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ENDOPARASITES OF HARES (*LEPUS TIMIDUS* L. AND *L. EUROPAEUS* PALLAS) IN FINLAND

T. Soveri[1] and M. Valtonen[2]

ABSTRACT: Intestinal and lung parasites of 85 mountain hares (*Lepus timidus*) and 24 European hares (*L. europaeus*) were examined. The species of parasites found in both hare species were *Trichostrongylus retortaeformis* Zeder, 1800; *Mosgovoyia pectinata* Goeze, 1782 and *Protostrongylus pulmonalis* Froelich, 1802. *Eimeria semisculpta* Madsen, 1938 and *E. townsendi* Carvalho, 1943 were found only in the European hares and *Eimeria leporis* Nieschulz, 1923 and *Dicrocoelium dendriticum* Rudolphi, 1819 only in the mountain hares. Ninety-five percent of the mountain hares and 88% of the European hares were infected with parasites. Mountain hares were more commonly infected with *P. pulmonalis* and *D. dendriticum* while European hares were more commonly infected with *Eimeria* spp. and *T. retortaeformis*. Young mountain hares were more often infected with *M. pectinata* and adult mountain hares with *P. pulmonalis*. The management technique of winter-feeding did not increase significantly the percentage of infected animals. *Dicrocoelium dendriticum* was found only in hares from islands where sheep had grazed during the summers. The absence of cysticerci of *Taenia pisiformis* Bloch, 1780 in this survey may be a reflection of improved hygiene practices instituted by hunters.

INTRODUCTION

In Finland there are two species of hares. The mountain hare is distributed throughout the country and is well adapted to winter and snow, while the European hare can survive only in the southern half of Finland (Fig. 1). The latter species spread to Finland in the late 1800's.

Many studies of the endoparasites of European hares have been conducted in Europe (Czaplinska et al., 1965, Kutzer and Frey, 1976; Nickel and Gottwald, 1979). In Sweden, Burgaz (1970) studied endoparasites of the mountain and the European hare and Berg (1981) has reported on endoparasites of the mountain hare in Norway. Lampio (1946) and Raitis and Ermala (1972) have reported on endoparasites found in hares in Finland.

The purpose of this study was to find out which endoparasites occur in hares in Finland and which factors have an effect on their occurrence.

MATERIALS AND METHODS

A total of 85 mountain hares and 24 European hares was studied. The animals consisted of three main Groups; Group I was comprised of hares from southern inland, Group II of hares from the southwestern coastal area of Finland and Group III of hares from isolated islands in the Gulf of Finland and in the Gulf of Bothnia (Fig. 1). Most of the hares were shot between September to March in the years 1976–1978 and 1980–1981. Seven mountain and four European hares were found dead during the winter in 1980 on the coastal area and inland. The causes of death varied. The most dense hare populations were on the islands (Group III) and the least dense were inland (Group I). The hare populations were more dense in the years 1980–1981 than in 1976–1978. The estimations of density were relative and were based on the observations of hunters and on statistics on hunter-killed hares collected by the Hunters' Central Organisation.

The ages of hares which were shot before January were determined by palpation of the growing cartilage of the radius and ulna (Habermehl, 1961).

The organs examined included liver, lungs, stomach and intestines. The liver, gallbladder and main biliary ducts were examined macroscopically and by a light microscope (×80). Lesions in the lungs were evaluated and the lungworms examined by a light microscope (×80). Macroscopical and stereomicroscopical examinations of the contents and walls of the stomach and intestines were conducted. Stomach and intestinal contents were examined by a light microscope (×80 and ×320) to discover eggs, oocysts and larvae of parasites. Oocysts were allowed to sporulate at 25 C in 2% potassium dichromate for 5 days before the determination of species. Intensities of infection with lungworms and intestinal worms were estimated with a four-category scale evaluated from 0 to 3 (Table 1).

Chi-square tests were used to determine differences in prevalence and intensity of infection. Differences between the species of hares, years 1976–1978 and 1980–1981, sexes, age classes and between study areas were compared. The effect of winter feeding was also evaluated. Values were considered significant at $P < 0.05$.

