PIRAJA DA SILVA reported intestinal schistosomiasis due to Schistosoma mansoni in Brazil in 1908 (14). Transmission was probably introduced with the African slaves in the north-east in Pernambuco and Bahia (62). Between 1920 and 1930, schistosomiasis began to spread in the central and southern regions of Brazil, as people from the north-east migrated in search of work and better living conditions. In the 1950s transmission was reported in the Espirito Santo, Rio de Janeiro, Minas Gerais, Sao Paulo and Paraná States. According to PELLON & TEIXEIRA (2), about 10% of the 7-14-year-old children in the nine north-eastern States were infected with S. mansoni. At the present time, it is generally believed that 30,000,000 Brazilians are exposed to S. mansoni infection (IAROTSKI & DAVIS - 1981).

I. — POPULATION DISTRIBUTION OF S. MANSONI INFECTION

In 1949, PELLON & TEIXEIRA (2) reported the geographical distribution of intestinal schistosomiasis. Eighty hundred and seventy-seven localities in 11 States in the north-east and east of Brazil were surveyed; 612 localities were endemic. The prevalence rate was above 4% in two-thirds, or 383 localities. In Pernambuco, Alagoas, Sergipe and Bahia States, schistosomiasis affected all, or almost all, the schoolchildren studied; mean prevalence rates were 16.5% in Bahia, 20.5% in Alagoas, 25.2% in Pernambuco and 30.1% in Sergipe. The mean prevalence was 7.5% in Paraiba, 4.4% in Minas Gerais, 2.3% in Rio Grande do Norte and 1.6% in Espirito Santo, and less than 1% in Maranhão, Piauí and Ceará. The endemic area extended from the Rio Grande do Norte to the heart of Minas Gerais, including the eastern part of Paraiba and Pernambuco, all of Alagoas, Sergipe, and Bahia and the north of Espirito Santo. Within this area the eastern zone had high prevalence rates along the Atlantic seaboard, while in the west, prevalence rates were moderate. Isolated foci of transmission were reported in the northern States of Pará, Maranhão, and Ceará; in a central State, Goiás; and in the south-eastern States of São Paulo, Paraná, Guanabara and Rio de Janeiro.

By 1972, schistosomiasis was endemic in 22 States and in the Federal District of Brasília. Out of 1,287 localities surveyed, only 343 reported no cases of schistosomiasis; in 466 the prevalence was under 4%, and in 478 over 4%. The overall prevalence was 7%. In the individual States the prevalence rates were mostly higher than those recorded in 1949. Generally speaking, the epidemiological pattern had not changed. The highest prevalences were still reported in the four north-eastern States: Alagoas, Sergipe, Pernambuco and Bahia. In Pernambuco State, there were 24 localities with prevalences over 50%, 17 in Alagoas, 11 in Bahia, and 10 in Sergipe. In Pernambuco, over two-thirds of the endemic localities had prevalence rates of over 20%; in Alagoas, the prevalence in three-quarters of the villages or towns surveyed was above that figure.

In the endemic areas transmission frequently occurs in the lowlands around streams and rivers. In Maranhão State, for example, in the land around the Pindaré river; in Paraiba, Alagoas and Sergipe, in the coastal plain and the piedmont slopes, and in Bahia throughout the lower Paraguacu valley and in the São Francisco valley.


I. — RÉPARTITION DES POPULATIONS INFESTÉES PAR S. MANSONI

En 1949, PELLON et TEIXEIRA proposent un premier inventaire de la distribution géographique de la schistosomiasi intestinale. 877 localités se répartissant entre onze États de la partie orientale du Brésil ont été étudiées. Dans 612, des bilharzias ont été repérés ; le taux d’infestation est supérieur à 4 % dans les deux tiers des cas (383 localités). Dans les États de Pernambuco, Alagoas, Sergipe, Bahia, la schistosomiasi interesse la totalité ou la quasi-totalité des populations scolaires étudiées ; les taux d’infestation sont relativement élevés (16,5 % à Bahia, 20,5 % à Alagoas, 25,2 % à Pernambuco et 30,1 % à Sergipe). Le taux d’infestation est supérieur à 16,5 % dans le reste du Brésil, 12,5 % dans Minas Gerais, 7,5 % dans Paraiba et 4,4 % dans Espírito Santo. Au-delà de l’Espírito Santo, moins de 1 à Maranhão, Piauí et Ceará. L’aire endémique s’étend du Rio Grande do Norte au cœur de Minas Gerais, sur la partie orientale de la Paraiba, du Pernambuco, la totalité d’Ala- goas et de Sergipe, l’est et le sud de l’État de Bahia et le nord d’Espírito Santo. Cette aire comporte une zone orientale de hautes prévalences, le long de la façade atlantique sur laquelle prend appui une zone occi- dentale plus développée, aux taux d’infestation modérés. Des foyers isolés de transmission peuvent être repérés concurremment dans les États du Nord (Pará, Maranhão, Ceará), du Centre (Goiás) et du Sud- Est (São Paulo, Paraná, Guanabara, Rio de Janeiro).

