THE PREVALENCE AND IMPORTANCE OF UNCINARIASIS
AMONG APPARENTLY HEALTHY SOUTHERN-BRED
WHITE MEN IN THE UNITED STATES ARMY *

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Until very recently the prevalence of hookworm disease among soldiers who have always resided in the United States appears to have been very little investigated. The only mention of uncinariasis in the report of the Surgeon-General of the Army for 1908 is that an examination of the stools of 21 soldiers at Fort Root, who had recently returned from the Philippine Islands, showed all to contain ova of *Ankylostoma duodenale*. In 1904 the surgeon at Fort Porter, New York, reported the presence of ankylostoma in many cases admitted to hospital for other conditions; but where the infection probably originated is not stated in the reference to his work. On Dec. 7, 1908, Captain J. F. Siler, of the Medical Corps of the Army, stationed at the large recruit depot of Fort Slocum, New York, reported to the Surgeon-General that of 19 southern recruits examined, 16, or 84 per cent., harbored ankylostoma. Of these, 3 were suspected of being so infected, while the remainder were in hospital for other reasons.

As a result of Dr. Siler's work, instructions were sent out for army surgeons to investigate the prevalence of uncinariasis among southern-bred soldiers.¹ The result of my work on this subject illustrates how a well-known condition may be entirely overlooked until one's mind is specially directed to it. Prior to the present investigation, no case of uncinariasis had ever been recorded on the sick report at Jackson Barracks. During the three years I have been stationed there two cases were suspected of ankylostomiasis, but on examination both proved negative. Yet the result of my recent work is to show that 25 per cent. of the entire command harbored the hookworm, and that the condition had been

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1. By "southern-bred" is meant in this article men who were born and always had lived in some one of the following states: Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Kentucky, Tennessee, Arkansas and Missouri.

wholly unsuspected. It is undoubtedly true that similar mild infections are being constantly overlooked throughout the southern states as well as in the army.

PERCENTAGE OF MEN INFECTED

The work at Jackson Barracks has consisted of the examination of the blood and stools of 147 apparently healthy soldiers. For analysis these 147 cases are separated into four classes. The details are given in appended tables.

Class 1.—Newly enlisted southern-bred recruits received at the recruit depot at Jackson Barracks. There were 43 of these, and 29 were infected with uncinaria, a percentage of 67 (Table 1).

Class 2.—Southern-bred soldiers in the permanent command at Jackson Barracks serving in their first enlistment; that is, having three years or less in the army. Fifty-seven of these were examined and 31 were found infected, a percentage of 54. The average length of service for these men was 1.1 years, and only a single one of the positive cases had been in the army over two years (Table 2).

Class 3.—Southern-bred soldiers in the permanent command at Jackson Barracks who have served more than one enlistment; that is, over three years. There were 33 of these examined, and only 4 were found to have uncinariasis, a percentage of 11. The average length of service for these men was 6.4 years. The four men infected had served, respectively, 4, 5, 6½ and 7 years. The number of worms found in these cases was small, the average being 5½ per man (Table 3).

Class 4.—Soldiers and recruits at Jackson Barracks who had lived little or not at all in the south. Fourteen of these were examined, and no ova of uncinaria were found nor did the eosinophile count of any suggest the presence of intestinal parasites.

If the new recruits (Class 1) and the soldiers in their first enlistment (Class 2) are combined, we have 100 southern-bred soldiers with less than three years' service among them among whom an even 60 per cent. were infected with hookworms. Adding the 4 positive cases among the older soldiers, gives in all 64 cases of uncinariasis to be studied.

