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HELMINTH PARASITISM IN MARTENS (*MARTES AMERICANA*) AND ERMINES (*MUSTELA ERMINEA*) FROM WASHINGTON, WITH COMMENTS ON THE DISTRIBUTION OF *TRICHINELLA SPIRALIS*

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ABSTRACT: Helminths are reported for the first time from ermines (*Mustela erminea*) and martens (*Martes americana*) in Washington (USA). Among 22 adult ermines, 41% were infected by one or more of five species (*Taenia mustelae, Alaria mustelae, Molineus patens, M. mustelae* and *Trichinella spiralis*). Among 78 adult martens from three geographic localities, the prevalence was 83%. Nine species were identified (*Mesocestoides* sp., *T. mustelae* and *T. martis americana, Euryhelmis squamula, M. patens, Baylisascaris devosi, Physaloptera* sp., *Soboliphyme baturini* and *T. spiralis*). *Trichinella spiralis* occurred with a maximum prevalence of 50% in martens, but only occurred in 9% of ermines. Compression and digestion techniques provided a similar estimate of prevalence of *T. spiralis*, yet neither was entirely accurate in identifying all infected hosts. The species richness of the helminth community of martens in Washington was greater than that reported from other regions of North America.

Key words: *Martes americana, Mustela erminea,* martens, helminths, *Trichinella spiralis,* survey.

INTRODUCTION

Martens (*Martes americana*) and ermines (*Mustela erminea*) occur throughout the boreal forests of North America (Strickland et al., 1982; Clark et al., 1987). Although these species are widespread geographically, there have been few detailed reports of helminth parasites. Holmes (1963), Poole et al. (1983), and Scranton (1986) examined the helminth faunas from martens in the Northwest Territories, Manitoba, and northeastern Alaska, respectively. Clark et al. (1987) summarized unpublished data on nematodes from martens in Ontario. Jennings et al. (1982) reported on the helminth fauna of ermines from Newfoundland. Additional accounts concerning either host have been limited to studies of single species of parasites. There are no previous records of helminths from martens or ermines in the northwestern United States and Canada.

Ancillary to several studies of mammalian populations in Washington, 78 martens from three areas (Columbia River Gorge, southern Cascade Range and northern Cascade Range) were examined for helminth parasites. We report the results of these necropsies, along with additional information on the helminth faunas of 22 ermines from the southern Cascade Range. New host and geographic records are reported for a number of helminth species from both martens and ermines.

MATERIALS AND METHODS

Two adult male martens were collected (by KBA) near the Columbia River Gorge at the border between Washington and Oregon State (ca 45°54′N, 121°49′W) on 1 March and 13 April 1984. The first animal was partially necropsied in the field, and viscera were removed and immediately frozen, whereas the latter animal was frozen entire; all internal organs were examined in the laboratory. Fourteen adult martens (five females, nine males) from the Cascade Range of northern Washington were collected (by JDB) from 25 October 1981 to 4 March 1982 (ca. 48°13′ to 48°55′N, 119°45′ to 120°24′W) and kept frozen until necropsy in the laboratory. Sixty-two adults (14 females, 48 males) from the southern Cascade Range (ca. 46°28′ to 47°11′N,

TABLE 1. Helminth parasites of martens and ermines from Washington, USA.

	Martens		Ermines
	Southern Cascades[a]	Northern Cascades	Southern Cascades
Taenia mustelae	30 (1–9) 3.05 ± 0.29[b]		12 (1–2) 1.5 ± 0.15
Taenia martis americana	16 (1–4) 1.8 ± 0.15	14 (1–2) 1.5 ± 0.19	
Mesocestoides sp.	59 (1–198) 20.45 ± 5.20[c]	21 (1–28) 10 ± 4.17[f]	
Euryhelmis squamula	6 (1–9) 4.25 ± 0.43		
Alaria mustelae			5 (1) —
Molineus patens	9 (1–4) 1.83 ± 0.17		27 (1–2) 1.17 ± 0.09
Molineus mustelae			14 (1–27) 10 ± 3.14
Baylisascaris devosi	2 (1) —	21 (1–2) 1.33 ± 0.16	
Physaloptera sp.	2 (1) —		
Soboliphyme baturini		7 (1) —	
Trichinella spiralis	31 (—) —[d]	50 (—) —	9 (—) —
Unidentified larvae	10 (29) —[e]		

[a] Including Columbia River Gorge (n = 2); and southern Cascade Range, 1985–1986 (n = 28) and 1986–1987 (n = 34).

[b] Prevalence (range in intensity) mean intensity and standard error.

[c] Mature and gravid specimens of *Mesocestoides* sp. were found in four hosts and identified as *M. lineatus*; other specimens were apparently destrobilate.

[d] Intensity of infection was not determined for *T. spiralis*; prevalence based on compression and microscopic examination of diaphragms. Specimens from the Columbia River Gorge (n = 2) were not examined.

