

## DISCOVERY OF A NEW ONCHOCERCIASIS FOCUS IN VENEZUELA<sup>1,2</sup>

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*A survey of villages in Venezuela near a focus of onchocerciasis (river blindness) across the border in Brazil has revealed a high prevalence of cases. Future human settlement of the area may well depend on control of this disease.*

The presence of onchocerciasis in Venezuela was first observed by Potenza et al. in 1949 (14), but it was not until 1958 that an epidemiologic survey was conducted in the area believed to be affected (22). Since that time the nature and extent of two foci, both of them in the coastal mountain range, have gradually been defined (Figure 1). One, located in the north-central region of the country, has primarily involved the states of Aragua, Carabobo, Miranda, and Guárico, but it has also caused a few sporadic cases in the states of Yaracuy and Cojedes. The other, in northeastern Vene-

zuela, covers portions of the states of Anzoátegui, Monagas, and Sucre (13, 17, 22).

These affected areas are fairly populous, the total number of inhabitants being reported at 1,898,827 in 1974. In early June 1974 some 1,628,370 persons were examined for onchocerciasis, and 40,091 were found to be positive (by the Mazzotti test in most instances). Thus the apparent rate of infection was 24.6 per 1,000 population.

The characteristic features of the disease in these endemic areas are (13,17,22):

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<sup>2</sup>Studies conducted by the Pan American Center for Research and Training in Leprosy and Tropical Diseases, Caracas, Venezuela. Dr. Celio P. Motta R. was adviser for the investigation. Also cooperating was the Border Service, Venezuelan Ministry of Health and Social Welfare—Dr. Luis González Herrera, Chief Medical Officer.

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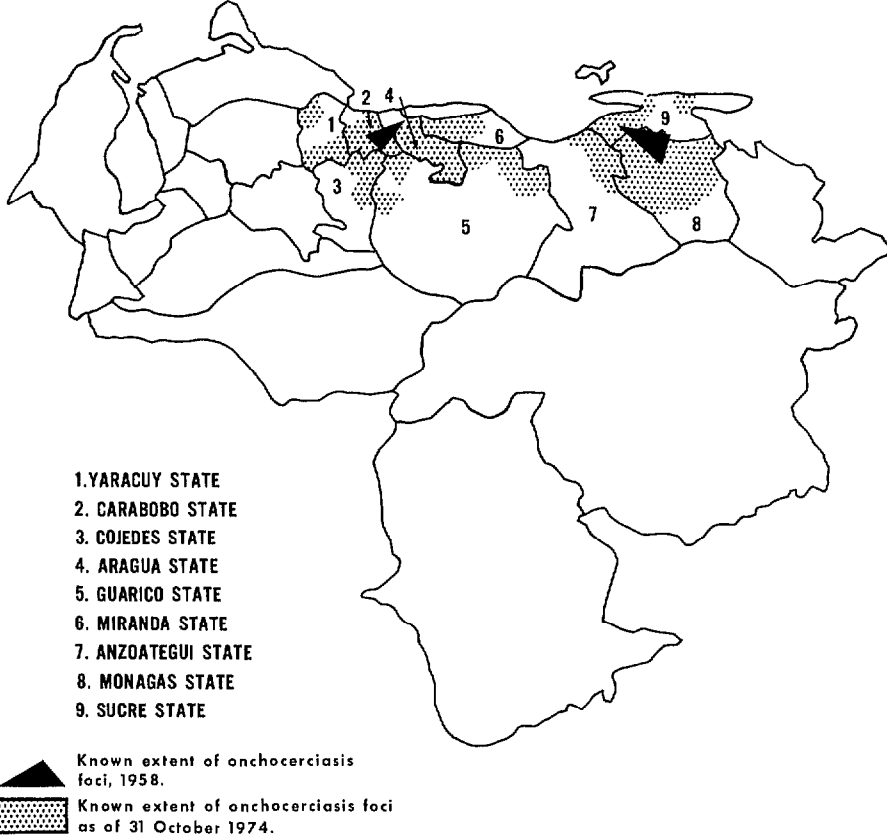
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Figure 1. Distribution of coastal onchocerciasis foci in Venezuela, 1958-1974.



Source: National Registry of Patients and Contacts, Department of Public Health Dermatology, Ministry of Public Health and Social Welfare, Caracas, Venezuela.

- Absence of dermatologic lesions;
- Absence of lymphatic involvement;
- Presence of ocular lesions in some 30 per cent of the cases, with 49.6 per cent of the reported cases involving punctate keratitis (no sclerosing keratitis observed);
- Low frequency of subcutaneous nodules, which were found in only 23 per cent of the subjects examined at the time control measures were first introduced and are currently very rare;
- Localization of the nodules low on the body, mainly from the hips downward; and
- Transmission of the *Onchocerca vol-*

*vulus* parasite by *Simulium metallicum* and, to a much lesser degree, by *Simulium exiguum*—the only vectors heretofore known in these foci (8,13,15,16).

The two foci described above diminish and fade out toward the south as ecologic conditions change and the two vectors gradually disappear. Neither of the vectors has been found in the vast expanse of the Venezuelan plains farther south, and until very recently no other Venezuelan foci were known.

New information was brought to light in 1974, however, when a member of the Pan

American Health Organization's advisory group completed a study in parts of neighboring Brazil where new endemic areas of the disease had been found. It was observed in the course of this study that onchocerciasis was present among Yanomama Indians in the far northern portions of Amazonas State and the Federal Territory of Roraima (10,21)—areas close to the Venezuelan border (Figure 2).

Brazil's three known foci—near, respectively, the Auaris, Surucucu, and Toototobi Missions—are not directly linked to each other. However, many of the Indians' communication routes extend into Venezuela. At Auaris there is a main route used by the local Sanumá and Makiritare which crosses the border and goes northward into the mountains, traveling along the valleys of the Upper Ventuari, Merewari, Canaracuni, and Upper Caura rivers. Another proceeds west by way of the Padamo and Cunucunuma river valleys. At Surucucu the Aikam-teri Indians have a major travel route that extends west into Venezuela through the mountainous Parima region. And the Xiriano-teri of Toototobi have a seasonal migration route across the mountains along the Brazil-Venezuela border which takes them into the valleys of the Upper Orinoco, Ugueto, and Siapa (21).

Only a very small proportion (0.75 per cent) of the predominant man-biting *Simulium* vectors captured at the Toototobi Mission were found to be naturally infested with *O. volvulus* (20). This low index is not compatible with the high infection rate (606.5 per 1,000 population) observed among the Xiriano-teri residents of this area. The investigators therefore reached the following conclusion:

Since the most heavily parasitized patients come from the area inhabited by the Venezuelan Yanomama Indians, we may assume that in some of the following places—the Upper Ventuari, Upper Merewari, and Padamo river valleys, the Parima mountain range, and the Upper Orinoco valley—oncho-

