

FIBROSARCOMA ASSOCIATED WITH THE CYSTICERCUS OF *TAENIA TAENIAEFORMIS* IN THE LIVER OF A MUSKRAT

WALTER W. GALLATI

Department of Zoology and Entomology, The Ohio State University, Columbus 10

The larval stage (cysticercus)¹ of *Taenia taeniaeformis* (Batsch, 1786) is a common parasite in the liver of rats and mice. The association of these larvae with sarcomatous growths in the liver of rats has long been known, and has been extensively used in the study of carcinogenesis for over thirty years. In numerous investigations, Bullock and Curtis (1920, 1924, 1925, 1926 and 1928) have employed *T. taeniaeformis* larvae to induce malignant growth of the connective tissue in the liver of rats. Although the parasite has been found in a number of rodents (table 1), a coexisting fibrosarcoma of the liver has not been reported in any animal other than the albino laboratory rat. The occurrence of this association in a feral muskrat is therefore noteworthy.

In the fall of 1953 a muskrat, *Ondatra zibethica zibethica* (L.), was found dead in a small corn field adjacent to the Olentangy River in Columbus, Ohio. The animal appeared to have died recently and was removed to the laboratory where it was examined for parasites.

The liver was greatly enlarged and half of the organ was replaced by yellow-brown, friable tumor tissue (fig. 1). The carcass was disposed of before examination for metastases to other organs was made. Three cysticerci of *T. taeniaeformis* were removed from the central portion of the tumor mass. After fixation in 75 percent alcohol under glass slide pressure, these worms measured 26.8, 19.3 and 18.7 cm. in length; the maximum width was 3 mm. (fig. 2).

Histological sections of the liver show massive replacement of hepatic cells by neoplastic connective tissue (fig. 3). The tumor is composed of elongated spindle shaped fibroblasts arranged in poorly defined interlacing bundles. The nuclei are large and pleomorphic; bizarre mitotic figures are frequently encountered (fig. 4). The neoplasm has the histological characteristics of a fibrosarcoma.

DISCUSSION

Taenia taeniaeformis is commonly parasitic in the small intestine of the domestic cat and other felines. Gravid proglottids are passed with the fecal material and the intermediate host ingests the eggs with feces-polluted food or water. The oncospheres pass through the stomach and are liberated in the small intestine where they penetrate the intestinal wall. Carried via the portal circulation to the liver, they become lodged in the capillaries of this organ. After about 6 days larvae can be found in small vesicles on the surface of the liver. The walls of the vesicles are formed by the proliferation of host connective tissue. Approximately 7 mo. are required for the larvae to become fully grown infective strobilicerci with caudal vesicles. When the definitive host (feline) eats the infected rodent liver, the larvae, freed by digestion, attach to the intestinal wall. The worms mature in 35 to 42 days when eggs first appear in the feces. The life cycle is completed in a minimum of 250 days.

The incidence of cysticerci of *T. taeniaeformis* in wild rat populations varies, according to the locality, from 8 to 96 percent. The surprisingly low incidence in roof rats (table 1) reported by Huggins (1951) is probably correlated with their

¹Also called *Cysticercus fasciolaris*.

restriction to the upper stories and roofs of dwellings, smoke houses, outhouses and other buildings, and less common occurrence in open fields. Such behavior allows for little exposure to gravid proglottids in cat feces.

The incidence in muskrats is comparatively low, usually not exceeding 6 percent. Warwick (1936) indicates that in the British Isles the rate of infection is also low. However, Rider and Macy (1947) and Byrd (1952) found a higher level of infection. Other "unusual" hosts for this larval cestode are listed in table 1. In none of these reports is mention made of a coexistent sarcoma in the liver.

