A SURVEY OF THE INTERNAL HELMINTHS IN BATS OF KANSAS AND NEBRASKA

by

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INTRODUCTION

This study was conducted in conjunction with a project of the Veterinary Diagnostic Laboratory, Kansas State University, whose aim was to determine the incidence of rabies in bats from Kansas and Nebraska.

A survey of trematodes of midwestern bats has been made by Gilford (M.S. 1952, University of Illinois) and a study on the helminth fauna of Tadarida brasilienses mexicana found in Oklahoma is being conducted at Oklahoma State University. This survey was undertaken for the following reasons: (1) to study the helminth fauna found in bats from Kansas and Nebraska, (2) to determine the over-all incidence of infection, (3) to determine variations in incidence of infections as correlated with sex and species of host, (4) to determine possible seasonal variations in helminth burden, and (5) to report new parasite-host relationships.

LITERATURE REVIEW

Inasmuch as this study involved three classes of parasites (Trematoda, Cestoda, and Nematoda), the literature review will be conducted as it pertains to these categories. Only a general summary of the literature relative to the internal helminths of Chiroptera will follow directly due to the voluminosity of the subject. More specific details and references concerning the specimens which were found in their respective hosts will be given with the results and discussion.

Trematoda

The Trematoda have received most of the attention from parasitologists interested in bats. Various bat trematodes have been considered briefly by early investigators such as Rudolphi (1819), Beneden (1873), von Linstow

(1877), Poirer (1886), Brandes (1888), Blanchard (1891), and Stossich (1892). However, the basis for much of the morphological and taxonomic work which was to follow is found in the studies by Looss (1896) on the helminth fauna of Egypt. It is a most detailed investigation which is not surpassed by more recent study. Following this, Braun (1900) described several parasites from Brazilian bats, however, it has been indicated by Looss (1907) that these descriptions do not sufficiently differentiate the parasites. Luhe (1909), Looss (1896, 1899, 1907) and Odhner (1911) studied the taxonomic relationships of many of the then-known bat trematodes. Travassos (1921) described trematodes from Brazilian bats collected in the regions where Braun obtained his original material. Bhalerao (1926, 1928) reported on several species of bat parasites from Burma while Northup (1928) added considerably to our knowledge of these forms. Modlinger (1930) studied the fauna of Hungarian bats, redescribing many of the earlier known species as well as a number of new ones. The condition of the family Lecithodendriidae was clarified by Dolfus (1931, 1937). Skarbilovich (1946, 1948) produced taxonomic studies of the helminth fauna of bats in Russia. Trematodes and other helminths from bats of Mexico, Panama and Costa Rica were described and listed by Caballero (1942, 1943, 1951, 1958, 1959). In his later work, Travassos (1955) described a new species from a Brazilian bat belonging to the family Dicrocoeliidae. The helminths of bats from Poland were investigated by Soltys (1959) while a similar study was conducted by Hurkova (1959) in Czechslovakia. A considerable volume of recent work in taxonomy and taxonomic revisions has been done by Dubois (1955, 1956, 1960, 1961, 1962, 1963). Some of his work consists of the revisions of the following genera; Prosthodendrium, Lecithodendrium, Acanthatrium and Paralecithodendrium.

Some of the studies concerning bat trematodes of the oriental regions

have been produced by Onaki (1929) and Yamaguti (1939, 1941) in Japan. Tabanugui (1928) described several species of trematodes from Philippine bats, while Sogandares (1956) found and described three new species of chiropteran trematodes from Korea.

In the years preceding 1932, only three trematodes had been reported from bats in the United States. These species were Acanthatrium nycteridis Faust, 1919, A. eptesicus Alicata, 1932 and Distomum sp. Stiles and Hassal, 1894. Stiles and Nolan (1931) published a catalogue of parasites of bats. Since 1930, Macy has contributed the major portion of our knowledge concerning the helminth fauna of North American bats (note twenty-one references in the bibliography). He has described numerous species of trematodes found in Chiroptera. Fairly recently, Caballero (1942, 1943, 1951, 1958, 1959) conducted extensive surveys of the helminth parasites of Mexican and South American chiroptera. Gilford (1955) revised the genus Allassogonoporus Oliver, 1938. Several new species in the genus Acanthatrium Faust, 1919 were described by Cheng (1957, 1959). Williams (1960, 1962) in recent studies has described trematodes from bats of the genus Myotis and has produced a key to the described species of Acanthatrium.

Life cycles of bat trematodes have received little attention. The most complete cycle appears to have been worked out for Prosthodendrium chilostomum (Brown, 1936, Lecithodendrium chilostomum). McMullen (1937) briefly described the life cycles of Prosthodendrium pyramidum Looss, 1896 and members of the genus Plagiorchis Luhe, 1899. Macy (1956, 1960) described the life cycles of Plagiorchis pararchis n. sp. and P. vespertilionis pararchis n. sp. The cycle for P. dilimanensis n. sp. was worked out by Velasquies (1964).

Cestoda

The literature pertaining to chiropteran cestodes is sparce compared with that of the other helminth parasites. The early work of classification of cestodes was done by Perrier (1897). A large portion of our knowledge of tapeworms has been provided by the work of Railliet; Railliet and Henry (1909) prepared a list, with descriptions, of the cestodes of bats of France. Mayhew (1925) conducted a study on the avian species of the cestode family Hymenolepididae. Hughs (1941) formulated a key to the species of tapeworms of the genus Hymenolepis. As indicated previously, Macy (1931a, 1946, 1947) has contributed considerably to our enlightenment involving chiropteran helminths. He has constructed keys to the cestodes found in bats and described many new species. Spassky (1954, 1961) made systematic studies and revisions in the hymenolepid cestodes including creating the generic name Vampirolepis for bat cestodes hitherto having the generic name Hymenolepis. Many of the recent studies concerning cestodes of chiroptera have been made by Arandas (1961, 1962, 1962). He has described several new species of Vampirolepis found in South American bats.

Nematoda

The early taxonomic work with nematodes of Chiroptera was conducted by Zeder (1800). Baird (1853) formulated a catalogue of intestinal worms contained in the collection at the British Museum. Kolenati (1856) described several nematodes of the genus Capillaria Zeder, 1800 from bats of Brazil. Van Beneden (1873) produced a list of the then-known nematode parasites of Belgian Chiroptera. Railliet and Henry (1915) contributed to the knowledge of bat nematodes of France as did Skarbilovich (1934) concerning the

Trichostrongylidae found in bats of that region. A revised classification of the Nematoda was created by Chitwood (1937b) which clarified the previously confused state of nematode taxonomy. Chandler (1938) reported on several new nematodes found in a certain species of bat from Texas. An extensive study of the nematode fauna of mammals from Japan was conducted by Yamaguti (1941) with the description of several new species. A great portion of our knowledge of chiropteran nematodes of South America has been contributed by Lent and Teixeira de Treitas (1934, 1936, 1940, 1945, 1946, 1963). Ricci (1949) described new species of nematodes belonging to the subfamily Capillariinae which were collected from bats in Italy. Dolfus (1954) formulated a list of strongyle nematodes of Chiroptera with their geographic distributions.

Chiroptera

The habitats and biology of many of the North American bats has been described by Hall and Kelson, 1959. Information about the Chiroptera examined in this study is given below.

The bat, Myotis keenii roost singly or in small colonies in obscure places. Other species of Myotis (M. velifer, M. lucifugus, M. grisescens, M. velifer incautus) are principally cave dwellers and often congregate in large numbers; however, they too may occasionally be found in small numbers in holes in trees, in attics, in barns and in a variety of other roosting sites. Pipistrellus subflavus, Eptesicus fuscus, Plecotus townsendii and Tadarida mexicana brasiliensis may also be found in large numbers in caves and in small numbers in the other roosting sites previously mentioned.

The Chiroptera named above are all insectivorous. They emerge from their roosts in the evening to feed throughout the night on flying insects. One genus (Tadarida) has been said to ingest as much as half of its body

weight during a night's feeding. These bats are all hibernating animals, except for Tadarida mexicana brasiliensis which migrates seasonally seeking warm temperatures. They pass the winter congregated in large numbers in caves and do not feed again until the following spring.

MATERIALS AND METHODS

Collection of Hosts

A total of 65 bats, representing 5 genera and 9 species, was collected throughout a period of one year beginning January 29, 1964 and ending February 1, 1965. The bats were supplied by Dr. J. Knox Jones from the University of Kansas at Lawrence in nine different groups as follows:

Group 1: Myotis lucifugus ---------- 4 specimens
Myotis keenii ---------- 2 specimens
Pipistrellus subflavus ---------- 4 specimens
Locality: ½ mile north, 1½ mile west of Blue Rapids, Marshall County, Kansas
Date: January 29, 1964

Group 2: Eptesicus fuscus ---------- 4 specimens
Locality: Gravel mine, Leavenworth, Leavenworth County, Kansas
Date: February 13, 1964

Group 3: Myotis keenii ---------- 2 specimens
Myotis lucifugus ---------- 4 specimens
Locality: ½ mile north, 1½ mile west of Blue Rapids, Marshall County, Kansas
Date: April 8, 1964

Group 4: Myotis keenii ---------- 2 specimens

Myotis lucifugus ---------- 4 specimens

Pipistrellus subflavus ---------- 6 specimens

Locality: 1 mile west of Meadow, Sarpy County, Nebraska

Date: April 8, 1964

Group 5: Myotis velifer ---------- 4 specimens

Locality: Swartz Canyon, 11½ miles south, 16 miles east, Coldwater, Comanche County, Kansas

Date: April 11, 1964

Group 6: Tadarida mexicana braziliensis ---------- 9 specimens

Locality: 6 miles south, 2 miles west, Aetna, Barber County, Kansas and Woods County, Oklahoma

Date: October 20, 1964

Group 7: Myotis grisescens ----------13 specimens

Locality: Storm sewer, Pittsburg, Crawford County, Kansas

Date: December 1, 1964

Group 8: Myotis velifer incautus ---------- 3 specimens

Locality: National Gypsum Mine, 2 miles south, Sun City, Barber County, Kansas

Date: December 20, 1964

Group 9: Plecotus townsendii ---------- 4 specimens

Locality: Swartz Canyon, 11½ miles south, 16 miles east, Coldwater, Comanche County, Kansas

Date: February 1. 1965

Recovery of Helminths

The bats were first sent to the Veterinary Diagnostic Laboratory, Kansas State University, to determine the presence of rabies. The bats were killed and then examined by the author for helminths. The gut was flushed several

times by using a 10 ml syringe, blunt needle and tap water. The stomach, liver, lungs, kidneys, trachea, and urinary bladder were teased apart in tap water and agitated manually to disengage existing parasites.

