

Low Incidence of *Enterobius vermicularis* in Natives of Guam, M. I.¹

By NORMAN R. STOLL,² B. M. CHENOWETH, JR.,³
and J. L. PECK, JR.⁴

U. S. Naval Medical Research Unit No. 2

DATA at variance with the "status of pinworms as the most common of all the pathogenic worm parasites of man"⁵ seem worth recording. On Guam, M. I., recent surveys⁶ revealed widespread intestinal parasitism, especially with hookworm, *Ascaris*, and *Trichuris*. When no ova of *Enterobius vermicularis* were encountered, a series of examinations to determine more accurately the status of pinworms was undertaken by scotch tape. Altogether, in 634 examinations—mostly of children—there were only 6, or one percent, positive. Nor did necropsies of natives reveal pinworm infections.

Guam and Guamanians. The Island of Guam, which was ceded to the U.S.A. in 1898, is at 13° 30' North Latitude and 144° 45' East Longitude. This southernmost of the Mariana (or Ladrone) Islands is four and one half to nine miles wide and thirty miles long, with an area of about 206 square miles. Of volcanic origin and somewhat rugged in terrain, its highest elevation is 1,334 feet. A considerable part of the present surface is coral, overlaid with a thin covering of red humus soil. In December 1941, its population was approximately 24,000.

The climate of Guam is distinctly tropical. McKinley⁷ gives 1921-1930 mean values as precipitation, 87.5 inches, and temperature, 81.3° F. The monthly mean maximum-mean minimum temperature variation is about 10° F., with an almost uniformly high humidity, evidenced by the monthly mean dew point falling 1 to 3° F. below the mean minimum temperature.

The natives of Guam are referred to as Chamorros (of Indonesian extraction) although most of the original stock was reputedly wiped

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2. Formerly Lieutenant Commander H(S), USNR.

3. Formerly Lieutenant MC(S), USNR.

4. Formerly Lieutenant MC(S), USNR.

5. L. Reardon, Studies on oxyuriasis. XVI. The number of eggs produced by the pinworm, *Enterobius vermicularis*, and its bearing on infection. U.S.Pub.Health Rep., 53:978-984, 1938.

6. To be reported.

7. E. B. McKinley, A Geography of Disease. Am.J.Trop.Med.(supp.), 15:32-34, 1935.

out by the Spaniards in the 17th Century. The present inhabitants, like the Filipinos whom they resemble, are much diluted with the chromosomes of the Spanish conquerors and more recent visitors to the island. Even blue-eyed and fair-skinned individuals, with the names of Anderson, Jackson, Johnson, and Payne, are met among the majority with dark eyes and straight black hair, who answer to Afleje, Benavente, Blas, Concepción, Cruz, Dueñas, Guerrero, and so on. There is evident little or no Melanesian admixture. The Guamanians are a friendly and attractive people, proud of their American tie.

Method of Examination. Graham⁸ recommended scotch tape for pinworm diagnosis as an alternative to Hall's⁹ N. I. H. cellophane swab. Mazzoti and Osorio,¹⁰ who compared the two, found that scotch tape revealed more positives. The authors employed a strip of scotch tape, an inch wide and about three inches long, held for sampling with the gummed side out over the bottom end of a test-tube, a method which was later found to have been already suggested by Von Hofe.¹¹ After pressing down the adhesive surface in several places on the perianal region, the tape was mounted, gummed side down, on a 1½ x 3-inch slide, and examined microscopically for ova. It was found advantageous to introduce a drop of fluid (normal saline or decinormal sodium hydroxide) under the tape before examination. The microscopy was carried out by the writers.

It is of interest—as bearing on the efficiency of scotch tape in removing eggs from the anal skin area and permitting them to be diagnosed by the microscopist later—that while few *Enterobius* ova were encountered, the eggs of other nematode parasites were frequently found. Altogether, there were 48 hookworm, 36 *Ascaris*, and 68 *Trichuris* positives—8, 6, and 11 percent, respectively—of the 634 individuals examined. In 21 instances, eggs of two or more parasitic species were present. While the particular individuals examined by scotch tape were not then given fecal examinations, other studies indicated that over three fourths of the natives harbored hookworm and whipworm, and more than half of them, *Ascaris*. The presence of eggs of these parasites on the perianal skin furnished objective

8. C. F. Graham, A device for the diagnosis of *Enterobius* infection. *Am.J.Trop.Med.*, 21:159-161, 1941.

9. M. C. Hall, Studies on oxyuriasis. I. Types of anal swabs and scrapers, with description of an improved type of swab. *Am.J.Trop.Med.*, 17:445-453, 1937.

