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Source: Journal of Wildlife Diseases, 7(4) : 317-323

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-7.4.317

THE PATHOLOGY OF *Filaria taxideae* (FILARIOIDEA: FILARIIDAE) INFECTION IN THE BADGER*

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Abstract: A description is given of the cutaneous lesions associated with *Filaria taxideae* Keppner, 1970 infections in badgers, *Taxidea taxus* (Schreber, 1778), from Wyoming. Female *F. taxideae* migrated into the dermis of the host and deposited their ova beneath the epidermis. Lesions developed gradually around the groups of ova, and no haemorrhagic lesions were observed on gross examination. First-stage larvae were observed at the periphery of developing and healed lesions along with embryonated ova. A comparison is made with the formation of the cutaneous lesions associated with the closely related *Parafilaria* Yorke and Maplestone, 1926.

The life cycles of the species of the genus *Filaria* Mueller, 1787 are unknown, but there have been proposals made with regard to the possible life cycle pattern within this genus.[1,6,9] The proposed life cycle pattern includes the presence of cutaneous lesions as a means of releasing the infective stage to the external surface of the definitive host where they would be available to the intermediate host.

The purpose of this paper is to describe the pathologic changes observed in the skin of badgers, *Taxidea taxus* (Schreber, 1778), that were infected with *Filaria taxideae* Keppner, 1970.

MATERIALS AND METHODS

The badgers examined during this study were obtained by shooting or as road kills in the vicinity of Laramie, Wyoming. Each animal was examined externally for the presence of cutaneous lesions and, when present, a determination was made of their number and distribution. Impression smears were made by puncturing the non-crusted lesions and smearing the bloody exudate on a slide. Smears were air dried, fixed in absolute methanol and stained with Giemsa's stain. Skin lesions were carefully excised from freshly killed badgers so as to disturb the female nematodes as little as possible. When females were encountered partially embedded in the dermis during this procedure, they were severed close to the undersurface of the dermis or were dissected free from the undersurface of the dermis. Skin from the corresponding areas of non-infected badgers were treated in the same manner to serve as controls. All tissues were fixed in 10% formalin, Bouin's fixative, or AFA. Standard histological procedures were employed in preparing the tissue for study and paraffin embedded material was sectioned at 8μ and stained with hematoxylin and eosin, Giemsa's stain or Mallory's trichrome stain.

RESULTS

Incidence and Location: Of the badgers examined from 1965-1970, 82% (18 of 22) of the adults were found to be infected with adult *F. taxideae* and 39%

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(7 of 18) of those infected had grossly visible skin lesions. Lesions were observed on adult badgers from May to December. Adult *F. taxideae* were not found in seven young of the year badgers.

Gross Pathology: Lesions were most often observed in the inguinal region only (7 of 9) but in heavy infections they were present over the entire ventral surface from the posterior margin of the thighs to the axillary region and laterally to the origin of the long, thick fur of the dorsal side. Lesions were not observed on the dorsal side of any of the badgers examined during this study.

In all the badgers that had cutaneous lesions, adult female *F. taxideae* were observed partially embedded in the dermis of the host. In the absence of grossly visible lesions, the adults were located in the fascia on the surface of the abdominal or pectoral muscles. In two instances adults were observed in abnormal locations within the host. In the first case a single female was found penetrating the abdominal muscles and extending into the peritoneal cavity. An adult male was found in the left atrium of the heart of another badger.

Female *F. taxideae* were found to have migrated from their position in the muscle fascia into the dermis of the host where they deposited ova in groups beneath the epidermis. Normally no more than one-quarter of the total length of the female was embedded in dermal tissue, but occasionally the entire anterior one-half was located in the dermis. Adult females averaged 339 mm long.

The lesions occurred singly or in groups which were either linear or circular in outline. The linear lesions paralleled the location of the female parasites. The circular lesions involved 2-9 females in the dermis and contained up to 35 individual raised areas and crusts which involved an area of skin up to 7 cm in diameter (Fig. 1). The lesions were of two general types. The first consisted of small, hard, nodules 2-5 mm in diameter. When punctured, a bloody exudate was expressed which contained embryonated ova and a few first-stage larvae. The second general type of lesion consisted of hard, brown crusts of varying size and shape that contained ova. Some of these crusts were firmly attached to the underlying epidermis while others were

FIGURE 1. A group of lesions (1) in the inguinal region of a badger and an area (s) from which a similar group of lesions had been removed.

free of the epidermis but adhered to the hairs. There was some loss of hair in the heavily infected areas, but never complete alopecia. Bleeding or draining lesions were not observed on any of the badgers.

