

CONTRIBUTION TO THE STUDY OF THE TOXOPLASMOSIS EPIDEMIOLOGY. SEROLOGIC SURVEY AMONG THE INDIANS OF THE UPPER XINGU RIVER, CENTRAL BRAZIL

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SUMMARY

The survey of antibodies to *Toxoplasma gondii* in 254 indians of the Upper Xingu River, Central Brazil, by means of indirect immunofluorescence revealed 51.6% of positive reactions, with titers equal or superior to 1/16. The aboriginal population of the Upper Xingu River is estimated in 600 indians, distributed into 9 tribes, living in a state of relative isolation maintaining their primitive habits and customs. The results have been compared with those of 2 other surveys made in different geographical areas of Brazil (in the Territory of Amapá and in the city of São Paulo), where the Authors have used a serologic technique superposable to the one used in our survey. The results of the Upper Xingu, in its whole, do not significantly differ — as one might suppose, considering the life conditions of the indian — from those observed in the Territory of Amapá and in the city of São Paulo, i.e. in populations of a more advanced degree of civilization.

INTRODUCTION

Toxoplasma gondii is a widespread parasite found both in the geographical and biological fields. In the animal kingdom it has been described as appearing in a great number of mammals and birds, domestic and wild. It has been identified as the cause of death of many zoo animals (RATCLIFFE et al.²² and MÖLLER²⁶), epizooties in lambs (BEVERLEY & MACKAY¹), wild rats (ELTON et al.¹¹), pigeons and rabbits (WIKTOR⁴¹) and chickens (ERICHSEN & HARBOE¹²; NOBREGA et al.²⁹).

The first observations that indicated the possibility of *Toxoplasma gondii* attacking man were made by CASTELLANI⁴, FEDOROVICH¹³, CHALMERS & KAMAR⁵, JANKU²³, MAGARINOS TORRES³⁸ and WOLF & COHEN⁴². Many other reports confirmed also the presence of

toxoplasmosis as a congenital or an acquired disease.

The introducing of the laboratory techniques permitting the serologic diagnosis of toxoplasmosis, which was initiated with the neutralization reaction described by SABIN & OLITSKY³³ in 1937, has brought a considerable contribution to the clinical diagnosis of this parasitosis and allowed the performance of serologic surveys. These demonstrated the existence of a great number of individuals, who although carrying antibodies to *Toxoplasma gondii*, presented no symptoms at all. Thus, in spite of the great dissemination of toxoplasma infection both in men and animals, was verified while toxoplasmosis as a disease is rather infrequent.

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Although 60 years have passed since the first description of the parasite (SPLENDORE³⁶ and NICOLLE & MANCEAUX²⁸, 1908) and a bulky scientific literature exists, the mechanism of transmission of *Toxoplasma gondii*, with the exception of the congenital form, is still unknown. The widespread distribution of the parasite suggests a simple, though highly active, way of transmission or even the existence of several mechanisms of transmission.

Reports based on researches of the prevalence of antibodies to toxoplasma in different human groups, along with the study of their habits and customs and of the existing ecologic factors, represent one of the ways to be attained for a better knowledge on the mechanism of the parasite transmission. Within this line of investigation, we have decided to study the indians of the Upper Xingu River, in Central Brazil. In view of the isolation in which it has lived, until recently, in the middle of a vast wild region this human group was able to preserve its primitive habits and customs. In the same way the fauna and flora of this region remain unchangeable. We believe the results we have observed in this indian group are worth of being compared with those of the surveys performed on populations presenting too different life conditions.

MATERIAL

The area denominated Upper Xingu is included in the Xingu National Park, an indian reserve situated in the north of the State of Mato Grosso, in Central Brazil. It is an area of transition between the Brazilian central plateau and the Amazon region, being located between 12° and 13° south latitude and 50° and 54° west longitude of Greenwich. The average altitude is 250 m. The maximum daily temperature runs, all through the year, between 26° and 34°C.

The Upper Xingu area was made into a safe refuge for some indian groups, in view of the difficulties the Xingu River presents to navigation, the long distances to cover and the existence of indian tribes hostile to civilized man. Its population is estimated in 600 indians (1966) distributed into 9 tribes:

Tribe	Linguistic Group
Aweti	Tupi
Kamaiura	Tupi
Iawalapiti	Aruak
Meinaku	Aruak
Waura	Aruak
Kalapalo	Caribe
Kuikuro	Caribe
Matipuhy	Caribe
Nahuquá	Caribe

According to VILLAS BOAS³⁹ the occupation of the Upper Xingu goes back to centuries. In 1887, VON DEN STEINEN³⁷ went through the region, finding it already inhabited by the above mentioned tribes. Contact among these tribes because of the long stay in the area and the frequency of intertribal marriages have bough about a similarity in their habits and customs, thus permitting that these tribes be considered a single indian group.

The "Instituto de Medicina Preventiva" of the "Escola Paulista de Medicina" has been studying this population, with the following purposes:

1) to determine the health condition of the Upper Xingu River indians; 2) to establish a prophylactic program adequate for their preservation.