Fixation, Staining and Mounting

All parasites recovered were fixed in Alcohol-Formalin-Acetic Acid (A.F.A.). The trematodes were stained with Delafield's and Ehrlich's hematoxylin according to procedures submitted by Dr. Franklin Sogandares of Tulane University. His procedure is as follows:

A. Stain solution is prepared by adding 1 ml Delafield's hematoxylin and 1 ml Ehrlich's hematoxylin to 100 ml saturated solution of 6% aluminum potassium sulfate.

B. Procedure:
   1. Fix worms in A.F.A.
   2. Wash in 70% ethanol
   3. Hydrate to water
   4. Dilute stain half with water and stain overnight
   5. Dehydrate
   6. If destaining is necessary, use 70% ethanol, then add lithium carbonate to 85% ethanol to allow specimens to blue
   7. Clear in beechwood creosote
   8. Mount in permount or piccolyte

The cestodes were stained either with Delafield's hematoxylin or by Sogandare's method. All flatworms were mounted in piccolyte, whereas the nematodes were mounted, unstained, in glycerine jelly.

Some bats were dead and refrigerated for a period of a day or more before the author was notified, therefore, some of the smaller trematodes and cestodes were badly cytolyzed. This made identification difficult and in a few cases resulted in being able only to identify a specimen to genus.

In identifying the specimens, publications of the following authors were useful: Dawes (1946), Yamaguti (1961), Skrjabin (1961, 1964). Dr. Franklin Sogandares, Department of Zoology, Tulane University verified all trematode identifications. Dr. M. F. Hansen, Department of Zoology, Kansas

State University, verified cestode and nematode identifications.

RESULTS

Helminths Recovered

Of the 65 bats examined, 25 were found to harbor parasites. Six genera and ten species of trematodes, one genus and three species of cestodes (according to Spassky's 1954 classification) and three genera and four species of nematodes were identified. These helminths are listed below.

Trematoda:

Plagiorchis vespertilionis (Muller, 1784) Braun, 1900
Plagiorchis micracanthos Macy, 1931
Allassogonoporus marginalis Oliver, 1938
Prosthodendrium longiforme Bhalerao, 1926
Prosthodendrium swansoni Macy, 1936
Acanthatrium eptesici Alicata, 1932
Acanthatrium micracanthum Macy, 1940
Acanthatrium oregonense Macy, 1939
Dicrocoelium rileyi Macy, 1931
Urotrema scabridum Caballero, 1942

Cestoda:

Vampirolepis christensoni (Macy, 1931) Spassky, 1954
Vampirolepis roudabushi (Macy and Rausch, 1946) Spassky, 1954
Vampirolepis gertschi (Macy, 1947) Spassky, 1954

Nematoda:

Capillaria palmata Chandler, 1938
Allintoshius nycticeius Chitwood, 1937
Allintoshius travassosi Chandler, 1938
Molinostrongylus delicatus Schwartz, 1927

Table 1 lists information about groups of hosts captured, host species and sex, as well as the number and identity of the parasites recovered. All the helminths listed above have been previously described. However, with the exception of two species, Dicrocoelium rileyi Macy (1931) and Plagiorchis micracanthos Manter and Debus (1945), these helminths have not been reported from Kansas or neighboring states prior to this study.

Incidence of Infection

Table 2 shows the incidence of infection for each parasite in relationship to each host examined. Over-all incidence of infections were not high except for four helminths: Prosthodendrium swansoni (15.3%), Urotrema scabridum (13.8%), Capillaria palmata (16.9%), and Allintoshius travassosi (21.5%). The total incidence of infection of the three former species is elevated because of a high incidence in one species of host, whereas Allintoshius travassosi, the most widely found parasite in this study, has a relatively high incidence of infection in three different hosts.

Variations of incidence of infections in different hosts can be seen in both Tables 1 and 2. Some hosts such as Myotis lucifugus, M. keenii, and Pipistrellus subflavus were relatively free from infection, and the examination of specimens of Plecotus townsendii revealed no parasites. Conversely, the number of different specific helminth infections in Myotis velifer, M. grisescens, and Eptesicus fuscus ranged from three to nine.

Table 3 shows the incidence of infection in relationship to sex of the host as well as the over-all incidence of infection of the male and female hosts. The total incidence of infection of male hosts is slightly higher than in the female hosts. However, this difference is questionable when related to the population in that too few females were examined. More specimens of bats must be necropsied before a definite statement can be made concerning possible variations of incidence of infections in relation to sex of the host.

Helminth Burden

Information given in Table 4 indicates the difference in helminth burden correlated with host species and sex. Trematodes were the most

numerous helminths found. Two species, Prosthodendrium swansoni and Urotrema scabridum, were found in numbers exceeding 100. The second highest worm burden was associated with the nematodes. Only one genus of cestodes was recovered; infections were light and in most cases only one specimen per host was found. These data follow the pattern of infections reported in the literature for helminthiases in bats.

This table shows that there is considerable variation in the helminth burden of different host species. The burden in some species is light (1 to 5 helminths); one host, Plecotus townsendii, was free from infection. However, the burden of the specimens of Myotis grisescens was large in that 13 hosts were infected by 9 species of helminths and a total burden of 445 worms (average of more than 34 per host). A possible explanation for the large helminth burden in M. grisescens may be that these specimens were collected near the end of its seasonal feeding period (November 1), thus allowing more time for the helminth fauna to increase. However, specimens of hosts collected a month prior to and a month after the above date, did not show a large helminthic burden. This observation could lead one to believe that Myotis grisescens is a host with high susceptibility to helminth infection. However, in proving this, other factors must be considered in future investigations, such as locality of hosts, climatic conditions, shelter, and accessible food. All these variables influence the survival of infective parasite eggs as well as the number and kinds of invertebrate animals available to serve as intermediate hosts.

A third aspect illustrated by Table 4 is the substantial difference in the helminth burden between male and female hosts of all species. For each male host the average parasite burden was 10.75, whereas for each female it was only 1.68. Although slight in some instances, the male has a larger

burden than the female in 6 of the 9 species of hosts. In Myotis grisescens there is a great difference in the helminth burden related to sex. This is explained partly by the fact that only one female was available for examination. Nevertheless, the 11 parasites recovered from this female were still well below the average of more than 36 helminths recovered for each male host of this species.

Seasonal Variation in Helminth Burden

Figure 1 shows information regarding seasonal variation of the helminth burden in chiropteran hosts. The hosts are separated into groups corresponding to the time of their capture. There appears to be an increased burden in late autumn which dimishes in winter and gradually builds up again in the early spring. This would seem logical taking into account the seasonal feeding habits and hibernation of most Chiroptera. Investigation by Allen (1950) substantiates the data of seasonal variances obtained from this study. Manter and Debus (1945), Gilford (1952) and this study indicate, however, that there is a continued presence of a considerable number and variety of parasites in the hibernating forms. The literature fails to point out the presence of any special adaptations in host-parasite relationships which may permit the continued presence of these parasites during hibernation of the host.

Host Records

A number of new host records was established during the course of this study. They are presented below with information of earlier reports regarding these chiropteran helminths and their respective hosts.

Trematoda

Plagiorchis micracanthos has been reported from Minnesota in Eptesicus fuscus, Myotis lucifugus and M. californicus by Macy (1931). Manter and Debus (1945) also found this species in M. californicus captured in Nebraska. It has been reported from Ohio in Myotis sodalis by Williams (1962). Plagiorchis micracanthos was found in this research only in the host Pipistrellus subflavus which is a newly reported host for this trematode.

Plagiorchis vespertilionis was reported in Taderida brasiliensis of Mexico by Caballero (1940) and in Pipistrellus sp. of Korea by Sogandares and Bernal (1956). This parasite is wide spread geographically and is found in many genera of Chiroptera including the following: Myotis, Eptesicus, Plecotus, Vespertilio, Leuconoe, Nyctinomus, Rhinolophus, and Miniopterus. In this study Plagiorchis vespertilionis was recovered from Myotis lucifugus and Eptesicus fuscus.

Allassogonoporus marginalis was first found by Oliver (1938) in the muskrat, Ondatra zibethica in Michigan. Macy (1940b, 1947) reported it from Myotis californicus caurinus and later from M. lucifugus in Oregon. Williams (1962) recovered this trematode from M. sodalis captured in Ohio. Allassogonoporus marginalis was found in Myotis grisescens during the present study and is a new host record.

Prosthodendrium longiforme was described by Bhalerao (1926) from Nycticeius pallidus of Burma. Search of the literature revealed one other report of this trematode; by Skarbilovich (1947) in Nyctinomus plicatus in Russia. A new host was established for Prosthodendrium longiforme in the present study in Eptesicus fuscus. Finding this helminth in central United States indicates the geographical distribution of this parasite must surely be greater than revealed by the literature.

Prosthodendrium swansoni, to the knowledge of the author, has only been reported from Myotis lucifugus of Minnesota by Macy (1936c). Therefore, having found this trematode in Myotis grisescens during this study constitutes a new host record.

Acanthatrium eptesici has been found in Myotis lucifugus and Eptesicus fuscus in Washington, D. C. by Alicata (1932). Acanthatrium micracanthum was found by Macy (1940a) in Eptesicus fuscus from Minnesota and by Gilford (M.S. 1952) in Pipistrellus subflavus from Illinois. Acanthatrium oregonense was reported from Oregon bats, Myotis evotis evotis and M. californicus caurinus by Macy (1947). In this study a new host record was established for these three species of Acanthatrium with Myotis grisescens.

