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Gastro-Intestinal and Abdominal Helminths of White-Tailed Deer (Odocoileus virginianus) in Southern Illinois

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GASTRO-INTESTINAL AND ABDOMINAL HELMINTHS OF WHITE-TAILED DEER (ODOCOILEUS VIRGINIANUS) IN SOUTHERN ILLINOIS

(TITLE)

BY

Thomas W. Cook

THESIS

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I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
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WHITE-TAILED DEER (ODOCOILEUS VIRGINIANUS)

IN SOUTHERN ILLINOIS

Presented by

Thomas W. Cook

a candidate for the degree of Master of Science

and hereby certify that in their opinion it is acceptable.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Gastro-Intestinal and Abdominal Helminths of White-Tailed Deer (*Odocoileus virginianus*) in Southern Illinois

Abstract: In November and December 1971, forty deer from five southern Illinois counties were examined by necropsy for gastro-intestinal and abdominal helminths. Eight species of gastro-intestinal nematodes were found: *Gongylonema pulchrum*, *Spiculopteroides odocoilei*, *Ostertagia mossi*, *Haemonchus contortus*, *Cooperia sp.*, *Capillaria sp.*, *Trichuris ovis* and *Oesophagostomum venulosum*. *Setaria yehi*, a filiariad nematode, was found in the abdominal cavity. *Moniezia benedeni* was the only cestode found. No trematodes were recovered.

Parasitism of white-tailed deer (*Odocoileus virginianus*) has been extensively studied throughout its range. Only one study of protozoan and helminth infections using fecal samples has been carried out in Illinois (Mugwanya, 1971). This is a report of the gastro-intestinal and abdominal helminths recovered by necropsy of white-tailed deer from five southern Illinois counties.

MATERIALS AND METHODS

White-tailed deer were collected by hunters in Pope, Massac, Hardin, Saline, and Johnson counties during November and December 1971. The deer were aged by tooth development and wear (Severinghaus, 1949), sexed and weighed at check stations in each county.

The entire gastro-intestinal tract was removed and divided into eight sections for study: esophagus, rumen, reticulum, omasum, abomasum, small intestine, caecum, and large intestine.

Each section was cut open, scraped, and flushed with water into large buckets and then poured into one-gallon jars. The flushed material was allowed to decant and the supernate poured off and discarded. The concentrate remaining was preserved in 10% formalin. Mucosal linings of the eight sections were also preserved in 10% formalin.

The concentrate from each region of the gut was poured into a shallow black pan and scanned for helminths using an 8x - 45x dissecting scope. Nematodes were preserved in vials of 10% formalin and later mounted on slides in lacto-phenol for identification. Cestodes were fixed in AFA.

Nematodes were identified using keys from Skryabin et al., (1954), Yamaguti (1961), Becklund and Walker (1967, 1968, 1969), and Levine (1968). Cestodes were identified using keys from Wardle and McLeod (1952) and Yamaguti (1959).

RESULTS

Forty deer from the five southern Illinois counties were examined for gastro-intestinal and abdominal cavity helminths. Age distribution for the deer were: ½ year = 11, 1½ year = 15, and 2½ year and older = 13. One deer could not be aged.

Eight species of gastro-intestinal nematodes, one species of abdominal nematode, and one species of cestode were found (Table 1). The incidence varied greatly; only four species were found in over 20% of the deer, but Spiculopteroides odocoilei (=Ostertagia odocoilei) was present in 67.5%. The average number of helminths per deer was less

TABLE 1.--Gastro-intestinal and abdominal helminths recovered from 40 deer in five counties in southern Illinois.

Species	Location	Incidence of Parasitism		Parasites per Deer		Sex Ratio
		No. infected / No. examined	Percent	Mean ± SD	Range	(M : F)
NEMATODA						
Spiculopteroides odocoilei	Abomasum	27/40	67.5	29.9±13.5	1-238	1:1.14
Gongylonema pulchrum	Esophagus	18/39	46.3	3.9± 5.2	1- 19	1:1.73
Ostertagia mossi	Abomasum	14/40	35.0	7.1±10.0	1- 38	1:1.92
Haemonchus contortus	Abomasum	9/40	22.4	3.2± 2.0	1- 13	1:1.07
Setaria yehi	Abdominal cavity	7/40	17.5	2.1± 2.6	1- 8	1:1.00
Cooperia sp.	Small Intestine	2/40	5.0	1.0	---	----
Capillaria sp.	Small Intestine	2/40	5.0	2.0	---	----
Trichuris ovis	Large Intestine	2/40	5.0	1.5	1- 2	----
Oesophagostomum venulosum	Caecum	1/40	2.5	1.0	---	----
CESTODA						
Moniezia benedeni	Small Intestine	6/40	15.0	1.3± 2.4	1- 3	----

variable. Less than five parasites per deer were recovered except for Ostertagia mossi (7.1) and S. odocoilei (29.9). The largest number of any one helminth found in a deer was also S. odocoilei; an adult female had 238 in the abomasum.

S. odocoilei outnumbered O. mossi and Haemonchus contortus by 8 to 1 and 27 to 1 respectively, in the trichostrongyle complex inhabiting the abomasum. S. odocoilei was the only trichostrongyle present in six deer. Two deer had only H. contortus present. No deer had only O. mossi present, it was always found with S. odocoilei. Four deer had all three present.

The incidence of parasitism was related to the age of the deer in several instances (Table 2).

Gongylonema pulchrum showed a significantly higher level of incidence in yearlings and 2½ year and older deer. Setaria yehi (=Setaria cervi, see Bucklund and Walker, 1970), Cooperia sp., Trichuris ovis and Moniezia benedeni showed significant decreases in incidence in yearlings and older deer.

Measurements were also made as an aid to identification for five species of nematodes (Tables 3 and 4). The results closely agreed with descriptions in the keys cited earlier.

DISCUSSION

White-tailed deer of southern Illinois were found to harbor ten species of helminths. Only Samuel and Trainer (1969) with eleven species in Wisconsin deer have found more; others have reported fewer: Samuel and Beaudoin (1966) and Beaudoin, et al. (1970) found eight in Pennsylvania deer, Dinaburg in Florida (1939) and Samuel in Texas (1969) found six, and Boddiker and Hugghins (1970) found only three in deer of South Dakota.

TABLE 2.--Gastro-intestinal and abdominal helminths infecting deer by age group. All figures are in percent.

Species	Deer Age in Years			All Deer
	½	1½	2½+	
Spiculopteroides odocoilei	63	75	69.2	67.5
Gongylonema pulchrum	18.2*	46.5	69.2**	46.3
Ostertagia mossi	27.3	40	38.4	35
Haemonchus contortus	27.3	20	23	22.4
Setaria yehi	36.4**	13.3	7 *	17.5
Moniezia benedeni	36.4**	6.7*	7 *	15
Cooperia sp.	18.2**	0 *	0 *	5
Capillaria sp.	0 *	6.7	7	5
Trichuris ovis	18.2**	0 *	0 *	5
Oesophagostomum venulosum	0	6.7**	0	2.5

* = significantly less than average
** = significantly more than average (p=95%)

TABLE 3.--Measurements (mm) of *Spiculopteroides odocoilei* and *Ostertagia mossi* recovered from white-tailed deer in southern Illinois.

Species	n*	Sex	Length			Width			Eso. Length			Spic. or Ovej. Length		
			Mean	Range	SD	Mean	Range	SD	Mean	Range	SD	Mean	Range	SD
S. odocoilei	20	♂	7.2	6.0- 8.3	1.50	.122	.108-.135	.017	.562	.540-.590	.018	.161	.153-.170	.014
	20	♀	8.2	7.7-10.6	1.32	.126	.108-.152	.013	.601	.552-.630	.022	.224	.180-.252	.020
O. mossi	20	♂	8.2	6.9- 9.1	1.49	.109	.090-.117	.012	.730	.666-.792	.029	.194	.189-.225	.002
	20	♀	10.2	8.6-14.3	1.89	.103	.090-.130	.013	.760	.620-.860	.015	.320	.270-.430	.012

*Abbreviations used: n = number measured, SD = Standard Deviation, Eso. = Esophagus, Spic. = Spicules, Ovej. = Ovejecto

TABLE 4.--Measurements (mm) of *Gongylonema pulchrum*, *Haemonchus contortus*, and *Setaria yehi* recovered from white-tailed deer in southern Illinois.

Species	Number Measured	Sex	Length		Width	
			Mean	Range	Mean	Range
Gongylonema pulchrum	10	♂	28.4	25-35	0.224	0.200-0.235
	10	♀	78.6	65-94	0.341	0.270-0.375
Haemonchus contortus	10	♂	15.2	14-17	0.263	0.262-0.275
	10	♀	23.3	20-26	0.458	0.300-0.540
Setaria yehi	5	♂	41.0	38-49	0.324	0.300-0.360
	5	♀	83.2	65-98	0.575	0.410-0.625
	10	micro.*	0.275	.260-.290	0.007	-----
			0.289**	.272-.315		

*micro. = microfiliaria
**measurement of sheath

The helminths observed during this survey can be divided into three groups. The first is the host specific nematodes Spiculopteroides odocoilei and Ostertagia mossi. S. odocoilei incidence has ranged from 35% (Dinaburg, 1939) to as high as 98% (Samuel, 1969). O. mossi is similarly widespread and has been found in as many as 68% of the deer (Samuel, 1969).

The second group of helminths infect ruminants in general: Gongylonema pulchrum, Haemonchus contortus, Setaria yehi, and Moniezia benedeni.

