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Source: Journal of Parasitology, 91(6):1490-1491. 2005.

Published By: American Society of Parasitologists

DOI: <http://dx.doi.org/10.1645/GE-547R.1>

URL: <http://www.bioone.org/doi/full/10.1645/GE-547R.1>

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ments will come to be the standard of care for studies of acute toxoplasmosis in mice.

LITERATURE CITED

CHRISTOPH, T., B. KOGEL, K. SCHIENE, M. MEEN, J. DE VRY, AND E. FRIDERICH. 2005. Broad analgesic profile of buprenorphine in rodent models of acute and chronic pain. *European Journal of Pharmacology* **507**: 87–98.

KING, M. D., D. S. LINDSAY, S. HOLLADAY, AND M. EHRLICH. 2003. Neurotoxicity and immunotoxicity assessment in CBA/J mice with chronic *Toxoplasma gondii* infection and multiple exposures to methylmercury. *Journal of Parasitology* **89**: 856–859.

LUTFY, K., S. EITAN, C. D. BRYANT, Y. C. YANG, N. SALIMINEJAD, W. WALWYN, B. L. KIEFFER, H. TAKESHIMA, F. I. CARROLL, N. T. MAIDMENT, AND C. J. EVANS. 2003. Buprenorphine-induced antinociception is mediated by mu-opioid receptors and compromised by concomitant activation of opioid receptor-like receptors. *Journal of Neuroscience* **23**: 10331–10337.

MARTUCCI, C., A. E. PANERAI, AND P. SACERDOTE. 2004. Chronic fentanyl or buprenorphine infusion in the mouse: similar analgesic profile but different effects on immune responses. *Pain* **110**: 385–392.

MITCHELL, S. M., A. M. ZAJAC, W. L. DAVIS, AND D. S. LINDSAY. 2004. Efficacy of ponazuril in vitro and in preventing and treating *Toxoplasma gondii* infections in mice. *Journal of Parasitology* **90**: 639–642.

J. Parasitol., 91(6), 2005, pp. 1490–1491
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Prevalence of Agglutinating Antibodies to *Toxoplasma gondii* in Adult and Fetal Mule Deer (*Odocoileus hemionus*) From Nebraska

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ABSTRACT: *Toxoplasma gondii* is an apicomplexan parasite of mammals and birds. Herbivores acquire postnatal infection by ingesting oocysts from contaminated food or water. *Toxoplasma gondii* infection is common in white-tailed deer, *Odocoileus virginianus*, but little is known about the prevalence of infection in mule deer, *O. hemionus*. We examined sera from 89 mule deer from Nebraska for agglutinating antibodies to *T. gondii* using the modified direct agglutination test (MAT) with formalin-fixed tachyzoites as antigen. Thirty-one (35%) of the samples were positive at dilutions of $\geq 1:25$. Samples were examined from 29 fetuses from these mule deer and none were positive in the MAT. Sera from 14 white-tailed deer from Nebraska were also examined and 6 (43%) were positive for *T. gondii*. Samples were examined from 5 fetuses from these white-tailed deer and none was positive in the MAT. Our results in both deer species from Nebraska are similar to studies conducted in white-tailed deer from other regions of the United States. Our findings indicate that mule deer are frequently infected with *T. gondii* and that mule-deer meat may be a source of human infection.

Mule deer, *Odocoileus hemionus*, have been shown to be natural intermediate hosts (Dubey, 1982) for the zoonotic protozoan parasite, *Toxoplasma gondii*. These animals can suffer acute fatal infections if they ingest as few as 1×10^5 *T. gondii* oocysts (Dubey et al., 1982). Studies of the prevalence of antibodies to *T. gondii* in mule deer have been limited in number. *Toxoplasma gondii* infection in hunters associated with consumption of white-tailed deer meat has been reported (Sacks et al., 1982; Ross et al., 2001). The present study was done to examine the prevalence of antibodies in mule deer collected in Nebraska.

Mule deer were collected from the southwestern portion of the Nebraska panhandle from Cheyenne (n = 42; 39 females, 3 males), Deuel (n = 1, female), and Kimball (n = 46; 38 females, 8 males) counties during March and April of 2001. Samples were collected from the fetuses of 29 mule deer and examined using the modified direct agglutination test (MAT). Mule deer were shot by members of the Nebraska Game and Parks Commission as part of a survey to determine the prevalence of chronic wasting disease in this population. Additionally, 14 white-tailed deer (12 female, 2 male) were tested for the presence of agglutinating antibodies to *T. gondii*. Seven white-tailed deer (6 female, 1 male) from Deuel County and 7 white-tailed deer (6 female, 1 male)

from Keith County were tested. Samples were collected from the fetuses of 5 white-tailed deer and examined using the MAT.

