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Research Note

Seroprevalence of *Toxoplasma gondii* in Wild Mammals in Kansas

DIANNE B. BRILLHART,¹ LLOYD B. FOX,² J. P. DUBEY,³ AND STEVE J. UPTON^{1,4}

¹ Division of Biology, Kansas State University, Manhattan, Kansas 66506,

² Kansas Department of Wildlife and Parks, Emporia, Kansas 66801, and

³ U.S. Department of Agriculture, Agricultural Research Service, Livestock and Poultry Sciences Institute, Zoonotic Diseases Laboratory, BARC-East, Building 1040, Beltsville, Maryland 20705

ABSTRACT: Between 1989 and 1993, serum samples from 516 mammals in Kansas representing 17 species were examined for antibodies to *Toxoplasma gondii* using a modified direct-agglutination test. The overall prevalence was 84/516 (16%) mammals infected. When considering only animals where adequate sample sizes were available, the highest prevalences were found in raccoons (*Procyon lotor*), of which 14/20 (70%) were infected; white-tailed deer (*Odocoileus virginianus*), with 47/106 (44%) seropositive; and Virginia opossums (*Didelphis virginiana*), with a prevalence of 9/28 (32%). The seroprevalence in rodents and pronghorn antelopes was <8%.

KEY WORDS: *Toxoplasma gondii*, coccidia, survey, deer, raccoon, Kansas.

The intermediate host range of *Toxoplasma gondii* (Nicolle and Manceaux, 1908) Nicolle and Manceaux, 1909, is unusually wide for a coccidian, currently comprising >350 known species of vertebrates (Beyer and Poljansky, 1989). Felids, the definitive hosts, are thought to become infected principally by ingesting tissues of infected mammals and birds, and most cats are seropositive by weaning time (Dubey and Beatlie, 1988).

Although numerous studies have examined the seroprevalence of antibodies to *T. gondii* in humans and wild and domestic animals, limited information exists concerning the seroprevalence of this coccidian in Kansas. Lindsay et al.

⁴ Corresponding author.

Table 1. Seroprevalence of *Toxoplasma gondii* in various wild mammals from Kansas.

Host	County	No. positive/ No. tested (%)		Antibody titer			
				<1:25	1:25	1:50	≥1:500
<i>Antilocapra americana</i> (pronghorn antelope)	Greeley	0/02		2	0	0	0
	Logan	0/16		16	0	0	0
	Sherman	1/11	(9)	10	1	0	0
	Wallace	2/34	(6)	32	1	1	0
Subtotal		3/63	(5)				
<i>Blarina hylophaga</i> (Elliott's short-tail shrew)	Geary	0/01		1	0	0	0
<i>Castor canadensis</i> (beaver)	Riley	0/02		2	0	0	0
<i>Didelphis virginiana</i> (Virginia opossum)	Coffey	3/07	(43)	4	2	1	0
	Lyon	5/16	(31)	11	3	2	0
	Pottawatomie	0/01		1	0	0	0
	Riley	1/04	(25)	3	1	0	0
Subtotal		9/28	(32)				
<i>Dipodomys ordii</i> (Ord kangaroo rat)	Harvey	0/05		5	0	0	0
	Morton	0/10		10	0	0	0
<i>Mephitis mephitis</i> (striped skunk)	Morris	0/01		1	0	0	0
<i>Microtus ochrogaster</i> (prairie vole)	Mitchell	0/01		1	0	0	0
	Sherman	1/01	(100)	0	0	1	0
<i>Mus musculus</i> (house mouse)	Pottawatomie	0/06		6	0	0	0
	Riley	0/04		4	0	0	0
	Sherman	0/01		1	0	0	0
<i>Neotoma floridana</i> (eastern woodrat)	Geary	1/02	(50)	1	1	0	0
	Greenwood	0/01		1	0	0	0
	Lyon	0/01		1	0	0	0
	Pottawatomie	1/24	(4)	23	1	0	0
Subtotal		2/28	(7)				
<i>Odocoileus virginianus</i> (white-tailed deer)	Chautauqua	10/16	(63)	6	2	3	5
	Crawford	2/08	(25)	6	1	0	1
	Ellis	1/01	(100)	0	1	0	0
	Finney	0/02		2	0	0	0
	Jefferson	0/01		1	0	0	0
	Linn	6/15	(40)	9	0	1	5
	Lyon	4/06	(67)	2	1	1	2
	Marshall	2/05	(40)	3	0	2	0
	Mitchell	0/01		1	0	0	0
	Rawlins	2/02	(100)	0	1	1	0
	Reno	2/02	(100)	0	2	0	0
	Riley	18/46	(39)	28	5	6	7
	Thomas	0/01		1	0	0	0
Subtotal		47/106	(44)				
<i>Peromyscus leucopus</i> (white-footed mouse)	Cherokee	1/22	(5)	21	0	1	0
	Geary	1/10	(10)	9	0	1	0
	Mitchell	0/04		4	0	0	0
	Osborne	0/12		12	0	0	0
	Pottawatomie	0/41		41	0	0	0
	Riley	0/13		13	0	0	0
	Russell	0/11		11	0	0	0
	Trego	0/02		2	0	0	0
Subtotal		2/115	(2)				
<i>Peromyscus maniculatus</i> (deer mouse)	Cherokee	0/01		1	0	0	0
	Geary	0/06		6	0	0	0
	Greenwood	0/03		3	0	0	0
	Osborne	0/09		9	0	0	0
	Pottawatomie	0/03		3	0	0	0
	Riley	1/05	(20)	4	0	1	0
	Russell	2/24	(8)	22	2	0	0
	Sherman	0/05		5	0	0	0
Subtotal		3/56	(5)				

