

HYMENOLEPIS NANA; POSSIBLE CERCOCYSTIS STAGE *

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Since the prediction of Stiles ¹ that *Hymenolepis nana* would prove to be a common intestinal parasite in the United States, cases have been reported with increasing frequency, and the indications are that it is the most common tapeworm in many parts of the United States.

Ransom ² compiled the United States cases up to 1904, reporting twenty-five cases, all but one of the twenty-five having been reported after 1902.

Deaderick, ³ in reporting two new cases in 1910, found that the number had reached thirty-three.

Schloss ⁴ in the same year reported twenty cases of *Hymenolepis nana* in 280 children examined for intestinal parasites and only five cases of *Tenia saginata*.

Amesse ⁵ reported one case from Professor Howland's service at Bellevue Hospital.

M. A. Wood ⁶ reported three cases of *Hymenolepis nana* from Houston, Texas.

Bass and Gage ⁷ reported fifteen cases out of 577 persons examined in New Orleans, and only three cases of *Tenia saginata*.

H. B. Wood, ⁸ from records of examinations made during 1911 and the first quarter of 1912 in the state laboratories of the South, found *Hymenolepis nana* in 1,004 of 62,785 persons examined, and only ten cases of *Tenia saginata*.

Deaderick and Thompson ⁹ stated that during 1911-1913, of 56,543 infections found by the Rockefeller Sanitary Commission, 1,879, or 3.3 per cent., were dwarf tapeworm.

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* This paper was read in abstract by Dr. George Dock at the meeting of the American Society of Tropical Medicine, held at New Orleans, April 27, 1920. In the discussion that followed it was shown that *Tenia saginata* is much less common in some places than it was about thirty years ago.

1. Stiles, C. W.: New York M. J. **77**:877 (Nov. 7) 1903.

2. Ransom, B. H.: U. S. P. H. Service, Hyg. Lab. Bull. **18**: 1904.

3. Deaderick, W. H.: Arch. of Schiffs u. of Trop. Hyg. **14**:21, 1910.

4. Schloss, O.: Am. J. M. Sc. **139**:675, 1910.

5. Amesse, J. W.: Colorado M. **7**:483, 1910.

6. Wood, M. A.: Texas State J. M. **6**:144, 1910.

7. Bass, C. C., and Gage, J. W.: New York M. J. **92**:769 (Oct. 15) 1910.

8. Wood, H. B.: J. A. M. A. **59**:1707 (Nov. 9) 1912.

9. Deaderick, W. H., and Thompson, L.: The Endemic Diseases of the Southern States, p. 503.

Gerber¹⁰ reported the first case from Boston.

Judkins¹¹ found seventy-one cases among 15,000 people examined throughout Texas.

McNeil¹² reported six cases of *Hymenolepis nana* in the Southern Pacific Hospital in Houston, Texas.

Greil¹³ found seventy-five children under twelve years of age in Montgomery, Ala., with dwarf tapeworm infection.

Frey¹⁴ reported that out of 118 cases of parasite infections in the Texas State Orphan Home, 32.6 per cent. were *Hymenolepis nana*.

Van Liere¹⁵ reported one case in twenty foreign students examined at the University of Wisconsin.

Willets¹⁶ reported six cases in the Georgia State Sanitarium.

Lyon,¹⁷ in a study of 477 patients at the Walter Reed General Hospital, found two cases of dwarf tapeworm and five cases of *Tenia saginata*. The latter, however, were diagnosed before being referred to the hospital.

Kofoed and Kornhauser¹⁸ examined the stools of 1,200 American soldiers who had been overseas and of 300 home service men. In the former series there were seven cases of *Hymenolepis nana*; in the latter none.

DeBuys¹⁹ studied 595 children from seven different institutions in New Orleans, and found *Hymenolepis nana* in fifty-five cases, or 9.25 per cent. No other tapeworms were found.

Lucke²⁰ reported 230 cases of dwarf tapeworm in 35,000 white and black troops at Camp Zachary Taylor, Kentucky. *Tenia saginata* was found twelve times.

