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PARASITIC LOAD IN SOUTH AMERICAN TRIBAL POPULATIONS

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1. HOST-PARASITE RELATIONSHIPS AT DISTINCT SOCIOCULTURAL SETTINGS

The relationship between humans and their parasites is as old as our species, and involves subtle interactions. Dunn (1968) has aptly classified this relationship using two dichotomies. First, we can consider whether the infections occurred by sexual or asexual organisms; and second whether they need a vector or not (indirect or direct infections, respectively). Asexual infections may be introduced into a population by a single dose in a single individual, and multiplication in the community occurs most readily if the agent is rare. Examples of indirect asexual infections are malaria and yellow fever; of direct asexual infections are measles and smallpox.

Sexual infections cannot normally be introduced into new populations by single doses, and the agents multiply more readily if they occur in large numbers. Indirect sexual infections involve many of the helminthiases; direct sexual infections are not numerous, but they include the well-known helminth *Enterobius vermicularis*. Asexual infections are generally more immunogenic than sexual ones.

The study of the effects of infection in bones and mummified tissues, as well as of archeological data, can be of value in assessing prehistoric relationships (Fonseca, 1970; Ferreira et al., 1982). On the other hand, it should be borne in mind that the host-parasite relations evolve, and the view that commensalism (peaceful coexistence) should be the ideal evolutionary end point for both host and parasite was recently questioned by Ewald (1983). After considering several pieces of evidence he concluded that (a) Diseases transmitted by biting, terrestrial arthropods are more severe than those transmitted without vectors; and (b) Among vector-transmitted parasites, severity is positively associated with the degree to which humans are used as vertebrate hosts.

Another angle was considered by Damian (1964). He examined in what way antigen sharing by parasite and host("molecular mimicry") could influence their coevolution. This author introduced the term "eclipsed antigen" for an antigenic determinant of parasite origin which resembles an antigenic determinant of its host, and reviewed cases of such antigens in helminths, bacteria and viruses.

Fix (1984) developed a Monte Carlo simulation based on the

Semai Senoi of Malaysia, that is similar to that seen among unacculturated South American Indians (small nomadic groups, with frequent fissions and fusions; see Neel and Salzano, 1967). He verified how epidemics of infectious diseases would affect the genetic microdifferentiation of these groups, and therefore their rate of evolution.

In what way cultural practices could influence the pattern of diseases seen in a given group? This question has been considered by many investigators, examples of them being Alland (1966) and Garruto (1981). The first stressed the importance of considering the cognitive system as it relates to disease theory, as well the role of the medical practitioner. Garruto (1981) examined the natural history of several types of diseases in isolated groups: infections (endemic and epidemic), nutritional, toxic or deficiency states, genetic disorders and congenital anomalies, and culturally specific psychoses.

The different factors involved in the acculturation process have been classified by Salzano (1985), who also discussed some specific cases among South American Indians. The interactions between nutrition and infection have been considered by Dubos (1965) and Holmes (1984), the latter presenting specific examples from Venezuela. The need for global evaluations was stressed by Ross (1978), who discussed food taboos, diet and hunting strategies among the Ecuadorian Jívaro. This ecological approach was followed in an investigation of four Brazilian tribes (Mekranoti, Xavante, Bororo and Kanela), described by Gross et al. (1979), Werner et al. (1979) and Flowers et al. (1982). It is clear that only through such integrated studies will we be able to at least partially understand the many factors which influence disease patterns at this sociocultural level.

2. DATA FROM SOUTH AMERICA

2.1. *Introduction*

Although the literature on the health of South American Indians is already voluminous, few attempts have been made to interpret them in more general terms. In what follows I will review some of these data, with the hope of providing background for more meaningful analyses. The extensive investigations of F.L. Black and coworkers will not be presented, since it is expected that he will also participate in this symposium, summarizing his own findings. The data on the prevalence of tuberculosis among these Indians was reviewed recently (Salzano, 1985) and will not be considered again.

2.2. *General health surveys*

General observations about the Amerindian health, without quantitative data, are numerous and one such study can be traced to as early as the end of the last century (Ranke, 1898). Table 1 summarizes the 12 studies I could find in which a more systematic and comprehensive approach was followed. They involved 15 tribes and one group of tribes (the Xingu Indians of Brazil), in six countries, and included 3,555 individuals. If the items of a thorough physical examination are classified in 13 categories, it will be seen that not all of these individuals were examined with equal detail; however, in 12 of the 14 samples the number of items examined systematically was seven or more. Skin tests were concomitantly performed in eight of the 14 surveys, and almost all of them involved at least one laboratory study on blood. Stool and urine studies were also done in six of them.

While the majority of the tribes lived in a tropical environment, one (the Aymara) inhabited the highlands of Chile, and three others (Alacaluf, Ona, Yamana) the cold southern tip of this same country. The types of pathologies observed among these four tribes, however, did not show marked departures from those seen in the other groups. Moreover, Damianovic (1948) observed differences in the state of health of the Ona and Yamana on one hand, and the Alacaluf on the other at the time of his investigation. The latter showed lower frequencies of caries and tuberculosis infection , but higher prevalences of syphilis, scabies and pyoderma.

The most important disease in the majority of the tropical tribes is malaria. Tuberculosis infection was documented in most of them also, with and without the occurrence of active forms of the disease. The immunological system of individuals from these groups is being subjected to a constant challenge, and this is manifested by high gamma-globulin levels, observed in several of them. Other health problems mentioned frequently are epidemics of influenza, measles and whooping cough.

I have personally participated of the investigations in the

Xavante and Cayapo, and can attest to the difficulty of establishing generalizations about the health of these populations. For instance, 12% of the 209 Xavante Indians seen at the village of Simões Lopes presented a diffuse, non-toxic goiter, completely absent in the 78 inhabitants examined in another community (São Domingos) of the same tribe. The marked difference in the prevalence of diseases in men and women found among the Xavante, on the other hand, did not occur among the Cayapo. The latter showed skin problems of varying degrees of magnitude (about one-half had scabies or a dermatitis like condition), ailments practically absent among the Xavante.

2.3. *Intestinal parasites*

Results related to 18 studies which investigated the prevalences of intestinal parasites in South American Indian populations, including 2,071 individuals, are presented in Table 2. There is wide variation both among different tribes and among villages within a tribe. Considering first the helminths, it will be seen that six of the 21 values presented there for *Trichuris trichiura* (29%) lie in the interval of 91% - 100%. About half of those related to *Ancylostoma duodenale* occur in the range between 71% and 100%, while two-thirds of those dealing with *Ascaris lumbricoides* fall in the interval between 31% and 70%. *Strongyloides stercoralis* is much less frequent (highest prevalence of 33% among the Surui), while *Enterobius vermicularis*, *Taenia sp*, *Hymenolepis nana* and *Capillaria sp* have been reported only sporadically.

