

THE INVESTIGATION and CONTROL of HOOKWORM DISEASE.

at the

STATE ORPHANAGE, TOWNSVILLE, NTH. QLD.

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by

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Description
and
History.

The Townsville Orphanage, situated in North Ward, Townsville, accommodates at the present date some 50 children, many of whom are actually orphans, others being children placed under the care of the State because of the straitened circumstances of their parents. From time to time children are boarded out with various approved persons, or take supervised situations, or, in certain instances, are adopted into outside families.

The population of the Orphanage is therefore essentially a migratory one, as the figures shown later will further emphasize, and it is reasonable to suppose that the Orphanage might therefore act as a disseminating centre for any disease which was prevalent amongst its inhabitants. The activities of the Hookworm Campaign had at the time the present investigation was undertaken been directed towards obtaining accurate figures in respect of this possibility for some time past, but for various reasons it had been difficult to put forward definite findings as to the actual situation.

Both Dr. J. A. Ahearne and Dr. S. Humphry, who have been intimately associated with the Orphanage for a considerable time, agree that hookworm disease has occurred there for very many years, diagnoses of ancylostomiasis having been made at various times by several observers. The actual number of children showing clinical signs has not been notable until recent years, when apparently the disease has become more widely prevalent.

In 1918, Dr. A. Breinl, (then Director of the Austral-

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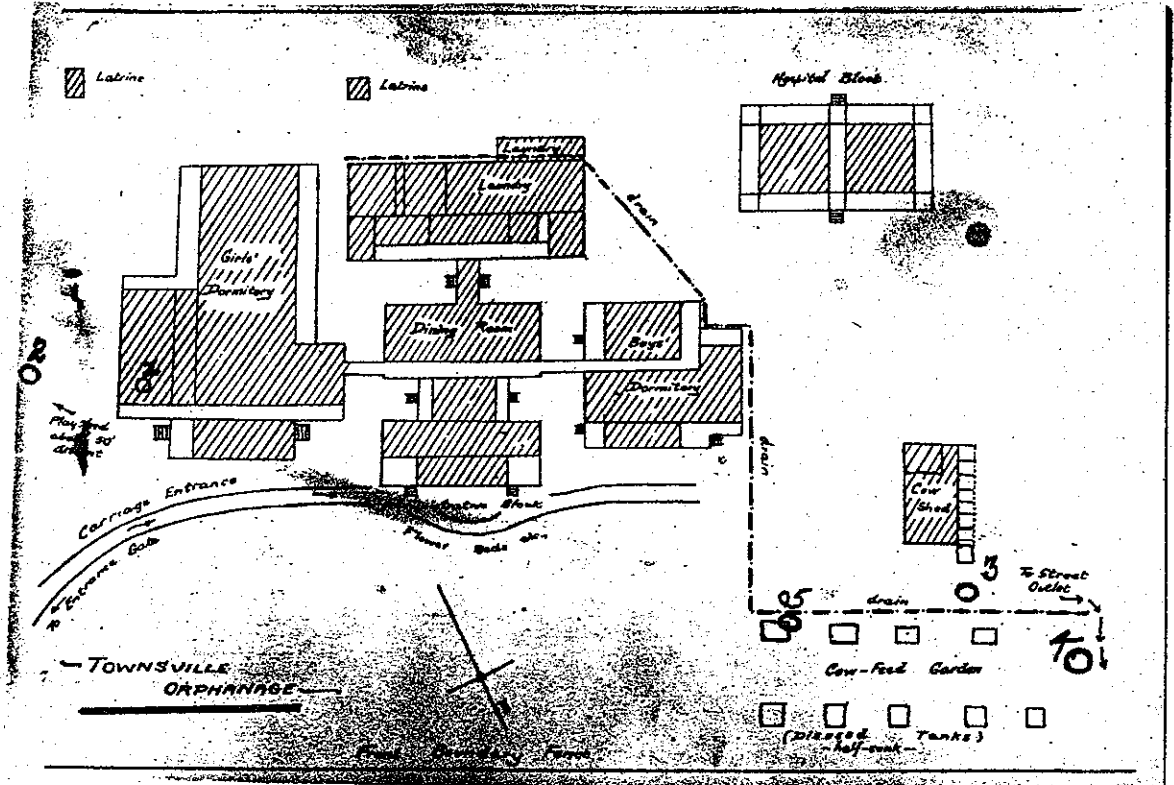
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ian Institute of Tropical Medicine), and his staff,