Each tribe has its village, separated from the others by dozens of kilometers, and located by a river or lake which provides the indians with water. The villages are made up of many "ocas" (huts), thatched with sape grass, arranged in circles around a large yard, where their feats and ceremonies are performed.

In the indian villages there are no horses, donkeys, oxen, pigs, goats, rabbits or cats, exception made to the dog, which was introduced in the region in 1946 by the time of the Roncador-Xingu expedition.

Inside the ocas (huts) there are many birds, such as parrots, parrakeets and macaws, from which the indians take the feathers for the manufacture of headdresses, necklaces and ear-rings. They frequently keep small monkeys (*Cebus sp.*, *Saimiri sciureus*) inside the ocas. During the night several kinds of wild rats go into the ocas searching for scraps. Among the arthropods, cockroaches are found (*Periplaneta americana* and *Blatella germanica*). No domestic triatoma was observed.

A few wild muscids were found and only a small number of domestic flies (*Musca domestica*). Among the anophelines, the predominant species are, inside the oca *Anopheles (Nyssorhincus) darlingi*, and outdoors *Anopheles (Nyssorhincus) darlingi*, *Anopheles (Nyssorhincus) albitarsis* and *Anopheles (Arribalzagia) minor*. Tabanids, simuliidae and culicidae are also found.

The daily diet of the Upper Xingu River indian is mainly based on mainoc (*Manhiot sunculenta*) and fish and, less frequently, on maize (*Zea mays*), sweet-potato (*Ipomoea batatas*) and several wild fruits. The indians dislike hunting animals, but on some occasions they eat monkeys and, among birds, curassow (*Crax sp*) and jacu (*Penelope pileata*). The mothers breast-feed their children till the age of 3, their food being supplemented by manioc pap or boiled fish broth.

The Upper Xingu River indians live habitually naked, wearing only a few ornaments, such as necklaces and ear-rings. The men paint their bodies with a red ink, the urucum. The intertribal marriages are frequent, but the union between too near consanguineous relatives are not allowed. The minimum age observed among the married individuals was 18 years for the men and 14 for the women.

In our study on toxoplasmosis 254 indians were examined, distributed according to sex and age, as shown in Table I. The indian age was calculated roughly based on physical aspect, odontological examination and kinship.

TABLE I
Indians examined in the Upper Xingu, 1966.
Distribution according to age and sex

Age group	Men	Women	Total	
			no.	%
0 — 4	18	25	43	16.9
5 — 9	21	17	38	14.9
10 — 19	26	23	49	19.3
20 — 29	27	22	49	19.3
30 — 39	26	26	52	20.4
40 — 49	8	7	15	5.9
50 and more	4	4	8	3.1
Total	130	124	254	100.0

Clinical Examination

All the indians included in this report were submitted to clinical examination. As personal habits we registered the bath taken in rivers or lakes many times a day. The water for drinking and for preparing food is collected by the women in big clay pans either from river or lake close to the village. The indians defecate inside the wood.

The Upper Xingu indian has an athletic complexion and a well developed strong musculature. The determination of the stature and body weight of 118 adult indians revealed:

Men

Average stature:	1.620 m
Standard deviation:	0.051 m
Average body weight:	63.07 kg
Standard deviation:	7.11 kg

Women

Average stature:	1.500 m
Standard deviation:	0.047 m
Average body weight:	49.39 kg
Standard deviation:	5.58 kg

None of the individuals examined presented any symptom of goitre or remarkable ganglion enlargement, being observed a slight increase of the regional lymph nodes in 15 indians, specially in the ganglionic chains both submaxillary and inguinal. The blood pressure varied from 90 to 120 mmHg for the maximum and from 60 to 80 mmHg for the minimum. The splenomegaly was the occurrence more frequent in the clinical examination, as show the Table II, being accompanied by hepatomegaly in 66 cases.

TABLE II
Indians examined in the Upper Xingu River, Brazil Central, 1966. Distribution according age and Boyd's splenic index

Age (years)	Splenic index					Total
	0	1	2	3	4	
0 — 1	4	—	6	1	—	11
2 — 9	16	15	30	6	1	68
10 — 19	5	11	16	9	2	43
20 — 29	5	2	15	12	14	48
30 or more	9	8	20	19	14	70
Total	39	36	87	47	31	240

The examined children presented a good general health and no dystrophy or neurologic pathology was observed.

Along with the physical examination some laboratory health tests were performed. The blood count performed by Pío DA SILVA³⁵ in 69 indians revealed hemoglobin values inferior to 10% in only two indians and ferro-serum values below the normal in 4 indians (one women and 3 children). The leucocitary form indicated neutropenia in 52%, eosinophilia in 88% and lymphocytosis in 46%.

The survey on the intestinal parasitosis performed in 139 indians of the Upper Xingu River (D'ANDRETTA⁷) revealed the presence of ancylostomiasis in 81% of the examined individuals, *Ascaris lumbricoides* in 18%, *Enterobius vermicularis* in 13%, *Strongyloides stercoralis* in 11% and no eggs of *Trichuris trichiura* were observed. As for protozoans, *Entamoeba coli* appeared in 87% of the examinations, the *Histolytic* complex in 61%, *Iodamoeba butschlii* in 39%, *Endolimax nana* in 38%, *Giardia lamblia* in 29%, *Chilomastix mesnili* in 17% and *Balantidium coli* in only one case.