Table 1. Continued.

Host	County	No. positive/ No. tested (%)		Antibody titer			
				< 1:25	1:25	1:50	≥ 1:500
<i>Procyon lotor</i> (raccoon)	Coffey	2/04	(50)	2	0	0	2
	Lyon	11/15	(73)	4	0	5	6
	Riley	1/01	(100)	0	0	0	1
Subtotal		14/20	(70)				
<i>Reithrodontomys megalotis</i> (western harvest mouse)	Osborne	1/02	(50)	1	1	0	0
<i>Sigmodon hispidus</i> (hispid cotton rat)	Butler	0/12		12	0	0	0
	Cherokee	0/05		5	0	0	0
	Geary	0/10		10	0	0	0
	Greenwood	0/01		1	0	0	0
	Mitchell	0/03		3	0	0	0
	Osborne	0/12		12	0	0	0
	Pottawatomic	0/01		1	0	0	0
	Riley	0/10		10	0	0	0
	Russell	0/08		8	0	0	0
<i>Sylvilagus floridana</i> (eastern cottontail rabbit)	Osborne	1/02	(50)	1	0	1	0
<i>Vulpes velox</i> (swift fox)	Wallace	1/02	(50)	1	0	1	0
Overall prevalence		84/516	(16%)				

(1990) found 57/229 (25%) dogs in Kansas seropositive using the direct agglutination test, and Dubey (1973) reported 16% of cats in Kansas seropositive by the Sabin-Feldman dye test. A recently published nationwide survey of *T. gondii* in swine suggests a seroprevalence of about 21% in Kansas and Nebraska (Dubey et al., 1991). Because we are aware of no studies examining the seroprevalence of *T. gondii* in Kansas wildlife, we chose to conduct a statewide serologic survey for the parasite in various wildlife species.

Animals were collected during all seasons between December 1989 and March 1993. Rodents were captured using Sherman live-traps baited with a combination of peanut butter and oatmeal. Blood was collected from each animal by direct heart puncture following the administration of an overdose of ether. Blood from other mammals was obtained from the Kansas Department of Wildlife and Parks either at check stations during hunting season or by trapping. Blood was centrifuged at 800 g, and serum was collected and frozen at -20°C until tested. Sera were shipped frozen to the Zoonotic Diseases Laboratory, USDA, Beltsville, Maryland, where they were tested at titers of 1:25, 1:50, and 1:500 using the modified direct agglutination technique (Dubey et al., 1991). Titers at or above 1:25 were considered positive, as has been utilized previously (Dubey et al., 1991). The direct agglutination technique was chosen because of its ease

of use, reproducibility, and sensitivity (Dubey and Beattie, 1988; Dubey et al., 1993) and because we felt that complement fixation tests may not be as accurate for some of the hemolysed samples inherent in this type of survey.

Antibodies to *Toxoplasma gondii* were found in 84/516 (16%) mammals tested (Table 1). Of those animals where adequate (> 10) sample sizes were obtained, highest prevalences were found in raccoons, *Procyon lotor* (70%), white-tailed deer, *Odocoileus virginianus* (44%), and Virginia opossums, *Didelphis virginiana* (32%). Although different serologic tests can give varying results, raccoon and deer seem to have relatively high seroprevalences in the U.S.A. (Walton and Walls, 1964; Franti et al., 1976; Burrige et al., 1979; Lindsay et al., 1991; Dubey et al., 1992), and it is not surprising that opossums are commonly infected considering their omnivorous habits and that they have been reported previously as infected (Walton and Walls, 1964; McCulloch et al., 1967; Franti et al., 1976; Burrige et al., 1979; Frenkel and Sousa, 1983). We also found a rabbit and a fox to be infected, but sample sizes were too low to obtain an accurate prevalence. However, both of these hosts, as well as many additional medium-sized carnivores and omnivores, are considered common carriers of toxoplasmosis (Morris et al., 1956; Havlík and Hübner, 1958; Eyles et al., 1959; Kulasiri, 1962; Galuzo et al., 1964; Walton and Walls, 1964; McCulloch