Frozen sera or plasma were sent to the Center for Molecular Medicine and Infectious Diseases, Department of Biomedical Sciences and Pathobiology, Virginia–Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg, Virginia for agglutination testing. The MAT (Dubey and Desmonts, 1987) for *T. gondii* was used to test sera. Controls consisted of sera from experimentally infected mice that were negative for parasites, positive for *T. gondii*, positive for *Neospora caninum*, or positive for *Sarcocystis neurona*. The MAT was used to screen all sera at a 1:25 dilution. Positive sera were further tested at dilutions of 1:50, 1:100, and 1:500.

Thirty-one (35%) of the 89 mule deer (78 females and 11 males) samples tested positive in the MAT (Table I). Twelve (29%) of the 42 samples (39 females and 3 males) from mule deer from Cheyenne County were positive in the MAT. All 12 positive animals were females. The single sample from mule deer (female) from Deuel County was negative in the MAT. Nineteen (41%) of 46 samples (38 females and 8 males) from mule deer from Kimball County were positive in the MAT. Seventeen of the positive mule deer from Kimball County were female and 2 were males. The overall prevalence of antibodies to *T. gondii* with regard to mule deer sex was 31 (40%) of 78 females and 2 (18%) of 11 males. None of the 29 fetuses examined were positive in the MAT, however the mothers of 15 of these fetuses were positive in the MAT (1:25 N = 2; 1:50 N = 5; 1:100 N = 7; and 1:500 N = 1).

Three (43%) of the 7 white-tailed deer from Deuel County tested positive for *T. gondii*. All positive white-tailed deer were females and

TABLE I. Prevalence and agglutinating antibody titers to *Toxoplasma gondii* in samples from mule deer from Nebraska.

County	No. tested/ no. positive	Number positive at dilution of:			
		1:25	1:50	1:100	1:500
Cheyenne	42/12	1	6	5	0
Deuel	1/0	0	0	0	0
Kimball	46/19	9	6	1	1

TABLE II. Prevalence of *Toxoplasma gondii* in mule deer (MD), black-tailed deer (BTD), and white-tailed deer (WTD) from the United States.

Reference	Species	Test*	Location	Prevalence
Present study	MD	MAT	Nebraska	35% of 89
Chomel et al., 1994	MD	LAT	California	7% of 276
Franti et al., 1976	MD	LAT	California	0% of 9
Franti et al., 1975	BTD	LAT	California	20% of 382
Franti et al., 1976	BTD	LAT	California	8% of 40
Present study	WTD	MAT	Nebraska	43% of 14
Brillhart et al., 1994	WTD	MAT	Kansas	44% of 106
Humphreys et al., 1995	WTD	MAT	Pennsylvania	60% of 593
Lindsay et al., 1991	WTD	MAT	Alabama	44% of 16
Lindsay et al., 1997	WTD	MAT	Alabama	34% of 50
Vanenk et al., 1996	WTD	MAT	Minnesota	30% of 1,367
Dubey et al., 2004	WTD	MAT	Mississippi	46% of 73

* MAT = modified direct agglutination test, LAT = latex agglutination test.

the sera tested positive at dilutions of 1:25, 1:50, and 1:100. Three (43%) of the 7 white-tailed deer from Keith County were also positive; they were all females. Their sera were positive at dilutions of 1:25, 1:50, and 1:100. None of the 5 fetuses examined was positive in the MAT; however, the mothers of 2 of these fetuses were positive in the MAT (1:25 and 1:100).

Table II summarizes data on the prevalence of *T. gondii* in mule deer, black-tailed deer, and white-tailed deer from various states in the United States. Chomel et al. (1994) found that only 7% of 274 mule deer from California were positive using the latex agglutination test (LAT) compared to the 35% MAT-positive mule deer observed in the present study. The LAT is not considered to be as sensitive and specific as the MAT (Dubey et al., 1985, 1987; Dubey and Desmonts, 1987) for use in animals. Thus, the study of Chomel et al. (1994) may reflect this and underestimate the prevalence of *T. gondii* in mule deer in California.

Attempts to demonstrate *T. gondii* in mule-deer tissues have been few in number. Dubey (1981) did not isolate *T. gondii* from portions of skeletal muscle from 43 mule deer collected in Montana using mouse bioassay. He later reported (Dubey, 1982) that *T. gondii* was isolated from 2 mule deer from Montana by feeding skeletal muscles to cats. Mule-deer meat, like white-tailed deer meat, should be considered a potential source of *T. gondii*.

The contribution of S.M.M. was supported in part by a grant from Bayer HealthCare Animal Health.