Gongylonema pulchrum, a spuiroid nematode, has been reported with increasing frequency in recent years. Samuel and Beaudoin (1966), who reported an incidence of 65%, believe it was simply overlooked in older surveys despite its ease of recovery. This contention is supported by the 46% of the deer infected in this survey. Prestwood, et al. (1970) found 457 of 788 (57.9%) deer infected in thirteen southeastern states. This nematode was found in significantly greater numbers in older deer in Illinois. According to Beaudoin, et al. (1970) their indirect life history and lengthy sexual development contributes to a greater incidence in older deer.

Haemonchus contortus, which along with S. odocoilei and O. mossi make up the trichostrongyle complex of the abomasum, is also a common parasite of deer. The incidence in southern Illinois deer (22.4%) however, is somewhat lower than other surveys: Samuel and Trainer (1969) found 31% incidence, Dinaburg (1939) found 37.5%, Samuel (1969) and Emerson (1969) found 88 and 90% respectively.

Setaria yehi was found in 17% of the southern Illinois deer examined; this is in contrast to other reports of 4% of 176 deer (Samuel, 1969), 1% (Boddiker and Huggins, 1969) and an even lower 0.83% (Samuel and

Trainer, 1969). An explanation of the high percentage in southern Illinois deer is lacking, since little is known about the life history of this filiariad. One factor may be that other workers have placed greater attention on extracting helminths from within the digestive tract rather than searching for S. yehi that may be clinging to the outside of the tract.

Moniezia benedeni was the only cestode encountered in this survey. Fifteen percent of the southern Illinois deer were infected, which is a higher incidence than any previous report; such as 2% (Boddiker and Huggins, 1970), 2-4% (Samuel and Trainer, 1969) and 13% (Mugwanya, 1971). Moniezia, however, is a common tapeworm in the southern Illinois area. Mansfield's (1958) survey of eight southern Illinois counties showed that 31% of 131 farms had feeder calves discharging Moniezia sp. eggs into the feces. Assuming the orbatid mites needed for the life cycle (Cheng, 1964) are present, it is not difficult to account for Moniezia's prevalence.

The third group of nematodes (Capillaria sp., Cooperia sp., Trichuris ovis, and Oesophagostomum venulosum) favor livestock as hosts, but will infect deer if the opportunity for transmission exists. The low incidence (5%) of Capillaria sp. in southern Illinois deer agrees with other surveys; such as 2% (Dinaburg, 1939), 4% (Samuel and Trainer, 1969), 3.2% (Mugwanya, 1971), and 12% (Samuel and Beaudoin, 1966).

T. ovis was found in slightly higher incidence (5%) than other surveys: 3.3% (Samuel and Beaudoin, 1966), 4% (Samuel and Trainer, 1969), and 4.3% (Mugwanya, 1971).

Cooperia sp. is rare in white-tailed deer; it has been reported only once previously (Dikmans, 1934).

Oesophagostomum venulosum is normally a sheep parasite (Levine, 1968) and heavy deer infections are thought to occur only when deer range over areas heavily grazed by sheep (Whitlock, 1939). Reports of incidence vary widely. Olsen and Fenstermacher (1943) reported 0.13% (for Oesophagostomum sp.), while 2-24% incidence was reported by Beaudoin et al. (1970).

The variety of helminths recovered in this survey was, in part, due to the physiography of the southern Illinois region, which is an extension of the Ozark highlands and is the most extensively forested area of the state (King and Winters, 1952). The area has large stretches of forest interspaced with small farms and cultivated areas which result in contact of the deer with domestic livestock. Deer are, therefore, introduced to ruminant parasites of a more general host specificity. Experimental cross-infections have been reported between livestock and deer (Longhurst and Douglas, 1953; Samuel, 1968); the same phenomenon probably occurs in the natural environment.

Although white-tailed deer in southern Illinois harbor a large number of helminth species, the actual number of these parasites is rather or relatively low; the average deer carried no more than 40 helminths for the entire digestive tract. The low parasite burden may be attributed to several factors.

The southern Illinois counties sampled are not overpopulated with deer (Andrews and Calhoun, 1968). A herd that is well dispersed could be expected to have fewer and less intense parasitic infections than a herd inhabiting an overpopulated and restricted environment, since the deer herd has fewer chances to pick up and transmit parasitic infections (Dogiel, 1966).

Another factor influencing low parasite load in deer may be the lowering of the levels of parasitism in livestock. Surveys of helminth egg counts in southern Illinois cattle done in 1956, 1961, and 1964 by Mansfield and Meyerholz (1968) indicated that the eggs per gram of feces decreased from 805 to 457 from 1956 to 1964. Considering the contact between wild deer and domestic cattle this could be significant.

Inhibitory reactions among parasites have been noted by Turner et al. (1962) and Samuel (1969). Therefore, inhibitory reactions taking place between nematodes in the abomasum may be a factor influencing the low numbers of Ostertagia mossi and Haemonchus contortus recovered. In this study, Spiculopteroides odocoilei was 8 times and 27 times as abundant as O. mossi and H. contortus respectively. It was noted that the largest number of H. contortus recovered (13) was recovered from a deer where S. odocoilei was absent. Only one deer had O. mossi outnumbering S. odocoilei (20 vs. 12) in the 14 abomasums so infected.

It would be hard to characterize any of the helminths considered in the present study as pathogens. The nematodes Gongylonema pulchrum, Capillaria, Trichuris ovis, and Setaria yehi are regarded as non-pathogenic to their host (Levine, 1968) and Cheng (1964) considers Moniezia benedeni a non-pathogenic cestode.

S. odocoilei, O. mossi, and H. contortus are potentially pathogenic since they are blood sucking parasites. Only the effect of H. contortus is known. In large numbers (>1000) they produce anemia, edema, emaciation, and general digestive disturbances (Levine, 1968). Infections of over 1000 sexually mature Haemonchus cause haemonchosis in deer and contribute to older fawn mortality (Samuel, 1969). The maximum number found in any Illinois deer was thirteen and there was no sign of pathological damage to the abomasal mucosa.

Cooperia and Oesophagostomum venulosum are also quite pathogenic to their hosts in heavy infections. Cooperia causes diarrhea, anoxrhea, and progressive emaciation in cattle (Levine, 1968). O. venulosum causes large nodules on the large intestine and caecum as a result of the host's immune reaction (Monnig, 1934). The host loses weight and becomes weak through diarrhea and loss of blood. No pathogenic disturbance was noted in the only Illinois deer infected with a single O. venulosum.

Helminths confirmed by this study and Mugwanya's earlier (1971) fecal sample study are: Spiculopteroides odocoilei and/or Ostertagia mossi, Oesophagostomum venulosum, Capillaria sp., Trichuris ovis, and Moniezia benedeni. Gongylonema pulchrum, and Haemonchus contortus were not reported by Mugwanya. Mugwanya listed Skyabnema sp., Strongyloides sp., and Anoplocephala sp. which were not found in this study. The fact that her sample was nearly three times larger (116 deer) may account for these unconfirmed species. Neither study found any evidence of Trichstrongylus axei or Nematodirius. It would seem that the two species have not established themselves in the deer population of southern Illinois.

As Samuel and Beaudoin (1966) pointed out, both methods of survey have their advantages and disadvantages. Autopsy will reveal most helminths and can differentiate nematodes of the abomasal complex easier. Fecal samples are considerably more accurate for the detection of Capillaria and Trichuris.

LITERATURE CITED

Andrews, R. D. and J. C. Calhoun. 1968. Characteristics of a White-Tailed Deer Population in Illinois. Ill. Dept. of Consv. Game Management Report No. 1.

Beaudoin, R. L., W. M. Samuel, and C. P. A. Strome. 1970. Comparative Study of the Parasites of Populations of White-Tailed Deer. J. of Wildlife Diseases. 6: 56-63.

Becklund, W. W. and M. L. Walker. 1967. Redescriptions of the nematodes Ostertagia bisonis Chapin, 1925, of cattle and wild ruminants, and Ostertagia mossi Dikmans, 1931, of deer. J. Parasit. 53: 1273-1280.

_____. 1968. Ostertagia dikmansi sp. n. (Nematoda: Trichostrongylidae) from deer, Odocoileus virginianus, with a key to the species of medium stomach worms of Odocoileus in North America. J. Parasit. 54: 441-444.

_____. 1969. Taxonomy, hosts, and geographic distribution of the Setaria (Nematoda: Filariodea) in the United States and Canada. J. Parasit. 55: 359-368.

_____. 1970. Checklist of the Internal and External Parasites of Deer, Odocoileus virginianus and Odocoileus hemionus in the United States and Canada. U.S. Dept. of Ag. Special publication No. 1. 45 p.

Boddicker, M. L. and E. J. Hugghins. 1969. Helminths of big game mammals in South Dakota. J. Parasit. 55: 1067-1074.

Cheng, T. C. 1964. The Biology of Animal Parasites. W. B. Saunders Co. Philadelphia. 727 p.

Dinaburg, A. G. 1939. Helminth parasites collected from deer, Odocoileus virginianus, in Florida. Proc. Helm. Soc. Wash. 6: 102-104.

Dogiel, V. A. 1966. General Parasitology. Academic Press, N. Y. 516 pp.

King, D. B. and R. K. Winters. 1952. Forest Resources and Industries of Illinois. Bulletin 562. U of I Agri. Exper. Station. Urbana, Ill.

Levine, N. D. 1968. Nematode Parasites of Domestic Animals and of Man. Burgess Publishing Co. Mineapolis, Minn. 600 pp.

Longhurst, W. M. and J. R. Douglas. 1953. Parasite interrelationships of domestic sheep and Columbian black-tailed deer. Tr. 18. North Am. Wildl. Conf., p. 168-188.

Mansfield, M. E. 1958. A Survey of Gastro-Intestinal Nematodes in Feeder Calves in Southern Illinois. J. Am. Vet. Med. Ass. 132: 99-100.

