STUDY OF THE AREA AFFECTED BY ONCHOCERCIASIS IN BRAZIL: SURVEY OF LOCAL RESIDENTS[1,2]

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Previous articles have described recently discovered foci of river blindness (onchocerciasis) in Brazil (10, 11). The report that follows defines the area affected, describes a new focus discovered in this area, analyzes the nature of the infection in all the known foci, and seeks to assess the potential public health threat posed by the presence of the disease.

Introduction

The presence of onchocerciasis in Brazil was first reported in 1967 by Bearzoti, *et al.* (*3*), who described the disease in a three-year-old child. In 1972 Moraes and Dias discovered two other cases in missionaries residing in the Toototobi River area of Amazonas State; and in mid-1973 Moraes and others discovered onchocerciasis among groups of Yanomama Indians living along the left bank of the Toototobi River (*10, 11*).

By chance, Brazil's Northern Perimeter Highway passes very near the region inhabited by the Yanomamas (*7*), especially the area of the Xiriano-teri tribe living along the Toototobi River. The possibility that the disease might spread via this important highway to other parts of the rapidly developing Amazon region has been of great concern to Brazilian health authorities.

The Brazilian Government therefore requested that PAHO provide a consultant to assist with the epidemiologic investigation of the disease focus and to help in identifying possible onchocerciasis vectors in the region. The ensuing investigation, carried out with PAHO collaboration, was concerned with a vast area encompassing the Federal Territory of Roraima and the extreme northern portion of Amazonas State. As a result of this investigation, the epidemiology of onchocerciasis in the region has been defined and a new focus of the disease has been discovered among the culturally distinct Makiritare Indians at a site (Auaris) in the Roraima Territory.

Materials and Methods

Our area of activity was bounded on the north and west by Venezuela, on the east by Guyana and the Boa Vista-Carcaraí Highway, and on the south by a section of the Northern Perimeter Highway. The whole

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[1] Also appearing in Spanish in the *Boletín de la Oficina Sanitaria Panamericana* 80 (4) : 288-302, 1976.

[2] For a previous report on another aspect of this investigation, see E. Rassi, *et al., Bull Pan Am Health Org* 9: 10-12, 1975.

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region has practically no land communication links, but various sites have landing fields that can be reached by small planes.

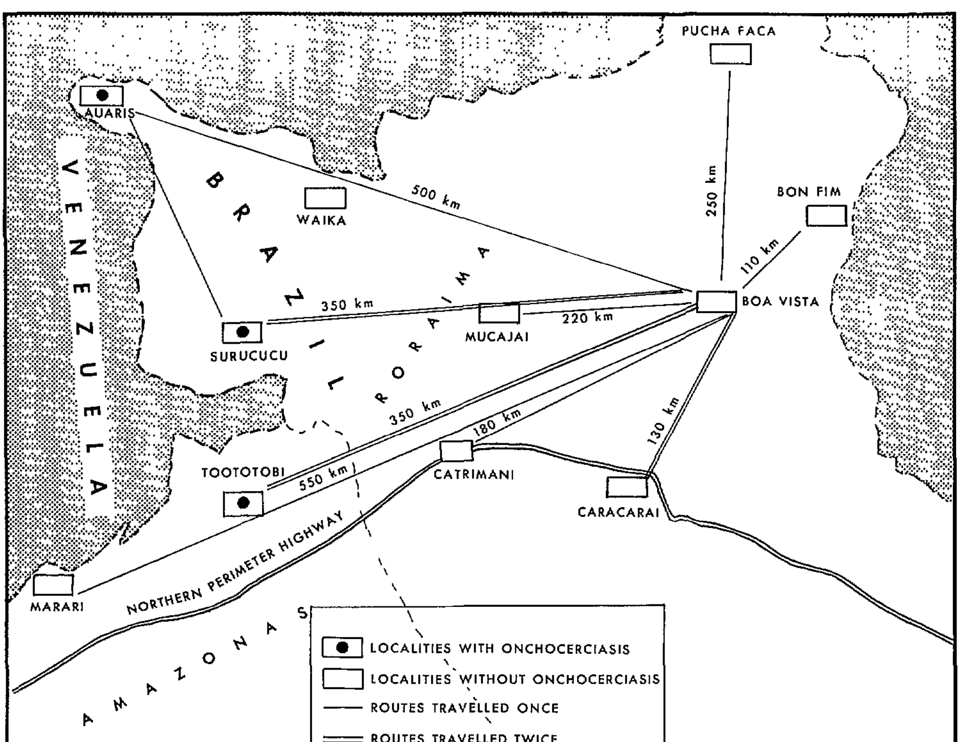
Plans were therefore made to examine localities accessible by air for presence of the disease, and in this way to determine the extent of the focus. The localities studied for this purpose were in the vicinity of the Auaris, Boa Vista, Bon Fim, La Piedra, Marari, Mucajaí, Pucha Faca, Surucucu, Toototobi, and Waica missions, the Upper Catrimani River, the Port of Caracaraí, and the route of the Northern Perimeter Highway (see Map 1). Two small aircraft, which logged a total of 56 flying hours, were used to transport personnel and equipment from place to place.