Considering now the protozoans, Table 2 indicates that six species occur most frequently, the respective most common intervals of prevalences being as follows: *Entamoeba coli*, 62% of the percentages between 31% and 70%; *Giardia lamblia*: 95% in the interval between 1% and 30%; *Entamoeba histolytica*: 59% also between 1% and 30%; *Endolimax nana*: 85% between 11% and 40%; *Iodamoeba butschlii*: 71% between 11% and 30%; *Chilomastix mesnili*: 64% between 1% and 20%. The remaining species (*Trichomonas hominis*, *Balantidium coli*, *Entamoeba hartmanni*, *Enteromonas homini* and *Dientamoeba fragilis*) are much less common, and were detected in a few surveys only.

What generalizations can be presented related to these results? There has been some discussion about the presence of *Ascaris lumbricoides* and *Ancylostoma duodenale* in precolumbian Indians, the evidence for or against this presence being unfortunately mostly indirect and inconclusive. Allison et al. (1974) reported the presence of *Ancylostoma duodenale* in a Peruvian mummy dating around 900 AD, while Ferreira et al. (1980, 1983) also found indications of ancylostomids in archeological material and a Brazilian mummy dated as being about 3500 years old. These observations, therefore, suggest that at least infections with *Ancylostoma duodenale* could have existed in the continent before the Conquest, what raises an interesting question. Fonseca (1970) asserts that if this was true, the parasites could not have been carried by human migrations accross the Bering Strait, since the larval forms could not have resisted the low temperatures of the soil.

The prevalences observed may have been influenced by many factors, such as: (a) Diagnostic methods; (b) Level of parasitemia; (c) Age structure of the subjects tested; (d) Nutrition; (e) Level of sanitation; (f) Cultural practices; (g) Treatment. These factors may interact in complex ways, making generalizations difficult. But examples of meaningful approaches exist. Schwaner and Dixon (1974), for instance, considered the prevalences of helminthiasis in two communities of Ticuna Indians as a measure of cultural change. Modernization in one of them contributed to a reduced incidence and worm burden in the inhabitants. On the other hand, they mentioned that the Cofan Indians of eastern Ecuador use a hallucinogenic drug (prepared from the plant *Banisteriopsis rusbayana*) which was shown to contain antihelminthic properties. Holmes (1984) was surprised to find that intestinal parasitism did not significantly affect the nutritional status of the Rio Negro and Yanomama Indians studied by her. What is still lacking, however, are more analytical analyses relating types and levels of parasitism to other quantifiable indicators of cultural change. It is still unclear, for instance, whether hunter and gatherers with rudimentary agriculture are less or more infected than agriculturalists, in the absence of therapeutic measures, although we could guess that they would probably have lower burdens.

As an example of the investigation of bacterial intestinal parasites, mention can be made of the study of Eveland et al. (1971). They found a wide spectrum of known pathogenic and non-pathogenic strains of *Escherichia coli* among Yanomama Indians living in northern Brazil, but in addition 13 serotypically unique 0 strains. This is a striking finding, since only 147 previously recognized 0 serotypes of this microorganism have been found in a very large number of isolates from samples obtained in all parts of the world.

2.4. *Filariasis*

Search for microfilariae was performed in 18 samples, including a total of 13,073 individuals (Table 3). As would be expected,since *Mansonella ozzardi* is the only autochthonous filaria species in the continent, this parasite is the most common of the microfilariae found in South American Indians. The prevalences vary from zero to as high as 96%, without a clear clustering of values. It should be pointed out, however, that part of this variation may be due to technical problems. For instance, Lawrence et al. (1979b) obtained higher prevalences of this filaria in villages of Amazonian Indians examining peripheral blood lymphocyte culture preparations not specifically designed for the purpose of detecting the parasite than with conventional smears. This was probably due to the concentration effect inherent to the lymphocyte method. *Dipetalonema perstans* occurs in some populations together with *M. ozzardi*; but their detection (and that of *Wuchereria bancrofti*) is made more difficult because they migrated to the peripheral blood circulation at night only (while *M. ozzardi* do not show this periodicity). Skin biopsies also furnish underestimates of the true prevalence of this last parasite (Moraes et al., 1978).

Since both *D. perstans* and *W. bancrofti* were probably introduced in the continent through individuals of African ancestry, their presence may be an indicator of contacts with people of this extraction. But the situation, in each case, should be examined considering the presence of vectors, that may be different in diverse regions. Another question that has been considered is whether a single species of vector may transmit more than one type of filaria (Orihel, 1967). Time trends are also important. For instance, the latter author asserts that *D. perstans* and *M. ozzardi* are not as prevalent among Guyanese Amerinds now as they apparently were 70 years ago.

Onchocerciasis had never been found in Brazil until the end to the sixties and beginning of the seventies. In mid - 1973 M.A.P. Moraes and colleagues discovered the infection among groups of Yanomama Indians living along the left bank of the Tootobi river. Since a pioneer highway which was being opened through the jungle passed near the region inhabited by these Indians, the possibility that the disease might rapidly spread became a reality; and work by Rassi et al. (1976) proved this to be true. They discovered two other foci of the infection in Brazil and its spread to the Makiritare Indians. Just to illustrate the rapidity of the spread of the disease, it might be mentioned that our team of investigators had performed in 1966/67 thorough physical examinations (including eye observations) in villages situated in the regions of two of these foci, without finding signs of the disease (Salzano and Neel, 1976). This situation is of extreme practical and theoretical interest, since documentation can be made of the way this disease may spread, and how measures could be taken to erradicate it before it becomes a public health problem.

2.5. *Malaria*

Since, as was indicated before, malaria is one of the main health hazards faced by South American Indians (as well as by a very large fraction of non-Indians living in the tropics) it is surprising to find how little has been published on the prevalence and other aspects of this disease in these people. Table 4 lists the four studies I could locate. While *Plasmodium vivax* and *P. falciparum* are the most important infectious agents among the Xingu Indians, *P. malariae* is the most frequent parasite among the Campa. The latter finding is interesting, since in general *P. malariae* is much less frequent than the other two species. The isolation of the Campa, and conditions especially favorable to the reservoir (which may be animal) and vector of this microorganism may be responsible for the finding. Since it is believed that *P. falciparum* was not present in the Americas before the 15th century, its occurrence among Indians reflect contact with people of European or African descent.

