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Elaphostrongylus odocoilei n. sp., a New Lungworm in Black Tail Deer (Odocoileus columbianus). Description and Life History.

A. HOBMAIER AND M. HOBMAIER.

From the Hooper Foundation for Medical Research, University of California, Berkeley.

During the examination of about 100 Black Tail deer of the California Coast Range approximately 25 were found to be affected with a lungworm-disease as yet unknown among ruminants. Heavily infested lungs showed macroscopically the picture of an induration. Microscopically this was found due to innumerable small nodules, invisible to the unaided eye. Each tubercle ordinarily enclosed several eggs of a nematode or embryos or both. In no case could adult stages be found, either in the parenchyma or in the blood vessels of the lungs. The regular distribution of the nodules on the other hand indicated that an embolisation of the eggs had taken place. Larvae, of course, were present in large numbers throughout the tubulous system of the lungs.

In a single case 2 adult nemas could be seen twisted around a trabecle of the right proventricle of the heart, thus indicating that the regular localization of the worms was distant from lungs and heart.

Finally, eggs as well as the nematodes themselves could be detected embedded in the connective tissues of the vessels beneath the spine and their nearby branches. They could be extracted even from between the muscles surrounding the body cavity and from along the vessels of the upper part of the hind legs. No traces of the worms, however, or of the eggs were seen on the subcutaneous tissue of the entire body, nor between the muscles of the head, neck, and frontlegs, nor between the mesenterium. Ordinarily they were coiled up in the lymphatic spaces of the connective tissue. Several specimens, however, were secured which had penetrated the wall of larger venous vessels of the hind legs.

The nematodes presented different stages of growth. Sexual larvae have as yet not been found. Worms recovered from the subserosa were usually smaller than those found in remote muscles. Inconspicuous accumulations of hemoglobin or hemosiderin deposited under the peritoneum or small hemorrhages between the connective tissue of the muscles together with the brown colored intestine of the worms were sometimes of assistance in the detection of the minute nematodes.

Both small and large accumulations of eggs also have been encountered in the places named above, in lymphatic spaces as well as in lymphatics. Due to the engorgement with eggs lymphatic vessels often were seen greatly extended just in front of the valves. The vessel was thus shaped like a rosary.

Freshly deposited eggs are spherical, colorless, unsegmented, and covered with a tiny shell. They measure about 40μ in diameter. (Fig. 1.) Their general appearance conforms with that of the genus

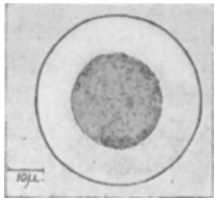

FIG. 1.

Angiostrongylus. It seemed that no embryonization takes place outside the lungs. Eggs found on the places of ovoposition showed regular forms and sizes practically without exception. A part at least of the eggs in the lungs were found to be abnormal in both shape and size. Eggs with diameters varying from normal to 47x78μ, 65x85μ, and even 78x93μ, were found. Most of these irregularly formed eggs, however, were in state of decomposition.

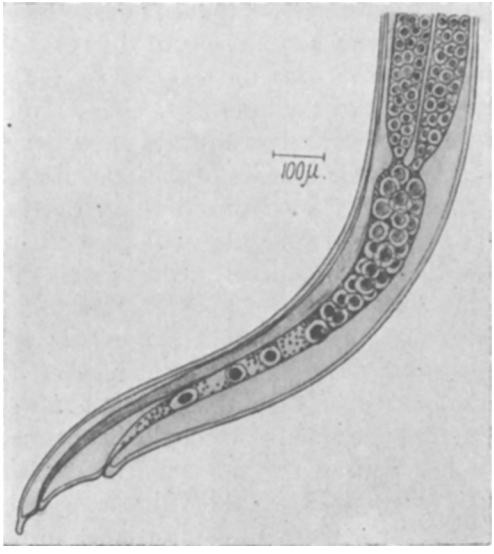

FIG. 2.

The adult nemas are hairlike worms. The intestine of the young specimens appears greenish, in the older ones reddish brown. The region of the oesophagus presents always a clear white color. No striation could be observed. Both ends of the nematode are only slightly attenuated. The mouth opening seems to be surrounded by 6 extremely small papillae. The simple muscular cylindrical oesophagus is 670μ long.

The female (Fig. 2) measures 5.5 cm. in length and 0.165 mm. in width. Its posterior end is slightly curved and ends in a bluntly pointed tail. The anus is situated 40μ above the tip of the tail and the vulva slit 144μ above the anus. Vagina and ovejector are about 1 mm. long. The parallel uteri are double. Eggs are round and unsegmented.

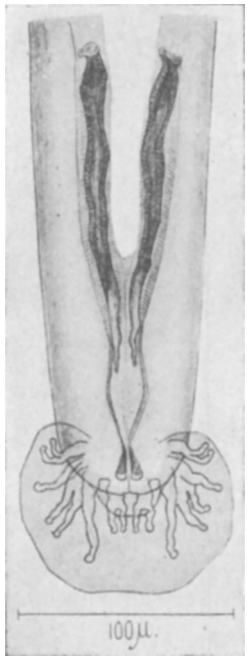

FIG. 3.