Overall, our activities were directed at two basic objectives: case-finding on the one hand and collection of entomological specimens for identification of possible vectors on the other (*1,2,4,8,12,13,15*). The entomological work, preliminary conclusions of which were reported previously (*16*) will be described in detail in a separate article. Our case-finding work, described in the account that follows, employed several diagnostic techniques. These included superficial biopsy (performed only on persons over ten years of age); the Mazzotti test (observation of the subject's response to 50 mg of Hetrazan[6]—*5,6,9,14*); dermatologic examination; detection of nodules by palpation; and evaluation of visual acuity (*12*).

Regarding biopsies, a single skin specimen (3-4 mm^2) was taken with a razor blade from the upper shoulder-blade area of each person tested. The specimen was then placed on a slide in a drop of distilled water and was teased with two needles to facilitate emergence of microfilariae. An initial reading was

[6]Diethylcarbamazine.

MAP 1—*The area surveyed, showing the routes travelled and places visited in May-June 1974.*



taken at 3-4 minutes; if the results were negative, two other readings were made at 15 and 30 minutes (*13*).

A special eye chart for illiterates was used to test the visual acuity of persons responding positively to either the biopsy or the Mazzotti test.

The account that follows describes the specific results obtained in each of the localities surveyed.

Auaris

Description

The Auaris Mission is located at the northern end of the Roraima Territory (Lat. 4°8', Long. 64°25'). Some 670 m above sea level in tropical jungle, it is about 500 km by air from the territorial capital of Boa Vista (see Map 1). At Auaris the season of heavy rains begins in late April and lasts until early September No information had previously been reported concerning possible onchocerciasis cases in this area.

About 100 Sanuma Indians (the Sanumas are a Yanomama subgroup) live near the Mission. The other Sanumas who live in Brazil (some 400-500 Indians) are scattered over a vast area that can be reached by foot in anywhere from one hour to five days. Other Sanumas live beyond the Venezuelan border in the valleys of the Merewary and Ventuari rivers (see Map 3).

Also near the Mission, about an hour away by canoe, live a group of Makiritare Indians. The culture and customs of the Makiritares differ markedly from those of the Yanomamas (see Map 2). The Auaris name for Makiritare is Mayongon.

Results

Our findings show for the first time that Auaris is a focus of onchocerciasis and that the Makiritare Indians—in addition to the

MAP 2—*Lands inhabited by the Yanomama Indians in Brazil and Venezuela (May-June 1974).* Source: *Luis Cocco,* Quince años entre los Yanomamas, *Editorial Salesiana.*

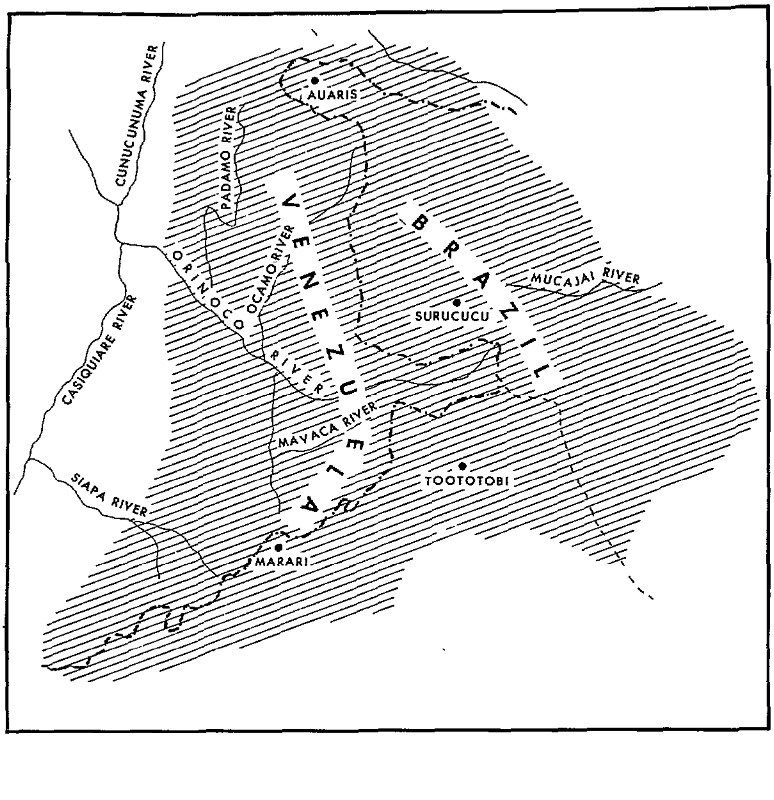


TABLE 1—*Results of biopsies performed on Yanomama (Sanuma) and Makiritare Indians at Auaris, by age group and sex (May-June 1974).*

Age group in years	Males			Females			Total		
	No. examined	No. positive	Rate positive (per 1,000)	No. examined	No. positive	Rate positive (per 1,000)	No. examined	No. positive	Rate positive (per 1,000)
10-14	7	1	142.8	3	0	-	10	1	100.0
15-19	6	0	-	10	2	200.0	16	2	125.0
20-24	10	2	200.0	8	1	125.0	18	3	166.6
25-34	9	2	222.2	16	6	375.0	25	8	320.0
35-44	6	3	500.0	7	2	285.7	13	5	384.0
45-54	7	3	428.5	5	2	400.0	12	5	416.6
55-64	1	0	-	4	1	250.0	5	1	200.0
65	1	0	-	2	0	-	3	0	-
Total	47	11	234.0	55	14	254.5	102	25	245.0

Yanomamas—constitute an infected ethnic group.

