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LEISHMANIA AND LEISHMANIASIS OF THE NEW WORLD, WITH PARTICULAR REFERENCE TO BRAZIL

LEISHMANIA AND LEISHMANIASIS OF THE NEW WORLD, WITH PARTICULAR REFERENCE TO BRAZIL*

It is my intention, here, to discuss the parasites responsible for cutaneous and mucocutaneous leishmaniasis in the Americas, rather than the clinical manifestations of the diseases they may cause in man. Particular reference will be made to the taxonomy of the organisms, and to the epidemiologic situation in Brazil in the light of recent research.

The disease remains a major problem in Brazil where, as in most other parts of the New World, it is principally an occupational hazard of the forest worker. It is thus of considerable economic importance in this country, which is at present taking rapid developmental strides involving the exploration and clearing of large areas of virgin forest for agricultural or mineralogic purposes and the construction of extensive new road systems.

Because past emphasis has been placed largely on clinical aspects, there has resulted a bewildering array of terms, but little progress in our understanding of the organisms causing the disease. Thus, in textbooks, one may refer to "chiclero's ulcer," "Bay-sore," "pian-bois," "framboesiform," "verrucosal," or "nodular" leishmaniasis, "simple" and "mucocutaneous" leishmaniasis, "espundia," "ulcera de Bauru," "uta," and "anergic, diffuse cutaneous leishmaniasis".

If infection with *Leishmania* were restricted to man, such a classification might be excused, but the various forms of the disease in the Americas are zoonoses and stem from a wide variety of wild or domestic animals. Man is more correctly regarded, therefore, as an accidental host, who plays no important role in the maintenance of the parasites in nature. It should be remembered, too, that while a given

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Leishmania may produce an overall similar clinical picture, individual persons may react differently to the same parasite. Extreme examples of this are patients with anergic, diffuse cutaneous leishmaniasis. Due to their anergic condition, these unfortunate persons develop a particularly disfiguring and incurable infection in which large nodules may be scattered over most of the body. In immunologically competent subjects the same parasite produces a single ulcer or limited number of lesions, that are relatively easily treated. Finally, the aspect of the disease may vary greatly at different stages of the infection. Thus the mucocutaneous disease is initiated by a primary lesion that can develop anywhere on the body, and the nasopharyngeal destruction may only start as late as 15 to 20 years after the initial ulcer has disappeared and been forgotten. In pian-bois there may also be metastatic spread from the primary sore, particularly along the lymphatics, to give ulcers scattered all over the body.

In general, then, taxonomy of the leishmanias on a clinical basis is unsound. Unfortunately, however, classification on a firmer, biologic basis has proved difficult in the past, because of the close similarity of both amastigote and promastigote stages of most of the parasites and our relative ignorance of the biology of the organisms.

In the New World, leishmaniasis extends from the Yucatan, Mexico, in the north, to Argentina in the south. In spite of the immense geographic area involved and the obvious ecologic differences in many of the regions, the tendency has been, for a long time, to attribute all the disease forms to a single parasite, Leishmania braziliensis (60). As constantly stressed by the late Saul Adler (1), however, "... use of one name L. braziliensis .... has been an important obstacle in the path of research." Although Velez (59) separated off the parasite responsible for uta in the Peruvian Andes as Leishmania peruviana, most authors still referred to it as L. braziliensis, in the face of completely different ecology and epidemiology for the two parasites.

The first serious attempts to separate off the different leishmanias were made by Biagi (17) and Floch (15) who referred to Leishmania tropica mexicana as the cause of chiclero's ulcer in

Mexico, Guatemala, and British Honduras, and L. tropica braziliensis as the parasite associated with mucocutaneous leishmaniasis in Brazil. The organism responsible for pian-bois in the Guyanas, uta in Peru, and cutaneous leishmaniasis in general in Panama and Costa Rica was simply referred to as L. tropica guyanensis. On the other hand, Pessôa (43) preferred to consider all these parasites as subspecies of Leishmania braziliensis, and called them L. braziliensis mexicana, L. braziliensis guyanensis, and L. braziliensis peruviana. He also included the name L. braziliensis pifanoi for the organism isolated from a case of anergic, diffuse cutaneous leishmaniasis, in Venezuela (37). Finally, Garnham (21) gave the parasite of chiclero's ulcer specific rank as Leishmania mexicana.

