Transactions of Illinois Academy of Sciences
(1982). Volume 75, 3 and 4, pp. 289-295

GASTROINTESTINAL HELMINTHS IN GRAY FOXES (*UROCYON CINEREOARGENTEUS*) OF SOUTHERN ILLINOIS.

William G. Dyer and Willard D. Klimstra
Department of Zoology, Southern Illinois University at Carbondale,
Carbondale, Illinois 62901

ABSTRACT

Gastrointestinal helminths recovered from 454 (83.6%) of 543 *Urocyon cinereoargenteus* in southern Illinois between 1959 and 1963 included *Ancylostoma caninum* (2.4%), *Physaloptera rara* (68.0%), *Toxascaris leonina* (0.2%), *Toxocara canis* (0.2%), *Trichuris vulpis* (2.7%), *Alaria maricanae* (6.7%), *Taenia pisiformis* (69.7%), and *Mesocestoides variabilis* (2.0%). One hundred and thirty-seven animals were positive for only 1 species (25.2%), 271 for two (49.9%), 43 for three (7.9%), and 3 for four (0.6%). Infections with *T. pisiformis* and *P. rara* were high for each year while infections with all other parasites were relatively low and negative for some years.

INTRODUCTION

Several extensive studies on gastrointestinal parasites in wild canid populations have been conducted in North America, (see Samuel *et al.*, 1978 and references therein). However, there is a paucity of studies on the gastrointestinal parasites of gray foxes *(Urocyon cinereoargenteus)* (Schreber). The only extensive study was that conducted by Buechner (1944) who examined 112 gray foxes from Texas. Other studies include reports on the parasites of 15 gray foxes from Massachusetts (MacGregor, 1942; Rankin, 1946), 17 from Mississippi (Ward, 1947), and 15 from North Carolina, 7 from Georgia and 2 from South Carolina (Miller and Harkema, 1968).

The only study of fox parasites from Illinois was by Leigh (1940) who examined 12 red foxes *(Vulpes vulpes* L.*)* from counties in the northern part of the state. The purpose of this study was to determine the helminth fauna of the gastrointestinal tracts of a large sample of *U. cinereoargenteus* taken over a period of several years from counties in southern Illinois and to compare the data with the results of published studies.

MATERIALS AND METHODS

Five hundred and forty-three gray foxes were either shot or trapped in Union, Williamson, Johnson, and Jackson counties, southern Illinois between November, 1959 and October, 1963. The gastrointestinal tract of each fox was divided into the

stomach, small intestine, and large intestine, examined macroscopically, questionable items checked under a dissecting microscope and any helminths found were isolated in tap water.

Trematodes and cestodes were fixed in alcohol-formalin-acetic acid (AFA), stained with either Harris' or Delafield's hematoxylin and mounted in Canada balsam. Rostellar hooks were removed from the cestodes, mounted in aquamount, and compared with hooks from known species. Nematodes were fixed in glycerin-alcohol, cleared in glycerine, and examined from glycerine wet mounts.

RESULTS

The monthly prevalence of infection in the 543 *U. cinereoargenteus* collected over a discontinuous 36 month period is summarized in Table 1. All of 9 animals from 1959 were infected. Ninety-four (91.3%) of the 103 animals from 1960, 235 (81.0%) of the 290 animals from 1961, 61 (84.7%) of the 72 animals from 1962, and 55 (79.7%) of the 69 animals from 1963 were positive.

The prevalence of gastrointestinal helminths of 335 male and 208 female *U. cinereoargenteus* is summarized in Table 2. Eighty-nine (16.4%) of the 543 gray foxes were free of helminths in both stomach and intestines. Five species of nematodes, one of trematodes, and two of cestodes were found in 454 (83.6%) animals. One hundred and thirty-seven animals were positive for only 1 parasitic species (25.2%), 271 for two (49.9%), 43 for three (7.9%), and 3 for 4 (0.6%). *Physaloptera rara* Hall and Wigdor, 1918 and *Taenia pisiformis* (Bloch, 1780) were the most frequent helminths encountered either as single infections (11.6%) and 12.5%) or combined (single and mixed) infections (68.0%) and (69.7%) respectively. The frequency of occurrence of helminth species did not vary significantly ($P > 0.05$) between the sexes.

