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Source: Journal of Wildlife Diseases, 7(3) : 205-212

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-7.3.205

PULMONARY ARTERIAL FILARIASIS IN THE HOUSE SPARROW[1]

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Abstract: A field survey of the house sparrow, *Passer domesticus domesticus* Linn., for the filarial nematode, *Splendidofilaria passerina*, was conducted in Illinois during May 1968 to May 1969. Fifty-four (19.9%) of 271 birds of both sexes were infected with adult male and/or female worms within the walls of the pulmonary arteries. A mean of 5.8 and range of 1-23 worms per bird were recovered. Forty (14.8%) sparrows were positive for microfilariae in smears of lung blood, but there was no correlation between adult worm burden and numbers of microfilariae per 100 microscopic fields. Eleven birds infected only with female worms were negative for microfilariae. Patent infections were first observed in immature sparrows during September and October, which suggests an approximate 3 month prepatent developmental period of the adult worm. The incidence of infection remained high throughout most of the year, with a decline during the months of June through August. The data indicate increased infection in the autumn, possibly related to the activity of an unknown vector during the summer months. The walls of the pulmonary arteries of heavily infected sparrows were grossly thickened and enlarged, with worms occupying most of the tissue and occasionally extending free into the lung and heart. Microscopic lesions included fibrosis, necrosis and stenosis of the pulmonary artery. Accumulations of foreign body giant cells were observed surrounding dead worms, but there were no reactive cells around living worms.

INTRODUCTION

During a survey of the house sparrow, *Passer domesticus domesticus* L., for blood protozoa, a new species of filarial nematode, *Splendidofilaria passerina*, was found and described by Koch and Huizinga.[5] The present paper gives the seasonal incidence and intensity of infection of *S. passerina* in sparrows from Illinois. Lesions caused by adult worms in the walls of the pulmonary arteries are described.

MATERIALS AND METHODS

House sparrows used in this study were collected from a farmyard area of approximately 4 acres at Mt. Stering, Brown County, Illinois, during 1967 to 1969. The majority of both young and adult birds were taken by hand after dark as they roosted in barns. A light flashed into the birds' eyes caused them to become immobile. Other birds were caught in a mist net (30 x 6 ft., 1 in. sq. mesh) which was set in areas of bird activity near barns and field roosting sites. The sex and state of maturity of sparrows was determined from plumage coloration and gonadal examination. Smears of blood from lung tissue were stained with Giemsa's stain after the method of Lainson[6] and examined microscopically for microfilariae at X 400 for ten minutes. The number of microfilariae per

[1] Supported by research grants numbered 69-21 and 70-62 from the Illinois State University Foundation (to H.W.H.).

100 microscopic fields (X980) was counted. A drop of fresh lung blood was examined in 0.85% citrated saline for living microfilariae.

Pulmonary arterial tissue was first softened by soaking it in warm 0.85% physiological saline (36C) for several hours and then the adult nematodes were teased from tissue with fine-pointed insect needles. Worms were fixed in warm 70% alcohol (containing 5% glycerine) and examined in glycerine. Arterial and heart tissues were fixed in 10% neutral formalin. Histological sections were taken transversely and longitudinally through pulmonary arteries and adjacent tissues. Tissues were processed by routine paraffin embedding techniques and stained with hematoxylin and eosin.

RESULTS

Seasonal Incidence of Infection

During the preliminary phase of the study, between October 1967 and April 1968, 21 sparrows were examined for microfilarial infection and 6 (28.6%) were positive. Adult worms were not found during a dissection of the internal organs of these birds because at first we failed to examine the pulmonary arteries. Therefore, the 21 birds are not included in Table 1. During the examination of bird number one in May of 1968, the long, slender adult male and female worms of *Splendidofilaria passerina* were found cryptically sewn into the walls of the pulmonary arteries where they resembled strands of connective tissue (Figure 1). A study of the seasonal incidence and intensity of infection of *S. passerina* was then conducted during the one year period of May 1968 to May 1969. Bird collection data from various dates within a single month were lumped together for convenient analysis (Table 1).

A total of 271 sparrows was examined and 54 (19.9%) were infected with adult worms (Table 1). The numbers of worms per bird ranged from 1 to 23 with a mean of 5.8. Microfilariae were found in smears of lung blood from 40 (14.8%) of the 271 birds. In 11 birds, male worms were absent, but 1-4 unfertilized female worms were recovered (Table 2). These female worms were observed to be infertile by examination of the uterus which contained undeveloped eggs. Microfilariae were not found in the blood of the 11 birds which partly explains the observed difference between the 54 birds infected with adult worms and the 40 birds positive for microfilariae. In addition, three birds were infected with both male and female worms, but did not have microfilariae in the blood.