Notwithstanding the fact that the parasite has been one of the most frequently encountered, according to the reports of several authors, yet in many localities *Hymenolepis nana* has either not been looked for or has not been found. So far as is known there are no case reports from the region of St. Louis.

The following cases occurred in that city in the B. family, colored. The family came to St. Louis from Mississippi early in 1917. There were eight children, seven of whom were infected with the dwarf

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10. Gerber, I.: Boston M. & S. J. **168**:346 (March 6) 1913.
 11. Judkins, O. H.: Texas State J. M. **10**:126 (July) 1914.
 12. McNeil, H. L.: Southern M. J. **8**:486 (June 1) 1915.
 13. Greil, G. J.: Am. J. Dis. Child. **10**:363 (Nov.) 1915.
 14. Frey, J. H.: Texas State J. M. **11**:229, 1915.
 15. Van Liere, E. J.: J. A. M. A. **67**:1369 (Nov. 4) 1916.
 16. Willets, D. J.: Southern M. J. **10**:42 (Jan. 1) 1917.
 17. Lyon, M. W.: J. A. M. A. **72**:326 (Feb. 1) 1919.
 18. Kofoed, C.; Kornhauser, S., and Plate, J. T.: J. A. M. A. **72**:1721 (June 14) 1919.
 19. DeBuys, L. R., and Dwyer, H. L.: Am. J. Dis. Child. **18**:269 (Oct.) 1919.
 20. Lucke, B.: Mil. Surgeon **44**:620 (June) 1919.

tapeworm and the eighth with *Ascaris lumbricoides*. The mother had pin worms, the father was free from parasites. The first patient was sent into Barnes Hospital from the out-patient pediatric service; the others were seen at their home.

REPORT OF CASES

CASE 1.—F. B., male, aged 5 years, born in Mississippi. Entered Barnes Hospital, Jan. 19, 1920, on account of severe diarrhea. In October, 1919, he began having numerous loose mucoid stools with blood, sometimes bright red, sometimes tarry. Considerable straining at stool, no vomiting or pain; appetite greatly increased. Physical examination showed moderate distention of abdomen. Red blood cells, 4,160,000; hemoglobin, 80 per cent.; eosinophilia, 7 per cent. Stool was liquid, light yellow, with mucus, benzidin positive; very many ova of *Hymenolepis nana*.

Treated with male fern January 21; no worms recovered. Stools egg free up to January 28, an interval of seven days. Treatment repeated February 10 and at least one thousand *Hymenolepis nana* worms were obtained. Stools were egg free up to February 23, when many small circular bodies from 5 to 15 microns in diameter were observed. February 24, thymol, 15 grains, was given, and one worm was found. Stools egg free to March 15, an interval of eleven days. March 19 male fern was given but vomited, and March 20 another dose was given through a tube. Many tags of tissue containing heads of dwarf tapeworm embedded within the tissue were found. No whole worms or segments were observed. Stools egg free to March 29, an interval of ten days. Discharged from hospital April 4. Stool on discharge, soft, brown, little mucus, no blood; dwarf tapeworm eggs, from 1 to 3 per low power field. April 18, condition good; stool as on April 4. May 28, patient had had measles in interim and was very anemic; passing considerable blood in stools. Stool was soft, yellow and blood streaked and contained large numbers of *Hymenolepis nana* eggs.

CASE 2.—J. B., male, aged 1 year 7 months, born in St. Louis. February 22, no symptoms; physical examination negative; stools hard, brown, few *Hymenolepis nana* eggs found; eosinophils, 3 per cent.

CASE 3.—E. B., female, aged 3 years, born in Mississippi as were all the others. All through January had four or five loose stools a day. For the past four months has frequently had similar symptoms. Complains of abdominal pain during these periods. February 22, stool gray-brown, much mucus, many *Hymenolepis nana* eggs; eosinophils, 6 per cent.