En 1972, la schistosomiasi affecte avec une plus ou moins grande intensité la population de 22 États et du District Fédéral de Brasilia. Sur 1 287 localités étudiées, 343 seulement ne présentent aucun individu souffrant de schistosomiasi ; dans 466 cas, le taux d’infestation est inférieur à 4 % ; dans 478 cas, il est supérieur à 7 %. A l’échelle des États, les taux d’infestation sont la plupart du temps en augmentation par rapport à ceux enregistrés en 1949. Mais d’une façon générale le paysage épido- miologique ne varie pas : les plus fortes prévalences sont toujours le fait des quatre États du Nord-Est (Alagoas, Sergipe, Pernambuco et Bahia). On compte un nombre appréciable de collectivi- tés où plus de la moitié de la population est infestée par S. mansoni. Dans l’État de Pernambuco, on en dénombre 24, 17 dans celui de Ala- goas, 11 dans celui de Bahia, 10 en Sergipe. Dans le Pernambuco, plus des deux tiers des populations infestées présentent des prévalences supérieures à 20 % ; en Alagoas, les trois quarts des villes ou villages prospectés sont dans le même cas.

Dans les régions d’endémie, les terres déprimées comportant des cours d’eau sont les plus exposées. Dans l’État de Maranhão, par exemple, il s’agit des terrains encadrant le fleuve Pindaré ; dans la Paraiba, l’Alagoas et le Sergipe, de la plaine littorale et des plénonts, dans l’État de Bahia, de la basse vallée du Paraguacu et du São Fran- cisco.
During 1972 and 1975, the prevalence in Pernambuco was 15.8% and 38.8% in Sergipe. In 1976, over a million stool examinations (KATO method) were carried out in the endemic area. The prevalence in Sergipe was reported to be 41.9% and 38.6% in Alagoas; and 21.3% in Pernambuco. In the States of Alagoas and Sergipe, the prevalence ranged from 22.7% to 5.4%; in Ceará it was 2.4% in 1975 and 6.8% in 1976; in Maranhão it was 2.7% in 1975; 8.3% in 1976 and in Goiás State it had increased sixfold (3.5% in 1975; 20.4% in 1976). Every where else statewide mean infection rates were below 4%.

In 1981, out of 1,840,626 people examined, 172,242 were carriers of S. mansoni eggs. As a result of the national schistosomiasis control program a remarkable reduction in prevalence has been reported in the northern half of the country. In the middle northern States, the mean prevalence ranged from 9.1% in Pernambuco to 16.2% in Sergipe. In Espírito Santo the prevalence was 25.4%.

Schistosomiasis has now been reported in the State of Acre in the west and in the southern State of Santa Catarina (66). Schistosomiasis has not been reported in three States: Amazonas in the northwest, Mato Grosso in the center-west and Rio Grande do Sul at the southern tip of the country, as well as the western territory of Rondônia and the northern territories of Roraima and Amapá, except for a few cases in Macapá (28).

The overall prevalence has decreased due to the widespread use of chemotherapy. However, in Sergipe, the prevalence rates have been administered since 1975. In some localities in the north-east high prevalence rates persisted particularly in Alagoas and Sergipe.