That this high percentage of uncinaria infections among southern-bred recruits is probably the rule rather than the exception is shown by the following reports: Captain P. J. Owen, Medical Corps, U. S. A., stationed at Columbus Barracks, Ohio, records the finding of 8 cases of infection with *Uncinaria americana* among southern recruits, though how many were examined in all is not stated. Captain Siler has recently written me that he has now examined 140 recruits, finding over 85 per

TABLE I.—FORTY-THREE UNSELECTED SOUTHERN-BRED RECRUITS EXAMINED AT JACKSON BARRACKS, LA. *

Case No.	Age, Height, inches.	Weight before treatment.	Weight after treatment.	Occupation at time of enlistment.	Occupation previous to enlistment.	Birthplace.	Residence.	History of ground itch.	Years since ground itch.	Color.	% Polynuclears.	% eosinophiles.	% lymphocytes, small.	% lymphocytes, large.	% transitionals.	% mast cells.	Number of ova found in stool.	Number of worms found after treatment.	Remarks.
1	22 66	124	133	Farmer	Farmer	Miss	Miss	N	Good	Good	100 62	6.5 22	7	2.5	0	Many	18		
2	21 68	133	140	Farmer	Farmer	Miss	Miss	P	12	Good	100 66.5	8.5 16.5	5.5	2	1	Many	42		
3	23 69	135	135	Plumber	None	S. C.	Ala	P	14	Pale	80 74.5	2	15	3.5	5	0	Few	0	
4	18 66	127	124	Factory	Farmer	Miss	N. C.	P	14	Good	100 44	26	22	4	0	Few	3		
5	21 68	145	152	Farmer	Farmer	Miss	Miss	P	14	Pale	80 46	7	26	11.5	9.5	0	Few	17	
6	21 69	127		Solicitor	Engineer	Ala	Ala	N			35.5	7	44.5	9	3.5	0.5	0		Never lived in country.
7	19 66	118		Laborer	Laborer	Miss	Miss	?		Good	90 40	20.5	25.5	4	5	0	Very few		Left before treatment.
8	23 68	128	129	Collector	Farmer	Ga.	La	P	15	Good	90 60.5	7.5 30	7	4.5	0.5		33		Farmer 6 years ago.
9	20 66	126	129	Lumber	Farmer	Tex.	Miss	P	9	Good	90 63	11	17	6	3	0	Many	10	
10	28 68	153	159	Engineer	Farmer	Ala	Miss	P	20	Good	80 47	8.5 32	7	5.5	0	Very few	2		Farmer 6 years ago.
11	22 69	144	154	Farmer	Farmer	Ala	Ala	P	12	Fair	80 69	7	15.5	4	3.5	1	Very many	12	
12	27 66	130		Carpenter	Farmer	Miss	Miss	P	18	Pale	90 62.5	15	9.5	3.5	9	0.5	Few	5	
13	23 65	128		Sawmill	Farmer	Miss	Miss	N		Good	90 65	1.5 20	8.5	4.5	0.5	0			Not on farm for 11 years.
14	23 72	151		Barber	Farmer	Fla	La	P	7	Fair	80 51.5	17	23	2.5	5	1	Very many		Left before treatment.
15	18 67	150	159	Laborer	Farmer	W. Va.	La	N		Pale	90 49	11	28.5	5.5	5	1	Very few	0	
16	26 67	129	139	Laborer	Farmer	Ala	Ala	P	20	Good	90 68	5	23	2.5	1.5	0	Few	1	
17	20 69	152		Factory	Farmer	Ala	Ala	P	5	Pale	90 71.5	4.5 18	3	2	1	Few			Left before treatment.
18	23 72	150	154	Farmer	Farmer	Ga.	Ga	P	15	Good	80 65	10.5 14	3.5	6.5	0.5	Very many	0		
19	31 70	190		Carpenter	Butcher	Ga.	Ga	P	4	Good	100 56	2.5 34.5	4.5	2.5	0	0			
20	23 72	147	157	Stable	Farmer	Ala	Ala	P	12	Pale	100 68	4	20	6	2	0	Very many	2	
21	25 65	124		Cooper	Farmer	La	La	P	15	Good	100 50	2	39.5	5.5	3	0	0		