carried out for the Hookworm Campaign an examination of the children of Townsville, including all children from the Orphanage. On this occasion 105 children from the Orphanage and the homes of guardians were examined, and in 46 of them hookworm disease was found to be present (43.4%). Subsequent examinations between 1920 and 1921 by Dr. H. H. Willis showed in regard to 57 children then resident or approachable, that 37 were positive for Hookworm ova, thus giving the very high total of 64.9% of infestation. [On 5th January, 1923, arrangements were made by the writer for a very thorough examination of the whole of the available Orphanage children, together with a simultaneous inspection of the Orphanage buildings and grounds and the immediate vicinity.

new paragraph

*Fig. 1.
Approximate
Scale map of
Orphanage
1" = 75'*

It will be seen from the subjoined sketchmap that the institution consists of a main administrative block, behind which is the common dining room. In the rear of this again is a kitchen block with dressing rooms, bath rooms, and laundry attached; on either side of the main dining room and in connection both with it, and with the administrative block, is a dormitory, that nearest the entrance drive being the girls' dormitory and sewing room, and that on the further side being the boys' dormitory. A playground and a tennis court are set on the nearer side of the girls' dormitory; while a cowshed, tool room, and milking bails are located on the further side of that occupied by the boys. The girls' dormitory, moreover, is raised on brick supports ap-



ap-/

proximately 3 feet in height. In the rear of the whole building and removed to the right of it is a Hospital block in two divisions. The Institution is fronted by flower beds, which on the right hand side give access to a kitchen garden plot set aside for cow-feed. Excellent latrines are provided. Drainage from the laundry is continued along that side of the building farthest from the main entrance drive, thence between the boys' dormitory and the cow-saed, and is finally continued along the border of the cow-feed garden to a street outlet. In the latter part of its course it passes through ground which is continually moist. The drain itself is well constructed of concrete.

Sanitation
Features
of
Importance.

Certain outstanding features of the sanitation at once attracted attention from the point of view of the possible dissemination of Hookworm Disease. These were, firstly:- That beneath the girls' dormitory the ground surface (which was kept moist by the drippings from the constant washing of the floors above) was fouled to a most marked extent by dry, partially dry, and moist human excreta. Secondly:- While the latrines were in themselves excellent structures, faecal refuse was thrown out in an open field a short distance behind the Orphanage, which was accessible to the children; and thirdly:- that the laundry waste, which must frequently contain infected faecal matter, passed down the drain to which reference has been made, and found its exit along the course of the drain, and more particularly in the cow-feed garden.

*Fig 2.
area below the
girls' dormitory
was fouled
possibly with faeces.*

playing/

or at work, some of them spending a very considerable portion of their day, for example, in the cowfeed garden. As a further generalisation, it was observed that all the children were bare-footed, not merely for purposes of economy, but from actual choice, the children preferring not to wear boots under any circumstances, even if they were provided with them.

Fig 3.
Portion of the
cement drain.
Hookworm larvae
were found at the
spot marked "5."

Soil
Samples

The persistence of the infection at the Orphanage and its high percentage rate on previous examinations, suggested that it would be desirable to take soil samples to determine whether or no infection could be detected in certain definite areas. Soil samples were accordingly taken from the fouled ground below the girls' dormitory, from the cow-sled, the playshed, the latrines, from the wet course of the drains in several places, (more especially in the moist and muddy cow-feed garden), and in various other localities.

