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The "Lungworm"
Filaroides milksi,
in Iowa Dog

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The purpose of this report is to describe for the first time the lungworm Filaroides milksi (Whitlock, 1956) in a dog in Iowa.

LITERATURE REVIEW

"The genus Filaroides (v. Beneden, 1858) of the superfamily Metastrongyloidea (Lane, 1917) includes those nematodes which have undergone an almost complete loss of the typical strongyline bursa. The cuticular part of the bursa is rudimentary or lacking and the bursal rays are little more than papillae." Eight species have been described in the genus Filaroides. These species have a worldwide distribution in a wide range of hosts including the dog, pine marten, mongoose, squirrel-monkey, and harbor seal. The most important of these species in veterinary medicine is Filaroides osleri (Cobbold, 1879) first described in the canine respiratory tract by Osler in 1877. In 1956, Whitlock described a new species of Filaroides in the lungs of a dog from the region of Geneva, New York, which he named Filaroides milksi. The parasite was differentiated from Filaroides osleri by its smaller size, the spicule characteristics of the male, and by the structure of the posterior end of the female. Filaroides milksi also differed in its location in the lung.

In September, 1959, tissues were submitted to the Iowa Veterinary Medical Diagnostic Laboratory from a dog having a chronic cough and a mild chronic pneumonia. Tissue sections revealed a large number of lungworms. These lungworms have been identified as Filaroides milksi.

CASE REPORT

On September 11, 1959, a five-year-old male brindle boxer dog was submitted for examination at a veterinary hospital in Waterloo, Iowa, with symptoms of weakness and dyspnea. The patient was a household pet which had received very good care. The dog was whelped and raised in Cedar Falls, Iowa, and was taken on vacation trips to Minnesota. The patient was first treated for a cough in August, 1958. In September 1958, the patient was admitted to the clinic with symptoms of coughing and vomiting. He responded well to treatment for tonsillitis and nephritis. Five weeks later, after several coughing spells, a tonsillectomy was performed. Severe hemorrhage occurred. The dog recovered rapidly from the operation. In February 1959, vomiting recurred with satisfactory recovery upon treatment. In June, however, the cough recurred. During the following three months, while the appetite remained good, emaciation became evident. Respiration was more difficult and weakness was apparent.

Clinical examination revealed severe emaciation, anemia, icterus, and dehydra-
tion. The patient was alert but weak. Temperature and pulse were normal. Mucous membranes were pale. Respiration was rapid and shallow. A painless, weak, dry, hacking cough was heard several times each hour. The cornea was cloudy and bilateral retinal detachment was observed. Radiographs demonstrated diffuse cloudy areas in the lungs. The hematocrit was 27 percent and a very rapid sedimentation was noted. Fecal examinations and tracheal swabs were negative. A tentative diagnosis of mycotic pneumonia was made and euthanasia was recommended.

**GROSS EXAMINATION**

Necropsy of the patient revealed emaciation, icterus, anemia, and dehydration. Excessive serous fluid was present in the pleural and peritoneal cavities. Kidney surfaces were pitted with focal scars. Bronchial and mesenteric lymph nodes were enlarged and edematous. The trachea contained frothy exudate. The lungs were edematous. The dorsal posterior border of the diaphragmatic lobes were thickened, enlarged, firm and brownish grey. The characteristics were typical of vermiform bronchopneumonia. Specimens from various organs were preserved by refrigeration for further laboratory study. Portions of the specimens were fixed in 10% formalin to facilitate histopathologic examinations. Bacteriologic and mycologic examinations were negative.

**MICROSCOPIC EXAMINATION**

Histopathologic examinations revealed a very large number of adult and juvenile nematode parasites in the lung parenchyma. The number of parasites was greatest in marginal areas of chronic pneumonia. They were found primarily in groups or nests in the alveoli and smaller bronchioles. Their presence appeared to be only mildly irritating. Secondary bacterial infection was suggested by the focal accumulation of neutrophiles in the alveoli. Edema and hemorrhage were also observed.

Histologically, the lobular distribution of the parasites resulted in a sharp line of demarcation between the normal and affected portions of the lungs. The posterior dorsal border of the lung revealed an organizing chronic pneumonia with septal cell proliferation, neutrophiles, macrophages, smooth muscle hypertrophy, and extensive connective tissue formation. In this cellular area only a few dead or dying adult parasites were found in the bronchioles. Many juvenile parasites were migrating in the organizing tissue. In the vicinity of both juvenile and adult parasites, large multinucleated giant cells were found. Tissue in the areas of chronic pneumonia appeared to be non-functional.
The bronchial lymph nodes were edematous and contained migrating juvenile parasites. Giant cells were present in their vicinity.

The liver revealed cloudy swelling, bile pigments, and mild eosinophilic interstitial hepatitis. In the kidney, lymphatic obstruction, focal interstitial fibrosis, and mild inflammatory changes were noted. Sections of the spleen, the colon, and the prostate gland revealed no significant lesions.

DESCRIPTION OF THE PARASITES

By soaking fixed lung tissue in a solution of 10% glycerin in 70% alcohol, it was possible to dissect out parasite fragments from which the nematodes could be identified. However, because the specimens were previously fixed in 10% formalized saline and stored in 70% alcohol, some distortion of the specimens occurred and therefore some morphological characteristics could not be described.