TABLE 11.—FIFTY-SEVEN UNSELECTED SOUTHERN-BRED SOLDIERS IN THEIR FIRST ENLISTMENT PERIOD (THREE YEARS) *

Case No.	Age.	Years in Army.	Height, inches.	Weight before treatment.	Weight after treatment.	Occupation at time of enlistment.	Occupation previous to enlistment.	Birthplace.	Residence.	History of ground itch.	Color.	% hemoglobin.	% polynuclears.	% eosinophiles.	% lymphocytes, small.	% lymphocytes, large.	% transitionals.	% mast cells.	Number of ova found in stool.	Number of worms found after treatment.	Remarks.	
44	34	1	64	140	.....	Mechanic	Cook	Ga.	Ga.	N	Good..	90	76	3.5	16	3	1.5	0	0	.....	Never lived in country.	
45	23	1	68	143	146	Fireman	Fireman	Miss.	Miss.	N	Good..	90	55	4	31	7	2	0	Many...	2	Never lived in country.	
46	22	1	68	151	.....	Student	Farmer	Miss.	Miss.	P	Good..	90	68	3	20	5	3	1	0	.....	.....	
47	21	1	67	126	135	Farmer	R. R. Laborer	Miss.	Miss.	P	Pale...	80	63	7.5	24	2.5	3	0	Very many	82	.....	
48	23	1	69	166	167	Fireman	Farmer	Miss.	Miss.	P	Pale...	100	64	6	23	4	3	0	Many...	35	.....	
49	22	1/2	72	146	.....	Machinist	Machinist	Miss	Va.	N	Good..	100	60	2	28	3	7	0	0	.....	.....	
50	29	3/4	70	146	.....	Engineer	Farmer	Ala.	Miss.	P	Good..	90	53	7.5	29	5	4	5	0	2	.....	
51	19	1	65	145	138	Farmer	Farmer	Ala.	Miss.	P	Good..	90	42	8	37	7.5	4	1	Many...	35	.....	
52	22	3/4	66	115	124	Farmer	Farmer	Ala.	Miss.	N	Good..	90	46	12	32	6.5	2.5	0.5	Very many	13	.....	
53	26	1 1/4	69	140	140	Laborer	Farmer	Ala.	Miss.	P	Good..	100	58	4	36	1	1	0	Very few	3	.....	
54	20	3/4	68	144	132	Smith	Smith	Miss.	Miss.	N	Good	100	62	4.5	26	5	3.5	0.5	Few...	4	.....	
55	14	1/2	67	135	.....	Farmer	Factory	Miss.	Miss.	P	Fair...	100	65	3.5	24	4	2	0.5	0	.....	.....	
56	25	1	70	149	.....	Stock Farm	Same	Miss.	Miss.	N	Xint...	100	58	2	32	6	2	0	0	.....	.....	
57	19	1	65	143	149	Canning	Canning	Tex.	La.	N	Good..	90	60	7	24	4	5	0	Few...	0	Never lived on farm.	
58	23	1	70	138	142	Fireman	Farmer	La.	Miss.	P	Good..	90	65	2.5	25	5	3	0	Few...	55	.....	
59	28	1	65	123	.....	Boxmill	Painter	La.	La.	N	Fair...	90	36	0.5	49	5.5	8.5	0	0	.....	Never lived in country.	
60	25	1	70	135	135	Sawmill	Farmer	Miss.	Miss.	P	Good..	90	30	6	32	15	17	0	Few...	13	.....	
61	19	1	69	134	.....	Section man	Section man	Miss.	Miss.	P	Good..	100	47	1.5	37	5.5	8.5	0.5	0	.....	.....	
62	31	1	65	115	116	Lumbering	Farmer	Miss.	Miss.	P	Good..	100	63	8	24	3	2	0	Many...	31	.....	
63	23	1	60	136	139	Pile driving	Farmer	Fla.	La.	N	Good..	90	65	5	24	5	1.5	4	0	Few...	11	
64	30	1	70	160	.....	Photographer	Farmer	Tenn	Tex.	N	Good..	100	55	1	29	8	7	0	0	.....	.....	
65	29	1 1/4	65	138	139	Machinist	Farmer	Fla.	Fla.	P	Pale...	90	41	5	48	2	4	0	Few...	32	.....	
66	22	1	69	132	132	Express	Express	Tex.	Tex.	N	Fair...	90	54	6	32	5	3	1.5	Very few	1	Never lived in country.	
67	19	1	67	130	.....	Engineer	Clerk	Ga.	Ala.	P	Fair...	90	58	2	33	4	3	0	0	.....	Never lived in country.	
68	23	1	66	146	140	Clerk	Farmer	Ala.	Ala.	N	Good..	90	55	5	26	5	7	2	Few...	18	.....	
69	23	1/2	69	130	127	Farmer	Farmer	La.	La.	N	Good..	90	59	13	23	2	2	1	Few...	10	.....	
70	22	1 1/4	70	151	148	Logging	Farmer	Miss.	Miss.	P	Good..	90	49	11.5	28	6	5	0.5	Few...	1	.....	
71	23	1/2	65	142	.....	Log scaler	Log scaler	Miss.	Miss.	P	Fair...	80	59	2.5	30	3	5	0.5	0	.....	.....	

