> | 1 | 0.4 | 3 | 0.01 | 1 | 0.5 | 1 | 0.005 |
| <i>Eulaelaps stabularis</i> | 1 | 0.4 | 1 | 0.004 | 0 | 0.0 | 0 | 0.0 |
| Larval ticks | 1 | 0.4 | 15 | 0.06 | 0 | 0.0 | 0 | 0.0 |
| <i>Hoplopleura captiosa</i> | 1 | 0.4 | 2 | 0.01 | 0 | 0.0 | 0 | 0.0 |
| Misc. Mites | 13 | 5.1 | 18 | 0.07 | 11 | 5.1 | 15 | 0.07 |
| <i>Listrophorus leuckarti</i> | 0 | 0.0 | 0 | 0.00 | 1 | 0.5 | 1 | 0.005 |
| <i>Orchopcas leucopus</i> | 0 | 0.0 | 0 | 0.00 | 1 | 0.5 | 1 | 0.005 |
| <i>Ctenophthalmus pscudagyrtcs</i> | 0 | 0.0 | 0 | 0.00 | 1 | 0.5 | 1 | 0.005 |
| <i>Androlaelaps morlani?</i> | 0 | 0.0 | 0 | 0.00 | 1 | 0.5 | 1 | 0.005 |

Mites, then, were the dominant form of external parasites, with 11 species being found in all. Seven of these, *Androlaelaps morlani* (?), *Dermacarus hypudaei* (not previously reported), *Eulaelaps stabularis*, *Haemogamasus longitarsus* and *Listrophorus leuckarti* were represented by only one or two specimens each, and *Hirstionyssus talpae* by only four, hence these species were not considered as important parasites of the housemouse in the area under consideration.

The hypopial form of the mite, *Dermacarus heptneri*, was found on 3 housemice, totaling 58 individuals. This species is very tiny and can be easily overlooked, hence it may be more abundant than indicated. Mites of this type cling tenaciously to the individual hairs; one must separate the hairs with dissecting pins and examine their bases to find the hypopi. *D. heptneri* was found on no other species of Vigo County mammal, but the hypopi of another species of *Dermacarus*, *D. hypudaei*, were found on two housemice. *D. hypudaei* is primarily a species of *Zapus*, but is also found on other species, especially *Microtus ochrogaster* and *M. pennsylvanicus*.

Androlaelaps fahrenheitzi, totaling 29 individuals on 14 mice, was a parasite of the housemouse, as was the case with most species of small mammals examined. It occurred at a lower rate, at 0.07 individuals per housemouse, than on most of the other species (4).

Fifteen housemice yielded 56 specimens of the tiny Listrophorid mite, *Mycoptes musculinus*. This species of mite was not restricted to the housemouse, but all except seven specimens taken were from that host.

Ornithonyssus bacoti was an important mite on *Mus musculus*, 34 specimens being taken from 18 mice. This mite occurred at a similar rate on *Peromyscus maniculatus bairdi*, and three specimens were taken from *P. leucopus*.

Radfordia affinis was taken almost entirely on *Mus*, with 65 individuals being taken from a total of 36 different mice. Two specimens were taken from *Peromyscus maniculatus* in the area under consideration (4).

Myobia musculi, a tiny white form similar in general appearance to *Radfordia affinis*, and like that species a myobiid mite, was the most common species of external parasite on *Mus musculus* in Vigo County. It was taken on 9.1% of the housemice, but was not found on any of the other species of small mammals examined (4).

The housemouse, in Indiana, appears to be relatively flealess, only 2 fleas being taken on the 470 housemice examined during the present study, 1 each of *Orchopeas leucopus* and *Ctenophthalmus pseudagyrtes*. A third species, *Epitedia wenmanni*, again one specimen, was previously reported from a Vigo County housemouse (3). Likewise Wilson (5) took only two fleas from Indiana *Mus*, one an *Epitedia wenmanni*, the other a specimen of *Orchopeas leucopus*.

One of the housemice examined yielded two lice, *Hoplopleura captiosa*, the only louse recorded from *Mus* in Indiana. Wilson (5) took four specimens from the housemouse from Carroll and Tippecanoe Counties.