Baruzzi et al. (1976) investigated the role that malaria may play in the occurrence of the so-called Tropical Splenomegaly Sindrome among the Xingu Indians. The sindrome is characterized by the presence of a persistently large spleen, hepatic sinusoidal lymphocytosis, and disproportionate elevation of serum Ig M levels, as well as malaria antibody titers. As a rule the Indians with these characteristics do not demonstrate limitation of their physical activity, but after acute episodes of hemolysis they may present physical prostration, intense anemia, as well as increase in reticulocyte counts and bilirrubin levels. Death may occur in the most severe cases.

2.6. *Toxoplasmosis*

Toxoplasma gondii has been shown to be almost cosmopolitan in distribution, and numerous serologic surveys have revealed that infection with this parasite is common in both man and animals. The prevalences found in seven studies of South American Indians are presented in Table 5. The frequencies vary all the way from 25% to 100%. Among the Xavante Weinstein et al. (1967) found an adult with the type of inactive chorioretinitis often associated with congenital toxoplasmosis. The mode of transmission of this parasite is still obscure. Lovelace et al. (1978) attributed the low prevalence found in some Ticuna communities to their dietary preference for fishing and the unimportance of hunting and animal husbandry to their culture and economy; other authors concur with the opinion that the ingestion of meat may be an important epidemiological factor in the spread of the infection.

2.7. *Papovaviruses*

Eight Brazilian and one Paraguayan Indian populations have been studied for the prevalences of JC and BK papovaviruses (Table 6). The frequencies range from 0% to 8% for the first and 0% to 28% for the latter. These values are much lower than those found in other populations, where percentages as high as 75% were reported for JC and 89% for BK in apparently normal individuals (Brown et al., 1975). These viruses are interesting, because they can exist in man as a latent infection. Transmission may be through urinary contamination, since urine has been the source of most isolations of the BK virus. The two types seem to behave independently at the population and individual level.

2.8. *Hepatitis B antigen*

Shortly after the discovery of the Australia antigen (hepatitis B antigen, HB Ag), seroepidemiological studies in various parts of the world indicated that its prevalence among apparently healthy tropical African and Southeast Asian populations was generally between 5% and 20%, whereas in Europeans, North Americans and Brazilians was less than 1% (Salzano and Blumberg, 1970). The results obtained among several South American Indian populations is shown in Table 7. The prevalences found ranged from 0% in the Quechua of Peru to 71% among the Brazilian Mekranoti, a Cayapo subgroup. It is curious that another subgroup of the same tribe, the Xikrin, also show a high prevalence of the antigen (61%); the other tribe with a high frequency, however, lives farther apart in Ecuador (the Waorani, with 64%).

Experimental studies and clinical observations have shown that the serum hepatitis virus may be transmitted by a non-parenteral route. An oral transmission may be possible, since saliva may contain minute amounts of blood. The possibility that arthropods could be vectors has also been considered.

2.9. *Skin diseases*

Pyoderma is one of the most common dermatologic morbid condition in the tropics. But population surveys from remote populations are not numerous. Among South American Indians Lawrence et al. (1979a) studied members of three Brazilian Amazonian tribes, while two other populations from the same general region, but living further to the Southwest, were investigated by Tanus et al. (1984). *Staphylococcus aureus* was isolated in both studies; in the first other microorganisms found were *Streptococcus pyogenes* and *Corynebacterium diphtheriae*, while in the second *Staphylococcus epidermidis* was also observed. In both investigations resistance to some of the most common antibiotics were already detected.

A high prevalence of keloid blastomycosis was reported by Baruzzi et al. (1973) among a single tribe of the Xingu National Park, the Caiabi. Fifteen of the 180 individuals examined (8%) presented the condition. The observed lesions included papules, nodules and verrucose formations that could be clearly distinguished histologically from the more common blastomycosis caused by *Paracoccidioides brasiliensis*, and always showed the presence of *P. loboi*. Visceral impairment was not found and the carriers were generally not much affected by the infection. No new cases, however, were discovered among the Caiabi after 1956, date of their transfer to the Xingu National Park, despite the fact that no precautions were taken to avoid transmission of the disease. Therefore, this unusual aggregation of cases was due to conditions prevailing in the environment where they formerly lived.

Another epidemic, this time of leishmaniasis, was described by Carneri et al (1963) in other tribe of the Xingu National Park, the Waurá. Among 50 Indians of a village, 12 were affected by ulcers, in some cases multiple in number. The outbreak began a few months after the village had been moved from an earlier site situated four hours canoe journey up the Rio Batovi. The epidemic started in 1962, but by late 1964 was over, and when a new medical team visited the tribe in 1968 there were no active lesions (Aston and Thorley, 1970). The latter authors performed a detailed survey, using the Montenegro skin test, and verified a high prevalence of antibodies to *Leishmania braziliensis* (present in 76% of 212 males and 47% of 188 females). This high percentage of positive reactions was not accompanied by the presence of active primary or secondary lesions, since none was found. This was in sharp contrast with the situation in a nearby neo-Brazilian "fazenda", where they did found such lesions. The explanation given for the difference was better hygiene and nutrition among the Indians. As for the epidemic, two hypotheses can be advanced to explain it; either the area was a temporary focus of a higher concentration of infected flies, or there was a very localized strain of *Leishmania* which was significantly more virulent than the surrounding normal strain.

3. RETROSPECT AND PROSPECT

In global evaluations about the parasitic load of South American Indians, the obvious, first question to ask is whether the disease was present in the New World before Columbus. This is important because host-parasite adaptations require time; and for many of the pathogenic organisms considered here (*Ascaris lumbricoides*, *Ancylostoma duodenale*, *Dipetalonema perstans*, *Wuchereria bancrofti*, *Plasmodium vivax*, *Plasmodium falciparum*) no conclusive evidence exists for or against this view.

Time trends are intimately connected with these sources of origin, but other factors are undoubtedly important, such as the size and mobility of the populations, sociocultural practices and preventive or curative measures. Such trends were documented in relation to the prevalence of microfilariae in Guyana. The identification of situations in which a given parasite is in the process of colonizing new hosts and territories can be of the utmost importance for the understanding of the dynamics of host-parasite relationships, and such a situation is now hapenning for onchocerciasis in northern Brazil.

The importance of the general physical environment was made clear by the epidemics of blastomycosis among the Caiabi and of leishmaniasis among the Waurá Indians. But host effects may be significant also. The benign effect of leishmaniasis among the Xingu Indians, compared to neo-Brazilians, was already mentioned. Nutels (1968) was also surprised at both the clinico-radiological and epidemiological aspects of tuberculosis in "virgin" populations like the Suiá and Txukahamae Indians of Central Brazil. He would have expected different patterns, such as the so-called infant type in adults and the rapidly evolving and miliary forms, similar to those found among the Senegalese soldiers taken to France during the First World War. Instead, he found a disease that in its clinical, radiological and even epidemiological aspects, could be equated with that of persons with a long experience with the bacillus. At the other end of the scale, Giglioli (1968) asserted that the high susceptibility of the Guyana Indians to malaria was without doubt one of the major causes of their decline over the past 150 years.