The parasites are very small filiform nematodes. The females measure 96 to 105 microns in diameter. The males are 37 to 58 microns in diameter. No entire specimen could be isolated to measure their length. However, fragments suggest that these specimens fall into the size range of those described by Whitlock. According to Whitlock, males measure 3.4 to 4.4 mms. and a female measures 10.9 mms. in length.

The anterior end of both the males and females is simple, with four rudimentary lips and several smaller papillae. A buccal cavity is absent. The esophagus is simple. The intestinal tract is pigmented with dark brown to golden granules which are believed to be blood pigments. The female reproductive tract is well developed, beginning just behind the esophagus and extending along the entire length of the body. The uteri appear as two parallel rows containing numerous embryonated eggs which are distinctive both in fresh material and in histologic preparations. These larvae are approximately 175 to 250 microns in length. In some females, infertile eggs could be seen among the embryonated ova. The shell membrane is thin and difficult to demonstrate. The tail of the female quickly tapers to a point. The vulva is located at the posterior end of the female, slightly anterior to the anus. Exact measurements, however, could not be made because of cuticular distortion.

The male is thinner and somewhat smaller than the female. The posterior end of the male is rounded and sharply bent in the shape of a hook. The spicules are paired and slightly unequal in size. The left spicule is slightly longer than the right, the length of the left spicule being 31.5 to 43.0 microns, and that of the right, 30.9 to 38.8 microns. The spicules are broad, thin, and have a sharp, irregular dorsal border with a thickened ridge along the side. They are sharply bent in the middle giving them a sickle shaped appearance. The posterior end appears bluntly pointed and the anterior end presents a distinct knob-like protrusion. The bursa of the male is reduced to 4 or 5 closely grouped papilla-like lobes.

DISCUSSION

The life cycle of Filaroides milksi is unknown at this time. However, the life cycle of Aelurostrongylus falciformis (Schlegel, 1933), a lungworm closely related to the Filaroides milksi, and Filaroides martis (Werner, 1782) is known. These lungworms utilize land snails and slugs as intermediate hosts. Filaroides milksi is morphologically closely related to Aelurostrongylus falciformis and produces similar lung lesions. Filaroides milksi is believed to follow a similar life cycle. Because of the low incidence of Filaroides milksi in dogs, it is believed this parasite is probably widespread in brief sub-clinical infections of wild life. The dog is probably only an accidental host. In this case the patient is believed to have had ample opportunity to become infected either in the Cedar river area of Iowa or on the trips to Minnesota. There is a possibility that transport hosts such as mice may play a role in the transmission of this parasite.

SUMMARY

In September, 1959, a dog having a history of a chronic cough, weakness, and emaciation was necropsied disclosing a chronic bronchopneumonia. Histopath-
therapy and diagnosis. Projects which have been completed are an electrically shielded room containing electronic equipment and surgical apparatus for neuroanatomical studies. High gain preamplifiers have been constructed for a twin beam CRT oscilloscope for use in cardiovascular and neurophysiology experiments. A simplified, ultrasafe cardiac defibrillator is in the final proving stages. An electronic analog computer is currently being used to investigate the feedback regulation problems associated with normal and abnormal hormone function. Considerable research is being done with miniaturized transistor radiotelemetering equipment for remotely monitoring body function in the active animal.

Presently all research is being done in the available facilities present in each department. The State of Iowa and the United States Public Health Service have allocated funds totaling $400,000 for the construction of a Biomedical Electronics laboratory building. This building will be a three floor structure extending from the southwest corner of the Veterinary Medicine Quadrangle. Construction is to begin in the summer of 1960. This building will contain an electronics shop, small animal quarters, a fully shielded and instrumented surgery room, radiotracer laboratories, drug and chemical rooms, and research laboratory space. The program will continue to be supported by research and training grants.

Data to be obtained in the near future will include correlation and evaluation of neuroanatomical and neurophysiological findings on a quantitative basis employing electronic methods. Biological measurements of the aging process and more exact recordings of numerical values in physiology will be forthcoming. After these data have become established one can then gain the benefits of better teaching through more vivid and exact descriptions of biological processes. Even more important, the establishment of normal values will be important as a diagnostic aid, as well as a means of evaluating methods of therapy both in research and practice.

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logic examination revealed the presence of numerous lungworms in the alveoli and bronchioles. These parasites have been identified as Filaroides milksi (Whitlock, 1956).23

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Parke-Davis) three times daily, by oral administration, was initiated. On the following day the temperature was 101.4°F, and the appetite had returned. This therapy was continued for one week. Throughout this period gross examination revealed normal urine. Laboratory examination of the urine on February 12 was negative for occult blood, with a specific gravity of 1.032. On the following day the bowels and appetite were normal and Geriodiet (Atlas Canine Products) was prescribed. The patient's condition remained favorable until released on February 23, 1960.

The tissue examined histologically revealed an infected papilloma containing small cysts in the epithelium. Microscopically, such tumors are composed of numerous papillae, each with a central stalk of delicate vascular connective tissue, which is covered by layers of transitional epithelium.¹ There was also evidence of a concurrent purulent cystitis.

Approximately two months after the operation, the client reported no evidence of hematuria or urinary incontinence in the dog. Recurrence in this case seems improbable because of the favorable postoperative history and the benign nature of the tumor. Recurrence of such papillomas, and a tendency to become malignant have been reported as frequent unfavorable sequelae by Bloom.²

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