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Comparison of Helminth Parasites of the Cotton Rat, *Sigmodon hispidus*, from Several Habitats in Florida

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ABSTRACT

Twenty-five species of helminths were found in 197 cotton rats, *Sigmodon hispidus*, from north-central and south-central Florida—including seven species of trematodes, six of cestodes, and twelve of nematodes. Six species of trematodes were restricted to rats from salt marshes. Incidence of four nematodes with free-living larval stages was highest in rats from freshwater marshes, lower in those from saltwater marshes, and lowest in those from more xeric upland habitats. Undescribed species of *Raillietina* (Cestoda) and *Gongylonema* (Nematoda) were restricted to rats from upland habitats. The cotton rat was found to be an intermediate host of three carnivore tapeworms and to share adult helminths with ecological associates, such as squirrels, rabbits, deer mice, and rice rats. A checklist of the helminths of the cotton rat is included.

INTRODUCTION

The helminth fauna of the cotton rat (*Sigmodon hispidus* Say and Ord) in southeastern United States is comparatively well known. Major surveys of helminths of the cotton rat were conducted by Baylis (1945) on specimens from the "southern United States," Harkema and Kartman (1948) in Georgia and North Carolina, and Hugghins (1951) in Texas. Melvin

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TABLE 1

INCIDENCE OF HELMINTH PARASITES (EXCLUDING LIVER PARASITES) IN *Sigmodon hispidus* FROM SEVERAL HABITATS IN FLORIDA

Species	Freshwater Marshes			Saltwater Marshes			Upland Habitats		
	% Incidence	No. of Worms Mean	(Range)	% Incidence	No. of Worms Mean	(Range)	% Incidence	No. of Worms Mean	(Range)
TREMATODA									
Microphallus basodactylophallus (2)[a]	0	—	—	28	8	(1–25)	0	—	—
Nudacotyle novicia (2)	0	—	—	17	9	(1–20)	0	—	—
Gynaecotyla adunca (2)	0	—	—	11	4	(3–5)	0	—	—
Probolocoryphe glandulosa (2)	0	—	—	6	210	(210)	0	—	—
Maritrema sp. (2)	0	—	—	6	37	(37)	0	—	—
Plagiorchis muris (2)	0	—	—	6	1	(1)	0	—	—
CESTODA									
Monoecocestus sigmodontis (2)	66	6	(1–18)	34	5	(1–15)	5	3	(3)
Raillietina bakeri (2)	0	—	—	11	1	(1–2)	9	18	(3–33)
Raillietina sp. (2)	0	—	—	0	—	—	86	24	(3–64)
NEMATODA									
Trichostrongylus sigmodontis (2)	86	57	(1–625)	67	13	(1–88)	18	15	(1–48)
Hassalstrongylus aduncus (2)	81	55	(1–325)	100	75	(6–240)	59	14	(1–55)
Trichostrongylus affinis (3)	77	19	(1–65)	34	5	(1–11)	14	2	(1–3)
Strongyloides sigmodontis (2)	64	42	(1–277)	17	7	(3–10)	14	2	(1–2)
Litomosoides carinii (4)	53	16	(1–69)	34	44	(31–50)	100	35	(1–135)
Mastophorus muris (1)	28	2	(1–4)	39	5	(1–17)	50	12	(1–25)
Physaloptera hispida (1)	4	1	(1)	0	—	—	50	10	(1–28)
Syphacia sigmodontis (3)	2	1	(1)	22	84	(2–150)	0	—	—
Pterygodermatites ondatrae (2)	0	—	—	6	15	(15)	0	—	—
Gongylonema sp. (1)	0	—	—	0	—	—	23	6	(1–15)
Physocephalus sexalatus (1)	0	—	—	0	—	—	5	4	(4)

[a]Locality in host: (1) stomach, (2) small intestine, (3) cecum and large intestine, (4) pleural cavity.

and Chandler (1950) added several records of nematodes from Florida and Texas. The present paper supplements these studies with additional records from Florida and compares the helminth faunas of cotton rats from freshwater and saltwater marshes in north-central Florida and several upland habitats in south-central Florida. Particular attention is given to the relationship of the fauna of the cotton rat to those of ecologically associated rodents.

MATERIALS AND METHODS

Rats were livetrapped in Sherman traps from April, 1970, through July, 1973. Two freshwater marshes, Paynes Prairie and Lake Alice, near Gainesville (Alachua County) were sampled. Saltwater marshes sampled were near Crescent Beach (St. Johns County) on the Atlantic Coast and near Cedar Key (Levy County) on the Gulf Coast. Upland habitats were sampled at the Archbold Biological Station (Highlands County) and included bayheads, scrubby flatwoods, sand pine scrub, and a moist railroad ditch adjoining scrubby flatwoods.