Diet factors are undoubtedly important when intestinal parasites are considered, but, as was indicated previously, they may have also influenced the epidemiology of toxoplasmosis.

Some of the populations considered here are quite isolated, and this may explain the peculiar composition of the *Escherichia coli* strains found among the Yanomama Indians of northern Brazil. The low frequencies of the JC and BK papovaviruses, as well as of the Hepatitis B antigen in some South American Indian populations, may result from this same isolation.

An alarming observation was the one that many strains of the microorganisms responsible for pyoderma are already resistant to some of the most common antibiotics. This indicates a need for a more judicious use of these therapeutic agents.

Several ongoing medical investigations are being developed in Brazil, with the dual objectives of assisting the Indians and obtaining more scientific information about the factors responsible for their health and disease. The studies at the Xingu National Park performed by teams of the Escola Paulista de Medicina and headed by Dr. R.G. Baruzzi started in 1965 and continue up to the present. The program of tuberculosis diagnosis and control was started by Dr. N. Nutels in 1952, and is also fully active at present, now coordinated by Dr. J.A.N. de Miranda, from the National Service of Tuberculosis Control in Rio de Janeiro. Two other projects started recently; the first is under the responsability of the Brazilian National School of Public Health, also located in Rio de Janeiro, and is headed by Dr. L.F. Ferreira, while the other is being directed by Dr. H.V. Dourado, Head of the Hospital of Tropical Diseases in Manaus. It is hoped that these systematic investigations may furnish in the future important additional data on the subject of the present article.

More meaningful insights on the many questions raised here may be obtained through efforts in the following lines: (a) More paleopathological studies, with an emphasis in areas (like the deserts of Chile) especially suited for the preservation of human remains; (b) Determination of the reservoirs and vectors of a series of pathogenic agents, some of them discussed above; (c) Experimental studies (like those of Wood, 1975), with the objective of determining the factors responsible for the atraction of disease vectors to susceptible hosts; (d) Immunological profiles of individuals who, due to their genetic constitution in the chromosome region responsible for the immune response, may show differential susceptibility to a given parasite; (e) More detailed investigations about parasite cycles; and (f) Development of statistical models and computer simulations aiming at understanding the several factors responsible for a given host/ parasite situation; for instance, the effects of population sizes, degree of isolation, sources of infections, and specific biological and cultural attributes.

The future of the South American Indian will depend to a great extent of the policies of the national governments of the countries where they live. For instance, the present emphasis of the Brazilian government in the building of huge dams for the production of energy has already affected many tribal territories, essential for their survival. A more disciplined control of contacts with non-Indians, especially those of the more isolated groups, is also very important. For example, it is known that the two most famous Brazilian Jesuit catechists of the 16th century, Manoel da

Nóbrega and José de Anchieta were affected by tuberculosis, and should have infected a large number of Indians, possibly with fatal consequences. A recent symposium held in Rio de Janeiro also considered the medical services presently offered by the Brazilian National Indian Foundation (Funai) and several alternatives. The difficulties of providing medical care to villages scattered over a vast territory of difficult access were examined. The recommendations stressed the importance of combining the scientific approach to medicine with the traditional methods of treatment.

There is a tendency, well established in Brazil, for the Indian leaders to take over the direction of their own affairs, until recently dealt with exclusively by non-Indians. This salutary move will enable them to best define their goals and to firmly adopt measures that could reduce the level of morbidity in their populations, therefore contributing for a healthier and happier life.

REFERENCES

Alland, A., Jr. 1966. Medical anthropology and the study of biological and cultural adaptation. Am. Anthrop., 68: 40-51.

Allison, M.J., Pezzia, A., Hasegawa, I. and Gerszten, E. 1974. A case of hookworm infestation in a precolumbian American. Am. J. Phys. Anthrop., 41: 103-106.

Asin, H.R.G. and van Thiel, P.H. 1963. On intestinal protozoa in the urban and bushland population in Surinam. Trop. Geogr. Med., 15: 108-120.

Aston, D.L. and Thorley, A.P. 1970. Leishmaniasis in Central Brazil: results of a Montenegro skin test survey among Amerindians in the Xingu National Park. Trans. Royal Soc. Trop. Med. Hyg., 64: 671-678.

Ayres, M. and Salzano, F.M. 1972. Health status of Brazilian Cayapo Indians. Trop. Geogr. Med., 24: 178-185.

Baruzzi, R.G. 1970. Contribution to the study of the toxoplasmosis epidemiology. Serologic survey among the Indians of the Upper Xingu river, Central Brazil. Rev. Inst. Med. Trop., 12: 93-104.

Baruzzi, R.G., Castro, R.M., D'Andretta, C., Jr., Carvalhal, S., Ramos, O.L. and Pontes, P.L. 1973. Occurrence of Lobo's blastomycosis among "Caiabi" Brazilian Indians. Intern. J. Dermatol., 12: 95-98.

Baruzzi, R.G., Franco, L.J., Jardim, J.R., Masuda, A., Naspitz, C., Paiva, E.R. and Ferreira-Novo, N. 1976. The association between splenomegaly and malaria in Indians from the Alto Xingu, Central Brasil. Rev. Inst. Med. Trop., 18: 322-348.

Baruzzi, R.G., Marcopito, L.F., Serra, M.L.C., Souza, F.A.A. and Stabile, C. 1977. The Kren-Akorore: a recently contacted indigenous tribe. In: Health and Disease in Tribal Societies (Elliott, K. and Whelan, J., eds.). Elsevier, Amsterdam, p. 179-211.

Beaver, P.C., Neel, J.V. and Orihel, T.C. 1976. *Dipetalonema perstans* and *Mansonella ozzardi* in Indians of southern Venezuela. Am. J. Trop. Med. Hyg., 25: 263-265.

Berlin, E. and Markell, E. 1977. An assessment of the nutritional and health status of an Aguaruna Jívaro community, Amazonas, Peru. Ecol. Food Nutrit., 6: 69-81.

Black, F.L. 1975. Infectious diseases in primitive societies. Science, 187: 515-518.

Blumberg, B.S., London, W.T., Sutnick, A.I. and Millman, I. 1970. Australia antigen, hepatitis and susceptibility to leukemia. In: Comparative Leukemia Research (Dutcher, R.M., ed.). Karger, Basel, p. 659-677.

Brown, P., Tsai, T. and Gajdusek, D.C. 1975. Seroepidemiology of human papovaviruses. Discovery of virgin populations and some unusual patterns of antibody prevalence among remote peoples of the world. Am. J. Epidemiol., 102: 331-340.