Biopsy. Specimens were obtained from 102 Makiritare and Sanuma Indians ten or more years of age (see Table 1). Positive results were obtained from 25 specimens, for an overall rate of 245 per thousand.

It is difficult to estimate infection rates in different age groups because of the smallness of the groups involved. However, it should be noted that the apparent case rate was considerable in the 15-19 age group (125 per thousand), and that it rose successively to 166 per thousand in the 20-24 group, 320 per thousand in the 25-34 group, 384 per thousand in the 35-44 group, and 417 per thousand in the 45-54 group. A lower positive rate of 200 per thousand was observed in the 55-64 age group, and no subjects 65 or over yielded positive results. However, the small number of subjects in these age groups and the known day-to-day or even more frequent variations in the number of microfilariae in the skin could account for these latter findings.

A slightly higher positive rate was noted among females (254.5 per thousand, as opposed to 234.0 per thousand among males), but this was not statistically significant ($p > 0.50$).

One of every four persons tested for onchocerciasis was also given a thick-film examination for *Mansonella ozzardi* microfilariae, but all the results were negative. Similar examinations were carried out on subjects in the Surucucu and Toototobi areas, again with negative results.

With regard to the intensity of infection, after staining we counted an average of 10.25 microfilariae per positive biopsy specimen.

Mazzotti test. A total of 111 individuals were given the Mazzotti test (see Table 2). The group included 96 subjects from whom biopsy specimens had been taken and 15 children in the 0-9 age range from whom no specimens had been obtained. The rate of positive response to the Mazzotti test was 477.6 per thousand. Very high rates of positive response were observed in groups over 15 years of age, a maximum rate of 818 per thousand being found in the 35-44 year age group.

The same slight predilection for females revealed by the biopsies was also reflected in the Mazzotti test results (again, $p > 0.50$).

A comparison was also made between the distinct Sanuma (Yanomama) and Makiritare ethnic groups coexisting in the Auaris area. This showed the Sanuma to have higher overall infection rates than the Makiritares, the respective rates being 300 vs. 209.6 per thousand by biopsy and 633.3 vs. 419.2 per thousand by the Mazzotti test.

Dermatologic Examination. No dermatologic lesions attributable to onchocerciasis were observed. The only dermatologic findings were lesions caused by insect bites, a suspected chronic dermatitis, and some superficial mycoses.

Palpation. Only three nodules were found, but we feel that some small ones may have

TABLE 2—*Results of Mazzotti tests given to Yanomama (Sanuma) and Makiritare Indians at Auaris, by age group and sex (May-June 1974).*

Age group in years	Males			Females			Total		
	No. tested	No. positive	Rate positive (per 1,000)	No. tested	No. positive	Rate positive (per 1,000)	No. tested	No. positive	Rate positive (per 1,000)
0-4	1	0	-	1	0	-	2	0	-
5-9	8	1	125.0	5	0	-	13	1	76.9
10-14	13	2	153.8	6	3	500.0	19	5	263.1
15-19	4	2	500.0	7	3	428.5	11	5	454.5
20-24	10	5	500.0	5	1	200.0	15	6	400.0
25-34	8	7	875.0	13	9	692.3	21	16	761.9
35-44	6	5	833.3	5	4	800.0	11	9	818.1
45-54	7	4	571.4	4	3	750.0	11	7	636.3
55-64	1	0	-	4	2	500.0	5	2	400.0
65	1	1	1,000.0	2	1	500.0	3	2	666.6
Total	59	27	457.6	52	26	500.0	111	53	477.4

escaped detection during this examination, which was not always performed under the best conditions.

Eyesight. A missionary, Donald Porgman, assisted in carrying out this examination on 35 patients. Two women, one 40 and the other 34 years of age, were found to have a visual acuity two-tenths below normal, but all others tested were found to have normal acuity ranging from 1.00 (20/20) to 1.20 (20/24).

Surucucu

Description

The Surucucu Mission (Lat. 2°50', Long. 63°45') is about 200 km southeast of Auaris at an altitude of some 830 m (see Map 1). Its location—in a narrow valley surrounded by high mountains—makes access to the landing strip very difficult. The small Obobu River, a tributary of the Uraricoera, flows by the Mission at a distance of about 200 meters. The season of heavy rains lasts from May to mid-September.