10. L. Mazzotti and M. T. Osorio, The diagnosis of enterobiasis. Comparative study of the Graham and Hall techniques in the diagnosis of enterobiasis. *J.Lab. & Clin.Med.*, 30:1046-1048, 1945.

11. F. H. Von Hofe, An improved method of demonstrating ova of *Enterobius vermicularis*. *J.A.M.A.*, 125:27, 1944.

evidence—confirmed by visual observation—that, generally speaking, bathing had not recently occurred before the examinations were made, a requirement for the detection of pinworm ova.

RESULTS

The series studied includes 634 natives examined during the period of March 15 to April 9; of these, 632 were examined once, and two of them, twice.

Agana Civilian Hospital. Through the cooperation of the physicians in charge of the various wards, examinations were made before in-patients were bathed in the morning. Of 74 males (ages 5 months to 64 years) and 52 females (ages 3 months to 60 years), none was discovered positive for pinworm. It might be added that no pinworms were found in examining the washed stools of 7 pediatric cases, after treatment for hookworms.

Agat School. The majority of the school children of Agat, a coastal village about ten miles southwest of Agana, was examined. This included 166 boys (ages 7 to 19) and 126 girls (ages 7 to 20). No pinworm ova were found in these 292 examinations.

Dededo School. Dededo is a village about six miles northwest of Agana. One hundred children (ages 7 to 14) were examined. Of 51 boys and 49 girls, two were positive, a boy of 11 and a girl of 8.

Agana Schools. Before the war, Agana was the only large town on Guam. It is situated on the shores of Agana Bay on the west coast of the island and now, in the ruined city and its environs, there dwells the largest "urban" group of natives on the island. Children to the number of 106 in the age group of 7 to 11 were examined, about half of the number coming from each of the two Agana schools. Of 50 boys and 56 girls, two were positive, a boy of 8 and a girl of 7.

Agana Families. In view of the familial status of pinworm infection, the families of the two Agana children found positive were sought out. All the members of these families were not available for examination but, in each case, the mother was included. Of 7 examined in one family (ages 2, 4, 5, 8, 9, 12, and 31), only the 8-year-old boy, earlier diagnosed in the school group, was again found positive. Of 5 examined in the second family (ages 1, 3, 5, 7, and 27) two boys, 1 and 5 years old, were positive. The 7-year-old girl, diagnosed earlier in the school group, failed to show ova on re-examination. These two families, therefore, had 4 positives in the 12 members examined at least once.

These examinations are summarized by age groups in the accompanying table.

Age Distribution of 634 Natives of Guam, M. I., Examined by Scotch Tape for the Ova of *Enterobius vermicularis* during March to April 1945

Ages	Individuals Examined by Scotch Tape			Independent Series of Necropsies (Data of H. M. Zimmerman)
	Male	Female	Positive	
3½-5	22	17	2 boys: 1, 5	52
6-10	178	169	1 boy, 8 2 girls: 7, 8	3
11-15	101	63	boy, 11	20
16-20	13	13	none	
21-30	5	6	none	26
31-40	5	8	none	29
41-50	12	9	none	23
51-60	9	3 ^a	none	14
61 and over	1 ^a	0	none	20 ^b
Total	346	288	6 in 634	187 ^c

^aEldest male examined by scotch tape, 64; female, 60.

^bEldest necropsied male, over 70; female, over 80.

^cBoth sexes are represented in each age group and in about equal numbers. Of 187 necropsied, 45 percent were males compared to 55 percent males in the 634 examined by scotch tape.

