Lutzomyia (Nyssomyia) whitmani s.l. (Antunes & Coutinho, 1939) (Diptera: Psychodidae: Phlebotominae): geographical distribution and the epidemiology of American cutaneous leishmaniasis in Brazil – Mini-review

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The aim of the present study, in view of the widespread geographical distribution of Lutzomyia (Nyssomyia) whitmani s.l. *in Brazil, in close association with the regions of transmission of* Leishmania (Viannia) braziliensis *and* L. (V.) shawi*, is to investigate the distribution of this sand fly species and American cutaneous leishmaniasis (ACL) in relationship to vegetation and landscape ecology throughout Brazil. Thematic maps were elaborated by the MapInfo programme, giving information on the spatial distribution of* L. whitmani s.l.*, in accordance with types of vegetation and foci of ACL. With regards to the known areas of transmission of ACL in Brazil, it is notable that* L. (N.) whitmani s.l. *occurs in most of them, where it has been implicated as a possible vector of* L. (V.) braziliensis*. The presence of* L. whitmani s.l. *has been registered in 26 states, the one exception being Santa Catarina; in some states such as Roraima, Acre, Tocantins, and Mato Grosso do Sul this sand fly species has been recorded in a large number of municipalities*. L. whitmani s.l. *has been found in association with a variety of vegetation types, including the Amazonian forest, savanna ("campos cerrados"), and north-eastern savanna ("caatingas nordestinas" or "savana estépica").*

Key words: *Lutzomyia (Nyssomyia) whitmani s.l .- Leishmania (Viannia) braziliensis - Leishmania (Viannia) shawi* - eco-epidemiology - American cutaneous leishmaniasis

Among the more serious health problems affecting the Brazilian population, the leishmaniases have been given special attention by the Brazilian Health Authorities.

American cutaneous leishmaniasis (ACL) has been registered in all Brazilian states: initially its presence was principally the consequence of man's continuous intrusion into the sylvatic cycle of transmission among the wild animal hosts of *Leishmania* species and their sand fly vectors, during such activities as deforestation for agriculture, wood and mineral exploitation, the construction of roads through forested regions, and the building of hydroelectric dams (Lainson 1988). In relatively recent times, however, another epidemiological profile of the disease has been seen on the outskirts of urban areas (Rangel 1995, Rangel & Lainson 2003). This has been due to man's continuing destruction of the natural sylvatic habitat of sand fly vectors, some of which have needed to adapt to a peridomiciliary or even an intradomiciliary environment in order to survive. In all these situations ACL may be considered as a social and economic problem of the poor population which has resulted largely from an intense migratory movement into rural areas and the forested hillsides that are close to the outskirts of the urban centres (Rangel et al. 1990, Rangel 1995).

In Brazil, ACL is associated with a diversity of dermotropic *Leishmania* species within the subgenera *Viannia* and *Leishmania*. Transmission is by a variety of sand fly species, and this results in different transmission cycles in the various geographical regions. In this context *L. (V.) braziliensis* has received special attention, as it is distributed in every Brazilian state and its transmission is associated with such sand fly vectors as *Lutzomyia (Psychodopygus) wellcomei*, *L. (P.) complexa, L. migonei, L. (N.) whitmani s.l.*, and *L. (N.) intermedia* (Rangel 1995, Lainson & Shaw 2005, Rangel & Lainson 2003).

Faced with the magnitude of this problem, the National Programme of Leishmaniases, of the Brazilian Ministry of Health, has made a study of ACL in distinct epidemiological situations, in an attempt to relate the frequency of human cases with socio-environmental variables according to epidemiological circuits ("The spatial epidemiological circuits producing cutaneous leishmaniasis extends as an extensive, continuous and complex region. It is determined by way of the elevated concentration of cases during a determinate period, mostly overlapping more than one municipality. It does not form a homogeneous area, but is composed of areas with dif-

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ferent levels in the density of cases. The circuits are due to individual and dynamic socio-environmental processes which may show a tendency to either expand or contract, according to the characteristics of their determinantes"; http://portal.saude.gov.br/portal/arequivos/pdf/boletim eletronico_05_ano02.pdf).

At present in Brazil, it is possible to diagnose important transmission foci throughout the whole country.

