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Authors: GIBBS, H. C., CRENSHAW, W. J., and MOWATT, M.

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SEASONAL CHANGES IN STOMACH WORMS (*Obeliscoides cuniculi*) IN SNOWSHOE HARES IN MAINE

H. C. GIBBS, W. J. CRENSHAW and M. MOWATT
Department of Animal and Veterinary Sciences and School of Forest Resources,
University of Maine, Orono, Maine 04473, USA [1]

Abstract: The stomachs of 141 (96.5%) of 146 snowshoe hares (*Lepus americanus*) collected in the area of East Corinth, Maine between the months of February, 1972 and February, 1973 were infected with *Obeliscoides cuniculi*. Nematodes were counted in 140 infected adult hares. The greatest intensity of infection occurred during the period from spring into summer (March to July) and at this time the populations of nematodes were mainly adults. During this period, female hares harbored significantly greater numbers of nematodes than males. Lowest numbers of nematodes were seen in late fall and early winter (October to December). The proportions of immature (fourth stage) nematodes in the populations increased appreciably from late summer on into winter and by December these constituted some 60% of the total population. A marked decline in immature nematode numbers was observed after February, with a concurrent increase in numbers of adults. A well-defined cyclical population fluctuation in natural infections of *O. cuniculi* was evident.

INTRODUCTION

Obeliscoides cuniculi, a trichostrongylid nematode parasitic in the stomach of lagomorphs was described by Graybill[8] from a natural infection in a domesticated rabbit. A number of studies have been done on this parasite in recent years. Of particular interest have been studies[6,7,9,11,15,17] demonstrating that, under certain conditions of development, the parasite will remain in the fourth stage (L_4) for relatively long periods of time before resuming normal growth to the adult stage.

While there is information on the seasonal prevalence of this parasite in wild populations of hares[5] and cottontails,[3] no information exists on seasonally related changes in the developmental behavior of this nematode in wild hosts. Examination of parasite burdens in adult snowshoe hares were therefore made over the period of a year, with emphasis on the ratio of immature to mature nematodes and to seasonal differences in the parasite burdens between the two host sexes.

MATERIALS AND METHODS

A total of 146 hares were collected from February, 1972 to February, 1973. Of these, 140 infected adult hares, 67 females and 73 males were used in the study. All hares were shot within an area approximately 3.8 km^2 near East Corinth, Maine. Stomachs were removed and refrigerated. The stomach contents were washed through a series of four screens having openings of 0.250 mm, 0.149 mm, 0.105 mm and 0.074 mm respectively. Also the mucosa was scraped and screened to recover additional worms. One tenth aliquots of this material were removed and preserved in 10% Formalin. Samples were examined with the aid of a dissecting microscope and the adult and immature (L_4) nematodes counted.

[1] Financial assistance of the Maine Agricultural Experiment Station is acknowledged.

Data were analyzed statistically by analysis of variance[14] and Duncan's multiple range tests.[16]

RESULTS

Of the 146 hares collected, 141 (96.5%) were infected with *O. cuniculi*. No other nematodes were found in the stomachs. The mean seasonal nematode population fluctuations in female hares are given in Figure 1. Figure 2 shows those for male hares. Similar seasonal distribution patterns were seen in both sexes. A definite seasonal fluctuation in intensity of infection was evident, with highest densities from March to July. The infections at this time were primarily adult nematodes; very few immature nematodes were present. Female