_____ and G. W. Meyerholz. 1968. Gastrointestinal Parasitism in Feeder Calves of Southern Illinois. Am. J. Vet. Res. 29: 1472-1482.

Monnig, H. O. 1934. Veterinary Helminthology and Entomology. Williams and Wilkens, Baltimore. 402 pp.

Mugwanya, S. M. 1971. Protozoan and Helminth Parasites of White-Tailed Deer (Odocoileus virginianus) in Southern Illinois. M. S. Thesis. Eastern Illinois University. 40 p.

Prestwood, A. K., J. F. Smith, and W. E. Mahan. 1970. Geographic Distribution of Gongylonema pulchrum, Gongylonema verrucosum, and Paramphistomum liorchis in White-Tailed Deer of the Southeastern United States. J. Parasit. 56: 123-127.

Samuel, W. M. 1968. Endoparasites of Domestic Ruminants and White-Tailed Deer. Tr. 33 North Am. Wildl. Conf., p. 364-371.

_____. 1969. Parasites of White-Tailed Deer (Odocoileus virginianus) in South Texas. Ph.D. Thesis. University of Wisconsin. 196 pp.

_____ and R. L. Beaudoin. 1966. Evaluation of two survey methods for detection of helminth infections in white-tailed deer (Odocoileus virginianus). Bull. Wildl. Dis. As. 2: 100-107.

_____ and D. O. Trainer. 1969. A technique for survey of some helminth and protozoan infections of white-tailed deer. J. Wildl. Mgt. 33: 888-894.

Severinghaus, C. W. 1949. Tooth Development and wear as criteria of age in white-tailed deer. J. Wildl. Mgt. 13: 195-216.

Skryabin, K. I., N. P. Shikhobalova, and R. S. Schulz. 1954. Essentials of Nematodology. Trichostrongylids of Animals and Man. Academy of Sciences of the USSR, Moscow. 704 pp.

Turner, J. H., K. W. Kates, and G. I. Wilson. 1962. The interaction of concurrent infections of the abomasal nematodes Haemonchus contortus, Ostertagia circumcincta, and Trichostrongylus axei in lambs. Proc. Helm. Soc. Washington. 29: 210-216.

Wardle, R. A. and J. A. McLeod. 1952. The Zoology of Tapeworms. The University of Minnesota Press, Minneapolis. 780 p.

Whitlock, S. C. 1939. The prevalence of disease and parasites in white-tail deer. Tr. 4 North Am. Wildl. Conf. p. 244-249.

Yamaguti, S. 1959. Systema Helmenthum. Vol. II The Cestodes of Vertebrates. Interscience Publishers, New York. 860 pp.

_____. 1961. Systema Helmenthus. Vol. III The Nematodes of Vertebrates. Interscience Publishers, New York. 1261 pp.

LITERATURE REVIEW

A great deal of literature is available on the gastro-intestinal and abdominal helminths of the white-tailed deer (Odocoileus virginianus). It is the most common and popular big game available. As such, it is important to learn of and recognize diseases that may affect the well-being of the deer population. Many of the parasites that infect O. virginianus also infect other domestic ruminants such as sheep and cattle. Wild deer may serve as reservoir hosts.

The following literature review is presented in tabular form. In the table one can find the species of helminth, its anatomical location, incidence, type of report and geographical location, and the author of the report.

Gastro-Intestinal and Abdominal Helminths reported from White-Tailed Deer in the United States and Canada.

Helminths	Location	Incidence (%)	Type of Report and Geographical Location	Author
NEMATODES				
Gongylonema pulchrum	Esophagus	-	case rept.* N. Carolina	Dikmans and Luckner, 1935
		-	" "	Ruff, 1938
				Schilling, 1938
		-	Gen. Rev.	Anderson, 1962a
		-	" "	Anderson, 1962b
		65	case rept., Penn.	Samuel and Beaudoin, 1966
		-	Gen. Rev.	Samuel, 1968
		0.57	case rept., Tex.	Samuel, 1969
		H.	case rept., Tex.	Emerson, 1969
		46-70	case rept., Penn.	Beaudoin, Samuel, and Strome, 1970
		92	case rept., Ala.	Prestwood, Smith, and Mahan, 1970
		86	case rept., Ark.	
		69	case rept., Fla.	
		58	case rept., Ga.	
		62	case rept., Ky., W. Va.	
		59	case rept., La.	
		75	case rept., Md.	
		82	case rept., Miss., Tenn.	
		87	case rept., N. C., Va.	
		46	case rept., S. C.	
G. verrucosum	Esophagus Rumen	-	case rept., N. C.	Dikmans and Luckner, 1935
		1.3	case rept., Fla.	Dinaburg, 1939

*Abbreviations used: case rept. - case report or survey; Gen. rev. - mentioned in general review of diseases; sp. rev. - review of that specific disease or a specific parasite description; H. - heavy infestation.

Helminths	Location	Incidence (%)	Type of Report and Geographical Location	Author
G. verrucosum	Esophagus Rumen	-	Gen. rev.	Anderson, 1962a
		-	Gen. rev.	Anderson, 1962b
		21	case rept., Ala.	Prestwood, Smith, and Mahan, 1970
		42	case rept., Fla.	
		38	case rept., Ga.	
		33	case rept., La.	Prestwood, et al., 1970
		4.5	case rept., Miss.	
		6.5	case rept., N. C.	
		16	case rept., S. C.	
Haemonchus contortus	Abomasum	37.5	case rept., Fla.	Dinaburg, 1939
		-	sp. rev., Mich.	Whitlock, 1939
		-	sp. rev.	Hayes, Greer, and Shotts, 1958
		-	Gen. rev.	Anderson, 1962b
		-	case rept., Wisc.	Dahlburg and Guettinger, 1956
		2.7	case rept., Penn.	Samuel and Beaudoin, 1966
		-	case rept., Tex.	Robinson, Kuttler, Thomas, and Marburger, 1967
		-	sp. rev.	Samuel, 1968
		88	case rept., Tex.	Samuel, 1969
		90	case rept., Tex.	Emerson, 1969
		31	case rept., Wisc.	Samuel and Trainer, 1969
H. similis	Abomasum	2.9	case rept., Fla.	Dinaburg, 1939
		-	Gen. rev.	Anderson, 1962b
Obeliscoides cuniculi	Abomasum	20	case rept., Ark.	Maples and Jordan, 1966
		-	case rept., Ga.	
Ostertagia circumcincta	Abomasum	-	case rept., N. Y.	Dikmans, 1934

Helminths	Location	Incidence (%)	Type of Report and Geographical Location	Author
Ostertagia spp.	Abomasum	77	case rept., Wisc.	Samuel and Trainer, 1969
		72	case rept., Penn.	Beaudoin, Samuel, and Strome, 1970
		5.2	case rept., Ill.	Mugwanya, 1971
Ostertagia dikmansi	Abomasum	-	case rept., Ga.	Becklund and Walker, 1968
		-	sp. rev., La.	
		-	Ontario	
		-	Penn.	
		-	case rept., Wisc.	Samuel and Trainer, 1969
		-	case rept., Penn.	Beaudoin, et al., 1970
Ostertagia mossi	Abomasum	-	case rept., Penn.	Dikmans, 1931
		-	case rept., Penn.	Samuel and Beaudoin, 1966
		68	case rept., Tex.	Samuel, 1969
		-	case rept., Wisc.	Samuel and Trainer, 1969
		-	case rept., Penn.	Beaudoin, et al., 1970
Spiculopteroides odocoilei (=Ostertagia odocoilei)	Abomasum	-	case rept., Penn.	Dikmans, 1931
		-	case rept., La.	Dikmans, 1932
		-	case rept., N. Y.	Dikmans, 1934
		35	case rept., Fla.	Dinaburg, 1939
		-	case rept., Penn.	Samuel and Beaudoin, 1966
		3	case rept., S. D.	Boddicker and Hugghins, 1969
		98	case rept., Tex.	Samuel, 1969
		-	case rept., Wisc.	Samuel and Trainer, 1969
		-	case rept., Penn.	Beaudoin, et al., 1970
Ostertagia ostertagia	Abomasum	-	case rept., Wisc.	Dahlburg and Guettinger, 1956

Helminths	Location	Incidence (%)	Type of Report and Geographical Location	Author
Trichostrongyle complex (includes O. dikmansi, O. mossi, S. odocoilei, and H. contortus)	Abomasum	63	case rept., Penn.	Samuel and Beaudoin, 1966
		18-77	case rept., Wisc.	Samuel and Trainer, 1969
		72	case rept., Penn.	Beaudoin, et al., 1970
Trichostrongylus axei	Abomasum	70	case rept., Tex.	Samuel and Trainer, 1968
		70	case rept., Tex.	Samuel, 1969
		50	case rept., Wisc.	Samuel and Trainer, 1969
Capillaria sp.	Small Intestine	2	case rept., Fla.	Dinaburg, 1939
		12	case rept., Penn.	Samuel and Beaudoin, 1966
		4	case rept., Wisc.	Samuel and Trainer, 1969
		2-21	case rept., Penn.	Beaudoin, et al., 1970
		3.2	case rept., Ill.	Mugwanya, 1971
Cooperia sp.	Small Intestine	-	case rept., N. Y.	Dikmans, 1934
		-	Gen. rev.	Samuel, 1968
Monodontus louisianesis	Small Intestine	-	sp. rev., La.	Chitwood and Jordan, 1965
Nematodirus filicollis	Small Intestine	-	case rept., Mich.	Whitlock, 1939
		9.2	case rept., Penn.	Samuel and Beaudoin, 1966
		10-29	case rept., Wisc.	Samuel and Trainer, 1969
		2-15	case rept., Penn.	Beaudoin, et al., 1970
Nematodirus sp.	Small Intestine	-	case rept., Wisc.	Dahlburg and Guettinger, 1956
Strongyloides sp.	Small Intestine	-	case rept., Tex.	Glazener and Knowlton, 1967
		1.7	case rept., Ill.	Mugwanya, 1971

