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A Comparative Study of the Parasites in Two Populations of White-Tailed Deer*

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Abstract

The study compares parasite prevalence in two geographically separated populations of white-tailed deer in central Pennsylvania. Differences in prevalence were found for certain of the parasites studied. Characteristics of curves comparing prevalence with host-age group, however, were remarkably similar for individual parasites from both populations. Prevalence increased with host age for certain species of parasite and decreased or remained constant for others. Some of the underlying biological properties of the infections which may be responsible for the characteristics of the age specific prevalence curves are discussed.

Introduction

Although reports of selected parasite species of the white-tailed deer (*Odocoileus virginianus* Zimmermann) have appeared recently,[3,9,10,12] few data are available dealing with the total parasite fauna of this host. Following the description of methods for detecting deer parasites[11,15] attempts were made to assess the entire endoparasitic composition of white-tailed deer from two geographically isolated areas of central Pennsylvania. The prevalence and abundance of selected parasites were correlated with host age. This paper summarizes the findings.

Materials and Methods

Parasite collection, identification and abundance

The methods of collection, storage and examination of deer entrails as well as identification of most parasites are described elsewhere.[15] Both necropsy for adult parasites and examination of feces for selected immature parasite stages were accomplished on most deer. Microfilariae of *Wehrdikmansia cervipedis* were detected using the technique reported by Hibler.[8]

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Deer collection sites

Deer examined during the study were killed by hunters in December 1963-1967. Collection sites were Letterkenny Army Ordnance Depot, Franklin County, south central Pennsylvania and The Pennsylvania State University Experimental Forest at the Stone Valley Recreation Area, Huntingdon County in central Pennsylvania.

Letterkenny is located geographically in a valley of gently rolling terrain and was removed from cultivation in 1943. Most deer were collected in the ammunition storage section, a 10,000-acre area of small oak-hickory woodlots and old field associations.[6] The Stone Valley area is basically forest cover of small oaks and hardwoods which is representative of much of Pennsylvania's deer habitat.

Age determination

Deer were aged, using tooth characteristics according to the method described by Severinghaus.[16] Because deer were collected during the month of December they were aged to the nearest half year assuming a June 1 birthdate. Deer 6 months old were considered fawns; deer 1½ years of age, yearlings; and deer 2½ years and older, adults.

TABLE 1. *List of parasites found in deer in Pennsylvania, their location in the host and the method of diagnosis*

Species	Location of mature parasite in the host	Method of diagnosis
Capillaria sp.	Small intestine	Eggs in feces
Dictyocaulus viviparus (Bloch, 1782)	Bronchi, bronchioles	Necropsy + larvae in feces
Eimeria spp.[1]	Intestine	Oocysts in feces
Gongylonema pulchrum Molin, 1857	Esophageal mucosa	Necropsy + eggs in feces
Nematodirus filicollis (Rudolphi, 1802)	Small intestine	Necropsy + eggs in feces
Odocoileostrongylus tenuis (Dougherty, 1945): (= *Pneumonstrongylus tenuis)*	Subdural spaces of the cranium	Necropsy + larvae in feces
Oesophagostomum venulosum (Rudolphi, 1809)	Large intestine + caecum	Necropsy + eggs in feces
Haemonchus contortus (Rudolphi, 1803)	Abomasum	Necropsy + eggs in feces
Ostertagia dikmansi Becklund and Walker, 1968	Abomasum	Necropsy + eggs in feces
Ostertagia mossi (Dikmans, 1931)	Abomasum	Necropsy + eggs in feces
Spiculopteroides odocoilei (Dikmans, 1931); (= *Ostertagia odocoilei)*	Abomasum	Necropsy + eggs in feces
Trichuris ovis (Abildgaard, 1795)	Large intestine + caecum	Necropsy + eggs in feces
Wehrdikmansia cervipedis Wehr and Dikmans, 1935	Subcutaneous fascia	Larvae in tissue extracts

[1] Includes *E. mccordocki*, Honness, 1941; *E. virginianus*, Anderson and Samuel, 1969; and *E. odocoilei*, Levine, Ivens and Senger, 1967.

Results

Each species of parasite encountered in the deer during this study is listed in Table 1 with its location in the host and the diagnostic methods used to detect it.