Rats were brought to the laboratory and killed immediately before examination. In 111 animals, only the liver was examined for tapeworm cysts and the lesions of *Capillaria hepatica*. Complete necropsies were performed on 86 subadult and adult animals. The gastrointestinal tract was separated into three parts: esophagus and stomach, small intestine, and cecum and large intestine. Each section was opened and washed in a 100-mesh sieve and the washings examined under the dissecting microscope. The lungs, heart, and liver were teased apart, then washed in the sieve before examination. Nematodes were killed in glacial acetic acid and fixed in 70 percent alcohol. Trematodes and cestodes were relaxed, then preserved in alcohol-formalin-acetic acid (AFA). Nematodes were studied in temporary lactophenol mounts. Trematodes and cestodes were stained in Harris's hematoxylin or Mayer's paracarmine before study. Cestode hooks were sometimes teased and mounted in a clearing agent (Turtox CMC-10).

RESULTS AND DISCUSSION

Table 1 lists the helminths exclusive of those occurring in the liver found in 86 cotton rats from freshwater marshes (46), salt marshes (18), and upland habitats (22). Table 2 gives the incidence of liver parasites in a total of 197 animals.

Trematoda

The only previous report of a trematode from the cotton rat was of an

TABLE 2

INCIDENCE OF LIVER HELMINTHS IN *Sigmodon hispidus* FROM SEVERAL HABITATS IN FLORIDA

Species	Freshwater Marshes			Saltwater Marshes			Upland Habitats		
	No. Examined	No. Infections	% Infections	No. Examined	No. Infections	% Infections	No. Examined	No. Infections	% Infections
CESTODA (LARVAL)									
Taenia mustelae	142	0	0	34	0	0	22	1	5
Taenia taeniaeformis	142	20	14	34	0	0	22	0	0
Taenia rileyi	142	11	8	34	0	0	22	1	5
TREMATODA									
Zonorchis komareki	46	0	0	18	0	0	22	2	9
NEMATODA									
Capillaria hepatica	142	43	30	34	4	12	22	1	5

unidentified species in the bile duct by Childs and Cosgrove (1966). This may have been the dicrocoelid *Zonorchis komareki* (McIntosh, 1939) found in the present study only in rats from upland habitats. Dicrocoelid flukes utilize land snails as first intermediate hosts.

Rats collected from salt marshes were infected with six species of trematodes. *Microphallus basodactylophallus* (Bridgman, 1969), *Gynaecotyla adunca* (Linton, 1905), *Probolocoryphe glandulosa* (Coil, 1955), and *Maritrema* sp. belong to the family Microphallidae, a predominantly marine group utilizing Crustacea as second intermediate hosts. Feeding experiments with the rice rat (*Oryzomys palustris*) have demonstrated that fiddler crabs of the genus *Uca* are the intermediate hosts of these four flukes at Cedar Key. *Nudacotyle novicia* Barker, 1916, has been reported from both freshwater and salt marshes from the muskrat (Abram, 1969) and other rodents. Metacercariae of this species encysted on vegetation are ingested by the final host. The single specimen of *Plagiorchis muris* Tanabe, 1922, was found in a cotton rat from Cedar Key.

Cestoda

Monoecocestus sigmodontis (Chandler and Suttles, 1922) is a common parasite of the cotton rat in every area where it has been studied. In the present study it was common in freshwater marshes, but its incidence was reduced in salt marshes. It was absent from most upland habitats, being found only in a single rat trapped from a bayhead.

Raillietina bakeri Chandler, 1942, was absent from freshwater marshes and uncommon in salt marshes and upland habitats. A second, apparently undescribed, species of *Raillietina* was found only in the upland habitats. This species is characterized by having 98 to 104 hooks, 30 to 32 microns long, on the scolex as compared with *R. bakeri*, with 66 to 80 hooks, 22 to 24 microns in length.

Larval cysts of the genus *Taenia* were absent in salt marshes (table 2). Rats from Paynes Prairie and the Archbold Biological Station were infected with *T. rileyi*, a parasite of the bobcat, *Lynx rufus*, and *T. mustelae*, reported from weasels and martens. Rats from Lake Alice on the University of Florida campus were infected with *T. taeniaeformis* (Batsch, 1786), the common tapeworm of the house cat. Bobcats have been recorded as frequent visitors to all the upland habitats, although they would be expected to be rare in the Lake Alice area.

Nematoda

Capillaria hepatica (Bancroft, 1893) occurred in the liver of cotton rats from all three major habitats. Infections were extremely heavy in rats

from Paynes Prairie but absent in rats from Lake Alice. The incidence was reduced in rats from salt marshes and only a single rat, trapped in scrubby flatwoods, was infected from the other habitats. Layne (1968, 1970) has made extensive studies of the ecology and host distribution of this worm in Florida and found a strong correlation with relatively xeric scrublike vegetation types. The high incidence in the present study in a marsh habitat indicates that the ecology of this species may be more complex than was previously thought. No reason was apparent for its absence in the similar habitat at Lake Alice.