Dicrocoelium rilevi was reported from Aetna, Kansas and Freedom, Oklahoma in the bat Tadarida cynocephala by Macy (1931b). In Texas, Chandler (1938), found Nycticeius humeralis to harbor this parasite. This present research revealed two new hosts for Dicrocoelium rilevi: Myotis velifer and Tadarida mexicana brasiliensis.

Urotrema scabridum has been reported from a number of species and has quite a large geographic distribution. It was first found by Alicata (1932b) in Washington, D. C. parasitising Lasiurus borealis. In Minnesota Macy (1933) found this parasite in Lasionycteris noctivagans. Nycticeius humeralis in Texas was discovered to harbor this trematode by Chandler (1938). Caballero (1942) is credited with the proper naming and description of this helminth. He reported finding it in Eptesicus fuscus, Tadarida brasiliensis, Molossus nigricans and Natalus mexicanus, all of Mexico. This present investigation revealed, apparently for the first time, that Myotis grisescens may serve as host for Urotrema scabridum.

Cestoda

Vampirolepis christensoni was described by Macy (1931a) from Myotis lucifugus captured in Minnesota. Arandas (1962) reported finding this cestode in Tadarida laticaudata of Brazil. This author recovered Vampirolepis christensoni from Myotis grisescens which constitutes a new host record for this parasite.

Vampirolepis roudabushi has been reported by Macy and Rausch (1946) in Eptesicus fuscus, Nycticeius humeralis and Lasionycteris noctivagans, Chiroptera captured in Ohio and Iowa. During this study, Vampirolepis roudabushi was found in Myotis keeni representing a new host record.

Vampirolepis gertschi, it appears, has been reported only by Macy (1947) from Myotis californicus caurinus in Oregon. This present research revealed a new host for this cestode in Myotis velifer.

Nematoda

Molinostrongylus delicatus was described by Schwartz (1927) from "certain Chiroptera of Texas"; the term brown bat was used which is the common name of Eptesicus fuscus. It is likely, therefore, that Tadarida mexicana brasiliensis, the host disclosed in this investigation, may be considered a newly reported host for Molinostrongylus delicatus.

Allintoshius nycticeius was found by Chitwood (1937a) in Nycticeius humeralis taken in Washington, D. C. The present study established a new host record with Myotis velifer incautus.

Allintoshius travassosi was described by Chandler (1938) from Nycticeius humeralis of Texas. During the present study, this species of nematode was recovered from Eptesicus fuscus, Myotis velifer and M. grisescens which are new host records.

Capillaria palmata was also described by Chandler (1938) from Nycticeius

humeralis captured in Texas. In this investigation Myotis grisescens was found to harbor Capillaria palmata constituting a new host record.

Table 1. Parasites recovered for individual hosts.

Group	Host	Sex	Parasites Harbored	Specimens (no.)
1	Myotis lucifugus	F	negative	
	M. lucifugus	F	negative	
	M. lucifugus	M	negative	
	M. lucifugus	M	negative	
	M. keeni	M	negative	
	M. keeni	M	Vampirolepis roudabushi	1
	Pipistrellus subflavus	M	negative	
	P. subflavus	M	negative	
	P. subflavus	M	negative	
	P. subflavus	F	negative	
2	Eptesicus fuscus	F	Plagiorchis vespertilionis	1
	E. fuscus	F	negative	
	E. fuscus	M	Allintoshius travassosi	2
			Prosthodendrium longiforme	6
	E. fuscus	M	negative	
3	Myotis keeni	F	negative	
	M. keeni	M	negative	
	M. lucifugus	M	negative	
	M. lucifugus	M	negative	
	M. lucifugus	M	negative	
	M. lucifugus	M	negative	
4	Myotis keeni	F	negative	
	M. keeni	M	negative	
	M. lucifugus	M	negative	
	M. lucifugus	F	negative	
	M. lucifugus	F	negative	
	M. lucifugus	M	Plagiorchis vespertilionis	1
	Pipistrellus subflavus	F	Plagiorchis micracanthos	2
	P. subflavus	M	negative	
	P. subflavus	M	negative	
	P. subflavus	M	negative	
	P. subflavus	M	negative	
	P. subflavus	F	negative	

Table 1 (cont.)

Group	Host	Sex	Parasites Harbored	Specimens (no.)
5	Myotis velifer	F	Vampirolepis gertschi	1
	M. velifer	F	Vampirolepis gertschi	1
			Allintoshius travassosi	9
	M. velifer	M	Vampirolepis gertschi	1
			Vampirolepis sp.	1
			Allintoshius travassosi	2
	M. velifer	M	Dicrocoelium rileyi	33
6	Tadarida mexicana brasiliensis	M	negative	
	T. mexicana brasiliensis	F	negative	
	T. mexicana brasiliensis	F	negative	
	T. mexicana brasiliensis	M	negative	
	T. mexicana brasiliensis	M	Dicrocoelium rileyi	3
	T. mexicana brasiliensis	M	negative	
	T. mexicana brasiliensis	F	Molinostrongylus delicatus	2
	T. mexicana brasiliensis	F	negative	
7	T. mexicana brasiliensis	M	negative	
	Myotis grisescens	M	Vampirolepis christensoni	1
			Urotrema scabridum	10
	M. grisescens	M	Urotrema scabridum	6
			Prosthodendrium swansoni	8
			Capillaria palmata	6
	M. grisescens	M	Prosthodendrium swansoni	7
			Capillaria palmata	5
			Allintoshius travassosi	15
	M. grisescens	M	Urotrema scabridum	10
			Prosthodendrium swansoni	12
			Acanthatrium sp.	2
			Capillaria palmata	9
			Allintoshius travassosi	3
	M. grisescens	M	Urotrema scabridum	8
			Prosthodendrium swansoni	15
			Acanthatrium antesici	5
			Capillaria palmata	8
			Allintoshius travassosi	5
	M. grisescens	F	Urotrema scabridum	2
			Prosthodendrium swansoni	4
			Capillaria palmata	3
			Allintoshius travassosi	2
	M. grisescens	M	Urotrema scabridum	4
			Prosthodendrium swansoni	4
			Capillaria palmata	2
			Allintoshius travassosi	1

Table 1 (cont.)

Group	Host	Sex	Parasites Harbored	Specimens (no.)
7 cont.	Myotis grisescens	M	Allintoshius travassosi	6
	M. grisescens	M	Urotrema scabridum	9
			Prosthodendrium swansoni	3
			Capillaria palmata	3
			Allintoshius travassosi	4
	M. grisescens	M	Prosthodendrium swansoni	6
			Capillaria palmata	4
			Allintoshius travassosi	3
	M. grisescens	M	Urotrema scabridum	78
			Prosthodendrium swansoni	75
			Acanthatrium micracanthum	18
			Allassogonoporus marginalis	1
			Capillaria palmata	2
			Allintoshius travassosi	9
	M. grisescens	M	Urotrema scabridum	5
			Prosthodendrium swansoni	41
			Acanthatrium oregonense	6
			Capillaria palmata	1
	M. grisescens	M	Capillaria palmata	2
			Allintoshius travassosi	7
8	M. velifer incautus	F	Allintoshius nycticeius	5
	M. velifer incautus	M	negative	
	M. velifer incautus	M	negative	
9	Plecotus townsendii	M	negative	
	P. townsendii	M	negative	
	P. townsendii	M	negative	
	P. townsendii	M	negative	

Table 2. Incidence (%) of helminth infections in bats.

Helminth / Host	* 1	2	3	4	5	6	7	8	9	All hosts
TREMATODA										
Plagiorchis vespertilionis	8.3						25.0			3.0
P. micracanthos						10.0				1.5
Allassogonoporus marginalis					7.6					1.5
Prosthodendrium longiforme							25.0			1.5
P. swansoni					77.0					15.3
Acanthatrium eptesici					7.6					1.5
A. micracanthum					7.6					1.5
A. oregonense					7.6					1.5
Dicrocoelium rilevi			25.0					11.1		3.0
Urotrema scabridum					69.2					13.8
CESTODA										
Vampirolepis christensoni					7.6					1.5
V. gertschi			75.0							4.6
V. roudabushi		16.6								1.5
NEMATODA										
Capillaria palmata					84.6					16.9
Allintoshius travassosi			50.0		77.0		25.0			21.5
A. nycticeius				33.3						1.5
Molinostrongylus delicatus								11.1		1.5

* Hosts and the number examined in parentheses: 1 Myotis lucifugus (12), 2 M. keeni (6), 3 M. velifer (4), M. velifer incautus (3), 5 M. grisescens (13), 6 Pipistrellus subflavus (10), 7 Eptesicus fuscus (4), 8 Tadarida mexicana brasilienses (9), 9 Plecotus townsendii (4).

Table 3. Incidence of infection correlated with host species and sex.

