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## Domestic and Peridomestic Transmission of American Cutaneous Leishmaniasis: Changing Epidemiological Patterns Present New Control Opportunities

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*Predictions that deforestation would reduce American cutaneous leishmaniasis incidence have proved incorrect. Presentations at a recent international workshop, instead, demonstrated frequent domestication of transmission throughout Latin America. While posing new threats, this process also increases the effectiveness of vector control in and around houses. New approaches for sand fly control and effective targeting of resources are reviewed.*

Key words: American cutaneous leishmaniasis - deforestation - domestication - transmission - control

In undisturbed Neotropical forests, the *Leishmania* species which cause American cutaneous leishmaniasis (ACL) and mucocutaneous leishmaniasis (MCL), are transmitted amongst sylvatic mammals by the bite of phlebotomine sand flies. The close association between forest, wild mammal reservoirs and sand flies has previously led to predictions that deforestation would lead to local eradication of some of the most important *Leishmania* species, including *Leishmania braziliensis* in the State of São Paulo, Brazil (Sampaio 1951), and *Leishmania panamensis* in Panama (Herrer & Christensen 1976).

Presentations at a recent EUROLEISH workshop (August 26, Montpellier, France) demonstrated that such optimistic predictions were far from accurate. Researchers from throughout South America described how the unprecedented deforestation of recent decades has instead been accom-

panied by an increase in ACL and MCL cases, and documented various examples of sand fly and *Leishmania* species responding to human encroachment by invading the domestic environment. The increasing importance of domestic transmission is leading to reconsideration of the view that "cutaneous leishmaniasis and mucocutaneous leishmaniasis in the New World can, for the most part, be considered occupational diseases since they are directly related to professional activities in enzootic areas, especially in forests" (WHO 1990).

E Martinez (La Paz, Bolivia) described the recent definition of the role of *Lutzomyia nuneztovari anglesi* as a domestic vector of *L. amazonensis* in the new sub-Andean focus of Cajuta, Bolivia (Martinez et al. 1998). *Lu. n. anglesi* was incriminated on the basis of repeated isolation and culture of the same parasite species from sand flies as from human patients, high sand fly densities inside houses, high anthropophily, and similar geographical distributions of sand flies and human cases (Martinez et al. 1999). *L. amazonensis* had not previously been isolated from *Lu. n. anglesi*, which acts as a domestic vector for *L. braziliensis* elsewhere in Bolivia (Torrez et al. 1999). This site is at a relatively high altitude (1450-2100 m a.s.l.) suggesting possible expansion of the distribution of *L. amazonensis* from previously reported foci in the lowlands of Bolivia, where it had been considered a sylvatic parasite. Infections were detected in dogs, adding to the accumulating indirect evi-

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dence that dogs act as alternative reservoirs for a range of cutaneous leishmaniasis parasites (Reithinger & Davies 1999).

E Perez (Lima, Peru) gave an account of *L. peruviana* transmission by *Lu. verrucarum* and *Lu. peruensis* in the Andean highlands of Peru. In this region, transmission is overwhelmingly domestic, possibly involving domestic dogs as reservoir hosts, with indoor (rather than peridomestic) sand fly abundance providing the best predictor of transmission rate in humans. Further evidence for indoor transmission was provided by a case-control study, which identified significant house-related risk factors, and by the absence of any relationship between risk and either age or gender. However, evidence from the case-control study and from a village-based cohort study both demonstrated that risk increased with nocturnal visits to crops (e.g. for irrigation).

MD Feliciangeli (Maracay, Venezuela) described how an analysis of over 41,250 cases of cutaneous leishmaniasis reported in Venezuela reveals an increase from approximately 600 cases/year in 1955 to 2000/yr in 1998, and a spread from sylvatic to peridomestic/domestic (Feliciangeli 1997) and even peri-urban foci (MD Feliciangeli, unpublished data). This trend has also been accompanied by a recent increase in transmission of visceral leishmaniasis [caused by *L. infantum/chagasi* and transmitted by *Lu. longipalpis* (Feliciangeli et al. 1999)] and an emergence in peri-urban areas, associated with an increase in poverty and malnutrition (Aguilar et al. 1998). Full descriptions of reported cases are now organized in a Geographical Information System (GIS) format, allowing the rapid mapping of changes in the geographic, ecological and epidemiological pattern of transmission.

These examples constitute convincing evidence that the increasing domestication of cutaneous leishmaniasis transmission, already well characterized in deforested areas of Brazil (e.g. Tolezano 1994, Gomes 1994, Brandão-Filho et al. 1999), is widespread in Latin American.