Up to now, one of the major obstacles in the way of taxonomy of the leishmanias of the neotropics was our poor knowledge of their life cycles. Very little was known, too, about their comparative serologic and immunologic characters. Adler (2) differentiated L. tropica, L. mexicana, and L. braziliensis by serologic techniques, while Lainson & Shaw (26) found that whereas a previous infection of man by L. braziliensis panamensis would protect him against L. mexicana mexicana, the reverse did not apply and L. m. mexicana did not protect against L. b. panamensis.

During the 1960's, efforts were largely devoted to the epidemiology of the various leishmanias of the New World, in the hope that a better understanding of the life cycles might throw some light on the control of the diseases caused by these parasites and, incidentally, provide evidence for better classification. In Panama (4) workers at the Gorgas Memorial Laboratories isolated a Leishmania from the heart-blood of the forest rodents Proechimys and Hoplomys. This Leishmania was generally considered as the same as that infecting man in that country, but attempts to find the parasite in other animals of these genera failed, and the significance of the blood infections in Proechimys and Hoplomys remained obscure. Forattini (16), again using NNN-medium culture of heart-blood, examined over 900 wild animals of several different species, in Brazil. Amastigotes were seen in skin lesions of a single agouti

(Dasyprocta sp.), and a forest rat (Kannabateomys); and promastigotes were isolated in the NNN cultures of heart-blood from a single paca (Cuniculus paca). As far as I know, however, the parasites were not studied further and their true nature remains unknown. In the same year, Alencar, et al. (3) reported on the isolation of promastigotes from the heart-blood of a domestic rat, in Ceará State, Brazil. Again, the exact nature of the infection is not certain.

During 1959-1962, work was started in British Honduras, Central America, in attempts to unravel the life cycle of Leishmania mexicana (32, 33, 34, 55, 56). The studies were concentrated, this time, principally on the skin of the wild animals, because experimental infections in both wild and laboratory animals had showed that the parasites were usually restricted to that issue. This hypothesis proved correct and L. mexicana was finally isolated from numerous specimens of forest rodents, including the genera Ototylomys, Heteromys, and Nyctomys, the parasites being localized in discrete skin lesions on the tail. Inoculation of the parasites into volunteers produced lesions typical of L. mexicana and the organism was successfully transmitted to another volunteer by the bite of an experimentally infected sandfly, Lutzomyia pessoana. Subsequent work in British Honduras and the Yucatan showed the natural vector of L. mexicana to be Lu. olmeca (8, 14, 65).

These observations provided a stimulus that quickly produced results elsewhere in the New World. In 1963, I had the good fortune to discuss our findings in British Honduras with Dr. Otis Causey, in his arbovirus laboratory at the Evandro Chagas Institute, Belém, Brazil. He mentioned having seen skin lesions on the tails of some of the rodents captured during his work in the forests around Belém, and promised to examine them for Leishmania at the next opportunity. Within 2 weeks he had uncovered a remarkably heavy focus of rodent leishmaniasis in the cricetid Oryzomys capito (39, 40, 41). Similar infections have since been found in the same region by Lainson and Shaw, in the spiny rat Proechimys and the opossum Marmosa (27, 29). The latter authors (28, and unpublished observations), extended their observations to new roads being built in the Mato Grosso and Amazon regions and found infections in Oryzomys capito, O. macconnelli, O. concolor, Proechimys guyannensis, Neacomys spinosus, Dasyprocta sp. (all Rodentia), and the marsupials Marmosa and Caluromys spp.. Infections of a similar nature have also been reported in Zygodontomys microtinus in Venezuela (25), in Oryzomys in Rio de Janeiro State, Brazil (54), and in Marmosa, Heteromys, and Oryzomys from Trinidad (58 and personal communication). In Panama, workers at the Gorgas Memorial Laboratories had isolated Leishmania from sloths, Bradypus infuscatus and Choloepus hoffmanni, procyonids, Potos flavus and Bassaricyon gabbii, and a marmoset, Saguinus geoffroyi (5, 6, 57). The parasite resembled that infecting man, and has generally been regarded as L. braziliensis. More recently Herrer, et al. (24) have found a second type of Leishmania that is very similar to L. mexicana, in the rodents Proechimys, Oryzomys, Diplomys, and Agouti, and the marsupial Marmosa.