In studying the malaria occurrence in the region, D'ANDRETTA et al.⁸ performed a search of plasmodium in 127 indians by means of the examination of thick drops and thin smears. The search was positive in 70 indians, with the following distribution:

<i>Plasmodium vivax</i>	47.7%
<i>Plasmodium falciparum</i>	35.8%
<i>Plasmodium malariae</i>	16.4%

Still with the purpose of evaluating the malaria prevalence in the Upper Xingu River, we have searched for malaria antibodies in 23 sera of children under the age of 10 included in our survey on toxoplasmosis. The tests were performed at the Hygiene Department of the Catholic University of Nijmegen, Netherlands, where *Plasmodium fieldi* was used as antigen. As show by Table III, there was only negative reaction, considering 1/20 the initial dilution.

TABLE III

Occurrence of serum antibodies to plasmodium in 23 children of the Upper Xingu River, 1966, by the indirect immunofluorescence technique

Serum titer 1:	Frequency
< 20	1
20	2
40	5
80	5
160	6
320	3
640	1
Total	23

A great number of the individuals examined presented splenomegaly. The survey on entero-parasites, already mentioned, did not reveal *Schistosoma mansoni* eggs in any of the faeces samples. Visceral leishmaniasis, another eventual cause of splenomegaly, was not observed. These observations and the high prevalence of malaria in the region allow us to formulate the hypothesis that the high occurrence of splenomegaly in the Upper Xingu originated from the repeated malaria infections.

METHODS

The indians attended the examination in family groups. After the individual identification each indian was submitted to clinical and odontological examination and, finally, a blood sample was drawn.

The blood was put into dry tubes, the clot retraction occurring at room temperature. The serum was separated and put into sterile flasks and these kept in the freezer at 4°C for 4 to 5 days; afterwards they were shipped to São Paulo by plane, packed in refrigerated containers. Prior to being used they remained in the freezer at -20°C.

For the survey of the serum antibodies to the *Toxoplasma gondii* the indirect immuno-

fluorescence reaction was employed, according to the technique prescribed by CAMARCO², and used at the "Instituto de Medicina Tropical de São Paulo". Toxoplasmas from the MOC strain isolated by Dr. MARIA DEANE from one lymph node of a child with acute toxoplasmosis have been used. The toxoplasmas were obtained by peritoneal punch of previously inoculated mice. The antiglobulinic conjugates were prepared from immune sera of rabbits inoculated with human globulin solution obtained by the precipitation of sera with ammonium sulfate in half saturation. The globulines of the immune sera were marked with isothiocyanate of fluorescein (from Sylvana Company).

For the performance of the indirect immunofluorescence reaction the sera studied were diluted at the ratio of 4, from the 1/16 dilution through 1/4096 and, then, at the ratio of 2. As dealt with epidemiological survey the reactions with titers equal or superior to 1/16 were considered positive.

With the purpose of evaluation the possibility of reproducing our results, 30 sera were examined vagain one year later at the Hygiene Department of the Catholic University of Nijmegen, Netherlands, by means of the indirect immunofluorescence reaction. The antigen being the Deelen strain inoculated into the brain of mice, according to the technique described by VAN NUNEN & VAN DER VEEN³⁰. Table IV shows the results.

For the statistical analyses, in view of the natura of our data, we have chosen to use non-parametric tests. We have used the X² decomposition in the patterns prescribed by COCHRAN⁶ and the X² test in frames of 2 x 2 (association), employing when necessary the Fisher's exact method and having in mind the restrictions established by Cochran.

RESULTS

Of the 254 serum samples of the Upper Xingu River indians, submitted to the indirect immuno-fluorescence reaction for toxoplasmosis, 131 were positive, i.e. 51.6%, with titers equal or superior to 1/16. Table V shows the results according to age and titers.

a) *Results according to sex and age* — Among 130 men 61 positive reactions were obtained, i.e. 46.9%, while among 124 women there were 70 positive reactions, i.e. 56.5%. Table VI shows the distribution of the positive reactions in both sexes, according to age. To each class a symbol was attributed in order to facilitate the statistical analyses used (X² additive decomposition).

It was verified that in the 0-9 year group the proportion of positive reactions was significantly lower than in the 10 — 60 year group. There is no marked difference in the proportion of positives for each sex.

TABLE IV

Comparative results of tests with 30 sera of the indians from the Upper Xingu River, Central Brazil, examined for the determination of antibodies to *Toxoplasma gondii* by means of the indirect immunofluorescence technique in São Paulo, Brazil (1966) and Nijmegen, Netherlands (1967). Titer of reactions (1:)

		Nijmegen					Total
		Negative	64	256	1024	≥ 4000	
Titer of reactions (1):	São Paulo						
	Negative	7	—	—	—	—	7
	64	—	4	—	—	—	4
	256	—	1	—	2	—	3
	1024	—	1	2	4	—	7
	4000	—	—	2	3	1	6
	≥ 8000	—	—	—	2	1	3
Total	7	6	4	11	2	30	

BARUZZI, R. G. — Contribution to the study of the toxoplasmosis epidemiology. Serologic survey among the indians of the Upper Xingu River, Central Brazil. *Rev. Inst. Med. trop. São Paulo* 12:93-104, 1970.