Prevalence of each parasite found in deer on Letterkenny is compared with the corresponding prevalence in deer taken at Stone Valley in Table 2. The population of deer at Stone Valley supported the higher prevalence for *Capillaria* sp., *G. pulchrum*, *N. filicollis*, *O. tenuis* and *O. venulosum*, while no significant difference in prevalence was found between deer collection areas for the remaining parasite species. Reliable data on parasite abundance (density/infection) were difficult to obtain. Thus, they are entirely lacking for infections with *W. cervipedis*, the trichostrongyles of the abomasum, *Capillaria* sp., *Eimeria* spp. and *D. viviparus*, while only limited data are available for *N. filicollis*, *O. venulosum*, *T. ovis* and *O. tenuis* (Table 3). These data are either incomplete or largely from a single study area. Only in the case of *G. pulchrum* could sufficient data on abundance be obtained to provide a meaningful comparison between the two study areas. Because it was often difficult to obtain an intact esophagus the density of *G. pulchrum* is expressed as density unit area of esophagus in Figure 1. The density of this parasite in the esophagus of deer from Stone Valley showed a stronger direct correlation with increase in age of the host ($r = .99$) than was found at Letterkenny ($r = .58$).

TABLE 2. *Comparison of parasite prevalence in white-tailed deer from the Letterkenny Depot to deer from the Stone Valley Recreation Area*
Number deer infected/number deer examined (per cent deer infected)

Species	Letterkenny	Stone Valley	Chi square values	Values of P[3]
Capillaria sp.	1/54(2)	13/61(21)	8.39	.01
Dictyocaulus viviparus	2/53(4)	2/53(4)	0	NS
Eimeria spp.[1]	10/80(12)	12/66(18)	0.52	NS
Gongylonema pulchrum	41/89(46)	70/100(70)	10.16	.01
Nematodirus filicollis	1/54(2)	9/61(15)	4.48	.05
Odocoileostrongylus tenuis	21/71(30)	56/74(76)	39.37	.001
Oesophagostomum venulosum	1/55(2)	15/62(24)	10.47	.01
Trichostrongyle-abomasal complex[2]	49/68(72)	47/65(72)	0.04	NS
Trichuris ovis	1/55(2)	3/62(5)	0.15	NS
Wehrdikmansia cervipedis	20/94(21)	10/33(30)	1.65	NS

[1] Includes *E. mccordocki*, *E. virginianus* and *E. odocoilei*.
[2] Complex includes *Haemonchus contortus*, *Ostertagia dikmansi*, *O. mossi*, and *Spiculopteroides odocoilei*.
[3] NS indicates no statistical significance.

STONE VALLEY			
HOST AGE	NUMBER DEER	NUMBER WORMS	W/IN^2
.5	12	66	.52
1.5	14	208	.96
2.5	14	394	1.53
3.5	8	268	1.87
4.5–8.5 $\bar{x}$=6.2	7	346	2.81

LETTERKENNY			
HOST AGE	NUMBER DEER	NUMBER WORMS	W/IN^2
.5	7	11	.19
1.5	5	23	.28
2.5	5	14	.27
3.5	4	22	.34
4.5–6.5 $\bar{x}$=5.5	4	23	.27

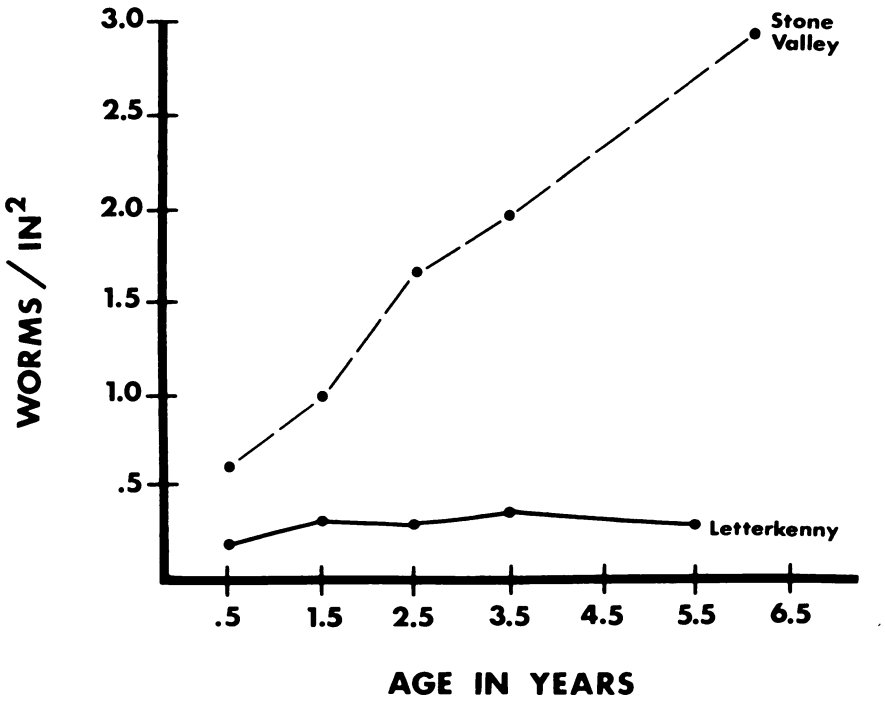

FIGURE 1. *Relationship between the density of* Gongylonema pulchrum *and the age of the host. (Density expressed as worms/sq. in. of esophagus).*