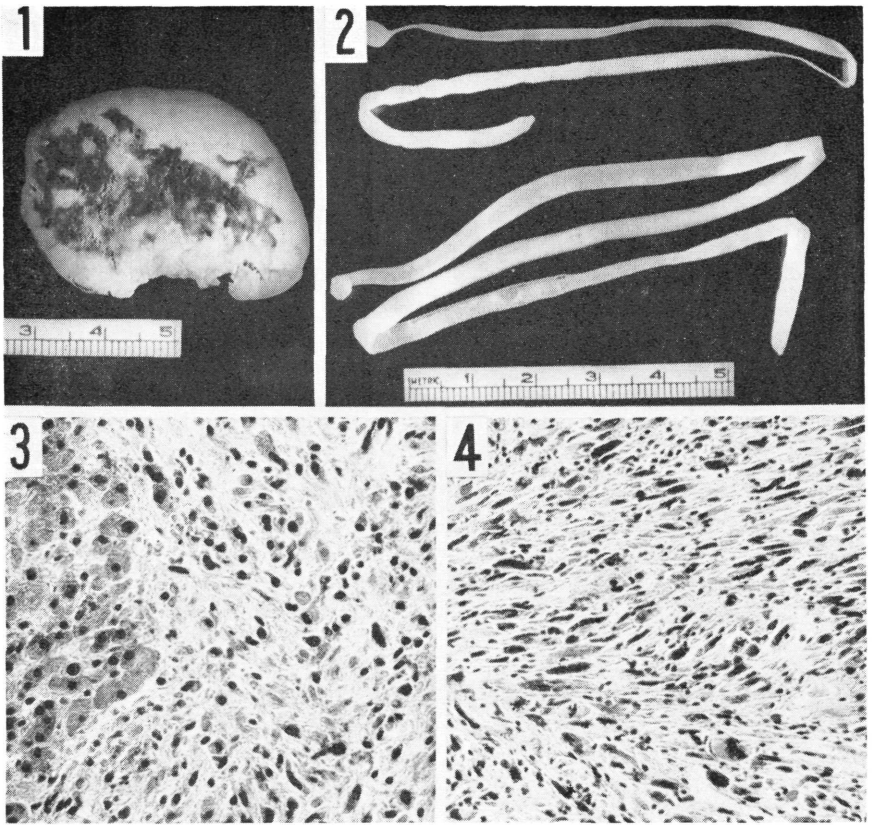


FIGURE 1. Cut surface of tumor showing extensive haemorrhage.

FIGURE 2. Two of the cysticerci (*Taenia taeniaeformis*) recovered from the neoplasm.

FIGURE 3. Section of liver showing distortion of normal architecture by fibrosarcoma (right). Polyhedral liver cells (left) showing pyknotic nuclei and granular cytoplasm probably the result of post-mortem autolysis. Hematoxylin and eosin stain. Mag. X 255.

FIGURE 4. Area of the tumor showing spindle shaped malignant fibroblasts with pleomorphic bizarre nuclei, several of which show abnormal mitotic figures. Hematoxylin and eosin stain. Mag. X 155.

Recent attempts have been made by Dunning and Curtis (1946 and 1953) to identify the active carcinogenic substance in the cysticerci. Their results (1953) indicate that "a highly labile agent capable of inducing sarcoma when introduced into the peritoneal cavity of rats may be present in larvae of *Taenia taeniaeformis* that have resided 12 or more months in the liver of other rats of the same strain."