TABLE V

Positive serological reactions for Toxoplasmosis, by means of the indirect immunofluorescence technique, according to age and titers, among indians of the Upper Xingu River, Central Brazil, 1966

Age group (years)	Sera examined	Titer of reactions (1:)								Positive reactions	
		16	64	256	1024	4000	8000	16000	32000	no.	%
0 — 4	43	2	5	3	1	1	1	—	1	14	32.6
5 — 9	38	5	2	2	3	2	—	1	—	15	39.5
10 — 19	49	8	6	6	5	2	2	—	—	29	59.2
20 — 29	49	7	2	9	7	—	—	—	—	25	51.0
30 — 39	52	2	4	13	9	3	1	—	—	32	61.5
40 — 49	15	—	3	3	4	—	—	—	—	10	66.7
50 or more	8	1	1	3	—	1	—	—	—	6	75.0
Total	254	25	23	39	29	9	4	1	1	131	51.6

TABLE VI

Proportion of the positive serological reactions, by means of the indirect immunofluorescence technique, according to sex and age groups, in indians of the Upper Xingu River, Central Brazil, 1966

Age group (years)	Men				Women			
	Examined	Positive	Ratio (+) (P)	Symbol	Examined	Positive	Ratio (+) (P)	Symbol
0 — 4	18	5	0,277777	T ₁	25	9	0,360000	T ₂
5 — 9	21	8	0,380952	T ₃	17	7	0,411764	T ₄
10 — 19	26	15	0,576923	T ₅	23	14	0,608695	T ₆
20 — 29	27	13	0,481481	T ₇	22	12	0,545454	T ₈
30 — 39	26	12	0,461538	T ₉	26	20	0,769230	T ₁₀
40 — 49	8	6	0,750000	T ₁₁	7	4	0,571428	T ₁₂
50 and more	4	2	0,500000	T ₁₃	4	4	1,000000	T ₁₄
Total	130	61	0,469230		124	70	0,564516	

$$X^2 = 22,762198 *$$

X²

$$13GL - 0,05 = 22,36$$

b) *Results according to reaction titers* — Table VII gives the distribution of the 254 sera, according to the reaction titers. From the 1/16 titer, 131 tests were positive and 123 negative.

TABLE VII
Serological reactions for toxoplasmosis by the indirect immunofluorescence technique, according to reaction titers, in indians of the Upper Xingu River, Central Brasil, 1966

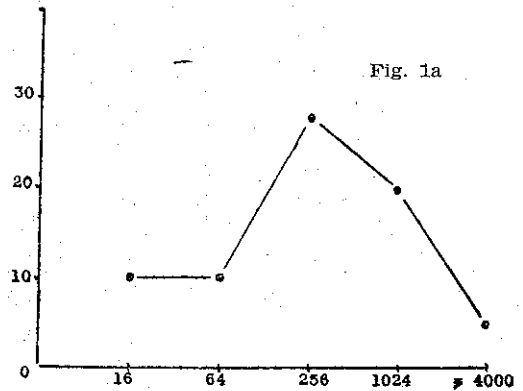
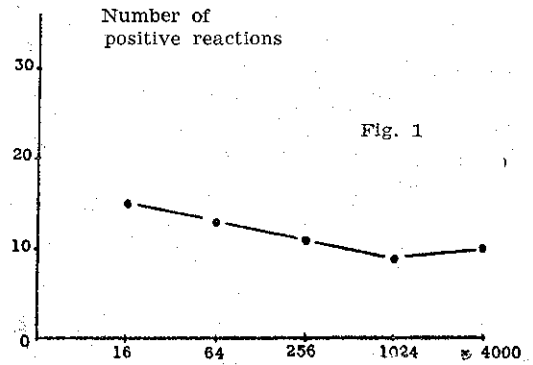
Reaction Titer (1:)	Sera examined	
	no.	%
< 16	123	48.4
16	25	9.8
64	23	9.1
256	39	15.4
1024	29	11.4
4000	9	3.5
8000	4	1.6
16000	1	0.4
32000	1	0.4
Total	254	100.0

A difference in proportion of the positive reactions, according to titers, was observed in individuals under and above the age of 20. Thus it was investigated through analyses whether the reactions of low titers (1/16 and 1/64), medium titers (1/256 and 1/1024) and high titers (1/4000 and above) occurred in the same proportions of the populations in the same proportions of the populations between the ages 0 — 19 and 20 — 60. Table VIII and Figs. 1 and 1a indicate the distribution of positive reactions according to titer, in the two above mentioned populations.