The sand fly *L. (N.) whitmani s.l.* has been considered a vector of *L. (V.) braziliensis* in Northeastern, Southeastern, Central, and Southern Brazil; in the North it is also a vector of *L. (V.) shawi* among wild animal reservoir hosts. In view of this, the aim of the present study was to investigate the distribution of *L. (N.) whitmani s.l.* and ACL in relationship to vegetation and landscape ecology throughout the country.

MATERIALS AND METHODS

For the location of Brazilian municipalities where the presence of *L. (N.) whitmani s.l* has been registered, data from scientific articles, review chapters in textbooks, and all available information from the State Health Departments (Leishmaniases Programme, Entomological Survey) were consulted. All this information was tabulated in an EXCEL Programme, including the code of each municipality, and a variable related to the presence of *L. (N.) whitmani s.l.*.

In order to prepare thematic maps within the MapInfo programme, the epidemiological variables were grouped as follows: map of Brazil with the division into states and municipalities, since 1997; map of the spatial distribution of *L. (N.) whitmani s.l.,* as indicted by its recorded presence, or without information, in the different municipalities investigated; map of Brazil with the transmission foci of ACL during the period 1999-2004.

This MapInfo programme permits one to map the distribution of the above-mentioned data concerning the presence of this vector in the different municipalities by superimposing the transmission foci and spread of ACL during 1999-2004. Later, the data were applied to a Geographic Information System – GIS, used with the object of mapping the spatial distribution of the data obtained from the various sources and, for this purpose, a data bank was created, by which a table was produced indicating the municipalities in which the presence of *L. (N.) whitmani s.l.* had been registered.

A map of the different Brazilian vegetation regions was used to correlate the different ecological types with the presence of *L. (N.) whitmani s.l.* (http://hidroweb.ana.gov.br).

RESULTS

Two maps were created by the above-mentioned superimposition, which enabled one to visualize the distribution of *L. (N.) whitmani s.l* in the different Brazilian municipalities in association with the different types of vegetation and active transmission of ACL (Fig. 1A, B).

Spatialization - The obtained data indicated that *L. (N.) whitmani s.l.* was recorded in 720 Brazilian municipalities and distributed throughout 26 states, with the exception of Santa Catarina. The states of Roraima, Acre, Tocantins, and Mato Grosso do Sul presented the largest number of municipalities in which this sand fly had been collected.

Distribution and vegetation - The relationship between the type of vegetation and the occurrence of *L. (N.) whitmani s.l.*, evidenced the presence of sand flies in a diversity of vegetation, including the Amazonian forest, representative areas of "dense rain-forest", "open rain-forest", and "mixed rain-forest". Also included were "savanna" (campos cerrados), "northeastern savanna" (caatingas nordestinas or savana estépica) and the Atlantic primary forest (Fig. 1A, B).

Epidemiology - With regard to the known areas of transmission of ACL in Brazil, it is notable that *L. (N.) whitmani s.l.* occurs in most of them, where it is the suggested vector of *L. (V.) braziliensis*. This sand fly species has been associated with ACL epidemiological circuits (Fig. 1B). In the North, notable transmission areas that merit attention include the states of Acre, Rondônia, Pará, and Amapá, while in the Northeast, Southeast, South, and Central-west, this sand fly occurs in some endemic areas in Maranhão, Ceará, Pernambuco, Bahia, Minas Gerais, São Paulo, Paraná, Mato Grosso, Mato Grosso do Sul, and the Federal District.

DISCUSSION

Many publications have discussed the extensive geographical distribution of *L. (N.) whitmani s.l.* in Brazil, and/ or other countries of the American Continent as French Guyana, Peru, Paraguay, and Argentina, where this species has been recorded (Martins et al. 1978, Young & Duncan 1994, Aguiar & Medeiros 2003, Rangel & Lainson 2003).

Drastic alterations in the environment have modified the ecology of some species of *Leishmania* and their sand fly vectors and, consequently, the epidemiology of the leishmaniases. In the new epidemiological situation that emerges from deforestation, some wild mammalian hosts of the parasite may invade areas inhabited by man, where there are sand flies that are either in the process of domiciliation or totally adapted to the new environment. With eclectic feeding habits, such sand flies would be able to transmit the parasite between humans and domestic mammals.