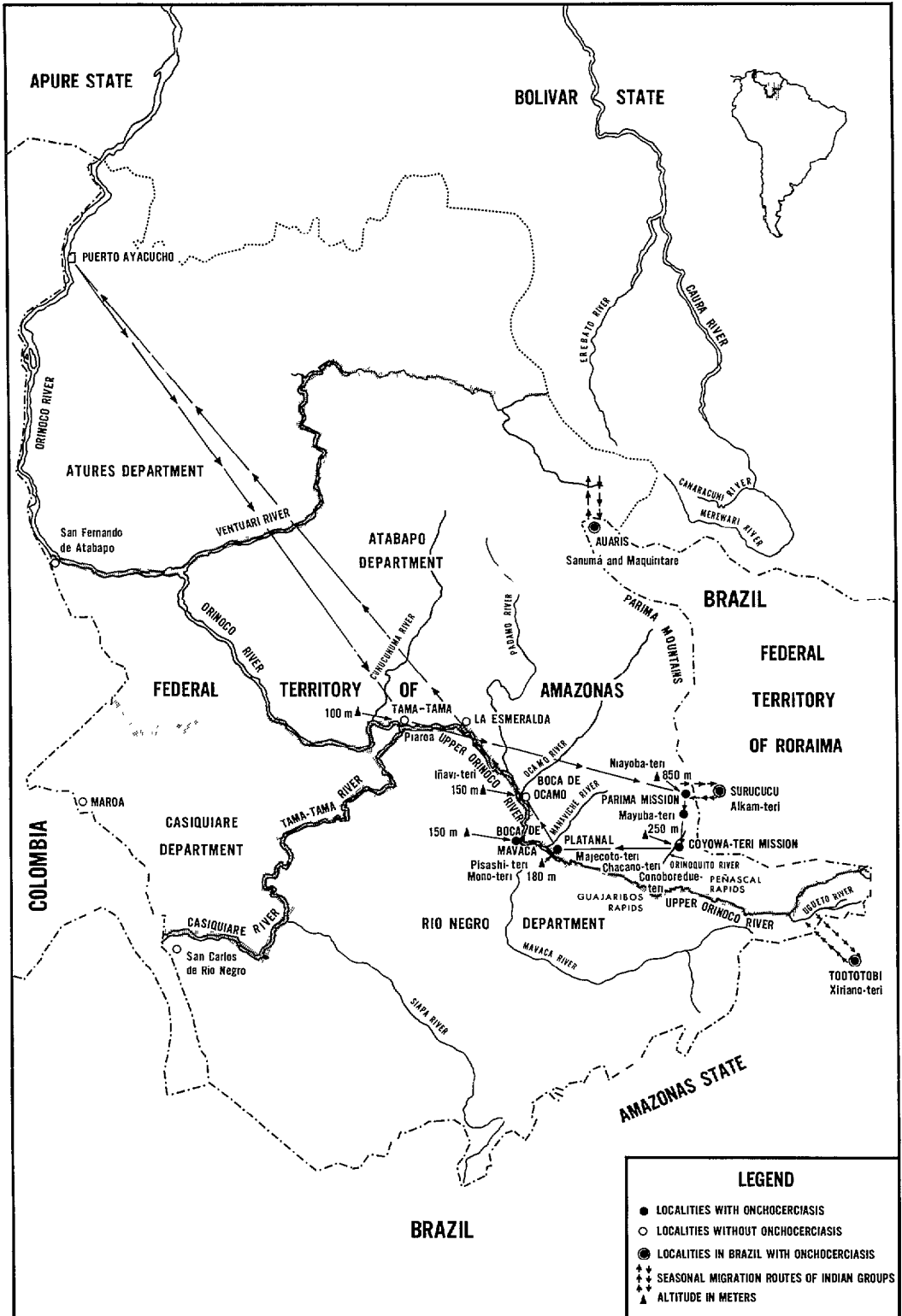
cerciasis transmission must be greater, with a higher vector infestation index, and that the Indians of Auaris, Toototobi, and Surucucu come in temporary contact with these more efficient vectors in the course of their seasonal migrations (21).

## Materials and Methods

On the basis of the foregoing facts and assumptions, an expedition was planned for early 1975 into the region of the Parima mountains and the Upper Orinoco river. The expedition's itinerary, shown in Figure 2, was as follows: Puerto Ayacucho—Tama-Tama—Parima Mission—Coyowa-teri Mission—Platanal—Boca de Ocamo—La Esmeralda—Puerto Ayacucho. In addition, side trips were made by launch from Platanal to the area of the Guajaribos and Peñascal rapids and from Boca de Ocamo to Boca de Mavaca.

The basic aims of the undertaking were: to detect cases of onchocerciasis in the local populations, and to collect entomologic specimens for the purpose of identifying man-biting Simuliidae and determining indexes of natural *O. volvulus* infestation in these species. Other activities carried out included tuberculin-testing and BCG administration, collection of *Phlebotomus* flies, biopsy of dermatologic lesions, and removal of subcutaneous nodules. Specifically, the case-detection work consisted of procuring and examining skin snips from the inhabitants (one each, taken with a razor from the area above the shoulder blade), usually from persons 10 years of age or over; administering the Mazzotti test (50 mg of hetrazan—2,3,9,10); conducting a general dermatologic examination; palpating the skin to detect nodules; and, in every tenth subject, testing for the presence of *Mansonella ozzardi* microfilariae in the blood. All the tests for *M. ozzardi* were negative. The particular work done in each of the different localities and the results

Figure 2. Onchocerciasis in southern Venezuela: Preliminary investigation of possible foci in the Federal Territory of Amazonas, April 1975.



obtained are described in the sections that follow.

**Parima Mission**

*Description*

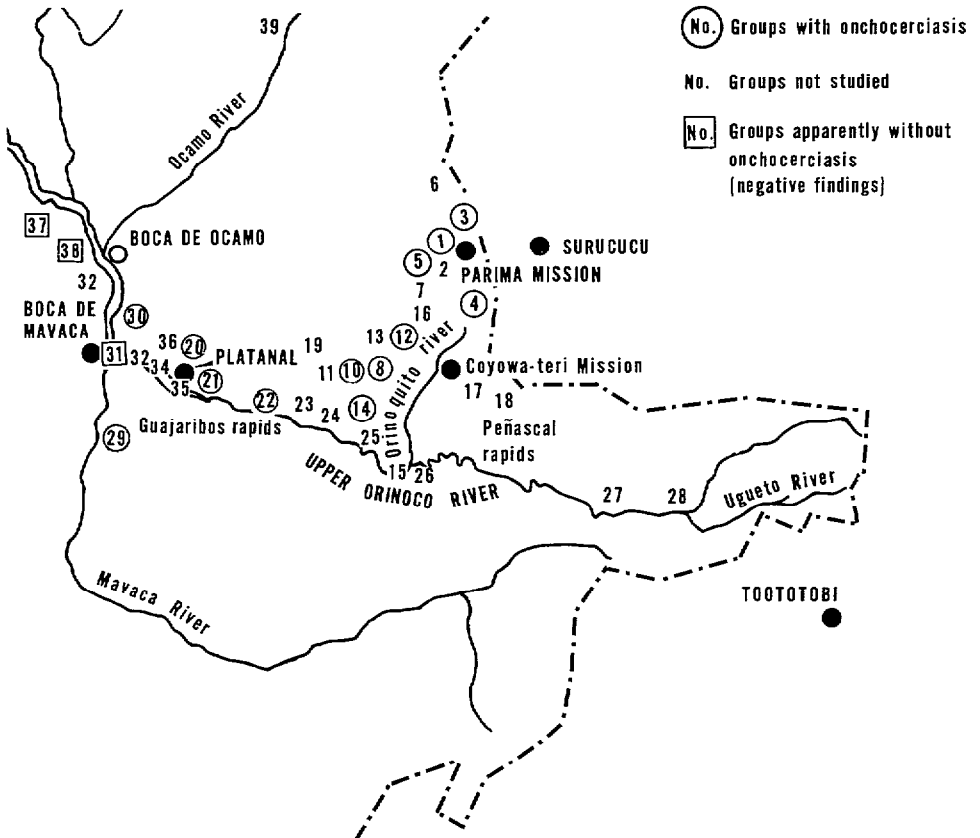
The Parima Mission is located near the Brazil-Venezuela border (2°50'N, 64° 20'W). It is set in a valley near a small stream at an altitude of about 850 meters. The rainy season begins in May and ends in September. About 200 Yanomamas, from the Niayoba-teri group, live near the mission. In addition, there are some 15 other settlements with a total population of about 1,140 located nearby at distances of

from one hour to five days on foot (Figure 3). Several of the individuals examined were from these other settlements.