72	26	¾	70	164	176	Laborer.....	Farmer.....	Ga...	Ga...	N	Good..	100 62	5	23	5.5	4.5	0	Very few	13	
73	21	½	68	151	146	Coal miner...	Lived on farm	Ala..	Ala..	N	Good..	100 52	8	37	3	0	0	Many..	27	
74	24	½	68	189	...	Salesman...	Clerk.....	La...	La...	N	Good..	100 59	0	31	4	5	1	0		Never lived in country.
75	19	1	67	132	136	Laborer.....	Laborer.....	Miss	Miss	P	5 Pale...	100 83	6	9	1	1	0	Very many	77	Laborer in city. Never lived in country.
76	24	1	67	153	...	Carpenter.....	Farmer.....	Miss	Miss	N	...	90 51	6	32.5	4	6	0.5	0		
77	28	1	67	138	...	Bricklayer.....	Express.....	La...	La...	N	XInt...	100 53	7	26	5	6	3	0		Never lived in country.
78	21	½	70	160	164	Cotton mill...	Farmer.....	Ala..	Ala..	P	7 Fair...	100 62	4	26	6	2	0	Few...	75	
79	22	¾	68	137	138	Fireman.....	Scholar.....	Miss	Miss	P	12 Good..	100 53	4.5	33	4.5	5	0	Very many	99	
80	25	½	65	124	...	Waiter.....	Clerk.....	Ga...	Ga...	N	Pale...	90 57	2	20	12	8	1	0		Never lived in country.— Syphilitic.
81	25	2	6	159	144	Lu : beri g...	Farmer.....	Ala..	Ala..	P	15 Good..	100 54	1	27.5	10	7.5	0	Very few	1	
82	23	2	68	165	105	Lumbering...	Farmer.....	Ala..	Ala..	P	11 Good..	90 48	11	31	4.5	3.5	2	Very few	3	
83	23	2	68	132	137	Electrician...	Electrician...	Ala..	Ala..	N	Fair...	90 24.5	13.5	51	5	5	1	Very many	38	
84	33	2	72	184	...	Lumberman...	Farmer.....	Miss	Mo...	N	Fair...	100 49.5	0.5	39	5	6	0	0		Lived in Mo. last 13 years.
85	33	1	67	150	...	Farmer.....	Farmer.....	Tenn	Tenn	N	Good..	90 48.5	5	34	5.5	6.5	0.5	0		
86	23	½	64	123	117	Laborer.....	Laborer.....	Miss	Miss	N	Fair...	80 45.5	3.5	35	10.5	5.5	0	Very few	5	
87	28	2¼	74	175	173	Farmer.....	Farmer.....	Miss	Miss	P	10 Good..	100 35.5	7	42.5	9	5	1	Very few	15	
88	29	½	66	139	...	Electrician...	Merchant...	La...	La...	N	Good..	90 65.5	0.5	16.5	9	8	0.5	0		Never lived in country.
89	26	1	67	142	...	Telegrapher...	Clerk.....	Tex.	Tex.	N	Good..	100 68	6	21	3	1	1	0		
90	22	2¼	69	161	...	Telegrapher...	Telegrapher...	Tenn	La...	N	Pale...	90 61.5	1.5	21	6.5	9	0.5	0		
91	24	2	67	138	...	Carpenter.....	Carpenter.....	Miss	Miss	N	Pale...	90 64.5	4.5	26	2.5	2.5	0	0		Lived on farm till 16 years old. Never farmed.
92	23	½	72	163	...	Drummer.....	Fireman.....	La...	La...	N	Fair...	90 54	4	37.5	3	1	0.5	0		Never lived in country since 8 years old.
93	24	½	68	137	139	Millman.....	Farmer.....	Miss	Miss	P	10 Good..	100 38	12	47	1	1	1	Very many	24	
94	31	1	72	184	...	Farmer.....	Farmer.....	Miss	Miss	N	XInt...	100 45	3.5	36.5	11	3.5	1.5	0		
95	27	2	69	149	...	Clerk.....	Clerk.....	Ala..	Tenn	N	Good..	90 74	0	23	1	1	1	0		Never lived in country.
96	23	¾	65	138	136	Brakeman...	Millhand.....	N. C.	S. C.	P	15 Good..	100 62.5	3	24.5	4	6	0	Few...	10	
97	22	½	66	140	136	Circusman...	Farmer.....	Tex.	La...	N	Pale...	80 56	12.5	28	1.5	1	1	Few...	0	
98	32	¾	69	145	...	Machinist...	Ironworker...	Va...	Va...	N	Fair...	90 61.5	5	27.5	2.5	3.5	0	0		Few ova tricocephalus dispar.
99	23	½	65	136	...	Salesman...	Salesman...	Ky...	La...	N	Good..	100 57	2	35.5	3.5	2	0	0		Never lived in country.
100	24	½	70	144	...	Smith.....	Painter.....	Va...	Ala..	N	Good..	100 56	3	30.5	5.5	5	0	0		Never lived in country.