In Brazil, it was first thought that the very common Leishmania of rodents and marsupials was that responsible for human cutaneous and mucocutaneous leishmaniasis in general. Some authors, indeed, referred to it as L. braziliensis (42). After a comparative study of several hundreds of isolates from man, wild animals, and sandflies, however, Lainson & Shaw (30, 31) concluded that the parasite was biologically quite different from L. braziliensis and named it Leishmania mexicana amazonensis. L. m. amazonensis in fact only rarely infects man because its vector, Lutzomyia flaviscutellata, is not an anthropophilic species (28, 51, 52).

From these and other studies, it became clear that some revised system of classification was urgently needed if utter confusion was to be avoided in subsequent literature on Leishmania and leishmaniasis. Lainson & Shaw (31) consequently divided the neotropical leishmanias causing cutaneous leishmaniasis into two major groups--the mexicana and the braziliensis complexes. This classification is reorganized here into a table form, and brought up to date with more recent information.

The enigmatic L. enriettii (38) is included in the mexicana complex (Table 6). Although not normally infective to the hamster, its behavior in the guinea pig is comparable with the development in the hamster, of other members of the mexicana group, with relatively rapid metastasis to the extremities. The unusually large amastigote of L. enriettii, up to 7.0 µm x 4.0 µm, enables ready differentiation from all other leishmanias, and this feature alone warrants specific rank within the mexicana complex. Discovered in a laboratory guinea pig in Curitiba, Paraná, Brazil, the parasite has never been encountered again and its natural host and vector remain unknown. In this respect it is curious that L. enriettii will not infect the wild guinea pig, Cavia aperea, from the same region of Brazil. How the infection was transmitted to the laboratory animal remains a mystery. It seems difficult to imagine that it was by the bite of an infected sandfly, under the circumstances described, and it remains possible that the infection originated in a guinea pig previously inoculated with material from a wild animal during some other study. No human infection with L. enriettii has yet been recorded, and attempts to infect volunteers with amastigotes and promastigotes apparently failed (38).

Leishmania mexicana pifanoi is known only from human cases of anergic, diffuse cutaneous leishmaniasis in Venezuela. It is very similar to L. m. amazonensis, and it indeed remains to be seen if it is not identical to that parasite. If this is so, the subspecific name of pifanoi will of course take preference over amazonensis, which would then become a synonym. Only future epidemiologic and other studies will resolve this point. In the meantime, it is convenient to refer to the parasite as L. m. pifanoi, within the mexicana complex (Table 4).

Leishmania peruviana is another parasite deserving specific rank, if only by virtue of its unique epidemiology. It is the only known causative agent of neotropical leishmaniasis in man which is not associated with forest, and which apparently has no wild animal reservoir. The disease, uta, occurs up to almost 3,000 meters on the barren slopes of the Peruvian Andes. The only known reservoir is the domestic dog; the vector is thought to be Lutzomyia verrucaram or Lu. peruensis (22) and the peridomestic nature of these sandflies has enabled an efficient control of the disease by DDT spraying. L. peruviana is somewhat difficult to classify as there is little available literature on its behavior in the laboratory. The lack of available strains of the parasite in hamsters and the difficulty in acquiring cultures suggest that L. peruviana certainly does not behave like an organism of the mexicana group. It is placed, therefore, in the braziliensis complex (Table 10).