More female (178) than male (137) worms were recovered but this difference was not statistically significant (Table 1). The incidence of infection in adult male and female birds was similar, 16 and 17 birds positive for worms, respectively. Immature birds were negative during May through August, 1968 and were first observed positive in September 1968 when a single sparrow contained four worms and microfilariae in the blood. The immature birds showed an increased incidence of infection during the months of October and November, 1968.

There was no apparent correlation between adult worm burden and number of microfilariae per 100 microscopic fields (Table 2). A single adult female sparrow held in captivity for one year (May 1968 to May 1969) was continuously negative for microfilariae and was found upon necropsy to be infected with one infertile female worm (Table 2, No. 24).

In view of the rare occurrence of filarial worms in the house sparrow, the following unpublished data are given through the courtesy of Dr. James E. Applegate, Naval Medical Research Institute, Bethesda, Maryland. During a study of malaria, Applegate found 12 (0.5%) of 2283 sparrows collected on the campus of Pennsylvania State University over the four year period of 1967 through 1970 to be positive for unknown microfilariae in peripheral blood smears. The infections were all in adult birds collected in a farmyard habitat of approximately 10 acres. Nine of the 12 birds were females and 7 of the 12 infections were found in the month of May.

Between July 13 and August 10, 1968, 37 immature and *S. passerina*-free sparrows were trapped, banded and released

Table 1. Seasonal incidence of **Splendidofilaria passerina** in English Sparrows from Illinois.

Mo. & year examined	No. birds examined	No. positive for microfilariae	No. positive for adult worms	Total worms recovered	Mean No. worms per bird	Total No. male worms & range in ( )	Total No. female worms & range in ( )	Sex of birds and No. positive for worms in ( ).				
								Adult		Immature		
								Male	Female	Fledgling	Male	Female
5-68	11	2	2	4	2.0	0	4	6 (0)	3 (2)	2 (0)	0	0
6-68	12	0	0	0	0	0	0	4 (0)	1 (0)	7 (0)	0	0
7-68	6	0	0	0	0	0	0	1 (0)	1 (0)	4 (0)	0	0
8-68	25	0	0	0	0	0	0	0	0	25 (0)	0	0
9-68	36	1	1	4	4.0	1	3	0	0	0	14 (0)	22 (1)
10-68	24	8	8*	56	7.0*	27 (1-10)	25 (1-9)	1 (0)	0	0	14 (4)	9 (4)
11-68	31	8	10	57	5.7	30 (1-16)	27 (1-10)	5 (1)	0	0	13 (3)	13 (6)
12-68	26	6	7	28	1.4	15 (1-7)	13 (1-2)	12 (4)	2 (0)	0	3 (1)	9 (2)
3-69	24	5	7	36	5.1	16 (1-8)	20 (1-11)	14 (6)	10 (1)	0	0	0
4-69	13	3	4	55	13.8	25 (1-22)	30 (1-23)	6 (0)	7 (4)	0	0	0
5-69	63	7	15	72	3.7	23 (1-9)	56 (1-11)	33 (5)	27 (10)	1 (0)	1 (0)	1 (0)
TOTALS	271	40 (14.8%)	54 (19.9%)	312	5.8	137	178	82 (16)	51 (17)	39 (0)	45 (8)	54 (13)

*Two birds used for histology, data based on 6 birds.