Infections with *T. pisiformis* and *P. rara* were high each year while infections with other helminths were relatively low and absent in some years (Table 3). The prevalence of *Trichuris vulpis* (Froelich, 1789) and *P. rara* varied significantly among years ($P < 0.05$) while other helminths remained at about the same prevalence each year.

DISCUSSION

Because gray foxes were collected at selected seasonal intervals between 1959 and 1963 and not systematically by month over a period of several consecutive years (Table 1), there are insufficient data to form convincing conclusions on the seasonal dynamics of *U. cinereoargenteus* parasites.

With the exception of *T. pisiformis* and *P. rara*, the overall prevalence of gastrointestinal parasites was low with the majority of gray foxes infected with either one or two species (Table 2).

The high yearly prevalence of infection with *T. pisiformis* and *P. rara* coupled with the large number of worms recovered from the intestine and stomach respectively reflects the dependence of gray foxes in southern Illinois on rabbits, rodents, and insects for a large part of their diet.

While the prevalence of most helminths remained about the same from 1960 to 1963, that of *P. rara* and *T. vulpis* varied significantly among years. This could be due to a number of factors such as sample size, collection period, seasonal availability of food items, etc.

High prevalence of *T. pisiformis* in gray foxes from other areas has been reported, namely, 51 (56.7%) of 112 *U. cinereoargenteus* from Texas (Buechner, 1944), 9 (37.5%) of 24 from N. Carolina, S. Carolina, and Georgia (Miller and Harkema, 1968), and 15 (88%) of 17 from Mississippi (Ward, 1947). *Taenia pisiformis* is also a prevalent cestode in *C. latrans* from certain geographic areas. This species has been reported in 1758 (95%) of 1850 coyotes from Kansas (Gier and Ameel, 1959), 41 (54.6%) of 75 from Utah (Butler and Grundmann, 1954), 66 (19.5%) of 339 from Ontario (Freeman *et al.*, 1961), 29 (67%) of 43 in Manitoba (Samuel *et al.*, 1978), and 23 (31%) of 75 in Alberta (Holmes and Podesta, 1968).

Mesocestoides variabilis Mueller, 1927, was recovered in only 10 (2.0%) animals. This species has also been reported from 5 (20.8%) of 24 gray foxes from N. Carolina, S. Carolina, and Georgia (Miller and Harkema, 1968). Buechner (1944) reported *M. litteratus* (Batsch, 1786) in 9 (10.2%) of 88 gray foxes in Texas. *Mesocestoides variabilis* has a wide geographic distribution throughout the contiguous United States and has been recorded for a variety of hosts other than the gray fox.

Current taxonomic criteria for differentiating species of *Mesocestoides* are inadequate. Morphological differentiation is slight and variability of characters extensive. Voge (1955) concluded that on the basis of available data *M. corti* Hoeppli, 1925, and *M. variabilis* cannot be satisfactorily differentiated and that *M. manteri* Chandler, 1942, is a dwarf form of *M. variabilis*. For this reason, she proposed that *M. manteri* and *M. variabilis* be regarded as synonyms of *M. corti*. However, Voge states that even though the evidence justifies this procedure, two disadvantages result, "One is the loss of the very appropriate specific name *variabilis*, and the other is that the type host of *Mesocestoides corti* is not a characteristic one." For this reason and in concurrence with Miller and Harkema (1968), we feel that pending further study the specific epithet *variabilis* should be retained.

Alaria marcianae (La Rue, 1917) Hall and Wigdor, 1918 (= *A. canis* LaRue and Fallis, 1936) see Dubois (1963), the only fluke encountered, occurred in 36 (6.7%) of the 543 gray foxes. Miller and Harkema (1968) reported it in 1 (6.7) of 15 gray foxes from N. Carolina. It has also been reported from several other canids in North America. Pearson (1956) has shown that mesocercariae of *A. arisaemoides* Augustine and Urbie, 1927, and *A. marcianae* develop in tadpoles and frogs and that a variety of vertebrates act as collector or paratenic hosts making the mesocercariae more readily available to the definitive host because of its habitat and foot habits. Bullfrogs, *Rana catesbeiana* Shaw, southern leopard frogs, *Rana pipiens sphenocephala* Cope, and green frogs, *Rana clamitans melanota* (Rafinesque), are common amphibians in Union, Williamson, Johnson, and Jackson counties. The gray foxes in these areas may have acquired infection by ingesting either frogs or a paratenis host, probably a rodent, as suggested for *A. marcianae* in Alaskan wolves (Rausch and Williamson, 1959) and for wolves and coyotes from Alberta (Holmes and Podesta, 1968).