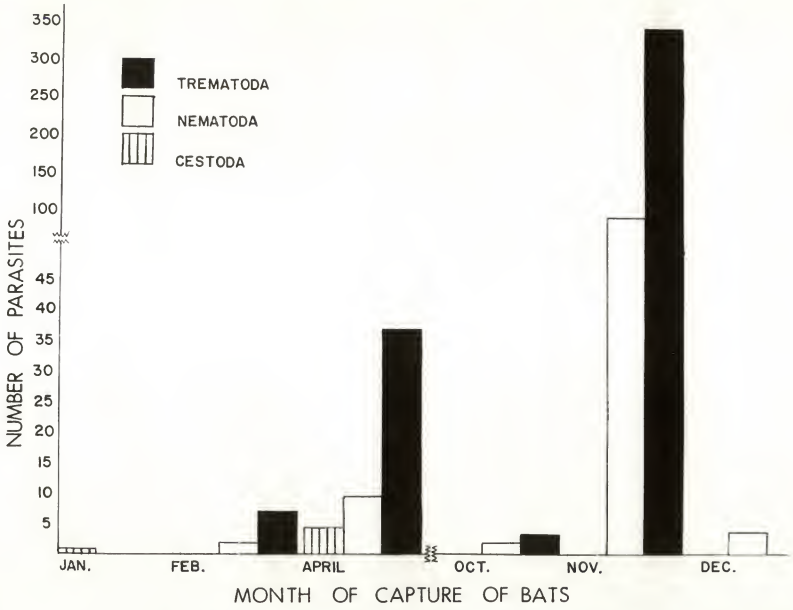
Host	MALES Examined (No.)	MALES Infected (No.)	MALES Infected (%)	FEMALES Examined (No.)	FEMALES Infected (No.)	FEMALES Infected (%)	Helminth
Myotis lucifugus	8	1	12.5	4	0	0	Plagiorchis vespertilionis
M. keeni	4	1	25.0	2	0	0	Vampirolepis roudabushi
M. velifer	2	1	50.0	2	2	100.0	Vampirolepis gertschi
		1	50.0		1	50.0	Allintoshius travassosi
		1	50.0		0	0	Dicrocoelium rileyi
M. velifer incautus	2	0	0	1	1	100.0	Allintoshius nycticeius
M. grisescens	12	9	75.0	1	1	100.0	Prosthodendrium swansoni
		8	66.6		1	100.0	Urotrema scabridum
		10	83.3		1	100.0	Capillaria palmata
		9	75.0		1	100.0	Allintoshius travassosi
		1	8.3		0	0	Allassogonoporus marginalis
		1	8.3		0	0	Vampirolepis christensoni
		1	8.3		0	0	Acanthatrium eptesici
		1	8.3		0	0	Acanthatrium micracanthum
		0	0		1	100.0	Acanthatrium oregonense
Pipistrellus subflavus	7	0	0	3	1	33.3	Plagiorchis micracanthos
Eptesicus fuscus	2	1	50.0	2	0	0	Allintoshius travassosi
		1	50.0		0	0	Prosthodendrium longiforme
		0	0		1	50.0	Plagiorchis vespertilionis
Tadarida mexicana	5	1	20.0	4	0	0	Plagiorchis vespertilionis
brasiliensis		0	0		1	25.0	Molinostrongylus delicatus
Plecotus townsendii	4	0	0	0	0	0	
ALL HOSTS	45	18	40.0	19	7	36.9	ALL HELMINTHS

Table 4. Actual number of helminths correlated with species and sex of host.

Helminth *	Hosts and Number Examined in Parentheses																					
	1 (12)		2 (6)		3 (4)		4 (3)		5 (13)		6 (10)		7 (4)		8 (9)		9 (4)		ALL	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Trematoda	1	0	0	0	33	0	0	0	334	6	0	2	6	1	3	0	0	0	377	9
Cestoda	0	0	1	0	2	2	0	0	1	0	0	0	0	0	0	0	0	0	4	2
Nematoda	0	0	0	0	2	9	0	5	100	5	0	0	2	0	0	2	0	0	104	21
Total Burden	1	0	1	0	37	11	0	5	434	11	0	2	8	1	3	2	0	0	485	32

* Hosts: 1 Myotis lucifugus, 2 M. keeni, 3 M. velifer, 4 M. velifer incautus, 5 M. grisescens, 6 Pipistrellus subflavus, 7 Eptesicus fuscus, 8 Tadarida mexicana brasiliensis, 9 Plecotus townsendii.

Figure 1. Seasonal variation in number of helminths recovered.


350
300
250
200
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100
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TREMATODA
NEMATODA
CESTODA
NUMBER OF PARASITES
JAN.
FEB.
APRIL
OCT.
NOV.
DEC.
MONTH OF CAPTURE OF BATS

Keys and Descriptions of the Species of Helminths

Recovered from Bats in Kansas and Nebraska

Key to the Trematoda

1. a. Body size generally very small, shape is oval to pyriform; Testes located on both side of body opposite each other----------2

   b. Body size generally moderate, shape is elongate; Testes located one behind the other----------7

2. a. Genital pore marginal----------Allassogonoporus marginalis

   b. Genital pore medial, preacetabular----------3

3. a. Spines present in or on genital atrium----------4

   b. Spines not present in or on genital atrium----------6

4. a. Spines of genital atrium about 25 microns long and arranged in a compact crescent-shaped group----------Acanthatrium eptesici

   b. Spines much shorter than 25 microns----------5

5. a. Spines 3-7 microns long and arranged in single straight row; prostate mass smaller than either testes-------Acanthatrium micracanthum

   b. Spines 10-15 microns long and arranged in single crescent; prostate mass not smaller than either testes-----Acanthatrium oregonense

6. a. Body broad, pyriform measuring 2.0 - 3.5 mm long-Prosthodendrium longforme

   b. Body ovate, measuring 0.93 - 1.4 mm long--------Prosthodendrium swansoni

7. a. Cirrus sac and genital opening at posterior end of the body----------Urotrema scabridum

   b. Cirrus sac and genital opening near acetabulum----------8

8. a. Ovary behind testes----------Dicrocoelium rileyi

   b. Ovary in front of testes----------9

9. a. Vitellaria extending past acetabulum almost to pharynx----------Plagiorchis micracanthos

   b. Vitellaria not extending anterior beyond acetabulum---------- Plagiorchis vespertilionis

Descriptions of trematodes

Family: Plagiorchiidae Ward, 1917

sub-Family: Plagiorchiinae Pratt, 1902

Genus: Plagiorchis Luhe, 1899

species: micracanthos Macy , 1931

Specific diagnosis: Plagiorchis micracanthos (Plate I, Figure 1). Body not much flattened dorso-ventrally, somewhat constricted at both ends and measuring 2.2 mm long by 0.8 mm wide; anterior third of the cuticula provided with spines, Oral sucker 0.17 mm wide by 0.19 mm long; ventral sucker, 0.15 mm wide by 0.15 mm long, and situated 0.54 mm from anterior end of body. Muscular pharynx 0.082 mm wide by 0.096 mm long; esophagus short but may stretch to length of pharynx. Intestinal caeca thick walled and reach almost to posterior end of body; intestinal fork approximately mid-way between oral sucker and genital pore. Anterior testis measures 0.28 mm wide by 0.23 mm long; posterior testis, 0.32 mm long by 0.26 mm wide. Cirrus sac 0.34 mm long, passes over acetabulum and curves aroung to genital pore which is just pre-acetabular. Cirrus present; posterior part of the cirrus sac adjacent to the ovary and anterior testis. Seminal vesicle large and distinct. Ovary, 0.16 mm wide by 0.22 mm long, located immediately in front of anterior testis and slightly to right of longitudinal axis of body. Seminal receptacle and Laurer's canal apparently not present. Uterus consists of ascending and descending limb filling median field of posterior half of body. Eggs 0.037 mm long by 0.013 mm wide.

Host; Pipistrellus subflavus

Habitat: Intestine

Locality: Sarpy County, Nebraska

Family: Plagiorchiidae Ward, 1917

sub-Family: Plagiorchiinae Pratt, 1902

Genus: Plagiorchis Luhe, 1899

species: vespertilionis (Mueller, 1784) Braun, 1900

Specific diagnosis: Plagiorchis vespertilionis (Plate I, Figure 2) Body elongate, tapering at both extremities but more gradually at posterior than anterior, measures 4.0 to 9.0 mm long by 0.9 mm wide. Cuticula spined; less so laterally and posteriorly. Oral sucker subterminal, slightly larger than ventral sucker, measures 0.23 to 0.25 mm in diameter. Pharynx, 0.145 mm long by 0.125 mm wide; esophagus short and wide; caeca, long and relatively wide, extending almost to posterior end of body. Acetabulum, 0.21 to 0.22 mm in diameter, located approximately two-fifths of body length from anterior end. Prominent, muscular cirrus sac occupies space between ovary and acetabulum measures approximately 1.0 mm long. Genital pore, slightly in front of ventral sucker, located a little to one side of median line. Testes rounded, situated diagonally one behind the other in posterior half of body. Ovary in front of testes, in posterior portion of anterior half of body, dorsal to cirrus sac. Uterus composed of ascending and descending limb, passes between testes and between anterior testis and ovary to genital pore. Eggs 0.033 mm long by 0.018 mm wide. Vitellaria well developed, lateral, often extending under caeca and confined to region behing acetabulum, terminating in front of posterior end of body. Excretory bladder Y-shaped.

Host: Eptesicus fuscus, Myotis lucifugus

Habitat: Intestine

Locality: Leavenworth County, Kansas and Sarpy County, Nebraska

Family: Lecithodendriidae Odhner, 1910

sub-Family: Allassogonoporinae Skarbilovitch, 1943

Genus: Allassogonoporus Oliver, 1938

species: marginalis Oliver, 1938

Specific diagnosis: Allassogonoporus marginalis (Plate I, Figure 3) (syn. Myotitrema asymmetrica Macy, 1940 and Allassogonoporus vespertilionis Macy, 1940) Body somewhat elongate, 0.77 to 1.5 mm long by 0.65 to 0.70 mm wide, flattened dorso-ventrally; prominent spines cover two-thirds of body surface. Oral sucker subterminal, 0.07 to 0.08 mm long by 0.10 to 0.11 mm wide. Pharynx 0.04 mm long by 0.03 to 0.05 mm wide; esophagus relatively long. Intestinal bifurcation at anterior margin of acetabulum. Intestinal caeca moderately long, reaching past middle of body. Acetabulum somewhat larger than oral sucker, 0.11 to 0.13 mm in diameter, situated anterior to middle of body. Testes, subtriangular to ovate, average diameter 0.13 to 0.14 mm, postacetabular, located just anterior to middle of body. Seminal vesicle sinuous, lying free in body parenchyma, maximum width 0.037 to 0.038 mm. Prostate cells, numerous but diffusely arranged. Genital pore, on right side of body at or near level of acetabulum. Ovary subtriangular with tendency toward slight lobation, situated immediately anterior to testes on left side of body. Neither a seminal receptacle nor Laurer's canal observed. Vitellaria, elongate follicles, characteristically diffuse extending from level of acetabulum to region just behind pharynx. Uterus fills most of posterior half of body, terminating in a swollen transverse sling which extends from level of ovary across body to genital pore. Excretory bladder V-shaped. Eggs similar to related genera, 0.019 mm long by 0.012 mm wide.