Two new parasites have recently been discovered in Panama. One of these, as yet unnamed, (Table 5) is clearly closely related to L. m. amazonensis and may even prove to be identical. It infects wild rodents and opossums and is probably transmitted by Lutzomyia olmeca bicolor, a sandfly closely related to Lu. flaviscutellata (24). Human infections have not yet been reported, but it is possible that the situation is similar to that of L. m. amazonensis, with rare infections in man due to a vector generally reluctant to bite him. The other parasite has been given specific rank, Leishmania hertigi, due to its individual morphology (23). It appears to only infect the tree porcupine, Coendou rothschildi, in which it produces asymptomatic infection, with parasites scattered throughout the dermis. The organism grows very poorly in hamster skin, and has been included here with parasites of the braziliensis complex. It is not whether or not L. hertigi is capable of infecting man, and its vector is unknown.

It is appropriate, at this point, to mention new observations, either very recently published or in the process of being published, which have some bearing on the present discussion.

The Parasites and Reservoir Hosts

Chance, et al (9) have studied the DNA from various leishmanias and concluded that "In terms of DNA buoyant density....representatives of the fast and slow growing strains (31) are clearly separate species". This observation has now been included in Table 1, on the principal characters differentiating parasites of the L. mexicana and L. braziliensis complexes.

Long-term studies on animals trapped along the new Trans-Amazon Highway, in Pará State, Brazil (Lainson & Shaw, unpublished observations) have indicated that, in some areas at least, the major host of L. mexicana amazonensis is the echimyid rodent Proechimys guyannensis, and not the cricetid Oryzomys capito as previously thought. Furthermore, (Table 12), the most common type of infection is asymptomatic, with the parasites scattered throughout apparently normal dermis. Infections were picked up by routine intradermal inoculation of hamsters with triturated skin taken from the nose, ears, and the base of the tail of each Proechimys. Of 166 hamsters, 26 (15.7 percent) were infected, only 5 showed visible skin lesions. An infection was also noted in a single opossum, Metachirus nudicaudatus, from the same area; once again, the parasite was isolated from apparently normal skin.

Information on the isolation of L. braziliensis braziliensis from wild animals appears limited to reports of infections in the cricetid rodents Oryzomys concolor from Mato Grosso State, Brazil (28, 30) and Oryzomys nigripes and Akodon arviculoides from São Paulo State, Brazil (19). In each case the animals showed inconspicuous lesions on the tail.

In general, however, attempts to pinpoint wild animal hosts of L. b. braziliensis have met with disappointing results and are dogged by difficulties due to the parasite's very poor growth in both hamster skin and NNN medium. In this respect it may be mentioned that Lainson, et al. (35) have reported apparent failure to infect hamsters at all, after the intradermal inoculation of material taken from human lesions proved to contain amastigotes, and rich suspensions of promastigotes from infected sandflies. A single isolation of a parasite resembling L. b. braziliensis has been made in hamster skin, however, following the inoculation of a liver and spleen suspension from a Proechimys captured along the Trans-Amazon Highway. The parasite shows all the characteristics of the L. braziliensis group, and further observations on the true nature of this organism are in progress. Its visceral location in the wild host is particularly interesting, especially as no isolation could be made from the animal's skin (Lainson & Shaw, unpublished observations).

Recently, a new Leishmania has been noted in the viscera of an opossum, Didelphis marsupialis, also from the Trans-Amazon Highway (Lainson & Shaw, unpublished observations). It is morphologically distinct from L. mexicana and L. braziliensis.