TABLE VIII
Proportion of the positive serological reactions by the indirect immunofluorescence technique, according to reaction titers and age, in indians of the Upper Xingu River, Central Brazil, 1966

Reaction titers (1:)	Individuals examined			P(0 - 20)
	0 — 19	20 - 60	Total	
16	15	10	25	0,600000
64	13	10	23	0,565217
256	11	28	39	0,282051
1024	9	20	29	0,310344
≥ 4000	10	5	15	0,666666
Total	58	73	131	0,442748

$\chi^2 = 13,094712$ * $\chi^2 = 9,49$
4GL - 0,05



Figs. 1 and 1a — Serological reactions to toxoplasmosis, according to reaction titers in 0 — 19 and 20 — 60 year groups, in indians of the Upper Xingu River, Central Brazil, 1966

The statistical analyses shows a significant difference in the two groups. There is a higher proportion of the reactions of medium titers (1/256 and 1/1024) in the second group (20 — 60 year), while in the 0 — 19 year group the reactions of low titers (1/16 and 1/64) and high titers (1/4,000 and above) are more frequent.

DISCUSSION

The study of the prevalence of infection by *Toxoplasma gondii* in men and animals is fundamentally based on the search of serum antibodies. In spite of the existence of many laboratorial techniques for the identification of antibodies to toxoplasma, we cannot count yet with an ideal reaction, perfectly standardized, of easy performance accessible to a great number of laboratories throughout the world.

The first observations on the use of the immunofluorescence techniques in toxoplasmosis were made by GOLDMAN²⁰, who developed the fluorescence inhibition technique²¹ for the search of antibodies to *Toxoplasma gondii*. KELEN et al.²⁴ used for the first time the indirect immunofluorescence technique in toxoplasmosis. Through the works of GARIN & AMBROISE-THOMAS¹⁷, CAMARCO³, FULTON & VOLLER¹⁶, VAN NUNEN & VAN DER VEEN³⁰ and WALTON et al.⁴⁰ it was possible to demonstrate that the results of the indirect immunofluorescence reaction are comparable to those obtained in the SABIN-FELDMAN³⁴ reaction, traditionally employed in toxoplasmosis. The specificity of the indirect immunofluorescence reaction for the search of antibodies to *Toxoplasma gondii* was pointed out by the works of FULTON & VOLLER¹⁶ and FLETCHER¹⁵.

The indirect immunofluorescence presents, in relation to the Sabin-Feldman test, the following advantages: it reduces the handling of the living toxoplasmas; it does not require the accessory factor present in fresh blood of determined individuals, which is always difficult to obtain and to maintain; it permits that a more rapid reading of the results of the test; it is a reaction of easy standardization, being possible to distribute the antigen and the conjugate from a central laboratory to smaller places.

We consider it justified the use of the immunofluorescence reaction in this survey, as well the comparison of our results with those obtained by many Authors who have employed the Sabin-Feldman reaction. The possibility of reproducing our results was demonstrated in Table IV when we compared the results of 30 sera examined in São Paulo and in Nijmegen, Netherlands.

There was an agreement in the results: 23 positive and 7 negative. As for the positive sera, 18 presented the same titer or variation of one dilution at the ratio of 4, the remaining 5 sera presented a difference of two dilutions. This agreement may be considered satisfactory, considering the technical differences, the use of toxoplasmas from different strains and the interval between the two reactions.

The serologic survey performed on 254 indians of the Upper Xingu River, by means

of the indirect immunofluorescence technique, revealed 51.6% of reactions with titers equal or superior to 1/16.

FELDMAN & MILLER¹⁴, in 1956, examined 10 human groups, including individuals of healthy aspect, using the Sabin-Feldman reaction, starting from 1/16, with the following results:

Population	Sera examined	Positives %
Esquimó	21	0
Indios Navajos	236	4
Islandia	108	11
Portland, U.S.A.	293	17
St. Louis, U.S.A.	184	26
New Orleans, U.S.A.	270	31
Pittsburg, U.S.A.	144	35
Haiti	104	36
Honduras	266	64
Tahiti	121	68

GIBSON et al.¹⁸ starting from 1/16 have found 21.8% of positive among 987 negroes of Tennessee, U.S.A. GIBSON & COLEMAN¹⁹ starting from the 1/4 dilution, had 94% of positive results in Guatemala and 88.5% in Costa Rica. LUNDE & JACOBS²⁵ starting from 1/16 had 54.4% of positives results in Trinidad and MORALES et al.²⁷ 92% in Easter Island.

DELASCIO¹⁰ in the city of São Paulo, has observed among normal pregnant women 42% of positive results to the Sabin-Feldman reaction, starting from 1/4 titer. NUSSENZWEIG³¹, also in the city of São Paulo, has registered 71.2% of positives among blood donors, starting from the 1/16 titer.

In particular, we have preferred to compare our results of the Upper Xingu River with those registered in two other surveys carried out in Brazil. In the first performed by DEANE et al.⁹, 1963, in the Territory of Amapá, in the extreme north of Brazil, including 354 individuals whose age was above 10, the percent of positive tests was 68.1%. The second, performed by JAMRA²², in 1964, on 300 individuals living in the city of São Paulo, yielded 67% of positive results. In both surveys the Sabin-Feldman reaction was used, starting from the 1/16 dilution and toxoplasmas of the MOC strain were employed as antigen.

The results of the toxoplasmosis surveys performed in the Upper Xingu River, Amapá and São Paulo are given in Tables IX and in Fig. 2.