Bruno, A.A.G. 1978. Condições Sanitárias de Escolares em Zonas Rurais do Território Federal do Amapá. M. Sc. Dissertation, Universidade Estadual de Campinas, Campinas, Brazil.

Cabannes, R., Larrouy, G. and Ruffié, J. 1964. Étude clinique et hématologique des Indiens du Haut-Oyapock et du Haut-Maroni (Guyane Française) Oyampi, Emerillon et Oayana. Bull. Soc. Pathol. Exotique, 57: 307-325.

Candeias, J.A.N., Baruzzi, R.G., Pripas, S. and Iunes, M. 1977. Prevalence of antibodies to the BK and JC papovaviruses in isolated populations. Rev. Saúde Publ., São Paulo, 11: 510-514.

Carneri, I., Nutels, N. and Miranda, J.A. 1963. Epidemia de leishmaniose tegumentar entre os índios Waurá do Parque Nacional do Xingu (Estado de Mato Grosso, Brasil). Rev. Inst. Med. Trop., 5: 271-272.

Coimbra, C.E.A., Jr. 1982. Notas para uma análise epidemiológica dos achados de ovos de *Capillaria sp* em exames de fezes realizados entre os Suruís do Parque Indígena de Aripuanã, Rondônia. Bol. CEPAM, Brasília, 1: 5-6.

Coimbra, C.E.A., Jr. and Mello, D.A. 1981. Enteroparasitas e *Capillaria sp* entre o grupo Suruí, Parque Indígena Aripuanã, Rondônia. Mem. Inst. Oswalso Cruz, 76: 299-302.

Damian, R.T. 1964. Molecular mimicry: antigen sharing by parasite and host and its consequences. Am. Natur., 98: 129-149.

Damianovic, J. 1948. Realidad sanitaria de la población indígena de la zona austral Antártica. Rev. Chil. Hig. Med. Prev., 10: 3-17.

D'Andretta, C., Jr., Ramos, A.S., Kameyana, I., Souza Dias, L.C. and Penteado, H., Jr. 1969a. Nota preliminar sobre a prevalência da malária entre os indígenas do Parque Nacional do Xingu. Rev. Paul. Med., 74: 331-332.

D'Andretta, C., Jr., Baruzzi, R.G., Sarmento, M.F., Kameyana, I., Souza Dias, L.C and Penteado, H., Jr. 1969b. Estudo da prevalência da malária em Índios do Parque Nacional do Xingu. Determinação dos Índices parasitários e esplênico. Rev. Soc. Bras. Med. Trop., 3: 12.

Da Rocha, F.J. and Salzano, F.M. 1972. Anthropometric studies in Brazilian Cayapo Indians. Am. J. Phys. Anthrop., 36:95-101.

Díaz, B., Gallegos, D., Murillo, F., Covarrubias, E., Covarrubias, T., Rona, R., Weidman, W., Rothhammer, F. and Schull, W.J. 1978. The multinational Andean genetic and health program: II. Disease and disability among the Aymara. Bull. Pan Am. Health Organ., 12: 219-235.

Dubos, R. 1965. Man Adapting. Yale Univ. Press, New Haven.

Dunn, F.L. 1968. Epidemiological factors: health and disease in hunter-gatherers. In: Man the Hunter (Lee, R.B. and De Vore, I., eds.). Aldine, Chicago, p. 221-228.

Duque, O., Arcila, G. and Zuluaga, H. 1959. Estudio comparativo de la infección por *Entamoeba histolytica* y otros parasitos intestinales em indios y blancos del Chocó (Colombia). Antioquia Med., 9: 365-385.

Eichenberger, R.W. 1966. Una filosofía de salud pública para las tribus indígenas amazónicas. Am. Indig., 26: 119-141.

Eveland, W.C., Oliver, W.J. and Neel, J.V. 1971. Characteristics of *Escherichia coli* serotypes in the Yanomama, a primitive Indian tribe of South America. Infect. Immun., 4: 753-756.

Ewald, P.W. 1983. Host-parasite relations, vectors, and the evolution of disease severity. Ann. Rev. Ecol. System, 14: 465-485.

Ferreira, L.F., Araújo, A.J.G. and Confalonieri, U.E.C. 1980. The finding of eggs and larvae of parasitic helminths in archaeological material from Unai, Minas Gerais, Brazil. Trans. Royal Soc. Trop. Med. Hyg., 74: 798-800.

Ferreira, L.F., Araújo, A.J.G. and Confalonieri, U.E.C. 1982. Os parasitos do homem antigo. Ciência Hoje, 1(3): 63-67.

Ferreira, L.F., Araújo, A.J.G. and Confalonieri, U.E.C. 1983. The finding of helminth eggs in a Brazilian mummy. Trans. Royal Soc. Trop. Med. Hyg., 77: 65-67.

Fix, A.G. 1984. Kin groups and trait groups: population structure and epidemic disease selection. Am. J. Phys. Anthrop., 65: 201-212.

Flowers, N.M., Gross, D.R., Ritter, M.L. and Werner, D.W. 1982. Variation in swidden practices in four Central Brazilian Indian societies. Hum. Ecol., 10: 203-217.

Fonseca, O. 1969. Parasitismo e migrações humanas pré-históricas. In: Estudos de Pré-história Geral e Brasileira (Duarte, P., ed.). Instituto de Pré-história, Universidade de São Paulo, São Paulo, p. 1-346.

Fribourg-Blanc, A., Bois, E. and Feingold, J. 1975. Bilan épidémiologique des Amérindiens de Haute-Guyane Française: Sérologie de la toxoplasmose. Med. Mal. Infect., 5: 502-507.

Fros, J. 1956. Filariasis in South American Indians in Surinam. Docum. Med. Geogr. Trop., 8: 63-69.

Garruto, R.M. 1981. Disease patterns of isolated groups. In: Biocultural Aspects of Disease (Rothschild, H.R., ed.). Academic Press, New York, p. 557-597.

Giglioli, G.G. 1968. Malaria in the American Indian. In: Biomedical Challenges Presented by the American Indian. PAHO Scient. Publ., 165: 104-113.

Gross, D.R., Eiten, G., Flowers, N.M., Leoi, F.M., Ritter, M.L. and Werner, D.W. 1979. Ecology and acculturation among native peoples of Central Brazil. Science, 206: 1043-1050.

Holmes, R. 1984. Non-dietary modifiers of nutritional status in tropical forest populations of Venezuela. Interciencia, 9: 386-391.

Hugh-Jones, P., Aston, D.L., Cawley, M.I.D., Guillebaud, J., Jones, H.I., Mills, R.A., Rees, P.H. and Thorley, A.P. 1972. Medical studies among Indians of the upper Xingu. Brit. J. Hosp. Med., 7: 317-334.