TABLE I
Incidence of *Taenia taeniaeformis* larvae in the liver of rodents

Host	No. exam.	No. with larvae	% pos.	Locality	Author
Norway rat, <i>Rattus norvegicus</i> Erxleben.....	50	5	10%	Portage Co., Ohio.....	Forbes, 1942
" " " " " ".....	400	40	10%	Panama City.....	Calero, Ortiz & deSouza, 1950
" " " " " ".....	55	7	12.7%	North Carolina.....	Harkema, 1936
" " " " " ".....	200	35	17.5%	Bronx Zoo, New York.....	Herman, 1939
" " " " " ".....	2500	480	19.2%	Baltimore, Md.....	Luttermoser, 1936
" " " " " ".....	100	54	54%	Washington, D. C.....	Price & Chitwood, 1931
" " " " " ".....	65	63	96%	Columbus, Ohio.....	Voike, 1955
"house rats" (presumably <i>R. norvegicus</i>).....	26	21	80.7%	Ohio.....	Rausch & Tiner, 1949
roof rat, <i>Rattus rattus frugivorus</i> Raffinesque...	102	1	0.98%	Brazos Co., Texas.....	Huggins, 1951
osage wood rat, <i>Neotoma floridana osagensis</i> ...	50	4	8%	Payne Co., Oklahoma.....	Murphy, 1952
cottontail, <i>Sigmodon hispidus hispidus</i> Say & Ord	200	31	15.5%	North Carolina.....	Harkema & Kartman, 1948
cottonrat, <i>Sigmodon hispidus hispidus</i> Say & Ord	100	28	28%	Georgia.....	Harkema & Kartman, 1948
cottonrat, <i>Sigmodon hispidus hispidus</i> Say & Ord	30	10	33%	Brazos Co., Texas.....	Huggins, 1951
"wild rats" (genus and species not mentioned)	532	428	80.5%	Bloomington, Ill. (garbage dump).....	Wantland, 1953
muskrat, <i>Ondatra zibethica zibethica</i> (L.).....	36	0	0	South East Texas.....	Chandler, 1941
" " " " " ".....	108	1	0.92%	Hamilton, Ontario.....	Sweatman, 1952
" " " " " ".....	104	1	0.96%	Maine.....	Meyer & Reilly, 1950
" " " " " ".....	250	6	2.2%	North and central Illinois.....	Gilford, 1954
" " " " " ".....	230	3	1.3%	Ft. Snelling, Minnesota.....	Penner, 1940
" " " " " ".....	34	1	2.9%	Tonka Bay, Minnesota.....	" "
" " " " " ".....	17	1	5.8%*	Upper Grass Lake, Minn.....	" "
" " " " " ".....	13	1	7.7%*	Gideons Bay, Minnesota.....	" "
" " " " " ".....	2	1	50%*	Edina, Minnesota.....	" "
" " " " " ".....	252	8	3%	South and Central Mich.....	Arneel, 1942
" " " " " ".....	53	3	5.6%	Central New York.....	Edwards, 1949
" " " " " ".....	70	4	6%	Ohio.....	Rausch, 1946
" " " " " ".....	205	14	6.8%	British Columbia.....	Knight, 1951
" " " " " ".....	6	3	50%*	Western Massachusetts.....	Rankin, 1946
muskrat, <i>Ondatra zibethica rivalica</i> Bangs.....	53	0	0	Louisiana.....	Penn, 1942
muskrat, <i>Ondatra zibethica osoyooensis</i> (Lord)...	34	0	0	Western Colorado.....	Ball, 1952
muskrat, <i>Ondatra zibethica occipitalis</i> (Elliot)...	34	10	29%	North western Oregon.....	Rider & Macy, 1947
muskrat, <i>Ondatra zibethica</i> (no subspecies named).....	54	19	35.2%	Montgomery Co., Va.....	Byrd, 1952
muskrat, <i>Ondatra zibethica</i> (no subspecies named).....	420	12	2.8%	British Isles.....	Warwick, 1936
house mouse, <i>Mus musculus musculus</i> L.....	84	3	3.57%	North Carolina.....	Harkema, 1936
prairie meadow mouse, <i>Microtus ochrogaster</i> ...	46	1	2.8%	Ohio, Mich., Ind., Ill., & Wisc.....	Rausch & Tiner, 1949
meadow mouse, <i>Microtus pennsylvanicus pennsylvanicus</i>	570	43	7.5%	Ohio, Mich., Ind., Ill., & Wisc.....	Rausch & Tiner, 1949
meadow mouse, <i>Microtus pennsylvanicus pennsylvanicus</i>	3	1	33%*	Minnesota.....	Erickson, 1938
fox squirrel, <i>Sciurus niger rufiventer</i> Geoffrey	1	1	*	Manhattan, Kansas.....	Dobrovlny & Harbaugh, 1934
fox squirrel, <i>Sciurus niger rufiventer</i> , Geoffrey...	1	1	*	Lincoln, Nebraska.....	Martin, 1930
" " " " " " " ".....	94	2	2.1%	Ohio, Mich., Ind., Ill. & Wisc.....	Rausch & Tiner, 1948
southern gray squirrel, <i>Sciurus carolinensis carolinensis</i> Gmelin.....	53	1	1.89%	North Carolina.....	Harkema, 1936
rabbit, <i>Lepus americanus</i> (from back muscles)	1	1	*	Nova Scotia.....	Mahon, 1954

*The few animals investigated leave doubt about the actual level of infection in the total wild population.

The absence of cancer in association with these parasites when the latter occur in animals other than the albino white rat would suggest that a host factor is also important for the induction of this neoplasm.

SUMMARY

A fibrosarcoma in the liver of a muskrat was found associated with the cysticercus of *Taenia taeniaeformis* (Batsch, 1786). Three cysticerci were embedded in the neoplastic connective tissue that largely replaced the normal liver structure.

ACKNOWLEDGMENT

The author wishes to thank Dr. H. G. Schlumberger, Dept. of Pathology, College of Medicine, O. S. U., for aid in this study.

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