Helminths	Location	Incidence (%)	Type of Report and Geographical Location	Author
Trichostrongylus sp.	Small Intestine	-	case rept., Tex.	Glazener and Knowlton, 1967
Chabertina ovina	Small Intestine	-	case rept., N. Y.	Dikmans, 1934
		-	Gen. rev.	Anderson, 1962b
Eucyanthostomum longesubulatum	Large Intestine	3.9	case rept., Fla.	Dinaburg, 1939
Oesophagostomum cervi	Large Intestine	40	case rept., Ala.	Payne, Maples, and Smith, 1967
		45	case rept., La.	
		30	case rept., Md.	
		40	case rept., Miss.	
		12.5	case rept., N. C.	
		10	case rept., Va.	
		40	case rept., W. Va.	
O. columbiaum	Large Intestine	10	case rept., Tex.	Emerson, 1969
O. venulosum	Large Intestine	-	case rept., N. C.	Ruff, 1938 and Schilling, 1938
		-	case rept., Mich.	Whitlock, 1939
		15	case rept., Penn.	Samuel and Beaudoin, 1966
		-	case rept., Ala.	Payne, Maples, and Smith, 1967
		-	case rept., La.	
		-	case rept., Md.	
		-	case rept., Miss.	
		-	case rept., N. C.	
		-	case rept., Va.	
		-	case rept., W. Va.	
		2-24	case rept., Penn.	Beaudoin, *et al.*, 1970

Helminths	Location	Incidence (%)	Type of Report and Geographical Location	Author
Oesophagostomum sp.	Large Intestine	0.13	case rept., Minn.	Olsen and Fenstermacher, 1943
		7	case rept., Wisc.	Samuel and Trainer, 1969
		12	case rept., Ill.	Mugwanya, 1971
Skrjabinema parva	Large Intestine	-	case rept., N. Y.	Dikmans, 1942
		1- 7	case rept., Wisc.	Samuel and Trainer, 1969
Skrjabinema sp.	Large Intestine	2.6	case rept., Ill.	Mugwanya, 1971
Trichuris ovis	Large Intestine and Caecum	3.3	case rept., Penn.	Samuel and Beaudoin, 1966
		4	case rept., Wisc.	Samuel and Trainer, 1969
		4.3	case rept., Ill.	Mugwanya, 1971
Trichuris sp.	Large Intestine and Caecum	0.3	case rept., Fla.	Dinaburg, 1939
		-	case rept., N. Y.	Cheatum, 1952
Setaria cervi*	Abdominal cavity	-	case rept., N. J.	Mangold, 1958
		1	case rept., S. D.	Boddiker and Huggins, 1969
Setaria yehi	Abdominal cavity	-	case rept., sp. rev., Ga., N. J.	Yeh, 1959
		4.1	case rept., Tex.	Samuel, 1969
		-	case rept., sp. rev., Ala., Ga., Md., N. J., Tex., Wisc.	Becklund and Walker, 1969
Setaria sp.	Abdominal cavity	-	case rept., Mich.	Whitlock, 1939
		0.13	case rept., Minn.	Olsen and Fenstermacher, 1943
		-	case rept., Ontario	Shoho, 1958
		-	case rept., Gen. rev., Ontario	Anderson, 1962b

*Setaria cervi may be the same as S. yehi. See Becklund and Walker, 1970.

Helminths	Location	Incidence (%)	Type of Report and Geographical Location	Author
Setaria sp.	Abdominal cavity	0.83	case rept., Penn.	Samuel and Beaudoin, 1966
		50	case rept., Tex.	Emerson, 1969
TREMATODES				
Paramphistomum liorchis	Rumen	2.7	case rept., Ala.	Prestwood, et al., 1970
		24	case rept., Fla.	
		7.7	case rept., Ga.	
		2.9	case rept., La.	
		11	case rept., S. C.	
CESTODES				
Anoplocephala sp.	Small Intestine	5.2	case rept., Ill.	Mugwanya, 1971
Moniezia benedeni	Small Intestine	-	case rept., Mass.	Rankin, 1946
		2	case rept., S. D.	Boddicker and Huggins, 1969
		2- 4	case rept., Wisc.	Samuel and Trainer, 1969
		12	case rept., Ill.	Mugwanya, 1971
Moniezia expansa	Small Intestine	-	case rept., Mass.	Rankin, 1946
		1.9	case rept., Mich.	Swanson, 1959
		-	case rept., Wisc.	Dahlburg and Guettinger, 1956
		1.7	case rept., Penn.	Samuel and Beaudoin, 1966
Moniezia sp.	Small Intestine	-	case rept., N. C.	Ruff, 1938 and Schilling, 1938
Thysanoma actinoides	Small Intestine	-	Gen. rev.	Dikmans, 1934
		-	case rept., Wisc.	Dahlburg and Guettinger, 1956
		1	case rept., S. D.	Boddicker and Huggins, 1969

REVIEW LITERATURE CITED

Anderson, R. C. 1962a. The Parasites (Helminths and Arthropods) of White-Tailed Deer. Proc. 1 Nat. White-Tailed Deer Dis. Symp. pp. 162-171.

_____. 1962b. The helminth and arthropod parasites of the white-tailed deer (Odocoileus virginianus): a general review. Tr. Roy. Can. Inst. 34: 57-92.

Beaudoin, R. L., W. M. Samuel, and C. P. A. Strome. 1970. A comparative Study of the Parasites of Populations of White-Tailed Deer. J. Wildl. Dis. 6: 56-63.

Becklund, W. W. and M. L. Walker. 1968. Ostertagia dikmansi sp. n. (Nematode: Trichostrongylidae) from deer, Odocoileus virginianus, with a key to the species of medium stomach worms of Odocoileus in North America. J. Parasit. 54: 441-444.

_____. 1969. Taxonomy, hosts, and geographical distribution of the Setaria (Nematoda: Filariodea) in the United States and Canada. J. Parasit. 55: 359-368.

_____. 1970. Checklist of the Internal and External Parasites of Deer, Odocoileus hemionus and Odocoileus virginianus, in the United States and Canada. U. S. Dept. of Ag. Special Publication No. 1. 45 pp.

Boddicker, M. L. and E. J. Hugghins. 1969. Helminths of big game mammals in South Dakota. J. Parasit. 55: 1067-1074.

Cheatum, E. L. 1952. Disease and parasite investigations. Final Report, Pittman-Robertson Project 1-R, Suppl. E, New York State Conservation Dept., Division of Fish and Game, Bureau of Fish and Wildlife Investigations, p. 1-75.

Chitwood, M. B. and H. E. Jordan. 1965. Monodontus louisianensis sp. n. (Nematoda: Ancylostomatidae) from the white-tailed deer, Odocoileus virginianus (Zimmermann), and a key to the species of Monodontus. J. Parasit. 51: 942-944.

Dahlburg, B. L. and R. C. Guettinger. 1956. The white-tailed deer in Wisconsin. Tech. Wildl. Bull. (14), Game Mgt. Div., Wisconsin Conserv. Dept. p. 1-282.

Dikmans, G. 1931. Two new species of nematode worms of the genus Ostertagia from the Virginia deer, with a note on Ostertagia lyrata. Proc. U. S. Natl. Mus. (2872), 79, Art. 6: 1-6.

_____. 1932. Ostertagia odocoilei from the fourth stomach of a deer, Odocoileus virginianus, in Louisiana. J. Parasit. 19: 90.

_____. 1934. New records of helminth parasites. Proc. Helm. Soc. Wash. 1: 63-64.

_____. 1942. A new nematode, Skrjabinema parva, (Nematoda: Oxyruoidea), from deer. Proc. Helm. Soc. Wash. 9: 66-68.

_____ and J. T. Lucker. 1935. New records of nematode parasites from deer in the United States. Proc. Helm. Soc. Wash. 2: 83.

Dinaburg, A. G. 1939. Helminth parasites collected from deer, Odocoileus virginianus, in Florida. Proc. Helm. Soc. Wash. 6: 102-104.

Emerson, H. R. 1969. A comparison of parasitic infestations of white-tailed deer (Odocoileus virginianus) from central and east Texas. Bull. Wildl. Dis. As. 5: 137-139.

Glazener, W. C. and F. F. Knowlton, 1967. Some endoparasites found in Welder Refuge deer. J. Wildl. Mgt. 31: 595-597.

Hayes, F. A., W. E. Greer, and E. B. Shotts. 1958. A progress report from the Southeastern Cooperative Deer Disease Study. Tr. 23 North Am. Wildl. Conf., p. 133-136.

Mangold, R. E. 1958. Wildlife diseases and parasites and what they mean to you. N. Jersey Outdoors 9: 8-14.

Maples, W. P. and H. E. Jordan. 1966. A new host record for Obeliscoides cuniculi (Graybill, 1923) Graybill, 1924. J. Parasit. 52: 49.

Mugwanya, S. M. 1971. Protozoan and Helminth Parasites of White-Tailed Deer (Odocoileus virginianus) in Southern Illinois. M. S. Thesis. Eastern Illinois University. 40 p.

Olsen, O. W. and R. Fenstermacher. 1943. The helminths of North American deer with special reference to those of the white-tailed deer (Odocoileus virginianus borealis) in Minnesota. Tech. Bull. (159), Minn. Agr. Exp. Sta., p. 1-20.

Payne, R. L., W. P. Maples, and J. F. Smith. 1967. The occurrence of Oesophagostomum cervi Mertts, 1948, in white-tailed deer (Odocoileus virginianus) of the southeastern United States. J. Parasit. 53: 691.

