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found at the southern periphery of the beaver's range in central Texas. However, additional studies from other areas are necessary to verify the absence of these helminth species from beaver populations at the periphery of their native range. Alternatively, certain species such as *S. subtriquetrus* may conform to the exceptions outlined in Brown's (1984, op. cit.) concept of "a species' greatest density occurs at its epicenter with densities diminishing toward the periphery of its range." These exceptions include discontinuous changes in single environmental variables or multimodal patterns of abundance that are caused by environmental patchiness (Brown, 1984, op. cit.). Our study indicates that the primary (helminth) community component in this habitat (beaver host) consists of a single ubiquitously common helminth "indicator" species (Custer and Pence, 1981, J. Parasitol. 67: 289–307), *S. subtriquetrus*, across the entire geographical range where suitable habitat exists (range of the beaver host), with high abundances of that helminth species in at least one area at the periphery of that host's range.

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Parelaphostrongylus tenuis in New Brunswick: The Parasite in Terrestrial Gastropods

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Parelaphostrongylus tenuis, the meningeal worm of deer and moose, utilizes terrestrial gastropods as intermediate hosts. A review of the biology of this parasite is provided by Anderson and Prestwood (1981, *In* Diseases and parasites of white-tailed deer, W. R. Davidson et al. (eds.), Misc. Pub. No. 7, Tall Timbers Res. Sta., Tallahassee, Florida, pp. 266–317). Parker (1966, M.Sc. Thesis, Acadia Univ., Wolfville, Nova Scotia, 126 pp.) found five species of terrestrial gastropods in Nova Scotia which contained the L_3 larvae of *P. tenuis*, i.e., *Discus cronkhitei*, *Deroceras reticulatum*, *Striatura exigua*, *Zonitoides arboreus*, and *Philomyeus carolinianus*. Lankester and Anderson (1968, Can. J. Zool. 46: 373–383) in a similar study in Ontario found the following seven species of gastropods infected with *P. tenuis*: *Deroceras laeve*, *D. reticulatum*, *Arion circumscriptus*, *Zonitoides nitidus*, *Anguispira alternata*, *Cionella lubrica*, and *Succinea ovalis*.

The present survey was made to determine which species of gastropods are most important in the transmission of *P. tenuis* in central New Brunswick and to determine the number of infected individuals with respect to habitat types and time of year.

The Acadia Forest Research Station is located about 22 km east of Fredericton. The area of the station is approximately 93 km^2. It is located in the Bantalor Dis-

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trict of the Maritime Lowlands Ecoregion (Loucks, 1962, Proc. N.S. Inst. Sci. 25: 1959–1960). The topography is relatively flat, but slopes gently toward the southeast.

Cutting practices related to the research conducted at the Station have produced a highly diverse forest habitat suitable for many species of wildlife. The area has populations of both white-tailed deer (*Odocoileus virginianus*) and moose (*Alces alces*) with the deer being infected commonly with *P. tenuis* (Upshall, 1985, M.Sc. Thesis, University of New Brunswick, Fredericton, New Brunswick, 65 pp.).

Ten sites were selected for the collection of gastropods and were separated into three habitat types. These were softwood/softwood mixed sites, hardwood/hardwood mixed sites and cutovers. The softwood/softwood mixed sites were dominated by red spruce (*Picea rubens*), black spruce (*Picea mariana*), balsam fir (*Abies balsamea*) and some red maple (*Acer rubrum*), white birch (*Betula papyrifera*), grey birch (*Betula populifolia*), speckled alder (*Alnus rugosa*), trembling aspen (*Populus tremuloides*), and witherod (*Viburnum cassinoides*), with some young balsam fir, larch (*Larix laricina*) and red spruce present at the mixed sites. Thick leaf litter covered the ground at these sites. On the cutovers, the traps were placed along the edge. The ground cover consisted primarily of grasses, ferns, honeysuckle (*Lonicera canadensis*) and sphagnum moss. The dominant tree species along the edge were red spruce, white birch and red maple at one site and red maple, balsam fir and eastern white cedar (*Thuja occidentalis*) at the other.