The male (Fig. 3) is only 3.5 cm. long and 0.150 mm. wide. The simple undivided bursa is 100μ wide and 84μ long. The short ventral rays lie close together pointing in an anterior direction. The externo lateral ray is well developed. Medio- and anterolateral rays are close together. The externo dorsal ray is long and distinctly separated from the dorsal ray. The latter is divided in 2 stems and each stem in 2 branches. The branches are equal in length, but the

internal branch is more slender than the external branch. The dark brown colored spicules are equal in length, each measuring 144μ. They are alate. Their posterior end is twisted. The entrance of the cloaca is guarded by 2 small chitinous formations, each 20μ long and 10μ wide. The wall of the ductus genitalis nearby is strengthened by 2 small chitinous ribbons. They are of a light brown color and measure 67μ in length.

The first stage larva resembles those of *Muellerius capillaris*. It has their general structure and their characteristic, namely the undulating tail with the tiny dorsal spine. (Fig. 4.) They can be found

FIG. 4.

in the lungs and creeping on the surface of the intestinal mucosa. Therefore they are finally discharged covering usually the surface of the droppings. The same behavior moreover is to be observed on all types of lungworms. Moisture keeps the larvae alive for more than 9 months without development.

Unstained larvae show the outlines, the intestinal tract, the nerve ring, the ductus excretorius, the primary genital cells, and the anus. Staining reveals a far advanced inner structure, which hardly can be described. The principal measurements of the first stage larvae are as follows: Total length 378μ, width in the middle of the body 17μ, anterior end to excretion porus 98μ, length of the oesophagus 166μ, anus to tip of tail 40μ, length of the undulating part of the tail 10μ.

The lifecycle of the parasite involves the intercalation of an intermediate host. Different snails and slugs have been used successfully: *Agriolimax (A. agrestis, linné, A. campestris, Binney)*, and *Helix (Helix aspersa, Mueller* and *Epigramophora arrosa Gld)*. There is little doubt after our experience with *Muellerius capillaris*[1, 2] and *Synthetocaulus rufescens*[3] that some other snails and slugs may be found serving as intermediate hosts. The first stage larva enters the foot of the intermediate host. At the end of the fifth week the infestive stage is built up and has reached maturity. During their residence in the intermediate host they molt twice. They remain ensheathed (Fig. 5). First stage larvae swallowed by the inter-

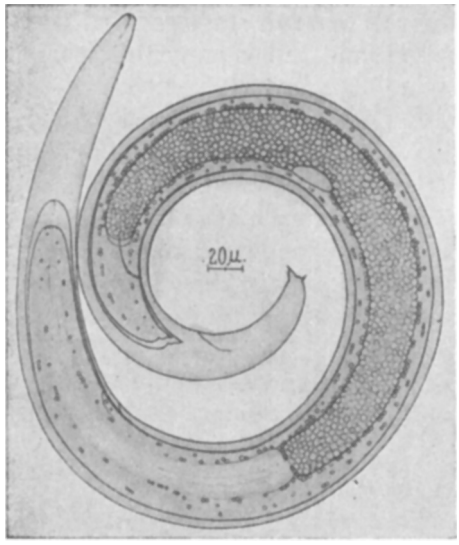

FIG. 5.

mediate host do not undergo further development. The principal measurements of the infective larvae are as follows: total length 624μ, width in the middle of the body 47μ, anterior end to the opening of the excretion porus 100μ, length of the oesophagus 218μ, length of the intestine 310μ, genital cells 168μ behind the anterior end of the intestine, anus to tip of the tail 40μ. The short pointed tail is without the dorsal spine of the first stage larva. The infestive stage larva is thus very similar to that of *Muellarius capillaris*.

A Black Tail deer, raised in captivity and free from lungworms,

[1] Hobmaier, A. and M., *Muenchn. tieraerztl. Wochenschr.*, 1929, **80**, 36.
[2] Hobmaier, A. and M., *Muenchn. tieraerztl. Wochenschr.*, 1930, **81**, 23.
[3] Hobmaier, A. and M., PROC. SOC. EXP. BIOL. AND MED., 1930, **28**, 156.

has been fed with infective larvae raised in *Agriolimax campestris* on April 8, 1933, and on July 7, 1933. The droppings of the deer contained first stage larvae of the lungworm from August 15 until October 10, 1933. Then they disappeared almost entirely. Beginning with December 2, 1933, they reappeared in great numbers. These results indicate that 4 to 5 months must pass after the infection until first stage larvae become discharged.

Miller discovered during the examination of an abnormal specimen of the Scottish Red deer *(Cervus elaphus)* several specimens of a bursate nematode lying on the connective tissue between the *M. latissimus dorsi* and the external intercostal muscles. Later the same nematode was found in 2 animals in a similar localization by Miller and Cameron. The adult stages of that nematode have been described by Cameron[4] and he has named the parasite *Elaphostrongylus cervi,* gen. n. and sp. nov.

The lungworm of *O. columbianus* described above obviously belongs to this newly established genus. Accordingly the name *Elaphostrongylus odocoilei n. sp.* is proposed.

The life history of the parasite as outlined above clearly indicates the close relationship of the lungworm to the lymphatics of the host, as it has been shown previously by the writers in the case of Dictyocaulus[5] and Metastrongylus.[6]

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[4] Cameron, Th. W. M., *J. Helminth.*, 1931, **9**, 213.

[5] Hobmaier, A. and M., *Muenchn. tieraerztl. Wochenschr.*, 1929, **80**, 45.

[6] Hobmaier, A. and M., *Muenchn. tieraerztl. Wochenschr.*, 1929, **80**, 26.