Experimental Transmission of *Trichinella spiralis* to Swine by Infected Rats

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**ABSTRACT:** The role of rats in the transmission of *Trichinella spiralis* to swine is controversial because some experimental investigations have failed to show that swine will eat rat carcasses. Confinement-reared, grain-fed hogs were offered fresh rat carcasses harboring varying densities of muscle larvae. In all trials, rat carcasses were readily eaten in part or in their entirety, usually within a few hours. At necropsy these hogs were infected with *T. spiralis* muscle larvae. Hogs ate rat carcasses whether their regular feed was withheld or not. The initial portions of the carcass eaten were the naso-frontal section of the head (NF) and the tail. The consistent ingestion of the NF, including the tongue and facial muscles, is of significance since larval densities are usually high in these particular muscles. We conclude that rats must be considered a potential source of infection to swine until sufficient detailed epizootiological investigations are carried out to determine their actual importance on the farm.

Infected rats are commonly regarded as an important source of *Trichinella spiralis* for domestic swine (Hall, 1924); the evidence to support this is largely circumstantial, however, consisting mostly of prevalence data from farm rats (Moy-nihan and Musfeldt, 1949a, b; Cironneau, 1974; Smith, 1980; Ramisz and Balicka-Laurans, 1981). Others have discounted the significance of rats (Hall, 1938; Kozar, 1969; Merkushev, 1970; Madsen, 1974). Madsen (1974) argued that Zenker's (1871) original theory of "swine to swine" transmission has been unjustifiably ignored in favor of the "rat-swine-man" pattern proposed by Leuckart (1866). Cameron (1970) reported that domestic swine actually have a great aversion to rats and, hence, he doubted that rats play a significant part in infecting pigs.

This question is important in establishing the major routes of transmission in swine trichinosis in the United States and, therefore, we carried out the experiments described below. Frequently related anecdotes from hog farmers concerning the propensity of waste- and grain-fed hogs to eat dead rats provided an impetus for this work. Our experimental results unequivocally demonstrate that farm-raised hogs can acquire trichinosis through the ingestion of partial or whole infected rat carcasses.

**Materials and Methods**

**Maintenance of *T. spiralis*, infection procedures, and recovery of parasites**

Muscle larvae (L1) were obtained from stock infections in TAC:SD rats (Taconic Farms, Germantown, New York) by digestion of muscle in 1% pepsin–1% HCl for 4 hr at 37°C. They were washed by sedimentation in warm water, counted and suspended to the desired concentration in water for oral inoculation into TAC:SD rats (150–200 g). The number of larvae/rat varied according to experimental design (see below).

Five to 6 weeks after infection, the rats were killed with CO2, and placed in an isolation pen with the experimental hogs. The amount of rat carcass eaten was recorded at varying time intervals (see Results). Infected littersmate s of the rats fed to the hogs were sacrificed, skinned, eviscerated and divided into: naso-frontal portion of head (NF), tail, i.e., posterior two-thirds of tail; and body, the remaining portion of the carcass. These sections were digested separately and the number of L1 present determined.

The experimental hogs were SPF animals farrowed and reared in confinement at the Animal Parasitology Institute. These hogs were routinely fed a grain ration once/day in the morning. Generally, the hogs were offered infected rat carcasses either in lieu of their grain ration (Exps. 1, 4, and 5), with their grain ration (Exp. 2) or after having their feed withheld for 24 hr (Exp. 3), which meant that they had received their previous ration 48 hr prior to exposure to the rat carcasses. The hogs were sacrificed 5–6 wk after exposure to the rats, and the tongue and diaphragm were ground together; at least 100 g of the ground meat mix were digested and the number of larvae/g (LPG) was determined.

**Results**

The results of the rat-feeding experiments are summarized in Table 1. The particulars of each experiment are as follows:

**EXPERIMENT 1:** By the end of the first hour, the hogs had eaten the tails of both heavily infected rats. It was observed that both hogs masticated the carcasses, rendering the fur wet with saliva although the action did not resemble actual chewing; this suggested some distaste for the rat’s
Table 1. Results of experimental attempts to transmit muscle larvae of *Trichinella spiralis* to hogs with infected rat carcasses.

