

A SANITARY SURVEY OF THE KNOX COUNTY INDUSTRIAL SCHOOL WITH RESPECT TO INTESTINAL PARASITES¹

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PROBLEM

Although conditions at the Knox County Industrial School are better than in most institutions, a survey for intestinal parasites has shown that among the children infection with intestinal parasites exists. These parasites do not necessarily cause any clinical symptoms, but there is always a drain on the child's vitality. This is evidenced by the fact that often the disciplinary problems are greater with the children who harbor parasites. Especially is this true in regard to those infected with tapeworms. Therefore it seems advisable to carefully weigh the various factors existing in the hope of throwing some light on the method operating for the transmission of these parasites.

FOUNDING THE SCHOOL

In 1895, by an act of the general assembly of Tennessee, the Knox County Industrial School was established; and although originally known as a reform school, the subsequent creation of other institutions has made it possible to restrict attendance to dependent children. Children between the ages of 6 to 18 years are sent here from all parts of the city and county.

THE BUILDINGS

The school is located on a hill in southwest Knoxville (Fig. 1. *A.*) upon which there are six dormitory buildings, a school building, and a garage. The buildings, which are of brick, were constructed in 1914, and to guard against any possible fire spreading, they are well spaced, thus also giving the maximum of light and air. The main building (Fig. 2. *A.*) is the largest and is used for administration purposes and for boys' dormitory. The smaller boys all live in Kings Cottage. The girls live in four dormitories, namely, Elizabeth Gibson, Eliza Brownlow, Phebe Park, and East Cottages.

¹The author wishes to express his appreciation to Mrs. Mary L. Vance for her careful study and tabulation of the parasites as shown by stool examination, also to Mrs. Lela Flecher, head of the school, and to her staff without whose hearty cooperation and interest in the children's health this survey could not have been made. For the benefit of those interested, it should be stated that these findings have been presented to the proper medical authorities and proper medical steps have been taken. This paper was read before the Tennessee Academy of Science at the Memphis Meeting, April 23, 1932.



Fig. 1. A. General view of buildings showing wide spacing and location overlooking farm. B. Girls playing in the rear of Elizabeth Gibson cottage. C. Boys playing in the rear of James Maynard Hall.

Elizabeth Gibson Cottage (Fig. 2, B.) is typical of all of the dormitories. From the main hall, stairs lead to the second floor and to the basement. On the left is the dining room with a kitchen adjoining and fully equipped. On the other side of the hall is a large room used for reception purposes, study hall, and sewing room. The second floor has two large rooms fitted as sleeping quarters. Each child has a bed which is made of steel and each week fresh linen is supplied. The basement is equipped with showers, and also is used as a playroom during inclement weather.

The ground about each cottage is a heavy clay, part of which is sodded, part cement, and part bare; this last part is either baked hard or is very damp. The buildings are heated from a central heating plant, and the firing is done by the older boys who bank the furnace at night and open it again in the morning.



Fig. 2. A. The James Maynard Hall used for administrative purposes and as a boy's dormitory. B. The Elizabeth Gibson Cottage. Note cement and clay grounds.

The laundry adjoins the boiler room and is operated by steam which runs the washing machines and supplies heat for the drier. The clothing is washed for twenty minutes and then placed in the drier. As soon as it is dry it is ironed, the girls doing the handwork and the boys operating the mangles.

THE FARM

Under supervisors, the children care for the farm. Every child has a definite task to do, the tasks being rotated monthly so that everyone has an opportunity of learning the different things to be done about a farm or a house. The stock consists of 30 head of cattle, 20 pigs,

2 horses, and 4 mules. The pigs are kept in low houses located near the power house and their pens are well kept and free from rats. Most of the food used is raised on the farm.

The dairy is thoroughly modern and has windows along both sides (Figs. 3. *A.* and *B.*). The floor is of cement and so drained that the whole barn may be easily washed out daily. The manure is removed with the aid of an overhead cart, which carries it more than a hundred feet from the barn. The milking is done by the boys, each boy having his own towel, and washing his hands and the cow's udder before