LITERATURE CITED

- BRILHART, D. B., L. B. FOX, J. P. DUBEY, AND S. J. UPTON. 1994. Prevalence of *Toxoplasma gondii* in wild mammals in Kansas. *Journal of the Helminthological Society of Washington* **61**: 117–121.
- CHOMEL, B. B., M. L. CARNICIU, R. W. KASTEN, P. M. CASTELLI, T. M. WORK, AND D. A. JESSUP. 1994. Antibody prevalence of eight ruminant infectious diseases in California mule and black-tailed deer (*Odocoileus hemionus*). *Journal of Wildlife Diseases* **30**: 51–59.
- DUBEY, J. P. 1981. Isolation of encysted *Toxoplasma gondii* from musculature of moose and pronghorn in Montana. *American Journal of Veterinary Research* **42**: 126–127.
- . 1982. Isolation of encysted *Toxoplasma gondii* from muscles of mule deer in Montana. *Journal of the American Veterinary Medical Association* **181**: 1535.
- , AND G. DESMONTS. 1987. Serological responses of equids fed *Toxoplasma gondii* oocysts. *Equine Veterinary Journal* **19**: 337–339.
- , ———, F. ANTUNES, AND C. McDONALD. 1985. Serologic diagnosis of toxoplasmosis in experimentally infected pregnant goats and transplacentally infected kids. *American Journal of Veterinary Research* **46**: 1137–1140.
- , J. P. EMOND, G. DESMONTS, AND W. R. ANDERSON. 1987. Serodiagnosis of postnatally and prenatally induced toxoplasmosis in sheep. *American Journal of Veterinary Research* **48**: 1239–1243.
- , D. H. GRAHAM, R. W. DE YOUNG, E. DAHL, M. L. EBERHARD, E. K. NACE, K. WON, H. BISHOP, G. PUNKOSDY, C. SREEKUMAR, M. C. VIANNA, S. K. SHEN, O. C. H. KWOK, J. A. SUMNERS, S. DEMARAIS, J. G. HUMPHREYS, AND T. LEHMANN. 2004. Molecular and biologic characteristics of *Toxoplasma gondii* isolates from wildlife in the United States. *Journal of Parasitology* **90**: 67–71.
- , E. T. THORNE, AND E. S. WILLIAMS. 1982. Induced toxoplasmosis in pronghorns and mule deer. *Journal of the American Veterinary Medical Association* **181**: 1263–1267.
- FRANTI, C. E., G. E. CONNOLLY, H. P. RIEMANN, D. E. BEHYMER, R. RUPPANNER, C. M. WILLADSEN, AND W. LONGHURST. 1975. A survey for *Toxoplasma gondii* antibodies in deer and other wildlife on a sheep range. *Journal of the American Veterinary Medical Association* **167**: 565–568.
- , H. P. RIEMANN, D. E. BEHYMER, D. SUTHER, J. A. HOWARTH, AND R. RUPPANNER. 1976. Prevalence of *Toxoplasma gondii* antibodies in wild and domestic animals in northern California. *Journal of the American Veterinary Medical Association* **169**: 901–906.
- HUMPHREYS, J. G., R. L. STEWART, AND J. P. DUBEY. 1995. Prevalence of *Toxoplasma gondii* antibodies in sera of hunter-killed white-tailed deer in Pennsylvania. *American Journal of Veterinary Research* **56**: 172–173.
- LINDSAY, D. S., B. L. BLAGBURN, J. P. DUBEY, AND W. H. MASON. 1991. Prevalence and isolation of *Toxoplasma gondii* from white-tailed deer in Alabama. *Journal of Parasitology* **77**: 62–64.
- , C. A. SUNDERMANN, J. P. DUBEY, AND B. L. BLAGBURN. 1997. Update on *Toxoplasma gondii* infections in wildlife and exotic animals from Alabama. *Journal of Alabama Academy of Science* **68**: 246–254.
- ROSS, R. D., L. A. STEC, J. C. WERNER, M. S. BLUMENKRANZ, L. GLAZER, AND G. A. WILLIAMS. 2001. Presumed acquired ocular toxoplasmosis in deer hunters. *Retina* **21**: 226–229.
- SACKS, J. J., D. G. DELGADO, H. O. LOBEL, AND R. L. PARKER. 1983. Toxoplasmosis associated with eating undercooked venison. *American Journal of Epidemiology* **118**: 832–837.
- VANEK, J. A., J. P. DUBEY, P. THULLIEZ, M. R. RIGGS, AND B. E. STROMBERG. 1996. Prevalence of *Toxoplasma gondii* antibodies in hunter-killed white-tailed deer (*Odocoileus virginianus*) in four regions of Minnesota. *Journal of Parasitology* **82**: 41–44.