Necropsy Records. Through the kindness of Commander H. M. Zimmerman, MC, USNR, a pathologist of the U. S. Naval Medical Research Unit No. 2, who had the opportunity of conducting an autopsy service at the Agana Civilian Hospital (later U. S. Naval Military Government Hospital No. 203), the writers are enabled to include a summary of his findings with reference to pinworm. One hundred and eighty-seven necropsies of Guamanians, in which the large bowel was examined, did not reveal a single instance of *Enterobius*. The age grouping of those necropsied is included in the last column of the attached table.

Earlier Records from Guam. While the present inquiry, designed specifically to reveal the status of pinworms, appears to be the first made on the island, published annual reports of naval medical officers, stationed there, furnish some supplementary information.

The earliest noted record of the presence of pinworm on Guam is in a brief report by Kerr¹² of the finding of several species of helminths, including *Oxyuris*, in the post-treatment stools of 14 children. Kerr is not explicit, however, as to whether the children treated were exclusively native; helminthic infections in American military personnel and their families, stationed in Guam, have been

12. W. M. Kerr, Note on the existence of *Agchylostoma duodenale* in Guam. U.S.Nav.M. Bull., 5:145, 328, 1911.

a preoccupation of the U. S. Navy medical officers since the first report in 1899.¹³ Kindleberger¹⁴ listed "*Oxyuris vermicularis*—rare." A year later, in reviewing 7,668 fecal examinations made during the period September 1, 1906—July 1, 1912, he summarizes: "Infection with *Oxyuris vermicularis* Linnaeus, 1758, is apparently extremely rare. In the 2 cases found, both children, the ova and adult parasites were discovered in stools which also contained the ova of 3 other parasites."¹⁵

Grant¹⁶ mentions: "*Oxyuris vermicularis* was observed," but without giving details. Reed,¹⁷ summarizing a survey of 1,957 fecal examinations on natives, noted that "in addition to the roundworms, whipworms and hookworms, *Strongyloides stercoralis* embryos and *Oxyuris vermicularis* ova have been frequently observed." The number of positives is unspecified. Mumford and Mohr,¹⁸ from their survey of the literature on diseases in the Pacific, state: "Oxyuriasis—A few cases have been reported from the Japanese Mandated Islands and Guam. . . . It is recorded from the Marshall Islands and from the Carolines."

McKinley,¹⁹ in his "Geography of Disease," omitted *Enterobius* from his questionnaire, and Simmons *et al.*,²⁰ in their "Global Epidemiology," noted that "infection with *Enterobius vermicularis* was rarely observed on Guam" but has "been recorded" from the Japanese Mandated Islands.

From these reports it would appear that, although the presence of pinworm was not specifically sought earlier, its status in Guam and neighboring islands has not been that of an obtrusive infection and may, indeed, have been rare for at least several decades.

DISCUSSION

Of opposite import to the pinworm situation on Guam are the findings in Manila, P. I., 1,595 statute miles west. Chanco and

13. P. Leach, Sanitary report on Guam, L. I. Rep. Surg. Gen., U. S. Navy, pp. 208-212, 1900.

14. C. P. Kindleberger, Sanitary conditions in Guam. U.S.Nav.M.Bull., 6:464-472, 1912.

15. C. P. Kindleberger, Intestinal parasites and diseases found in Guam. U.S.Nav.M.Bull., 7:86-93, 1913.

16. J. B. Grant, Hookworm Infection Survey of Guam from May 3 to May 24, 1918. 17 pp. (New York: International Health Board, 1918).

17. E. U. Reed, Human intestinal parasites in Guam. U.S.Nav.M.Bull., 20:137-140, 1924.

18. E. P. Mumford and J. L. Mohr, Preliminary report on the infectious diseases of enemy occupied territories. Part I. The Japanese Mandated Islands and Guam. J.Trop.Med. & Hyg., 46:15-23, 1943; Am.J.Trop.Med., 23:381-400, 1943.

19. E. B. McKinley, *op. cit.*

20. J. S. Simmons, T. F. Wayne, G. W. Anderson, and H. M. Horack, Global Epidemiology (Philadelphia: J. B. Lippincott Company, 1944).

Soriano²¹ found an incidence of 75.2 percent of *Enterobius* positives by one N. I. H. swab in a study of 431 Manila school children and 59 adults from the Associated Charities. Later, Chanco²² reported 41 percent of the caeca of 200 cadavers at the city morgue of Manila as containing pinworms, with positives in all age groups from 16 to 80.