One housemouse yielded about 15 larval ticks, which were preserved, but subsequently lost. Wilson (5) reported three different individuals of the tick, *Dermacentor variabilis*, from *Mus* from three Indiana counties.

Internal Parasites

No trematodes or acanthocephalans were taken from any of the 503 housemice examined for internal parasites, while both nematodes and cestodes were found to be relatively common.

Among the internal parasites the most abundantly represented group overall was the Nematoda, especially *Heligmosomoides polygyrus*. This species was generally tightly coiled when seen among materials from the intestinal tract, and was red. Fifty-six of the mice examined, or 11.1% contained from one to over 100 individuals of this species, totaling 653 worms, and averaging 1.30 worms per mouse. Eight of the mice yielded over 25 worms per host. This species was found mostly in *Mus*, but a few individuals, apparently *H. polygyrus* were found in *Peromyscus maniculatus bairdi*.

Eleven mice had 15 nematodes of the genus *Protopirura*, nearly all of which were in the stomach rather than in the intestine. Female oxyurids, *Syphacia*, were found in nine mice, totaling 96 specimens.

Cestodes were important as parasites of *Mus musculus*, but unfortunately these have not yet been identified and are treated here as a group. Forty-three housemice yielded 187 cestodes.

Cuterebra, sp., a botfly larva, was found in one mouse; one mouse yielded a nematode of the genus *Heterakis*; one harbored five objects from under the skin of the head which appeared to be larval cestodes; and one yielded a larval Ascarid nematode.

Parasites in Relation to Sex of Mice

A total of 270 male housemice were examined for internal parasites, of which 62, or 22.9%, yielded 593 parasites, or 2.20 per mouse. Of the 210 females examined, 47, or 22.3%, yielded 325 parasites, or 1.55 per mouse. Thus, males and females were about equally infested in terms of incidence, but the rate of infestation in terms of average number of parasites per mouse was higher in males than in females in this sample.

The two main types of internal parasites were nematodes, *Heligmosomoides polygyrus*, and cestodes. Of the 270 male housemice examined, 35, or 13.0%, harbored 482 nematodes, *Heligmosomoides*, averaging 1.79 worms per mouse for all mice, or 13.77 worms per mouse for those parasitized. Twenty-one of the 219 females, or 9.5%, yielded 171 *Heligmosomoides*, averaging 0.78 worms per mouse overall, and 8.1 in those infested. The higher average number in the males was primarily because of three males with particularly large infestations of 40, 58 and 100 worms.

A total of 93 cestodes were taken from 21, or 7.7% of the male *Mus* examined, averaging 0.34 cestodes per mouse overall, or 4.43 per parasitized mouse. In the females, 22 of 219, or 10.0%, harbored 94 cestodes, for an average of 0.43 per mouse, or 4.27 in the mice infested. Thus

males and females harbored relatively similar internal parasite loads. (Comparisons for the remainder of the individual kinds of parasites can be found in Table 1.)

Parasite Infestation and Age of Animal

To determine the relationship between age of the animal and parasite infestation, the mice were divided into 4 groups based on weight, those under 10 g, 10.0 to 14.9 g, 15.0 to 19.9 g, and those over 20 g.

There was a significant increase (Chi-square = 28.75**, 3 df) in the incidence of animals with internal parasites with increased age of the animals, going from 9.1 through 16.5, 23.5 and 47.8% of the mice being parasitized in the four size groups (Table 2). This trend was apparent in both the most important parasite groups, the nematode *Heligmosomoides*, and in the cestodes. For *Heligmosomoides*, the largest class again harbored the most worms per mouse, on the average, while the three smallest classes were about the same, but for cestodes there was an increased mean number of individuals per mouse with increased age.