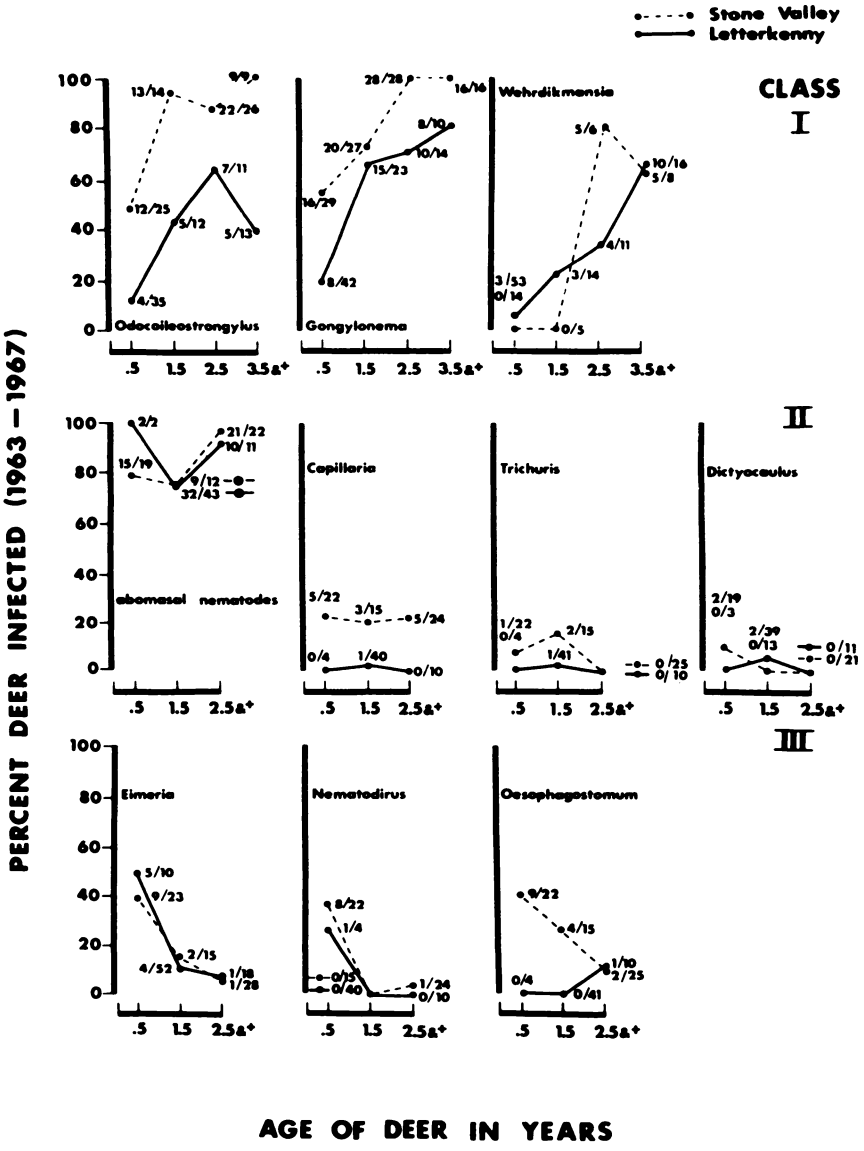

FIGURE 2. *Relationship of parasite prevalence to deer age in two herds in Pennsylvania.*

TABLE 3. *Abundance of four nematodes in infected deer in Pennsylvania*

	No. infected deer examined			Parasite burdens	
	Letterkenny	Stone Valley	Total	x	Range
O. tenuis	21	19	40	3.3	(1-23)
N. filicollis	1	9	10	75.6	(1-223)
O. venulosum	1	15	16	1.7	(1-7)
T. ovis	1	3	4	6.8	(1-28)

Host age

The characteristics of the age specific prevalence curves for each species of parasite were similar for deer from both localities (Figure 2), when adequate samples could be obtained for each age group. Prevalence increased with host age in *O. tenuis, G. pulchrum* and *W. cervipedis,* did not change significantly in infections with the abomasal complex, *Capillaria* sp. and *T. ovis,* and decreased with host age in *Eimeria* spp., *N. filicollis, O. venulosum* and *D. viviparus* infections. Dependence of prevalence on host age was statistically tested by X^2 ($p < .05$). These curves are herein referred to as Class I, II and III curves, respectively.

