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***Sarcocystis* Infections in Relation to Age of Iowa Cottontails (Protozoa: Sarcocystidae)¹**

FREDERICK J. VANDE VUSSE²

Abstract. *Sarcocystis leporum* was found in 42 of 173 (24.3 %) cottontail rabbits (*Sylvilagus floridanus mearnsi*) examined. Infections were not observed in cottontails less than 6 months old. Incidence rose from zero at age 5 months to 67% at age 12 months. Ninety per cent of cottontails 25-48 months old were infected. The age of individual cottontails was estimated from the eye lens weight.

Sarcocystis is cosmopolitan, protozoan parasite of voluntary and cardiac muscle found primarily in herbivores. Over 50 species have been described from mammals, birds and reptiles. While the taxonomic position of the group is unsettled, recent reports indicate it is related to *Toxoplasma* (Manwell and Drobeck, 1953). Reviews of *Sarcocystis* literature are provided by Scott (1939 and 1943) and Levine (1961). Although recognized in the cottontail over 70 years ago, *Sarcocystis* has apparently been overlooked by many investigators, since it is rarely mentioned in the numerous papers on cottontail parasites.

Miescher's original report of *Sarcocystis* in 1843 was based on material from a house mouse. Its presence in rabbits in Germany was noted by Manz in 1867. Stiles reported *Sarcocystis* in a cottontail, *Lepus sylvaticus* (*Sylvilagus floridanus*), from Maryland in 1894. Brumpt named *Sarcocystis cuniculi* from the European hare (*Oryctolagus cuniculi*) in 1913, but gave no description of the parasite. A second species, *S. leporum*, was described by Crawley in 1914 from a cottontail now known to be *Sylvilagus floridanus* (Erickson, 1946) in Maryland. Crawley also reported records of *Sarcocystis* from a cottontail taken in Pennsylvania and from rabbits that probably were cottontails from New York and Illinois (Erickson, 1946).

Erickson (1946) stated that the name *S. leporum* Crawley, 1914, should be used for the sarcosporidian of the cottontail. He considered *S. cuniculi* Brumpt, 1913, *nomen nudum* since no description was given.

Annual reports to the legislature by the New York Conservation Department (Section on Pathological Examination of

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Game) for 1935, 1936 and 1938–1940 stated that sarcocystis was found in 121 of 1438 cottontails examined, an incidence of 7.7%. Infections ranged from 0.5% in 1938 to 29.4% in 1936.

Morgan and Waller (1940) reported *Sarcocystis* in 20 of 199 cottontails (*S. floridanus mearnsi*) collected in Iowa. Bell and Chalgren (1943) found infections in four of 45 cottontails from New York, one of 67 from Virginia and nine of 65 from Missouri. Thirty of 78 cottontails (*S. floridanus mearnsi*) from southern Minnesota examined by Erickson (1946) were infected. Two heavily infected cottontails (*S. floridanus similis*) from eastern South Dakota were examined by Huggins (1961).

Sarcocysts (Miescher's tubules) are located within muscle fiber bundles, lying parallel to the fibers, and cause considerable distention of the bundles. In fresh muscle, they appear as thin, white spindles up to 8 mm long and 0.4 mm wide. Sarcocysts are most easily seen in the hind leg and loin of the cottontail.

The outer of the two layers of the cyst wall has villiform projections, cytophaneres, which apparently derive nourishment from surrounding muscle tissue. The inner layer produces septa dividing the lumen of the cyst into compartments (Frenkel, 1956). In the mature cyst, the compartments are filled with thousands of banana-shaped trophozoites measuring 12 by 4 microns. Trophozoites may range from 6-16 microns in length (Levine, 1961).

The life cycle of *Sarcocystis* in the cottontail has not been worked out. Scott's (1943) report on the life history of *S. tenella* in sheep and the work of Spindler et al. (1946) on transmission of *S. miescheriana* of swine indicated that the cycle was direct and did not involve an intermediate host. Trophozoites pass out with feces of an infected animal and are ingested by the same or another animal. A latent period, about which little is known, occurs between ingestion of trophozoites and appearance of cysts in muscle tissue. A latent period of 45 days has been reported for the mouse (Smith, 1901; Negre, 1907), a minimum of 6 weeks in lambs and pigs (Bergmann, 1913 and Scott, 1943) and 10 weeks for calves (Scott, 1943). A latent period of 3 months was more common for lambs and calves (Scott, 1943).