II. PHYSICAL GEOGRAPHY OF SCHISTOSOMIASIS

Covering an area of 8,512,000 km², Brazil is the largest country in South America. Its territory comprises the immense Amazonian basin, part of the Guyana mountain range, the vast central plateaux and the western portion of the Paraguay depression. Medium altitudes, 400-800 m, are common. The old crystalline strata covers half the area of Brazil, while sedimentary or volcanic rocks of the Palaeozoic and Mesozoic cover more than a quarter of the country; tertiary and quaternary formations are found in the Amazon valley proper.

Granitic surfaces sloping from east to west underlie more or less vast sedimentary tabular plateaux of limestone, sandstone or lenticular or dolomitic clays. In the north-east, this mantle has been deeply broken up, leaving a landscape of low hills. Between the São Francisco and Tocantins rivers, which follow a roughly southern direction for two-thirds of their course, lie vast low mountain ridges or "chapadas" on sandstone materials. Between the São Francisco river and the Atlantic Ocean there is a ridge of high crystalline rocks culminating in the Pico da Bandeira at 2 800 m. In the north the Amazon flows west to east for over 6,000 km. In its course through Brazil its gradient is negligible but its volume is enormous — over 240,000 m³ at the confluence of the Tapajós. The flooded plain is 200 km wide. Its permanent bed is encroached by sandy ridges separated from terras firma by periodically flooded clay bottomlands and by permanent lakes.

The streams and rivers from the plateaux flow along narrow valleys. They form rapids (cachoeiras) where they join the Amazon valley. The São Francisco is the main river running through the endemic areas of the country. Its length is 4,185 km, and it has a fall of 200 km from its mouth. It swings south-east over a depressed saddle in its lower course, thus passing north around the elevations formed by the Serra do Espinhaço and the Chapada Diamantina, and enters the ocean north of Aracaju. In the lower part of its course its rate of flow varies from 1,000 m³/s (at low water level) to 10,000 m³/s (at times of flood) and it carries along large amounts of alluvium and silt which cover the coastal plains of the coast of Ilha de Mozambique.

The coastal rivers rising in the coastal mountain range are rarely more than 500 km in length. On the other hand, in the south-west of the country, in the Paraguay river flood plain, there is a vast area of marshes known as the Pantanal.

There are a wide range of climates in this large country with its diversity of landscapes. In the Amazon region the climate has no seasonal pattern marked by high humidity, persistent cloud cover and the absence of strong winds. Temperatures constantly average about 20 °C. The heavy rainfall, always over 1,800 mm annually, is spread over all the months. In Amazonas, the months of May and June are the wettest, times interspersed with savanna of dense, tall grasses "campos" which are flooded occasionally and which overlie clay outcrops. The northeast is a transitional region with low brush vegetation "caatinga". The henequen tree is the dominant plant. The climate here is more humid but it is drier. The "campos" have a high concentration of trees and shrubs. The maquis is the forest and the climate is the sclerophyllous forest. There are well-marked seasons and a gradual reduction in rainfall further toward the interior. In Mato Grosso, Amazonas and Roraima, the annual rainfall ranges from 1,200 to 2,000 mm in the eastern coastal belt. The flat summits of the
"chapidées" are occupied by savanna. The valley bottoms have gal-
gy forest and forested slopes. In the north of Belo Horizonte, the
forest is established at the base of the limestone uplands, with "cam-
po" grassland on the acid soils. Below the Tropic of Capricorn, in the
latitude of São Paulo, the forested areas are limited in the north or
ortheast. Rainfall varies between 1,500 and 1,700 mm annu-
ally, mainly between November and May. The vegetation be-
comes deciduous, particularly in Paraná, Santa Catarina,
and Rio Grande do Sul the climate becomes temperate. The tempera-
tures are often too low for the snail hosts to survive.

In Brazil three species of Biomphalaria act as intermediate hosts of
S. mansoni: B. straminea, B. glabrata are B. tenagophila, are found together in the State of Minas Gerais and the
Federal District of Brasilia. B. straminea and B. glabrata co-exist
in bodies of water in the States of Pará, Maranhão, Rio Grande do Norte,
Paraíba, Pernambuco, Alagoas, Sergipe, Bahia, Espírito Santo and
Goiás. The area of distribution of B. straminea projects westwards into
the States of Amazonas, Acre and Ceará, and that of B. glabrata
strains in a southerly direction towards the States of São Paulo and
Paraná. B. tenagophila is found the furthest south and in Minas Gerais,
Mato Grosso, São Paulo, Paraná, Rio de Janeiro and Guanabara (30).
Biomphalaria occidentalis has been recently described by PARAENSE
(Memoria del Instituto Oswaldo Cruz [1981] 76: 199-211). It is not
susceptible to infection by S. mansoni.