Discussion

This study used prevalence as a basic measurement of parasite success in deer from two areas in Pennsylvania. Consideration of possible epizootiological factors involved in the higher prevalence of certain parasites in deer from the Stone Valley Recreation Area indicates that a number of factors may be involved. For example, only deer from the Stone Valley Recreation Area have free access to areas used by domestic livestock. Letterkenny is an army ordnance depot, enclosed since 1943, and deer therein have little or no contact with domestic ruminants. Most parasites of deer have been reported from domesticated ruminants.[1,13] In this study, however, species that are either nonexistent or rare in domestic ruminants *(O. tenuis* and *W. cervipedis)* were more prevalent in deer from Stone Valley. Other factors such as age composition and density of the host population as well as the ecological factors of the external habitat may be more important. For example, analysis of the age profiles of does killed in the two areas during 1966 indicates the age composition of the two populations was different, averaging 1.93 years in the Letterkenny herd compared to 2.39 years in the Stone Valley population. In addition to differences in the herds themselves, many differences existed in the physical as well as the biologic characteristics of the habitat, although the role these factors play is not known. The comparison of prevalence with density of *G. pulchrum* for different age classes was interesting in that the two independent measurements of parasite populations in the deer were in general agreement for the two collection areas although differences in density between areas were of a greater magnitude (Figure 1). Both higher prevalence and higher density of this parasite occurred at Stone Valley.

The most striking finding of the study was the discovery that although the levels of parasitism for many species differed in the two populations, the characteristics of the curves comparing parasite prevalence to host age are remarkably similar for each species in which an adequate sample could be obtained. Since samples of each of the deer populations were obtained independently of one another, but were handled identically they are in a sense independent replicates of each other. This suggests that the age specific curves are neither artifacts of sampling nor are they local geographic phenomena, but reflect some common biologic factor or group of factors as yet undetermined.

Although any conclusion reached about the underlying reasons for the similarity of the curves is premature, consideration of some aspects of the host-parasite system, even if highly speculative, is important at this time to call attention to some of the possible interpretations of the data and their sigificance.

Those parasites which show an increase in prevalence with increase in host age (Class I), including *O. tenuis, G. pulchrum* and *W. cervipedis,* share at least three broad biologic features: (1) all three have indirect life histories; (2) all are tissue parasites as adults; and (3) all presumably require a relatively long time to reach sexual maturity in the definitive host. The last factor may account for the low prevalence in the first age class in the case of at least two of the species, *O. tenuis* and *W. cervipedis,* since a long prepatent period (82-91 days) has been demonstrated for the former[2] and diagnosis of the latter depends on observing larval progeny in the host tissue. Although the details of the life cycle of *W. cervipedis* are not known, filarial worms characteristically undergo an extraordinarily long development time in the vertebrate host before reaching sexual maturity and would therefore have been undetected by the means used until the infection became patent. This factor does not, however, explain the prevalence data obtained for *G. pulchrum,* which should be recovered as soon as the adult stage reaches the esophagus from the lumen. The direct correlation of density of *Gongylonema* with host age also argues against the above hypothesis. The population dynamics of the intermediate hosts and their interaction with the parasites undoubtedly influence parasite prevalence. However, age-density data for *G. pulchrum* in deer from Stone Valley conform to a markedly steady rate of infection (compare Figures 1 and 2). The hypothesis that the observed age specific prevalence of *G. pulchrum* results from a stable population of infective intermediate hosts over the last six years would require spectacular stability in the invertebrate populations and their rate of infection over this period.

The second class of curve (Class II) indicates no change in parasite prevalence with age of the host and includes the four abomasal trichostrongyles, *Capillaria, Trichuris* and *Dictyocaulus.* This suggests one of two possible explanations. All susceptibles may be infected by six months and so remain for at least three years; the remaining negative animals represent either a failure of diagnosis or comprise a nonsusceptible segment of the deer population. An alternative explanation is that individuals are infected in the warm months and that the parasites are relatively short-lived. This latter explanation would appear to fit data for the parasites of the abomasum *(O. dikmansi, O. mossi, S. odocoilei* and *H. contortus),* and requires only that the rate of infection and the length of patency of the parasite be relatively stable. Such an explanation would not be compatible with the known biology of either *Capillaria* or *T. ovis* infections. Both of these worms are from genera which may be long-lived in the definitive host although there is much variation in species of both genera. No satisfactory explanation of the curves generated for these last two parasites has been arrived at.

