Prevalence of Agglutinating Antibodies to *Sarcocystis neurona* in Raccoons (*Procyon lotor*) From an Urban Area of Virginia

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Prevalence of Agglutinating Antibodies to *Sarcocystis neurona* in Raccoons (*Procyon lotor*) From an Urban Area of Virginia

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ABSTRACT: Equine protozoal myeloencephalitis is the most important protozoan disease of horses in North America and is usually caused by *Sarcocystis neurona*. Natural and experimentally induced cases of encephalitis caused by *S. neurona* have been reported in raccoons (*Procyon lotor*) and raccoons are an intermediate host for this parasite. A 3-yr-long serological survey was conducted to determine the prevalence of agglutinating antibodies to *S. neurona* in raccoons collected from Fairfax County, Virginia, a suburban–urban area outside Washington, D.C. Samples from 469 raccoons were examined, and agglutinating antibodies (≥1:50 dilution) were found in 433 (92.3%) of the raccoons. This study indicates that exposure to *S. neurona* is high in this metropolitan area.

Equine protozoal myeloencephalitis is a neurologic disease in horses from the Americas and is usually caused by infection with the apicomplexan parasite *Sarcocystis neurona* (Dubey et al., 1991). It is the most important protozoan disease of horses in North America (reviewed by Dubey, Lindsay, Saville et al., 2001). The Virginia opossum *Didelphis virginiana* is the only known definitive host in North America (Dubey and Lindsay, 1998), whereas *Didelphis albiventris* is a host in South America (Dubey, Lindsay, Kerber et al., 2001). Nine-banded armadillos (*Dasypus novemcinctus*), raccoons (*Procyon lotor*), and sea otters (*Enhydra lutris*) are natural intermediate hosts (Cheadle, Tanhauser et al., 2001; Dubey, Rosypal et al., 2001; Dubey, Saville et al., 2001; Tanhauser et al., 2001). Domestic cats (*Felis domesticus*), striped skunks (*Mephitis mephitis*), and raccoons are known experimental intermediate hosts (Dubey et al., 2000; Cheadle, Yowell et al., 2001; Dubey, Saville et al., 2001).

Dubey, Saville et al. (2001) reported clinical encephalitis in experimentally infected raccoons. Stanek et al. (2002) described the life cycle of *S. neurona* in experimentally infected raccoons.

This study was conducted to determine the serological prevalence of antibodies to *S. neurona* in a common intermediate host, the raccoon. The direct *S. neurona* agglutination test (SAT) described by Lindsay and Dubey (2001) was used.

Raccoons originated in various locations in Fairfax County, Virginia, a suburban–urban area outside Washington, D.C. Raccoons used for this study were livetrapped as part of a larger study on rabies in Fairfax County. Blood samples were collected from all trapped raccoons. Raccoons were released immediately after sampling was completed. The serum was collected, placed in a tube, and frozen at −70 C. Frozen sera 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. Samples from 137, 120, and 212 raccoons from 2000, 2001, and 2002, respectively, were examined (total = 469 for 3 yr). The SAT was used to test sera at dilutions of 1:50. The SAT has previously been validated using sera from experimentally infected raccoons (Dubey, Saville et al., 2001; Lindsay et al., 2001; Stanek et al., 2002).

The prevalence of antibodies in 2000 was 128 (93.4%) of the 137 samples, in 2001 it was 109 (90.8%) of 120 samples, and in 2002 it was 196 (92.5%) of 212 samples. The total prevalence of antibodies in the 469 raccoons was 93.3% (N = 433 positives).

This study is the largest conducted to date on the prevalence of *S. neurona* antibodies in raccoons. Mitchell et al. (2002) examined sera from 12 raccoons from Connecticut and found that all 12 were positive in the SAT. Lindsay et al. (2001) demonstrated that sera from 33% of raccoons (n = 24) from Florida, 72% of raccoons (n = 25) from New Jersey, 52% of raccoons (n = 25) from Pennsylvania, and 96% of raccoons (n = 25) from Massachusetts were positive in the SAT.

Clinical *Sarcocystis* sp.–associated encephalitis and myocarditis are common in raccoons (Stoffregen and Dubey, 1991; Thulin et al., 1992; Dubey, Hamir et al., 1990; Hamir and Dubey, 2001). These animals are often coinfected with canine distemper (Stoffregen and Dubey, 1992; Thulin et al., 1992). Experimental infection of raccoons with *S. neurona* is also potentially pathogenic for raccoons (Dubey, Saville et al., 2001; Stanek et al., 2002). *Sarcocystis kirkpatricki* is the only other named species of *Sarcocystis* infecting the muscles of raccoons (Snyder et al., 1990). Kirkpatrick et al. (1987) found sarcocysts in 26 (50%) of 52 raccoons from Ohio, Pennsylvania, Florida, and Maryland. Snyder et al. (1990) found *S. kirkpatricki* sarcocysts in 66 of 100 raccoons examined from Illinois. Demonstration of sarcocysts in tissues is not as accurate as acid–pepsin digestion of tissues or serological methods, and this method usually underestimates prevalence. The life cycle of *S. kirkpatricki* is not known. Molecular studies are needed to determine the taxonomic relationship between *S. neurona* and *S. kirkpatricki*.

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Parvicapsula minibicornis in Anadromous Sockeye (*Oncorhynchus nerka*) and Coho (*Oncorhynchus kisutch*) Salmon From Tributaries of the Columbia River

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ABSTRACT: The myxosporean parasite *Parvicapsula minibicornis* is described from adult sockeye and coho salmon during spawning migrations in tributaries of the Columbia River in Canada and the United States. These observations extend the known distribution of this parasite from the Fraser River drainage basin. The parasite was identified in Columbia River salmonids using polymerase chain reaction (PCR) and by in situ hybridization, but unlike in Fraser River salmon, it was not observed in conventional histological preparations of the kidney. Prevalence of the parasite determined by PCR was higher in spawning sockeye from the Fraser River than in those from the Okanagan River. Our ability to explain the relatively low prevalence and absence of clinical *P. minibicornis* infections in Columbia River salmon is hampered by our poor understanding of the life cycle of this parasite.

The myxosporean parasite *Parvicapsula minibicornis* was first described from the kidney of adult sockeye salmon (*Oncorhynchus nerka*) spawning at Weaver Creek, a tributary of the Fraser River in British Columbia, Canada (Kent et al., 1997). Pathological changes of the kidney were associated with *P. minibicornis* (Raverty et al., 2000; St-Hilaire et al., 2002), suggesting that severe infections may contribute to prespawn mortality observed among prematurely migrating sockeye