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SNAIL HOST CONTROL IN THE EASTERN COASTAL AREAS OF NORTH-EAST (NE) BRAZIL

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Schistosomiasis control in NE Brazil

In recent years a schistosomiasis control programme of unprecedented proportions, involving chemotherapy and, to a lesser extent, focal molluscicíding, was undertaken in Brazil (Machado, 1982). This Special Programme for Schistosomiasis Control (or PECE) was concentrated in the endemic areas of NE Brazil, which had long been characterized by high prevalence rates (Camargo, 1981). Although a full account of the results of the PECE programme has yet to be published, it would appear from the limited data which is available that its implementation has only resulted in a decrease of about 15.7% in the prevalence rate in the NE (from 25.2% in 1976 to 9.5%, on average) (LIMA, 1984).

In some of the areas included in the PECE programme, however, the reduction in prevalence was well below the average, despite the application of massive financial and human resources (SUCAM, 1984). For instance, in the State of Pernambuco the prevalence has dropped by only 8.5%, from 22.4% to 13.9%, although nearly 50% of the population of 2.3 million had been treated with drugs, and 40% of the 18.080 transmission sites identified had been treated with molluscicides (SUCAM, unpublished).

It is possible that this failure to reduce schistosomiasis to satisfactory levels in some endemic areas of the NE might have been avoided if other preventive measures such as sanitation, controlled water supply and health education had been implemented as well. Indeed, when this was done in small settlements such as Santo Antonio dos Palmares in Southern Pernambuco, the prevalence decreased markedly from 50% to 0.4%, between 1977 and 1981 (SUCAM, unpublished).

Another possible reason for the comparative lack of success was that these areas are so complex epidemiologically that they cannot be dealt with effectively by chemotherapy or molluscicíding without detailed prior planning. Similar views have been expressed on the basis of results obtained from other control programmes (Degremont, 1973; Evans, 1983; Jordan, 1985). For snail control, in particular, it is evident that the distribution, and if possible, the demographic characteristics of the snail populations in the catchment areas of the transmission sites should be known prior to the application of control measures (Thomas & Tait, 1984; Marti et al., 1985). The results given below, which are based on studies carried out in NE Brazil, provide a further illustration of the need to adopt a holistic approach and to take the complexity of the environment into account when planning control measures.

Physiographical diversity within NE Brazil

The area of NE Brazil where the snail hosts of schistosomiasis occur exhibits a great deal of diversity in terms of vegetation, climate and land use (Fig. 1). These features are discussed in some detail below.

The following vegetation types occur in the region (Kuhlman, 1977): (i) The coastal vegetation, which occupies a narrow strip consisting of beaches, sand dunes, mangroves and salt-marshes; (ii) a coastal rainforest or "mata umida", followed by (iii) a zone of transitional vegetation ("mata seca" and "agreste"); and (iv) a xeromorphic "caatinga". Relatively small, scattered areas of "cerrado", a savanna-type of vegetation, also occur in the region (Fig. 1A).

As regards temperature, the region can be divided into zones with mean annual temperature of 20, 22 and 24 ^{o}C, and minimum annual temperature of 8, 12 and 16 ^{o}C respectively (Nimer, 1977). The highest temperatures occur in the northern part, the lowest, in the central areas, and the intermediate temperatures, in the coastal areas (Fig. 1B and 1C).