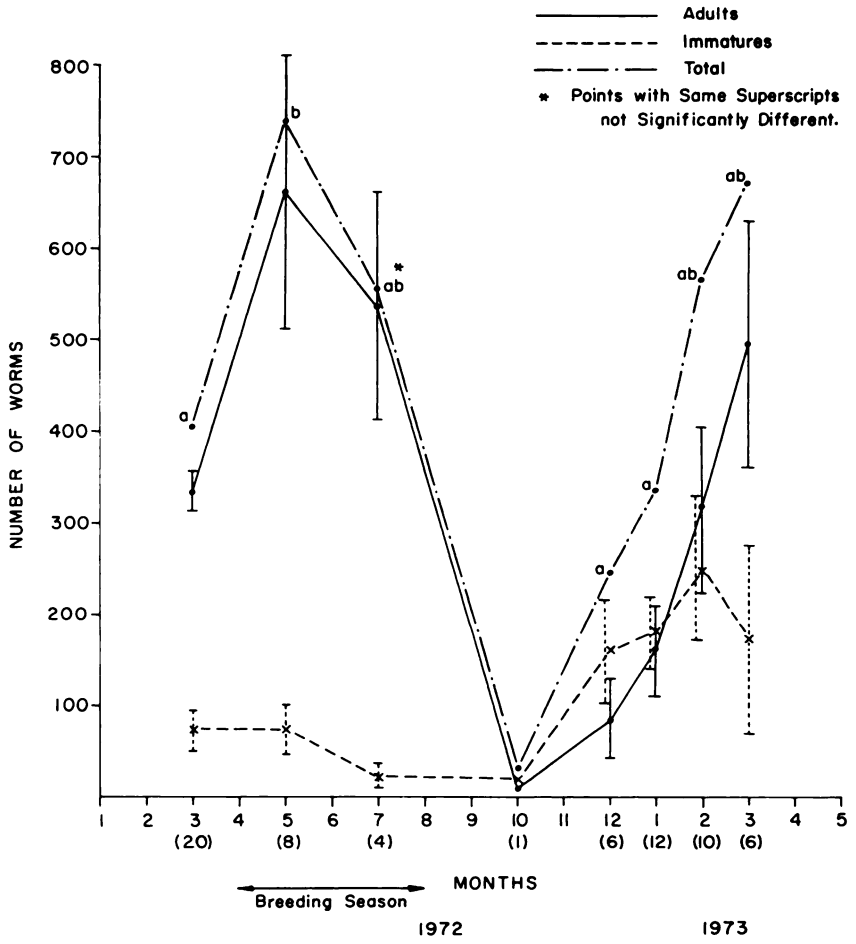

FIGURE 1. Monthly variations in the average numbers of **Obeliscoides cuniculi** recovered from adult female hares.

( ) Numbers of hares examined at each period.

Standard error of mean.

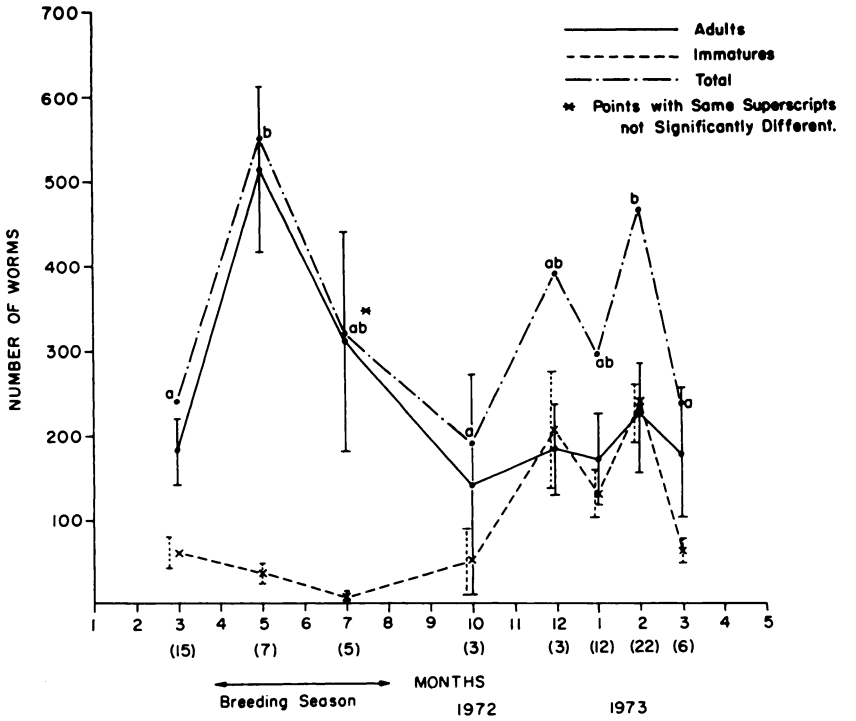

FIGURE 2. Monthly variations in the average numbers of **Obeliscoides cuniculi** recovered from adult male hares.

( ) Numbers of hares examined at each period.

Standard error of mean.