Prestwood, A. K., J. F. Smith, and W. E. Mahan. 1970. Geographic distribution of Gongylonema pulchrum, Gongylonema verrucosum, and Paramphistomum liorchis in White-tailed deer of the southeastern United States. J. Parasit. 56: 123-127.

Rankin, J. S. 1946. Helminth parasites of birds and mammals in western Massachusetts. Am. Midl. Nat. 35: 756-768.

Ruff, F. J. 1938. The white-tailed deer of the Pisgah National Game Preserve, p. 1-249.

Samuel, W. R. 1968. Endoparasites of Domestic Ruminants and White-Tailed Deer. Tr. 33 North Am. Wildl. Conf. p. 364-371.

_____. 1969. The parasites of White-Tailed Deer in South Texas. Ph.D. Thesis. 196 pp. University of Wisc.

_____ and R. L. Beaudoin. 1966. Evaluation of two survey methods for detection of helminth infections in white-tailed deer (Odocoileus virginianus). Bull. Woldl. Dis. Ass. 2: 100-107.

_____ and D. O. Trainer. 1969. A Technique for survey of some helminth and protozoan infections of white-tailed deer. J. Wildl. Mgt. 33: 888-894.

Schilling, I. A. 1938. Management of whitetail deer on the Pisgah National Game Preserve. Summary of five-year study. Tr. 3 North Am. Wilds. Conf., p. 248-255.

Shoho, C. 1958. Studies on the identity of Setaria species from the peritoneal cavity of American moose (Alces a. gigas) and white-tailed deer (Odocoileus virginianus). Ceylon Vet. J. 6: 43-47.

Swanson, D. O. 1959. A Study of the Helminth Parasites of the George Reserve Deer Herd. M. S. Thesis. Univ. of Mich. 56 p.

Whitlock, S. C. 1939. The prevalence of disease and parasites in whitetail deer. Tr. 4. North Am. Wildl. Conf., p. 244-249.

Yeh, L. S. 1959. A revision of the nematode genus Setaria (Viborg 1795), its host-parasite relationship, speciation and evolution. J. Helm. 33: 1-98.

FIGURE 1.--*Spiculopteroides odocoilei* from *Odocoileus virginianus* in southern Illinois. Anterior extremity of mature female, lateral view.

FIGURE 2.--Lateral view of *S. odocoilei* mature female showing ovejectors, vagina and vulva.

FIGURE 3.--Posterior-lateral view of *S. odocoilei* mature male, showing spicules.

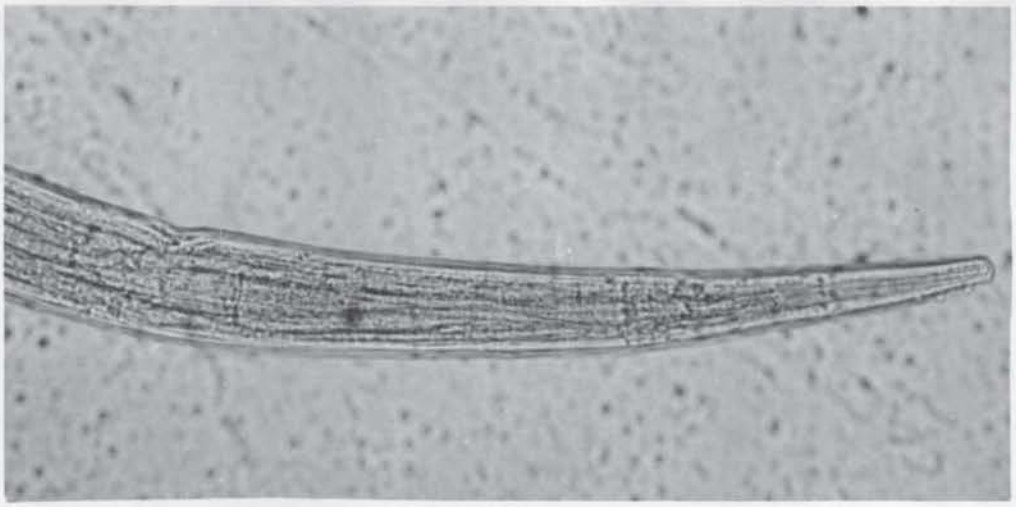

FIGURE 1

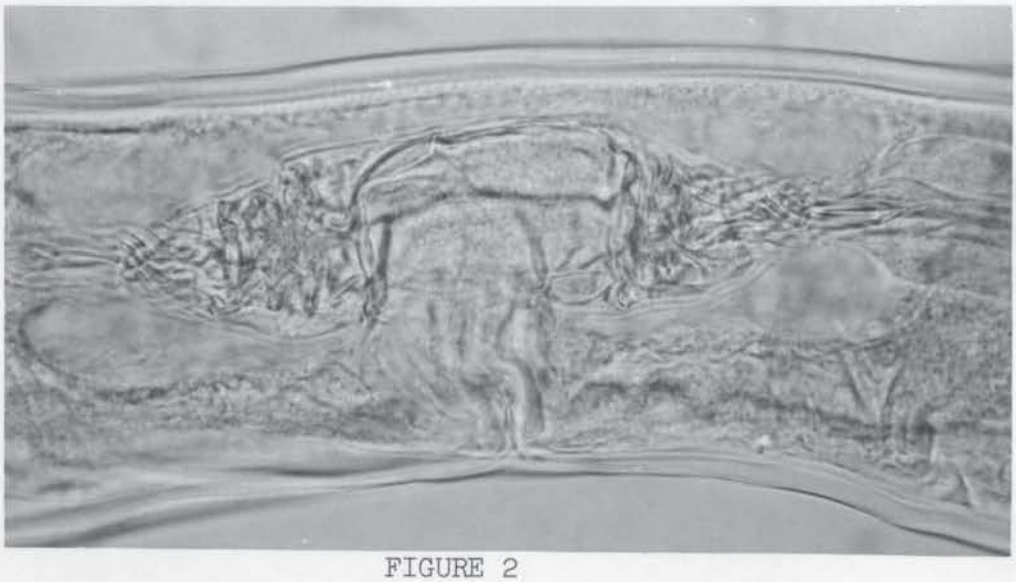

FIGURE 2

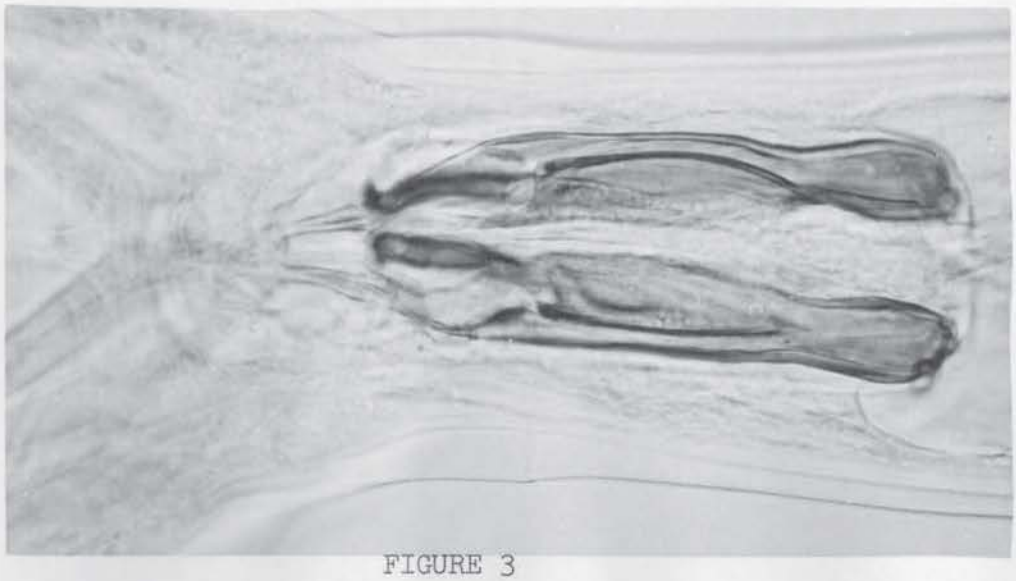

FIGURE 3

FIGURE 4.--*Ostertagia mossi* from *Odocoileus virginianus* in southern Illinois. Anterior extremity of female, lateral view.

FIGURE 5.--Lateral view of *O. mossi* mature female showing ovejectors, vagina, and vulva.

FIGURE 6.--Lateral view of posterior extremity of a mature female *Spiculopteroides odocoilei*.