B. glabrata is the most important and most common snail host in
the quadrilateral between 13°S and 21°S and 39°W and 45°W (28).
B. straminea and B. glabrata are found in drainage systems or bodies
of water of very many different kinds. They are encountered in particu-
lar in the more or less permanent pools which form in small natural
depressions where waterlilies and water hyacinths grow.

B. glabrata shows some resistance to desiccation and can stand
four months of drought. This is the case in the Recife region, since the
rains which begin in April end in November. The aquatic vegetation
grows from April to August, then remains unchanged until the begin-
nning of the dry season. The temperature of the water, which is around
25°C during the rainy season, goes up to 35°C or 40°C when the rivers run
dry (31). This type of climate enables maximum transmission from
August to December. In Minas Gerais, transmission is low when the
water temperature is below 20°C, i.e., from May to July. Similarly,
development of the snail hosts is greatly disturbed during the period of
heavy rains, from November to April, as a result of the high turbidity
of the water, which carries with it large quantities of fine particles of
silt. The turbidity slows up the growth of the algae and hence limits the
amount of food for the molluscs. During the dry season the water
becomes cleaner and aquatic plants flourish; in this area snail hosts
have their maximum development in September.

Several species of wild animals and even cattle, have been con-
sidered to be possible reservoirs of S. mansoni but their role in the epi-
demiology of schistosomiasis has not been clarified.

III. HUMAN ECOLOGY AND SCHISTOSOMIASIS

In Brazil, the traditional endemic area is in relatively densely
populated coastal regions. Near João Maranhão, Recife, Macaúb,
Salvador therefore always more than 50 or even 100 inhabitants
per km². In the regions where schistosomiasis has been intro-
duced after World War II the population density is more variable:
over 50 inhabitants/km² between Belo Horizonte and Rio de Janeiro
or around São Paulo and in Paraná State, population density in the valley
of the São Francisco river is never over 10 inhabitants/km². In the
States of Ceará and Maranhão, generally speaking, there are between
25 and 50 inhabitants/km², but there is scarcely more than 1 inhabi-
ant/km² between the Tocantins river and the São Francisco river and
there is less than 1 inhabitant/km² west of Belém, i.e. over two-thirds
of the area of Brazil; these low population densities are due to the
scattered settlements; the prevalence rates vary widely, particularly
in the areas where it has been present for less than 40 years. Schistoso-
masis is almost absent over a large area in areas with important
crops which require consistent water supply by irrigation such as:
sugar-cane, cotton, sisal, bananas and rice. In Brazil the commercial
vegetable gardens surrounding the cities in the tropical zone (Salvador,
Belo Horizonte, Recife and Rio de Janeiro) are far from transmission
sites by irrigation without proper drainage systems. In the areas around
the towns bodies of water frequently used for bathing are also transmis-
sion sites.

Several species of wild animals and even cattle, have been con-
sidered to be possible reservoirs of S. mansoni but their role in the epi-
demiology of schistosomiasis has not been clarified.

III. ÉCOLOGIE HUMAINE ET SCHISTOSOMIASIS

Au Brésil, la zone traditionnelle d’endémie s’inscrit dans des rai-
sons biologiques relativement bien peuplées. Autour de João Pessos,
Recife, Macaúba, Salvador, Belo Horizonte ou de São Paulo, la densi-

voire plus de 100 habitants/km². L’aire d’extension récente de l’endém-

mie (postérieure à la Deuxième Guerre mondiale) comporte des densi-
tés extrêmement faibles: jusqu’à 10 habitants/km² le long des rivières du
Sao Francisco et de l’Ouro Preto. En revanche, dans le Maranhão, la densité n’est jamais supérieure à
100 habitants/km², tout particulièrement dans l’aire occidentale. La schisto-
mosis a été introduite il y a plus de 50 ans, correspondant à l’aire de
distribution de l’Aulacophorus, qui est à l’époque de la transmission de
l’endémie il y a plus de 50 ans, correspondant à l’aire de
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The recurrence of schistosomiasis and its spread during the 1950s resulted from migration from the north-east, dispersed either northwards, along the trans-Amazonian highway, or towards the centre and south of Brazil. Between 1967 and 1969, 94.4% of the cases of S. mansoni infection reported in the Federal District of Brasilia occurred in persons who had originally lived in the Rio Grande do Norte, Paraíba, Pernambuco, Alagoas and Sergipe States and in the coastal region between Aracaju and Vitória in Espírito Santo. In 1972 at a health post on the trans-Amazonian highway, numerous cases of schistosomiasis were reported from the same States. In São Paulo the origin of cases was identical (28).

