Seroprevalence of Toxoplasma gondii and Trichinella spiralis in North Carolina Black Bears (Ursus americanus)

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Abstract: Serum samples from 143 hunter-killed black bears were collected during the 1996 and 1997 black bear hunting seasons in eastern North Carolina. All samples were tested for antibodies to Toxoplasma gondii by the modified agglutination test. Antibodies to T. gondii were present in 120 of 143 (84%) bears. Females had significantly higher titers than males (Wilcoxon rank sum test, P = 0.045), and titers increased with age (Jonckheere test, P = 0.01). Samples collected during 1996 (n = 79) were tested for antibodies to Trichinella spiralis by enzyme-linked immunosorbent assay. No samples were positive for antibodies to T. spiralis.

Toxoplasma gondii and Trichinella spiralis can cause severe disease in humans. Both can be acquired by consuming infective stages in undercooked meat. Toxoplasma gondii can also be contracted transplacentally or by consumption of food or water contaminated with oocysts (Dubey and Beattie, 1988). Historically, domestic animals have been considered the primary reservoir hosts of these parasites for humans, but wildlife also play a role as sources of both human and domestic animal infection.

Numerous point-source outbreaks of human trichinellosis have been traced to bear meat (Wand and Lyman, 1972), but recently black bears (Ursus americanus) from Pennsylvania were reported to have 80% seroprevalence for T. gondii (Bocch et al., 1993). Viable T. gondii was isolated from the heart of 10 of 22 seropositive bears (Dubey et al., 1995). However, the epizootiology of these parasites in black bears is not well understood. Opportunistic sampling of hunter-killed black bears in eastern North Carolina was undertaken to evaluate seroprevalence of T. gondii and T. spiralis. Hunters were also surveyed to investigate the disposition of the carcasses.

Blood samples were collected from the hearts of intact carcasses or from the body cavities of dressed carcasses of bears collected during the 1996 and 1997 black bear hunting seasons in eastern North Carolina.
in the prevalence of trichinellosis in the U.S. swine population has been documented from about 1.4% at the turn of the century to 0.125% by the 1970s (Zimmerman, 1977). During the same period, the role of wildlife, particularly bears, as a major sylvatic reservoir of the disease and important source of human infection was recognized (Bailey and Schantz, 1990). Between 1982 and 1986, 14.6% of trichinellosis cases in the United States were traced to infected bear meat (Bailey and Schantz, 1990). The reported prevalence of *T. spiralis* in North American black bears ranges from 1.8% in Pennsylvania to 15.6% in Montana (Worley et al., 1991; Dubey et al., 1994).

The lack of antibodies to *T. spiralis* in this study was not anticipated. The sample size was relatively small and limited in geographic distribution and may not have had sufficient power to detect low seroprevalence. Alternatively, the absence of antibodies in black bears may reflect the historically low prevalence of *T. spiralis* in the North Carolina swine herd and the low numbers of commercial swine operations in the region surveyed (Cowen et al., 1990). Domestic swine have long been considered the major source of infection for wildlife that scavenge improperly dumped swine carcasses or scraps at garbage dumps. However, recent surveys of wildlife in Europe and the United States suggest that a sylvatic cycle of *Trichinella* infection operates largely independent of the domestic pig cycle (Pozio et al., 1992; Snyder et al., 1993). These studies also suggest that the dominant *Trichinella* species in wildlife may be sylvatic genotypes *Trichinella* T5 and T6 (Worley et al., 1990; Zarlinga et al., 1991).

Toxoplasmosis is a serious disease of humans and livestock, although infections in immunocompetent individuals are rare. Congenital infectious can cause disease in the developing fetus, resulting in hydrocephaly, mental retardation, and other birth defects (Dubey and Beattie, 1988). Reported seroprevalence, by a variety of tests, for *T. gondii* in North American black bears has ranged from 8% to 80% across different regions of the country (Binninger et al., 1980; Briscoe et al., 1993). The results of this study are comparable to those recently reported for Pennsylvania black bears using the identical serologic test (Briscoe et al., 1993) and confirm that black bears have the highest seroprevalence of any animal or human population tested to date in the United States. While no testing for parasite burdens was undertaken for this study, previous work has shown the MAT to be the most consistent and reliable serologic test in black bears (Dubey et al., 1994, 1995). Sensitivity and specificity of the MAT in bears have not been fully evaluated but are established for pigs (Dubey, 1997; Dubey et al., 1997). As omnivores, black bears consume both forage and foraging animals, as well as carrion and garbage. This may contribute to their high *T. gondii* seroprevalence, although the prevalence in North Carolina and Pennsylvania black bears is much higher than reported in other wild omnivores. A 1990 survey of free-ranging wild hogs (*Sus scrofa*) in the Great Smoky Mountains National Park, reported 31% seroprevalence by MAT (Diderrich et al., 1996). A serosurvey of raccoons (*Procyon lotor*) from 7 states reported a mean prevalence of 50%, also by MAT (Dubey et al., 1992). The positive relationship between titer and the age of the bears suggests that the high seroprevalence may be due to cumulative exposure and supports similar observations from other studies (Briscoe et al., 1993; Zarlinga et al., 1997). Significant differences in the prevalence of *T. spiralis* and *T. gondii* infections between the two counties might be attributed to the difference in hosts or to environmental factors. The lower prevalence in Hyde County may reflect a lower density of swine in that area, as well as a lower density of *T. spiralis* infected swine or a difference in the number of sylvatic cycles in the two counties. The lower prevalence of *T. gondii* in Hyde County may reflect the lower density of omnivores in that area, as well as a difference in the number of sylvatic cycles in the two counties.

The prevalence of *T. spiralis* in black bears in Hyde County was significantly different from that in Tyrrell County (χ² test, P = 0.03). The prevalence of *T. gondii* in black bears in Hyde County was significantly different from that in Tyrrell County (χ² test, P = 0.03) and from that in Hyde County in 1997 (χ² test, P = 0.03). The prevalence of *T. gondii* in black bears in Tyrrell County was not significantly different from that in Hyde County in 1997 (χ² test, P = 0.29).
bias introduced by the hunters. Larger, heavier bears are favored targets, and accordingly male bears are overrepresented in the sample. The larger female bears that are also favored by hunters tend to be older and, as previously demonstrated, titers increase with age.

The hunter survey suggests that bear hunters and those who handle and consume bear meat should be educated about the potential risks of exposure to T. gondii and how to minimize them. Such education could be accomplished by inclusion of a pamphlet on safe carcass handling with hunting licenses or dissemination of similar material to hunting clubs or hunting supply retailers. Important points to address include: (1) wearing gloves while butchering carcasses, (2) washing hands thoroughly with soap and water after handling bear meat, (3) cooking bear meat until well done (to an internal temperature of 66°C for at least 3 min), and (4) burying viscera and carcass scraps to reduce scavenging by other animals.

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LITERATURE CITED


Hosts Manipulated by One Parasite Incur Additional Costs from Infection by Another Parasite

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ABSTRACT: Manipulation of host phenotype by parasites often serves to increase the predation rate of definitive hosts on intermediate hosts. For intermediate hosts, the indirect consequences of manipulation may extend beyond the direct increase in predation, however. Metacercariae of the trematode Cerura marginata infect in the foot of New Zealand cockles, Austrovenus stutchburyi, and stunt its growth, rendering cockles incapable of burrowing into the sediments. Here, we show that cockles manipulated by C. marginata are 5 times more likely to be infected by the castrating sporocysts of another trematode than normal, unmanipulated cockles. Our results indicate that the consequences for C. marginata-manipulated cockles are far more important than a simple increase in the risk of predator


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