Kaplan, J.E., Larrick, J.W., Yost, J., Farrell, L., Greenberg, H.B., Herrmann, K.L., Sulzer, A.J., Walls, K.W. and Pederson, L. 1980. Infectious disease patterns in the Waorani, an isolated Amerindian population. Am. J. Trop. Med. Hyg., 29: 298-312.

Knight, R. and Prata, A. 1972. Intestinal parasitism in Amerindians at Coari, Brazil. Trans. Royal Soc. Trop. Med. Hyg., 66: 809-810.

Lage, H.A. 1964. Mansonelose em Índios do grupo Aruak, do rio Içana. O Hospital, 66: 557-564.

Larrick, J.W., Yost, J.A., Kaplan, J., King, G. and Mayhall, J. 1979. Patterns of health and disease among the Waorani Indians of eastern Ecuador. Med. Anthrop., 3: 147-189.

Lawrence, D.N., Erdtmann, B., Peet, J.W., Nunes de Mello, J.A., Healy, G.R., Neel, J.V. and Salzano, F.M. 1979b. Epidemiologic studies among Amerindian populations of Amazônia. II. Prevalence of *Mansonella ozzardi*. Am. J. Trop. Med. Hyg., 28: 991-996.

Lawrence, D.N., Facklam, R.R., Sottnek, F.O., Hancock, G.A., Neel, J.V. and Salzano, F.M. 1979a. Epidemiologic studies among Amerindian populations of Amazônia. I. Pyoderma: prevalence and associated pathogens. Am. J. Trop. Med. Hyg., 28: 548-558.

Lawrence, D.N., Neel, J.V., Abadie, S.H., Moore, L.L., Adams, L.J., Healy, G.R. and Kagan, I.G. 1980. Epidemiologic studies among Amerindian populations of Amazônia. III. Intestinal parasitoses in newly contacted and acculturating villages. Am. J. Trop. Med. Hyg., 29: 530-537.

Leser, P.G., Camargo, M.E. and Baruzzi, R.G. 1977. Toxoplasmosis serologic tests in Brazilian Indians (Kren-Akorore) of recent contact with civilized man. Rev. Inst. Med. Trop., 19: 232-236.

Lovelace, J.K., Moraes, M.A.P. and Hagerby, E. 1978. Toxoplasmosis among the Ticuna Indians in the State of Amazonas, Brazil. Trop. Geogr. Med., 30: 295-300.

Madalengoitia, J., Ishida, N., Umenay, T., Miyamoto, T., Mejía, J., Flores, W., Sãnchez, S. and Mêndez, R. 1975. The prevalence of hepatitis B antigen among hepatitis patients and residents of Peru. PAHO Bull., 9: 142-147.

Marinkelle, C.J. 1973. First finding of *Dipetalonema perstans* in Colombia. Trop. Geogr. Med., 25: 51-52.

Marinkelle, C.J. and German, E. 1970. Mansonelliasis in the Comisaría del Vaupés of Colombia. Trop. Geogr. Med., 22: 101-111.

Moraes, M.A.P., Almeida, M.M.R., Lovelace, J.K. and Chaves, G.M. 1978. *Mansonella ozzardi* entre Índios Ticunas do Estado do Amazonas, Brasil. Bol. Of. Sanit. Panam., 85: 16-25.

Neel, J.V., Andrade, A.H.P., Brown, G.E., Eveland, W.E., Goobar, J., Sodeman, W.A., Jr., Stollerman, G.H., Weinstein, E.D. and Wheeler, A.H. 1968b. Further studies of the Xavante Indians. IX. Immunologic status with respect to various diseases and organisms. Am. J. Trop. Med. Hyg., 17: 486-498.

Neel, J.V., Mikkelsen, W.M., Rucknagel, D.L., Weinstein, E.D., Goyer, R.A. and Abadie, S.H. 1968a. Further studies of the Xavante Indians. VIII. Some observations on blood, urine, and stool specimens. Am. J. Trop. Med. Hyg., 17: 474-485.

Neel, J.V., Salzano, F.M., Junqueira, P.C., Keiter, F. and Maybury-Lewis, D. 1964. Studies on the Xavante Indians of the Brazilian Mato Grosso. Am. J. Hum. Genet., 16: 52-140.

Neel, J.V. and Salzano, F.M. 1967. Further studies on the Xavante Indians. X. Some hypotheses-generalizations resulting from these studies. Am. J. Hum. Genet., 19: 554-574.

Nutels, N. 1968. Medical problems of newly contacted Indian groups. In: Biomedical Challenges Presented by the American Indian. PAHO Scient. Publ., 165: 68-76.

Oliveira, H.C. 1952. O estado de saúde dos Índios Karajá em 1950. Rev. Mus. Paul., 6: 489-508.

Orihel, T.C. 1967. Infections with *Dipetalonema perstans* and *Mansonella ozzardi* in the aboriginal Indians of Guyana. Am. J. Trop. Med. Hyg., 16: 628-635.

Rachou, R.G. 1957. Distribuição geográfica das filarioses humanas no Brasil. Rev. Bras. Malariol. Doenças Trop., 9: 79-100.

Ranke, K.E. 1898. Beobachtungen über Bevolkerungsstand und Bevolkerungsbewegung bein Indianern Central-Brasiliens. Corresp. Deut. Gesellsch. Anthrop. Ethnol. Urgesch., 29: 123-134.

Rassi, E., Lacerda, N. and Guimarães, J.A. 1976. Study of the area affected by onchocerciasis in Brazil: survey of local residents. Bull. Pan Am. Health Organ., 10: 33-45.

Restrepo, M. 1962. Estudio parasitológico de una región del Amazonas colombiano. Antioquia Med., 12: 462-484.

Roever-Bonnet, H. 1967. Toxoplasmosis in Surinam (Netherlands Guyana). A serological survey. Trop. Geogr. Med., 19: 221-228.

Ross, E.B. 1978. Food taboos, diet and hunting strategy: the adaptation to animals in Amazon cultural ecology. Curr. Anthrop., 19: 1-36.

Salzano, F.M. 1985. Changing patterns of disease among South American Indians. In: Diseases of Complex Etiology in Small Populations: Ethnic Differences and Research Approaches (Chakraborty, R. and Szathmary, E.J.E., eds.), Alan R. Liss, New York (in press).

Salzano, F.M. and Blumberg, B.S. 1970. The Australia antigen in Brazilian healthy persons and in leprosy and leukaemia patients. J. Clin. Pathol., 23: 39-42.

Salzano, F.M. and Neel, J.V. 1976. New data on the vision of South American Indians. Bull. Pan Am. Health Organ., 10: 1-8.