TABLE 2. Major parasites of four size classes of housemice, *Mus musculus*.

| Parasites | Under 10 g | | 10.0-14.9 g | | 15.0-19.9 g | | 20 g and over | |
|----------------------------------|------------|---------------|-------------|---------------|-------------|---------------|---------------|---------------|
| | % Infest. | Avg. #/ Mouse | % Infest. | Avg. #/ Mouse | % Infest. | Avg. #/ Mouse | % Infest. | Avg. #/ Mouse |
| Internal Parasites | | | | | | | | |
| Number examined | (66) | | (206) | | (162) | | (69) | (503) |
| All internal parasites | 9.1 | 1.32 | 16.5 | 1.32 | 23.5 | 1.32 | 47.8 | 5.58 |
| <i>Heligmosomoides polygyrus</i> | 4.5 | 1.02 | 9.2 | 0.86 | 11.7 | 0.90 | 21.7 | 3.86 |
| Cestodes | 0.0 | 0.00 | 4.9 | 0.17 | 8.6 | 0.35 | 26.1 | 1.44 |
| <i>Syphacia</i> sp. | 3.0 | 0.32 | 1.5 | 0.24 | 1.2 | 0.03 | 2.9 | 0.30 |
| <i>Protospirura</i> | 1.5 | 0.02 | 0.9 | 1.94 | 3.7 | 0.05 | 2.9 | 0.03 |
| External Parasites | | | | | | | | |
| Number examined | (61) | | (194) | | (153) | | (62) | |
| All external parasites | 26.2 | 0.50 | 21.6 | 0.79 | 31.5 | 1.14 | 29.0 | 1.10 |
| <i>Myobia muscili</i> | 3.2 | 0.03 | 5.2 | 0.16 | 11.7 | 0.66 | 9.7 | 0.44 |
| <i>Radfordia affinis</i> | 3.2 | 0.05 | 4.6 | 0.11 | 7.8 | 0.18 | 16.1 | 0.25 |
| <i>Myocoptes musculinus</i> | 4.9 | 0.10 | 2.6 | 0.04 | 3.3 | 0.10 | 3.2 | 0.08 |
| <i>Ornithonyssus bacoti</i> | 0.0 | 0.00 | 4.1 | 0.07 | 4.6 | 0.10 | 4.8 | 0.10 |
| <i>Androlaelaps fahrenheitzi</i> | 4.9 | 0.24 | 2.1 | 0.04 | 2.6 | 0.03 | 4.8 | 0.06 |

Among external parasites as a group there was no such apparent trend in incidence (Table 2). Respective values for the 4 size classes are 26.2, 21.6, 31.5 and 29.0%. In most cases there was no definite relationship between parasites and age, or else the data were too scanty to draw conclusions. One species, however, *Radfordia affinis*, did show the same tendencies as the internal parasites. It is more apt to be taken in the older mice (Chi-square = 10.10, 2 df).

Parasite Infestation and Season

Data were summarized (Table 3) on a seasonal basis as Spring (Mar. through May), Summer (June through Aug.), Fall (Sept. through Nov.), and Winter (Dec. through Feb.).

TABLE 3. Seasonal distribution of major parasites of *Mus musculus*.

| Parasites | Spring | | Summer | | Fall | | Winter | |
|---------------------------|--------------|------------------|--------------|------------------|--------------|------------------|--------------|------------------|
| | % Infest. | Avg. #/ Mouse |
| Internal Parasites | | | | | | | | |
| Number examined | (79) | | (88) | | (194) | | (142) | |
| All internal parasites | 40.5 | | 19.3 | | 18.0 | | 19.0 | |
| <i>Heligmosomoides</i> | 34.2 | 4.48 | 5.7 | 0.89 | 5.2 | 0.24 | 9.9 | 1.23 |
| Cestodes | 1.3 | 0.06 | 11.4 | 0.65 | 12.9 | 0.57 | 4.2 | 0.10 |
| <i>Syphacia</i> | 2.5 | 0.51 | 4.5 | 0.35 | 0 | 0 | 2.1 | 0.18 |
| <i>Protospirura</i> | 5.1 | 0.09 | 2.2 | 0.02 | 1.5 | 0.02 | 1.4 | 0.02 |
| External Parasites | | | | | | | | |
| Number examined | (77) | | (85) | | (168) | | (140) | |
| All external parasites | 19.3 | | 34.1 | | 42.3 | | 12.9 | |
| <i>Myobia</i> | 3.8 | 0.43 | 8.2 | 0.46 | 13.1 | 0.41 | 2.9 | 0.15 |
| <i>Radfordia</i> | 2.6 | 0.17 | 10.6 | 0.27 | 12.5 | 0.18 | 1.4 | 0.01 |
| <i>Myocoptes</i> | 0 | 0 | 2.4 | 0.02 | 7.7 | 0.32 | 0 | 0 |
| <i>Ornithonyssus</i> | 1.3 | 0.04 | 11.8 | 0.24 | 3.0 | 0.07 | 1.4 | 0.02 |
| <i>A. fahrenheitzi</i> | 1.3 | 0.01 | 1.2 | 0.01 | 5.4 | 0.14 | 2.1 | 0.02 |