Host: Myotis grisescens

Habitat: Intestine

Locality: Crawford County, Kansas

Family: Lecithodendriidae Odhner, 1910

sub-Family: Prosthodendriinae Yamaguti, 1939

Genus: Prosthodendrium Dollfus, 1931

Species: longiforme Bhalerao, 1926

Specific diagnosis: Prosthodendrium longiforme (Plate I, Figure 5) Body broad, fusiform, greatest width at level of acetabulum; 2.14 to 3.48 mm long by 1.07 to 1.47 mm wide. Cuticula thin, without spines. Oral sucker subterminal, 0.488 mm to 0.55 mm long by 0.46 to 0.47 mm wide. Acetabulum smaller than oral sucker, circular, 0.32 to 0.37 mm in diameter. Muscular pharynx approximately 0.13 mm in diameter. Prepharynx apparently absent. Pharynx followed by short esophagus, 0.07 mm long. Intestinal caeca, 0.38 mm long and 0.12 mm broad, situated anterior to testes between them and vitellaria. Caecal walls thick, glandular, diverging laterally and reaching border of testes. Testes round to ovoid, 0.32 to 0.37 mm by 0.40 to 0.47 mm, symmetrically placed at sides of body, at end of anterior third of body, and occupy same transverse plane as ventral sucker. Prostate gland-complex round, 0.23 mm by 0.23 mm, containing seminal vesicle opening into unarmed genital atrium, through genital pore anterior to ventral sucker, slightly to left of midline. Ovary round to oval, 0.24 to 0.27 mm long by 0.19 to 0.27 mm wide, anterior to left testis, between it and intestinal caeca. Oviduct leaves ovary, passes posteriad between right testis and ventral sucker. Seminal receptacle, 0.12 mm in diameter, right of ootype into which it opens. Laurer's canal present. Uterine fold for most part longitudinal, usually limited to region behind level of testes and ventral sucker. Vitellaria consist of 10 to 15 follicles on each side of body, situated lateral of pharynx and esophagus and anterior to intestinal caeca. Vitelline ducts join on right side of ventral sucker. Eggs measure 0.029 to 0.035 mm long by 0.015 to 0.016 mm wide.

Host: Eptesicus fuscus

Habitat: Intestine

Locality: Leavenworth County, Kansas

Family: Lecithodendriidae Odhner, 1910

sub-Family: Prosthodendriinae Yamaguti, 1939

Genus: Prosthodendrium Dollfus, 1931

Species: swansoni Macy, 1936

Specific diagnosis: Prosthodendrium swansoni (Plate I, Figure 4) Body typically ovate but sometimes rather elongate, 0.93 to 1.42 mm long by 0.59 to 0.68 mm wide. Cuticula smooth in young specimens but small spines present at anterior end of larger specimens. Oral sucker subterminal, 0.122 to 0.166 mm wide by 0.123 to 0.146 mm long. Ventral sucker, 0.132 to 0.155 mm wide by 0.117 to 0.124 mm long, located in posterior part of anterior half of body. Pharynx, 0.055 to 0.071 mm wide by 0.04 to 0.053 mm long; esophagus very short and intestinal caeca extend from level of pharynx to anterior margin of testes. Testes, oval, measure 0.127 to 0.170 mm in width by 0.133 to 0.178 mm in length, placed one on each side on acetabulum. Seminal vesicle S-shaped and contained in prostate gland-complex. Prostate gland-complex, 0.171 to 0.195 mm in diameter lies with posterior margin against ventral sucker and anterior margin near pharynx. Genital pore, close to anterior third of prostate gland-complex, usually to one side of longitudinal axis of body. Ovary, entire or slightly lobed, more or less oval, 0.115 to 0.22 mm wide by 0.128 to 0.19 mm long, located between testes and usually a little to right of longitudinal body axis. Seminal receptacle, immediately posterior to ovary, 0.06 to 0.07 mm in diameter. Vitellaria, two groups of numerous, closely packed follicles extending on each side of body from oral

sucker to anterior margins of testes. Uterus occupies most of area behind posterior margin of testes, its coils mainly longitudinal. Eggs 0.012 to 0.013 mm wide by 0.020 to 0.022 mm long. Excretory bladder, V-shaped.

Host: Myotis grisescens

Habitat: Intestine

Locality: Crawford County, Kansas

Family: Lecithodendriidae Odhner, 1910

sub-Family: Prosthodendriinae Yamaguti, 1939

Genus: Acanthatrium (Faust, 1919) Skarbilovitch, 1948

species: eptesici Alicata, 1932

Specific diagnosis: Acanthatrium eptesici (Plate I, Figure 6) Body rounded, flattened dorso-ventrally; 0.702 to 1.200 mm long by 0.468 to 0.764 mm wide in middle of body. Cuticular spines absent. Oral sucker subterminal, 0.098 to 0.114 mm long by 0.098 to 0.114 mm wide; acetabulum 0.072 to 0.098 mm long by 0.080 to 0.098 mm wide. Prepharynx absent; pharynx 0.038 to 0.045 mm long by 0.080 to 0.098 wide; esophagus 0.034 to 0.076 mm long. Intestinal caeca short, simple, extending to anterior margins of testes. Excretory bladder V-shaped. Testes ovoid to pyriform, located on same zone as acetabulum and transverse in position; right testis 0.121 to 0.258 mm long by 0.091 to 0.197 mm wide. Seminal vesicle long and coiled; prostate gland cells numerous, forming a mass enclosed in a delicate sac-like membrane 0.121 to 0.327 mm long by 0.186 to 0.358 mm wide. Genital pore somewhat anterior to acetabulum and lined with one group of long, narrow spines about 25 microns long. Ovary ovoid, regular or lobed, largest axis transverse, oblique or longitudinal in position. Vitellaria composed of large follicles which may extent from about level of pharynx to anterior margins of testes. Uterus long and arranged, for the most part transversly, occupying posterior half of body

length and terminating in moderately developed metraterm. Eggs oval, 0.020 to 0.030 mm long by 0.015 mm wide with yellowish brown thin shell.

Host: Myotis grisescens

Habitat: Intestine

Locality: Crawford County, Kansas

Family: Lecithodendriidae Odhner, 1910

sub-Family: Prosthodendriinae Yamaguti, 1939

Genus: Acanthatrium (Faust, 1919) Skarbilovitch, 1948

species: oregonense Macy, 1939

Specific diagnosis: Acanthatrium oregonense (Plate I, Figure 8) Body pyriform, considerably flattened dorso-ventrally, 0.65 to 0.82 mm long by 0.65 to 0.83 mm wide. Cuticula without spines. Oral sucker terminal or subterminal, 0.078 to 0.090 mm in diameter. Acetabulum, just anteriad of middle of body, approximately equal to oral sucker, 0.085 to 0.090 mm in diameter; anterior margin of ventral sucker situated 0.27 to 0.30 mm from anterior end of body. Pharynx is 0.032 to 0.038 mm long by 0.042 to 0.045 mm wide. Prepharynx has not been observed. Esophagus apparently absent, or extremely short, if present. Testes ovate, 0.14 to 0.18 mm in diameter, located at ends of intestinal caeca. Prostate gland-complex large, 0.16 mm to 0.22 mm in its average diameter, bordered anteriorly by caeca and posterior portion of complex overlaps acetabulum. A coiled seminal vesicle empties into genital pore, the latter surrounded by a sphincter muscle and located near center of prostate gland-complex. Atrial spines 10 to 15 microns long and arranged in long crescent between genital pore and anterior margin of prostate gland-complex. Ovary, overlapping posterior portion of testicular zone, on right side of body, 0.07 to 0.11 mm long by 0.12 to 0.185 mm wide. Vitellaria in

two lateral compact masses which extend antero-posterad from level of pharynx to level of testes. Eggs of transverse uterine slings, which fill posterior portion of body, 0.030 mm long by 0.016 mm wide.

Host: Myotis grisescens

Habitat: Intestine

Locality: Crawford County, Kansas

Family: Lecithodendriidae Odhner, 1910

sub-Family: Prosthodendriinae Yamaguti, 1939

Genus: Acanthatrium (Faust, 1919) Skarbilovitch, 1948

species: micracanthum Macy, 1940

Specific diagnosis: Acanthatrium micracanthum (Plate I, Figure 7) Body 0.9 to 1.1 mm long by 0.65 to 0.70 mm wide. Cuticula without spines. Oral sucker subterminal 0.12 to 0.16 mm wide by 0.07 to 0.15 mm long. Ventral sucker 0.12 to 0.15 mm wide to 0.08 to 0.14 mm long, located between testes and overlapped by prostate gland-complex. Pharynx nearly spherical, 0.04 to 0.06 mm in diameter; esophagus in relaxed specimens very long; intestinal caeca short, lecithodendrid type. Testes rounded, 0.19 mm in diameter and postequatorial in relaxed specimens, equatorial to pre-equatorial in contracted forms. Prostate gland-complex approximately 0.17 mm in diameter and situated between testes and intestinal fork. Genital atrium near middle or in anterior portion of gland-complex. Spines line genital atrium, 0.005 to 0.007 mm in length. A coiled seminal vesicle present in gland-complex. Ovary approximately 0.15 mm in diameter, located between testes but in contracted specimens bay be shifted slightly backwards. Vitellaria reduced and located around intestinal caeca just anteriad of testes. Follicles of vitellaria rather distinct with 5 to 8 on each side of body. Uterus composed of heavy slings which nearly fill posterior half of body. Eggs measure 0.020 to 0.030

mm long by 0.015 mm wide. Excretory bladder V-shaped.