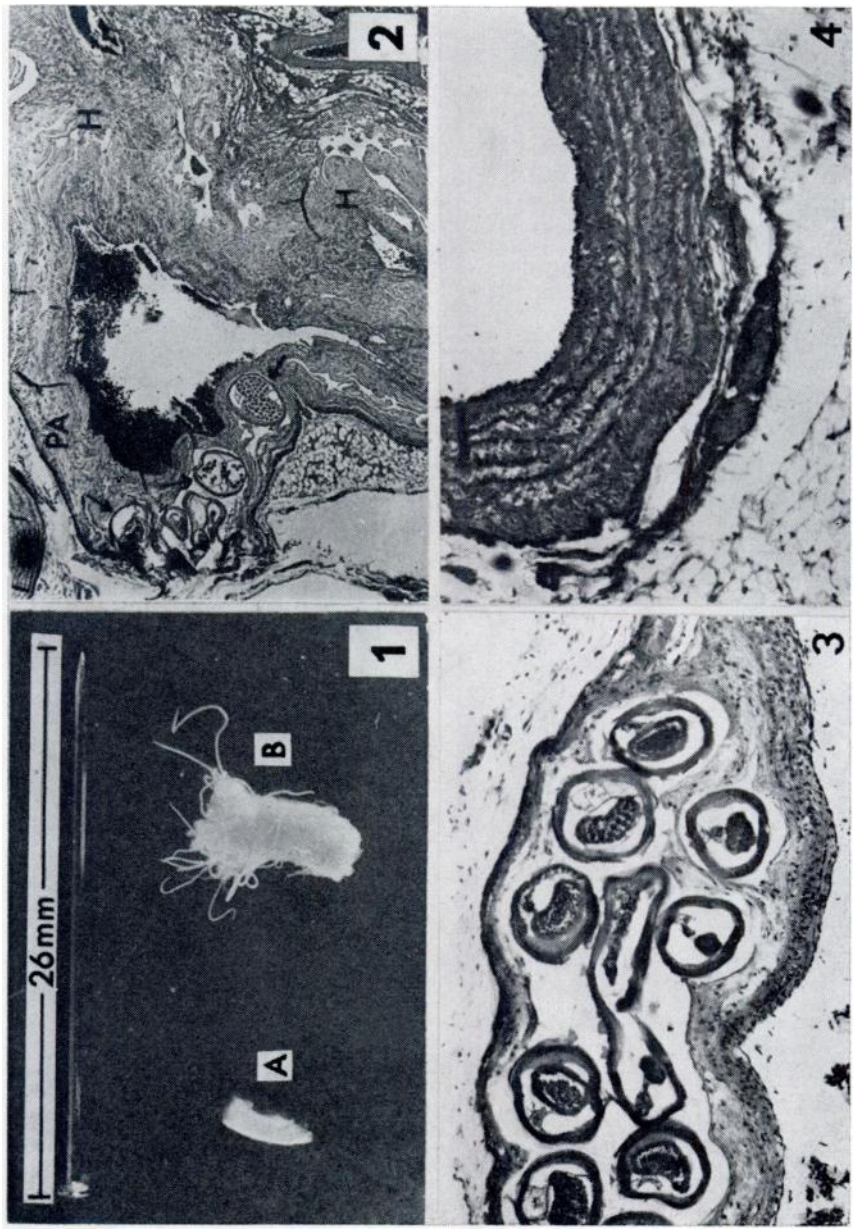

Figure 1. Normal (A) and infected (B) pulmonary arteries from house sparrows. Note large number of adult male and female **S. passerina** sewn through and extending from cut ends of artery.

Figure 2. Histological section of pulmonary artery (PA) of sparrow adjacent to heart (H) showing filarial nematodes (arrows) in the media with areas of medial separation, necrosis and wall thickening (X35).

Figure 3. Higher magnification of section of pulmonary artery with filarial nematodes replacing most of the media. Note the spaces around the worms and the loss of the usual musculoelastic layers (X140).

Figure 4. A normal pulmonary arterial wall for comparison with Figure 3 (X140).

in an attempt to recapture newly infected birds and determine the prepatent and patent periods of the nematode. Six banded birds recovered at various times during 1969 were negative for worms and microfilariae (not included in Tables 1 or 2). While these data were inconclusive concerning patency, they are given to show the sedentary, non-migratory habits of the sparrow in our collection area.

Pathology

The pulmonary arteries of uninfected sparrows were thin, reddish-colored and elastic on external examination (Figure 1A). In contrast, the arteries of heavily infected sparrows were grossly enlarged, white, and tough-textured (Figure 1B). In heavy infections, the worms were woven through much of the arterial tissue. In several cases, the worms were free within the arterial lumen and extended into the heart and lung.

Histologically, the infected arteries were thickened, partially due to the presence of worms with surrounding spaces formed from degenerating and necrotic arterial media, and partly from deposit of scar tissue (Figure 2, 3). No accumulation of leucocytes or reactive cells was seen around intact worms but worms that had died in tissue were surrounded by a weak foreign body giant cell reaction.