The greatest percentage of housemice harbored internal parasites during the spring, at 40.5%, while just under 20% of those taken were parasitized during the other 3 seasons. This difference was significant (Chi-square = 14.45, 1 df). The parasite load is heaviest during the spring because the principle internal parasite, *Heligmosomoides polygyrus*, is primarily a spring parasite, reaching by far its greatest percentage infection of mice, and its greatest average number of worms per mouse at that time. This nematode had its second greatest occurrence during the winter. Cestodes, as a group the second most important of the internal parasites, were least common during the spring and winter, and most common during the summer and fall. For *Syphacia*, the data are scanty, but this form would appear to be a spring and summer form. It was not taken at all in the fall sample of mice, even though this was the largest sample, at 194. *Protospirura* seemed to be most abundant in the spring, but data are too few concerning this species to be reliable.

External parasites, as a group, were most abundant in the fall and summer, and least abundant in the winter (Chi-square = 29.47, 3 df). *Myobia musculi*, *Radfordia affinis* and *Myocoptes musculus* were fall and winter mites, with *Myocoptes* occurring only during that season. *Ornithonyssus bacoti* was taken at its greatest rate in the summer, and *Androlaelaps fahrenheitzi* was taken at its greatest rate in the fall. With the exception of *A. fahrenheitzi*, all species occurred at their lowest abundance in the winter.

Parasites of *Mus* as Associated with Habitat

There were enough data concerning *Mus* parasites in eight habitats to make a meaningful presentation (Table 4). Late stage winter wheat (over 6 inches high) was the one habitat available only during the spring. As seen previously, *Heligmosomoides* was primarily a spring parasite, and as one might expect, winter wheat was the habitat in which the greatest incidence and abundance of this nematode occurred. The second greatest abundance occurred in cut corn, primarily a winter habitat, although some cut corn areas were available in the fall, and some were still present in the spring. The major habitats for cestodes were corn and cut wheat. *Syphacia* was most abundant in the winter wheat over 6 inches, and in winter wheat which had been cut. This latter habitat was available in late spring and early summer.

TABLE 4. Relationship of *Mus* parasites to habitat. (Numbers in parentheses are the numbers of plots in the habitats.)

| Habitat | Internal Parasites | | | | | | | | | |
|------------------------------|--------------------|------------------|----------|------------------|----------|------------------|--------------|------------------|------|--|
| | Heligmosomoides | | Cestodes | | Syphacia | | Protospirura | | | |
| | % | Avg. #/ Mouse | % | Avg. #/ Mouse | % | Avg. #/ Mouse | % | Avg. #/ Mouse | | |
| Weedy field (58) | 3.4 | 0.05 | 5.2 | 0.17 | 0 | | | 0 | | |
| Grassy field (69) | 5.8 | 0.72 | 4.3 | 0.35 | 0 | | | 2.9 | 0.06 | |
| Soybeans (25) | 12.0 | 0.12 | 4.0 | 0.04 | 4.0 | 0.04 | | 4.0 | 0.08 | |
| Winter wheat over 6" (37) | 29.7 | 5.22 | 5.4 | 0.27 | 5.4 | 1.08 | | 5.4 | 0.08 | |
| Corn (118) | 3.8 | 0.18 | 15.4 | 0.65 | 0 | | | 2.3 | 0.02 | |
| Sorghum (31) | 9.7 | 0.77 | 0 | | 3.2 | 0.03 | | 0 | | |
| Wheat, cut (79) | 10.1 | 0.71 | 12.7 | 0.65 | 3.8 | 0.62 | | 2.5 | 0.03 | |
| Corn, cut (69) | 27.5 | 4.35 | 4.3 | 0.07 | 2.9 | 0.07 | | 1.4 | 0.01 | |