Another Leishmania has been found in the viscera of the sloth, Choloepus didactylus, from various areas in Pará State, north Brazil. This is almost certainly the parasite originally recorded in this animal, from the same region, by Deane (12). Deane & Deane (13) were uncertain if the amastigotes, seen in smears of the viscera, were those of a Leishmania species or some stage in the development of Endotrypanum - a strange endoerythrocytic hemoflagellate commonly found in Choloepus didactylus. Present studies (Shaw & Lainson, unpublished observations) indicate that the parasite is distinct from L. braziliensis braziliensis, although it clearly belongs to the braziliensis complex. In Panama, the Leishmania commonly found in the sloths Choloepus hoffmanni and Bradypus infuscatus is considered to be the same as that infecting man, namely L. braziliensis panamensis (10).

Transmission of New World Cutaneous and Mucocutaneous Leishmaniasis

It is a remarkable fact that although some 504 natural infections with flagellates have been reported in wild-caught sandflies in the Americas, only in 16 instances have the parasites been proved to be Leishmania.

Within the L. mexicana complex, L. mexicana mexicana is transmitted among the wild rodents by Lutzomyia olmeca (14). Although Biagi, et al. (8) regarded this fly also as the principal vector to man, this remains somewhat in doubt. Lu. olmeca can by no means be regarded as a highly anthropophilic species, yet chiclero's ulcer is a very common disease in most of British Honduras, the Yucatan, and Guatemala. Attempts have been made to explain this paradox by suggesting that an increased biting-rate occurs when Lu. olmeca is disturbed, in leaf-litter, in the early hours of the morning (64). The argument does not seem convincing, however, and it remains possible that some other more anthropophilic species of sandfly may be involved in the onward transmission of L. m. mexicana to man.

In Brazil, L. mexicana amazonensis is also a parasite of rodents, and more rarely opossums, among which it is transmitted by a closely related sandfly, Lutzomyia flaviscutellata. Lainson & Shaw isolated the organism from six of eight infected flies and, since that time, infections have been encountered in a further 37 out of 4,802 Lu. flaviscutellata dissected (61). The flagellates have produced typical L. m. amazonensis infections when inoculated into hamsters. As previously stressed, however, few infections are encountered in man, because Lu. flaviscutellata rarely bites him.

It is a sad fact that we know little about the vectors of parasites in the braziliensis complex, which are clearly of greater medical importance in the Americas than are subspecies of L. mexicana. L. braziliensis panamensis is handled somewhat more easily in the laboratory than its companions from Brazil and the Guyanas, and this has undoubtedly helped a great deal in pinpointing the vectors. Five strains of sandfly promastigotes have been proved to be Leishmania in Panama. They were isolated from Lutzomyia trapidoi, one from Lu. gomezi, one from Lu. ylephiletrix, and one from Lu. panamensis (11, 36, 50).

Information on the epidemiology of L. braziliensis guyanensis is scanty, and nothing at all is known about reservoir hosts. Wijers & Longer (63) showed that Lutzomyia squamiventris was the most common man-biter in areas of Surinam where pian-bois was a problem, but no infections were found after the dissection of large numbers of this species. They did find, however, flagellates in 12 specimens of Lu. anduzei, but inoculation of the promastigotes into hamsters produced no conclusive evidence that the parasites were in fact Leishmania.

Up to recently there has been no direct isolation of L. braziliensis braziliensis from wild-caught sandflies, although promastigotes have been seen in Lutzomyia migonei, Lu. whitmani, and Lu. pessoai from São Paulo State, Brazil (44, 45, 46). Forattini & Santos (18) described a similar infection in a single Lu. intermedia from Paraná State, Brazil. In Venezuela, promastigotes have also been seen in Lu. migonei, Lu. longipalpis, and a specimen tentatively identified as Lu. anduzei (16, 47, 48). In none of these cases, however, was the exact nature of the flagellates determined. Finally, it has been suggested that Lu. panamensis may be the major vector of cutaneous leishmaniasis in Venezuela (47, 49), but evidence is still needed to support this view.

