of *Haemonchus*, *Oesophagostomum*, and *Trichostrongylus* in doses as low as 0.1 gram per pound of body weight. Apparently the drug was equally effective whether given in feed or by capsule and whether given with or without a preliminary period of fasting.


In 1929, the writers reported in abstract form the occurrence of multiple adenomata of the large intestine of a cat caused by an apparently new species of *Strongyloides*. This appears to have been the only report of the occurrence of tumors of the epithelial type associated with worms of this genus, the usual pathological changes resulting from parasitism with *Strongyloides* being inflammatory in nature.

Darling (1911) found that sections of the duodenum and jejunum of man heavily parasitized with *Strongyloides stercoralis* showed infiltrations of round and plasma cells in certain areas. Similar infiltrations were seen in the supporting reticulum of Brunner's glands, together with an increased number of polymorphonuclear leucoeytes, both neutrophilic and eosinophilic, associated with the round and plasma cells. In one section this author found a break in the muscularis mucosae and an attenuated downgrowth of epithelial cells from a crypt, at which point a female worm had entered Brunner's gland. This downgrowth of epithelial cells may represent a duct as he suggests, or it may indicate the beginning of a pathological process such as described in this paper. Darling also found inflammatory changes, similar to those occurring in man, in the ileum of monkeys (*Cebus hypoleucus*) infested with *Strongyloides cebus* and in the ant bear (*Nasua nasica panamensis*) infested with *Strongyloides nasua*.

Blacklock and Adler (1922) reported a lymphoid tumor caused by *Strongyloides* occurring in the jejunum of a chimpanzee. This tumor consisted of a core of muscle tissue surrounded by a thick layer of lymphoid cells and was situated beneath the muscularis mucosae. Adult worms were found in the tumor as well as in the adjacent connective tissue and in the mucous membrane. The intestinal wall in this case was three times its normal thickness owing to the large increase in lymphoid tissue in the mucosa and submucosa.

Ware and Ware (1923) report thickening of the intestine of a dog dying from a naturally acquired infestation with *Strongyloides stercoralis*, and Sandground (1926) found similar lesions in experimentally infested dogs; in none of these cases was any evidence of epithelial proliferation or tumor formation observed.

The case of adenomatous tumors in cats associated with *Strongyloides* referred to above (Price and Dikmans, 1929) was found by one of us (G.D.) on April 28, 1927, at Jeanerette, La. The cat was brought to the laboratory for necropsy to determine the cause of death. Upon examination of the large intestine a number of tumor-like lesions were observed, some of them being somewhat hemorrhagic. The entire section of gut was removed, preserved in formalin, and forwarded to the Bureau of Animal Industry for study.

A second case was found in 1930 by Dr. John Wells, West Palm Beach, Fla., in a cat which had been sent to his hospital for treatment. The cat had been suffering from intestinal disturbances for some time and finally died. Upon necropsy the mucosa of the large intestine was found to be studded with small tumorlike masses. The entire section of gut was sent to the Bureau of Animal Industry for diagnosis.

An examination of the nodules in both of these cases showed them to be similar in nature and caused by small nematodes which were found only in the nodules.
These worms belong to the genus *Strongyloides* and appear to be a new species for which the name *Strongyloides tumefaciens* is proposed.

**DESCRIPTION OF THE LESIONS**

The specimens from both cases present a similar appearance. The mucous membrane shows numerous tumor-like elevations which are irregularly distributed over the entire length of the large intestine (Fig. 1, A). These tumors are from 2 to 10 mm in diameter and each shows a small pit or depression at its summit. No evidence of hyperemia or hemorrhage can be detected, but this may be due to the bleaching effect of the formalin in which the tissues have been preserved for a considerable length of time. The nodules and adjacent mucous membrane are covered with a moderate amount of mucus. The wall of the gut appears normal in thickness and the serosa shows no evidence of inflammation. On section the nodules are found to be well encapsulated, more or less spherical in shape, and situated between the muscularis mucosae and muscular coats.

Sections prepared for histological study show considerable desquamation of the superficial epithelium of the mucous membrane and the membrane is covered with mucus. The cells lining the crypts are normal in appearance except for an apparent increase in the number of goblet cells. The submucous connective tissue shows a marked infiltration with leukocytes, both round cells and polymorphonuclears, but only a few eosinophiles are present. The submucosa appears normal except for an occasional circumscribed accumulation of round cells in the region of the nodules.

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*Fig. 1.* Lesions caused by *Strongyloides tumefaciens*, n. sp. A—Gross appearance of a portion of large intestine of cat (Jennette, L. A., case). B—Section through one of the tumors.
these masses being similar to those described and figured by Hung and Höppli (1923) in *Strongyloides* infestation in monkeys. The muscular coat shows a slight round cell infiltration; the serosa appears to be normal.