Lainson (1988) discussed the taxonomic status of *L. (N.) whitmani s.l.*, and, in view of the records of its presence in very different habitats, and in particular its non-anthropophilic and arboreal habits in primary and secondary Amazonian forest, suggested that *L. (N.) whitmani s.l.* could possibly be a complex of cryptic species. Rangel et al. (1996) analyzing morphometric and biological characters, as well as, the repetitive DNA sequence, showed the first evidences suggesting the occurrence of two geographically-isolated populations of *L. (N.) whitmani s.l* in Brazil. It has also been suggested, however, that *L. (N.) whitmani s.l.* might represent a notable example of high tolerance of an insect to drastic ecological changes – a very important factor to consider in studies on the ecology of the leishmaniases (Peterson & Shaw 2003).

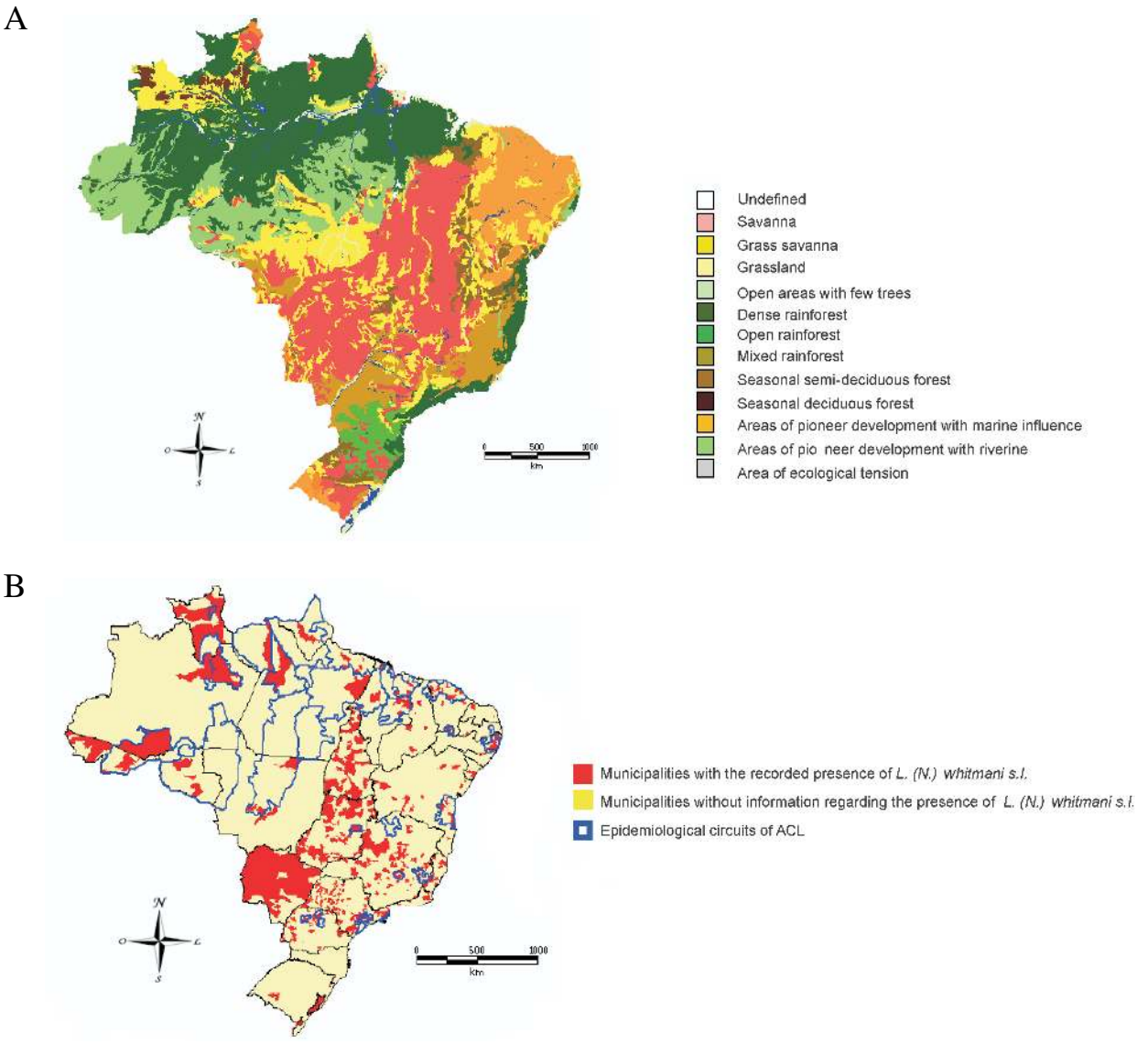

Fig. 1A: types of vegetation in Brazil; B: transmission areae of American cutaneous leishmaniasis (ACL) in association with the presence of *Lutzomyia (Nyssomyia) whitmani s.l.* in Brazil.