Representative specimens have been placed in the Collection of the Parasitological Laboratory of the College of Veterinary Medicine in Helsinki. Accession numbers are as follows: *Protostrongylus pulmonalis*, No. 801004-1; *Trichostrongylus retortae-*

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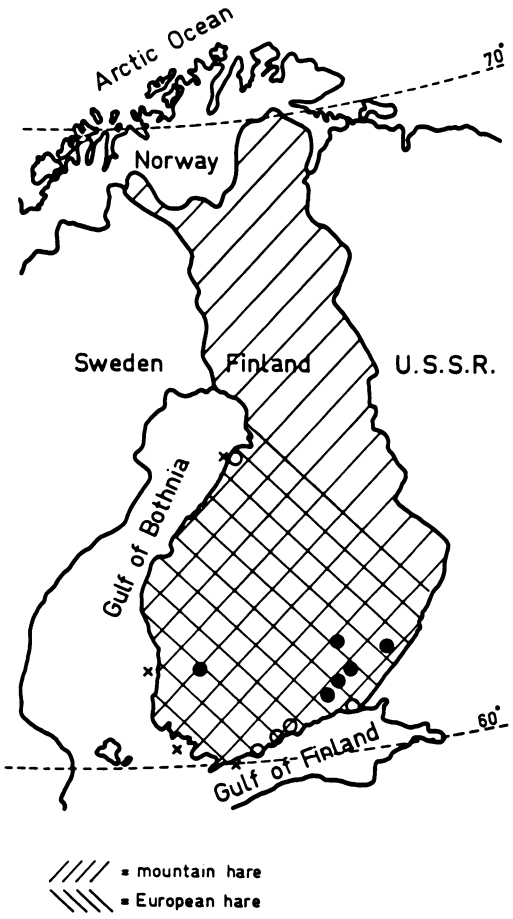

FIGURE 1. Distribution of mountain and European hares in Finland and study areas. Black circles = Group I; white circles = Group II; crosses = Group III.

formis, No. 800505-1; *Mosgovoyia pectinata*, No. 800309-1 and *Dicrocoelium dendriticum*, No. 771114-1.

RESULTS

The lungs of one, the stomach and intestines of one and the liver of six mountain hares could not be examined.

The parasites found in both hare species were: *Trichostrongylus retortaeformis* Zeder, 1800; *Mosgovoyia pectinata* Goeze, 1782 and *Protostrongylus pulmonalis* Froelich, 1802. *Eimeria semisculpta* Madsen, 1938 and *E. townsendi* Carvalho, 1943 were found only in the European hares and *E. leporis* Nieschulz, 1923 and *Dicrocoelium dendriticum* Rudolphi, 1819

TABLE 1. Estimates of intensity of infection for lungworms and intestinal worms of hares in Finland.

Estimate of infection	Number of parasites		% of affected area on lungs infected with
	Trichostrongylus retortaeformis	*Mosgovoyia pectinata*	*Protostrongylus pulmonalis*
0	0	0	0
1	1-200	1-2	1-5
2	200-1,000	3-4	6-15
3	>1,000	>4	>15

only in the mountain hares. Ninety-five percent of the mountain hares and 88% of the European hares were infected with parasites.

The geographical distribution, prevalence and intensity of parasites are given in Tables 2 and 3. Mountain hares were more often infected with *P. pulmonalis* and *D. dendriticum* while European hares more often had an infection of *Eimeria* spp. and *T. retortaeformis*. The prevalence of *M. pectinata* was slightly higher ($0.05 < P < 0.1$) in mountain hares.

The division of infections of *P. pulmonalis*, *T. retortaeformis* and *M. pectinata* to intensity categories is shown in Figures 2 and 3. The highest percentage of mountain hares infected with *T. retortaeformis* was on the islands and *D. dendriticum* occurred only in mountain hares from the islands. The young mountain hares were more often infected with *M. pectinata* and the adult hares with *P. pulmonalis*. The lungs of adult hares were more severely affected by *P. pulmonalis* than those of the young hares.

The mean numbers of species of parasites were 1.7 in the mountain hares and 1.4 in the

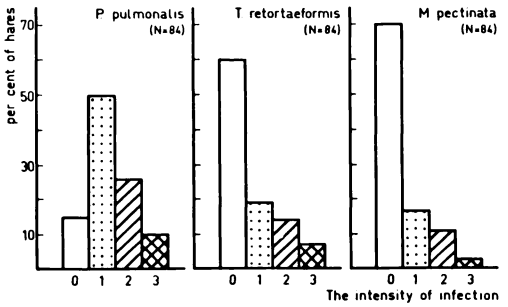

FIGURE 2. Intensities of infection with *Protostrongylus pulmonalis*, *Trichostrongylus retortaeformis* and *Mosgovoyia pectinata* in mountain hares in Finland. N = no. of hares examined.