Histological Changes: Lesions developed around groups of ova in the outer portion of the dermis. The early stages of lesion development were characterized by haemorrhage and a progressive accumulation of lymphocytes, histiocytes, and eosinophils in the region of the ova. A few neutrophils were present but the most abundant leukocyte in impression smears was the eosinophil.

The epidermis, at the edge of the developing lesion, was thickened due to acanthosis and epidermal pegs extended into the dermal tissue. In addition there was also a marked hyperkeratosis in this region (Fig. 2). There was an accumulation of leukocytes, primarily plasma cells, around the dermal blood vessels. Few first-stage larvae were observed during the early stages of lesion formation.

Later there was a marked decrease in the thickness of the epidermis overlying the lesion contents. Loss of epidermal layers proceeded from the basal layer toward the exterior surface until only an eosinophilic layer containing pyknotic nuclei and the stratum corneum covered the lesion contents. Tissue organization was lost around the ova and an abscess was formed. The base of the lesion consisted of granulation tissue and ova present in this region were enclosed by giant cells. First-stage larvae were most often observed during this stage of development both within the lesion and at the periphery (Fig. 3).

Continued development of the lesion resulted in necrosis and rupture of the overlying epidermis with release of the purulent contents to form a pustule. At the periphery there was a downward growth of the epidermis along the floor of the lesion. The entire process appeared to be gradual, so the lesion contents dried as they were exuded to the surface of the skin, forming a dried crust. Ova and first-stage larvae were often included in the proliferating epidermis (Fig. 4). The drying of the lesion contents as they were gradually removed to the skin surface would account for the lack of gross haemorrhagic lesions.

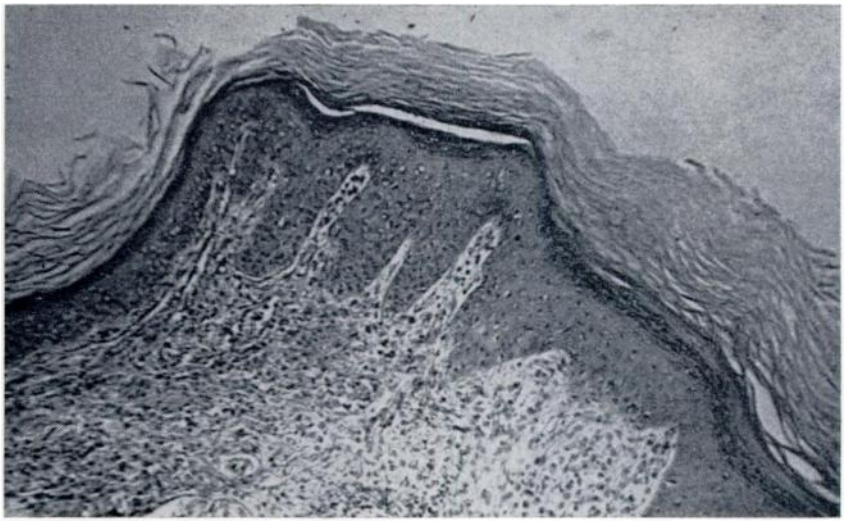

FIGURE 2. Cross section through the edge of a developing lesion with epidermal pegs and hyperkeratosis visible. X100.

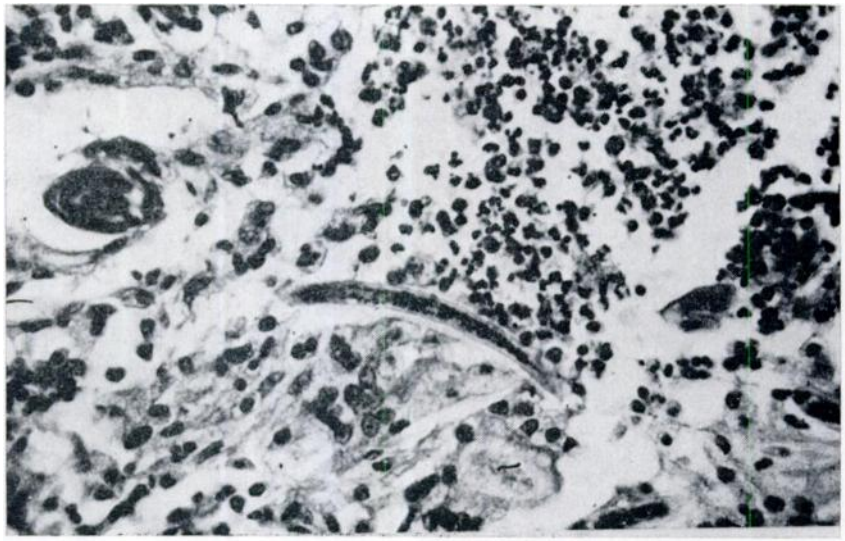

FIGURE 3. Ovum and first-stage larva of **F. taxideae** at the edge of a lesion. The lesion contents extend from the ovum and larva to the upper right. X400.