Schaad, J.D.G. 1960. Epidemiological observations in Bush Negroes and Amerindians in Surinam. Trop. Geogr. Med., 12: 38-46.

Schwaner, T.D. and Dixon, C.F. 1974. Helminthiasis as a measure of cultural change in the Amazon basin. Biotropica, 6: 32-37.

Soyano, A., Layrisse, Z., Layrisse, M. and Neel, J.V. 1979. Hepatitis-Bs antigen in an isolated Indian population of southern Venezuela: a family study. J. Med. Genet., 16: 201-205.

Soyano, A., Malavé, I., Walder, R., Layrisse, Z. and Layrisse, M. 1976. Hepatitis-B antigen in an isolated Indian population (Yanomama Indians), southern Venezuela. Rev. Bras. Pesq. Med. Biol., 9: 247-253.

Sulzer, A.J., Cantella, R., Colichon, A., Gleason , N.N. and Walls, K.W. 1975. A focus of hyperendemic *Plasmodium malariae-P. vivax* with no *P. falciparum* in a primitive population in the Peruvian Amazon jungle. Studies by means of immunofluorescence and blood smear. Bull World Health Organ., 52: 273-278.

Tanus, R., Coimbra, C.E.A., Jr. and Santos, R.V. 1984. Pesquisa de portadores inaparentes de *Staphylococcus aureus* entre os grupos indígenas Suruí e Karitiana, Rondônia. Abstracts, XX Congr. Soc. Bras. Med. Trop.: 136.

Weistein, E.D., Neel, J.V. and Salzano, F.M. 1967. Further studies on the Xavante Indians. VI. The physical status of the Xavantes of Simões Lopes. Am. J. Hum. Genet., 19: 532-542.

Werner, D., Flowers, N.M., Ritter, M.L. and Gross, D.R. 1979. Subsistence productivity and hunting effort in native South America. Hum. Ecol., 7: 303-315.

Wood, C.S. 1975. New evidence for a late introduction of malaria into the New World. Curr. Anthrop., 16: 93-104.

Table 1. General health surveys performed in South American Indians

Observations	Tribe, country, sample size and bibliographic reference													
	2 tribes Surinam 184 (1)	3 tribes French Guiana 257 (2)	Waorani Ecuador 293 (3)	Campa Peru 589 (4)	Cayapo Brazil 184 (5)	Kren-Akorore Brazil 79 (6)	Xingu Indians Brazil 254 (7)	Xingu Indians Brazil 600 (8)	Karajá Brazil 117 (9)	Xavante Brazil 287 (10)	Aymara Chile 636 (11)	Alacaluf Chile 19 (12)	Ona Chile 14 (12)	Yamana Chile 42 (12)
<u>Physical examination</u>														
Height / weight	+		+		+	+	+	+		+	+			
Eyes		+	+	+	+					+	+	+	+	+
Ears and hearing			+		+					+	+	+	+	+
Oral cavity		+	+	+	+				+	+	+	+	+	+
Thyroid			+				+			+	+			
Lymph nodes		+			+		+			+	+			
Cardiovascular system		+	+	+	+	+	+	+	+	+	+			
Pulmonary system	+	+	+		+	+			+	+	+	+	+	+
Spleen	+	+	+	+	+	+	+			+	+			
Liver		+	+		+	+	+			+	+			
Bone and joints		+	+	+	+					+	+	+	+	+
Skin and appendages		+	+	+	+	+				+	+	+	+	+
Central nervous system			+				+		+	+	+			
<u>Skin tests</u>	+		+	+				+		+		+	+	+
<u>Hematological variables</u>	+	+	+			+	+	+		+	+			
<u>Blood parasites</u>	+	+	+	+			+	+		+				
<u>Antibody tests</u>	+		+			+	+	+		+		+	+	+
<u>Stool and urine tests</u>			+	+		+	+	+		+				

Bibliographic references: (1) Schaad (1960); tribes studied: Oajana and Trio; (2) Cabannes et al. (1964); tribes studied: Oajana, Oyampi and Emerillon; (3) Larrick et al. (1979); Kaplan et al. (1980); (4) Eichenberger (1966); (5) Ayres and Salzano (1972); the height and weight data are given in Da Rocha and Salzano (1972); (6) Baruzzi et al. (1977); (7) Baruzzi (1970); (8) Hugh-Jones et al. (1972); (9) Oliveira (1952); (10) Neel et al. (1964); Weinstein et al. (1967); Neel et al. (1968a,b); (11) Díaz et al. (1978); (12) Damianovic (1948).

Table 2. Prevalences (in percent) of intestinal parasites observed in South American Indians

Parasites found	Unknown Surinam 120 (1)	Yanomama Venezuela 125 (2)	Yanomama Venezuela 177 (3)	Rio Negro Indians Venezuela 173 (3)	Chocõ Colombia 46 (4)	Ticuna Colombia 59 (5)	Ticuna Colombia 176 (6)	Waorani Ecuador 65 (7)	Aguaruna Peru 119 (8)	Campa Peru 405 (9)	Palikur Brazil 21 (10)	Galibi Brazil 55 (10)	Three tribes Brazil 53 (2)	Unknown Brazil 43 (11)	Surui Brazil 200 (12)	Kren-Akorore Brazil 35 (13)	Xingu Indians Brazil 139 (14)	Xavante Brazil 60 (15)
Helminths																		
Ascaris lumbricoides	-	89-99	73-80	52-76	74	60-85	76	3	62	28	76	78	46-67	70	53	15	18	70
Trichuris trichiura	-	68-92	9-53	0-29	30	92-95	77	2	92	20	19	49	46-100	91	5	76	-	20
Ancylostoma duodenale	-	76-79	39-67	6-22	30	60-100	83	46	93	45	90	80	60-96	95	43	97	81	97
Strongyloides stercoralis	-	3-11	0-1	0-12	-	-	25	-	7	11	10	10	0-20	26	33	30	11	5
Enterobius vermicularis	-	-	-	-	-	-	-	3	-	-	-	-	-	-	<1	-	13	2
Taenia Sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-
Hymenolepis nana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
Capillaria sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1*	-	-	-
Protozoans																		
Entamoeba coli	53-63	91-100	70-84	16-47	50	-	69	51	49	37	14	31	20-69	42	-	24	87	67
Giardia lamblia	5-22	4-5	20	12-52	-	-	22	28	11	-	5	7	20-27	12	3	9	29	7
Entamoeba histolytica	9-38	28-77	-	-	61	-	55	20	-	21	10	16	0-29	23	1	18	61	48
Endolimax nana	19-39	24-39	-	-	-	-	26	-	-	-	33	14	0-12	51	-	12	38	28
Iodamoeba butschlii	7-17	21-66	-	-	28	-	20	-	-	-	14	11	0-29	12	-	24	39	25
Chilomastix mesnili	11-25	10-53	-	-	-	-	15	-	-	-	-	-	0-38	7	-	9	17	8
Trichomonas hominis	-	-	-	-	-	-	4	-	-	-	5	-	-	-	-	-	-	-
Balantidium coli	-	-	-	-	-	-	2	-	-	-	-	-	0-11	-	-	-	1	-
Entamoeba hartmanni	5-29	0-19	-	-	-	-	-	-	-	-	-	-	0-32	16	-	-	-	-
Enteromonas hominis	-	-	-	-	-	-	-	-	-	-	-	-	0-6	-	-	-	-	-
Dientamoeba fragilis	-	-	-	-	-	-	-	-	-	-	-	-	0-2	-	-	-	-	-