Thirty-one cases of uncinariasis out of 57 = 54 per cent.
Average eosinophilia for positive cases, 5.85 per cent.
Average eosinophilia for negative cases, 2.50 per cent.
Average weight of positive cases, 141 lbs.
Average weight of negative cases, 148 lbs.
Average gain in weight after treatment, 0 lbs.

* N means negative history for ground-itch.
P. means positive for ground-itch.
XInt. means "Excellent."

cent. infected. My own work in this direction was brought to an unexpected conclusion because of the sudden cessation of recruiting in New Orleans made necessary by reason of the fact that the army had nearly reached its authorized strength.

Strong reports² that in an investigation of 4,106 Filipino prisoners 52 per cent. were found to be infected with uncinaria. If this can be taken as an index for the general population of the Philippines, it appears that the proportion of infections among the Filipinos, living in their insanitary manner, is not as high as that of southern-bred recruits who probably are less likely to be infected than the mass of the rural population of the south.

CLINICAL SIGNS OF LIGHT INFECTIONS

First of all, it must be clearly understood that none of these infected subjects studied by me were sick. Many never had been on sick report, and, of those who had, only one presented symptoms which, in the light of positive uncinaria findings, could be attributed to the parasites. This patient had been in hospital several times with slight fever, indefinite intestinal symptoms and fleeting pains in chest and abdomen. He was unable to do any heavy work without soon becoming used up. Hemoglobin was 80 per cent. Seventy-seven worms were obtained after he was treated. With this exception, the cases I am reporting belong to the class of which Stiles says: "Under light infections may be included those patients who show eggs in the feces on microscopic examination, but who do not exhibit any or sufficiently marked symptoms to attract special attention. These cases are numerous and important, as they are capable of keeping a region infected and thus giving rise to severe cases. Hence from a prophylactic standpoint they should always be treated when found." That these cases can not be detected by mere inspection is evidenced by the words of Stiles, that "if these light cases were submitted to physical examination for enlistment in the army or navy, probably most of them would be accepted as sound."

As will be seen in the appended tables, I have classed the color of the men examined as "excellent," "good," "fair" or "pale." By "excellent" is meant the fresh, ruddy complexion so common among healthy northern men. It will be observed that very few of the southern men possessed this "excellent" color. Many are recorded as fair and a few as pale, but there

2. Strong (R. P.): Combating tropical diseases in the Philippines by scientific methods. *Jour. Am. Med. Assn.*, 1909, lli, 524.

seem to have been no notable differences in color between the positive and the negative cases.