Host: Myotis grisescens

Habitat: Intestine

Locality: Crawford County, Kansas

Family: Dicrocoelidae Odhner, 1911

sub-Family: Dicrocoeliinae Looss, 1899

Genus: Dicrocoelium Dujardin, 1845

species: rileyi Macy, 1931

Specific diagnosis: Dicrocoelium rileyi (Plate I, Figure 9) Body flattened dorso-ventrally, lancet shaped, 2.0 to 2.8 mm long by 0.6 to 0.89 mm wide; cuticula without spines. Oral sucker 0.26 mm wide by 0.062 to 0.068 mm long; delicate esophagus present. Intestinal bifurcation approximately mid-way between two suckers, dorsal to genital pore; intestinal caeca narrow, thin-walled and do not extend posterior to vitellaria. Anterior testis, 0.29 to 0.49 mm wide by 0.27 to 0.40 mm long; posterior testis, 0.29 to 0.56 mm wide by 0.34 to 0.47 mm long. Testes somewhat lobed and obliquely placed; vasa efferentia unite near mid-acetabular zone to form vas deferans which passes into cirrus pouch where it terminated, in coiled seminal vesicle. Elliptical ovary, 0.22 mm wide by 0.11 mm long, located immediately behind posterior testis and slightly to right of median axis of body; in some specimens it is slightly lobed. Seminal receptacle ventral and slightly posterior to ovary, 0.073 mm in diameter. Mehlis' gland, composed of rather indefinite mass of gland cells posterior to and usually to left of ovary and seminal receptacle. Yolk reservoir located at union of two vitelline ducts which extend from vitellaria. Vitellaria located at maximum body width, usually post-equatorial and do not extend over one-sixth of body length; no more than 20 in number. Ascending and descending limbs

of uterus completely fill posterior part of body. Eggs, 0.019 mm wide by 0.035 mm long. Excretory bladder Y-shaped.

Host: Myotis velifer, Tadarida mexicana brasiliensis

Habitat: Gall bladder and bile duct

Locality: Comanche County, Barber County, Kansas; Woods County, Oklahoma

Family: Urotrematidae Poche, 1926

Genus: Urotrema Braun, 1900

species: scabridum (Braun, 1900) Cabellero, 1942

Specific diagnosis: Urotrema scabridum (Plate I, Figure 10) Body elongate, widest in middle region of body and flattened dorso-ventrally, 4 mm long by 0.83 mm wide. Cuticula finely spined over pre-equatorial portion. Oral sucker, sub-terminal, 0.187 mm long by 0.24 mm wide; acetabulum 0.271 mm long by 0.260 mm wide. Prepharynx very short, pharynx fairly prominent; esophagus comparatively long. Intestinal caeca extend nearly to anterior level of cirrus pouch, quite well developed. Testes sub-spherical to oval, situated in median line in posterior third of body and immediately anterior to cirrus pouch. Oval ovary entire, median, situated a short distance posterior to ventral sucker. Cirrus pouch pyriform to spindle-shaped, usually obliquely placed to somewhat parallel, post-testicular, in caudal end of body. Cirrus poorly developed and unarmed; seminal vesicle coiled and filling cirrus pouch. Uterus with numerous transverse folds, terminating in a metraterm. Genital pore caudo-terminal; shell gland slightly postovarial. Vitellaria marginal, symmetrical, in equatorial thrid, postacetabular, pretesticular, extending slightly preovarial. Eggs 0.018 mm long by 0.009 mm wide.

Host; Myotis grisescens

Habitat: Intestine

Locality: Crawford County, Kansas

EXPLANATION OF PLATE I

All drawings made with aid of camera lucida.

Fig. 1. Plagiorchis micracanthos, dorsal view.

Fig. 2. Plagiorchis vespertilionis, ventral view.

Fig. 3. Allassogonoporus marginalis, ventral view.

Fig. 4. Prosthodendrium swansoni, ventral view.

Fig. 5. Prosthodendrium longiforme, ventral view.

Fig. 6. Acanthatrium eptesici, ventral view.

Fig. 7. Acanthatrium micracanthum, ventral view.

Fig. 8. Acanthatrium oregonense, ventral view.

Fig. 9. Dicrocoelium rileyi, ventral view.

Fig. 10. Urotrema scabridum, ventral view.


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0.2mm


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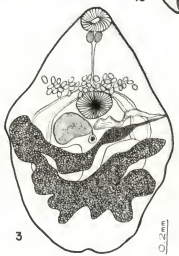
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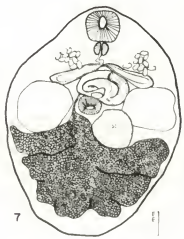
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Key to the Cestoda (Family Hymenolepididae)

1. a. Edges of strobila serrate---------- Vampirolepis roudabushi

   b. Edges of strobila not serrate----------2

2. a. Length of strobila not much more than 55 mm. Three testes placed close together in transverse row--------- Vampirolepis gertschi

   b. Length of strobila much more than 55 mm (up to 4.0 cm). Three testes, two antiporal and one poral in transverse row---------- Vampirolepis christensoni

Descriptions of cestodes

Family: Hymenolepididae Railliet and Henry, 1909

sub-Family: Hymenolepidinae Perrier, 1897

Genus: Vampirolepis Spassky, 1954

species: christensoni (Macy, 1931) Spassky, 1954

Specific diagnosis: Vampirolepis christensoni (Plate II, Figures 1 and 2) Strobila, 2.8 to 4.0 cm long; maximum width 1.5 mm, minimum width, 0.29 mm at a distance of 1.4 mm from anterior end. Last few proglottids somewhat distended by egg-filled uteri. Segmentation first noticeable at a distance of about 4.5 mm from anterior end. Genital pores unilateral and centrally located on right side of each proglottid. Scolex: poorly differentiated, about 0.32 mm wide and carrying four suckers, each about 0.11 mm in diameter. Musculature of suckers poorly developed. Rostellum, 0.13 mm long by 0.14 mm wide; provided with a rostellar sac somewhat longer than rostellum; distal end armed with a single row of about 35 small hooks, 0.033 mm long. Testes, three; two antiporal and one poral in transverse row in posterior region of proglottid. Those midway on strobila measure about 0.08 mm by 0.06 mm. Vasa efferentia lie on dorsal side of testes. Internal seminal vesicle, 0.08 mm long by 0.04 mm wide; dorsal to vagina and soon connecting to exterior seminal vesicle by a wide duct. External seminal vesicle about 0.5 mm by 0.03 mm. Cirrus duct,

0.04 mm wide by 0.11 mm long, with muscular walls. Cirrus straight, distal and lying along dorsal wall of genital atrium. Seminal vesicles and cirrus just dorsal to vagina. Ovary, narrow, somewhat lobed, about 0.22 mm long by 0.04 mm wide. Vitelline gland compact, oval, in transverse plane of testes but ventral to them, 0.06 mm long by 0.04 mm wide. Seminal receptacle, 0.5 mm. Uterus filling larger part of ripe proglottid; divided by septa into many lobes. Eggs about 0.05 mm in diameter.

Host: Myotis grisescens

Habitat: Intestine

Locality: Crawford County, Kansas

Family: Hymenolepididae Railliet and Henry, 1909

sub-Family: Hymenolepidinae Perrier, 1897

Genus: Vampirolepis Spassky, 1954

species: roudabushi (Macy and Rausch, 1946) Spassky, 1954

Specific diagnosis: Vampirolepis roudabushi (Plate II, Figures 3 and 4) Strobila serrate, 40 to 70 mm long by a maximum width of about 1.5 mm toward the posterior end. Scolex 0.26 to 0.31 mm wide, with sucker 0.07 to 0.08 mm in diameter, and a crown of from 41 to 48 hooks each measuring from 0.38 to 0.43 mm in length. Genital pores unilateral, slightly anterior to middle of each proglottid. Testes 0.11 to 0.18 mm in diameter, with one poral and two antiporal in position; arranged in a transverse field instead of a triangular position as in some species. External seminal vesicle about 0.25 mm long by 0.05 mm wide; reaching inward past longitudinal excretory canal, a point of difference compared with some other species. Internal seminal vesicle paralleling position of poral testis and measuring from 0.15 to 0.18 mm long by 0.10 mm wide. Cirrus often slightly protruding from genital pore; aspinose.

Ovary narrow, not appreciably lobed; about 0.3 mm long by about 0.04 mm wide; placed midway between longitudinal excretory canals. Vitellaria directly posterior to ovary; about 0.06 mm in diameter. Seminal receptacle prominent about 0.4 mm long; conspicuous and retort-shaped in gravid proglottids. Eggs 0.025 to 0.030 mm in size.

Host: Myotis keeni

Habitat: Intestine

Locality: Marshall County, Kansas

Family: Hymenolepididae Railliet and Henry, 1909

sub-Family: Hymenolepidinae Perrier, 1897

Genus: Vampirolepis Spassky, 1954

species: gertschi (Macy, 1947) Spassky, 1954

Specific diagnosis: Vampirolepis gertschi (Plate II, Figures 5 and 6) Maximum length of strobila about 55 mm long, margins not serrate. Mature proglottids average 0.65 mm wide by 0.23 mm long. Genital pores unilateral, without any noted exception, located just anterior to middle of proglottid. Scolex about 0.4 mm wide, only slightly wider than neck region. Suckers 0.08 to 0.10 mm in diameter. Rostellar sac 0.18 mm long by 0.18 mm wide. Rostellum with a crown of 35 to 41 hooks, each measuring 0.026 to 0.029 mm in length. Handle of each hook with a slight, characteristic bend. Three testes placed very close together in a transverse row near central, posterior part of proglottid. Average diameter of each testis, 0.075 mm. Internal seminal vesicle, 0.096 mm long by 0.050 mm wide. Cirrus sac 0.090 to 0.120 mm long by 0.030 to 0.039 mm wide. Ovary 0.16 mm long by 0.05 mm wide, anterior to testes and on longitudinal axis of proglottid. Vitelline mass about 0.07 mm in diameter, overlapping central testis. Seminal receptacle 0.130 mm long by 0.062 mm wide. Eggs, 0.027 mm by

0.032 mm in size.