Those are quite different regions, with human groups differing as to ethnical formation and customs and habits. In comparing the results observed in the Upper Xingu River

TABLE IX

Percentual of Positive Serological Reactions for Toxoplasmosis in inhabitants to Amapá (DEANE et al.), of city of São Paulo (JAMRA) and to Upper Xingu River (BARUZZI)

Age group (years)	Amapá		São Paulo		Xingu	
	Examined	Positive %	Examined	Positive %	Examined	Positive %
0 — 4	—	—	18	11.1	43	32.6
5 — 9	—	—	20	25.0	38	39.5
10 — 19	112	54.5	53	39.6	49	59.2
20 — 29	117	69.2	56	76.7	49	51.0
30 — 39	64	82.8	67	79.1	52	61.5
40 — 49	22	68.2	41	82.9	15	66.7
50 or more	39	79.5	45	95.5	8	75.0
Total	354	68.1	300	67.0	254	51.6

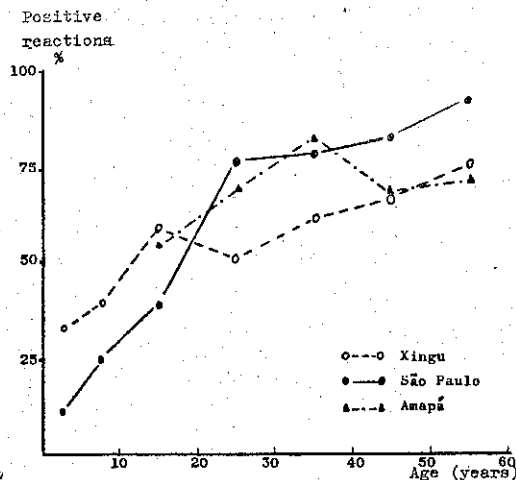


Fig. 2 — Percentile distribution of the positive serum reactions to toxoplasmosis, according to age, registered in the Upper Xingu River (1966), Amapá (DEANE et al., 1963) and São Paulo (JAMRA, 1964)

with those registered in Amapá (DEANE et al.⁹), within the same age groups, we have verified that there is a smaller proportion of positive reactions, statistically significant, in the Upper Xingu River in the 20 — 29 and 30 — 39 year groups.

The same comparative study was performed between the Upper Xingu River and São Paulo (JAMRA²²). A significant difference was registered only in the 20 — 29 year group, with a smaller proportion of positive reactions among the indians.

In verifying the behaviour of the positive reactions according to the reaction titer, 1/256 was the most frequently observed titer in all three regions, representing 29.8%, 34.4% and 34.8% of the total of positive reactions, respectively. The first 4 dilutions (1/16 to 1/1024 titers) encompass 88.5% of the positive reactions in the Upper Xingu River, 83.4% in Amapá and 92% in São Paulo. The highest titer registered in the Upper Xingu River and in São Paulo was 1/32000 and in Amapá 1/64000.

As for sex, we found in the Upper Xingu River 46.9% of positive reactions among men and 56.5% among women. In Amapá, DEANE et al.⁹ observed 71.2% of positive reactions in men and 66.5% in women. In São Paulo, JAMRA²² registered 63% of positive reactions among men and 69.6% among women. The statistical analysis of the results among the indians did not show a significant difference between sex, in different age groups. The results we have presented are similar to those already published in the literature, showing that in toxoplasmosis there is no predominance of positive reactions in relation to sex and that the differences eventually registered demonstrate occasional variations.

The titers of the reactions in two age groups, 0 — 19 and 20 — 60 years of age, are shown in Figs. 1 and 1a. We believe that the different results obtained, deserve more attention as they may suggest new hypothesis to explain certain peculiarities of toxoplasmosis in respect to transmission and pathogenesis.

CONCLUSIONS

The results of the Upper Xingu River do not significantly differ from those observed

in two Brazilian populations of a more advanced degree of civilization: Amapá (DEANE et al.⁹) and São Paulo (JAMRA²²). The observed differences are not sufficiently large to admit the existence of a different epidemiology structure for the toxoplasmosis in the Upper Xingu River, in relation to Amapá and São Paulo.

Our results allow us to state that the civilized habits do not have influence on the prevalence of the antibodies to the toxoplasma.

RESUMO

Contribuição para o estudo epidemiológico da Toxoplasmose. Levantamento sorológico em índios do Alto Xingu, Brasil-Central

A pesquisa de anticorpos ao *Toxoplasma gondii* em 254 índios do Alto Xingu, Brasil Central, pela técnica da imunofluorescência indireta revelou 51,6% de reações positivas de título igual ou superior a 1/16. A população indígena do Alto Xingu é avaliada em 600 índios, distribuídos por nove tribos, que vivem em relativo estado de isolamento mantendo muito de seus hábitos e costumes primitivos. Os resultados foram comparados com os de outros dois inquéritos realizados em áreas geográficas diferentes do Brasil (no Território do Amapá e na cidade de São Paulo), nos quais os Autores utilizaram técnica sorológica superponível àquela empregada por nós. Os resultados do Alto Xingu, no seu conjunto, não diferem de forma acentuada, como se poderia supor pelas condições de vida do índio, daqueles observados no Amapá e São Paulo, em populações com graus de civilização mais avançados.