CASE 4.—A. B., female, aged 8 years. At 3 years passed twenty-three ascarides (?). Occasional short attacks of diarrhea for past four months, with abdominal pain. Nausea and vomiting, frequently with dizziness. Patient is anemic and drowsy. Hemoglobin, 70 per cent.; red blood cells, 3,500,000; white blood cells, 9,000; eosinophils, 9 per cent. February 22, stool soft, gray, with considerable mucus. Very many *Hymenolepis nana* eggs. March 29, course of male fern. Several thousand *Hymenolepis nana* worms obtained. April 17, general condition good; no symptoms since treatment. No *Hymenolepis nana* eggs found in stools.

CASE 5.—A. B., male, aged 8 years. Complains of frequent frontal headaches. Examination negative; eosinophils, 3 per cent. February 22, stool normal; no eggs found in preparations. March 27, very many *Hymenolepis nana* eggs.

CASE 6.—R. B., male, aged 9 years. No symptoms; physical examination negative; eosinophils, 2 per cent.; stool normal; few *Hymenolepis nana* eggs.

CASE 7.—M. B., female, aged 11 years. For the past year has had attacks of diarrhea, the last one early in February. Frequently has tenderness in abdomen and gets dizzy at times. Recalls no symptoms previous to past year.

Patient anemic; has slight abdominal tenderness. February 22, stool normal; very many *Hymenolepis nana* eggs. Eosinophils, 7 per cent.; red blood cells, 3,800,000; white blood cells, 8,000. March 29, course of male fern; at least one thousand worms obtained. April 17, few *Hymenolepis nana* eggs found. No symptoms since treatment.

The morphology of the worms does not differ essentially in any respect from the usual descriptions. Specimens were sent to Dr. C. W. Stiles, who kindly reported that he identified the worms as *Hymenolepis nana*, the eggs belonging to the same.

In Case 1, the large number of very young specimens found, the smallest being 3×0.15 mm., is noteworthy. The largest specimens were 15 mm. in length, the maximum width 0.6 mm. Senna, cited by Ransom,² noticed in feces containing *Hymenolepis nana* eggs many small rounded bodies measuring from 5 to 30 microns in diameter. The smaller of these were homogenous, with a thin membrane, while the larger were more granular and tended to become oval, with thicker membrane. Senna thought these might be eggs in the course of development which had prematurely escaped from the uterus, but finding similar bodies in two cases in which he could not demonstrate the presence of *Hymenolepis nana*, he was left in doubt as to their true nature. In Case 1, of this series, thirteen days after the second course of male fern and before the eggs had reappeared in the stools, there were found a large number of homogenous structures from 5 to 15 microns in diameter, bounded by a thin membrane. The next day, for the first time, *Hymenolepis nana* eggs were observed, with fewer of the smaller structures. These were not observed again.

SYMPTOMS

Of the seven cases four had definite symptoms, which, in the absence of other factors, may be attributed to the dwarf tapeworm. Two of the children had no symptoms and in both cases very few eggs were found. One patient with a heavy infection had long-standing headache, which may possibly have been due to the parasites. The most frequent symptoms were abdominal pain, or tenderness, and diarrhea, found in four cases. There were anemia, dizziness and headache in two cases, increased appetite in one case. The presence of blood in Case 1 is interesting. Innes, cited by Ransom, in reporting a necropsy on a case, states that he found bloody extravasations on the mucous membrane of the ileum, which may have been the points of attachment of the tapeworms lying free in the intestine.

Eosinophilia, according to Schloss²¹ and others a constant finding in cases showing symptoms, ranged from 2 to 9 per cent. In the children with definite symptoms it was from 6 to 9 per cent., while in the others it was from 2 to 3 per cent.

21. Schloss, O.: Arch. Pediat. **27**:100 (Feb.) 1910.

Treatment was instituted in three cases, and an apparent amelioration of symptoms occurred in all. Case 1, after four courses of treatment, still showed a few eggs in the stool on the day of the patient's discharge. Subsequently, after an attack of measles, his intestinal symptoms reappeared. In Case 4 apparently complete cure was obtained after one course of male fern. In Case 7 few eggs showed after one course of treatment.