The Manila findings are higher than the 41.5 percent positives in 2,895 white children and adults in Washington, D. C.,²³ and the 60 percent in 300 non-institutionalized school children in Toronto, Canada.²⁴ These are but samples of the high incidence of *Enterobius*, revealed especially in temperate latitudes and in institutions, since Headlee²⁵ reminded American parasitologists of the inadequacies of fecal examination for diagnosis of this helminth, and Hall²⁶ introduced the N. I. H. swab.

Among reports of generally high incidence, there are four from more southern latitudes, which suggest a lower incidence. Waring,²⁷ in Charleston, South Carolina, found 11 percent incidence in hospitalized children, 14 percent in white rural school children and 54 percent in an orphan asylum, basis one N. I. H. swab. Cram, Jones, and Reardon²⁸ examined one N. I. H. swab, taken by the mothers of 438 white school children from a part of West Tampa, Florida, settled mostly by Latin-Americans, and found only 16 percent incidence with *Enterobius*. These authors considered the single swab technique, as thus employed, far from adequate; however, it seems probable that the West Tampa group had a lower incidence than that reputed from more northern communities.

In Puerto Rico, Brady²⁹ found in two children's institutions only 30 percent of 50 girls and 12 percent of 52 boys positive by 4 N. I. H. swabs, and remarks that the "results are of interest because . . . a high incidence was anticipated . . . and the number of colored

persons is not enough to explain the low incidence." In México, non-tropical México City shows a much higher incidence than tropical communities like Veracruz, Mérida, Yuc., Chetumal, Q. R., and Huixtla, Chis. Mazotti and Quintanar³⁰ reported one examination by scotch tape on each of 1,551 boys in México City with a finding of 48 percent positive. However, in similar examinations of 1,120 boys, 6 to 15 years of age in the four tropical localities mentioned above, Mazzotti³¹ found only 13 percent positive.

Why incidence less than currently anticipated should tend to appear in southern and tropical areas is not clear, especially when standing in such contrast are northern cities like Toronto, Canada, and Amsterdam, Netherlands (in which Schüffner³² estimates 100 percent of the children are infected). In the case of Guamanians, the possibility that a racial tendency towards low incidence is involved seems ruled out by the fact that high incidence in related ethnic stocks occurs in metropolitan Manila. Brady³³ discounts a racial interpretation of his Puerto Rico figures. He suggests, instead, that the constantly strong breezes of Puerto Rico may sweep away many ova; that temperatures never below 62° may favor decreased viability of the ova, and that increased time spent out-of-doors by children decreases their contact with the ova. Added to these, consideration should be given to the sparse and loose clothing worn by children in the tropics, which may cause the retention of fewer ova on garments, in contrast to opposite possibilities with the added layers of clothing necessary in chillier climates. Sparse clothing would also give more sunshine exposure to such ova as are retained on either clothing or skin. High humidity may also act by tending to anchor ova to the skin and clothing so that they become less dispersed in the environment and are thus more easily reached by the deleterious effects of sunshine and continued humid heat.³⁴

Jones and Jacobs³⁵ found that, at 79–84° F., eggs died rapidly at

21. P. P. Chanco, Jr. and L. P. Soriano, The incidence of *Enterobius vermicularis* among Filipino school children. A preliminary report. *Acta Med.Phil.*, 1:81-89, 1939.

22. P. P. Chanco, Jr., Incidence of *Enterobius vermicularis* in the caecum of man at autopsy. *Univ.Phil.Nat. & Appl.Sc.Bull.*, 7:291-295, 1940.

23. E. B. Cram, Studies on oxyuriasis. XXVIII. Summary and conclusions. *Am.J.Dis. Child.*, 65:46-59, 1943.

24. E. Kuitunen-Ekbaum, The incidence of enterobiasis in Toronto. *Canadian. M.A.J.*, 48:229-230, 1943.

25. W. H. Headlee, Studies on infections of human parasitic worms under institutional conditions. *J.Lab. & Clin.Med.*, 20:1069-1077, 1935.