*Results*

Skin snips were obtained from 104 persons, of whom 30 (28.8 per cent) proved to be positive (Table 1). The differences between the sexes were not statistically significant. The average number of microfilariae per unstained biopsy specimen was 14.4; counts with Giemsa-stained specimens were higher, averaging 21.8 per slide. Two of the individuals tested were children, four and five years old respectively, who had

**Figure 3. Distribution of the Yanomama Indian groups studied in the Federal Territory of Amazonas, Venezuela, April 1975 (see Annex on page 46).**



## ANNEX TO FIGURE 3

## Yanomama Groups Living in the Area Studied

Mission visited and nearby Indian groups	Indian populations	Distance away from missions
<i>Parima</i>		
1) Niayoba-teri (o)	200	Near the mission
2) Vainama-teri (o)	60	1/2 hour on foot
3) Pablo-teri (o)	100	1 hour on foot
4) Mayuba-teri (4 groups) (o)	300	8 hours on foot
5) Ysha-teri (4 groups) (o)	200	6 hours on foot
6) Mánapa-teri (several groups)	200	Between 12 hours and 3 days on foot
7) Shitali	80	24 hours on foot
Subtotal	1,140	
<i>Coyowa-teri Mission</i>		
8) Coyowa-teri (o)	85	Near the mission
9) Motowa-teri	95	4 hours on foot
10) Tolobo-teri (o)	65	5 hours on foot
11) Tacowa-teri	125	8 hours on foot
12) Adajubayaca-teri (o)	60	5 hours on foot
13) Yulucalewa-teri	60	6 hours on foot
14) Ijiliba-teri (o)	85	5 hours on foot
15) Shimuwa-teri (2 groups)	80	18 hours on foot
16) Fubiramao-teri	60	12 hours on foot
17) Coyoshiwa-teri	80	8 hours on foot
18) Obowaca-teri	60	10 hours on foot
19) Mayo-teri (several groups)	250	24 hours on foot
Subtotal	1,105	
<i>Platanal</i>		
20) Majecoto-teri (o)	120	Near the mission
21) Chachano-teri (o)	20	20 min. by boat
22) Conoboredue-teri (o)	150	90 min. by boat
23) Nabtawe-teri	60	90 min. by boat
24) Kashorawa-teri	110	2 hours by boat
25) Jاسوبue-teri	180	5 hours by boat
26) Jijiramawa-teri	50	6 hours by boat
27) Uarocoao-teri	150	8 hours by boat
28) Yesidue-teri	100	12 hours by boat
Subtotal	940	
<i>Mavaca</i>		
29) Patano-teri (3 groups) (o)	226	2 days on foot
30) Pisahi-teri (5 groups) (o)	200	Near the mission
31) Mono-teri	60	Near the mission
32) Masiquidue-teri	88	1 hour by boat
33) Moeropoi-teri and other groups	200	Upper Mavaca, 4 to 12 hours by boat
34) Macorima-teri	60	1 hour from Mavaca in the Manaviche Gorge
35) Ohyari-teri	60	Between Mavaca and Platanal
36) Carawai-teri	60	Between Mavaca and Platanal
Subtotal	954	
<i>Ocamo</i>		
37) Iñavi-teri	168	Near the mission
38) Vitocayo-teri	60	1 hour by boat
39) Sibari-teri	70	Upper Ocamo, 5 hours by boat
Subtotal	298	
Total	4,437	

(o) Groups in which onchocerciasis was found.

Table 1. Biopsy and Mazzotti test results obtained from members of the Niayoba-teri and Mayuba-teri tribes at Parima, Federal Territory of Amazonas, Venezuela (April 1975).

Age group (years)	Biopsies			Mazzotti tests		
	No. examined	No. positive	% positive	No. administered	No. positive <sup>a</sup>	% positive
0-4	1	1	100.0	0	0	0
5-9	1	0	0	0	0	0
10-14	4	0	0	5	1	20.0
15-19	11	2	18.2	9	4	44.4
20-24	33	10	30.3	26	9	34.6
25-34	27	5	18.5	22	13	59.1
35-44	12	3	25.0	10	8	80.0
45-54	7	3	42.9	5	4	80.0
55-64	6	5	83.3	3	2	66.7
65+	2	1	50.0	0	0	0
Total	104	30	28.8	80	41	51.3

<sup>a</sup>Weak positive responses (1+) to the Mazzotti test (such as pruritis without patent scratching lesions or infiltration of the tissues, erythema, and edema) were not included in these figures as positive findings.

been found on palpation to have nodules. The younger one turned out, in fact, to be positive. About eight hours away by foot (10 minutes by light aircraft) a Mayuba-teri settlement was found at an altitude of about 950 meters. It was only possible to obtain skin snips from nine individuals, three of whom were positive.

The Mazzotti test was given to 80 of the people who provided biopsy material, including some who had positive biopsies. The results (Table 1) were clearly positive in 41 instances (51.3 per cent). The positive responses included itching lesions, erythema, edema, and conjunctival reaction—this last being the most frequent and patent manifestation.

In the dermatologic examination, chronic dermatitis and "elephant skin" attributable to onchocerciasis were observed in three cases. Other findings included one case of ichthyosis and several of pyodermitis. In addition, 13 onchocercal nodules were

found on 12 patients, 10 (76.9 per cent) of them being localized on the scalp, two in the pelvic region, and one on the leg.

### Coyowa-teri Mission

#### Description

The Coyowa-teri Mission is located in the foothills of the Parima mountains to the south of the Parima Mission (Figure 3) on a bank of the Orinoquito river at an altitude of about 250 meters. The river is between 20 and 30 meters wide at this point.

Characteristic tropical forest features are more pronounced here than at the Parima Mission. Some 85 Yanomamas live nearby in the Coyowa-teri commune, and 12 other settlements, with a total population of roughly 1,000, live at points that can be reached by foot in from four hours to two days.

## Results

Skin snips were taken from 45 individuals, not all of whom belonged to the Coyowa-teri group. As Table 2 shows, 33 of these subjects (73.3 per cent) showed positive findings. The average microfilaria count was 18.8 per unstained slide and 24.0 per Giemsa-stained slide. Significant levels of infection were observed among young people (including the five-to-nine-year bracket), and the positivity rate among subjects over 20 years of age was nearly 100 per cent.

Of the 12 individuals with negative biopsies, seven had a clearly positive response in the Mazzotti test. Addition of these seven cases to the 33 detected earlier gave an overall infection rate of 88.9 per cent.

All the 40 patients above (33 plus the additional seven positive by the Mazzotti test) were examined dermatologically. Cutaneous manifestations of the disease were very evident and included some features previously described only in certain foci in Africa. Significant inguinal and femoral adenopathy was observed in eight subjects. In another four, including an eight-year-old boy, involvement of the inguinal and

femoral lymph nodes was most impressive, the inflammatory process affecting the tegument. These latter cases showed the feature described by British authors in Africa as "hanging groin." A total of 12 persons had obvious inguinal involvement.

Chronic papular dermatitis attributable to onchocerciasis was also found, together with "elephant skin," in 12 of the subjects (Figures 4,5). Two of these 12, as well as three others, also had acute skin lesions in the form of erythematous plaques, which were rounded, banded, or, in one case, irregular in shape, bearing a clear resemblance to lesions of dimorphous or lepromatous leprosy (Figures 6,7). In sum, chronic and/or acute skin lesions were observed in 15 persons, or 37.5 per cent of the patients under study. In addition, a total of 69 nodules were found, either by palpation or by visual inspection, in 33 of the patients (Table 3, Figure 8).

The histopathologic findings can be seen in Figure 9. The first frame (A) shows an H & E-stained section with perivascular infiltration by eosinophils, macrophages, and lymphoid cells. This tissue was obtained from a papillomatous lesion on the back of a 21-year-old male. The subject had severe papillomatous and irregular erythematous lesions, generalized chronic dermatitis, "elephant skin" on the buttocks, and inguinal adenopathy. Figure 9-B likewise shows a perivascular infiltrate composed of eosinophils, macrophages, and lymphoid cells. The biopsy came from an erythematous plaque on the shoulder-blade region of a 35-year-old male who had several such plaques, chronic generalized dermatitis, and inguinal adenopathy. Figure 9-C shows fragmentation of elastic fibers and, in some places, their actual disappearance from the dermis. This tissue was taken from an erythematous plaque located on the lumbar region of a 32-year-old male who had many irregular erythematous lesions and plaques of "elephant skin."

Table 2. Biopsy results obtained from Yanomama Indians near the Coyowa-teri Mission, Amazonas, Venezuela (April 1975).

Age group (years)	No. examined	No. positive	% positive
0-4	3	1	33.3
5-9	6	4	66.7
10-14	2	1	50.0
15-19	6	3	50.0
20-24	1	1	100.0
25-34	17	14	82.4
35-44	6	5	83.3
45-54	1	1	100.0
55-64	2	2	100.0
65+	1	1	100.0
Total	45	33	73.3



Figure 4. A Coyowa-teri case of generalized and marked chronic dermatitis with extensive involvement of elastic fibers approaching the condition described by writers in Africa as "elephant skin."