Molluscs were collected and analysed following Lankester and Anderson (1968, Can. J. Zool. 46: 373–383) except that only 10 cardboard sheets (traps) were placed 10 paces apart at each site and sheets were relocated by one pace randomly after each collection. The traps were checked 5 days a week from 1 June to 23 September 1983 and during May of 1984. These checks were made early in the morning when the cardboards were still wet with dew. Any larval nematodes recovered from the digestion technique were identified following Ballantyne and Samuel (1984, J. Parasitol. 70: 602–604). Voucher specimens of the L_3 larvae were deposited in the National Museum of Canada Invertebrate Collection, Ottawa (NMCP 1986-0006–0009).

TABLE 1. Numbers of terrestrial gastropods found at each site at Acadia Forest Research Station from June–September 1983 and May 1984.

Species	Habitat type[a]			
	S/SM	H/HM	C	Total
Deroceras laeve	41	137	47	225
Zonitoides arboreus	77	123	29	229
Discus cronkhitei	9	35	1	45
Pallifera dorsalis	8	19	1	28
Others[b]	7	34	1	42
Total	142	348	79	569

[a] S/SM = softwood/softwood mixed, H/HM = hardwood/hardwood mixed, C = cutover.

[b] *Stenotrema fraternum* (6), *Mesodon sayanus* (9), *Retinella binneyana* (9), *Philomyscus carolinianus* (3), *Strobilops labyrinthica* (5), *Anguispira alternata* (1), *Succinea ovalis* (5), *Vitrina limpida* (1), *Columella edentula* (2), *Helicodiscus parallelus* (1).

Fourteen species of terrestrial gastropods were found and a total of 569 individuals collected. Two species of snails, *Zonitoides arboreus* and *Discus cronkhitei*, and two species of slugs, *Deroceras laeve* and *Pallifera dorsalis*, accounted for 93% of the gastropods. *Zonitoides arboreus* and *D. laeve* were found at all 10 sites while *C. cronkhitei* and *P. dorsalis* were found in seven and eight sites respectively, being relatively uncommon in the cutovers (Table 1).

Infections with *P. tenuis* were found in *D. laeve*, *Z. arboreus* and *D. cronkhitei*. Twelve of the 14 infected individuals were *D. laeve*, and 12 of the 14 were found in the hardwood/hardwood mixed habitat type (Table 2). All but one infected gas-

TABLE 2. The distribution of gastropods infected with larvae of *Parelaphostrongylus tenuis* with respect to the various habitats at Acadia Forest Research Station from June–September 1983 and May 1984.

Gastropod	No. gastropods infected in each habitat type			
	S/SM[a]	H/HM[a]	C[a]	Total
Deroceras laeve	0	11	1	12
Zonitoides arboreus	0	1	0	1
Discus cronkhitei	1	0	0	1
Total no. infected	1 (2 L_3's)	12 (81 L_3's)	1 (1 L_3)	14 (84 L_3's)
Total no. gastropods examined	142	348		569

[a] S/SM = softwood/softwood mixed, H/HM = hardwood/hardwood mixed, C = cutover.

tropod were found between 20 June and 25 July, the only exception being 31 May (Table 3).

LaRocque (1961, Sterkiana 3: 40–42) listed 27 species of land molluscs found in New Brunswick. Clarke et al. (1968, Nat. Mus. Can. Contrib. Zool. No. 4, Bull. No. 223, 22 pp.) added eight more species not recorded previously for New Brunswick. All but *Columella edentula*, a small, pupa-shaped snail, have been reported previously from New Brunswick. Gleich and Gilbert (1976, Can. J. Zool. 54: 620–627) found one specimen of *C. edentula* in a similar study in Maine.