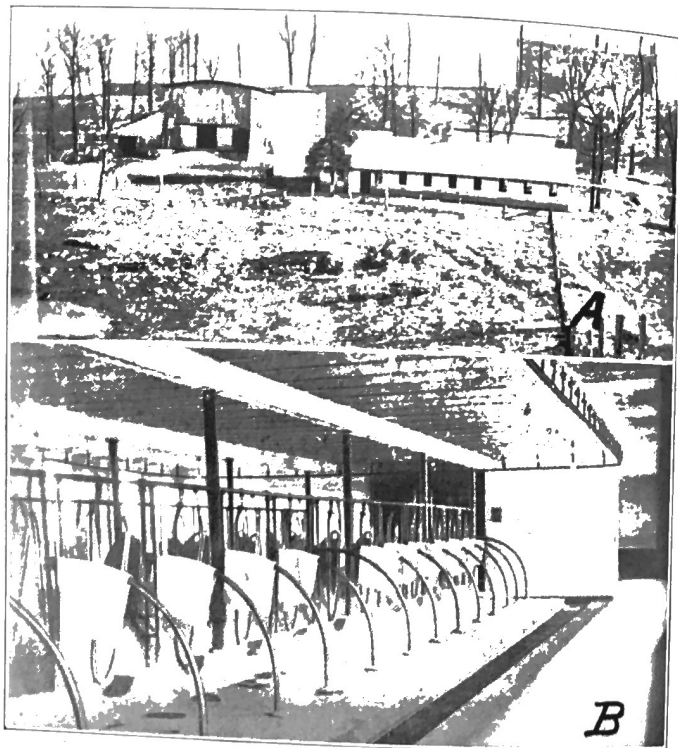


Fig. 3. *A.* Farm building and dairy. *B.* Interior of dairy barn.

milking. The milk is then carried in open pails up to the milk house which is located on the side of the hill between the dormitories and the farm buildings. Except for a small house, it is open (Fig. 4. *A.*). Near the milk house is a cold storage room which is set into the side of the hill and has a cement basin so arranged that the pails may be surrounded with cold water. The children come to the milk house for the milk supply.

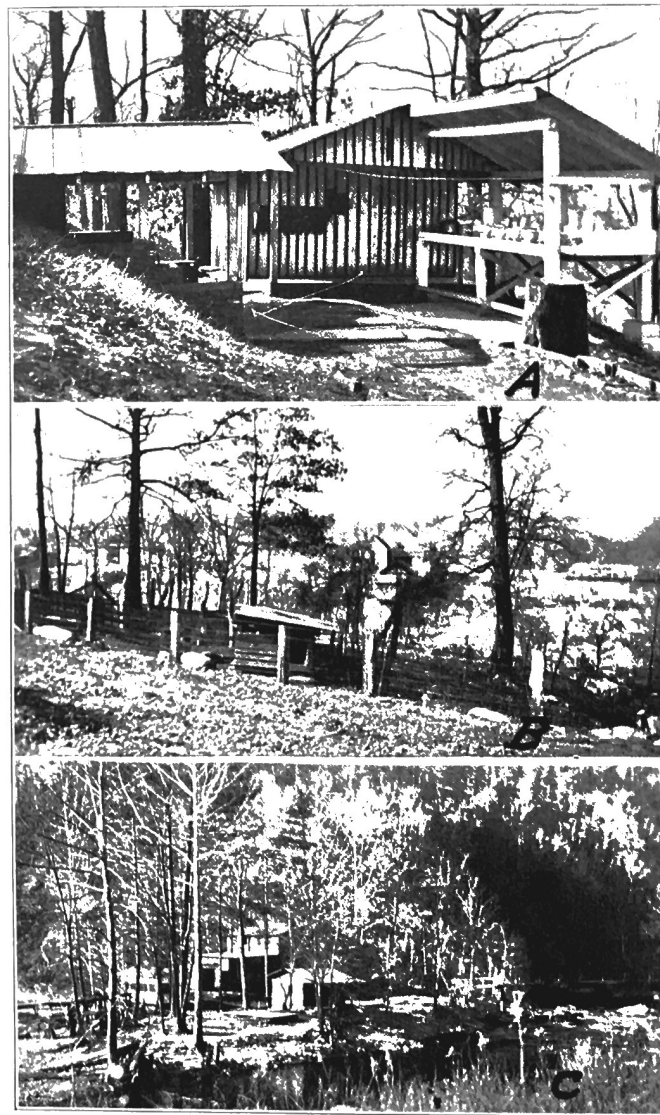


Fig. 4. *A.* The milk house. *B.* The pig pens. *C.* The camp. Note the river and shade.

Besides the farm tasks, each child attends school. The grammar grades are taught at the institution, while the more advanced students attend the public schools.

The water supply and sewerage system corresponds to that of the City of Knoxville.

THE CAMP

Two or three weeks each summer the children are taken to a camp (Fig. 4, C.) located in the mountains on a sand bar formed by the Little River. This bar is well-wooded and ideal for shedding the water, and also ideal for the development of hookworm larvae if the rules against soil pollution are not rigidly enforced. The privy is poorly located, for it is above the camp; and while not directly over the water, nevertheless seepage may escape into the river.