| Habitat | External Parasites | | | | | | | | | |
|-------------------------|--------------------|------------------|-----------|------------------|-----------------|------------------|-----------|------------------|-----------|------------------|
| | Myobia | | Radfordia | | A. fahrenheitsi | | Myocoptes | | O. bacoti | |
| | % | Avg. #/ Mouse | % | Avg. #/ Mouse | % | Avg. #/ Mouse | % | Avg. #/ Mouse | % | Avg. #/ Mouse |
| Weedy field (54) | 5.6 | 0.37 | 0 | | 3.7 | 0.04 | 0 | | 3.7 | 0.07 |
| Grassy field (65) | 4.6 | 0.05 | 7.7 | 0.12 | 6.1 | 0.06 | 1.5 | 0.05 | 1.5 | 0.02 |
| Soybeans (23) | 4.3 | 0.04 | 17.4 | 0.39 | 0 | | 4.3 | 0.04 | 0 | |
| Winter wheat 6" (37) | 8.1 | 0.89 | 2.7 | 0.03 | 0 | | 0 | | 0 | |
| Corn (118) | 14.4 | 0.64 | 16.1 | 0.26 | 5.1 | 0.17 | 10.2 | 0.42 | 2.5 | 0.08 |
| Sorghum (25) | 8.0 | 0.12 | 0 | | 0 | | 0 | | 20.0 | 0.24 |
| Wheat, cut (78) | 7.7 | 0.28 | 3.8 | 0.10 | 1.3 | 0.01 | 1.3 | 0.04 | 7.7 | 0.21 |
| Corn, cut (67) | 1.5 | 0.04 | 3.0 | 0.19 | 1.5 | 0.02 | 0 | | 1.5 | 0.03 |

Myobia was most abundant in the winter wheat and in the corn while *Radfordia* was taken at its greatest rates in soybeans and corn. *Myocoptes* was quite definitely a form of the cornfields while *Ornithonyssus bacoti* was found at its greatest rate in sorghum.

Discussion

Season, habitat and age of the host all seemed to influence the parasite population of the housemouse, *Mus musculus*, while the fourth factor under consideration, sex of the animal, seemed to have little or no effect. Some factors appeared interrelated in such a way that it was difficult to determine which of two factors was affecting the mice. For example, the nematode parasite, *Heligmosomoides polygyrus*, was most abundant in the spring in winter wheat fields in which the wheat was at least 6 inches high. Hence, one can conclude that the best situation in which to look for this species is in winter wheat fields during the spring, but I was unable to evaluate the relative effects of the particular season as opposed to those of the habitat.

The relationship of internal and external parasitism was assessed in an attempt to determine whether animals became parasitized because of their generally poor physical condition, or if the animals simply happened to be in the right place at the right time to become parasitized. If animals were infected because of a general overall poor physical condition, then the same animals that were parasitized internally should also tend to be parasitized externally. On the other hand, if parasitism was strictly a chance happening, then one should be able to compute the approximate number of mice expected to have both internal and external parasites by multiplying the percentage of mice with external parasites times the percentage with internal parasites. For this calculation, only the 470 mice examined for both internal and external parasites were used. Of these, 130, or 0.277 were found to have external parasites, and 102, or 0.217 were found to harbor internal parasites. One would expect, by chance, that $0.277 \times 0.217 = 0.060$ of the 470, or 28.20 mice would have both internal and external parasites. The actual number of mice with both internal and external parasites was 30, hence we can conclude that the relationship between internal and external parasites of the housemouse in Vigo County is strictly a chance one.

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