Recently, Ward, et al. (62) studied the phlebotomid fauna in forested area in Pará State, north Brazil, where cutaneous and mucocutaneous leishmaniasis was very prevalent. Among their findings was the observation that one particularly common sandfly, Psychodopygus wellcomei (20), frequently fed avidly on man during broad daylight. As this species was also highly attacted to wild rodents, it was an obvious suspect as a vector of L. b. braziliensis to man. Subsequently (Lainson, et al. (35) found heavy promastigote infections in three Psychodopygus wellcomei, two Ps. paraensis, and a single Ps. amazonensis. Inoculation of the flagellates from one Ps. wellcomei into hamster skin isolated a Leishmania that is indistinguishable from the L. b. braziliensis isolated from man in the same area.

The Epidemiologic Situation in Brazil

We now know of three different Leishmania that may be responsible for cutaneous and/or mucocutaneous leishmaniasis in Brazil.

The first, L. mexicana amazonensis, has a wide distribution throughout the country in its wild rodent and marsupial hosts. It certainly extends through north and central Brazil, and very likely into all parts where forest prevails. The parasite rarely infects man, however, because its vector, Lutzomyia flaviscutellata, is not anthropophilic. The other two parasites, L. braziliensis guyanensis and L. braziliensis braziliensis, have highly anthropophilic vectors, and man is frequently and seriously affected.

In the neighboring Guyanas, the disease is largely caused by L. b. guyanensis which produces pian-bois, the typically multilesion cutaneous infection, but apparently no subsequent nasopharyngeal involvement. Rare cases of the latter condition in these countries probably result from overlapping of L. b. braziliensis.

Passing into adjacent Brazilian Federal Territory of Amapá and north Pará State, the admixture of the two parasites becomes more marked and cases of mucocutaneous leishmaniasis more common: pian-bois remains, however, the major scourge of the forest workers.

Finally, as we move further south, through Pará, or westwards into Amazonas, pian-bois disappears and is replaced by the more typically single- or limited-lesion disease caused by L. b. braziliensis, with its frequent nasopharyngeal sequela.

In conclusion, few taxonomic systems are foolproof, and they require repeated modification as new facts and new parasites are uncovered. The present classification will certainly be no exception, but we hope that it will form a basis, making easier the comparison of known leishmanial parasites and the naming of new ones.

There have been great strides taken over the past 10 years in our knowledge of the leishmanias, giving workers a new awareness that these interesting and important organisms are not simply a small group of dubious species, with monotonously identical morphology and uninspiring natural histories. There remains much to be done, however, and only long and patient field studies will enable us to determine just how extensive is the range of parasites within this actively speciating complex, their importance in diseases of man, and the complexities of their life histories.

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TABLE I

CLASSIFICATION OF LEISHMANIAE OF THE NEW WORLD : PRINCIPLE CHARACTERS OF PARASITES IN THE *LEISHMANIA MEXICANA* AND *LEISHMANIA BRAZILIENSIS* COMPLEXES.

	Parasites of the *L. mexicana* Complex	Parasites of the *L. braziliensis* Complex
Vectors and Behaviour in Sandfly.	Sandflies of the *intermedia* Group. No development in the hindgut triangle.	Sandflies of the *Psychodopygus* and *intermedia* Groups. Development in hindgut triangle.
Behaviour in hamster skin.	Rapid formation of histiocytoma, very rich in amastigotes. Spread by metastases.	Very slow formation of small nodule or ulcer, with scanty amastigotes. No metastatic spread.
Behaviour in NNN medium	Luxuriant growth.	Poor to reasonable growth.
Comparative study of DNA	Parasites distinguishable from those of *braziliensis* Complex.	Parasites distinguishable from those of *mexicana* Complex.
	(Chance, Peters & Griffiths, 1973).	