Fig. 4
The drain in
its latter part,
the cowfeed
garden.
Larvae found
at "4")

localities:-

- (1) Beneath the girls' dormitory.
- (2) In the playshed.
- (3) Along the course of the drain, and to a very notable degree, in the cow-feed garden.

Fig. 5.

the playshed.
in which hook-
worm larvae
were also found.

The latrines were found to be free of infection as were the few remaining sites examined, though, in almost every instance, considerable collections of nematodes of a harmless nature were found. The fact that the latrines were free of infection is a feature of significance and importance, indicating not only the suitability of type, but also the high degree of control of hookworm dissemination by proper latrine accommodation. On the other hand, the faulty disposal of faeces, evidenced by the foul condition of the ground surface below the girls' dormitory, and the prevalence of hookworm larvae along the course of the drain by which the waste laundry water ^{is} ~~was~~ conveyed away, is a sufficiently dramatic proof of the realness with which, in an infested community, dissemination of the disease may occur.

Fig. 6.

(maize)
The garden
containing
many hookworm

Examination
of the
Inmates.

Examination of the actual inmates of the Orphanage was found difficult and unsatisfactory from various causes, more especially the fact that the children at the Orphanage varied in numbers and individuals from time to time. On the first occasion (5/1/23) 39 children were examined, and of these 31 were found positive for hookworm, i.e. 79.5%. Of those soil samples taken at the same time, five contained living hookworm larvae. Arrangements were now made to treat these children and to re-examine them at a later date. When, however, this was attempted, it was found that a considerable number of the original 39 children had left the Institution, while others had been newly admitted. Re-examination was, therefore, postponed for the time being, with a view to instituting a more satisfactory routine system.

The second survey was inaugurated on the 16th March, 1923, when 15 cases not previously examined, were dealt with. Of these six, or 40%, were found positive to hookworm. Eleven persons found positive in January were re-examined, and of these, six were found to have been cured; of the remaining ten found positive in January, seven had been removed, and three had been discharged from State control. In all, 37 persons were given treatment.

A resurvey was carried out on 15th April, when sixteen persons, either new arrivals, or returned Orphanage children were examined, and of these four, or 25% were found positive to hookworm. Five children previously found positive were given first re-examination, and one only found to have been cured; three children previously found positive were given a second re-examination, and two were found to be cured; the remaining three persons who had previously been infected, had been removed and were not available for re-examination.

On 17th May a further examination was made when five

Insert after 'in the areas to which they are sent' p. 8.
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Infection
Rate by
Sex.

The distribution of hookworm disease amongst the Orphanage children by sex yields for the boys the figure of 46.3% as compared with 38.7% for the girls. The difference is probably due to the fact that the boys work more in the heavily infected cowfeed garden.

Infection Rate by Sex.

<u>Males</u>			<u>Females</u>		
<u>Number examined</u>	<u>Found positive</u>	<u>%</u>	<u>Number examined</u>	<u>Found positive</u>	<u>%</u>
41	19	46.3	31	12	38.7

The Orphanage as a local infecting agency.

The importance of the Orphanage itself as an endemic focus for the disease, was tested by the classification of the children into groups, shewing the relation between the length of stay and the percentage of positive cases. Of seven children who had been at the Institution under one year, one (or 14.3%) was found infected with hookworm; three (or 42.9%) with Trichuris trichiura, and one (or 14.3%) with Hymenolepis nana. Of two, who had been in the Institution from one to two years, one was found infected with hookworm (50%); of nine children who had been between two and three years in the Institution, five (or 55.6%) were found to be infected; while of the children who had spent three to four years in the Institution (viz:7) five (or 71.4%) were found infected; of those who had spent more time in relation to the Institution, though not necessarily resident there, (14 in all) seven (or 50%) were found infected with ancylostomes.

Hookworm Infestation as related to length of stay in the Institution.