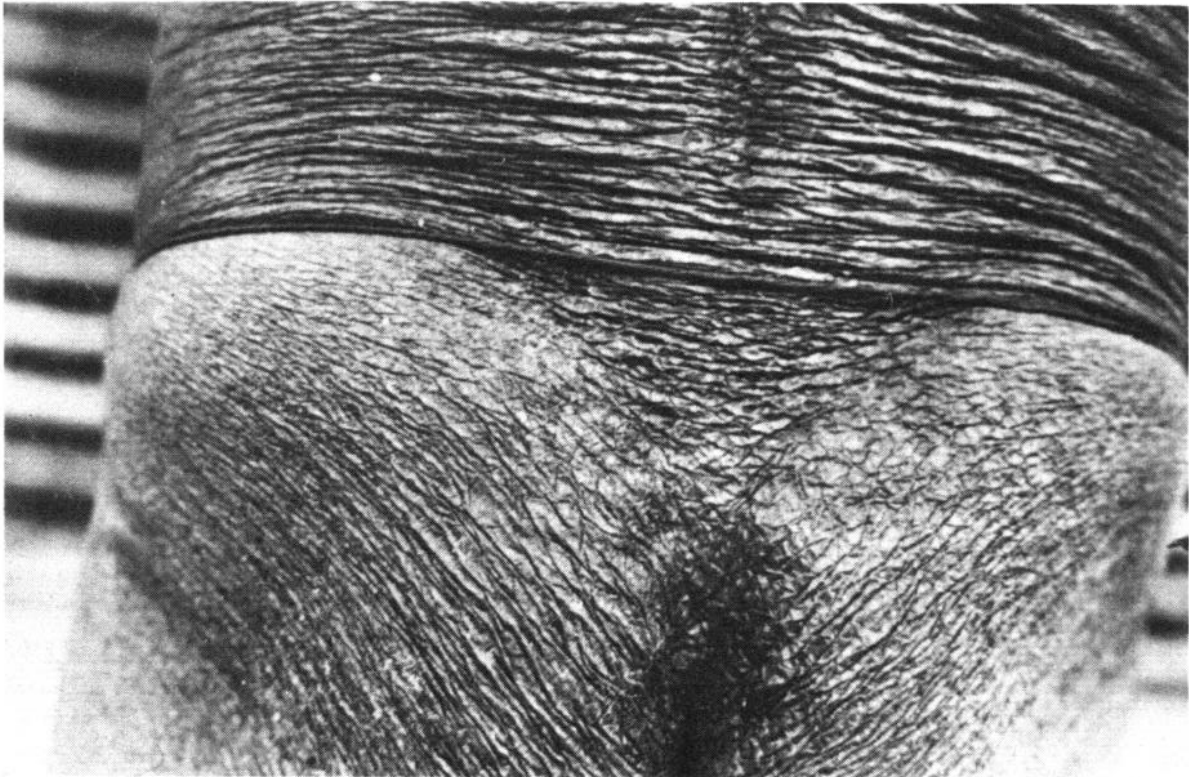


Figure 5. Another clinical picture of chronic dermatitis and marked "elephant skin" in a Coyowa-teri subject.



**Figure 6.** A well-defined erythematous plaque in another Coyowa-teri subject. Similar lesions, corresponding to the acute phase of cutaneous involvement, were observed in five cases.



**Figure 7.** Another picture showing the acute lesions (Coyowa-teri).

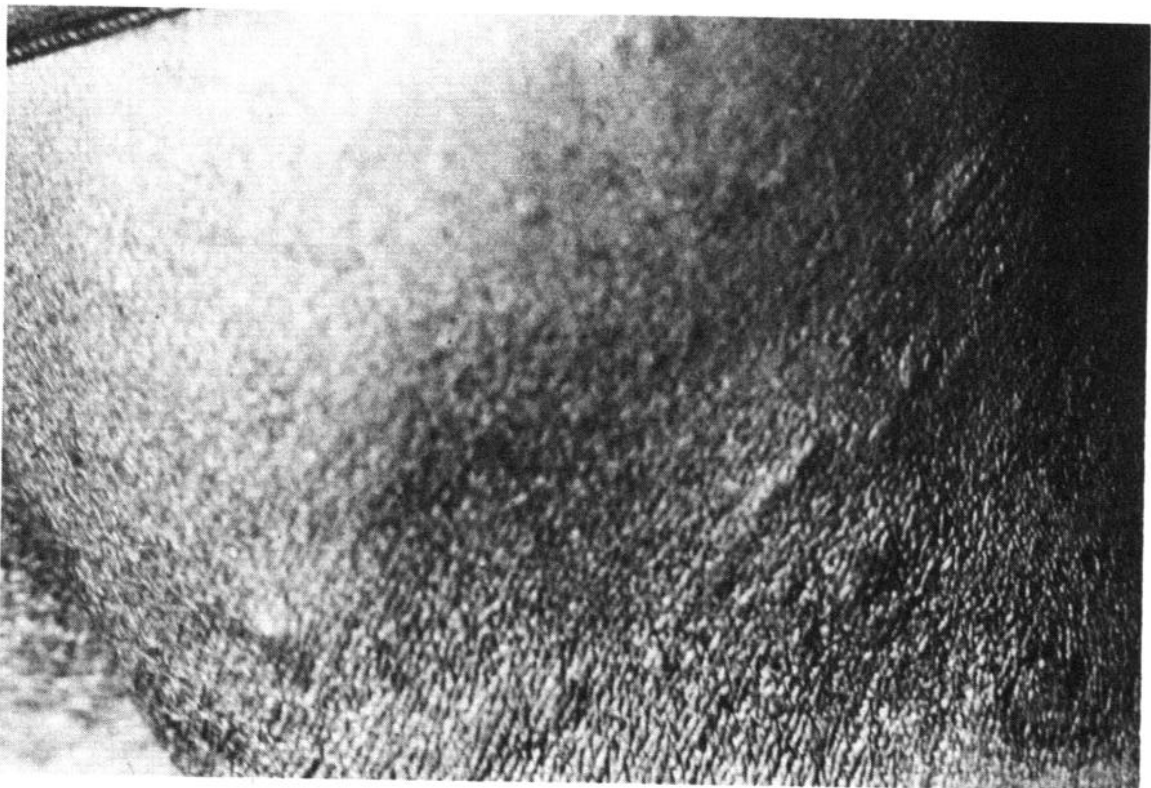


Figure 8. Nodules on the scalp of an eight-year-old Coyowa-teri boy. The swellings are confluent.



## Platanal

### *Description*

Platanal (2°23'N, 64°55'W) is situated a short distance from the Upper Orinoco river at an altitude of about 180 meters (Figure 2). Two settlements of Yanomamas located 10 to 15 minutes upriver from the mission by boat—one of 120 individuals belonging to the Majecoto-teri group and the other of 20 belonging to the Chachano-teri—were investigated. From there the study went on to include some of the 150 members of the Conoboredue-teri group living about 90 minutes farther upstream. Six other settlements are located along this waterway between the Guajaribos and Peñascal rapids. Altogether, about 900 Indians were found living in these nine settlements. Additional subjects included some 50-odd persons living in the vicinity of the mission post: a nurse, malaria personnel,

workers putting up a building for the Malaria Service, missionaries, mission personnel and their families, etc.

### *Results*

It was only possible to take biopsies from 36 individuals in the Majecoto-teri, Chachano-teri, and Conoboredue-teri groups, since most of the residents were away from their communal homes. Ten of the biopsies (27.8 per cent) were positive. The material showed an average of nine microfilariae per unstained slide, but most of them were found in skin snips obtained from two sick members of the Conoboredue-teri group. Biopsies were also taken from 30 of the 50 Platanal residents not belonging to the Yanomama groups, most of whom had only been in the area a short time. These latter specimens yielded generally negative results.

The subjects with negative biopsies were given the Mazzotti test. It was only possible

Table 3. Number and distribution of nodules found on members of the Coyowa-teri tribe, Coyowa-teri Mission, Amazonas, Venezuela (April 1975).