ACKNOWLEDGMENTS

Our thanks are due to Brazilian Air Force for transportation by air and especially to Claudio and Orlando Villas-Boas who made this inquiry possible.

REFERENCES

1. BEVERLEY, J. K. A. & MACKAY, R. R. — Ovine abortion and toxoplasmosis in the East Midlands. *Vet. Rec.* 74:499-501, 1962.

BARUZZI, R. G. — Contribution to the study of the toxoplasmosis epidemiology. Serologic survey among the indians of the Upper Xingu River, Central Brazil. *Rev. Inst. Med. trop. São Paulo* 12:93-104, 1970.

2. CAMARGO, M. E. — Improved technique of indirect immuno-fluorescence for serological diagnosis of toxoplasmosis. *Rev. Inst. Med. trop. São Paulo* 6:117-118, 1964.
3. CAMARGO, M. E. — Estudo comparativo das reações de Sabin-Feldman e de imuno-fluorescência indireta, para o toxoplasma, em 1.000 soros humanos. Comportamento anômalo de alguns soros. *Rev. Inst. Adolfo Lutz* 24:1-26, 1964.
4. CASTELLANI, A. — Note on certain protozoal-like bodies in a case of protracted fever with Splenomegaly. *J. Trop. Med. Hyg.* 17:113-114, 1914.
5. CHALMERS, A. J. & KAMAR, A. — *Toxoplasma pyrogenes* Castellani 1913. *J. Trop. Med. Hyg.* 23:45, 1920.
6. COCHRAN, W. G. — Some methods for strengthening the common X² test. *Biometrics* 10:417-451, 1954.
7. D'ANDRETTA Jr., C. — Inquérito de enteroparasitoses dos indígenas do Parque Nacional do Xingu (Em publicação).
8. D'ANDRETTA Jr., C.; BARUZZI, R. G.; SOUZA DIAS, L. C.; PENTEADO Jr., H.; KAMEYAMA, I. & SARMENTO, M. F. — Inquérito epidemiológico de malária do Parque Nacional do Xingu (Em elaboração).
9. DEANE, L. M. et al. — Inquérito de toxoplasmosse e tripanossomiase realizado no Território do Amapá pela III Bandeira Científica do Centro Acadêmico "Oswaldo Cruz" da Faculdade de Medicina da Universidade de São Paulo. *Rev. Méd. (São Paulo)* 47: 1-12, 1963.
10. DELASCIO, D. — Toxoplasmosse congênita (Aspectos clínicos obstétricos e experimentais). *Matern. Infanc.* (São Paulo) 15:179-532, 1956.
11. ELTON, Ch.; DAVIS, D. H. S. & FINDLAY, G. M. — An epidemic among voles (*Microtus agrestis*) on the Scottish border in the Spring of 1934. *J. Anim. Ecol.* 4:277-288, 1935.
12. ERICHSEN, S. & HARBOE, A. — Toxoplasmosis in chickens. I — An epidemic outbreak of toxoplasmosis in a chicken flock in south-eastern Norway. *Acta Path. Microbiol. Scand.* 33:56-71, 1953.
13. FEDOROVITCH, A. I. — Hémoparasites trouvés dans un cas de fièvre chronique. *Ann. Inst. Pasteur (Paris)* 30:249-250, 1916.
14. FELDMAN, H. A. & MILLER, L. T. — Serological study of toxoplasmosis prevalence. *Amer. J. Hyg.* 64:320-335, 1956.
15. FLETCHER, S. — Indirect fluorescent antibody technique in the serology of *Toxoplasma gondii*. *J. Clin. Path.* 18:193-199, 1965.
16. FULTON, J. D. & VOLLER, A. — Evaluation of immunofluorescent and direct agglutination methods for detection of specific toxoplasma antibodies. *Brit. Med. J.* 2:1173-1175, 1964.
17. GARIN, J. P. & AMBROISE-THOMAS, P. — Le diagnostic sérologique de la toxoplasmosse par la méthode des anticorps fluorescents (technique indirecte). *Presse Méd.* 71:2485-2488, 1963.
18. GIBSON, C. L.; EYLES, D. E.; COLEMAN, N. & SMITH, C. S. — Serological response of a rural negro population to the Sabin-Feldman cytoplasm-modifying test for toxoplasmosis. *Amer. J. Trop. Med.* 5:772-783, 1956.
19. GIBSON, C. L. & COLEMAN, N. — The prevalence of *Toxoplasma* antibodies in Guatemala and Costa Rica. *Amer. J. Trop. Med.* 7:334-338, 1958.
20. GOLDMAN, M. — Staining *Toxoplasma gondii* with fluorescein-labelled antibody. I — The reaction in smears of peritoneal exudate. *J. Exp. Med.* 105:549-556, 1957a.
21. GOLDMAN, M. — Staining *Toxoplasma gondii* with fluorescein-labelled antibody. II — A new serologic test for antibodies to toxoplasma based upon inhibition of specific staining. *J. Exp. Med.* 105:557-573, 1957b.
22. JAMRA, L. M. F. — Contribuição para a Epidemiologia da Toxoplasmosse. Inquérito em 100 famílias de uma área da cidade de São Paulo, Tese. São Paulo, Faculdade de Medicina da Universidade de São Paulo, 1964.
23. JANKU, J. — Pathogenesis and pathological anatomy of coitobomo of the macula lutea in an eye of normal dimensions and in a microphthalmic eye with parasites in the retina. *Cas. Lék. Cesk.* 62: 1021, 1054, 1081, 1111, 1139, 1923.
24. KELEN, A. E.; AYLLON-LEIDL, L. & LABGOFFSKY, N. A. — Indirect fluorescent antibody method in serodiagnosis of toxoplasmosis. *Canad. J. Microbiol.* 8:545-554, 1962.
25. LUNDE, M. N. & JACOBS, L. — A comparison of results of hemagglutination and dye tests for toxoplasmosis in a survey of Trinidad Natives. *Amer. J. Trop. Med.* 7: 523-525, 1958.