The tumors are regular in outline due to a well developed connective tissue capsule (Fig. 1, B). They are adenomatous in nature and consist of irregular acini of columnar cells, which are more or less distended with exudate. The parenchymatous portion of the nodule is supported by a delicate stroma of connective tissue which shows a marked infiltration with lymphoid cells. Scattered throughout the stroma and in the lumena of the acini are the adult worms, usually seen in cross section, and in some areas numerous larvae are present. In none of the sections examined were adult worms found outside the nodules.

**DISCUSSION**

The lesions described above appear to be new growths of tissue which have resulted from the presence of the worms. Whether these lesions should be regarded as true adenomata or cases of acquired heterotopia, or the abnormal smearing or displacement of cells with ‘subsequent growth out of place,’ is a matter which is difficult to determine. It is possible that cells of the intestinal mucosa might have become displaced by the penetration of the tissue by the infective larvae and that these cells proliferated in a form resembling an adenoma. Some writers have described heterotopia following trauma of the gut and in these cases the growth was limited to a mass of epithelial cells arranged as a simple, glandular loop. The present writers are of the opinion, however, that to make a distinction between heterotopia of glandular epithelium and adenoma is largely a matter of opinion and of little consequence since the two conditions are so similar and, under certain conditions, practically identical.

**DESCRIPTION OF THE PARASITE**

This description is based upon specimens dissected from the nodules. Unfortunately, it was impossible to obtain complete specimens owing to the brittleness of the formalin-fixed tissue. The total length of the worm as given below is based upon a specimen complete except for a small portion of the anterior end, the probable length of the missing portion being obtained from another specimen.

*Strongyloides tumefaciens*, new species

*Description.*—Parasitic female about 5 mm long by 109 μ wide. Cuticle finely striated transversely, the striae being indistinct except under very high magnification. Head 23 μ wide; oral opening oval and surrounded by the usual number of small papillae; buccal capsule very shallow and rudimentary. Esophagus slender, 0.75 to 1 mm long by 63 μ in diameter at the widest portion. Nerve ring situated about 200 μ from the anterior end of body. Vulva inconspicuous, situated about 1.6 mm from posterior extremity. Uterus containing an immature egg in each branch; ovaries simple and recurved, forming U-shaped bands. Tail short and pointed; anus situated 106 to 114 μ from the tip of the tail. Egg, as found in material dissected from the nodules, 114 to 124 μ long by 62 to 68 μ wide, containing a fully developed larva. Rhabditiform larvae found in the tissue are about 200 μ long by 10 μ wide.

*Specimens.*—U. S. N. M. Helm. Coll. No. 28190 (type); 28191 (paratypes), and 48857.

*Strongyloides tumefaciens* falls more nearly within the range of measurements given for *S. papillosus* of ruminants than with those given for the other species of the genus. It differs from this form, however, in that it is more robust, the tail is
pointed instead of bluntly rounded, and the characteristic twisting of the ovaries is absent. The only other species which approaches *S. tumefaciens* in size is *S. westeri* of the horse, this worm being from 8 to 9 mm long by 80 to 95 μ wide and in other respects resembling *S. papillosus*.

In proposing *S. tumefaciens* as a new species, the writers realize that the morphological characters are not outstanding. However, in view of the fact that the genus is composed of species which are more or less homogeneous and lack such well defined differential characters as are present in many other genera, the writers feel that the large size of this form, its location, and the type of lesion produced are characters that justify its recognition as a distinct species.

REFERENCES


PRICE, EMMEET W., and DIKMANS, G. 1929. Multiple adenomata of the large intestine of a cat caused by a species of *Strongyloides*. Jour. Parasitol. 16(2): 104.


**Hot-water-formalin treatment (at 110° to 111° F.) of field-grown and of forced narcissus bulbs infected with the bulb or stem nematode, *Ditylenchus dipsaci*.** B. G. CHITWOOD, Bureau of Plant Industry, U. S. Department of Agriculture; F. A. HAASIS, Department of Plant Pathology, Cornell University; and F. S. BLANTON, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

**INTRODUCTION**

Hot-water treatment of narcissus bulbs for the control of the bulb or stem nematode, *Ditylenchus dipsaci* (Kühn) Filipjev, was introduced by Ramsbottom (1918a, b) and Van Slogteren (1919). In order to protect narcissus planting in the United States, imported and domestic bulbs have been subjected to this hot-water treatment or modifications of it. Originally treatment consisted of the exposure of bulbs to water at 110° F. for 3 to 4 hours. Failure of such treatments (Chitwood and Blanton, 1941) to control the disease adequately was responsible for continued investigations to improve this treatment, by the authors and other members of the Bureau of Plant Industry and the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture. These investigations have led to the hot-water-formalin treatment as here discussed. In this treatment water containing 0.5 per cent formalin (1 part commercial formalin to 199 parts water) is used. Chitwood and Blanton (1941) reported that a 4-hour hot-water-formalin treatment of such concentration, at 110° to 111° F. is highly effective for the control of *D. dipsaci* in narcissus bulbs.

The present paper contains additional and more conclusive data on hot-water-formalin treatments of 3, 3½, and 4 hours' duration at 110° to 111° F. Data con-

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