TABLE 1. Seasonal incidence of immature (fourth stage) nematodes in total populations in male and female hares.

	Percent of Immature Nematodes (4th stage) in Total Population	
Date	Male Hares	Female Hares
3/72	24.5	17.8
5/72	6.7	10.2
7/72	1.6	4.1
10/72	26.3	66.7
12/72	53.1	65.3
1/73	42.6	52.7
2/73	51.4	43.7
3/73	24.6	25.8

hares had significantly higher ($P<0.05$) intensities of infection than males during this period. Later in the year, populations declined with lowest numbers of nematodes present from October to December. During this latter period, the number and proportion of immature worms began to increase, reaching a peak in February. The percentages of immature nematodes in the populations found at the different times of year for females and males is given in Table 1.

Some of the seasonal differences in mean populations were statistically significant ($P<0.05$) and are indicated on the figures by the use of different superscripts (a and b).

A gradual increase in numbers of worms was observed from October to February. From this point on the numbers of immature worms appeared to decrease, coincident with an increase in adult worm numbers.

DISCUSSION

The observation that the highest intensities of infection were present in the hares from March until July was similar to the findings of Erickson,[5] in Minnesota. This coincides with the spring and early summer months, when environmental conditions are most conducive to development of free-living stages.[1] However, the increase in adult nematodes started in March coinciding with the decrease in numbers of immatures, but when environmental conditions were unfavorable for larval development and reinfection. This suggests that the immatures resumed development in March, contributing to the increase in adult populations in both sexes. Dorney[3] observed a sharp increase in numbers of *Obeliscoides* ova in March pellet samples obtained from cottontails in Wisconsin. He found the increased numbers of ova difficult to explain because environmental conditions at that time of year were inimical to larval development. This phenomenon of an increase in numbers of adult worms in the spring months appears to be very similar to the "spring rise" phenomenon observed with other trichostrongyles.[10]

In Maine, the breeding season of the hare extends from April until August.[13] This also coincides with the period of greatest numbers of nematodes in both sexes, but particularly in the females. Dunsmore[4] working in Australia with *Graphidium strigosum*, a stomach nematode of domesticated rabbits, found significantly more parasites in female rabbits than in male rabbits during the breeding season; the only time in his study when such a significant difference was seen.

Appreciable numbers of L_4 larvae were present in the hares from October into February. This suggests factors, either within the host or within the larvae, altered or slowed their rate of development at this time of year. This phenomenon probably is analagous to that of the seasonal retardation of development seen with other trichostrongyle parasites in domesticated and wild hosts.[2,10] Stockdale *et al.*,[17] have shown that exposure of the infective larvae of *O. cuniculi* to temperatures below 6 C decreased rate of development. Environmental temperatures in Maine reach these levels in the late fall months from October. Furthermore, such altered development persisted for only a limited period (approximately 16 weeks) after which larvae resumed normal rate of growth.

The possibility of overcrowding effects due to heavy intakes of larvae, influencing larval development, also has been suggested by Russell *et al.*[12] Recently Fox[7] demonstrated that crowding of nematodes will lead to a high population of arrested L_4 larvae. Furthermore, he showed that immunological factors appear to be important in the arrested development of this species. In the present work the highest numbers of immature forms were not seen at the times of highest total nematode populations, suggesting that overcrowding effects did not play a major role in this instance. Presumably, there are population density, immunological and environmental aspects to the phenomenon of arrested development in this nematode.

The data indicate that infections were acquired during late fall and early winter. There was no snow cover until

January, 1973 in this region; thus the hares could have continued to graze until well into the winter, thereby acquiring the additional infections.

The cause of the decline in numbers of nematodes in late summer and fall is unknown. One factor might be increased immunity due to increased intake of larvae over the summer months. Another possibility could be the adverse effects on the development of free-living stages during the high temperature and low moisture conditions of midsummer. This would cause a decrease in the number of larvae available for replacement of populations lost by aging of adult nematode populations.

The importance of arrested development to overwinter persistence of the parasite in the present instance, is less obvious than it is with some of the other trichostrongyles, since acquisition of larvae continued into early winter. However, during years of early, prolonged winter conditions with heavy snowfall precluding larval acquisition, arrested larvae could be important in insuring this parasite's survival.

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