Length of residence	Number examined	Found Positive to:-					
		Hookworm	%	Trich.trich.	%	Hym.nana	%
Under 1 year	7	1	14.3	3	42.9	1	14.3
1 to 2 years	2	1	50.0	0	-	0	-
2 to 3 "	9	5	55.6	1	11.1	0	-
3 to 4 "	7	5	71.4	2	28.6	1	14.3
4 to 5 " or more	14	7	50.0	5	35.7	0	0

It will thus readily be seen that Hookworm infestation increases very considerably after the second year of residence, reaching its maximum in the third and fourth years. It becomes apparent also, that when boarded out, these children can readily become a disseminating centre in ^{the} areas to which they are sent.

The Orphanage as a general centre of disease dissemination.

The following figures shew the respective numbers boarded out in the neighbourhood of Townsville and in Townsville itself:-

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✘✘ Insert after "of their new homes" — p. 9.

Examination
of the
Children Fostered out.

Of a total of 113 children who were fostered out, it was possible to get in touch with 47. Of these 26, or 53.3% were found positive to hookworm. It will be seen, therefore, that the children retain materially the infection which they acquire at the Orphanage subsequent to their distribution to other homes.


Examination of Children Fostered out

	<u>Townsville.</u>	<u>Ch. Towers.</u>	<u>Atherton.</u>	<u>Total</u>
Number of children fostered out	47	65	1	113
Number examined.....	40	6	1	47
Found positive to hookworm	22	3	1	26
Per cent positive	55.0	50.0	100.0	53.3
Given first treatment	22	0	0	22

itself:-

Townsville	47
Charters Towers	65
Oenomba	3
Atherton	1
Cairns	2
Ayr	4
Ravenswood	4
Winton	1
Brandon	1
Malanda	1

The percentage of children who had been Orphanage children to the total infection rate in any of these localities, has not been deliberately estimated, except in the case of Charters Towers, where, of the total percentage of infected cases (53 persons), of 45 whose histories were taken, Orphanage children contributed 16 cases, or 35.6%; thus directly accounting for over one-third of the whole of the infection present among the schoolchildren in that town; omitting any mention of the possibility of their indirect influence as playmates, etc., among the remaining infected individuals. By placing these facts before the responsible officers, permission was obtained to control dissemination, by examination and effective treatment of all incoming and outgoing children, prior to their mixing with the other Orphanage children, or the inmates of their new homes.

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Certain features of importance may now more definitely be emphasized, namely:-

1. The children at the Orphanage are exposed to continued infection by hookworm disease, and evidence the fact that infection ^{constantly} does occur, by the progressive percentage found infected from year to year of residence.
2. There is a heavy soil infestation in certain areas frequented by the children both while at work and during play; in particular, beneath the girls' dormitory; in the cow-feed garden, and all areas adjacent to the drain; and in the playshed. (In respect of this last, the Matron volunteered the statement, unasked, that she had been struck by the fact that children set to play in the playshed, became, after a few months, pale, languid and listless).
3. Obvious soil pollution possibilities were detected in con-

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nection with the grossly polluted soil beneath the girls' dormitory; along the course of the drain leading from the laundry and in the field adjacent to the Orphanage where faeces were incompletely disposed of.

It is evident, therefore, that the vicious circle is a simple one—the children infect the soil; other children are thus infected; and they, in turn, more grossly infect the soil; and thus materially increase the rate and scope of infection.