Of the two species of *Trichostrongylus* present in the cotton rat, *T. sigmodontis* Baylis, 1945, occurred almost exclusively in the small intestine, whereas *T. affinis* Graybill, 1924, was found only in the cecum. Three of the four species of nematodes with free-living larval stages in their life cycles (*Trichostrongylus sigmodontis, Trichostrongylus affinis, Strongyloides sigmodontis* Melvin and Chandler, 1950) were most common in the freshwater marshes and least common in the upland habitats, while a fourth, *Hassalstrongylus aduncus* (Chandler, 1932), was most common in the salt marsh. The larval stages of *H. aduncus* may show a greater tolerance to a brackish environment than do those of the other species. The decrease in both incidence and intensity of infection of all four species in upland habitats appears to be directly related to moisture, as most infections were found in the mesic railroad ditch and were rare in the drier scrubby flatwoods.

The filarial worm, *Litomosoides carinii* (Travassos, 1919), was most common in upland habitats. This worm is transmitted by *Ornithonyssus bacoti*, a mite vector (Williams, 1948). Supplementary studies (Forrester and Kinsella, 1973) show that the reduced incidence of this worm in the salt marshes may be related to the higher percentage of subadult animals in this sample, as infection appears to be directly related to age of the host.

Five species of spirurids occurred in the rats. *Mastophorus muris* (Gmelin, 1790) and *Physaloptera hispida* Schell, 1950, were most common in upland habitats. *Pterygodermatites ondatrae* (Chandler, 1941) was found only in the salt marsh at Cedar Key, whereas a new species of *Gongylonema* and *Physocephalus sexalatus* (Molin, 1860) were found only in upland habitats. All five species presumably have an insect intermediate host and the distribution of these hosts probably determines the distribution of infections.

A new species of pinworm, *Syphacia sigmodontis*, has been described elsewhere (Quentin and Kinsella, 1972). Four animals were heavily infected at Cedar Key, whereas infection in other areas was limited to a single worm found in a rat from Paynes Prairie.

Host Relationships

Microphallid trematodes typically show little host specificity and *G. adunca* has been reported from such hosts as the raccoon (Harkema and Miller, 1964), the Clapper Rail (Heard, 1970), and the Seaside Sparrow (Hunter and Quay, 1953). The four microphallids found in the present study were all much more common in the rice rat (Kinsella, unpubl. data), which is more omnivorous than the cotton rat. *Nudacotyle* and *Plagiorchis* were not found in other mammals examined from the same marsh. *Zonorchis komarèki*, found in cotton rats only at the Archbold Biological Station, is a common parasite of the cotton mouse, *Peromyscus gossypinus*, in that area (Kinsella, unpubl. data).

The distribution of the larval infections of *Taenia* spp. is probably related to that of their carnivore final hosts. *Monoecocestus* and *Raillietina* sp. were found only in cotton rats. *Raillietina bakeri* was originally described from squirrels, and although reported from other hosts, its primary distribution may be related to sciurid hosts. This would explain its absence from the freshwater marshes and rarity in the other habitats, because cotton rats were rarely trapped in close association with squirrels.

The cotton rat appears to be the primary host of six species of nematodes (*Trichostrongylus sigmodontis*, *Hassalstrongylus aduncus*, *Strongyloides sigmodontis*, *Litomosoides carinii*, *Syphacia sigmodontis*, *Gongylonema* sp.). *Trichostrongylus affinis* is a parasite of *Sylvilagus* spp. and was found in both *S. floridanus* and *S. palustris* in the localities sampled. *Mastophorus muris*, *Physaloptera hispida*, and *Pterygodermatites ondatrae* were all more common in the rice rat at Paynes Prairie and Cedar Key, although both the cotton and rice rats appear to be suitable hosts. *Capillaria hepatica* appears to be infective to almost any species of mammal (Layne, 1970), and the reasons for its concentration in certain habitats and hosts remain an enigma.

The following checklist of the helminths of the cotton rat combines records from the present paper with previous records in the literature.

TREMATODA

Gynaecotyla adunca (Linton, 1905)—Florida.[1]
Maritrema sp.—Florida.[1]
Microphallus basodactylophallus Bridgman, 1969—Florida.[1]
Nudacotyle novicia Barker, 1916—Florida.[1]
Plagiorchis muris Tanabe, 1922—Florida.[1]
Probolocoryphe glandulosa (Coil, 1955)—Florida.[1]
"trematode, bile duct"—Tennessee (Childs and Cosgrove, 1966).
Zonorchis komareki (McIntosh, 1939)—Florida.[1]

[1]Present paper.