Age group (years)	Subjects examined	Subjects with nodules	% with nodules	Total no. of nodules <sup>a</sup>	Location of nodules				
					Head	Back	Pelvic region	Buttocks	Lower extremities
0-4	2	2	100.00	3	3	—	—	—	—
5-9	4	3	75.00	4	3	—	—	—	—
10-14	1	2	200.00	2	2	—	—	—	—
15-19	5	4	80.00	5	5	—	—	—	—
20-24	1	1	100.00	1	—	1	—	—	—
25-34	16	13	81.25	26	20	1	5	—	—
35-44	5	4	80.00	21	5	6	2	4	4
45-54	1	1	100.00	3	1	—	2	—	—
55-64	4	2	50.00	3	2	1	—	—	—
65+	1	1	100.00	1	1	—	—	—	—
Total	40	33	82.50	69	42	9	9	4	4

<sup>a</sup>Percentage of nodules located on the head: 62.3%.

to read the results in nine cases, but of these, *eight* were positive. The test was also given to the 30 non-Yanomama residents with negative biopsies. Twenty-nine of them responded negatively, but one woman, who had resided in the region of the Upper Ventuari, gave an intense positive response, including pruritus, erythema, and edema of the face and arms.

No cutaneous lesions definitely attributable to onchocerciasis were observed in the dermatologic examination.

Ocular lesions were the most significant and surprising finding at Platanal (Figures 10-13). Four individuals residing in this general area were found to have lesions of major importance, including sclerosing keratitis. In one instance the condition had progressed over a three-year period to total blindness; in another the sight of the right eye had been lost; and in a third there was significant impairment of vision. The fourth subject, a boy only four years of age, was found to have a 1.0 x 0.5 cm opaque area on his left cornea. In addition to these four cases, one of bilateral keratitis was found in an Indian girl visitor from the Upper Ventuari region (Figures 14, 15).

#### Boca de Mavaca

There is a mission post at the juncture of the Upper Orinoco and Mavaca rivers (2°25'N, 65°15'W) about two hours downstream by boat from Platanal. Some 250 members of the Pisashi-teri and Mono-teri groups were found living in three communes near the mission.

Biopsies obtained from 40 of the subjects gave negative results, but specimens from two additional Patano-teri visitors contained microfilariae.

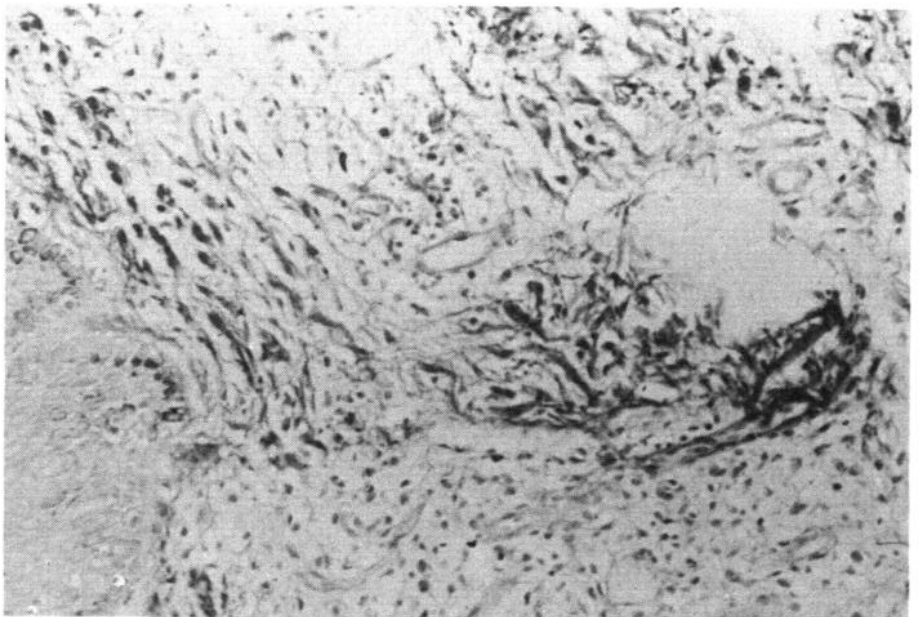
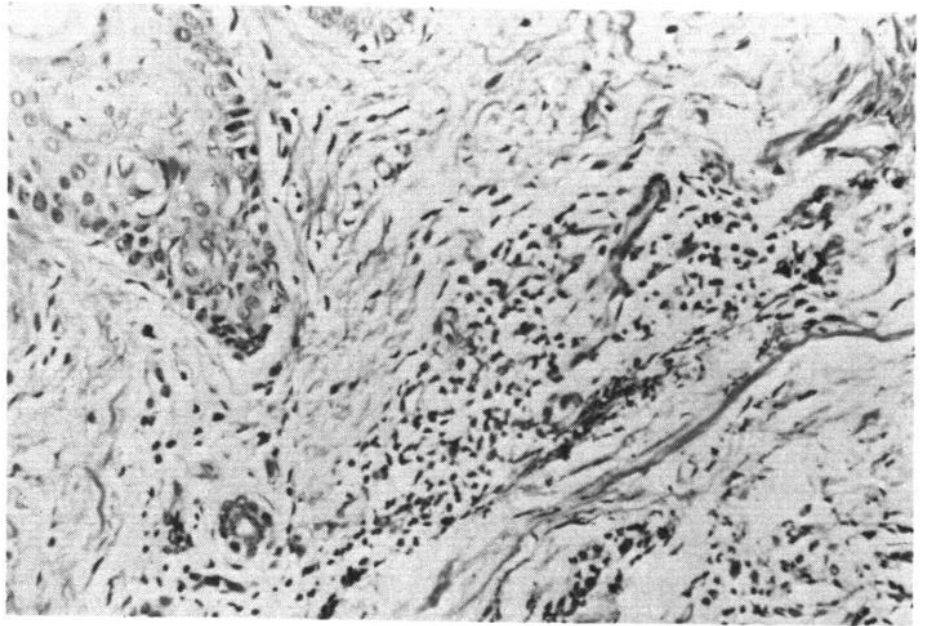
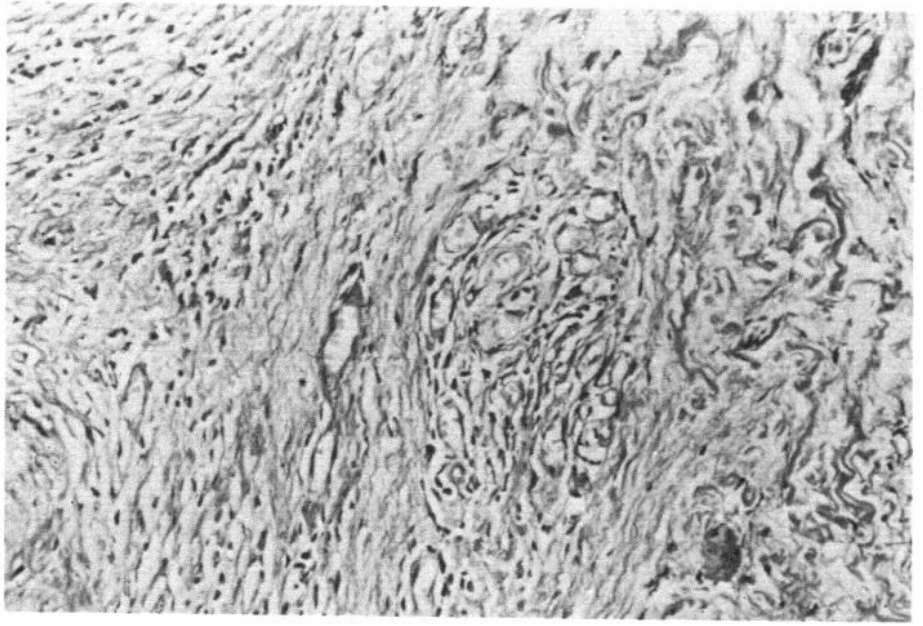
The Mazzotti test was given to all 42 individuals examined, and 15 had positive responses. In one case this response included severe facial edema.

Dermatologic examination failed to reveal any cutaneous lesions or onchocercotic nodules, but it should be mentioned that this phase of the investigation was conducted in the jungle under very difficult conditions.