#### OPPORTUNITIES FOR CONTROL

The consequent shift in the burden of disease towards children and women poses a new threat, but also presents new opportunities for control. Until recently, the interruption of ACL transmission has generally been considered unfeasible, due to its perceived sylvatic nature (Desjeux 1996). In domestic and peri-domestic transmission foci, however, interventions that decrease sand fly abundances and biting rates in and around houses may reduce disease incidence; some promising results were reported.

J-P Dujardin (La Paz, Bolivia) described early results of fieldwork in the Yungas region (Bolivia), where *Lu. n. anglesi* is a highly endophagic vector for *L. braziliensis*. Pyrethroid (deltamethrin) impregnated ribbons were placed around the doors and windows of bedrooms in three villages. The intervention resulted in a marked decrease in sand fly densities inside protected houses compared to unprotected controls, and most importantly, ACL incidence was also significantly lower in protected houses (one case/400 inhabitants) during the trial compared to the same period of the previous year (10/400: Fisher's exact test,  $P = 0.011$ ), or to the control houses (5/245: Fisher's exact test,  $P = 0.032$ ). E Martinez reported that the same intervention also greatly reduced the abundance of *Lu. n. anglesi* inside houses in the *L. amazonensis* focus, from an average of 40.8 females/CDC trap/night in unprotected control houses to 1.08 in protected houses.

E Perez described how indoor spraying of the insecticide lambda-cyhalothrin (ICON) reduced transmission of *L. peruviana* in recent trials in Peru, consistent with results of DDT trials in the 40's. Insecticide-treated bednets have also previously been demonstrated to protect users against the bites of the ACL vector *Lu. youngi* in Colombia (Alexander et al. 1995), and may therefore reduce domestic ACL transmission. Taken together, these results raise hopes for insecticide-based interventions in many foci.

#### LIMITATIONS AND FUTURE RESEARCH NEEDS

Such interventions may not always be effective, however. MD Feliciangeli described how the use of deltamethrin impregnated curtains had failed to reduce domestic abundance of *Lu. ovallesi* and *Lu. gomezi* in Venezuela, due to the practical difficulties of blocking all entrances to irregularly constructed house. This suggests that they will consequently reduce neither human-sand fly contact nor disease transmission.

A presentation by L Passerat de Silans (João Pessoa, Brazil) further illustrated the difficulties of controlling even exclusively domestic and peridomestic transmission cycles. In Northeast Brazil, pyrethroid insecticides (deltamethrin and cypermethrin) are applied inside and outside houses to control visceral leishmaniasis. Repeated entomological surveys showed that these measures significantly reduced sand fly densities inside all houses for approximately two months, but that densities subsequently returned to pre-control levels. Bioassays suggested that this was due to gradual loss of residual insecticide activity on the adobe house walls, which are typical of the region. Outdoor densities of *Lu. longipalpis* remained un-

affected throughout the trial period (Passerat de Silans et al. 1998).

These results illustrate the urgent requirement for a series of large scale intervention trials against the domestic transmission of ACL, in order to quantify the potential reduction in the burden of disease in a range of ecological settings. Even allowing for the development of appropriate control tools, the limited availability of health resources in most endemic countries will necessitate prioritization of interventions to where they will have greatest effect. For example, in São Paulo, Brazil, the current control policy for cutaneous leishmaniasis (transmitted domestically by *Lu. intermedia*) is to carry out house spraying only in localities with at least two notified cases (Gomes & Neves 1998).

Logistic constraints, however, mean that in most endemic areas case notification systems fail to achieve full geographic coverage and usually lack information on the particular parasite and vector species responsible. D Campbell-Lendrum (London, UK), described how GIS techniques may be used to extract maximum information from available data on intensity of leishmaniasis transmission and vector and parasite species. Ecological (e.g. temperature, vegetation) determinants of these distributions may be analyzed, and the observed relationships used to generate predictions for unsurveyed areas. These would improve estimates of the distribution of populations at risk, and of vector and parasite species, providing better evidence for allocation of control resources and the selection of appropriate interventions.

The final presentation and overall summary was made by P Desjeux (Geneva, Switzerland), representing the World Health Organization. Dr Desjeux thanked the workshop participants for raising awareness of the challenges posed by the changing epidemiological situation of the New World leishmaniasis. He stressed that research should continue on the characterization of complex zoonotic transmission cycles (both sylvatic and domestic), which continue to make control more challenging than for anthroponotic leishmaniasis diseases in other regions. The results of the few intervention trials presented in this workshop and elsewhere, however, offer sufficient encouragement to believe that cost-effective campaigns against domestic transmission of the New World leishmaniasis are an achievable goal. International co-operation will be essential to achieving this aim; vectors and parasites cross national boundaries, and this workshop confirmed that experience from one country is often of great relevance to others within the region. The sharing of research findings, the

central aim of the EUROLEISH workshops, is an essential first step on this path.

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