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TRICHINELLA SPIRALIS IN AN AGRICULTURAL ECOSYSTEM. III. EPIDEMIOLOGICAL INVESTIGATIONS OF *TRICHINELLA SPIRALIS* IN RESIDENT WILD AND FERAL ANIMALS

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ABSTRACT: As part of a larger epidemiological study examining the transmission of *Trichinella spiralis* in an agricultural ecosystem, resident wild and feral animals were trapped to determine the extent of their involvement in the natural, on-farm cycling of the parasite among swine. During a 21-mo-study, seven of 15 skunks (*Mephitis mephitis*), one of three opossums (*Didelphis virginiana*), two of two feral domestic cats and a raccoon (*Procyon lotor*) were found to be infected, while five shrews (*Blarina brevicauda*) and 18 deer mice (*Peromyscus* spp.) were uninfected. Most of the former hosts probably became infected by scavenging dead infected swine or rats (*Rattus norvegicus*). However, infections obtained through predation of living rats, particularly with regard to the cats, cannot be excluded. Our observations do not suggest that there was transmission of *T. spiralis* from the wild animals to swine. Therefore, transmission of *T. spiralis* appeared to occur only from the farm's swine and rats to the associated wild and feral animals.

Key words: Agricultural ecosystem, epidemiology, natural transmission, rats, swine, *Trichinella spiralis*, wildlife.

INTRODUCTION

Recent investigations on the epidemiology of trichinellosis in the eastern United States have included surveys of swine at slaughter (Duffy et al., 1985; Schad et al., 1985a, b), wildlife (Schad et al., 1984, 1986; Leiby et al., 1985) and related studies of recovered isolates (Murrell et al., 1985, 1986, 1987; Dame et al., 1987; Leiby and Bacha, 1987). In order to initiate some of these investigations, a hog found infected at slaughter was traced to its farm of origin (Gloucester County, New Jersey, USA) (Schad et al., 1987) where intensive epidemiological studies were conducted to determine how *T. spiralis* is transmitted and maintained in an agricultural ecosystem. Observations at the farm indicated that a number of wild and feral mammalian species were an integral part of this ecosystem. Thus, the role of sylvatic and feral hosts in the transmission of *T. spiralis* was of interest.

The importance of wildlife in synanthropic trichinellosis remains equivocal. A passive role is reasonably well established since the feeding of wildlife carcasses to swine does occur at least occasionally (Andrews et al., 1969; Kazacos *in* Schad et al., 1984; G. A. Schad, unpubl. data). An active role, wherein swine prey upon infected wild animals or scavenge dead ones, is less certain. However, interactions between sylvatic and synanthropic cycles of trichinellosis are not uncommon, because isolates obtained from wild animals occasionally demonstrate genetic characteristics of swine isolates (*T. spiralis spiralis*) (Dame et al., 1987; Murrell et al., 1987). In an attempt to determine what role, if any, wild and feral animals play in the transmission of *T. spiralis* under farmyard conditions various wild and feral mammalian species were included in our investigations.

The transmission of *T. spiralis* between swine and rats on this farm was reported previously (Schad et al., 1987). The biological and biochemical characteristics of isolates of *T. spiralis* taken from this farm were reported in separate papers (Dame et al., 1987; Murrell et al., 1987). Herein we report the epidemiological aspects of the infection in the local wildlife. Another part of the larger investigation detailing the longitudinal studies of the infection in the rat population will be reported separately.

MATERIALS AND METHODS

Both the farm on which trapping for wild animals was conducted and the surrounding area were described in detail previously by Schad et al. (1987) and Murrell et al. (1987). This farm was located in Gloucester County, New Jersey, USA (39°80′N, 75°30′W). Trapping of wild and feral animals was conducted during a 21-mo period. Initially, small box traps (Sherman; H. B. Sherman Traps Inc., Rt. 22, Box 365, Tallahassee, Florida 32304, USA) were placed randomly in fields and wooded lots adjacent to buildings and pens housing swine in order to trap small mammals. Squirrel-sized traps (Tomahawk Live Trap Co., P.O. Box 323, Tomahawk, Wisconsin 54487, USA) used for routine rat trapping near buildings and pens containing swine, occasionally caught various animals, including skunks, opossums and feral domestic cats. All traps were baited with a mixture of rolled oats and peanut butter. Traps were checked and reset five times/wk excluding weekends when the traps were closed to animals. A stream bed bordering the farm contained raccoon tracks. Therefore, a large Havahart (Allcock Manufacturing Co., Box 551, Ossining, New York 10562, USA) trap was placed in it and baited with canned tuna fish to trap any raccoons frequenting the farm.

All trapped animals were killed by an overdose of sodium pentabarbital (Euthanasia-6 Solution, Vet Labs Limited, Lenexa, Kansas 66215, USA). The entire tongue and diaphragm were removed from each animal and combined to make a total muscle sample of at least 5 to 10 g. Additionally, for small mammals, muscle tissue was taken from mid-abdominal muscle (internal oblique, external oblique, transverse and rectus abdominis) in order to obtain a 5-g sample. Tissue samples from individual animals were then digested using the artificial peptic digestion system described previously by Schad et al. (1984) to determine the prevalence and intensity of infection for each animal species.