The species of gastropods most heavily infected with *P. tenuis* were those that were most widely distributed. In the present study, *Deroceras laeve* was the most important intermediate host (Table 2). Lankester and Anderson (1968, op. cit.) also found *D. laeve* to be the primary intermediate host. Parker (1966, op. cit.) found *Deroceras reticulum* and *Discus cronkhitei* to be important hosts of *P. tenuis* in Nova Scotia. Gleich et al. (1977, J. Wildl. Dis. 13: 43–46) found two specimens of *Pallifera dorsalis* infected with *P. tenuis* in Maine. This was one of the most common species found in that survey. Although it was found in small numbers in eight of the sites sampled in this survey, none was infected.

Since all but one of the gastropods infected with L_3 larvae were found between 20 June and 25 July, it can probably be assumed that most deer and moose would become infected with *P. tenuis* during this period. In July, eight of 152 gastropods were infected with *P. tenuis*. Lankester and Anderson (1968, op. cit.) also found that the highest intensity of infection of adult *Deroceras laeve* was 25% in late June. Parker (1966, op. cit.) found three gastropods infected with L_3 larvae in July, one in August, and two in September. The low number of gastropods in May would be an important factor with respect to the potential transmission of infected gastropods to cervids. Getz (1959, Am. Midl. Nat. 61: 485–498) reported that *D. laeve* is seldom active at temperatures below 14 C and so it would be relatively unavailable for ingestion by deer and moose until this temperature is reached.

Snails and slugs infected with *P. tenuis* were found predominantly in the hardwood/hardwood mixed habitat. Kearney and Gilbert (1978, Can. J. Zool. 56: 688–

TABLE 3. The distribution of gastropods infected with larvae of *Parelaphostrongylus tenuis* at Acadia Forest Research Station with respect to month of the year, June–September 1983 and May 1984.

Month	Habitat type[a]				
	S/SM	H/HM	C	Total	Total infected
May	8	13	4	25	1
June	66	156	32	254	5
July	26	100	26	152	8
August	35	62	11	108	0
September	7	17	6	30	0

[a] S/SM = softwood/softwood mixed, H/HM = hardwood/hardwood mixed, C = cutover.

694) also found infected gastropods most often in hardwood or hardwood mixed habitats, and Parker (1966, op. cit.) found most of the infected molluscs in hardwoods. However, Parker did not classify his mixed sites as being either softwood or hardwood. It is possible that gastropods prefer hardwood sites because the leaf litter provides a moist refuge in which they can estivate during hot, dry weather.

Kearney and Gilbert (1978, op. cit.) suggested that areas where white birch was dominant were probably the primary transmission sites of *P. tenuis* because of the availability of infected gastropods and the fact that both moose and deer feed in these areas. Our results support this suggestion. However, it appears that all hardwood areas (primarily maple, birch and aspen) may serve as transmission points. The spring and summer feeding habits of deer at the Acadia Forest Research Station were documented by Skinner (1968, M.Sc. Thesis, University of New Brunswick, Fredericton, New Brunswick), and maple, birch and aspen were found commonly in their diet. Nothing is known about spring and summer feeding by moose in this area, but maple, birch and aspen have been found in the spring and summer diets of moose in other areas (Peck, 1973, *In Alces*: Moose Ecology, Les Presses de l'Université, Laval, Quebec, pp. 195–215). Both moose and deer sign were noted in the three habitat types in this study.

One factor which may be responsible for higher prevalences of infection of deer by *P. tenuis* is the tendency of deer to take dried leaves as part of their spring and summer diet which has not been noted in moose (Upshall, 1985, op. cit.; Skinner, 1968, op. cit.). In addition to this, preliminary data show that moose and deer in this area do not select the same habitat types during the summer (Trimper and Dilworth, unpubl. data). It is difficult to say to what degree they actually interact and how much potential there is for moose to become infected with *P. tenuis* in this area.

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