[e] During tissue digestion of specimens (hind limb musculature) from 1986–1987 (n = 34) larvae possibly referable to *Baylisascaris devosi* were recovered from two female and eight male hosts (see Scranton, 1986).

[f] All were *M. lineatus*, except for an immature specimen that could not be identified. Prevalence of infection was significantly lower than that observed in the southern Cascades.

121°08′ to 121°29′W) were collected by a local trapper from 28 December 1985 through 5 February 1986 (five females; 23 males) and from 20 December 1986 through 15 February 1987 (nine females; 25 males). All specimens were frozen immediately after skinning and later thawed for necropsy in the laboratory. Twenty-two adult ermines (17 females, five males) were collected (by KBA and EPH) in the southern Cascade Range in the fall of 1984 and 1985.

All internal organs were examined for helminth parasites. Compression preparations of diaphragm tissue were studied to determine the prevalence of infection by *Trichinella spiralis*. Additionally, samples of hind-limb musculature (approximately, 20–25 g), were collected from 34 martens (1986–1987 sample from the southern Cascade Range) for tissue digests conducted by D. E. Worley at Montana State University (Worley et al., 1974). These latter data from digests were not included in calculations of prevalence for *T. spiralis* or prevalence of infected hosts, as digestion was not a standard sampling technique used throughout the study. Trematodes and cestodes were stained in Semichon's acetic carmine and mounted entire; nematodes (other than *T. spiralis*) were cleared and studied in glycerine. Representative specimens were deposited in the Helminthological Collections of the U.S. National Museum (78257–78260; 80015–80023). Skins or skeletal material were deposited in the University of Washington Burke Museum.

Statistical analyses using SPSS-PC+ (Norusis, 1988) were performed to identify significant differences ($P \leq 0.05$) in prevalence (Chi square) and intensity (Mann-Whitney-U) of infection for the most commonly occurring helminth species. Differences in infection were compared between sexes, localities, year of collection and host species. Comparisons of the composition of helminth communities (percent shared species) from martens in Washington and other geographic regions in North America were based on calculations of the coefficient of community (Pielou, 1974). In these regional comparisons, collection localities from Washington were combined.

RESULTS AND DISCUSSION

Among 78 martens examined from three geographic localities in Washington, the prevalence was 83% (Table 1). Significant differences in prevalence or intensity were not observed, unless specified below. Martens from the southern Cascades and Columbia Gorge (n = 64) were infected with nine species of helminths (83% prevalence); 31 animals had multiple infections with a maximum of four species per host. In the northern Cascades ($n = 14$) five species of helminths were found (86% prevalence); three martens had multiple infections with a maximum of three species per host. Based on an examination of skulls, there was no evidence of infection by *Skrjabingylus nasicola* in martens. Among ermines ($n = 22$), the prevalence of infection was 41%, with five species being identified (Table 1).

Cestodes present in martens (*Mesocestoides* sp., *Taenia mustelae*; *T. martis americana*) and ermines (*T. mustelae*) had all been previously reported from these mustelids in North America. This constitutes the first record of *T. martis americana* from the Pacific Northwest. In previous studies where both *T. mustelae* and *T. martis* were reported from martens (Holmes, 1963; Poole et al., 1983), they never occurred in the same host. During the current study, only two martens (both from the southern Cascades) had concurrent infections. Cricetid and sciurid rodents are the primary intermediate hosts for both taeniids in North America (Freeman, 1956; Rausch, 1977) and are also the predominant prey for martens (Strickland et al., 1982; Zielinski et al., 1983; Buskirk and MacDonald, 1984; and others). Concurrent infections of metacestodes of these *Taenia* spp. have apparently not been reported. The low frequency of mixed infections of *T. martis americana* and *T. mustelae* could be attributable to differences in prey selection by individual hosts.

Digeneans were represented by *Alaria mustelae* in an ermine and *Euryhelmis squamula* in martens from the southern Cascades (Table 1). In North America, *Euryhelmis* spp. are characteristic helminths in mink (*Mustela vison*) and raccoons (*Procyon lotor*) (Schell, 1964; and others), but have not been reported in martens.

In Oregon and Washington, metacercariae of *E. squamula* infect red-legged frogs (*Rana aurora*), Cascades frogs (*R. cascadae*), and tailed frogs (*Ascaphus truei*), (Schell, 1964; and others). These species are common in forested habitats of the Cascade Range (Ruggiero et al., 1990) and are often abundant in meadows at higher elevations (Nussbaum et al., 1983). Amphibia have rarely been reported in dietary studies of martens (see Strickland et al., 1982; Clark et al., 1987). Although mesocercariae of *Alaria* spp. may be acquired from either amphibians or small mammals (Johnson, 1979; Poole et al., 1983), the occurrence of *E. squamula* unequivocally indicates that prey selected by martens included anurans.