DISCUSSION

There are no previous records of filarial nematodes from the house sparrow, but there are reports of unknown microfilariae found in blood films by Manwell[11] in New York and Wagner[20] in Washington. The occurrence of microfilariae in widely separated geographic areas suggests that *Splendidofilaria passerina* may occur more commonly in house sparrows than has been reported, due to the difficulty of finding adult worms in tissue. Several authors did not find microfilariae in the blood of sparrows from Georgia,[10,11,15] Ohio,[16] Oregon,[12] South Carolina,[4,6] Texas[3] and India.[17]

Nine of 22 species of *Splendidofilaria*[2] are associated with the heart and pulmonary arteries while eight species are found in subcutaneous tissue of birds, but there have been no studies of histopathology. Certain members of the genera *Cardiofilaria* and *Splendidofilaria* which live exclusively in the heart and blood vessels are remarkably well-tolerated by birds.[13] In our study, *S. passerina* caused necrosis, fibrosis and stenosis of the pulmonary arteries. When large numbers of worms were present, the arterial walls were markedly enlarged and thickened. The presence of dead worms in arterial tissue indicated that they may have been killed by the host response or died *in situ* of unknown causes and were surrounded by a foreign body reaction. It is possible that the tunnel-like lesions in the arteries were produced by the physical activity of the worms ,since there was little cellular reaction to undamaged worms.

Worms were observed within the lumen of the artery and also extending into both the lung and heart where they could interfere with heart or blood vessel function during times of heavy exercise. However, infected birds held in captivity for several months behaved normally.

The data suggest that field surveys for microfilariae may fail to give a true picture of the incidence of infection, since birds found negative for microfilariae may actually be infected with infertile female worms (Table 2, Nos. 7-10 and 21-24).

In our study, sparrows sustained a relatively high and constant incidence of

Table 2. Lack of correlation between adult worm burden and numbers of microfilariae in smears of lung blood from sparrows collected during the months of March, April and May, 1969.

Bird No.	Sex of Bird	No. & sex of worms		No. microfilariae per 100 microscopic fields (X980)
		Male	Female	
1	M	5	5	100
2	M	1	1	59
3	M	1	1	63
4	M	2	1	0
5	M	9	7	13
6	M	1	1	0
7	M	0	1*	0
8	M	0	1*	0
9	M	0	1*	0
10	M	0	1*	0
11	F	8	11	234
12	F	22	23	31
13	F	2	2	20
14	F	1	1	14
15	F	1	9	28
16	F	3	8	18
17	F	4	4	19
18	F	1	4	73
19	F	3	11	24
20	F	0	4*	34
21	F	0	4*	0
22	F	0	2*	0
23	F	0	1*	0
24	F	0	1*	0**
		—	—	—
	Means	2.7 ± 4.8	4.4 ± 5.2	30.4 ± 51.2

*Female worms negative for microfilariae by examination of uterus.
**Held in captivity for one year, continuously negative for microfilariae.

infection throughout the non-summer months. Summer collections were incomplete, but the increased number of immature birds that were positive during September through December indicates a fall rise in the infection, related to unknown vector activity during the summer months (Table 1). Robinson[15] observed a seasonal fluctuation in the incidence of an unknown microfilarial infection of bluejays. The lowest incidence (20%) was detected during the summer months with a sharp rise in the infection to about 60% in September. A sustained high infection average of about 65% was observed during the non-summer months of that same year. A partial decline in the incidence was observed during the following summer which suggested a repeating seasonal pattern related to the

breeding behavior and population dynamics of the jay. A similar seasonal infection pattern was reported in a microfilarial infection of the crow.[15]

Our finding of the first immature sparrow positive for microfilariae in September suggests a three month maximum developmental period from infective larva to patent adult worm. Studies [1,5,16,17] point to *Culicoides* or *Simulium* as likely vectors of *S. passerina*. Recent developments in the laboratory cultivation of *Culicoides*[7] may open up new areas of research in the life histories of bird filariae.

According to Summers - Smith,[19] the house sparrow was first introduced into New York City from Europe in 1850 and had spread across the entire continental limits of the United States by 1903. There are no records of filarial nematodes from the arteries of the sparrow in Europe. *Splendidofilaria passerina* shows closest morphological resemblance to *E. algonquinensis* (Anderson, 1955) from the barn swallow *(Hirundo erythrogaster)*. During our study, sparrows and barn swallows were observed to nest side by side in barns. It is speculated that the new species *(S. passerina)* may have been acquired through the gradual morphological and physiological adaptation of *S. algonquinensis* to the sparrow.

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Received for publication March 22, 1971