MODE OF INFECTION

The development as well as the manner of infection of the dwarf tapeworm is unknown. There is a form of tapeworm common in rats, the *Hymenolepis murina* of Dujardin, which morphologically is very similar to *Hymenolepis nana*. Grassi,²² quoted by Ransom, found this parasite common in rats in Catania, where also the dwarf tapeworm was common. In a series of carefully conducted experiments, he showed that the feeding of mature segments of *Hymenolepis murina* to rats was followed by infection with this tapeworm. The eggs liberate six-hooked embryos in the small intestine, which enter the villi of the last part of the ileum and there become transformed into cercocysts. The position of each cercocyst is in the dilated central lymphatic cavity of the villus. Subsequently, the cercocyst leaves its position in the villus and becomes changed to the adult worm, and is attached to the epithelium of the intestines. Just how the latter stage ensues is not noted. Joyeux²² repeated these experiments successfully.

Grassi, Lutz and Ransom consider *Hymenolepis nana* of man identical with the rat hymenolepis, but Braun, Loos and others doubt this. Grassi, Loos, Stiles,²³ Schnell,²⁴ and Joyeux²⁵ were unable to transmit the infection to rats and mice. Stiles states that the "form from rodents is entitled to at least subspecific rank." Castellani²⁶ states that the dwarf tapeworm of man is probably distinct from the rat type.

Minchin and Nicholl, and later Johnston,²⁷ state that they found cysticercoids of *Hymenolepis murina* in the body cavity of *Xenopsylla cheopis* and *Ceratophyllus fasciatus*, but Joyeux states that he was unable to transmit the infection experimentally in these and other fleas.

Grassi fed worms and eggs of both types to eight individuals and in only one case were adult tapeworms found. In this case, a boy

22. Joyeux, C.: Bull. Soc. Path. Exot. **9**:578, 1916.

23. Stiles, C. W.: Osler's Modern Medicine **2**:252.

24. Schnell, W.: Zentralbl. f. Bakteriol., Abt. **82**:304 (Nov. 11) 1918.

25. Joyeux, C.: Bull. Soc. Path. Exot. **12**:228 (May 14) 1919.

26. Castellani and Chalmers: Manual of Tropical Medicine, Ed. 3, p. 610.

27. Johnston, T. H.: Proc. Roy. Soc. Queensland **24**:63, 1913.

of 5 began to pass eggs fifteen days after ingesting several segments of the rat *hymenolepis* and later expelled fifty worms on treatment. In another instance a boy who was previously free from *Hymenolepis nana* was infected after a month during which time he was collecting the feces of an infected patient. Grassi himself raises objections to these cases because of the high incidence of *Hymenolepis nana* in the locality and because worms may be present, although the stools are egg free.

The experiments of Grassi, together with the failure to find an intermediate host, have led to the assumption that the mode of infection is direct, and that man himself, like the rat, may be the intermediate host. Stiles accepts this possibility. As possible evidence of direct infection, Grassi cites cases of dwarf tapeworm infection in several individuals, previously egg free, in whose families there were known to be cases of *Hymenolepis nana*. Schloss²¹ cites two similar cases in his series. The frequent findings of infection in several members of the same household would also point to the possibility of a direct infection. Thus the Hygienic Laboratory staff²⁸ found five cases in the same ward on an insane asylum. Magnenat, quoted by Stiles,¹ reported four cases in the same family. In all but one of Schloss' cases several members of the same family were infected. Carpenter,²⁹ in discussing DeBuys' paper before the American Pediatric Society, described an epidemic of *Hymenolepis nana* in a foundling asylum in Philadelphia and thinks the infection was direct. Rats examined by him were negative.

I attempted to determine the mode of infection of the dwarf tapeworm. The feeding of eggs and mature segments to six rats and six mice was negative. Attempts to incubate the eggs following their mixture with artificial gastric juice were also negative.

The house of family B was carefully inspected and found to be in a very unsanitary condition. The children played around the floor a great deal so that chances for coprophagia were very favorable. There were no rats. Several bedbugs were examined and were negative for cysticerci. Several lice from the head of Case 4 were also negative.