BARUZZI, R. G. — Contribution to the study of the toxoplasmosis epidemiology. Serologic survey among the indians of the Upper Xingu River, Central Brazil. *Rev. Inst. Med. trop. São Paulo* 12:93-104, 1970.

26. MÖLLER, T. — Three casuiste reports of toxoplasmosis in Zoo-Animals (*Macropus bennetti*, *Marmota marmota*, *Lepus timidus*) Nord. *Vet. Med.* 14:233-243, 1962.
27. MORALES, A.; MOSCA, A.; SILVA, S.; SIMS, A.; THIERMANN, E.; KNIERIM, F. & ATIAS, A. — Estudio sorológico sobre toxoplasmosis y otras parasitosis in Isla de Pascua. *Bol. Chile. Parasit.* 41:82-87, 1961.
28. NICOLLE, C. & MANCEAUX, L. — Sur un protozoaire nouveau du gondii: toxoplasma. *Arch. Inst. Pasteur (Tunis)* 2:43-50, 1909.
29. NOBREGA, P.; TRAPP, E. & GIOVANNONI, M. — Toxoplasmosis espontânea da galinha. *Arch. Inst. Biol.* 22:43-50, 1955.
30. NUNEN, M. C. J. van & VEEN, J. van der — Examination for toxoplasmosis by the fluorescent antibody technique. *Trop. Geogr. Med.* 17:246-253, 1965.
31. NUSSENZWEIG, R. S. — Toxoplasmosis. Inquérito sorológico feito pela prova do co-rante em doadores de sangue. *Hospital (Rio)* 51:723-728, 1957.
32. RATCLIFFE, H. L. & WORTH, C. B. — Toxoplasmosis of captive wild birds and mammals. *Amer. J. Path.* 37:655-667, 1951.
33. SABIN, A. B. & OLITSKY, P. K. — Toxoplasma an obligate intracellular parasitism. *Science* 85:336-338, 1937.
34. SABIN, A. B. & FELDMAN, H. A. — Dyes as microchemical indicators of a new immunity phenomenon affecting a protozoan parasite (Toxoplasma). *Science* 108:660-663, 1948.
35. SILVA, M. P. da — Contribuição para o estudo do sangue periférico e da medula óssea em índios do Alto Xingu. Tese. São Paulo, Escola Paulista de Medicina, 1966.
36. SPLENDORE, A. — Un nuovo protozoa parassita de'conigli incontrato nelle lesioni anatomiche d'una malattia che ricorda in molti punti il Kala-azar dell'uomo. *Rev. Soc. Sci.* 3:109-112, 1908.
37. STEINEN, K. von den — Entre os aborígenes do Brasil Central, 1887. Texto alemão em 1894. Trad. Depart. *Cultura (São Paulo)*, 1940.
38. TORRES, C. M. — Sur une nouvelle maladie de l'Homme, caractérisée par la présence d'un parasite intracellulaire, très proche du toxoplasma et de l'encephalitozoon, dans le tissu musculaire cardiaque, les muscles du squelette, le tissu cellulaire souscutané et le tissu nerveux. *C. R. Soc. Biol. (Paris)* 97:1778-1781, 1927.
39. VILLAS BOAS, O. & VILLAS BOAS, C. — Comunicação pessoal. Livro em elaboração, 1968.
40. WALTON, B. C.; BENCHOFF, B. M. & BROOKS, W. H. — Comparison of the indirect fluorescent antibody test and methylene blue dye test for detection antibodies to *Toxoplasma gondii*. *Amer. J. Trop. Med.* 15: 149-152, 1966.
41. WEKTOR, T. J. — Toxoplasmosis animale. Sur une épidémie des lapins et des pigeons à Stanleyville (Congo Belge). *Ann. Soc. Belge Med. Trop.* 30:97-107, 1950.
42. WOLF, A. & COWEN, D. — Granulomatus encephalomyelitis due to an encephalitozoon (*Encephalitozoic encephalomyelitis*). A new protozoan disease of man. *Bull. Neurol. Inst. (New York)* 6:306-371, 1937.

Recebido para publicação em 3/9/1969.