The village (*maloca*) of the Aikam-teri, a Yanomama tribe, is about an hour's walk from the Mission. Six to eight hundred other Yanomamas live at distances that can be walked in anywhere from seven hours to 10 days. Unfortunately, most of the Indian residents of this area were away from their villages on periodic migrations at the time of our visit.

Results

Biopsy. Biopsies were performed on 51 Indians and three missionary women (see Table 3). The sampling was extremely varied, since it included Indians from quite a number of different Yanomama tribes. Six Parafuri Indians were examined, two of whom yielded positive results. Positive results were also obtained from two out of seven Ximiu-teri Indians and three out of eight Xinamo-teri Indians. Three Moxaf-teris and five Malaxi-teris yielded negative results. Aikam-teri villagers constituted the largest single group examined; of these, six out of 22 persons showed positive results. Overall, 13 of the 54 subjects examined yielded a positive biopsy, making the rate of positive findings 240.7 per thousand.

The results of these 54 tests are broken down by tribal group in Map 3 and by age in Table 3. If only persons 19 or over are considered, the rate of positive findings rises to 333 per thousand, and if only those 34 and over are included the rate climbs to 480.0 per thousand.

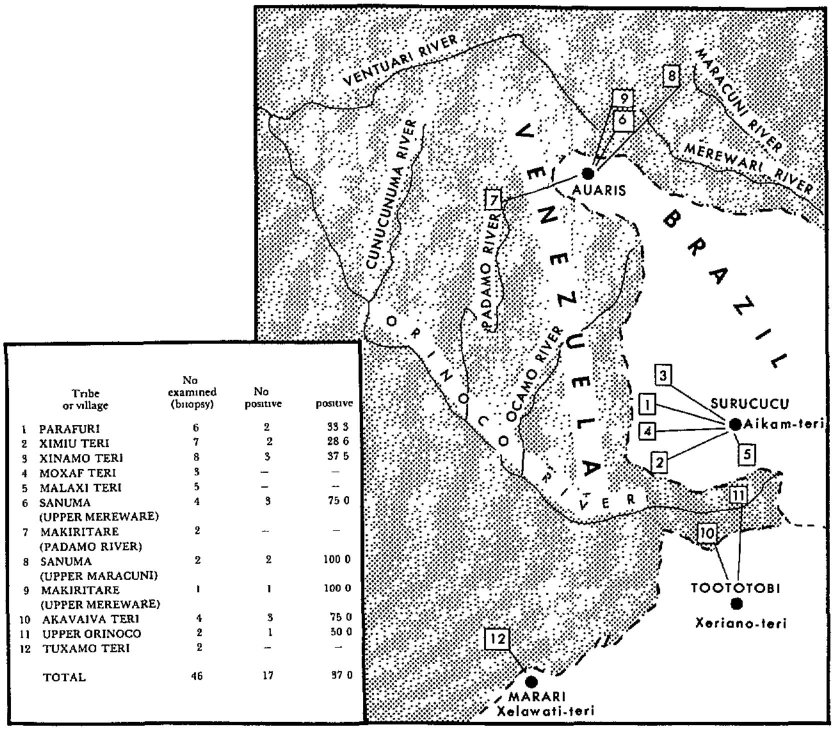
The apparent predilection for females was relatively great, the respective positive rates among males and females being 200 per thousand and 316 per thousand. Nevertheless, owing to the small size of the group tested, random variations could easily account for this difference ($p > 0.50$).

With regard to intensity of infection, an average of six microfilariae were counted

TABLE 3—*Results of Surucucu area biopsies performed on local Yanomama groups (the Aikam-teri Indians and their visitors) and on three Mission personnel (by age group and sex, May-June 1974).*

Age group in years	Males			Females			Total		
	No. examined	No. positive	Rate positive (per 1,000)	No. examined	No. positive	Rate positive (per 1,000)	No. examined	No. positive	Rate positive (per 1,000)
10-14	7	0	-	0	0	-	7	0	-
15-19	7	0	-	1	0	-	8	0	-
20-24	4	0	-	1	0	-	5	0	-
25-34	4	0	-	5	1	200.0	9	1	111.1
35-44	5	2	400.0	8	3	375.0	13	5	384.6
45-54	7	4	571.4	1	0	-	8	4	500.0
55-64	1	1	1,000.0	3	2	666.6	4	3	750.0
65	0	0	-	0	0	-	0	0	-
Total	35	7	200.0	19	6	315.7	54	13	240.7

MAP 3—*Onchocerciasis among outlying Indian groups (May-June 1974). The map shows the home areas of visiting Indians from whom biopsy specimens were obtained, and the accompanying chart shows the results of the ensuing biopsy examinations.*



	Tribe or village	No examined (biopsy)	No positive	positive
1	PARAFURI	6	2	33 3
2	XIMIU TERI	7	2	28 6
3	XINAMO TERI	8	3	37 5
4	MOXAF TERI	3	—	—
5	MALAXI TERI	5	—	—
6	SANUMA (UPPER MEREWARE)	4	3	75 0
7	MAKIRITARE (PADAMO RIVER)	2	—	—
8	SANUMA (UPPER MARACUNI)	2	2	100 0
9	MAKIRITARE (UPPER MEREWARE)	1	1	100 0
10	AKAVAIVA TERI	4	3	75 0
11	UPPER ORINOCO	2	1	50 0
12	TUXAMO TERI	2	—	—
	TOTAL	46	17	37 0

after staining in each positive biopsy specimen examined.