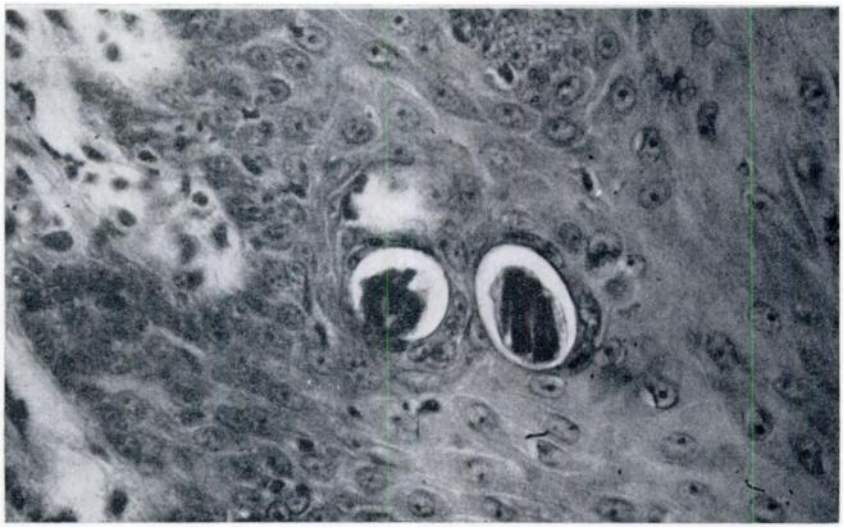

FIGURE 4. **Filaria taxideae** ova in the epidermis. The epidermal surface is to the right and the dermis to the left. X440.

The lesions resolved by epidermal growth from the periphery of the lesion. The dried exudate initially adhered to the new epidermis, and later became free of the epidermis but was still attached to the hairs. Larvae were very scarce in the dried exudate but embryonated ova were abundant. A few ova and many first-stage larvae remained in the dermis after the lesion had healed. The remaining ova were normally enclosed in giant cells but the larvae were free in the dermal tissue. Occasionally groups of ova and larvae were observed deep in the dermis of heavily infected badgers and it is doubtful if these could be removed to the surface of the skin. The ova in these locations were enclosed in giant cells and the larvae that were present appeared to be free in the dermis.

Reaction to Adults: The presence of the adult parasites on the muscle surfaces or in the dermis evoked little inflammatory response. A definite inflammatory response to the presence of adults in the dermis was observed on only one occasion, in a heavily infected old badger. The only gross lesion was a slight thickening of the underside of the dermis due to the bulk of the coiled parasites. Microscopic examination of this area revealed the presence of two dead adult *F. taxideae* females. Surrounding them was a thick zone of plasma cells and a large number of giant cells (Figs. 5 & 6). Many dead ova were present in this zone.

DISCUSSION

Prior reports of the reaction of the host to the presence of a member of the genus *Filaria* have been concerned with the mention of, or description of, living, encapsulated adults.[3,5,9] Living, encapsulated adults were not observed during this study.

Speculations about the life history pattern of *Filaria* generally agree that it will parallel that of *Parafilaria* Yorke and Maplestone, 1926.[1,9] The formation of cutaneous lesions has been described for two species of *Parafilaria* that live under the skin of their hosts. *Parafilaria multipapillosa* (Condamine and Drouilly, 1878) lives in the subcutaneous tissues of horses. Adult females migrate into

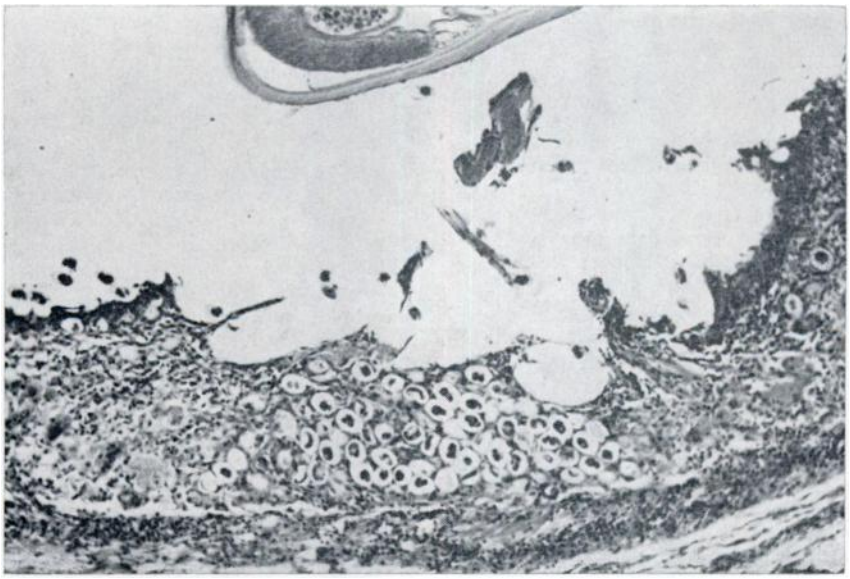

FIGURE 5. Cross section through the region of encapsulated adults. A portion of the adult is at the top and the wall containing many ova is at the bottom. X100.