The third type of curve (Class III) includes *Eimeria* spp., *N. filicollis* and *O. venulosum.* This curve is strongly suggestive of an immunity phenomenon. In the case of *Eimeria* this immunity most probably would be acquired, since the patent infection is self-limiting and, therefore, of short duration.[11] In this regard, prevalence figures for *Eimeria* represent a small percentage of the infected fawns, since this parasite is probably only patent for a relatively short period of time, and a strong acquired immunity ensues. In the case of the two nematode species an age immunity may be the responsible mechanism. The prevalence in the fawns may represent the infection rate which declines in subsequent years in the absence of new infection. The length of time a deer would remain infected would depend entirely on the life expectancy of the parasite. Similar immunity phenomena have been reported for these parasites in domestic ruminants.[4,5,7]

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Literature Cited

1. ANDERSON, R. C. 1962. The parasites (Helminths and Arthropods) of white-tailed deer. Proc. Natl. Deer Dis. Symposium, Georgia, U.S.A. Feb. 13-15, *1:* 162-173.
2. ANDERSON, R. C. 1965. Cerebrospinal nematodiasis *(Pneumostrongylus tenuis)* in North American cervids. Trans. N. Amer. Wildl. Conf. *13:* 156-167.
3. BEHREND, D. F., and WITTER, J. F. 1968. *Pneumostrongylus tenuis* in white-tailed deer in Maine. J. Wildl. Mgmt. *32*(4): 963-966.
4. BRUNDSON, R. V. 1962. Age resistance of sheep to infestation with the nematodes *Nematodirus filicollis* and *Nematodirus spathiger*. N.Z. Vet. J. *10:* 1.
5. DAVIES, S. F. M., JOYNER, L. P., and KENDALL, S. B. 1963. Coccidiosis. Oliver and Boyd, Edinburgh and London. 264 pp.
6. DAVIS, D. E., CHRISTIAN, J. J., and BRONSON, F. 1964. Effect of exploitation on birth, mortality, and movement rates in a woodchuck population. J. Wildl. Mgmt. *28*(1): 1-9.
7. GIBSON, T. E. 1959. Nematodiriasis in sheep. Agric. *66:* 126-129.
8. HIBLER, C. P. 1965. Description of the microfilaria of *Wehrdikmansia cervipedis* (Wehr and Dikmans, 1935) and observations on its location in Arizona deer. Bull. Wildl. Dis. Assoc. *1:* 44-48.
9. KARNS, P. D. 1967. *Pneumostrongylus tenuis* in deer in Minnesota and implications for moose. J. Wildl. Mgmt. *31*(2): 299-303.
10. KARSTAD, L., and TRAINER, D. O. 1969. Sarcocystis in white-tailed deer. Bull. Wildl. Dis. Assoc. *5*(1): 25-26.
11. LEVINE, N. P. and V. IVENS. 1965. The Coccidian Parasites (Protozoa, Sporozoa) of Rodents. III. Biol. Mon. *33:* 365 pp.
12. ROBINSON, R. M., KUTTLER, K. L., EMERSON, H. R., JONES, L. P., and MARBURGER, R. G. 1968. Blood parasites in Texas deer. Trans. N. Amer. Wildl. Conf. *33:* 359-364.
13. SAMUEL, W. M. 1968. Endoparasites of domestic ruminants and white-tailed deer. Trans. N. Amer. Wildl. Conf. *33:* 364-372.
14. SAMUEL, W. M., and BEAUDOIN, R. L. 1965. Identification of eggs and larvae of nematodes parasitic in deer in Pennsylvania. Proc. Penna. Acad. Sci. *39:* 73-77.
15. SAMUEL, W. M. and BEAUDOIN, R. L. 1966. Evaluation of two survey methods for detection of helminth infections in white-tailed deer *(Odocoileus virginianus)*. Bull. Wildl. Dis. Assoc. *2*(4): 100-107.
16. SEVERINGHAUS, C. W. 1949. Tooth development and wear as criteria of age in white-tailed deer. J. Wildl. Mgmt. *13*(2): 195-216.