Dermatologic Examination. No dermatologic lesions attributable to onchocerciasis were observed.

Palpation. Of the 13 patients with positive biopsies, two had one scalp nodule and another had two scalp nodules.

Mazzotti test. We were unable to perform this test on the local Indians, so it was only performed on mission personnel. One missionary, who was found negative by a previous parasitologic examination and our own biopsy examination, gave an intense positive response to administration of Hetrazan. This response included pronounced facial edema especially affecting the eyelids, intense pruritus, and general malaise. A second biopsy, taken two days later, showed three sluggish microfilariae. After staining, six microfilariae could be counted on the slide.

Eyesight. We were only able to test five subjects, all of whom were found to have normal visual acuity.

Toototobi

Description (See Photograph, p. 5)

The Toototobi Mission (Lat. 1°10', Long. 63°45') is about 130 km south of Surucucu at the lower altitude of 180 m above sea level (see Map 1). The Toototobi River, a tributary of the Demini, flows close to the Mission buildings. This section of the river has a width of 15 to 20 m and a relatively rapid current. Like the other two Mission posts just described, this one is located in heavy jungle. The season of intense rain begins in mid-May and ends in the first half of September.

Yanomama Indians belonging to the Xiriano-teri tribe live at the Mission site and at a village about an hour's walk away. Other Yanomamas, estimated at between 500 and 700, live along the Toototobi River and to the north, near the mountains along the Venezuelan frontier. These people can be reached by foot journeys ranging from 8 or 10 hours to several days in length.

Results

Biopsy. Biopsies were performed on 61 individuals over the age of ten (Table 4). Of these, 37 were found to be positive, making the overall observed infection rate 606.5 per thousand. Prevalences among different age groups were difficult to estimate because of the groups' small size, but the 15-19 year age group was found to have the lowest observed rate (473.6 per thousand) of any age group examined. Only one youth in the 10-14 group was examined, and most of the older groups (over 19) had observed rates of over 600 per thousand.

In this local survey the disease showed a slight apparent predilection for males, the respective positive rates for females and males being 575.7 and 642.8 per thousand. Again, this difference was not statistically significant ($p>0.50$).

Regarding the intensity of infection, the readings made directly showed an average of 11.4 microfilariae per biopsy specimen. However, stained slides showed a notably higher average of 14.2. Overall, the counts made after staining ranged all the way from one microfilariae per positive biopsy to 117; the next highest was over 100 microfilariae (on one slide); lesser counts of 50 (on two slides, 20 (on one slide), and 15 (on three slides) were also made. On most slides the microfilaria count was somewhere between three and eight.

TABLE 4—*Results of Toototobi area biopsies performed on Yanomamas of the Xiriano-teri tribe, by age group and sex (May-June 1974).*

Age group in years	Males			Females			Total		
	No. examined	No. positive	Rate positive (per 1,000)	No. examined	No. positive	Rate positive (per 1,000)	No. examined	No. positive	Rate positive (per 1,000)
10-14	1	1	1,000.0	0	0	-	1	1	1,000.0
15-19	8	4	500.0	11	5	454.5	19	9	473.6
20-24	4	3	750.0	7	4	571.4	11	7	636.3
25-34	6	5	833.3	9	5	555.5	15	10	666.6
35-44	6	3	500.0	4	3	750.0	10	6	600.0
45-54	2	1	500.0	1	1	1,000.0	3	2	666.6
55-64	1	1	1,000.0	1	1	1,000.0	2	2	1,000.0
65	0	0	-	0	0	-	0	0	-
Total	28	18	642.8	33	19	575.7	61	37	606.5

Mazzotti test. This test was performed on 59 individuals. The overall rate of positive response was 779.6 per thousand, but we observed (Table 5) that all persons over 14 years of age responded positively, as did the one person tested in the 10-14 group.

As regards children under 10 years of age, test results were observed in 11 children of the 5-9 age group, and two girls (one age five and the other age seven) showed a clearly positive response. The mothers of three other subjects tested in this age group told us their children had acute pruritis. However, these children are not listed in Table 5 because we were unable to confirm their positive response by direct examination. In contrast, none of the five subjects 0-4 years of age who received Hetrazan showed a positive response.

In this survey, the apparent predilection for females was presumably due to the predominance of males in the youngest age groups (see Table 5), since, as already noted, all individuals over 9 years of age showed a positive response.

Two male Indians, one 15 and the other 47 years of age, responded to Hetrazan with marked adenopathy and general discomfort. Symptoms clearly manifested by most other persons receiving the drug—including the two young girls previously mentioned—consisted of edema, erythema and/or lesions caused by scratching.