Physaloptera rara, the most prevalent and numerous nematode encountered, has a wide distribution in canines and felines in North America. Insects serve as intermediate hosts and frogs, snakes, birds, and mice may serve as paratenic hosts. Development in the definitive host is the same regardless of whether infection is acquired by ingesting parasitized insects or paratenic hosts (Olsen, 1971). Buchner (1944) reported 43 (38.4%) of 112 gray foxes from Texas infected with this species.

Miller and Harkema (1968) found 9 (37.5%) of 24 gray foxes from N. Carolina, S. Carolina, and Georgia infected with *P. maxillaris* Molin, 1860.

Ancylostoma caninum (Ercolani, 1954) was encountered in only 13 (2.4%) of the gray foxes examined. Some difficulty was experienced in separating the hookworms from their masses found in the intestines resulting in small recoveries. Based on this study, hookworm infections in gray foxes in southern Illinois do not pose a serious threat to the health of these canids. However, Foster (1932) found that hookworm larvae in pregnant dogs may enter the fetus, infecting them prenatally and most of the infected pups died before one month old. Perhaps this mode of infection exists for pups of *U. cinereoargenteus* as well.

Although *toxocara canis* (Werner, 1782) has a wide distribution in canids, only 1 (0.2%) gray foxes were infected. Sprent (1958) found that canids older than 6 months can become infected only by ingesting infected intermediate hosts while young canids can become infected by ingesting either embryonated eggs or infected rodents, or by prenatal migrating larvae. Visceral larval migrans may occur in humans on ingesting infective eggs (Olsen, 1974). Ward (1947) reported this species in 2 (12%) of 17 gray foxes from Mississippi. However, neither Buechner (1944) nor Miller and Harkema (1968), encountered it.

Toxascaris leonina (von Linstow, 1902) occurred in only 1 (0.2%) fox. According to Sprent (1959), this species may undergo either a direct life cycle or use an intermediate host, usually a rodent. While it is a common parasite of red foxes, coyotes, and wolves, the literature did not reveal its presence in gray foxes.

Trichuris vulpis (Froelich, 1789), cosmopolitan in dogs, foxes, and coyotes, was found in 14 (2.7%) gray foxes. Miller and Harkema (1968) reported it in one of 24 gray foxes.

Pils and Klimstra (1975) compared the results of their late fall food habit study of 169 gray foxes from southern Illinois with those published studies on the food habits of gray foxes from Virginia, Pennsylvania, Iowa and Missouri. While plants provided the primary food of the gray fox diet in southern Illinois, mammals provided the primary food of gray foxes from the other areas. These authors pointed out that the diet of the gray fox is highly omnivorous and that some differences in the food items of gray foxes from different areas may be attributed to seasonal availability.

The high prevalence of *T. pisiformia* (69.7%) in the present study corroborates the high percent frequency of occurrence of rabbits (27%) in the diet of Illinois grey foxes as reported by Pils and Klimstra (1975). Likewise, the high prevalence of *P. rara* (68.0%) corroborates the high percent frequency of occurrence of rodents (62%) and insects (54%) as given by the same authors. Results of this investigation support the conclusion of Holmes and Podesta (1968) that the relative frequencies of helminths with different intermediate hosts generally reflect the diet of the canid in question.

Table 1. Prevalence of intestinal helminths in 543 *Urocyon cinereoargenteus* collected between November, 1959 and October, 1963 from southern Illinois.