TABLE 2. Prevalences of parasites of mountain hares and intensities of *Trichostrongylus retortaeformis* and *Mosgovoyia pectinata* in different parts of Finland.

Species	Group I (n = 46)	Group II (n = 17)	Group III (n = 22)	All animals (n = 85)
Protostrongylus pulmonalis	88.9[a]	82.3	86.4	86.9
Trichostrongylus retortaeformis	22.2	41.2	77.3	40.5
	906 ± 2,154[b]	935 ± 1,124	791 ± 1,357	855 ± 1,542
	(3–7,000)[c]	(50–3,000)	(5–5,000)	(3–7,000)
Mosgovoyia pectinata	26.7	41.2	27.3	29.8
	3 ± 2	2 ± 1	2 ± 1	3 ± 1
	(1–6)	(1–4)	(1–4)	(1–6)
Dicrocoelium dendriticum	0	0	31.8	8.3
Eimeria spp.	4.4	0	9	4.8

[a] Prevalence.
[b] Intensity ± SD.
[c] Range.

European hares. Ranges were 0–3 in Groups 1 and 2 and 1–4 in Group 3. There was no correlation between weight or sex of the hare and parasite infections.

DISCUSSION

All the species of helminth parasites which were found in this study have been reported previously in Finland. In addition to these helminths, Lampio (1946) reported *Fasciola hepatica* Linne, 1758; *Graphidium strigosum* Dujardin, 1845; *Passalurus ambiguus* Rudolphi, 1819; cysticerci of *Taenia pisiformis* Bloch, 1780 and some unidentified larvae. The absence of these species in our study may be due to small sample sizes. All these species except *T. pisiformis* were very rare in Lampio's (1946) study. *Passalurus ambiguus* and *G. strigosum* are parasites with direct life cycles, while *T. pisiformis* and *F. hepatica* have indirect life cycles. *Taenia pisiformis* was quite common in the first half of this century (Lampio, 1946). However, *T. pisiformis* was not found in the present study and it is also very rare presently according to the State Veterinary Institute (statistics of the Institute). Thus the decline of *T. pisiformis* which was already reported by Lampio (1946) seems to have continued. The adult *T. pisiformis* occurs in the small intestine of dogs, cats, foxes and several other wild carnivores (Soulsby, 1968). The reason for this decline may be improved hunting hygiene whereby organs infected with cysticerci are no longer given to dogs. The decline of wild foxes in Finland may also have had an effect on this phenomenon.

All the species of helminths reported from hares in Finland have been reported also in Sweden (Burgaz, 1970). In addition *Andrya* spp., *Strongyloides* sp., *Capillaria* sp. and *Trichuris leporis* Froelich, 1789 were found. The greater number of species of parasites can

TABLE 3. Prevalences of parasites of European hares and intensities of *Trichostrongylus retortaeformis* and *Mosgovoyia pectinata* in different parts of Finland.

Species	Group I (n = 7)	Group II (n = 17)	All animals (n = 24)
Protstrongylus pulmonalis	28.6[a]	35.3	33.3
Trichostrongylus retortaeformis	28.6	64.7	54.2
	315 ± 403[b]	406 ± 496	337 ± 444
	(30–600)[c]	(5–1,500)	(5–1,500)
Mosgovoyia pectinata	0	17.6	12.5
		5 ± 2	5 ± 2
		(3–7)	(3–7)
Eimeria spp.	28.6	41.1	37.5

[a] Prevalence.
[b] Intensity ± SD.
[c] Range.

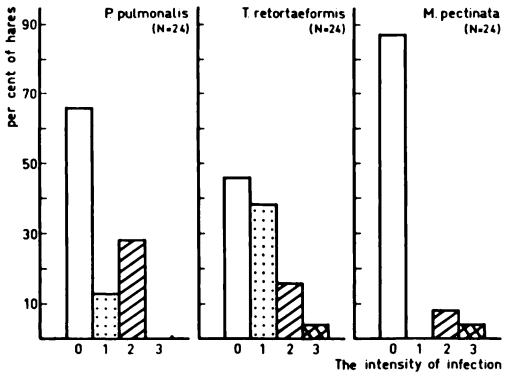

FIGURE 3. Intensities of infection with *Protostrongylus pulmonalis*, *Trichostrongylus retortaeformis* and *Mosgovoyia pectinata* in European hares in Finland. N = no. of hares examined.

partly be explained by the large sample sizes in that investigation and the different climate in Sweden. *Andrya* spp., *Strongyloides* sp. and *Capillaria* sp. occurred only in southern Sweden where the winters are warmer than in southern Finland. Berg (1981) found the same species of helminths in hares in Norway as were found in the present study.