THE FOOD

The food consists of the usual staple products such as oatmeal, potatoes, beans, corn bread, etc. From the herd of 30 cows, 70 gallons of milk are obtained every day and usually for Sunday a hog or a calf is killed. Regardless of the good food that the children receive, the total cost for a student is a little less than five dollars per month.

CONSIDERATION OF SANITARY CONDITIONS

I. PROTOZOAN INFECTIONS

Protozoan infections were found to occur in 46.8 per cent of the children (Table 1); and although the percentage of *Endamoeba histolytica* varied from 37 per cent to 5 per cent, there was little difference between the dormitories when the non-pathogenic protozoa are included. Nor was there any significant difference between the protozoan infection occurring among the boys and the girls. This indicates that the agencies which operated for the spread of protozoan infections were similar in all dormitories. The predominance of one form in a certain dormitory only indicates the probable presence of a carrier in that building.

In institutions of this type, particular care should be given to all food handlers for in their daily work they might easily carry cysts of protozoa on their hands, thus introducing them to food. That food handlers do play an active part is indicated by such investigations as those of Williamson, Koplán, and Greigor (1929).

The house fly is likewise a possible vector in the transmission of protozoan cysts, as has been proven by the experiments of many workers. Recently, Neeley has permitted flies to feed on faeces obtained from these children and within fifteen minutes found cysts deposited by the flies on a thin layer of corn syrup. Later dissection of these flies revealed cysts in their intestines as well. The fly, there-

fore, if allowed to feed on faecal material becomes an efficient carrier of infective cysts.

There are no open privies or evidence of faecal contamination about the grounds so that the only likely place the fly can become infested is from dirty or improperly flushed toilets. Children are often careless in regard to these matters and, if suffering from a mild diarrhoea, bits of faeces may be left on the seat. Children often fail to flush the toilets and thus faeces or paper smeared with faeces are left and kept moist over a long period, affording an ideal condition for flies to become contaminated.

Once the fly is infested, it might easily carry cysts to the dining room, kitchen, or dairy. The windows are all screened, but the dairy house is open and while this gives the maximum of light and air, still it affords an opportunity for the flies getting into the milk. As stated, the dairy barns and manure are all a considerable distance from the dormitories and are well kept. So flies, which are apt to contaminate the food supply, are not attracted from this source. However, near the milk house and behind the dormitory is the garbage pail where numerous flies gather. While this does not afford a breeding place, it is attractive to flies and it would be better if such refuse could be carried directly to the pigs, or further removed.

II. NEMATODE INFECTIONS

According to the route of infection, the nematodes may conveniently be considered under two heads: (1) Those entering by the ingestion of eggs; and (2) those entering through the skin.

(1) In the first group are *Ascaris lumbricoides*, *Trichocephalus trichiurus*, and *Enterobius vermicularis*. Investigations revealed that twenty-four and two-tenths per cent of the children were found to harbor ascaris infection, the girls showing a 31.3 percentage infection and the boys 17.2 per cent (Table 1). If the hog, as some have thought, is a vector, one would expect the boys who care for them to show the higher infection. This not being true, obviously other factors are operating.

Whipworm (*Trichocephalus trichiurus*), whose method of transmission is similar, also showed a higher percentage of infection among the girls, namely, 7.6 per cent as against 2.4 per cent among the boys (Table 1). Therefore the same factor which causes girls to have higher ascaris infection is likewise causing them to have a higher infection of whipworms.

The fly is a vector of worm eggs the same as it is a carrier of protozoan cysts. Food handlers might also transmit the eggs of these worms (but neither case explains the higher percentage of infection which apparently exists among the girls). These nematodes, however, have very heavy shelled eggs which before becoming capable of infecting an individual must exist for a time outside of the body of

TABLE 1
Percentage of Infection of Children at the Knox County Industrial School with Intestinal Parasites

| NAME OF COTTAGE | Number of Students | No intestinal parasites | Commen- sals | Endamoeba histolytica | Ascaris lumbricoides | Necator and Strongyloides | Trichocephalus trichiurus | Hymenolepis nana |
|-------------------------------|--------------------|-------------------------|--------------|-----------------------|----------------------|---------------------------|---------------------------|------------------|
| Girls: | | | | | | | | |
| Elizabeth Gibson..... | 27 | 22.2 | 62.9 | 37.0 | 40.7 | 11.1 | 0.0 | 7.4 |
| Elizabeth Brownlow..... | 20 | 40.0 | 45.0 | 5.0 | 35.0 | 5.0 | 5.0 | 0.0 |
| Phoebe Park..... | 21 | 33.3 | 33.3 | 9.5 | 28.6 | 14.3 | 4.8 | 4.8 |
| East Cottage..... | 32 | 31.2 | 43.0 | 9.4 | 25.0 | 6.2 | 18.5 | 21.9 |
| King's Cottage..... | 5 | 40.0 | 40.0 | 40.0 | 20.0 | 0.0 | 0.0 | 0.0 |
| Average..... | 105 | 31.4 | 43.5 | 17.1 | 31.3 | 8.6 | 7.6 | 8.5 |
| Boys: | | | | | | | | |
| King's Cottage..... | 36 | 38.9 | 38.9 | 16.6 | 8.3 | 2.7 | 2.7 | 22.2 |
| James Maynard..... | 86 | 29.1 | 40.7 | 12.7 | 20.8 | 6.9 | 2.3 | 6.9 |
| Average..... | 122 | 31.9 | 40.1 | 13.9 | 17.2 | 6.5 | 2.4 | 14.5 |
| Average (Girls and Boys)..... | 222 | 31.6 | 41.8 | 15.5 | 24.2 | 7.5 | 5.0 | 11.0 |