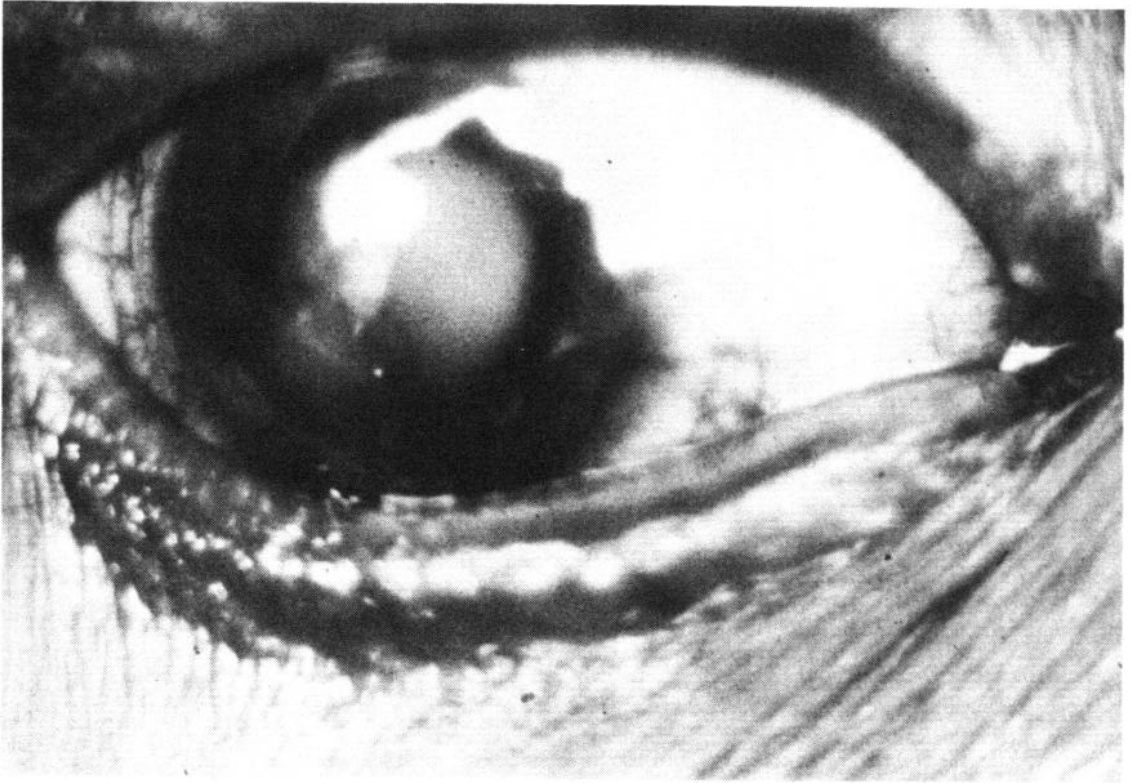
No ocular lesions were found, but Sister Nora of the Mavaca Mission informed us that she had noted cases of corneal opacity along the Upper Mavaca, where three Yanomama groups reside.



**Figure 9. (A) Biopsy 5347: Infiltration by eosinophils, macrophages, and lymphoid cells (H & E stain, x 16). (B) Biopsy 5362: Perivascular infiltration by eosinophils, macrophages, and lymphoid cells (H & E stain, x 40). (C) Biopsy 5363: Fragmentation of elastic fibers and their disappearance from some areas of the dermis (van Geison's stain, x 40).**



**Figura 10. Lesions of keratitis and bilateral cataracts involving loss of sight in the right eye of a 50 year-old Majecoto-teri male (Platanal).**



**Figure 11. Bilateral lesions of keratitis and bilateral cataracts in a totally blind Majecoto-teri tribesman 45 years of age (Platanal).**



Figure 12. Closeup of lesions in right eye of patient in Figure 11.

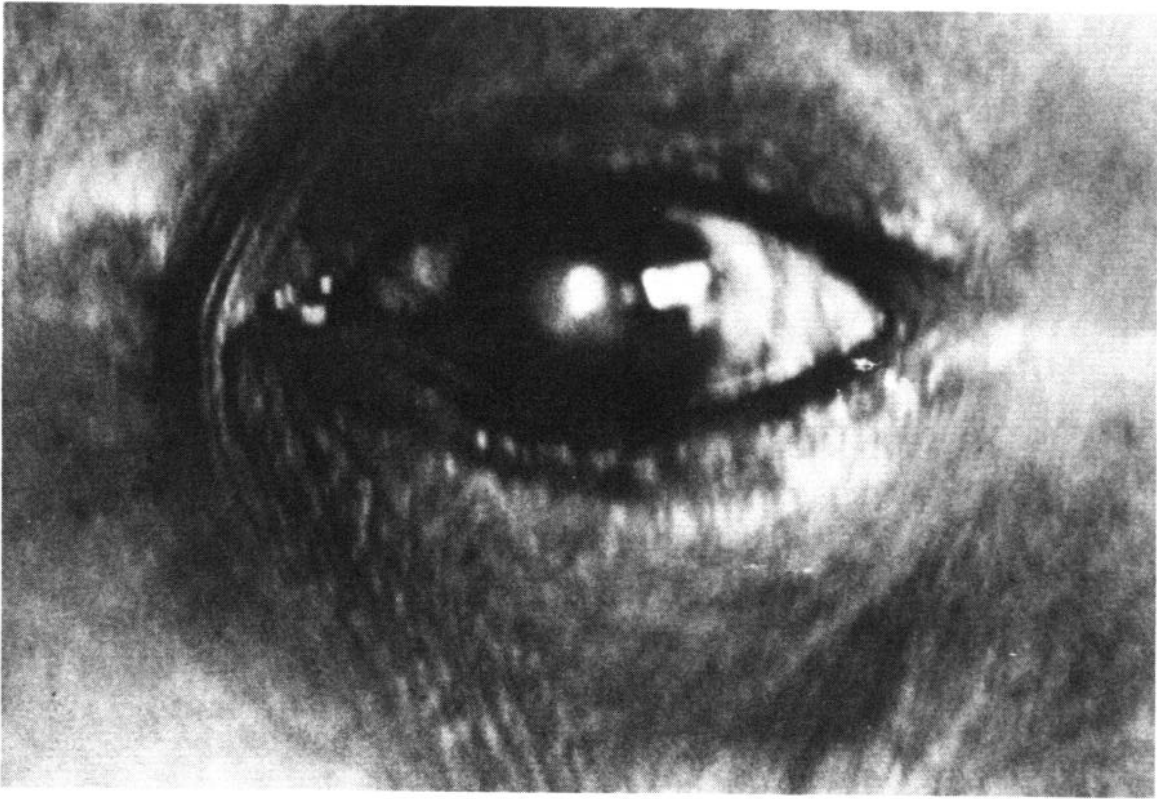


Figure 13. A 1.0 x 0.5 cm plaque caused by keratitis in a four-year-old Chachano-teri boy (Platanal).





Figure 14. Ocular lesions of an Upper Ventuari Indian girl with bilateral keratitis.



Figure 15. Closeup of ocular lesions in girl in Figure 14.





## Boca de Ocamo

The Ocamo Mission (2°45'N, 65°15'W) is situated near the confluence of the Ocamo and Upper Orinoco rivers about two hours downstream from Boca de Mavaca. Biopsies and Mazzotti tests were performed on over 100 Indians in this area, and the results were negative in all instances.

## Tama-Tama

The mission post serving this area (Figure 2) is on the Upper Orinoco near the confluence of the Tama-Tama river (3°15'N, 65°45'W). Some 250 Piaroa Indians (not belonging to the Yanomama Nation) were living at the mission at the time of the investigation. Biopsies were done on 38 subjects and Mazzotti tests were performed on over 100, all with negative results.

## *Simulium* Vectors

The predominant species of man-biting *Simulium* flies identified in the foci under study were *Simulium pintoï* (at the Parima and Coyowa-teri Missions) and *S. amazonicum* (at Platanal). *S. amazonicum* was the predominant man-biting species found at Boca de Ocamo and Tama-Tama.

Eight per cent of the *S. pintoï* collected at Coyowa-teri Mission were found to be infected with *O. volvulus*; of 100 females dissected, two had an infective form of the parasite in the head and six had developmental (sausage) forms in the thorax (Figure 16-A). In addition, one of the 400 *S. amazonicum* species captured at Platanal was found to have an infective form of *O. volvulus* in the head (Figure 16-B). Hence *S. pintoï* and *S. amazonicum* were revealed as new vectors of onchocerciasis in Venezuela.