Bibliographic references: (1) Asin and van Thiel (1963); (2) Lawrence et al. (1980); (3) Holmes (1984); the Rio Negro Indians include the descendants of many intertribal crosses; (4) Duque et al. (1959); (5) Schwaner and Dixon (1974); (6) Restrepo (1962); (7) Kaplan et al. (1980); (8) Berlin and Markell (1977); (9) Eichenberger (1966); (10) Bruno (1978); (11) Knight and Prata (1972); (12) Coimbra and Mello (1981); (13) Baruzzi et al. (1977); (14) Baruzzi (1970); (15) Neel et al. (1968a).

*Subsequently confirmed by Coimbra (1982).

Table 3. Prevalences (in per cent) of microfilariae among South American Indians

Tribe	Country	Sample Size	Bibliographic reference	Parasites found (%)			
				Dipetalonema perstans	*Wuchereria bancrofti*	*Mansonella ozzardi*	*Onchocerca volvulus*
Several	Guyana	9,506	1	11	0	1	-
Several	Surinam	881	2	47	<1	89	-
Oajana	Surinam	51	3	-	-	0	-
Trio	Surinam	71	3	-	-	0	-
Piaroa	Venezuela	28	4	18	0	14	-
Yanomama	Venezuela	159	4	0	0	11	-
Several	Colombia	18	5	11	0	39	-
Several	Colombia	332	6	0	0	96	-
Ticuna	Colombia	197	7	-	-	14	-
Yanomama + Makiritare	Brazil	258	8	-	-	0	0-61
Içana river Indians	Brazil	124	9	-	-	54-64	-
Baniwa	Brazil	24	10	0	0	87	-
Ticuna	Brazil	198	10	0	0	46-93	-
Kanamari	Brazil	30	10	0	0	20	-
Katukina	Brazil	30	10	0	0	0	-
Ticuna	Brazil	290	11	0	0	29	-
Ticuna	Brazil	800	12	-	-	33-57	0
Xavante	Brazil	76	13	-	-	0	-

Bibliographic references: (1) Orihel (1967); (2) Fros (1956); (3) Schaad (1960); (4) Beaver et al. (1976); (5) Marinkelle (1973); (6) Marinkelle and German (1970); (7) Restrepo (1962); (8) Rassi et al. (1976); (9) Lage (1964); (10) Lawrence et al. (1979b); (11) Rachou (1957); (12) Moraes et al. (1978); (13) Neel et al. (1964).

Table 4. Prevalences (in per cent) of malaria parasites in two groups of South American Indians

Parasites found	Tribe, country, sample size, bibliographic reference and date of study				
	Xingu Indians, Brazil			Campa, Peru	
	223 1 1966/1967	303 2 1968	97 3 1970	123 4 June, 1973	123 4 Sept., 1973
Plasmodium vivax	28	13	6	6	-
Plasmodium falciparum	18	29	5	-	-
Plasmodium malariae	5	1	-	54	83
Plasmodium sp	-	-	-	1	2
Mixed infections	1	3	-	3	1
Negative	48	54	89	36	14

Bibliographic references: (1) D'Andretta et al. (1969a); (2) D'Andretta et al. (1969b); (3) Baruzzi et al. (1976); (4) Sulzer et al. (1975).

Table 5. Prevalences (in per cent) of antibodies to *Toxoplasma gondii* among South American Indians

Tribe	Country	Sample size	Bibliographic reference	Infected with *Toxoplasma gondii* (%)
Not indicated	Surinam	27	1	30
Wayana + Emerillon	French Guiana	237	2	37
Oyampi + Emerillon	French Guiana	134	2	72
Tiriyo	Brazil	200	3	43
Ticuna	Brazil	408	4	25-59
Xikrin	Brazil	118	3	46
Mekranoti	Brazil	175	3	52
Kren-Akorore	Brazil	70	5	89
Xingu Indians	Brazil	254	6	52
Xavante	Brazil	107	7	100

Bibliographic references: (1) Roever-Bonnet (1967); (2) Fribourg-Blanc et al. (1975); (3) Black (1975); (4) Lovelace et al. (1978); (5) Leser et al. (1977); (6) Baruzzi (1970); (7) Neel et al. (1968b).

Table 6. Prevalences (in per cent) of antibodies to the JC and BK papovaviruses among South American Indians

Tribe	Country	Sample size	Bibliographic reference	Per cent positive	
				JC HI antibody	BK HI antibody
Tiriyo	Brazil	49	1	-	6
Kaxuyana	Brazil	18	1	-	28
Ewarhoyana	Brazil	9	1	0	0
Xikrin	Brazil	53	1	-	11
Kuben-Kran-Kegn	Brazil	47	1	-	6
Mekranoti	Brazil	60	1	8	2
Kren-Akorore	Brazil	66	2	0	6
Xingu Indians	Brazil	107	2	0-4	3-6
Guayaki	Paraguay	58	1	0	5

Bibliographic references: (1) Brown et al. (1975); (2) Candeias et al. (1977).

HI: hemagglutination inhibition.

Table 7. Prevalences (in per cent) of hepatitis B antigen among South American Indians

Tribe	Country	Sample size	Bibliographic reference	Por cent positive for HB Ag
Yanomama	Venezuela	1635	1	0-31
Waorani	Ecuador	181	2	64
Quechua	Peru	102	3	0
Cashinahua	Peru	89	3	20
Several	Peru	363	4	1
Tiriyo	Brazil	200	5	5
Xikrin	Brazil	118	5	61
Mekranoti	Brazil	175	5	71
Kren-Akorore	Brazil	68	6	23
Xingu Indians	Brazil	Unknown	6	2

Bibliographic references: (1) Soyano et al. (1976, 1979); (2) Kaplan et al. (1980); (3) Blumberg et al. (1970); (4) Madalengoitia et al. (1975); (5) Black (1975); (6) Baruzzi et al. (1977).