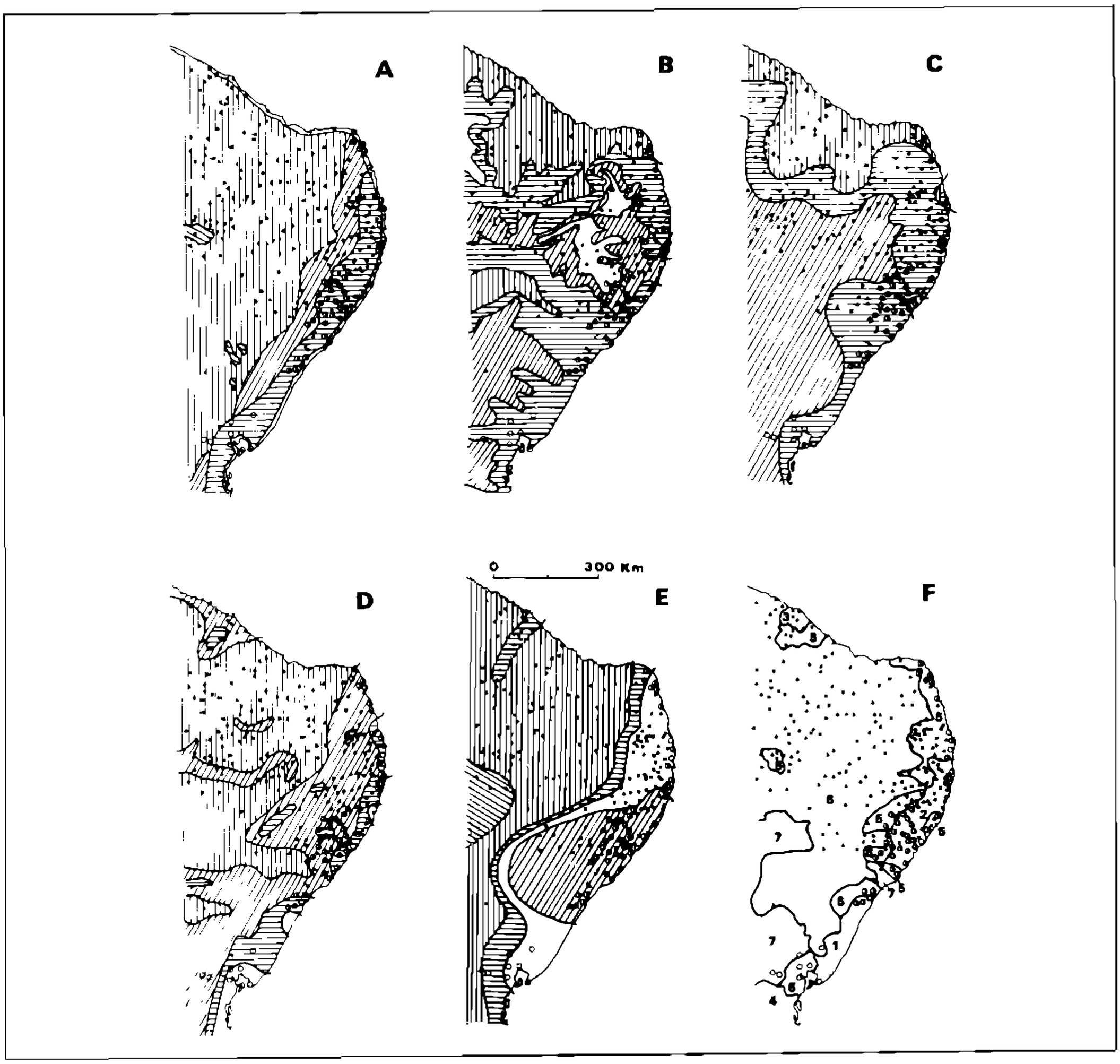

Fig. 1 : occurrence of host snails of schistosomiasis in NE Brazil between the coast and the coordinates 40°W2°S and 40°W14°S in relation to vegetation, climate and land use. The diagrams were obtained by plotting the localities listed by Paraense (1977), and superimposing the relevant patterns of vegetation (Kuhlman, 1977), temperature and rainfall (Nimer, 1977), and land use (Silva, 1977) accordingly. Localities with *Biomphalaria straminea* only, *Biomphalaria glabrata* only and with both species are indicated with ●, ○ and ◑, respectively.

A. Types of vegetation
- Coastal
- Tropical rainforest ("mata úmida")
- Transition zone ("mata seca" and "agreste")
- "Caatinga"
- "Cerrado"

B. Mean temperature
- 26 °C
- 24 °C
- 22 °C
- 20 °C

C. Minimum temperature
- 16 °C
- 12 °C
- 8 °C

D. Number of dry months
- None (super-humid)
- 1-3 (humid)
- 4-6 (semi-humid)
- 7-10 (semi-arid)

E. Three consecutive months of maximum rainfall
- JFM (January to March)
- FMA (February to April)
- MAM (March to May)
- AMJ (April to June)
- MJJ (May to July)

F. Main land use
1. Fruit culture
2. Sugar cane
3. Banana (hills) and cashew (coast) culture
4. Cocoa culture and cattle raising
5. Diversified agriculture
6. Cattle ranching
7. Cattle ranching and alimentary agriculture
8. Tobaccoculture and cattle ranching

In terms of rainfall, the region can be divided into super-humid, humid, semi-humid and semi-arid areas, according to the number of dry months (Nimer, 1977). The more humid areas are located near the eastern part, whereas the drier ones are in the northern and western parts (Fig. 1D). There are also differences in the seasonal distribution of rainfall in the region (Nimer, 1977). Thus, the rainy period tends to occur early in the year (January-April) in the drier north and west, and later (April-July) in the eastern and coastal areas (Fig. 1E).