## Discussion

The objectives of this study were:

- To confirm the presence of onchocerciasis in at least part of the Venezuelan territory inhabited by Yanomama Indians (21) and to determine the prevalence of the disease among the affected groups;
- To determine the intensity of infection and the severity of the clinical picture;
- To identify the predominant species of man-biting Simuliidae in the existing foci and ascertain the infestation index in these species; and
- To train personnel assigned to the study with a view to their effective participation in a future control program.

The results in terms of these objectives are reported on the pages that follow.

## Disease Prevalence

Biopsies obtained near the Parima Mission showed high rates of infection among members of the two groups tested, the Niayoba-teri (28.8 per cent positivity) and the Mayuba-teri (33.3 per cent positivity). To the south, in the Parima foothills, members of the Coyowa-teri group showed a much higher rate of positivity (73.3 per cent). Considerably west and somewhat south of these two areas, between Platanal and the Guajaribos rapids of the Upper Orinoco, small settlements of Majecoto-teri, Chachano-teri, and Conoboredue-teri yielded an overall positivity rate of 27.8 per cent.

Farther west, near Boca de Mavaca, only two of 40 biopsies gave positive findings, and these were taken from visiting members of a Patano-teri group to the south. However, there was a remarkable discrepancy between these results and the results from the Mazzotti test, which evoked a positive response in 32.5 per cent of the 42 subjects tested.

Figure 16. (A) Sausage forms of *O. volvulus* found in the thoracic muscles of a female *Simulium pinto* captured at Coyowa-teri Mission (Mayer's hemalum). (B) An infective form of *O. volvulus* removed from the head of a female *S. amazonicum* captured at Platanal (Mayer's hemalum).

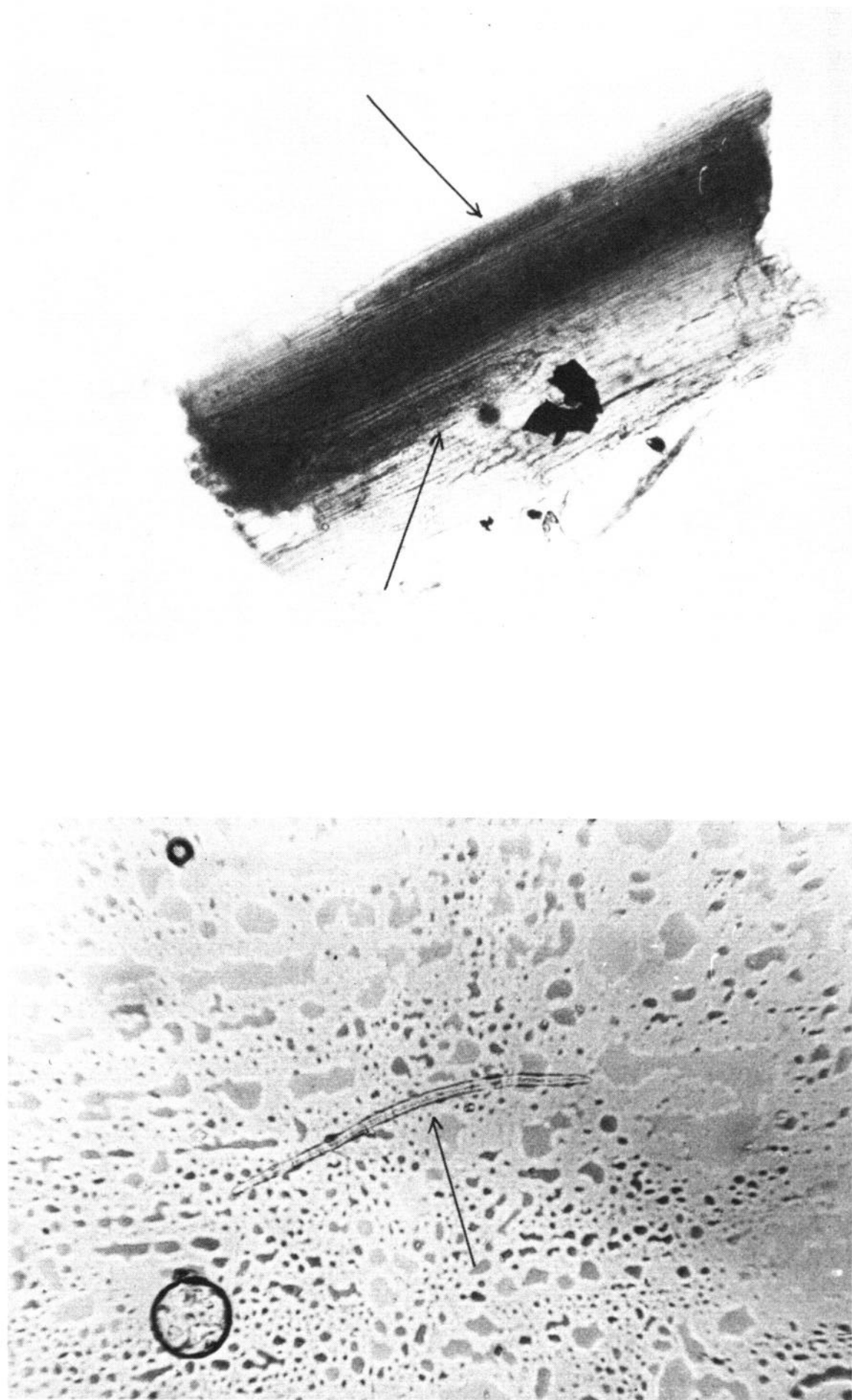


Table 4. Synopsis of findings.

Place <sup>a</sup>	Biopsy and/or Mazzotti test		
	No. examined	No. positive	% positive
Parima	104	45	43.3
Mayuba-teri Mission	9	3	33.3
Coyowa-teri Mission	45	40	88.9
Platanal	36	18	50.0
Boca de Mavaca	42	15	35.7
Total	236	121	51.3

<sup>a</sup>Does not include Tama-Tama or Boca de Ocamo (178 people), which are outside the affected area.

In general, when the figures reflect the total positive findings from persons showing a positive response either on biopsy or in the Mazzotti test—which is considered to be specific for the disease (3)—then the overall prevalences become higher (43.3 per cent at Parima, 88.9 per cent at Coyowa-teri Mission, 50.0 per cent at Platanal, and 35.7 per cent at Boca de Mavaca), for a general average of 51.3 (Table 4). Neither the biopsies nor the Mazzotti tests yielded positive results farther north at Boca de Ocamo (among Yanomamas belonging to the Iñaviteri group) or farther west among the Piaroa Indians at Tama-Tama.

#### Intensity of Infection

The average number of microfilariae found per unstained biopsy specimen was 14.4 at Parima, 18.8 at Coyowa-teri Mission, and 9.3 at Platanal. It should be noted, however, that a disproportionate share of the Platanal microfilariae were found in specimens from the Conoboredueteri group. The other subjects from the Platanal area (members of the Majecoto-teri and Chachano-teri groups) yielded an average of only 3.0 microfilariae per unstained specimen, even though it was in this series of subjects that the severe ocular

lesions, supposedly onchocercal, were observed.

Giemsa-stained slides yielded higher average microfilaria counts at both Parima and Coyowa-teri Missions, the respective average figures being 21.8 and 24.0 per biopsy. By way of comparison, a previous survey in a northern Venezuela focus showed a much lower average count: in all, 71 microfilariae were found in 93 biopsy specimens from 31 patients, for an average count of 0.76 per specimen (19).

Another matter to consider in evaluating the intensity of infection is the extent to which young children were affected (12). Although it was not possible to make a systematic study in this regard, several cases were observed in children in the four-to-nine age bracket: three four-year olds—one at Parima Mission, another in Platanal, and the third at Coyowa-teri Mission—plus four other Coyowa-teri children between five and nine years of age.

#### Severity of Clinical Symptoms

Estimates of the clinical severity of onchocerciasis are based on the degree of ocular compromise; the presence, nature, and extent of cutaneous lesions; the extent

of lymphatic involvement; and the frequency of onchocercal nodules (12).

Four residents with significant ocular lesions were observed at Platanal. One subject had bilateral blindness (complete loss of vision, developed over a three-year period); another had lost the use of one eye; and two others, including a boy four years of age, had less advanced ocular lesions. However, the microfilaria counts were relatively low among the population groups in which the lesions were found, and thus the onchocercal etiology of these lesions has not been confirmed.

