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Aspiculuris tetraptera in wild *Mus musculus*. The prevalence of infection in male and female mice

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ABSTRACT

A survey was carried out of the levels of infection with *Aspiculuris tetraptera* and *Syphacia obvelata* in a wild house mouse population living in the Charles Clore Small Mammals Pavilion at the London Zoo in Regent's Park. The extent of infection with *A. tetraptera* is analysed according to the sex of the host. It is shown that the prevalence of infection was greater in male than in female mice and frequency distribution studies suggest that this is not only because fewer female mice become infected but also because females resist larvae more effectively than do males.

Several authors have reported on the prevalence of the oxyurid nematode *Aspiculuris tetraptera* in wild populations of its natural host *Mus musculus* and in abnormal hosts such as *Rattus norvegicus* and *Clethrionomys glareolus*. Most have only cited the presence or absence of the parasite and consequently there is little information on differences in the distribution of infection levels between the sexes and amongst the various age groups in wild host populations.

Roman (1951) reported a pronounced sex difference in the prevalence of *A. tetraptera* in wild *M. musculus*. He found the parasite in 48% of male mice but in only 24·4% of females. Other authors have given overall infection rates in *M. musculus* ranging from 10–16% (Bernard, 1963) to 57% (Akhtar, 1955) and in abnormal hosts from 6·4% in *Clethrionomys glareolus* (Sharpe, 1964) to 60% in *Rattus rattus rufescens* (Akhtar, 1955). Besides Roman's work (1951) the only remaining qualitative study was that of Sharpe (1964) on the prevalence of infection in the abnormal host *C. glareolus*. In this species the prevalence of *A. tetraptera* was 7% in immature males, 5·3% in mature males, 9·7% in immature females and 3·6% in mature females.

Laboratory studies likewise have indicated that female *M. musculus* resist infection more effectively than do males (Mathies, 1959b; Stahl, 1962) and that older animals are less susceptible to infection (Mathies, 1959a; Stahl, 1962). In view of these results and also of Roman's preliminary observation, it is pertinent to establish how these phenomena are manifest in wild populations of *M. musculus*. A survey was, therefore, carried out of the prevalence of *A. tetraptera* in a wild *M. musculus* population in the London Zoo and the degree of infection was analysed according to the sex of the host.

MATERIALS AND METHODS

The mice sampled were from a population living in the Charles Clore Small Mammals Pavilion at the London Zoo in Regent's Park prior to a mouse proofing programme. These mice were mostly found inside the cages containing exhibition animals but they had free movement in and out of the cages and in the corridors, etc. The mice obtained food by stealing from the food trays in the cages and since there was always an adequate quantity of food available, they were presumably well fed.

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Mice were caught in break-back traps, baited with cheese, bread, or both. The traps were set up on Friday evening every week for a period of 3 months between May and July, 1971. Traps were inspected and collected early on Saturday morning and the mice were taken to the laboratory where they were weighed and sexed.

All the mice were deep frozen at −18°C until examined. In each case the colon and caecum were examined in detail. Every fifth mouse was also examined for the presence of other helminth parasites, but only *A. tetraptera* and *Syphacia obvelata* were recorded.

On thawing, the intestines were opened under water in petri dishes, and the mucosa was scraped with the edge of a glass slide and then examined under a low power binocular microscope. Worms were recovered with forceps and a pipette. A distinction was made between mature worms (which were then sexed) and larvae. The number and position of all the parasites in the gut was recorded.

RESULTS

A total of 102 mice were caught, of which 45 were male and 57 were female. Among the 57 females there were 9 pregnant mice and, therefore, female mice were studied in three groups, comprising the pooled results from all female mice, non-pregnant mice and pregnant mice.

The analysis of infection rates is shown in Table 1. More male mice (84·4 %) were infected than females (70·8 %) but the difference was on the borderline of statistical significance (0·05 > P > 0·02). However, the infection rate with mature worms was significantly greater in males (P < 0·01).