The data obtained in the present study confirm the widespread occurrence of *L. (N.) whitmani s.l.,* by recording the presence of this sand fly in a great number of municipalities in all the Brazilian states, excepting one, and thus in all of the country's five geographical regions. In addition to its extensive territorial distribution and association with very different vegetation types, as shown in the present study, *L. (N.) whitmani s.l* adapts to variable climatic conditions and, as a result, can be collected throughout the year. It appears to be most abundant, however, during the cooler months of June, July, and August (Souza et al. 2002, Teodoro et al. 2003). This indicates that it could be the species which most readily tolerates the drastic environmental changes found in areas devastated by man. Teodoro et al. (1999) noted that in spite of the felling of trees and the application of insecticide along the edge of the forest, there was an increase in the population of *L. (N.) whitmani s.l.*

In primary forest of Pará, North Brazil, *L. (N.) whitmani s.l.*, is considered as a vector of *L (V.) shawi* among the forest animal hosts. In view of the reluctance of this sand fly to bite man, its absence in and around houses and the abundant cases of human ACL due to this parasite in this environment (i.e. in Amazônia, Amapá, and Pará), it is likely that another, anthropophilic sand fly is involved in the epidemiology of ACL (R Lainson, pers. commun.). In an endemic area of ACL in the state of Acre, *L. (N.) whitmani s.l.* is thought to be the most likely vector of *L. (V.) braziliensis*, considered by the State's Secretary of Health to be the major agent of the disease in that region (Tojal 2003, Azevedo et al. 2005).

In the state of Tocantins the transmission cycle/s of ACL is/are at present ill-defined, but the disease is of considerable interest because of its occurrence in practically all of the municipalities of the state and the high percentage of cases of mucocutaneous leishmaniasis

(8.5%). Interestingly, the distribution of *L. (N.) whitmani s.l.* matches that of the cases of ACL, leading to the suggestion that it may be the vector (Vilela et al. 2005).

L. (V.) braziliensis is the parasite largely responsible for ACL in Northeastern, Southeastern, Southern, and Central-west Brazil. Significant areas of transmission are located in the states of Maranhão, Ceará, Pernambuco, Bahia, Minas Gerais, São Paulo, Paraná, Mato Grosso, and the Federal District, where *L. (N.) whitmani s.l.* populations inhabit domiciliary environments. These populations present two basic epidemiological criteria for the incrimination of a vector, namely the presence of a sand fly which is highly anthropophilic, and the coincidental presence of cases of ACL. In this respect, it should be noted that this sand fly species has already been found infected by *L. (V.) braziliensis* in Ceará, Bahia, and Paraná (Hoch et al. 1986, Azevedo et al. 1990, Luz et al. 2000). Although epidemiological circuits of ACL have not yet been defined in the state of Mato Grosso do Sul, ACL has been registered in all its municipalities, and it is of particular interest that *L. whitmani s.l.* is to be found throughout the larger part of this state and in view of the fact that this sand fly has been found naturally infected with *L. (V.) braziliensis*, is indicated as a likely vector of this parasite in that part of Brazil (Rangel & Lainson 2003). *L. (N.) whitmani s.l.* has not been registered in some endemic areas for ACL; this could be explained, in part, by the lack of entomological survey.

Whether or not *L. (N.) whitmani s.l.* is in fact a complex of cryptic species, this sand fly, or group of sand flies, is clearly of great importance in the epidemiology of ACL. Working with ecological niche models, Peterson and Shaw (2003) predicted that with its capacity to survive environmental changes and to adapt to new ecological niches, *L. (N.) whitmani s.l.* could be capable of tolerating the effects of global climatic alterations. They emphasized the important role of *L. (N.) whitmani s.l.* as a vector of ACL in Southeastern Brazil, due to its wide distribution and close association with humans in the peridomiciliary environment.

Without doubt, a new epidemiological profile has resulted from drastic environmental alterations, largely of human origin, and in consequence there has been a partial or complete domiciliation of some sand fly species. Beyond the important fact that *L. (N.) whitmani s.l.* is so frequently present in the areas of active transmission of ACL due to *L. (V.) braziliensis*, there exists further proof of its vectorial efficiency by its role as the vector of at least one other causative agent, *L. (V.) shawi*, in Amazônia.

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