Significant cutaneous lesions were observed at Coyowa-teri Mission. These included both acute lesions (multiple erythematous plaques) and chronic ones (extensive or generalized papular dermatitis with "elephant skin"), often accompanied by severe involvement of the femoral and inguinal lymph nodes. Several of these cases had led to a "hanging groin" picture of the sort previously reported only in Africa (1, 7).

Onchocercotic nodules were found in 33 of the 40 Coyowa-teri residents who tested positively for onchocerciasis (Table 3), although one of the 33, a four-year-old boy, was negative on biopsy. This proportion, 82.5 per cent, was considerably higher than that found in Parima, where 12 out of 45 subjects (26.7 per cent) had a total of 13 nodules. An even lower frequency was observed at Platanal, where the findings were limited to a single nodule on one of the nine subjects examined.

#### *Vector Species*

The predominant man-biting Simuliidae species near Parima Mission (altitude 850 meters) and at Coyowa-teri Mission (altitude 250 meters) was *S. pintoi*. *S. amazonicum* was found to be the predominant man-biting species at the Platanal and Boca

de Mavaca foci and also at Boca de Ocamo and Tama-Tama.

#### *Infestation Index*

The infective and developmental (sausage) forms of *O. volvulus* found in eight of 100 unstained *S. pintoi* specimens collected at Coyowa-teri Mission clearly demonstrate the role of this species as vector of the disease. It should also be noted that *S. pintoi* was the predominant man-biting simuliid found in the onchocerciasis focus at Auaris in Brazil's Federal Territory of Roraima. This focus was previously described on the basis of work done in 1974 (21). At that time it was not possible to determine the natural rate of vector infestation at Auaris, since no developmental stages of the parasite were found in the 178 specimens examined. Nevertheless, it may be assumed that the natural infestation index was far lower at Auaris than at Coyowa-teri Mission.

Only one infective (final) form of *O. volvulus* was found in 400 *S. amazonicum* females captured on the banks of the Orinoco at Platanal. By comparison, a slightly higher index of *S. amazonicum* infestation (0.75 per cent) was previously found in flies captured along the Toototobi river in Brazil's Amazonas State (20).

#### *Personnel Training*

Personnel from the Department of Public Health Dermatology, National Institute of Dermatology, and three auxiliaries appointed by the administration of the Federal Territory of Amazonas to be responsible for carrying out the programs of the Public Health Dermatology Service, participated alternately in the work of the investigation.

#### *Conclusions*

Previous epidemiologic study of onchocerciasis in Brazil (21) contributed to

analysis of the disease foci in Venezuela.

The traditional foci in the central and eastern parts of the country—both located mainly in the coastal highlands (13, 22)—fade out as they approach the southern parts of Monagas and Guárico states. This is attributed to changing ecologic conditions beyond the base of the highlands, together with disappearance of *S. metallicum* and *S. exiguum*, the two local vectors of the disease. To the south the great plains of Venezuela extend for hundreds of miles, criss-crossed periodically by the rivers of the Orinoco basin. Eventually the Amazon jungle begins, rising finally into the upper headwaters of these rivers, which is where the Yanomama groups reside.

This situation in terms of geography and the vectors suggests that there is no epidemiologic relationship between these traditional Venezuelan foci in the coastal highlands and the newly discovered focus in the Amazon region. In other words, the latter appears to be indigenous to the tropical forest area shared by Venezuela and Brazil—in the same way, in turn, that the Western Hemisphere foci appear to be indigenous and epidemiologically unrelated to those in Africa. In regard to this latter point, Mazzotti and others have felt—and Duke has recently confirmed (5, 6)—that the African foci are quite distinct in their etiology from those in Guatemala and along the Venezuelan coast.

Direct observation of the Amazon focus and analysis of its epidemiologic and clinical features likewise confirm that it is distinct from the coastal foci. The high positivity rates found at Coyowa-teri and Parima Missions and at Platanal contrast sharply with the much lower rates recorded in the traditional foci in the north, where, before the initiation of control measures, response to the Mazzotti test usually ranged between 3 and 10 per cent, rarely exceeding the latter figure.

The presence of severe skin lesions in 37.5

per cent of the Coyowa-teri subjects and of significant lymphatic involvement in 26.7 per cent (including four cases of “hanging groin”) also provide a marked contrast to the absence of such lesions in the coastal foci. Nor have the latter areas ever reported the progressive sclerosing keratitis which was observed at Platanal.

Similarly, before control measures were adopted in the coastal foci, onchocercal nodules were found in some 23 per cent of the patients examined—a proportion far smaller than the 82.5 per cent observed among the Coyowa-teri subjects.

The same kind of evidence that prompted the search for onchocerciasis in the Parima mountains, at Coyowa-teri Mission, and along the Upper Orinoco (21) now suggests that the Amazon focus must extend farther north toward the headwaters of the Ventuari, Merewari, Canaracuni, and Caura rivers and farther west toward the source of the Padamo.

Quite apart from the personal consequences suffered, the transmission of *O. volvulus* with such a high infestation index among small groups of primitive Indians scattered in a vast rain forest is a matter of real epidemiologic concern; the Indians, who are identified with the local environment, act as the reservoir of infection, and secondary cases have already occurred in missionaries in Brazil and Venezuela (10, 21).

The area in question is of particular importance because its development is called for in the national plan. Given the wide distribution—far beyond the zone investigated—of *S. amazonicum* and *S. pintoii*, which were found to be naturally infected by *O. volvulus* at Platanal and Coyowa-teri Mission, the implications are serious.

More than 10,000 individuals (4) inhabit the Venezuelan Yanomama territories. The area in which onchocerciasis was found—a triangle running from Parima to Boca de Mavaca to the Peñascal rapids (Figure 3)—

contains numerous Yanomama groups and a total of about 4,300 inhabitants, about 50 per cent of whom could be affected.

Anthropologist Napoleón Chagnon, who has been studying the population dynamics and other features of the Yanomamas since 1965, has reported (personal communication) that the various groups are becoming increasingly numerous, some more than others, in the wake of declining infant mortality. Moreover, they are spreading out, since as soon as a settlement reaches a

population of about 200, some of its people will move away and establish a new one.

Thus it is considered essential that a broad control program, with adequate human and material resources, be established in the affected area to combat onchocerciasis through case-finding and treatment of patients. If this is not done, the disease will frighten away settlers and a sizable portion of the Federal Territory of Amazonas will remain blocked to progress.

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#### SUMMARY

The discovery of onchocerciasis (river blindness) at sites in Brazil near the Venezuelan border prompted a survey of the Venezuelan area most likely to be affected. The localities investigated—small, scattered settlements of Yanomama Indians deep in the jungle—are situated in Venezuela's Federal Territory of Amazonas near the Parima mountains and the Upper Orinoco river.

Investigation in this area revealed a high prevalence of onchocercal disease in several localities. Skin biopsies and Mazzotti tests gave positivity rates ranging from 35.7 per cent, near the Mavaca Mission, to 88.9 per cent, in the neighborhood of the Coyowa-teri Mission. The average number of microfilariae observed per unstained biopsy specimen varied from 9.3 in Platanal to 18.8 at the Coyowa-teri Mission.

Several cases of disease were observed in children four to nine years of age. Two *Simulium* flies (*S. pintoi* and *S. amazonicum*) appear to be the predominant vectors of *Onchocerca volvulus* in the area surveyed.

Severe ocular lesions, including one case of total blindness, were observed at Platanal, but it is not certain that they were caused by onchocerciasis. On the other hand, numerous significant dermatologic lesions definitely attributable to the disease were found at the Coyowa-teri Mission. Several of these cases presented a "hanging groin" picture of the sort previously reported only in Africa. Nodules were found in

82.5 per cent of the infected Coyowa-teri subjects.

Epidemiologic analysis of this Venezuelan Amazon focus suggests that it is unrelated to the other traditional Venezuelan foci near the coast. At the same time, there are indications that the Amazon focus extends farther to the north and west, into the headwaters of several Orinoco tributaries not included in the present survey.

The area in question is scheduled for development under the national plan. The wide distribution of the two *Simulium* vectors of the disease is cause for concern. It is essential that a broad control program be established in the focal area, lest it become blocked to human settlement.

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