RESULTS AND DISCUSSION

Forty-four wild and feral animals were caught on the premises of the pig farm (Table 1). Previously deer mice (*Peromyscus leucopus*) (Holliman and Meade, 1980) and various shrews (*Neomys fodiens, Sorex araneus, S. caecutiens, S. minutus*) (Rausch, 1970) have been reported to be infected with *T. spiralis*. The lack of infection in deer mice (*Peromyscus* spp.) and shrews (*Blarina brevicauda*) on this farm may simply reflect the small numbers examined. Additionally, the apparent lack of infection in these animals also may be due to insufficient muscle sample sizes which would have decreased the accuracy with which infections of ≤ 0.2 larvae/g (LPG) of tissue would have been detected. Furthermore, all shrews and deer mice were trapped in wooded lots and fields near the periphery of the farm. While these species may have had occasional access to dead infected swine or rats, we never observed dead individuals close to the areas in which the mice and shrews were trapped.

In contrast to the above, larger mammals were infected frequently with *T. spiralis*; prevalence rates varied from 33 to 100% (Table 1). Skunks (*Mephitis mephitis*), opossums (*Didelphis virginiana*) and a raccoon (*Procyon lotor*) probably became infected by scavenging dead swine and rats (*Rattus norvegicus*). However, it is possible that these animals may have preyed on living rats or scavenged carcasses of wild or feral animals. The infected raccoon, caught very early in the trapping period, was the only one observed on the farm during the 21-mo period of the study. All 15 skunks were trapped during a 2-mo period on four separate days, apparently when groups consisting of adults and juveniles visited the farm. Within these groups, three of four, two of four, none of four, and one of two skunks were infected suggesting that those infected may have shared a trichinous meal. The source of infection appears to be the rats and swine on this farm; however, we cannot exclude the possibility that the skunks became infected through scavenging carcasses of wildlife or at another farm.

TABLE 1. Prevalence and intensity of *Trichinella spiralis* infection in resident wild and feral animals trapped on a pig farm with active transmission of *T. spiralis*.

	Number examined	Number infected	Prevalence (%)	Mean intensity (LPG)[a]	Range (LPG)
Deer mice (*Peromyscus* spp.)	18	0	0	NA[b]	NA
Skunks (*Mephitis mephitis*)	15	7	47	22.2	0.1–93.2
Shorttail shrews (*Blarina brevicauda*)	5	0	0	NA	NA
Opossums (*Didelphis virginiana*)	3	1	33	84.4	NA
Feral domestic cats	2	2	100	632.3	56.5–1,208.0
Raccoons (*Procyon lotor*)	1	1	100	426.0	NA

[a] LPG, larvae per gram of muscle.
[b] NA, not applicable.

Indeed, the nearest swine operations were located approximately 8 km away, well within the distances skunks have been reported to travel (Verts, 1967).

Feral cats were observed at the farm throughout the study. On one occasion a cat was seen with a litter of three kittens. Two of these kittens (Table 1) were trapped when they were 3- and 6-mo-old, respectively; they were infected with *T. spiralis*, indicating exposure at a very young age. The intensity of infection was 56.5 LPG for the 3-mo-old cat and 1,208.0 LPG for the 6-mo-old cat. Ample opportunity existed on the farm to ingest infected rodents, particularly those dead or dying of a variety of unidentified etiologies. It was not uncommon to find carcasses of dead rats on the premises, or to observe ataxic rats during daylight hours. Trichinellosis may well have been a contributing factor, because it changes rodents behaviorally and may make them more vulnerable to predation (Rau, 1983a, b; Leiby and Bacha, 1987). While these cats probably acquired infections by eating rodents, carcasses of dead infected swine also were available occasionally and should be considered as a potential source of infection.

During the 21-mo study, direct interactions between wild animals and living rodents or swine were never observed. Therefore, the scavenging of dead, *T. spiralis*-infected carcasses appears to be the most likely route of infection. However, since most predators are nocturnal, the likelihood that predation of rats would have been observed is minimal. Transmission of *T. spiralis* in this ecosystem appears to be centered about the swine and endemic rat population on this farm (Schad et al., 1987).

Dame et al. (1987) and Murrell et al. (1987) conducted extensive analyses of isolates of *T. spiralis* from the infected swine, skunks, opossums and the raccoon. Based on pig infectivity trials, isoenzyme analyses and repetitive DNA sequence analyses, all the isolates were genetically similar, suggesting they are *T. spiralis spiralis* (domestic pig subspecies). Thus, the swine herd was considered as the source of the *T. spiralis* in the farm's wildlife. However, the parasite's origin on this farm remains obscure. In addition to the possibility that the parasite was introduced directly by infected pork, it may have been introduced by a wild animal that had become infected elsewhere. Similarly, the wild and feral animals at this farm could serve as reservoirs of infection for other swine operations in the vicinity. This is particularly important since these animals are infected with isolates of swine origin. Thus, any attempt to control the spread of *T. spiralis*

spiralis in a farm ecosystem must consider the role that wildlife may play in transmission of the parasite.

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