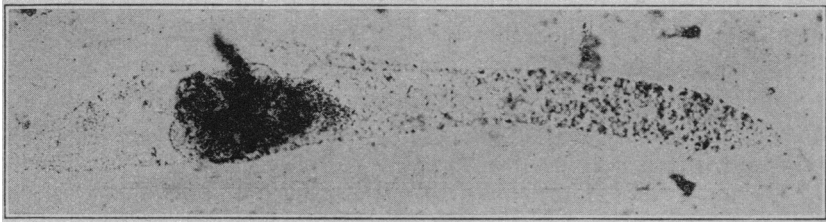
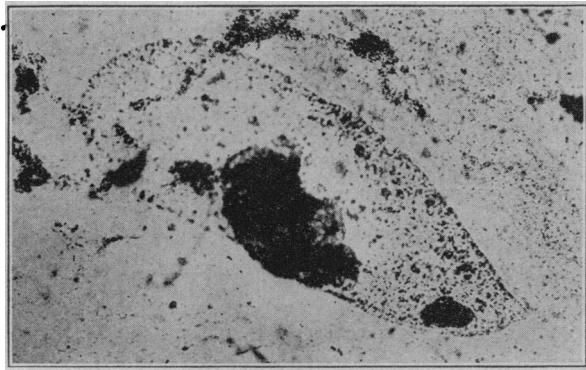
There was an old pet dog with which the children were very intimate. A stool from the dog, obtained while the dog was at the B. home, showed several eggs, which were exactly similar to eggs of *Hymenolepis nana*, the characteristic filaments of the latter being present. There were also present trichomonads and eggs of *Dipylidium caninum* and *Tenia serrata*. The dog was removed from the

28. Stiles and Garrison: U. S. P. H. S., Hyg. Lab. Bull. **28**: 1906.

29. Carpenter, H. C.: Arch. Pediat. **36**:379 (June) 1919.

home and daily examinations of stools were made, but hymenolepis eggs could no longer be found. Two weeks later a necropsy was made and *Dipylidium caninum* and *Tenia serrata*, but no *Hymenolepis nana* were recovered.

The presence of the parasite in all but the oldest boy, age 12, is of interest. In Case 5, no eggs were observed in the specimen of February 22 after twelve examinations, while on March 27 the stool was loaded with them. The difficulty of ridding the host of all the worms is a striking feature. It has been stated by Ransom and other authors that one course of treatment is frequently not sufficient. In two of my three cases which were treated eggs showed subsequently. In Case



Figs. 1 and 2.—Head of dwarf tapeworm surrounded by saclike structure. Head shows some details.

1 four courses of treatment were given and at the end of these there were still many eggs present. The large number of very young forms following the second treatment was striking.

Following the last administration of the vermifuge, the full dose being repeated next day because of the vomiting of the male fern, there were passed a number of mucoid looking tags of tissue, but no worms. The largest of these pieces were 20 x 10 mm. Each had from two to eight heads of *Hymenolepis nana* studded throughout it, but no segments could be found. Microscopically, there were observed the rostellum, a row of hooklets, four suckers and a small caudal append-

age. Surrounding each head there could be seen in the unstained specimen a definitely clear area. In the stained specimen, there was seen microscopically a saclike structure completely surrounding each head. The shape of the structures varied, some being elliptical, others ovoid, still others approaching a spherical shape. Grossly, both the head and the sac could be seen in the stained tissue. It does not seem likely that the adult worm could develop within the saclike structure.

Figures 1 and 2 show the relative size and shape of the head and sac. The tissues were stained several times with hematoxylin-eosin and also with methylene blue, but no nuclei could be seen. I felt that the structures might possibly represent the cercocyst stage of the dwarf tapeworm, thus indicating that man himself may be the intermediate host. The occurrence of autoinfection is proved by the large number of worms present and the difficulty in getting completely rid of them.

SUMMARY

1. A review of the literature shows that the dwarf tapeworm is the most common tapeworm in many parts of the United States.
2. The first cases of *Hymenolepis nana* from St. Louis are reported.
3. A possible cercocyst stage of *Hymenolepis nana* is demonstrated in man.

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