In view of the great prevalence of uncinariasis in the South, it is thought that much caution must be used in looking on hookworms as the cause of atypical symptoms in a patient simply because the ova are found in the feces, since the presence of uncinaria in the intestines may be a mere coincidence.

TABLE III.—FOUR CASES OF UNCINARIASIS FOUND AMONG THIRTY-THREE UNSELECTED SOUTHERN-BRED SOLDIERS WHO HAVE SERVED MORE THAN ONE ENLISTMENT PERIOD (OVER THREE YEARS)*

Case No.	Age.	Years in Army.	Height, inches.	Weight before treatment.	Weight after treatment.	Occupation at time of enlistment.	Occupation previous to enlistment.	Birthplace.	Residence.	History of ground itch.	Color.	% hemoglobin.	% polynuclears.	% eosinophiles.	% lymphocytes, small.	% lymphocytes, large.	% transitionals.	% mast cells.	Number of ova found in stool.	Number of worms found after treatment.
109	26	4	68	156	148	Farmer....	Logging...	Tenn...	Tenn...	N	Good	90	55	4	31	5	4	1	Very few	2
127	22	5	71	140	140	Machinist.	Farmer...	N. C....	N. C....	N	Fair.	90	50	8	38	2	2	0	Many	11
129	29	6½	68	145	140	Salesman.	Farmer....	Miss...	Miss...	N	Good	90	55.5	10.5	24	4.5	5	0.5	Very few	6
132	28	7	65	156	160	Farmer....	Farmer....	Tenn...	Tenn...	N	Fair.	90	31.5	26.5	36.5	3	2.5	0	Very few	3

* Twenty-nine negative cases are omitted from table as showing nothing of interest.

N. means negative for ground-itch.

Average eosinophilia 4 positive cases, 12.5.

Average weight 4 positive cases 149.7 lbs.

Average number of worms found, 5½.

BLOOD APPEARANCES IN MILD INFECTIONS

The reduction in hemoglobin in infected men was very slight, being less marked than was found in the cases reported by Siler. No case was found with the hemoglobin lower than 80 per cent; the majority showed 90 per cent. and a considerable number 100 per cent. Among the 133 southern-bred men the average hemoglobin percentage for the infected cases was 91.5 per cent. and for the non-infected 94.2 per cent., a difference of only 2.7 per cent. No counts of red cells were made.

The leucocyte count was made in 12 infected cases, but, as it did not seem to show anything of interest, it was discontinued. The highest count was 12,700, the lowest 7,600, and the average 9,600 per cubic millimeter.

A differential count of the white cells was made in all cases and demonstrated, as was to be expected, that eosinophilia was present in the majority of those harboring hookworms. In the 64 positive cases the lowest eosinophile count was 1 per cent. and the highest 26 per cent. Fourteen cases showed less than 5 per cent. of eosinophiles. The average eosinophile count for the 64 infected cases was 8.5 per cent., and for 83

non-infected cases 2.2 per cent. In the 83 negative cases, only 9 subjects showed an eosinophile count over 5 per cent., and, of these, 2 were infected with *Trichocephalus dispar*, which doubtless caused the eosinophilia. From these observations it appears that an eosinophilia of over 5 per cent. is a very strong point in favor of infection with an intestinal parasite, but that one below 5 per cent. is of no value in excluding infection with *Necator americanus*.

THE PARASITES

Of the 64 patients in whom ova of uncinaria were demonstrated in the feces, 4 left before treatment. The remaining 60 patients were treated in the usual manner with 4 gm. of thymol, and worms were recovered from the stools of 56. The smallest number found was 1, the largest 99, and the average number per patient was 16. Whether this represents the entire amount of infection is not yet known, as very few of the patients have been re-examined since treatment, and it is probable that some worms still remain in many of the patients. The majority of the men interrogated some weeks after treatment reported that they felt better than before; one did not feel so well, and a few noted no change, these last being patients from whom only 2 or 3 worms were obtained.