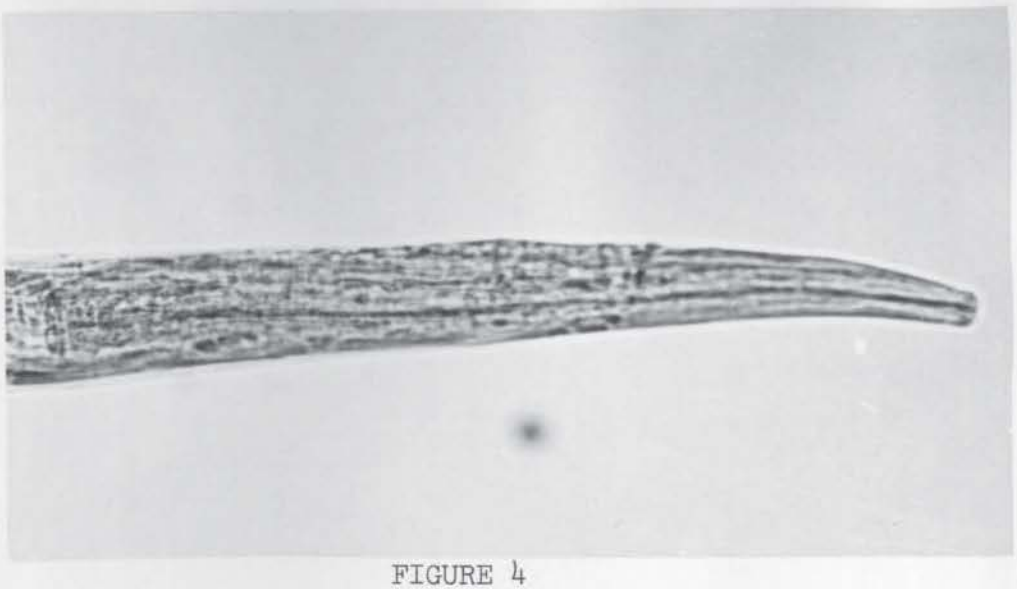

FIGURE 4

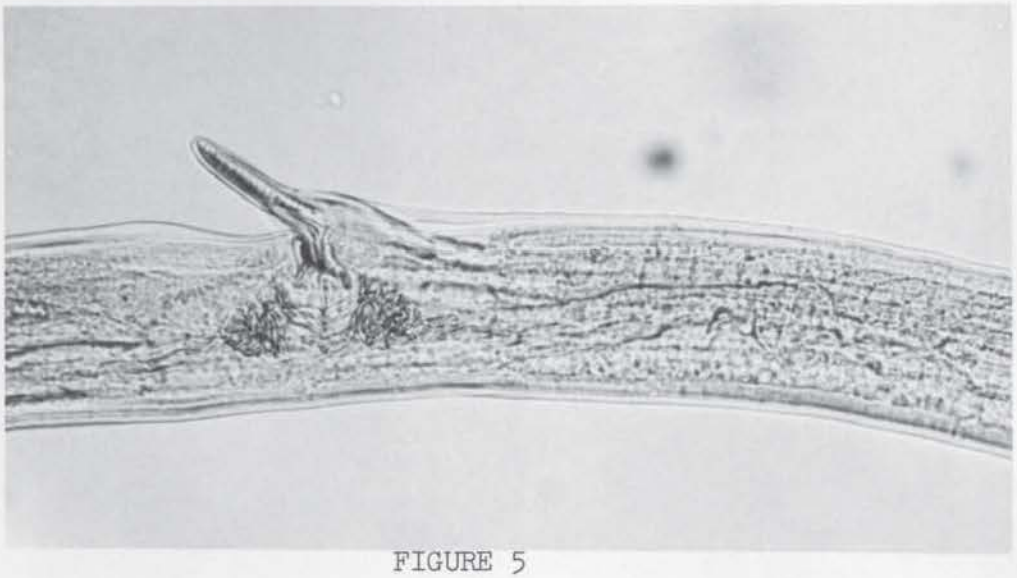

FIGURE 5

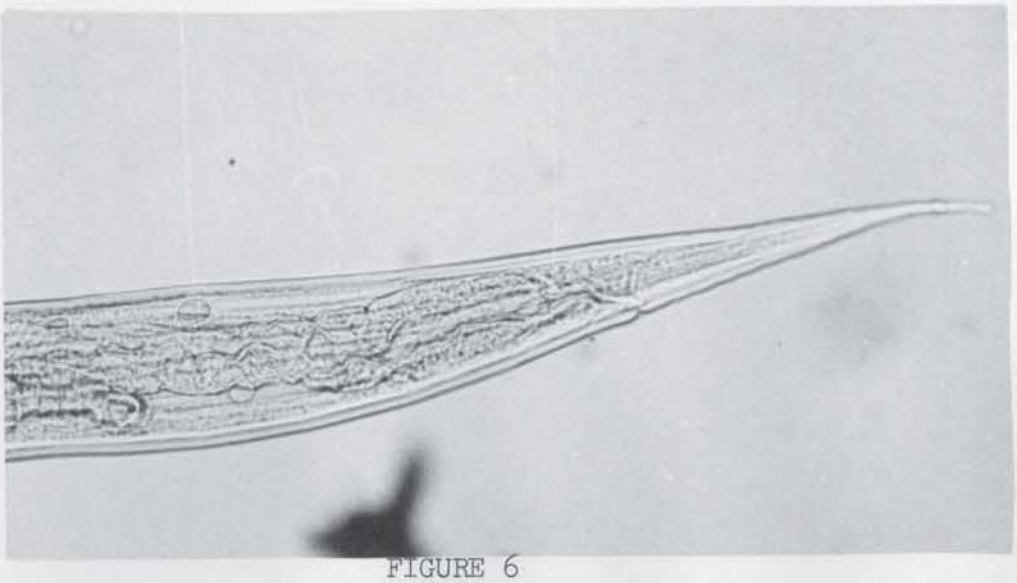

FIGURE 6

FIGURE 7.--Haemonchus contortus from Odocoileus virginianus in southern Illinois. Anterior extremity of mature male, lateral view.

FIGURE 8.--H. contortus, lateral view, showing posterior extremity spicules, and copulatory bursa.