Host: Myotis velifer

Habitat: Intestine

Locality: Comanche County, Kansas

Key to the Nematoda

1. a. Esophagus long, straight and formed of single cells; head region very small, indistinct with no cephalic cuticular expansion---------- Capillaria palmata (Family Trichuridae)

   b. Esophagus short and more or less club-shaped; head region distinct with cephalic cuticular expansion----------2 (Family Trichostronglidae)

2. a. Tail of female with three tooth-like processes; male with long, slender spicules----------Molinostrongylus delicatus

   b. Tail of female narrows to one sharp process; male with short, conical spicules----------3

3. a. Female, cephalic cuticular expansion 40 microns wide with indentation near anterior; body 125-140 microns wide just anterior to vulva. Male, spicules 70-75 microns long---------- Allintoshius travassosi

   b. Female, cephalic cuticular expansion 35 microns wide with no indentation, body 100 microns wide just anterior to vulva. Male, spicules 100-110 microns long---------- Allintoshius nycticeius

Descriptions of nematodes

Family: Trichuridae Railliet, 1915

sub-Family: Capillariinae Railliet, 1915

Genus: Capillaria Zeder, 1800

species: palmata Chandler, 1938

Specific diagnosis: Capillaria palmata (Plate II, Figures 7, 8 and 9) Very small, slender transparent worms. Mouth small, without papillae. Cuticle with extremely fine transverse striations in about second fourth of body.

Cuticle with fine longitudinal striations. Female 21 to 22 mm long; body tapers from very fine head, only about 8 to 10 microns in diameter, to a maximum diameter of 110 to 120 microns in posterior third of body. Near caudal end, body tapers again, and has a bluntly rounded termination with a slight furrow in it. Body about 50 microns broad just anterior to subterminal anus. Esophagus, 6.7 to 6.9 mm long, running one-third of body length. Vulva situated about 50 microns behind end of esophagus, and opens on a penis-like prominence which is about 65 to 90 microns long and 22 to 25 microns in diameter. Vulva opens into a vagina which has a very narrow lumen and a very thick muscular wall; about 40 to 50 microns posterior to vulva, wall thins and lumen gradually enlarges. Eggs 47 to 50 microns by 31-32 microns, embryonated. Male 10 to 12 mm long, tapering from fine head, 8 microns in diameter, to a maximum diameter of 50 to 60 microns, which is maintained for greater part of its length. Esophagus, 3.7 to 4.4 mm long; spicules 1.05 to 1.2 mm long and about 5 to 6 microns in diameter. Sheath about 20 microns broad, without spines, but with conspicuous transverse straitions except towards distal end where they become fine. Caudal end of body provided with a pair of lateral alae about 75 to 80 microns long and about 8 microns in diameter, and with a well developed bursa which opens ventrally; about 30 microns long and 30 microns broad. Two dorsal blunt, finger-like lobes extend to about half the length of bursa. From tips of these lobes a process extends to tip of bursa on either side. A group of associated processes, suggesting a group of poorly developed lateral rays springs from latero-ventral margin of each dorsal lobe and supports each side of the bursa.

Host: Myotis grisescens

Habitat: Stomach

Locality: Crawford County, Kansas

Host: Myotis velifer incautus

Habitat: Intestine

Locality: Barber County, Kansas

Family: Trichostrongylidae Leiper, 1912

sub-Family: Strongylacanthinae York and Maplestone, 1926

Genus: Allintoshius Chitwood, 1937

species: travassosi Chandler, 1938

Specific diagnosis: Allintoshius travassosi (Plate II, Figures 10, 11, 12 and 13) Small, nearly transparent worms. Cuticle with very fine transverse striations and with about eight well-developed longitudinal ridges. Cephalic cuticular inflation about 70 microns long and somewhat asymmetrical, being more expanded dorsally. Diameter of head, exclusive of inflated cuticle, about 20 microns, with inflation about 40 microns. Esophagus club-shaped, about 300 microns long. Female about 8 to 10 mm long, with a maximum diameter just anterior to vulva of about 125 to 140 microns. Vulva, 1.05 to 1.25 mm from posterior end, a transverse slit, with a barely projecting anterior and posterior lip, but bordered on one side, occasionally on both by a conspicuous fin-like expansion of cuticle. Vagina only about 20 microns long, perpendicular to body wall. Male 3.5 to 4.5 mm long with a maximum diameter of about 82 microns; diameter, just anterior to bursa, about 67 microns. Bursa, large, lateral lobes about 110 microns long and same in width. Dorsal lobe about 75 microns long and 40 microns broad, without a deep incision where it joins lateral lobes. Dorsal ray single, about 75 microns long, ending in four small prongs formed by a terminal bifurcation and two short subterminal branches. Externo-dorsal ray long, arising from root of dorsal and spreading in a broad arc to terminate at margin of bursa just lateral to junction of dorsal and lateral lobes. Postero-lateral ray curves away from other lateral rays to

become contiguous with the more slender externo-dorsal ray for greater part of its length. Medio-lateral and externo-lateral rays very long, 130 microns, straight, of uniform thickness, and contiguous for their entire length. Ventral rays divergent, both curving ventrally, latero-ventral longer and more slender than ventro-ventral. Spicules 70 to 75 microns long, conical in shape, sharply pointed distally; 12 to 14 microns in diameter at open proximal ends. Gubernaculum about 25 microns long.

Host: Myotis velifer, M. grisescens, Eptesicus fuscus

Habitat: Intestine

Locality: Comanche County, Crawford County, Leavenworth County, Kansas

Family: Trichostrongylidae Leiper, 1912

sub-Family: Strongylacanthinae York and Maplestone, 1926

Genus: Allintoshius Chitwood, 1937

species: nycticeius Chitwood, 1937

Specific diagnosis: Allintoshius nycticeius (Plate II, Figures 14, 15, 16 and 17) Oral opening rounded, lips absent. Stoma rudimentary, dorsal tooth absent. Cephalic cuticular expansion measures from 62 to 70 microns long by about 38 microns wide. Longitudinal ridges numerous, conspicuous. Male with short, unstriated, conical spicules; gubernaculum present. Bursa large, dorsal lobe nearly long as, but not set off from, lateral lobes; ventral assessory bursal lobe present. Rays well developed, elongated. Female with two ovaries; oviparous; tail elongated, subcylindrical, bearing one elongated caudal process. Male 2.58 to 2.65 mm long by 66 to 85 microns wide. Esophagus 200 to 230 microns long. Spicules 103 to 108 microns long. Bursal formula: ventro-ventral and latero-ventral rays parallel, separated; externo-lateral and medio-lateral rays close together, diverging near tip; dorso-lateral ray separate from other laterals to trunk; dorsal ray termi-

nating in four small digitations. Female 5.25 mm long by 100 microns long and ending in one sharp projection. Vulva located 1.05 to 1.25 mm from posterior end. Eggs 85 to 90 microns long by 33 to 37 microns wide.

Host: Myotis velifer incautus

Habitat: Intestine

Locality: Barber County, Kansas

Family: Trichostrongylidae Leiper, 1912

sub-Family: Strongylacanthinae York and Maplestone, 1926

Genus: Molinostrongylus Skarbilovitch, 1934

species: delicatus Schwartz, 1927

Specific diagnosis: Molinostrongylus delicatus (Plate II, Figures 18, 19 20 and 21) Male 4.25 mm long by 120 microns in maximum width. Diameter of head, excluding the cuticular expansion, 21 microns. Cephalic cuticular expansion from 46 to 50 microns long by about 38 microns wide. Esophagus club-shaped, anterior narrower portion being almost twice as long as broader posterior portion; total length of esophagus, 350 microns, its diameter in middle of anterior narrower portion being 17 microns and its maximum diameter in posterior portion being about 33 microns. Bursa spread out, 227 microns wide. Ventro-ventral ray longer and narrower than latero-ventral ray, these rays being divergent and their tips being separated by a distance of approximately 42 microns. Tip of latero-ventral ray more or less falcate. Tip of externo-lateral ray, which diverges from common stem of other two lateral rays, terminates in elongated knob. Postero-lateral ray narrower and somewhat shorter than medio-lateral ray, tips of these rays being about 21 microns apart. Externo-dorsal rays relatively long and terminate in knob-like tips. In spread out bursa, tips of externo-dorsal rays 122 microns apart.

Dorsal ray, about 60 microns long, divided into two branches in its posterior third, each of branches being more or less indistinctly divided; terminal division is unequal, outer terminal branches being shorter than inner terminal branches. Spicules slender, becoming gradually attenuated and 170 microns long; proximal ends of spicules separated by distance of 58 microns. Gubernaculum 55 microns long. Female 5.7 mm long by about 95 microns in maximum width. Head, 33 to 36 microns wide; cephalic cuticular expansion transversly striated, 70 microns long by about 47 microns wide. Esophagus 352 microns long by 25 microns wide in anterior narrower portion, and about 50 microns in maximum diameter in posterior portion. Vulva located at distance of 1.45 mm from posterior extremity. Eggs from 63 to 75 microns long by 42 microns wide. Tail terminates in three tooth-like projections; one dorsal, two lateral. Measurement of tail from 84 to 100 microns long.

Host; Tadarida mexicana brasiliensis

Habitat: Intestine

Locality: Barber County, Kansas; Woods County, Oklahoma

EXPLANATION OF PLATE II

All drawings made with aid of camera lucida.

Fig. 1. Vampirolepis christensoni, scolex.

Fig. 2. Vampirolepis christensoni, mature proglottid, ventral view.

Fig. 3. Vampirolepis roudabushi, mature proglottid, ventral view.

Fig. 4. Vampirolepis roudabushi, scolex.

Fig. 5. Vampirolepis gertschi, mature proglottid, dorsal view.

Fig. 6. Vampirolepis gertschi, scolex.

Fig. 7. Capillaria palmata, vulvular region of female, lateral view.

Fig. 8. Capillaria palmata, bursa of male, lateral view.

Fig. 9. Capillaria palmata, caudal end of female, lateral view.

Fig. 10. Allintoshius travassosi, cephalic region of female.

Fig. 11. Allintoshius travassosi, vulvular region of female, ventral view.

Fig. 12. Allintoshius travassosi, caudal end of female, ventral view.

Fig. 13. Allintoshius travassosi, bursa of male, ventral view.

Fig. 14. Allintoshius nycticeius, cephalic region of female, lateral view.

Fig. 15. Allintoshius nycticeius, bursa of male, ventral view.