All of the parasites are believed to have been American hookworms. Specimens from half of the cases were sent to Dr. C. W. Stiles for identification, and he reports that all were *Necator americanus*.

In the examination of the entire 147 men, it was surprising to find the ova of other parasites in only 3 cases, all of the 3 being infections with *Trichocephalus dispar*.

LONGEVITY OF THE HOOKWORM IN THE INTESTINES

The length of time the parasite will live in the intestines seems to be in doubt, but that it may sometimes be a period of several years appears probable from my findings. The habits of the soldier and the sanitary conditions at this and practically all other army posts are such that reinfection with uncinaria larvæ is not probable. In the new recruits examined, 67 per cent. of infection was found; in the soldiers in their first enlistment, 54 per cent., and in those in subsequent enlistments, 11 per cent. This apparently indicates that there is a tendency for the worms in the soldier's intestine to die out gradually. This tendency, however, is not always rapid, as is shown by the persistence of the infection in some cases even to the fourth, sixth and seventh years of service.

DIAGNOSIS

In the cases like those covered by this report the general appearances and ordinary physical examination are of no diagnostic value. Diagnosis must rest solely on the microscopic findings. As stated above, an eosinophilia of over 5 per cent. is very suggestive, but one below that by no means excludes uncinariasis. In these light infections the finding of ova in the feces is often a tedious process. I made my examinations by mixing a bit of feces with water and covering with a seven-eighth-inch cover-glass. In Tables 1, 2 and 3 I have recorded the number of eggs in the stools as "very few," "few," "many" and "very many." If two or more slides were gone over before a single egg was found, the record "very few" was made. If one or two ova were found in a slide, the record was "few." The tables show "very few" in 18, or 28 per cent., of the 64 cases, which means that at least two slides were gone over before an ovum was found. In several cases six or eight slides were examined before the first egg was discovered.

In some cases the number of eggs found in the feces seemed to bear no relation to the number of worms passed after the first course of treatment.

SOURCE OF INFECTION

In this series of cases, the findings coincide with previous experience as to the importance of rural life as a predisposing cause of infection. Among the 64 infected subjects, 53 gave a history of having at some time worked on a southern farm. Of the 11 remaining subjects 3 were laborers, 2 firemen and 1, each, a plumber, country blacksmith, expressman, brakeman, electrician and canning factory employé. Only 4 infected subjects reported never having lived in the country, and, of these, 1 was a laborer, 1 an expressman, 1 a locomotive engineer and 1 worked in a factory canning shrimps and oysters.

Among the 100 recruits and soldiers in their first enlistment, 74 had been farmers at some period of their lives, the percentage of uncinariasis among these being 81 per cent. This closely approximates the findings of some physicians who have asserted that in parts of the south 90 per cent. of the rural population is affected with hookworm disease.

Most of the men gave a history of having gone barefooted in childhood, and a little over half reported having had ground itch, but in most cases the last attack was stated to have been a great many years before, so it is doubtful if much importance can be attached to that feature in this series (Tables 1, 2 and 3).

RELATION OF UNCINARIASIS TO THE PHYSICAL DEVELOPMENT OF RECRUITS

It is considered by many recruiting officers that the physical development of the southern applicants for enlistment is below that of northern men, and it is known that a great number of southern men are rejected at the recruiting stations for poor physical development and weight under that required. The observations made by myself, as well as by other army surgeons, have given the impression that the southern recruits are poorly developed and poorly nourished. Some statistics from the records of the examination of recruits at Jackson Barracks confirm these impressions, as indicated by Table 4.

TABLE IV—HEIGHT AND WEIGHT OF RECRUITS

	Average Height.	Average Weight.	Relation of Weight to the Army Standard
149 recruits not born in south.....	66	145	13 lbs. above.
308 recruits born in the south	68 2/5	141 3/4	2 1/3 lbs. below.
70 southern-born farmer recruits.....	68 1/6	140	2 1/6 lbs. below.
64 soldiers with uncinariasis.....	68 3/7	140 1/2	3 1/2 lbs. below.