Dermatologic examination. No dermatologic lesions clearly attributable to onchocerciasis were observed. The only skin disorders that might have been caused by *O. volvulus* were manifested by three persons with symptoms of chronic papulous dermatitis.

Palpation. As may be seen in Table 6, 11 of the 37 persons with positive biopsies (29.7 per cent of the total) were found to have onchocercotic nodules. In all, 14 nodules were found; one subject (a 57-year-old Indian named Isaqui) had four—one on his head, two on his back, and one in his sacral region. Of the 14 nodules, eight were on the subject's head, two were on the back, two were in the pelvic region, one was on the thorax, and one was on the buttocks. No nodules were found on the legs.

Eyesight. With the valuable assistance of Missionary Tony Poulson, we were able to test the vision of 35 subjects who had yielded positive Mazzotti test results and in some cases a positive biopsy. All of these 35 were found to have visual acuity that was normal or superior, ranging from 1.20 (20/24) to 1.50 (20/30). Isaqui, the old Indian with four nodules, showed loss of vision in the right eye due to sclerosing keratitis (the only case observed); but he was found to have normal vision in his left eye. In addition, one 22-year-old man was found to have slightly reduced vision in one eye.

Other Localities Studied

Marari

This site is located in a valley southwest of Toototobi, at an altitude of 180 m, and is

TABLE 5—*Results of Toototobi area Mazzotti tests given Xiriano-teri Indians, by age group and sex (May-June 1974).*

Age group in years	Males			Females			Total		
	No. tested	No. positive	Rate positive (per 1,000)	No. tested	No. positive	Rate positive (per 1,000)	No. tested	No. positive	Rate positive (per 1,000)
0-4	5	0	-	0	0	-	5	0	-
5-9	6	0	-	5	2	400.0	11	2	181.8
10-14	1	1	1,000.0	0	0	-	1	1	1,000.0
15-19	5	5	1,000.0	4	4	1,000.0	9	9	1,000.0
20-24	3	3	1,000.0	5	5	1,000.0	8	8	1,000.0
25-34	3	3	1,000.0	8	8	1,000.0	11	11	1,000.0
35-44	5	5	1,000.0	2	2	1,000.0	7	7	1,000.0
45-54	2	2	1,000.0	1	1	1,000.0	3	3	1,000.0
55-64	1	1	1,000.0	1	1	1,000.0	2	2	1,000.0
65	0	0	-	0	0	-	0	0	-
Total	31	20	645.1	26	23	884.6	57	43	754.3

TABLE 6—*Onchocercotic nodules found on Xiriano-teri Indians of the Toototobi region, by age group and nodule site.*

Age group in years	No. of cases	No. of cases with nodules	% of cases with nodules	Location of observed nodules					Total no. of nodules found
				Head	Shoulders	Chest	Pelvic region	Buttocks	
10-14	1	0	-	-	-	-	-	-	0
15-19	9	5	55.5	4	-	-	-	1	5
20-24	7	1	14.3	1	-	-	-	-	1
25-34	10	2	20.0	2	-	-	-	-	2
35-44	6	1	16.7	-	-	1	-	-	1
45-54	2	1	50.0	-	-	-	1	-	1
55-64	2	1	50.0	1	2	-	1	-	4
65	0	0	-	-	-	-	-	-	-
Total	37	11	29.7	8	2	1	2	1	14
Proportion of nodules at each site (%)				57.1	14.3	7.2	14.3	7.2	100.0

situated between high mountains (see Map 1). A slow-moving river three to six meters wide flows near the local Mission. One hour away from the Mission by foot is the Yanomama village of Xelawati-teri with a population of about 160. Other Indian groups in this general area inhabit Venezuelan territory (known as *Tama-tama*) two or three days' walking distance away. (This latter information was provided by Missionary Helio Alberti, who collaborated closely with us).

Because the Indians were travelling when we arrived, our investigation was limited to 44 persons. Of these, all were given the Mazzotti test and biopsies were performed on all those over the age of ten. None of the results were positive.

Catrimani

The *Consolata* Mission on the Upper Catrimani River, a tributary of the Branco, is located east of Toototobi on the route of the Northern Perimeter Highway.

A Yanomama settlement inhabited by 41 Korihana-teri Indians is located next to the Mission. According to Missionary Carlos Zacquini, a total of about 400 Indians inhabit the river basin of the Upper Catrimani.

Because the Indians were experiencing an outbreak of influenza, our investigation was limited to the Mazzotti test. This was given to 38 Indians over age 10, 30 of them local residents and eight of them visiting Yanomama tribesmen from Xaxanapiu-teri. All the results were negative. Mission personnel and 12 laborers working on the Northern Perimeter Highway were also tested, again with negative results.

Caracaraí

This port on the Branco River (altitude 180 meters) is a major base camp of the companies building the Northern Perimeter Highway. Connected by road to Boa Vista 130 km to the north, this town will be an important future communications link. Fifteen biopsies and 70 Mazzotti tests were performed on residents of Caracaraí and on Northern Perimeter Highway workers. All were negative.