Nematodes other than *Molineus patens* and larvae of *Trichinella spiralis* were uncommon (Table 1). All have been found in martens elsewhere in North America; *M. patens* had not been reported previously in ermines from North America.

Among martens, differences in prevalence of *T. spiralis* between geographic localities or sex of host were not demonstrated. However, martens in the northern Cascades (50%; $P \leq 0.05$) and the southern Cascades (31%; $P \leq 0.10$) were more commonly infected than were ermines (9%). Both mustelids have been recognized as hosts for *T. spiralis*, but not in Washington. Levels of infection in martens from other regions have been low [Manitoba (Poole et al., 1983); Quebec (Borque, 1986); Ontario (Dick et al., 1986); central Alaska (Scranton, 1986); Montana, Idaho, Wyoming (Worley et al., 1974)] or larvae have not been demonstrated in adequate samples (Rausch et al., 1956; Stromberg and Prouty, 1987). Only in southcentral British Columbia was the prevalence (61%) greater than that reported here (Schmitt et al., 1976). In contrast, the prevalence of infection among ermines in Alaska (35–42%; Rausch et al., 1956) far exceeded that documented for this species in the present study.

Maintenance of the sylvatic cycle of *T. spiralis*, involving a broad range of carnivores (Zimmermann, 1971), has been attributed to three possible mechanisms that also may be determinants of the preva-

TABLE 2. Coefficient of community for helminth faunas of martens in North America.

	Locality of collection			
	1	2	3	4
1. Washington[a]	—	62[b]	33	67
2. Manitoba		—	75	55
3. Northwest Territories			—	22
4. Alaska				—

[a] Unidentified nematode larvae from tissue-digests of specimens in the 1986–1987 season were excluded.
[b] Percent similarity.

lence of infection. Variation in the levels of infection may be due to differences in prey selection among carnivores (Worley et al., 1974; Schmitt et al., 1976; Schad et al., 1984). Maintenance of the cycle also may result from differential scavenging on carcasses of other carnivores (Rausch, 1970; Campbell, 1983). Lastly, Cole and Shoop (1987) suggested a possible role for amphiparatensis (Shoop and Corkum, 1987) in transmission of *T. spiralis* in raccoons. Data from the present study do not indicate a significantly greater prevalence of infection among males (32% in males; 42% in females) and thus would not support an hypothesis for amphiparatenic transmission.

Thus, the occurrence of *T. spiralis* among martens in the Pacific Northwest probably has an ecological explanation. Strickland et al. (1982) regarded carcasses of carnivores and other mammals as an important prey source for martens in the winter. Differential use of carrion as a food source could account for the substantially higher prevalence in martens than in ermines observed in our study. However, Rausch et al. (1956) and Schmitt et al. (1976) have documented *T. spiralis* in a broad range of potential prey, (insectivores, cricetids, zapodids, sciurids, and other small rodents) that are used by both martens and ermines. Schad et al. (1984) and Dick et al. (1986) provided additional support for the role of rodents in maintaining the sylvatic cycle. The high prevalence of infection recorded for martens in the current study suggests that in the Pacific Northwest, as in other regions of boreal North America (Dick et al., 1986), martens are of primary importance as hosts of *T. spiralis* and in transmission of sylvatic trichinellosis. Additional study will be required to establish the primary route for transmission in this geographic region.

Although the occurrence of larvae in the current study was similar in samples examined by compression (35%) and digestion (38%), the prevalence based on combined results was 44%; only 10 hosts (29%) were identified by both methods. The compression method detected *T. spiralis* in samples with a minimum of 0.5 larvae per gram (LPG), but failed in three specimens with a range from 0.2 to 5.6 LPG. Conversely, two infections identified by compression were not recognized by digestion. Numbers of larvae per gram of musculature as determined from digests ranged from 0.2 to 97.8 ($\bar{x}$ = 12.95).

Variation in the reliability of compression and digestion techniques has been recognized (Zimmermann, 1983). In the present study, each technique provided a similar index of prevalence but neither identified all infected hosts. It is evident that continued evaluation of these techniques is warranted in studies of sylvatic trichinellosis.

Species richness of the parasite fauna of martens in Washington was greater than that found in other regions of North America (see Holmes, 1963; Poole et al., 1983; Scranton, 1986). The coefficient of community indicated that faunas in Washington, Manitoba and Alaska were relatively similar, but that Manitoba and the Northwest Territories shared the greatest number of species (Table 2). *Mesocestoides* sp., taeniid cestodes, *Baylisascaris devosi* and *T. spiralis* may be ubiquitous throughout the range of martens in North America as a result of a diet dominated by small mammals (Strickland et al., 1982). Other species, particularly digeneans, appear to have more restricted distributions that may be due to environmental constraints imposed on their life cycles at certain localities

(Poole et al., 1983). The occurrence of some parasites, notably *Alaria* spp., *E. squamula* and *Mesocestoides* sp. also may be influenced by interactions with an array of other carnivores that also serve as definitive hosts for these helminths.

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