TABLE 1

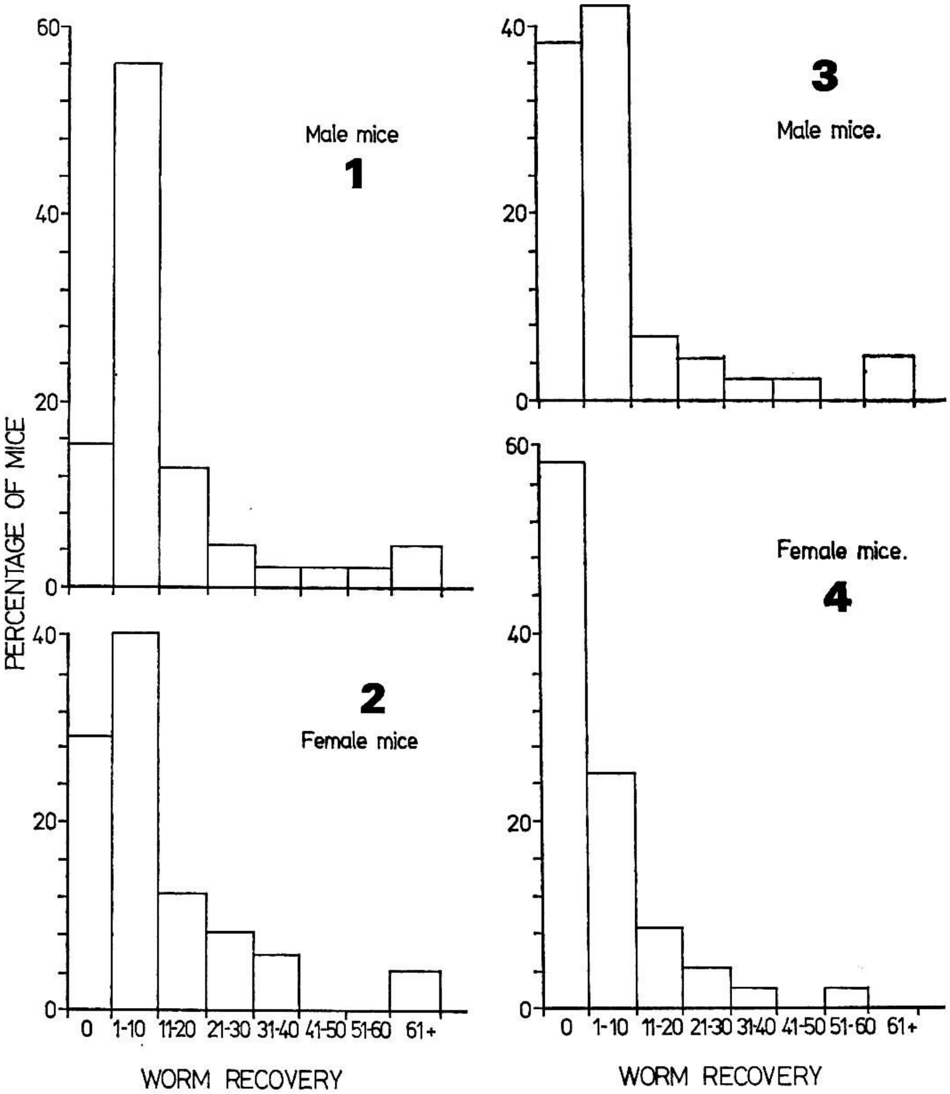
Analysis of the prevalence of infection, the mean worm recovery and the mean mature worm recovery in male and female mice

	Male mice	Female mice: Total	Female mice: Non-pregnant	Female mice: pregnant
Number of mice infected / Number of mice caught	38/45	42/57	34/48	8/9
% mice infected	84·4*	73·7	70·8*	88·9
Mean worm burden	12·4***	13·1	11·4***	21·9
± s.d.	±19·2	±19·9	±18·0	±27·4
Number of mice infected with mature worms	28	27	20	7
% of mice infected with mature worms	62·2**	47·4	41·7**	77·8
Mean mature worm burden	9·0****	6·8	5·4****	14·3
± s.d.	±18·8	±12·2	±10·7	±17·2

Statistical analysis: * P < 0.05; ** P < 0.01; *** P = N.S.; **** P = N.S.

There was no significant difference between the overall worm burdens of male and female mice. The mean worm recovery of mature worms from male mice was numerically almost twice that in females (9·0 ± 18·8 and 5·4 ± 10·7) but there was no significant difference here. In general, pregnant mice were more heavily infected than non-pregnant mice but the figures were not compared statistically since the sample was too small to compare accurately with the much larger group of non-pregnant female mice.

Figures 1 to 4 show the frequency distribution of *A. tetraptera* in male and female mice. For statistical analysis, however, mice of each sex were compared in three groups: group 1, mice with no worms; group 2, mice with 1–10 worms; group 3, mice with more than eleven worms.