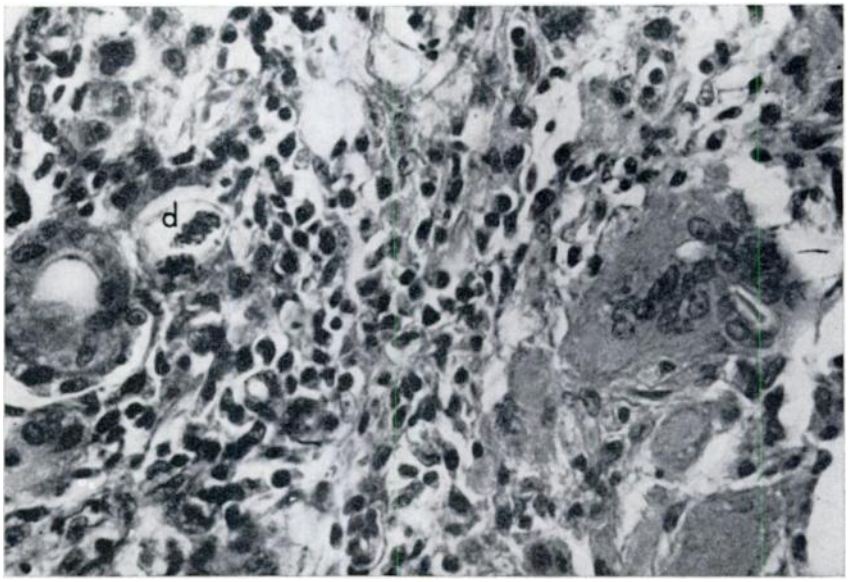

FIGURE 6. High power view of a portion of the capsule wall. The cavity of the capsule is to the left. A single dead ovum (d) is present. X440.

the dermis and come to rest with their anterior ends immediately below the epidermis. The lesion forms about the anterior end of the parasite and appears as a circular, raised nodule. The center of the nodule opens and the haemorrhagic exudate that issues contains the embryonated ova and some free larvae of the parasite.[2,4] *Parafilaria bovicola* Tubangui, 1934, a subcutaneous parasite of bovids, also has cutaneous lesions associated with it that develop in a manner quite similar to that of *P. multipapillosa*.[7]

The observations reported herein support the life history pattern as proposed for the genus *Filaria* in that they establish the presence of cutaneous lesions as part of the life cycle of one species of the *Filaria*. There were two apparent differences in the formation of the lesions associated with *F. taxideae* as compared to those associated with the *Parafilaria*. Firstly, the lesions develop around groups of ova deposited in the dermis of the host by *F. taxideae* rather than around the anterior end of the female as with the *Parafilaria*. Secondly, haemorrhagic lesions were not observed with *F. taxideae*, probably because the exudate dried as it was gradually expressed to the surface. Haemorrhagic lesions that carry the stage infective to the intermediate host to the skin surface are common with the *Parafilaria*.[2,4,7]

The intermediate host for *P. multipapillosa* in Russia is the blood-sucking dipteran *Haematobia atripalpis* Bezzi, 1895 which obtains the infective stages of the parasite when feeding on the bloody exudate from the lesions.[5] Since some larvae and ova of *F. taxideae* remain in the papillary layer of the dermis of the host after the lesions have healed, they would be available to blood-sucking diptera that have a method of feeding similar to that of the tabanids and simulids. Should one of these diptera serve as the intermediate host of *F. taxideae*, infection of the definitive host could occur during the feeding of the infected intermediate host. Infective larvae would then gain direct access to the dermis by entering the wound made by the intermediate host.

Acknowledgements

I am grateful to Dr. W. B. Owen, Department of Zoology and Physiology, University of Wyoming, Dr. N. E. Kingston and Mr. R. F. Honess, Division of Microbiology and Veterinary Medicine, University of Wyoming who directed this study. I am also indebted to Dr. G. E. Cosgrove, Oak Ridge National Laboratory for his examination of the material collected during the study and for reviewing the manuscript.

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Received for publication June 11, 1971