Recommendations:-

Measures of control in hookworm disease readily resolve themselves into :-

- a) the cure of the infested individual;
- b) the prevention of soil pollution;
- c) measures to render primarily polluted areas innocuous.

a). Measures for the cure of the individual were undertaken in accordance with the standard routine method employed by the Hookworm Campaign. It has been pointed out by Smillie in Brazil, and is the conclusion of many who have had experience in this regard, that hookworm treatment frequently fails to lower appreciably the actual percentage of cases found positive, but immensely reduces the numbers of worms harboured. This fact may be further illustrated by the suggestion that, whereas 90% of the worms are removed with ease at one treatment, the remaining 10% are apparently extremely difficult to remove by any number of subsequent treatments, though, since they cannot increase within the body, they fall far below the number necessary to produce clinical symptoms. Though ova may appear in the stools, therefore, yet in the absence of fresh infection, and provided soil pollution is prevented, their presence is of negligible importance. Patients whose worm parasites have been reduced to this "irreducible minimum" may be regarded as cured, from the point of view of the individual, though, from the viewpoint of the community, they still need continued supervision and control.

b). The fact referred to above renders it obvious that mass treatment per se is useless if unsupported by the prevention of

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soil pollution. At the Orphanage, steps in this direction had been taken by the provision of adequate latrines, and, as stated above, these areas were found to be free from hookworm infestation. The uncontrolled factor, however, was in this instance, the infant population of 2 to 6 years of age, over whose promiscuity in the matter of defaecation, it was impossible to exercise adequate control. The condition found beneath the girls' dormitory was sufficiently indicative in this regard. In the case of this dormitory, it would be a simple matter to prevent future error by the complete netting round of the accessible space below the building. Strong iron wire, from one brick pier to another throughout the whole circuit of the building, would readily effect a remedy. In the case of the laundry, the cowshed, the playshed, and the drains, however, there is no such ready means of control, short of the complete roofing of the drain. This measure, while effective in the case of the drain itself, and probably also for the laundry, would be no means ^{fully} control the infection which exists in the cow-feed garden and the playing shed. These localities, therefore, must be included under the third sub-division, namely:- "Measures to render primarily polluted areas innocuous".

Cort & Payne, in a study of the effect of hookworm control measures on soil pollution and infestation in a sugar estate in the West Indies, found that soil pollution, which was widespread and very gross, was especially localised in character, and, that there was little migration of infective hookworm larvae from their places of development, although there was some evidence that they might be carried considerable distances by water. After the reduction of soil pollution in the areas referred to by the institution of suitable latrines, and the treatment of the people of the area, it was demonstrated that there was a very rapid diminution in the numbers of infective hookworm larvae found, so that, in about six weeks, soil infestation was practically eliminated. Similarly, in a subsequent publication respecting hookworm disease in a cacao estate, examinations of the soil

soil/

of the intensely polluted spots in the cacao, six weeks after three routine treatments had been given to the people, shewed a very marked reduction of soil infestation, indicating that in this situation, the life of the infective hookworm larvae is short. D. L. Augustine, carrying on experiments in the same locality from May to September, 1922, confirmed the fact that infective hookworm larvae placed on moist soils do not migrate to any extent, but may be carried out from centres of soil infestation by surface water, and can when the water recedes, establish themselves in these new locations.

Moreover, it was found that they shewed no automatic tendency to migrate to favourable situations, when their original environment became unfavourable. It was further demonstrated by Augustine that, under optimum conditions of moisture and temperature, infective hookworm larvae were found to remain on and in the upper surface of the soil.

In some further experiments on the length of life of infective hookworm larvae in soils, the same author shewed that, whereas from the observations of various investigators of hookworm larvae under unnatural conditions, the opinion has become current that they live for months, or even years, in the soil if the conditions of temperature and moisture are favourable, on the other hand, laboratory experiments carried on in Trinidad, shewed that a rapid diminution in the hookworm larvae occurs in soil of various types, and that the extent of their life is limited to about six weeks. Indeed, he draws the conclusion that environmental conditions such as tropical temperatures which tend to increase the activity of the mature hookworm larvae will shorten their life by the more rapid using up of the stored food material. Experiments of a related nature by Florence King Payne, shewed that in garden soil with uniform conditions of moisture, very few larvae migrated more than two inches from the point of inoculation. In water-logged garden soil there was apparently a very high death rate and little migration, while in garden soil

soil/

in which the conditions of rising ground water were simulated 74.4% of the larvae recovered had migrated three inches or more; 15.4% had migrated five inches or more; while a few had migrated more than seven and a half inches. Migration was apparently more difficult in the specimens of fine sand, and ^{the} mixtures of clay and sand, than in the specimens of garden soil.