The species of *Eimeria* in hares in northern Europe are poorly understood. Lampio (1946) reported *E. stiedae* Lindeman, 1865; *E. perforans* Leuckart, 1879 and *E. media* Kessel, 1929. According to Pellerdy (1974), *E. perforans* and *E. media* are species occuring mainly in the rabbit. Burgaz (1970) found *E. stiedae* and *Eimeria* spp. in Sweden and Berg (1981) found *E. leporis*, *E. townsendi*, *E. semisculpta*, *E. hungarica* Pellerdy, 1956 and *E. robertsoni* Madsen, 1938 in Norway. The last two species mentioned were not identified in the present study. The number of specimens of *Eimeria* was so small in this study that more species of *Eimeria* will very likely be found in Finland in the future.

In Sweden (Burgaz, 1970) the prevalence of parasites of European hares was on the same level as in this study but prevalences in mountain hares were lower. In Europe (Czaplinska et al., 1965; Gottschalk, 1973; Kutzer and Frey, 1976; Nickel and Gottwald, 1979) the percentage of European hares infected with parasites was higher than in this survey. The prevalence of *Eimeria* spp. and *T. retortaeformis* was higher while the prevalence of *M. pectinata* and *P. pulmonalis* seemed to be on the same level or slightly lower in middle Europe. Thus it seems that parasites with indirect life cycles, *P. pulmonalis* and *M. pectinata* manage relatively better in Finland compared to middle Europe than parasites with direct life cycles, *T. retortaeformis* and *Eimeria* spp. This can partly be explained by colder weather in Finland and partly by higher densities of hares in middle Europe. The parasites with direct life cycles may be more sensitive to low temperatures than parasites with intermediate hosts. The dense hare populations may favor the transmission of parasites with direct life cycles because the populations of intermediate hosts do not set any limits to transmission. Those parasites, *P. pulmonalis* and *M. pectinata* which seemed to manage relatively well in European hares in Finland occurred more commonly in the mountain hares. This may increase the infection pressure against the European hares and partly increase the prevalence of these parasites.

Although *E. semisculpta* and *E. townsendi* were found only in the European hares and *E. leporis* and *D. dendriticum* only in the mountain hares, all of these species have been reported in both species of hares (Gottschalk, 1973; Berg, 1981). The number of specimens of *Eimeria* was so small in this study that nothing can be concluded from their host specificity. No samples of the European hares were received from the areas where *D. dendriticum* occurred. This parasite was found only in dense populations of mountain hares on the islands. Thus the occurrence of *D. dendriticum* may be dependent also on other factors than the species of hare although the prevalence of this parasite was much lower in the European hares in middle Europe than in the mountain hares in this study (Nickel and Gottwald, 1979). These islands in this study were areas where sheep grazed during the summers. This may explain the occurrence of *D. dendriticum* since sheep are quite often infected with this parasite.

In dense populations (islands, coastal areas, years 1980–1981, areas of winter feeding) some trends can be seen, although these observations are not statistically significant. The percentage of hares infected seemed to be higher and the number of species of parasites in the hares seemed to be greater than in less dense populations. Particularly the prevalence of *T. retor-*

taeformis became higher in dense populations, but also the prevalences of *Eimeria* spp. and *P. pulmonalis* became slightly higher.

The young mountain hares were more often infected with *M. pectinata* and the adult hares with *P. pulmonalis*. In addition to these findings Berg (1981) reported that the young mountain hares were more often infected with *Eimeria* spp. and the adult hares with *D. dendriticum* and *T. retortaeformis*. These observations of *Eimeria* spp. and *D. dendriticum* were done also in this study although these results were not statistically significant. The development of lung lesions caused by *P. pulmonalis* takes time. So in the young hares the infection may have occurred some time ago. This may explain the higher prevalence and intensity of *P. pulmonalis* observed in adult hares.

In Finland wild hares are fed commonly during the winters with hay, grain and/or green plants. These are served from automatic feeders or scattered on the ground. A great amount of crowding occurs on these feeding areas (Aarnio and Vikberg, 1980). Still, winter-feeding increased the percentage of infected animals only slightly ($0.05 < P < 0.1$). This may have been a consequence of cold winter weather which does not favor the transmission of parasites. In spite of the slight increase in parasites the hares which received extra food during the winter had more subcutaneous and abdominal fat than those which did not receive any extra food (Soveri and Aarnio, 1982).

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