Miscellaneous Sites

Our investigation also took in Boa Vista, Bon Fim, Pucha Faca, La Piedra, Waica and upper and lower portions of the Mucajaí River, but there were no positive findings in any of these places (see Map 1).

Discussion

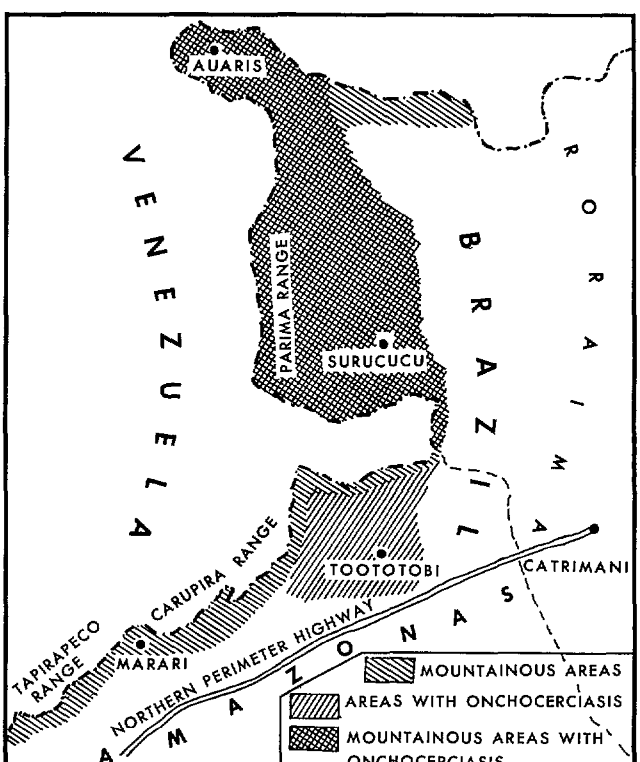
Some of the basic aims of our investigation were to determine (1) the prevalence of onchocerciasis in accessible locations; (2) the intensity of the infections; (3) the severity of the clinical picture; (4) the extent of the focus; and (5) the potential danger posed by the nearness of the Northern Perimeter Highway. Other basic work relating to the *Simulium* vectors of onchocerciasis—including identification of possible vector species in the known foci and preliminary determination of their distribution—will be described in detail elsewhere. The subject of vector infestation indices has already been discussed (*15*).

Extent of the Focus

As previously noted, surveys conducted in the towns of Boa Vista and Caracaraí, near the missions of La Piedra, Marari, Mucajaí, and Pucha Faca, and around the Upper Catrimani River yielded negative results. Therefore, the Brazilian region currently affected by onchocerciasis would appear limited to the mountain-ringed plateau regions of Auaris (670 m) and Surucucu (838 m) and to the lower terrain of the Upper Toototobi (180 m) (see Map 4). These three foci do not appear linked to one another, since there is no communication between the Auaris and Surucucu tribes, nor is there any contact between the Surucu and Toototobi areas. In the first case the lack of contact stems from both difficult terrain and the presence of hostile mountain tribes, while in the latter it is due especially to adverse topographic conditions.

Sociocultural factors play an important if not a dominant role in maintaining this pattern (see Map 5). For the Sanuma and

MAP 4—*Areas endemic for onchocerciasis and nearby mountainous areas in the Roraima Territory and northern Amazonas State (May-June 1974).*



Makiritare of Auaris, the natural channels of communication and of socioeconomic interchange open into Venezuela—to the northeast toward the mountains and valleys of the Upper Merewari, to the northwest toward the Upper Ventuari, and to the southwest toward the Padamo and Cunucunuma rivers. For the Aikam-teri Indians of Surucucu, the established channel is to the west, connecting with the inhabitants of Venezuela's mountainous Parima region. And for the Xiriano-teri Indians of the Toototobi region the channel is through the mountains on the Venezuelan border—their seasonal migrations leading them to the region of the Upper Orinoco and the Ugueto, from whence they also receive visitors such as the four Akavaiva-teri we examined.

The existence of *O. volvulus* transmission in neighboring areas of Venezuela has been confirmed by the following observations:

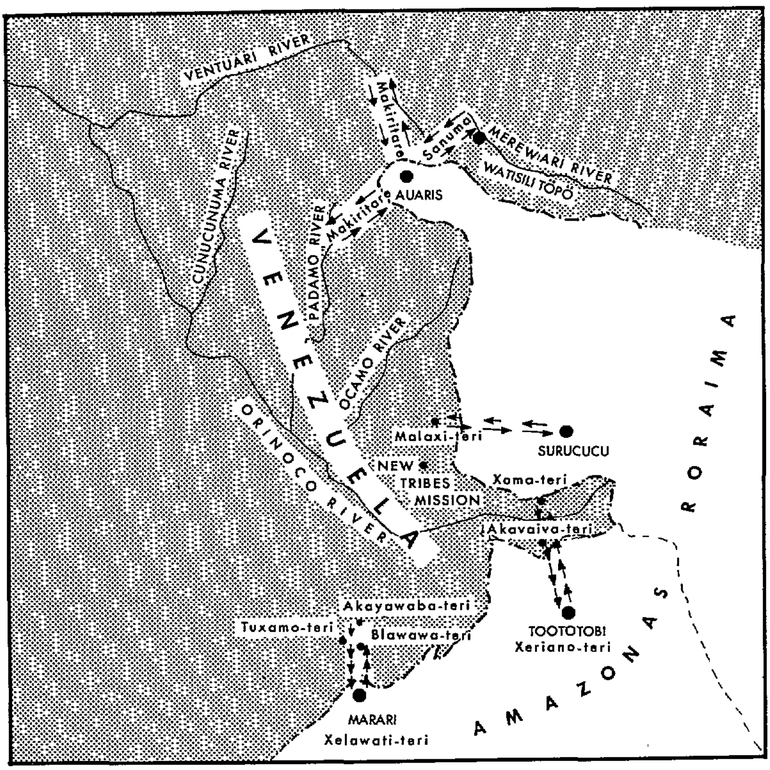
a) At Auaris we found an infection in a 12-year-old Sanuma boy named Silaka from the Upper Merewari area, who had arrived in Auaris only four days before being examined.

b) At Toototobi, three of the four Akavaiva-teri Indians who had just arrived for a visit were infected, the biopsy specimen from one yielding over 100 microfilariae.

Prevalence of Infection

Both the biopsies and the Mazzotti test results showed onchocerciasis to be most prevalent in the Upper Toototobi region (see Tables 4 and 5). The Mazzotti test in particular evoked a clear positive response in all Toototobi subjects over 15, in the only child within the 10-14 group, and in two girls of the 5-9 group.

The prevalence of infection at the newly discovered focus of Auaris was found to be



MAP 5—*Seasonal migrations of Indian groups inhabiting areas affected by onchocerciasis in Brazil.*

substantially lower by biopsy (245 per thousand) than by the Mazzotti test (547.3 per thousand). Here the rate of positive biopsy was similar to that found in Surucuru (240.7 per thousand), where the Mazzotti test was not performed.

Rough data on onchocerciasis prevalence in uninvestigated areas on both sides of the Venezuelan border are presented in Map 3, which shows the home areas and the rate of positive biopsies for the 46 Indians who came from outlying regions. The mere fact that 46 Indians (16.8 per cent of all those examined) were visitors from such outside areas gives a good idea of the high rate of movement and sociocultural interchange taking place among these groups (*7*).

Intensity of the Infection

As noted, the average number of microfilariae per positive biopsy was six in Surucucu, 10.25 in Auaris, and 14.2 in Toototobi, with most counts ranging between three and eight in all areas.

Regarding infections among the 0-9 age group, two of 16 children in Toototobi and one of 15 in Auaris gave a clear positive response to the Mazzotti test. In the 10-14 age group the results were positive in five out of 19 in Auaris and one out of one in Toototobi.

Severity of the Clinical Picture

Because ophthalmologic examination of the patients was not possible, we have used evaluation of visual acuity (*12*) as a rough indicator of ocular debilitation. A total of 75 subjects tested were found to have average or above average vision (1.20-1.50). In Toototobi we observed one case of blindness in the right eye of an old man suffering from severe parasitosis, and a case of slightly reduced vision in one eye of a 22-year-old subject. In both cases the vision of the other eye was normal.

Other clinical indications of relative severity are cutaneous lesions and lymphatic involvement (*12*). Concerning the former, we found only one case of generalized chronic papulous dermatitis—in Isaqui of Toototobi. Less severe cases were observed in some other subjects, but these could not be definitely attributed to onchocerciasis. No case of lymphatic involvement was found. It should be noted, however, that the Mazzotti test provoked a violent response—with infarction of the inguinal lymph nodes—in two male subjects 15 and 47 years of age.

Conclusion

The transmission of *Onchocerca volvulus* described in this report poses a potential danger for other areas of Brazil. Factors contributing to this potential are the high incidence of infection, the vast area of jungle involved, the relative closeness of Toototobi to the Northern Perimeter Highway, and exposure of the highway to the Toototobi and Demini river valleys. By air, the Toototobi area and the highway are only about 100 km apart, and the Demini River Valley crosses the highway at km 1,650.

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SUMMARY

An epidemiologic survey encompassing most of Brazil's Federal Territory of Roraima and the northern tip of Amazonas State has been carried out in an effort to define the boundaries and the epidemiologic characteristics of onchocerciasis in Brazil. This article describes results relating to human infections—including discovery of a new focus at Auaris in northern Roraima and analysis of data from tests conducted there and at various other locations. These findings lead the authors to conclude that the three known Brazilian foci represent independent influxes of the disease from neighboring Venezuela, that groups of both Yanomama and Makiritare Indians have been infected, and that various factors (including proximity of these foci and the route for Brazil's Northern Perimeter Highway) indicate the disease could pose a potential danger for other areas of Brazil.

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