	Monthly prevalence—(no. infected) no. examined											
Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1959											(8) 8	(1) 1
1960	(28)30	(8) 10	(13)16							(1)1	(5) 7	(39)39
1961	(47)54	(49)67	(79)95	(14)15	(5) 7		(2)3	(3)3	(8)11	(7)10	(21)25	
1962	(4) 5	(10)12		(10)10	(10)11	(2)2	(1)1	(1)1		(4) 6	(2) 3	(17)21
1963	(14)20	(18)22	(6) 7	(4) 4	(4) 4		(4)6		(1)1	(4) 4		

Table 2. Prevalence of single, mixed, and combined infections in relation to sex of 54 *Urocyon cinereoargenteus* from southern Illinois.

Parasite	Prevalence—(number) percent		
	Sexes Combined (543)	Male (335)	Female (208)
Single infection			
Ancylostama caninum	(4) 0.7	(2) 0.6	(2) 1.0
Physaloptera rara	(63)11.6	(40)11.9	(23)11.1
Toxascaris leonina	(0)	(0)	(0)
Toxocara canis	(0)	(0)	(0)
Trichuris vulpis	(0)	(0)	(0)
Alaria americana	(2) 0.4	(1) 0.3	(1) 0.5
Taenia pisiformis	(68)12.5	(46)13.7	(22)10.6
Mesocestoides variabilis	(0)	(0)	(0)
Mixed infection			
A.c. + *T.p.*	(4) 0.7	(2) 0.6	(2) 1.0
P.r. + *T.v.*	(1) 0.2	(0)	(1) 0.5
P.r. + *A.a.*	(4) 0.7	(2) 0.6	(2) 1.0
P.r. + *T.p.*	(254)6.8	(149)44.5	(105)50.5
P.r. + *M.v.*	(2) 0.4	(1) 0.3	(1) 0.5
T.l. + *T.p.*	(1) 0.2	(0)	(1) 0.5
T.v. + *T.p.*	(2) 0.4	(2) 0.6	(0)
T.p. + *M.v.*	(3) 0.6	(2) 0.6	(1) 0.5
A.c. + *P.r.* + *T.p.*	(2) 0.4	(1) 0.3	(1) 0.5
A.c. + *T.p.* + *A.a.*	(2) 0.4	(2) 0.6	(0)
P.r. + *T.c.* + *T.p.*	(1) 0.2	(1) 0.3	(0)
P.r. + *T.v.* + *T.p.*	(9) 1.7	(8) 2.4	(1) 0.5
P.r. + *A.a.* + *T.p.*	(25) 4.6	(13) 3.9	(12) 5.8
P.r. + *A.a.* + *M.v.*	(1) 0.2	(1) 0.3	(0)
P.r. + *T.p.* + *M.v.*	(3) 0.6	(2) 0.6	(1) 0.5
A.c. + *P.r.* + *T.p.* + *M.v.*	(1) 0.3	(1) 0.3	(0)
P.r. + *T.v.* + *A.a.* + *T.p.*	(2) 0.4	(2) 0.6	(0)
Combined (single and mixed) infection			
Ancylostoma caninum	(13) 2.4	(8) 2.4	(5) 2.5
Physaloptera rara	(368)68.0	(221)66.0	(147)70.9
Toxascaris leonina	(1) 0.2	(0)	(1) 0.5
Toxocara canis	(1) 0.2	(1) 0.3	(0)
Trichuris vulpis	(14) 2.7	(12) 3.6	(2) 1.0
Combined (single and mixed) infection			
Alaria americana	(36) 6.7	(21) 6.3	(15) 7.3
Taenia pisiformis	(377)69.7	(231)69.0	(146)70.4
Mesocestoides variabilis	(10) 2.0	(7) 2.1	(3) 1.5

Table 3. Percent of gray foxes infected with gastrointestinal parasites in southern Illinois from 1960 to 1963.

Parasite	Yearly Prevalence—percent			
	1960	1961	1962	1963
Ancylostoma caninum	2.9	2.4	5.6	0.0
Physaloptera rara	75.7	75.9	61.1	46.4
Toxascaris leonina	1.9	0.0	0.0	0.0
Toxocara canis	1.0	0.0	0.0	0.0
Trichuris vulpis	11.7	0.3	2.8	0.0
Alaria americana	7.8	7.6	2.8	0.0
Taenia pisiformis	77.7	69.0	66.7	75.4
Mesocestoides variabilis	1.0	2.1	4.2	0.0

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