Eight patterns of agrarian activity can be distinguished in the region (Silva, 1977). The coastal areas are used mainly for industrial or subsistence agriculture (1, 2, 3, 4, 5 and 8 in Fig. 1F), whereas the more central part is dominated by cattle ranching (6 and 7 in Fig. 1F).

In view of this diversity it is necessary to consider each ecological zone separately when evaluating possible snail control strategies. In the present account attention will be focused on the vegetation, climate and snail habitats in the eastern coastal area of the NE.

Vegetation and climate in the eastern coastal areas of NE Brazil

The eastern coastal zone of the NE, in which most of the endemic areas in the states of Rio Grande do Norte, Paraíba, Pernambuco, Alagoas and Sergipe occur, is relatively homogeneous. This makes it more likely that studies on snail ecology in a specific area will apply to others within the zone. When the patterns of vegetation and climate in this zone are superimposed (Fig. 2), it may be seen that the distribution of *Biomphalaria glabrata*, which is almost invariably associated with schistosomiasis (Paraense, 1977), is confined to an area characterized by an overlap of the following: (i) non saline coastal or rainforest vegetation, (ii) minimum yearly temperature between 12 and 16 ^{o}C, (iii) up to six dry months annualy and (iv) maximum rainfall between May and July. The main physiographical features of this zone are as follows:

Geologically, it consists of (i) recent (Holocene) deposits of alluvial, colluvial and marine origins, and (ii) tertiary (Pliocene) formations, known as "barreiras". The former occur in the lower, levelled areas of the coast ("baixada litoranea"); the latter are distributed in plateaux ("tabuleiros") of low altitude (50 to 150 meters) lying over the bedrock and following irregularly the coastal lowlands (Moreira, 1977).