With over 65 million rural inhabitants Brazil therefore still has a large population at risk to be infected by schistosomiasis. Interventional control programmes have effectively reduced morbidity; however, the potential risk of transmission still exists throughout the endemic area, particularly near the numerous man-made bodies of water.

The recurrence of the schistosomiasis and its large diffusion in the years 1950s and 1960s resulted from migration from the north-east, dispersed either northwards, along the trans-Amazonian highway, or towards the centre and south of Brazil. Between 1967 and 1969, 94.4% of the cases of S. mansoni infection reported in the Federal District of Brasilia occurred in persons who had originally lived in the Rio Grande do Norte, Paraíba, Pernambuco, Alagoas and Sergipe States and in the coastal region between Aracaju and Vitória in Espírito Santo. In 1972 at a health post on the trans-Amazonian highway, numerous cases of schistosomiasis were reported from the same States. In São Paulo the origin of cases was identical (28).

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Note: the majority of the data in this table is derived from the 1972 survey (28). The survey was undertaken among school-age children, 7-14 years of age and the specimen were examined by focal sedimentation (SS). The localities are not identified on the map, nor are they followed by a symbol.

The data of localities followed by the symbol • was derived from a 1960 survey of school children (25). In the case that the data was similar to that of 1972 the symbols o0 were used. If the data was similar between the 1960, 1972 and the 1978 surveys the symbols oo were used.

Les noms de localités suivis du signe • sont des renseignements fournis par l’enquête de 1970 portant sur une population scolaire de âge (de 7 à 14 ans), les prélèvements étant traités par la méthode de sédimentation des sels SS-28. Les noms des localités concernées ne portent pas de signe distinctif.

Les noms de localités suivis du signe o sont des renseignements fournis par l’enquête de 1960 portant sur une population scolaire de âge (de 7 à 14 ans), les prélèvements étant traités par la méthode Kato (53).

Dans le cas où une localité entre dans la même classe de prévalence en 1972 et en 1978, elle est signalée par le signe •.

Certs Eo rest assis l'objet d'études particulières qui sont alors mentionnées individuellement dans l'État concerné, elles s'ajoutent éventuellement aux enquêtes précédentes.

PARA
P. 0 Belém • Curuçá • Fordlandia • Igarapé-Açu • Monte Alegre • Nova Timbó • Santa Isabel de Fer • Santarém •
P. 0 Acre • Itaituba •
P. 0 Amapã • Prainsa •
AMAPA
P. 0 Amapã • Dep. Macapá •
Marañão
The data of localities followed by the symbol • was derived from a 1960 survey of school children (25). In the case the data was similar to that of 1972 the symbols oo were used. If the data was similar between the 1960, 1972 and the 1978 surveys the symbols oo were used.

Les noms de localités suivis du signe • sont des renseignements fournis par l’enquête de 1960 portant sur une population scolaire (o). Dans le cas où ce renseignement s'ajoute à celui de 1972, la localité est signalée par oo et par oo elle est aussi concernée par les renseignements de 1978.

P. 0 Macapá • Ana Teles • Belém • Belterra • Cachoeira • Epitacu • Itaituba • Macapá • Marabá • Macapá • Manaus • Porto Velho • Porto Velho • Santarém •
P. 1 Amapã • Amapã • Belém • Belterra • Cachoeira • Epitacu • Itaituba • Macapá • Marabá • Manaus • Porto Velho • Porto Velho • Santarém •
P. 2 Amapã • Amapã • Belém • Belterra • Cachoeira • Epitacu • Itaituba • Macapá • Marabá • Manaus • Porto Velho • Porto Velho • Santarém •