CESTODA

Aprostatandrya macrocephala (Douthitt, 1915)—North Carolina (Rausch and Schiller, 1949); Georgia (Henry, 1970).

Hymenolepis dimunuta (Rudolphi, 1819)—Venezuela (Voge and Diaz-Ungria, 1958–1959); North Carolina (Harkema, 1946; Harkema and Kartman, 1948).

Hymenolepis microstoma (Dujardin, 1845)—North Carolina (Harkema and Kartman, 1948).

Monoecocestus sigmodontis (Chandler and Suttles, 1922)—Southern United States (Baylis, 1945); Texas (Chandler and Suttles, 1922; Hugghins, 1951; Melvin, 1952); Georgia (Harkema and Kartman, 1948); Florida (McIntosh, 1935).[1]

Paranoplocephala omphalodes (Hermann, 1783)—North Carolina (Harkema, 1946).

Raillietina bakeri Chandler, 1942—Southern United States (Baylis, 1945); Texas (Hugghins, 1951); Georgia (Henry, 1970); North Carolina (Harkema, 1946; Harkema and Kartman, 1948); Florida.[1]

Raillietina demerariensis (Daniels, 1895)—Venezuela (Voge and Diaz-Ungria, 1958–1959).

Raillietina sigmodontis Smith, 1954—Oklahoma (Smith, 1954).

Raillietina sp.—Florida.[1]

Taenia mustelae Gmelin, 1790—Georgia (McKeever and Henry, 1971); Florida.[1]

Taenia rileyi Loewen, 1929—Georgia (Harkema and Kartman, 1948; McKeever, 1971); Florida.[1]

Taenia sp.—Georgia (Henry, 1970).

Taenia taeniaeformis (Batsch, 1786)—Venezuela (Voge and Diaz-Ungria, 1958–1959); Southern United States (Baylis, 1945); Texas (Hugghins, 1951); North Carolina (Harkema, 1946); South Carolina (Hawkins, 1942); Tennessee (Cosgrove et al., 1964; Childs and Cosgrove, 1966); Georgia (Harkema and Kartman, 1948); Florida.[1]

NEMATODA

Angiostrongylus costaricensis Morera and Cespedes, 1971—Costa Rica (Morera, 1970).

Capillaria hepatica (Bancroft, 1893)—Texas (Read, 1949); Florida (Layne, 1968; 1970).[1]

Gongylonema sp.—Florida (Melvin and Chandler, 1950).[1]

Hassalstrongylus aduncus (Chandler, 1932)—Southern United States (Baylis, 1945); Texas (Chandler, 1932; Hugghins, 1951); Tennessee (Childs and Cosgrove, 1966); North Carolina (Harkema, 1946; Harkema and Kartman, 1948); Florida.[1]

Litomosoides carinii (Travassos, 1919)—Southern United States (Baylis, 1945); Mexico (Ochoterna and Caballero, 1932; Vogel and Gabaldon, 1932); Texas (Chandler, 1931; Scott and Cross, 1946; Eads and Hightower, 1952); Florida (Williams, 1948; Forrester and Kinsella, 1973).[1]

Mastophorus muris (Gmelin, 1790)—Texas (Hugghins, 1951); Oklahoma (Chandler and Suttles, 1922); Tennessee (Childs and Cosgrove, 1966); North Carolina (Harkema, 1946); Georgia (Harkema and Kartman, 1948); Florida.[1]

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[1]Present paper.

Monodontus floridanus McIntosh, 1935—Florida (McIntosh, 1935).
Physaloptera bispiculata Vaz and Pereira, 1935—Texas (Morgan, 1941); Georgia (Morgan, 1941); Florida (Morgan, 1941).
Physaloptera hispida Schell, 1950—Florida (Schell, 1950).[1]
Physaloptera murisbrasiliensis Diesing, 1861—Georgia (Morgan, 1941; 1943).
Physaloptera sp.—Southern United States (Baylis, 1945).
Physocephalus sexalatus (Molin, 1860)—Florida (Melvin and Chandler, 1950).[1]
Pterygodermatites ondatrae (Chandler, 1941)—Texas (Melvin and Chandler, 1950); Florida.[1]
Strongyloides sigmodontis Melvin and Chandler, 1950—Texas (Melvin and Chandler, 1950); Florida (Melvin and Chandler, 1950).[1]
Strongyloides sp.—Southern United States (Baylis, 1945).
Syphacia sigmodontis Quentin and Kinsella, 1972—Florida (Quentin and Kinsella, 1972).[1]
Trichosomoides crassicauda (?) (Bellingham, 1840)—Georgia (Harkema and Kartman, 1948).
Trichostrongylus affinis Graybill, 1924—Florida.[1]
Trichostrongylus sigmodontis Baylis, 1945—Southern United States (Baylis, 1945); Georgia (Thatcher and Scott, 1952); Florida.[1]

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