Siler considers it probable that the poor development of the southern recruit is due to uncinariasis. In this connection these words of Stiles are of interest: "If infection occurs before puberty, it is likely to retard development, both mental and physical." My own work shows that the average weight of the infected cases was lower than that of the non-infected southern soldiers, though the difference is not very marked among the new recruits.

TABLE V—WEIGHT OF INFECTED AND NON-INFECTED SOUTHERN RECRUITS

	Average Weight.	Difference.
14 southern recruits not infected.....	143	
29 southern recruits infected.....	140 1/4	2 3/4 lbs.
26 southern soldiers in first enlistment non-infected.....	148 1/2	
30 southern soldiers in first enlistment infected.....	142	6 1/2 lbs.

As seen in Table 4, the average weight of 64 infected soldiers, as compared with their height, was 3 1/2 pounds below the army standard, while the average for 149 northern-born recruits was 13 pounds above.

Whether the eradication of the parasites at the age of the average soldier will lead to an increase in weight is left in uncertainty by my observations. Siler reports a constant gain in weight in recruits after treatment. My 29 recruit patients, weighed about five weeks after treatment, showed an average gain of 3 1/2 pounds. It is not fair, however, to attribute a gain of weight in recruits solely to the fact that they have been relieved of their hookworms, because it has been found that under ordinary circumstances recruits gain weight as a result of the regular life, good food, excellent sanitary conditions and graduated exercises associated with the military life.

Among 34 seasoned soldiers, weighed on the average about one month after treatment, there was a total loss of 11 pounds, or about one-third of a pound per man. Some men gained markedly, while others lost as heavily. It is thought that further treatment of such as may be found still to harbor worms may show, if the patients be weighed one or two months later, after the effects of treatment have fully passed off, that eradication of the worms has favorably affected the weight.

PROPHYLAXIS

It is probable that any applicant for enlistment in the army who has a marked infection with *uncinaria* will be detected by the ordinary examination given a recruit. The light infections which escape the examining officer apparently do not affect materially the efficiency of the soldier and do not, in the patients' interest, urgently demand treatment. From the standpoint of prophylaxis, however, thorough treatment of the mild infections is of great importance both in the army and in civil life. It is probable that there are hundreds, perhaps thousands, of cases of mild *uncinariasis* in the army, some of which may be setting up new foci of infection in localities hitherto free from the disease. Just as the typhoid bacillus-carrier is a menace to the community, so is the hookworm-carrier, and the treatment of the comparatively few carriers in the military service and the countless ones outside the army will be one of the steps absolutely necessary if the disease in its severer manifestations is to be eradicated from the south.

CONCLUSIONS

1. Infection with *uncinaria* is very common among southern-bred soldiers during the first three years of service. In 100 men examined, 60 per cent. showed *uncinariasis*. Among new recruits the percentage of infections is at times as high as 85.
2. Southern-bred soldiers with more than three years' service show a much lower percentage of infection, only 11 per cent. in 33 cases.
3. The worms gradually die out, most of them during the first three years, and under the favorable sanitary conditions obtaining in the army at home reinfection occurs rarely, if at all.
4. The symptoms produced by a light infection with hookworms are so slight that they can not be detected by the usual methods employed by the examining surgeon, and diagnosis must be made with the microscope.

5. An eosinophile count of over 5 per cent. is very strong evidence of infection with an intestinal parasite, but one below 5 per cent. is no evidence against uncinariasis.

6. The parasite in probably all cases is *Necator americanus*.

7. In some cases the worm probably lives several years in the intestines.

8. In many light infections, the ova are difficult to find, requiring the complete examination of five or six cover-glass preparations.

9. Farm life is very important as a predisposing cause. Among 74 men who had farmed at some time, 81 per cent. were infected.

10. Most of the men had gone barefooted in childhood, and over half reported having had ground itch, though usually not since childhood.

11. Southern recruits are less well developed physically than northern ones.

12. Uncinariasis in childhood is a very probable cause of this underdevelopment.

13. Light infections do not materially affect the efficiency of the soldier, though the majority report that they feel more vigorous after treatment.

14. Treatment of the light infections is of great importance in any attempt to stamp out the disease.