FIGS. 1. and 2. The frequency distribution of *Aspiculuris tetraptera* in wild male and female *Mus musculus.*

FIGS. 3. and 4. The frequency distribution of mature *Aspiculuris tetraptera* in wild male and female *Mus musculus.*

Whereas an almost equal percentage of male and female mice were infected with more than eleven worms (group 3, $P = N.S.$), more females were not infected (group 1, $P < 0{\cdot}05$) and fewer females were infected with 1–10 worms (group 2, $P < 0{\cdot}05$). The distribution of mature worms was similar, but with the exception of mice with more than 11 worms (group 3, $P = N.S.$), the differences betweeen the percentages of male and female mice in the remaining two groups were relatively greater (group 1, $P < 0{\cdot}02$; group 2, $P < 0{\cdot}01$).

DISCUSSION

At least three parameters can be considered in determining the presence or absence of sex differences in wild host populations (e.g. mean parasite recovery, the prevalence of infection and the frequency distribution of the parasite) and all three are particularly necessary if the phenomenon is to be fully evaluated. However, authors in the past have varied as to which of these parameters they have considered and consequently it is possible that some studies may have overlooked sex difference by neglecting to ascertain all of the information available. Whitaker (1970), considering the overall parasite burden in house mice irrespective of the species involved, found that there was no difference in the percentage of male and female mice infected. When he examined the mean number of parasites per mouse, however, there were more parasites in male than in female mice. Unfortunately *Aspiculuris tetraptera* was not recorded in Whitaker's survey. Lewis (1968) reported that male *Apodemus sylvaticus* were more susceptible than females to infection with *Nematospiroides dubius*, *Syphacia stroma* and *Corrigia vitta.* In the case of *N. dubius*, the percentage infection was high and not dissimilar in both sexes, but the mean worm recovery from male mice was higher.

A sex difference in the prevalence of *A. tetraptera* in wild hosts has been reported twice; Roman (1951) found that more male mice were infected, and Sharpe (1964) reported that the prevalence of this parasite in mature *Clethrionomys glareolus* was similarly greater in males, although the actual figures show only a minimal difference to support this conclusion. These last reports agree with the present work since the sex difference in the prevalence of the parasite in house mice was found to be statistically significant. However, in spite of a greater percentage of male mice infected with mature worms, the mean worm recovery was very similar for both sexes.

The most informative analysis is presented in Figs. 1 to 4, which compare the frequency distribution of overall and mature worm burdens. The worm burden was greater than 11 in an equal percentage of both sexes suggesting that the similar mean worm recoveries for male and female mice were due to an equal distribution of individual mice with high worm burdens. A single heavy worm burden is more likely to alter the mean worm recovery, hence, the mean worm recovery is more an expression of the incidence of high worm burdens in the population, than a true representation of the typical worm burden encountered in most of the mice. Since this incidence was similar in both sexes it follows that the mean worm recoveries could not be expected to differ significantly. Whitaker (1970), who found that male mice had more *Heligmosomoides polygyrus* (1·79) than female mice (0·78), attributed this difference primarily to three males with particularly heavy infections (40, 50, and 100 worms).

The frequency distribution figures in this study showed that more female mice were not infected and conversely more male mice were found to be in the 1–10 worms category. Although these differences were statistically valid in the overall worm burden comparisons, they showed a reduced P value when only the mature worms were considered. This suggests not only that more male mice became infected and more worms matured in male mice (excepting mice infected with 11+ worms), but also that the fewer juvenile worms found in female mice were prevented from reaching maturity.

This observation agrees with the finding that in laboratory infections with *A. tetraptera* fewer worms reach maturity in female mice because of a sex difference in the extent of worm expulsion taking place during the third week of infection (Behnke, in press). It is suggested, therefore, that the female mice in this wild population rejected more larvae and acquired a greater resistance to reinfection than male mice. The presence of heavy worm burdens in almost a third of male and female mice indicates that some individuals in both sexes were equally affected by either exogenous or endogenous factors which enhanced their susceptibility to infection.

Although Lewis could find no substantial difference in the prevalence of parasites in pregnant mice, and Dunn and Brown (1962) failed to demonstrate a difference in the worm burden of pregnant, lactating and control mice infected with *A. tetraptera*, it is known that lactation has a profound influence on the immune mediated spontaneous self-cure in some parasitic infections (Dineen and Kelly, 1972; O'Sullivan and Donald, 1970; Connan, 1970, 1972, 1973). Behnke and Wakelin (1973) attributed the high *Trichuris muris* worm burden found in female mice to the effects of lactation. In the present study only nine mice were pregnant but, of these nine, eight were infected (88·9%), four of them heavily, and the mean worm recovery was greater than in either males or non-pregnant females ($21{\cdot}9 \pm 27{\cdot}4$; $12{\cdot}4 \pm 19{\cdot}2$; $11{\cdot}4 \pm 18{\cdot}0$ respectively). It is possible, therefore, that lactation is one factor resulting in high infection levels in some female mice.

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