the host. During this period the embryo develops within the egg. The egg, therefore, being resistant to drying, may be carried on the feet of children or animals and deposited again on the playground. The source of the eggs may be from hogs or human beings. That the soil does become infected with the eggs of these nematodes in this manner has been shown by Brown (1927), Cort, Otto, and Spindler (1929, 1930). A possible explanation of the apparently higher percentage of infection existing among the girls may be found in their habits. The girls' play is more restricted, thus the soil upon which they play has the greater possibility of becoming more heavily contaminated. The higher percentage of infection found in girls is likewise understandable from the work of Stoll (1929) who has shown the peak of the curve of infection in males falls in the 5-to-7-year-age group and in females in the 10-to-11-year-age group.

The percentage of infections with Pinworm (*Enterobius vermicularis*) could not be determined, as the eggs of this helminth are not passed in the faeces. However, one case was observed which indicated that this infection existed. Transmission of this form differs somewhat as *Enterobius* deposits embryonated eggs in patches, which by means of a mucous secretion become attached to clothing or bedding. The anal itching, especially severe at night, causes the child to scratch, thus the eggs are easily carried to his mouth. However, the fact that each child has a single bed, and that the steam laundry will kill any eggs on clothing or bedding, has, no doubt, done much to prevent an increase of this infection.

(2) Belonging to the second group is the hookworm (*Necator americanus*) and *Strongyloides stercoralis*. Together they showed a 7.5 per cent infection (Table 1). The girls again showed a slightly higher percentage of infection than the boys (8.6 per cent and 6.5 per cent, respectively). However, the possibility of becoming infected with hookworm or strongyloides infections at the Industrial School is remote. The soil, as already mentioned, is a heavy, red clay, not suitable for the maturing of hookworm larvae. Therefore, it seems more likely that these infections were picked up at the summer camp, or before the child came to the school. The camp, as stated, is located on a sand bar built by a bend of the river where conditions are ideal for the development of hookworm larvae. The children spend the majority of their time barefooted so that ideal conditions exist for the spread of such infections. At this camp also initial infection of ascariis and protozoa may begin for an open privy, built on the side of the river bank and above stream, is used. Possibilities for contamination of hands, feet, water, and flies are all combined.

III. CESTODE INFECTIONS

Sanitary education has done much to prevent infection with the beef or hog tapeworms, for none were found in this survey. However, *Hymenolepis nana* was found in 11 per cent of the children. *Hymenolepis nana* is also found in dogs and cats. Therefore children

handling these pets might become infected as the eggs of this cestode does not have to pass through an intermediate host. It is also largely a parasite of the smaller children (6 to 8 years) for the highest infections were found in East Cottage (21.9 per cent) where the small girls live and Kings Cottage (22.2 per cent) where the small boys live. In both of these buildings the children have large cats which they like to fondle. Once this infection is established the cat is no longer a necessary factor, but each infected child passes many embryonated eggs. These, upon being taken into the body of a child, develop into tapeworms. Of all the parasitic infections, this should be especially watched. Every nervous or undernourished child should be examined and if found infected, freed of these parasites. This is not only necessary for the child's good, but also for the good of others.

CONCLUSION

In conclusion, it seems that the Knox County Industrial School is one of the better institutions, yet much may be accomplished by carefully checking routes of infection. The control of flies, their destruction, and the prevention of their becoming infested will do much towards the control of parasitic infection. Particular care should be given to food handlers and the playground immediately about the houses should be covered with loose gravel so that eggs or cysts would sift out and the ground would drain rapidly. Each child, on entering the institution, should be examined for intestinal parasites and a yearly examination regularly made of all children as they will later become adult citizens of the state. If given proper training, they will become assets, but if slighted, they may become liabilities. Money spent in the raising of better citizens, mentally and physically, is money well spent.

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