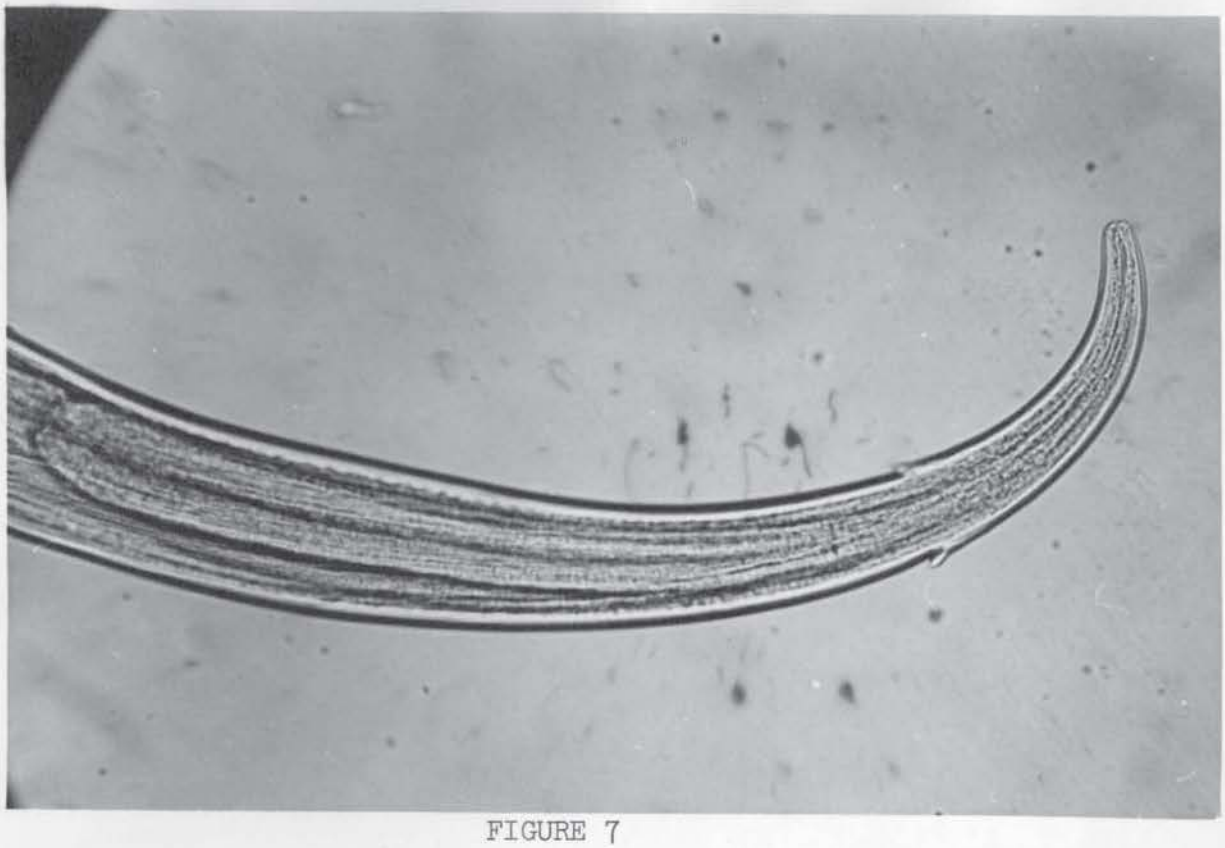

FIGURE 7

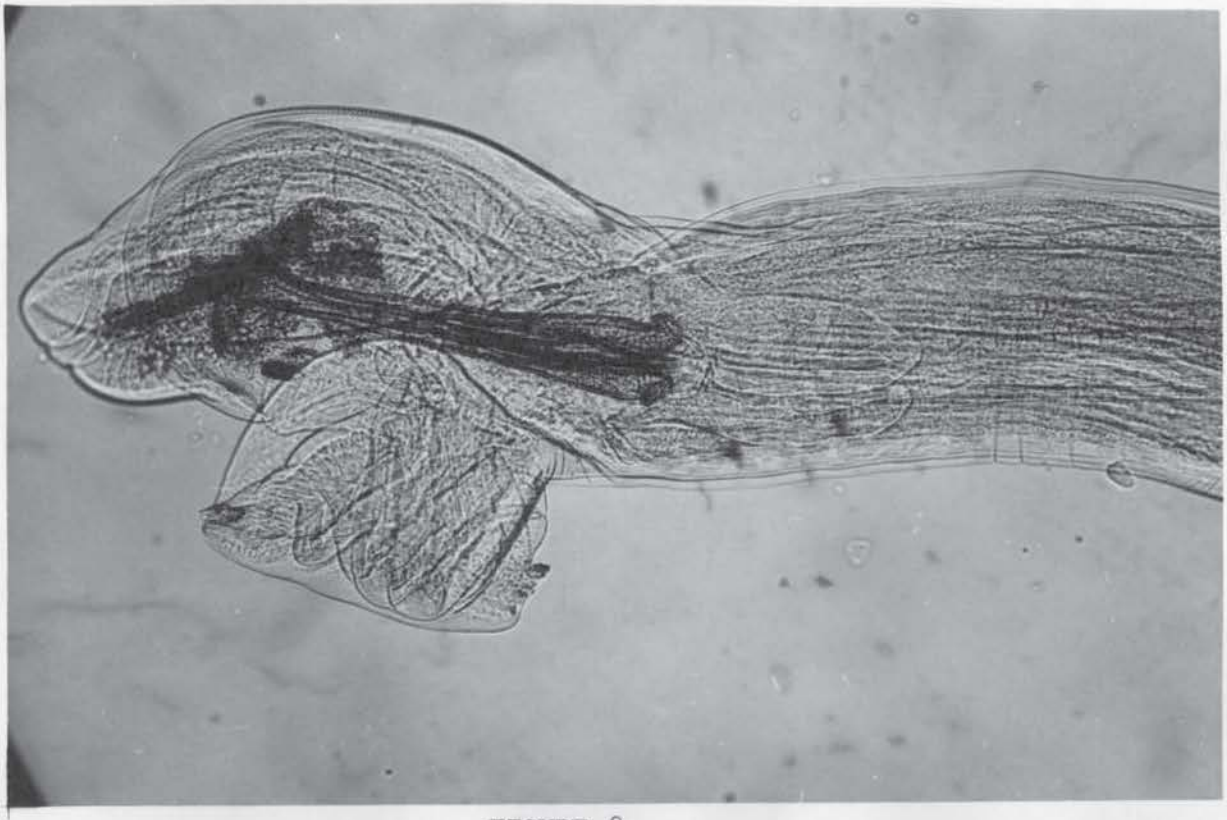

FIGURE 8

FIGURE 9.--*Setaria yehi* from *Odocoileus virginianus* in southern Illinois. Posterior extremity of mature male, lateral view.

FIGURE 10.--*S. yehi*, lateral view, showing anterior extremity of mature male.

FIGURE 11.--*Oesophagostomum venulosum* from *Odocoileus virginianus* of southern Illinois. Anterior end of mature female, lateral view.

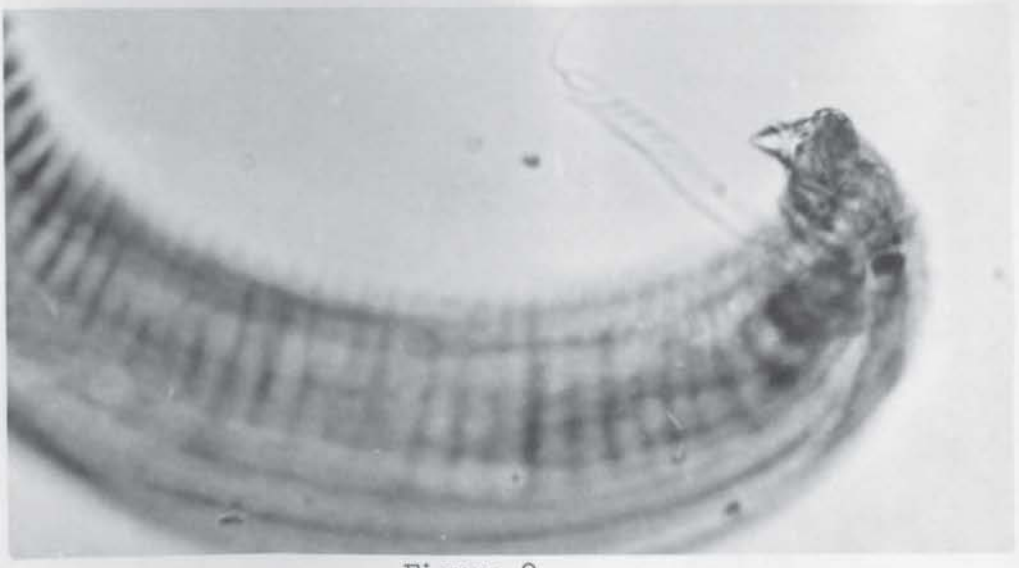

Figure 9

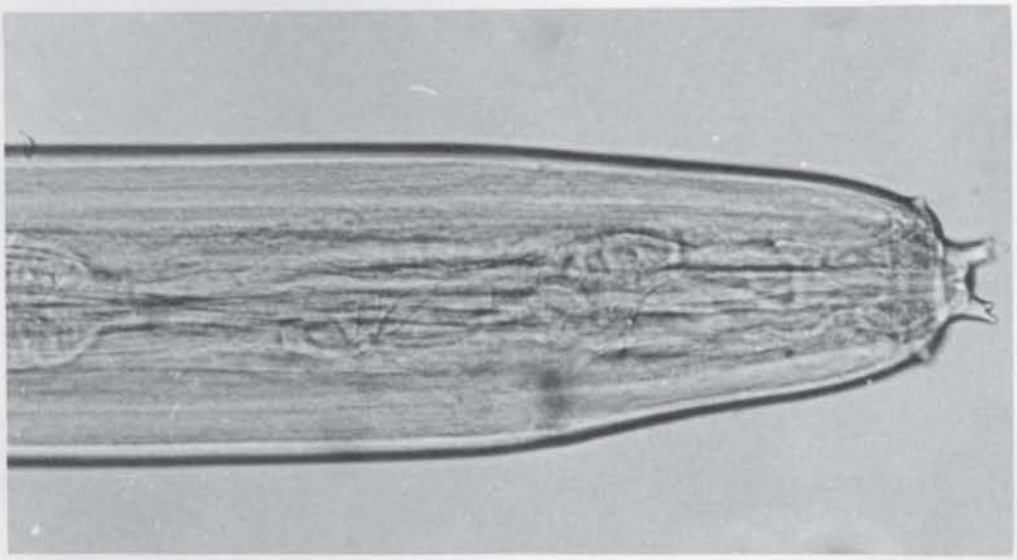

FIGURE 10

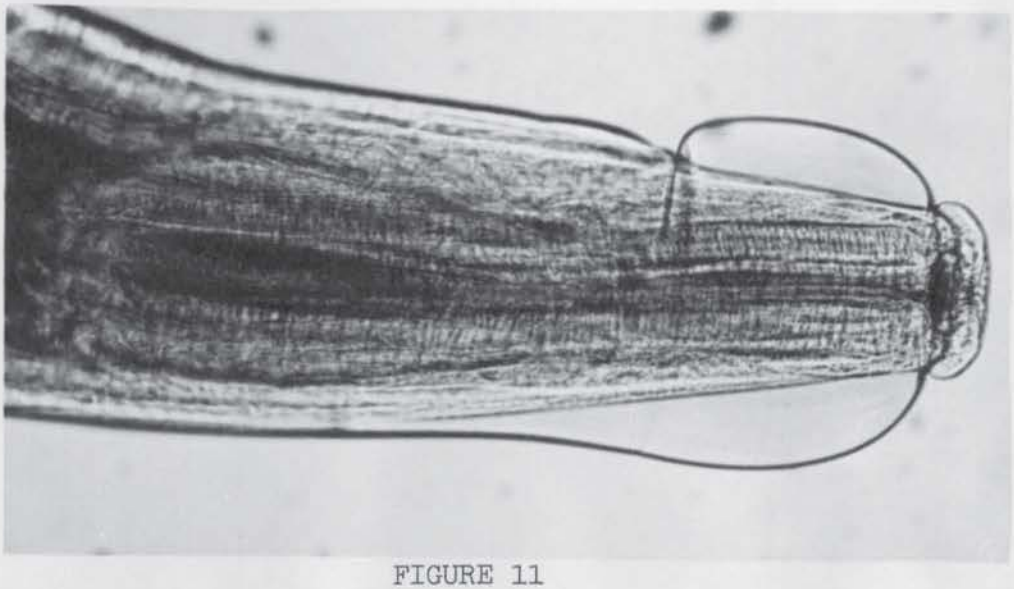

FIGURE 11

FIGURE 12.--En face view of mature Setaria yehi male.