Some species of *Sarcocystis* have been shown to contain a powerful, heat-labile endotoxin, sarcocystin. Sato (1926) reported that the intravenous minimum lethal dose for the rabbit of an extract of *S. fusiformis* from the ox was 0.05 mg/kg of body weight. When uncooked infected flesh was fed to experimental animals, a loss of intestinal epithelium by mice was reported by Crawley (1916) and vomiting, diarrhea and temporary

posterior paralysis in swine were observed by Spindler et al. (1946).

Sarcocystis is not generally considered very pathogenic (Levine, 1961) and nothing is known of its effect on cottontails. Spindler et al. (1946) indicated that heavily infected swine were unthrifty and showed signs of muscular stiffness.

METHODS

Data for this paper were obtained from cottontails (*S. floridanus mearnsi*) taken in Ames, Story County, Iowa during January 1962 to January 1963. Age of individual animals was estimated with the method of Lord (1950) as modified by Dudley (1963) utilizing weight of the eye lens. Sex of the specimens was determined by internal examination. The surface of the muscle of the hind legs and loins was examined for presence of visible sarcocystis which were situated throughout the muscle, but visible only when near the surface. Thus, some very light infections may have been overlooked.

RESULTS

One-hundred seventy-three cottontails (88 males and 85 females), ranging in age from 1-48 months, were examined. *Sarcocystis leporum* was observed in 42 (24.3%). However, sarcocystis was not observed in cottontails less than 6 months old. Incidence rose from zero at age 5 months to nearly 70% by age 12 months. Ninety per cent of cottontails 25-48 months old were infected. (Table 1).

Table 1. Age of Iowa cottontails in relation to *Sarcocystis* infection.

Age in months	Number examined	Per cent infected	Age in months	Number examined	Per cent infected
1	9	0	8	5	60
2	12	0	9	11	36
3	19	0	10	9	67
4	18	0	11-15	12	67
5	18	0	16-24	13	62
6	14	29	25-48	10	90
7	7	14	1-48	173	24

Incidence was lowest in summer and fall when cottontails less than 6 months old comprised most of the population. Incidence rose through late fall and winter, reaching a maximum in the spring, when addition of young, uninfected individuals reduced overall incidence (Table 2).

Forty-two of 96 cottontails (43.8%) 6 months of age or older were infected. Sixteen of 48 males (33.3%) and 26 of 48 females (54.2%) had *Sarcocystis* in their muscles. The difference in rate of

Table 2. Seasonal variation of incidence of *Sarcocystis* in Iowa cottontails.

Month	Number examined	Per cent infected	Month	Number examined	Per cent infected
January	19	50	July	14	7
February	7	29	August	19	10
March	22	45	September	10	30
April	18	50	October	20	15
May	9	56	November	16	6
June	11	27	December	7	14

infection between sexes appears to be a result of unequal sampling rather than a difference in susceptibility. Males predominated in the low-incidence (6-15 month) age groups, while females outnumbered males two to one in the high incidence (25-48 month) age group.

Relative density of cysts in individual cottontails was noted, although quantitative measurements were not made. Light infections were most common in young rabbits, while heaviest infections occurred in older animals.

DISCUSSION

If the life cycle of *Sarcocystis* in cottontails is similar to that of sheep and swine, and involves direct infection, juvenile cottontails could ingest trophozoites as early as their second week, when they begin to take solid food. The 5 months between birth and appearance of sarcocysts in cottontails is considerably longer than 6-12 weeks reported for other animals. This may represent a true difference in latent period for the cottontail; or, perhaps a physical or physiological mechanism acts to prevent infections in very young cottontails. Cottontails regularly re-ingest a portion of their feces which, presumably, would maintain and increase the infection.

Variation in the incidence of sarcocystis in cottontails exists in the reports in the literature. In view of the relationship between age and incidence, the season in which collections are made has a definite bearing on the incidence reported.

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