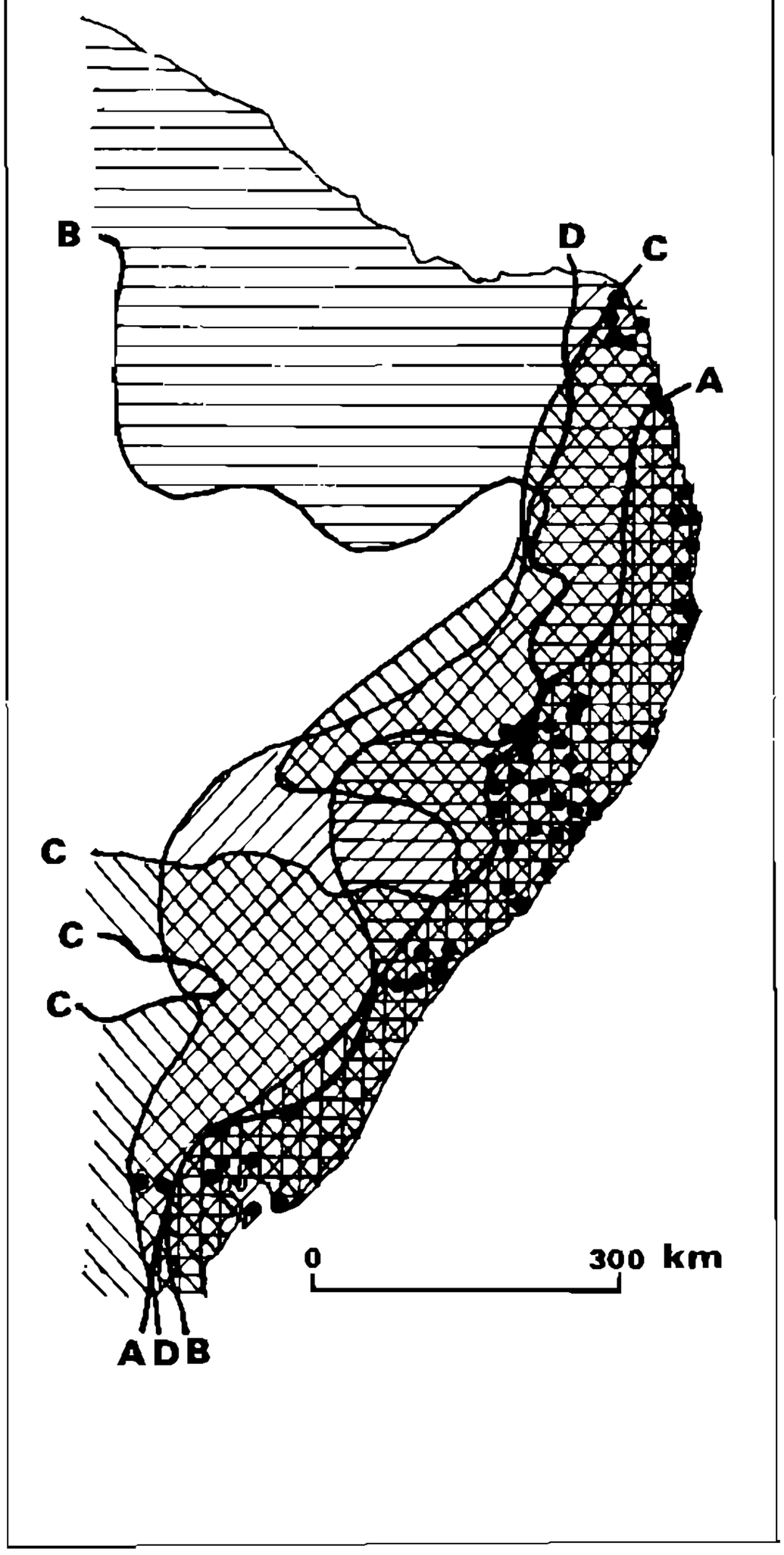

Fig. 2: vegetation and climatic patterns prevailing in the areas of occurrence of *Biomphalaria glabrata* in NE Brazil. The lines indicated by letters correspond to the western limits of a given pattern, as shown in Fig. 1. Black circles indicate the occurrences of *B. glabrata* according to Paraense (1977).

- A. Coastal and rainforest vegetation.
- B. Minimum yearly temperature between 12 and 16 ^{o}C.
- C. Up to six dry months.
- D. Maximum rainfall between March and July.

The following vegetation patterns are associated with particular topographical features (Kuhlman, 1977): (i) coastal communities in the lowlands or beaches, dunes, salt marshes and coastal terraces in the vicinity of the seashore; (ii) fresh-water marshland communities in the proximity of water-courses and on humid or wet plains; (iii) semiperennial coastal rainforest, which occur on the tertiary plateaux. These communities, however, have been extensively altered by the development of both subsistence and cash-crop agriculture (sugar-cane mainly, but also coconut and cassava).

Ecological features of snail habitats in the eastern coastal areas of NE Brazil

The transmission sites located in urban areas of the eastern coastal zone of the NE are mainly small lotic or lentic habitats in the vicinity of houses. These habitats originate as small trickles either from springs or tap-water and other waste-water runoffs. After flowing relatively slowly in shallow gulies or drains, they enter heavily vegetated swampy areas. Since only a few of the houses have soak-away devices, in the majority of cases the water from latrines runs directly to the streams. There is little doubt that the snail habitats are also frequently contamined by local people disposing of faecal material into the gullies or defecating in the bushes nearby. During times of flood in the wet season the snails are liable to be washed out of the permanent habitats into the streets and even into houses. As the children, in particular, walk about in bare feet it is to be expected that the probability of cercarial success in locating a human host is greatly increased at that time.

Although there are considerable differences in the water volume between the rainy and the dry season, the constant runoff from taps and latrines at the catchment areas prevents the streams and swamps from drying out completely. Neither are the small head-water streams, swamps and pools subjected to any marked changes in water level or flow rates. The streams, though small, are plentifully endowed with small back-waters. As the latter have depositing sediments rich in organic matter, it would appear the snails have a plentiful food supply. The habitats are shaded by water-side trees and subaquatic plants, and the latter also provide the snails with a substrate for oviposition and for feeding on epiphytes.

Snail refugia in swampy head-waters or springs with subaquatic plants, such as *Commelina* and *Cyperus* species, are likely to be particularly important in maintaining stable snail populations. They tend to be neglected by the epidemiologists in charge of control programmes as the work is generaly delegated to unskilled labour. Such snail foci could easily be overlooked by an untrained person and, as result, recolonization could quickly occur after snails in the main streams had been eliminated by mollusciciding.

Suggested manipulations to control the snail hosts

The above considerations enable to suggest the following environmental manipulations aiming to control or exclude the snail hosts in endemic areas of the eastern coastal zone of NE Brazil:

(i) Implementation of efficient surface drainage including the provision of soak-away systems and the canalization of waste-water preferably underground.
(ii) Elimination of head-water swamps and springs which act as major snail refugia.
(iii) Dredging and straightening of streams to reduce the area of depositing sediments rich in detritus.
(iv) Exclusion of subaquatic vegetation, particularly those species of Graminae and Cyperacea which encroach into the water.
(v) Judicious application of molluscicides in the catchment areas, including those habitats not directly implicated with transmission but which may act as refugia for the snail hosts.

Following the experimental phase to test the efficacy of the above measures in the field, the ones which prove to be successful could be implemented as part of a morbidity control programme (McCullough, 1986), preferably as a part of a primary health care scheme involving the community at risk on a self-help basis (WHO, 1980).

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