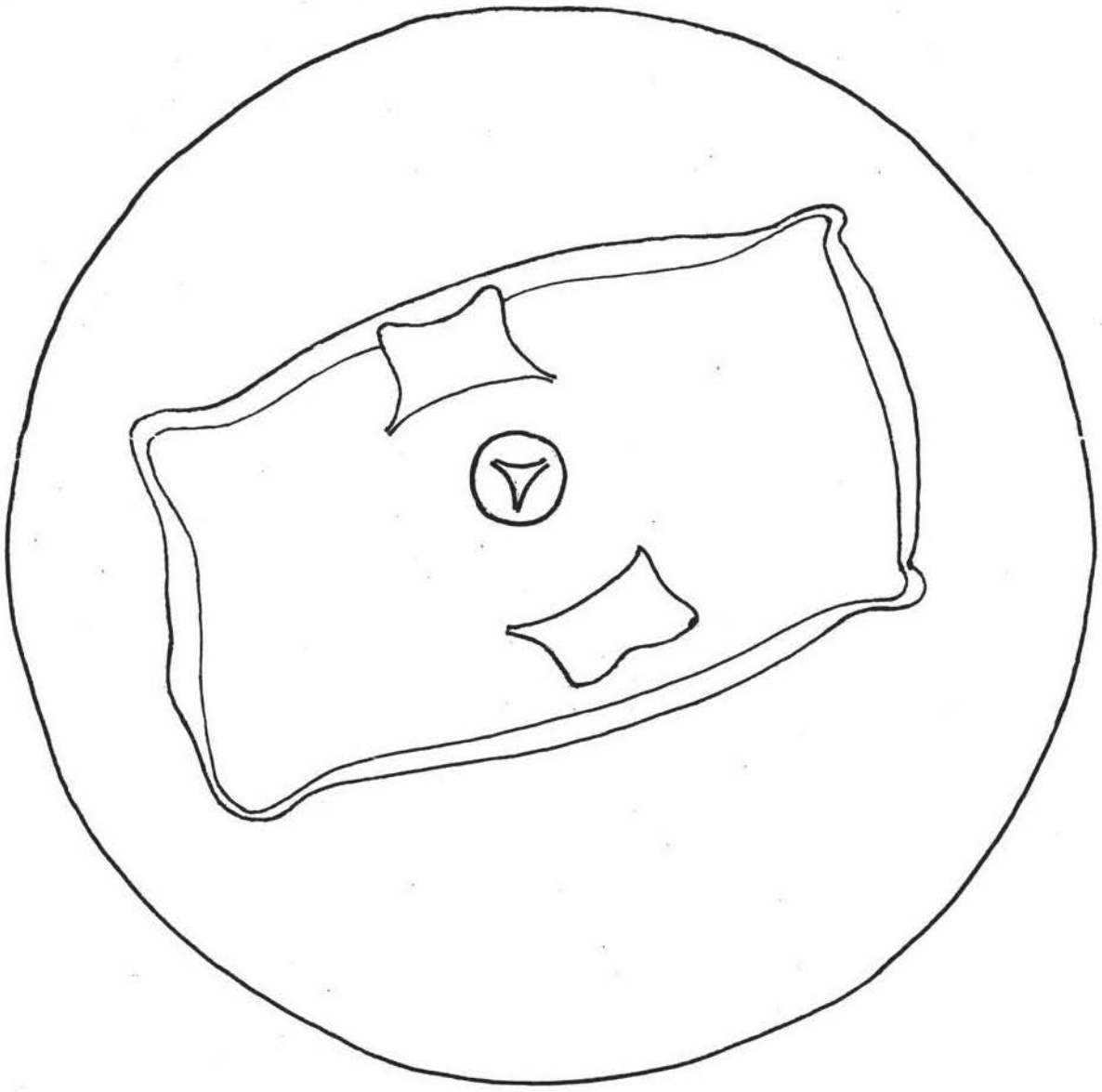

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FIGURE 13.--Spicules of mature male Spiculopteroides odocoilei.

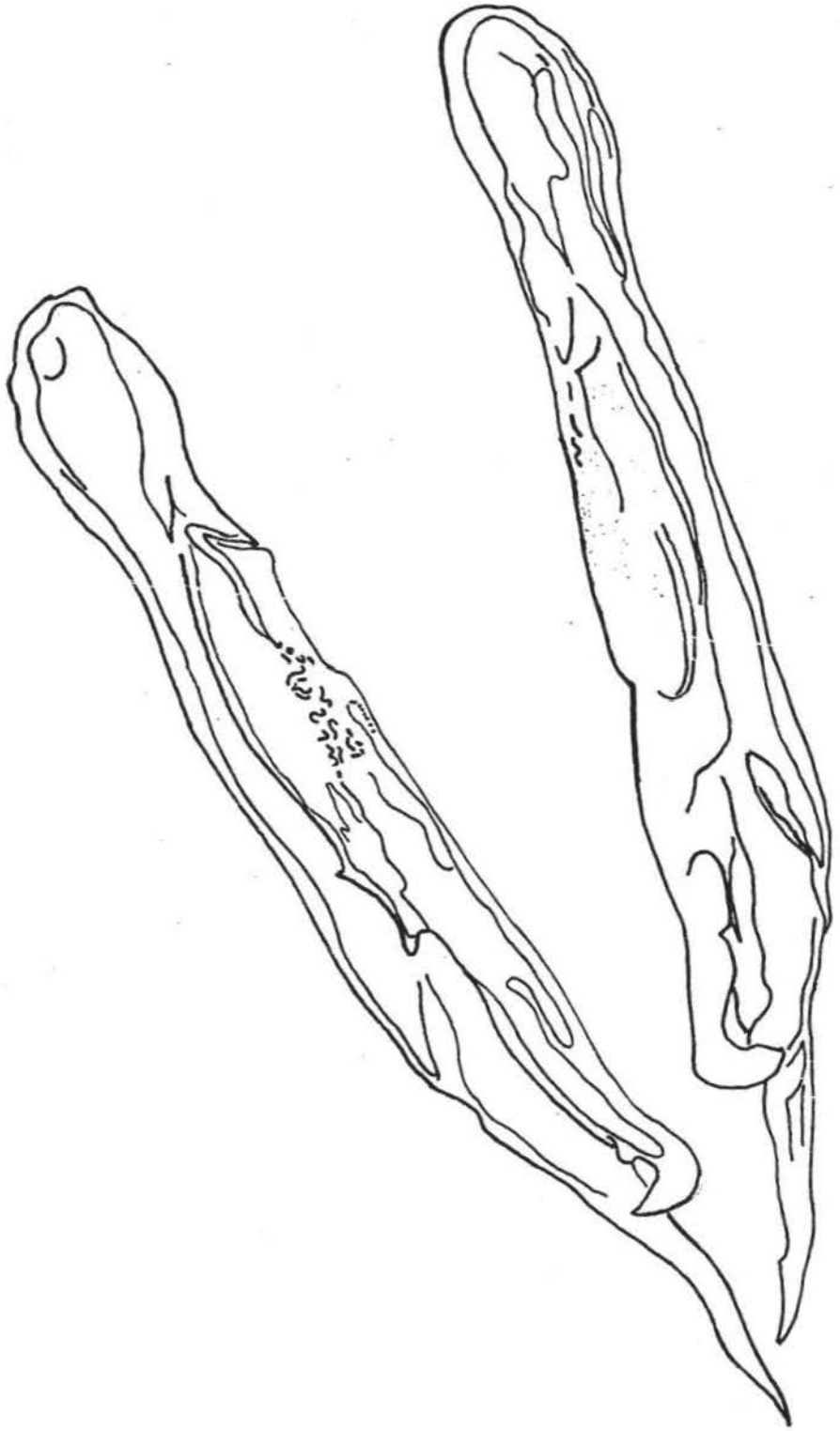

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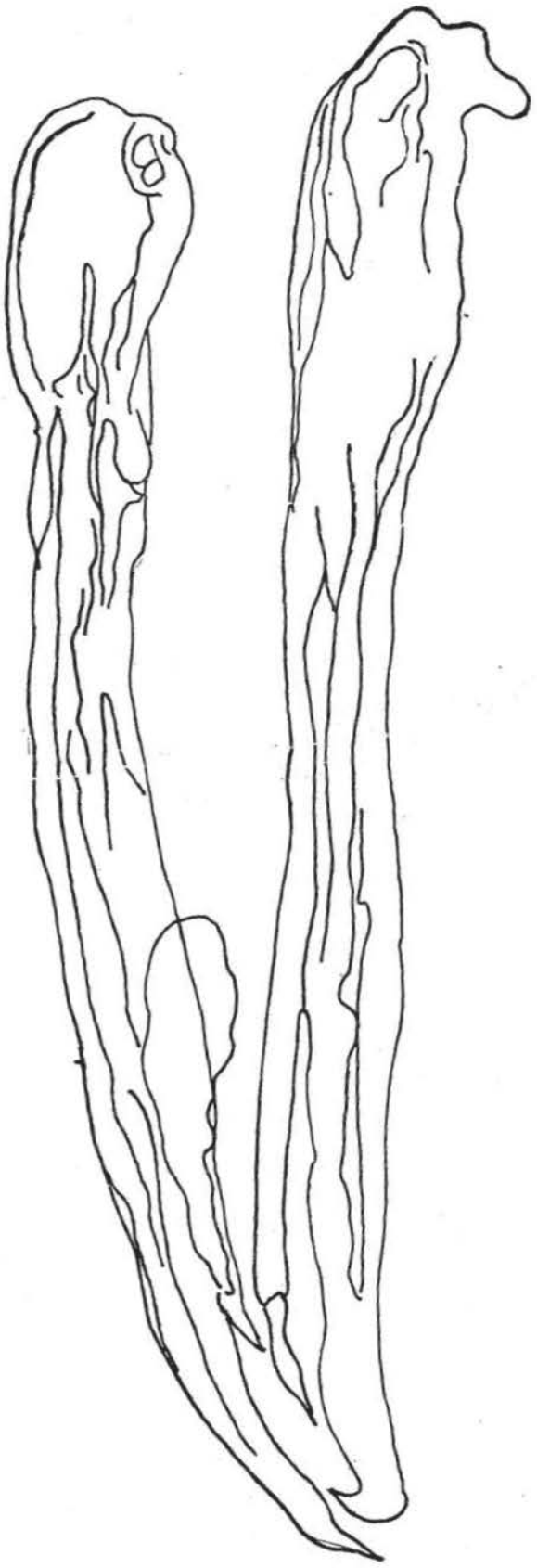
FIGURE 14.--Spicules of mature male Ostertagia mossi.



25 μ

THOMAS W. COOK

Zoo 540 Cell Phys
Zoo 520 Hist of Bio
Zoo 480 Ichthylg
Zoo 456 Fld. Zoo
Zoo 460 Invert Zoo
Zoo 530 Nematology
Zoo 521 Orgn Evolution
Zoo 555 Adv. Zoo

Zoo 525 Protozoology
Zoo 535 Arthroplgy
Zoo 556 Adv. Zoo
Zoo 450 Methods Research
Zoo 557 Adv. Zoo
Zoo 558 Adv. Zoo
Zoo 595 Thesis