26. M. C. Hall, *op. cit.*

27. J. I. Waring, Oxyuris infestation. *Arch.Ped.*, 57:615-619, 1940.

28. E. B. Cram, M. F. Jones, and L. Reardon, The incidence of pinworms (*Enterobius vermicularis*) in various population groups. *Rev.de med.trop.y parasitol., bacteriol., clin.y lab.*, 7:4-6, 1941.

29. F. J. Brady, The incidence of oxyuriasis in two institutions in Puerto Rico. *Proc.Helm. Soc.Wash.*, 8:10, 1941.

30. L. Mazzotti and E. Quintanar, Examen de 1,551 niños de la ciudad de México, utilizando el método de Graham para investigar oxiuriasis. *Rev.Inst.Salub.y Enferm.Trop.*, México, 4:173-178, 1943.

31. L. Mazzotti, Investigación sobre oxiuriasis en 1,120 niños residentes en regiones tropicales de México. *Rev.Inst.Salub.y Enferm.Trop.*, México, 6:37-40, 1945.

32. W. Schüffner, Die Bedeutung der Staubinfektion für die Oxyuriasis. *Richtlinien der Therapie und Prophylaxe. Münch.med.Woch.*, 91:411-414, 1944 (*Rev.in Trop.Dis.Bull.*, 43:233-236, 1946).

33. F. J. Brady, *op. cit.*

34. Schüffner puts dustborne infection (M. O. Nolan and L. Reardon, *J.Parasitol.*, 25:173-177, 1939) in a key position in the epidemiology of enterobiasis. Madsen (*Acta Path.et Microbiol.Scandinavica*, 22:392-397, 1945) goes as far as to conclude: "It has been rendered almost certain that the infestation most often takes place by inhalation."

35. M. F. Jones and L. Jacobs, Studies on oxyuriasis. XXIII. The survival of eggs of *Enterobius vermicularis* under known conditions of temperature and humidity. *Am.J.Hyg.*, 33 (D):88-102, 1941.

38-46 percent relative humidity, and that less than 10 percent survived two days at 64-80 percent humidity. The review of Heller's work³⁶ suggests that eggs, becoming infective at 70 percent humidity, were then poorly viable and that a heavy mortality of infective eggs, after four to five hours at body temperature, contrasted with good viability for four days at 61-64° F. If such factors do exercise the controlling influence on the transmission of *Enterobius* infection on Guam, the counterbalancing factors, which permit high incidence in a large city like Manila (600,000), with similar ethnic and climatic factors, remain puzzling.

Of related interest was the absence of tapeworms in Guamanians, although *Hymenolepis nana* was found during routine fecal examinations of service personnel stationed on the island. This absence of tapeworms has been attested periodically over the years in the reports of naval medical officers on duty there. It seems possible that failure of *H. nana* to become established is related to the causes for the low incidence of *Enterobius*, inasmuch as both are similarly transmitted. This is the more notable in that conditions of considerable fecal contamination of the Guamanian environment are evidenced by high incidence of hookworm, *Ascaris*, *Trichuris*, and intestinal protozoa.

The questions raised suggest the need of further data on the incidence of *Enterobius vermicularis* and *Hymenolepis nana* in non-institutionalized children in tropical communities, with associated data on temperature, humidity, racial stocks, customs, and so forth. Factors which control their epidemiology are still inadequately understood.

SUMMARY

An exceptionally low incidence for *Enterobius vermicularis* (one percent) was found among native Guamanians examined by scotch tape. Necropsies failed to reveal pinworms. Earlier records point to a low incidence of pinworms for at least several decades. This record indicates that conditions on Guam, in which there occurs widespread intestinal parasitism, do not favor the life history of this parasite.

Of subsidiary interest is the absence of evidence of tapeworm infections in natives of Guam. In the case of *Hymenolepis nana*, this suggests that unfavorable conditions for its transmission are related to conditions unfavorable for *Enterobius*.

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36. E. R. Heller, The epidemiology of enterobiasis. *Med. Parasitol. & Parasit. Dis.*, 13: 16-23, 1944 (Rev. in *Trop. Dis. Bull.*, 42:579, 1945).