Baermann, in his investigations which antedated all these observations, established somewhat similar data in respect of the plantation coolies' hookworm infested habitations in Sumatra, Dutch East Indies. The most important point in his work was the discovery that ancylostome larvae harbouring in the soil are not diffused over wide areas, but are concentrated in the neighbourhood of latrines, defaecation places, and in constantly damp soil such as that around vessels where water is stored and frequently spilled. Baermann proceeds^{ed} to point out that the curative methods and soil prophylaxis hitherto practised, while they have reduced the density of infection greatly, have failed to eradicate it, -- only constant attention and renewed efforts keeping the disease even within bounds.

The author went on to demonstrate that larvae wander rapidly from artificially disturbed earth, -- all having gone from loose earth in twentyfour hours, and most after the first half-hour; that many more moved downwards than moved upwards, and that the mixing with water and breaking up of lumps of earth, expedited their removal. Further, by a lengthy series of experiments, it was found that planted soil afforded very favourable conditions for the development and persistence of larvae; in unplanted soil the larvae did not develop when exposed to sun with little rain, though they did so when rain was abundant. Shade was always a favourable factor, and a network of roots or a little grass was sufficient to retain the necessary moisture. Larvae were not found upon the surface, but very close beneath it, and at greater depths, so that in wet ground, the weight of the feet was sufficient to open up the

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soil in a manner which gave the larvae access to the skin; infested particles of earth, moreover, might be carried away on the feet.

In concluding his paper, Baermann insisted on the importance of the concentration of the population and of their faeces in producing a heavy infestation rate. These conditions of course exist at any such Institution as an Orphanage. Even under such conditions, a considerable period is necessary, approximating in his experience, four years. It will be noted that this figure corresponds closely with that found in Townsville for the heaviest infection rate. At the Orphanage, in the playshed and cow-feed garden, we have respectively in the first case, an only occasionally moist, loamy soil, which is however, polluted from time to time by the casual faeces of children; in the second case, a rich, constantly moist, garden soil, receiving the overflow from the drain, which collects not only the waste from the laundry, but drains the larger portion of the possibly polluted ground surfaces; moreover, the cowfeed garden lies at the lowest part of the Orphanage block and is the neck through which the natural subsoil and surface drainage tends to make its way.

A simple solution for the Orphanage would be the continuous wearing of shoes. Apart from the cost, which would be considerable, however, ^{wear} they could not be assured in the most important places, the cowfeed garden and the playshed, since the children use boots ^{with} ~~such as one wears~~ "best clothes", namely, on special occasions, and then, only under compulsion.

The netting around of the frequently moistened, polluted space beneath the girls' dormitory, and the roofing over completely of the drain, have already been referred to.

Without moisture, of course, the larvae cannot develop, and the obvious course is to remove all sources of water.

This, however, is impracticable.

Baermann made experiments on the disinfection of circumscribed areas, using, with more or less success, lysol, izal, hycol, Jeyes' Fluid, carbolineum, and crude creolin. The best

naphazard./

- e). Insistence upon the use of boots amongst those children who are working in the cowshed or the cowfeed garden.
3. Examination of the children at intervals of three months for hookworm with the exhibition of the standard routine treatment in all cases found positive.
4. The continuance of the present system of examination of new entrants to the Institution, and all children leaving the place, with a view to curing them of any hookworm infestation before allowing them to mix either with the remaining Orphanage children, or the families outside the Orphanage to which they may be destined.
5. Determination from time to time by actual soil examination of spots locally infested with hookworm larvae, and their treatment in accordance with the method advocated by Baermann.

ACKNOWLEDGEMENT:-

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