<table>
<thead>
<tr>
<th>Exp. no.</th>
<th>Pig no.</th>
<th>Wt. (lb)</th>
<th>Starved*</th>
<th>Portion of rat eaten</th>
<th>Time (hr) required†</th>
<th>Calculated number of muscle larvae ingested</th>
<th>Necropsy results LPG/hog</th>
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<tr>
<td>1</td>
<td>1115</td>
<td>220 (110 kg)</td>
<td>No</td>
<td>NF§ and tail</td>
<td>3</td>
<td>18,000</td>
<td>776</td>
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<tr>
<td></td>
<td>1116</td>
<td>240 (109 kg)</td>
<td>No</td>
<td>NF and tail</td>
<td>3</td>
<td>18,000</td>
<td>200</td>
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<tr>
<td>2</td>
<td>1094</td>
<td>250 (114 kg)</td>
<td>No</td>
<td>NF and tail</td>
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<td>2,756</td>
<td>0.01</td>
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<td></td>
<td>1113</td>
<td>240 (109 kg)</td>
<td>No</td>
<td>NF and tail</td>
<td>4</td>
<td>2,756</td>
<td>0.03</td>
</tr>
<tr>
<td>3</td>
<td>P1</td>
<td>150 (68 kg)</td>
<td>Yes</td>
<td>Complete carcass</td>
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<td>11,733</td>
<td>388</td>
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<tr>
<td></td>
<td>P2</td>
<td>150 (68 kg)</td>
<td>Yes</td>
<td>Complete carcass</td>
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<td>110</td>
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<tr>
<td>4</td>
<td>P313</td>
<td>150 (68 kg)</td>
<td>No</td>
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<td>23</td>
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<td></td>
<td>P1153</td>
<td>75 (34 kg)</td>
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<td>19,938</td>
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<tr>
<td>5</td>
<td>XB-5</td>
<td>220 (100 kg)</td>
<td>No</td>
<td>NF and tail</td>
<td>0.5</td>
<td>1,320</td>
<td>8</td>
</tr>
</tbody>
</table>

* Previous feeding of grain ration was 48 hr before exposure to rat carcasses.
† Time required to consume amount of carcass indicated.
‡ NF = naso-frontal portion of head, including tongue and facial muscles.

Our results show unequivocally that confinement-reared, grain-fed hogs, without prior exposure to rat carcasses, ingested substantial numbers of muscle larvae. Table 1. Results of experimental attempts to transmit muscle larvae of *Trichinella spiralis* to hogs with infected rat carcasses.

**Experiment 4:** In this trial, in which two infected rats were offered in place of the regular grain ration, the experimental hogs ate the tails and NF portions of the carcasses within 5 hr, and had consumed the entire carcasses by 23 hr. The whole carcass L₁ levels of rat littermates were estimated to be 101 LPG (19,938 L₁, total). At necropsy both hogs had high LPG values.

**Experiment 5:** A single 220-lb grain-fed hog was offered a freshly killed rat approximately 1 hr before its normal feeding time. The rat had been inoculated 5 wk earlier with only 50 *T. spiralis* larvae; analysis of four similarly inoculated littermates indicated that the NF portion of the head weighed approximately 10 g and contained about 1,320 muscle larvae. After 30 min exposure to the hog, the rat was withdrawn and examined and the amount of carcass eaten recorded; by this time only the NF portion and about ¾ of the tail was eaten. The tails of the 4 infected littermates did not contain larvae. At necropsy, the hog’s LPG for tongue and diaphragm mix was determined to be eight.

**Discussion**

Our results show unequivocally that confinement-reared, grain-fed hogs, without prior exposure to rat carcasses, ingested substantial numbers of muscle larvae.
Exposure to rats, readily eat rat carcasses. In every instance, transmission of trichiniae to the hogs occurred, even with lightly infected rats (Exp. 5). Prior starvation of the hogs was not necessary for the consumption of all or parts of the rat carcass (Exps. 1, 2, 4, and 5). A consistent observation was the tendency of the hogs to eat the naso-frontal (NF) and tail portions of the rats first, usually within a brief time after exposure to the carcass. This is significant because the facial muscles and tongue are among the richest muscles in terms of larval abundance. In lightly infected rats (inoculated with 50 larvae) the tails were devoid of encysted larvae, demonstrating that this muscle was of no consequence in transmission.

The claim that hogs have a strong aversion to rats (Cameron, 1970) is not supported by these results, nor by the observations of farmers and field investigators. Although the role of rodents in the transmission of sylvatic trichinosis is still subject to debate (Schad and Chowdhury, 1967), we conclude from our findings that rats cannot be discounted as an important source of infection for domestic swine, nor is the eating of rats by pigs predicated on diets deficient in protein as suggested by Hall (1938) and Cordero Del Campillo, et al. (1970) because the ration fed in these experiments contained 16% crude protein and an extensive mix of vitamins and minerals. Clarification of the major routes of transmission of *T. spiralis* to swine is of vital importance and the pursuit of this goal is hindered by the perpetuation of unsubstantiated claims regarding possible sources of swine infection. This is true also with regard to garbage feeding; the evidence bearing on its importance in swine trichinosis is essentially circumstantial and deserves careful study.

The sources of *T. spiralis* infection for rats trapped on hog farms also requires clarification. Although the prevalence of infection varies widely in rats associated with farms known to have infected hogs, its relation to the prevalence in swine is uncertain (Moynihan and Musfeldt, 1949a; Rothrock, 1965; Martin et al., 1968; Smith, 1980; Ramisz and Balicka-Laurans, 1981) and it could be argued that infected rats are of secondary importance rather than a direct source of infection to hogs. Hopefully, this problem will eventually be resolved by intensive investigation and a useful rationale for the control of swine trichinosis may result.

**Acknowledgments**

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**Literature Cited**


Hall, M. C. 1924. Worm Parasites of Domesticated Animals. II. Parasites of Swine. L. A. Merillat, Chicago, IL.