Fig. 16. Allintoshius nycticeius, vulvular region of female, lateral view.

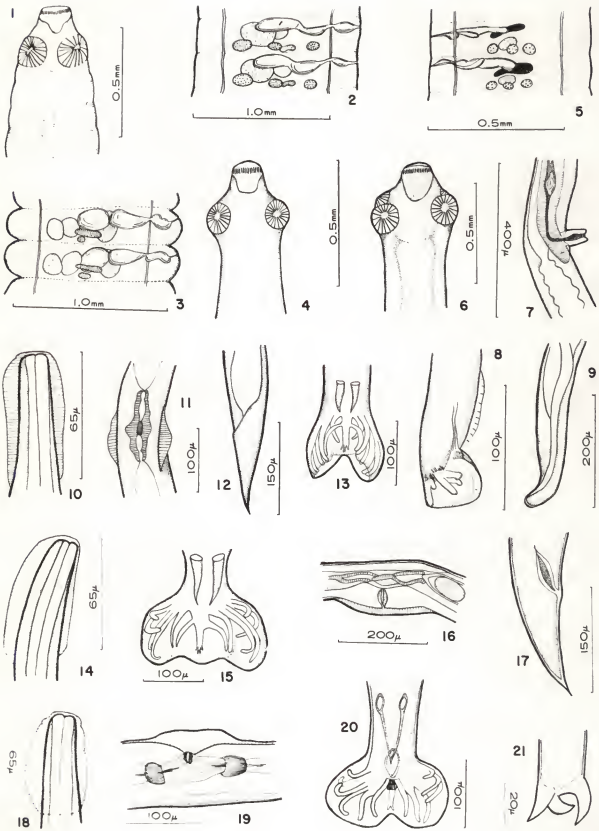
Fig. 17. Allintoshius nycticeius, caudal end of female, lateral view.

Fig. 18. Molinostrongylus delicatus, cephalic region of female.

Fig. 19. Molinostrongylus delicatus, vulvular region of female, lateral view.

Fig. 20. Molinostrongylus delicatus, bursa of male, ventral view.

Fig. 21. Molinostrongylus delicatus, caudal end of female, lateral view.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DISCUSSION

Nine species of bats representing 65 specimens from Kansas were examined during this investigation. The helminths recovered in this study have been previously described but only two have been previously reported from Kansas or neighboring states: Dicrocoelium rilevi by Macy (1931) and Plagiorchis micracanthos by Manter and Debus (1945). Examination of the different species of hosts revealed extensive variations in the helminth burden, incidence of infections, and species of parasites harbored. No information was found in the literature which would illuminate the causes of these variations and the present study was not extensive enough to definitely explain them. However, factors which would be contributory are host specificity of the helminth, host susceptibility to parasitism, season of collection, and location of host habitat (including feeding range).

No studies have been reported relative to the incidence of infections of the helminths involved in this research in their respective chiropteran hosts. Apparently, the reported species are highly host specific as only three of the helminths collected, (Plagiorchis vespertilionis, Dicrocoelium rilevi and Allintoshius travassosi), were found in more than one species of host. The other 14 species of helminths were recovered from one species of host and 10 of these 14 were found in only a single specimen of host.

Data obtained from this study showed that the males of a host species were more commonly burdened with more helminths than the females; this occurred in 6 of the 9 species of bats examined. There is no information in the literature concerning sexual variance of helminth burden in chiroptera with which to compare results. Therefore, further work is necessary before it is possible to state this variance as a general rule.

Results of this survey indicated an apparent seasonal variation in the helminth burden of chiroptera. Following winter hibernation, the helminth burden of the bats is low, but begins to build up in the spring as the bat once again starts feeding. The highest burdens were noted in the late autumn or early winter. Work by Allen (1950) substantiates these conclusions. However, the present study, as well as studies by Manter and Debus (1945) and Gilford (1952), found that the hibernating forms often retain a helminth fauna of variety and sometimes of considerable number.

In all, this current research established one or more new host records for 16 of the 17 parasites found in this survey (see list in Summary). The exception was Plagiorchis vespertilionis which has been reported from ten genera of chiropterans. Previous to this study several of the parasites, especially the Cestoda and Nematoda, have been reported from only one or two species of hosts. Future investigations undoubtedly could produce additional new host records, as well as provide further information about incidence of infection and relationship of sex of the host to worm burden.

SUMMARY

Sixty-five bats, collected in Kansas and Nebraska, representing five genera and nine species were examined for helminths. No new parasites were discovered; however, only two of the seventeen species identified in this study have been previously reported from Kansas or neighboring states. Trematodes were the most numerous helminths recovered; six genera and ten species were identified. Nematodes of four genera and three species were found in moderate number, whereas only five specimens of cestodes representing three species of Vampirolepis were recovered.

The incidence of infection of the helminths was quite variable depending

on the parasite and host involved. Nevertheless, the incidence of infection of a particular parasite in a certain species of host was often relatively high thus indicating a considerable degree of host specificity in these chiropteran helminths. No significant difference of incidence of infection between male and female hosts was noted.

The range of variation of the helminth burden in the different host species was sizable. In one species, Plecotus townsendii, no helminths were recovered while over four-hundred were found in specimens of Myotis grisescens.

A substantial difference in the helminth burden was revealed in correlation with sex of the host. A higher burden was found in the males of six of the nine host species examined which resulted in a striking difference in over-all burden of the hosts.

There appears to be a seasonal variation in the chiropteran helminth burden. During winter hibernation by the host, the burden diminishes. It begins building up in the early spring and reaches a peak in late autumn. However, this study substantiates findings of previous investigations in that hibernating bats may retain a helminth fauna often of large numbers and variety.

One or more new host records were established for all helminths identified except Plagiorchis vespertilionis. These new host records are listed below.

Trematoda

Plagiorchis micracanthos in Pipistrellus subflavus
Allassogonoporus marginalis in Myotis grisescens
Prosthodendrium longiforme in Eptesicus fuscus
Prosthodendrium swansoni in Myotis grisescens
Acanthatrium eptesici in Myotis grisescens
Acanthatrium micracanthum in Myotis grisescens
Acanthatrium oregonense in Myotis grisescens
Dicrocoelium rileyi in Myotis velifer and Tadarida mexicana brasiliensis
Urotrema scabridum in Myotis grisescens

Cestoda

Vampirolepis christensoni in Myotis grisescens
Vampirolepis roudabushi in Myotis keeni
Vampirolepis gertschi in Myotis velifer

Nematoda

Molinostrongylus delicatus in Tadarida mexicana brasiliensis
Allintoshius nycticeius in Myotis velifer incautus
Allintoshius travassosi in Myotis velifer, M. grisescens and Eptesicus fuscus
Capillaria palmata in Myotis grisescens

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A SURVEY OF THE INTERNAL HELMINTHS IN BATS OF KANSAS AND NEBRASKA

by

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ABSTRACT

Helminths of bats in Kansas and Nebraska are not well known. The present study was initiated to: (1) study the helminth fauna found in bats of Kansas and Nebraska, (2) determine the over-all incidence of infection, (3) determine variations in incidence of infections as correlated with sex and species of host, (4) ascertain possible seasonal variations of helminth burden, and (5) report new parasite-host relationships.

Chiroptera, representing nine species, were collected in Kansas and Nebraska by Dr. J. Knox Jones of the University of Kansas at Lawrence. The bats were first sent to the Veterinary Diagnostic Laboratory, Kansas State University, for determination of rabies; all were negative. After the bats had been killed, they were examined for helminths. The following organs were examined: stomach, intestine, liver, lungs, kidneys, trachea, and urinary bladder. All parasites recovered were fixed in Alcohol-Formalin-Acetic Acid. All flatworms were stained in Delafield's and Ehrlich's hematoxylin, according to procedures provided by Dr. Franklin Sogandares of Tulane University, and mounted in piccolyte. The nematodes, unstained, were mounted in glycerine jelly.

A total of sixty-five bats was examined for helminths. The helminth fauna of these Chiroptera was mainly trematodes; the families Plagiorchiidae, Lecithodendriidae, Dicrocoelidae and Urotrematidae were represented by the ten species identified. Nematodes were recovered in moderate numbers with four species identified belonging to the Trichuridae or Trichostrongylidae. Only five specimens of cestodes were found representing three species of Vampirolepis of the family Hymenolepididae (according to Spassky, 1954).

The incidence of infection was quite variable depending on the parasite and host involved. Nevertheless, a considerable degree of host specificity

was indicated by the relatively high incidence of infection of particular helminths in specific hosts. No marked differences in incidence of infection were noted between male and female hosts.

There was a large range in the variation of the helminth burden relative to host species. No helminths were found in one species of host while over four-hundred were recovered from another. A substantial difference in helminth burden was noted between sexes of hosts. The males of most host species had a larger burden than did the females.

There appeared to be a seasonal variation in the helminth burden of these Chiroptera which corresponded to the hibernating habits of the host. The parasite burden diminished during winter hibernations and increased in the spring, peaking by autumn. It was found that hibernating forms often retained a large and variable helminth fauna.

One or more new host records were established for all helminths identified except Plagiorchis vespertilionis. These new host records are listed below.

Trematoda

Plagiorchis micracanthos in Pipistrellus subflavus
Allassogonoporus marginalis in Myotis grisescens
Prosthodendrium longiforme in Eptesicus fuscus
Prosthodendrium swansoni in Myotis grisescens
Acanthatrium eptesici in Myotis grisescens
Acanthatrium micracanthum in Myotis grisescens
Acanthatrium oregonense in Myotis grisescens
Dicrocoelium rilevi in Myotis velifer and Tadarida mexicana brasiliensis
Urotrema scabridum in Myotis grisescens

Cestoda

Vampirolepis christensoni in Myotis grisescens
Vampirolepis roudabushi in Myotis keeni
Vampirolepis gertschi in Myotis velifer

Nematoda

Molinostrongylus delicatus in Tadarida mexicana brasiliensis
Allintoshius nycticeius in Myotis velifer incautus
Allintoshius travassosi in Myotis velifer, M. grisescens and E. fuscus
Capillaria palmata in Myotis grisescens