TABLE II

LEISHMANIAE OF THE NEW WORLD

A. The Leishmania mexicana complex.

1. Leishmania mexicana mexicana	
Known Geographic Areas :	The Yucatan, Mexico; British Honduras; Guatemala.
Known Natural Hosts :	Forest rodents : Ototylomys phyllotis, Heteromys desmarestianus, Nyctomys sumichrasti, Sigmodon hispidus
Vectors :	Lutzomyia olmeca
Disease in Man :	Common in man - "chicler's ulcer". Single or limited number of skin lesions, with high involvement of ear tissue. No naso-pharyngeal lesions or other metastases. Rare cases reported of "anergic, diffuse cutaneous leishmaniasis".

TABLE III

LEISHMANIAE OF THE NEW WORLD

A. The Leishmania mexicana complex

2. Leishmania mexicana amazonensis	
Known Geographic Areas :	The Amazon Basin, Mato Grosso, Brazil; Trinidad. Probably extends throughout Brazil where the vector occurs.
Known Natural hosts :	Forest rodents and marsupials : Oryzomys capito, O. concolor, O. macconnelli, Proechimys guyannensis, Heteromys anamalous, Neacomys spinosus, Nectomys squamipes, Dasyprocta spp., Marmosa murina, M. mitis, Caluromys philander, Metachirus nudicaudatus.
Vectors.	Lutzomyia flaviscutellata
Disease in Man :	Rarely infects man because the vector is not anthropophilic. Single or limited number of skin lesions. No preference for ear tissue and no naso-pharyngeal involvement. Several cases of "anergic, diffuse cutaneous leishmaniasis" due to this parasite recorded in Pará State, Brazil.

TABLE IV

LEISHMANIAE OF THE NEW WORLD

A. The Leishmania mexicana complex.

3. Leishmania mexicana pifanoi	
Known Geographic Areas:	Venezuela
Natural Hosts:	Probably forest rodents : Zygodontomys microtinus and Proechimys guyannensis have been found with tall lesions containing amastigotes.
Vectors:	Not known
Disease in Man:	So far only described from a few cases of "anergic, diffuse cutaneous leishmaniasis"

TABLE V

LEISHMANIAE OF THE NEW WORLD

A. The Leishmania mexicana complex.

4. Leishmania mexicana s. sp.	
Known Geographic Areas:	Panama
Known Natural Hosts:	Forest rodents and marsupials: Oryzomys capito, Proechimys semispinosus, Diplomys labilis, Agouti paca, Marmosa robinsoni.
Vectors:	Not known. Probably Lutzomyia olmeca bicolor.
Disease in Man:	Not yet described.

TABLE VI

LEISHMANIAE OF THE NEW WORLD

A. The Leishmania mexicana complex

5.	Leishmania enriettii
Known Geographic Areas:	Curitiba, Paraná State, Brazil.
Known Natural Hosts:	Unknown. Discovered in a colony of laboratory guinea pigs (Cavia porcellus) but will not infect wild guinea pigs (Cavia aperea).
Vectors:	Not known
Disease in Man:	Not yet described.

TABLE VII

LEISHMANIAE OF THE NEW WORLD

B. The Leishmania braziliensis complex.

1. Leishmania braziliensis braziliensis	
Known Geographic Areas:	Brazil, eastern Peru, Ecuador, Bolivia, Venezuela, Paraguay, Colombia.
Known Natural Hosts:	Poorly known. Forest rodents Oryzomys concolor (Mato Grosso); O. nigripes and Akodon arviculoides (São Paulo State, Brazil).
Vectors:	(a) Proven by isolation of L. b. braziliensis after inoculation of hamster with flagellates from sandflies: Psychodopygus wellcomei in Pará State, Brazil. (b) Microscopical evidence of promastigotes only: Ps. paraensis, Ps. amazonensis, in Pará. Lutzomyia migonei, Lu. whitmani, in south Brazil. Lu. anduzei in Venezuela.
Disease in Man:	Lesions usually single, or few in number. Frequently very large, persistent and disfiguring. Metastases to naso-pharyngeal tissues a common sequel - "espundia".

TABLE VIII

LEISHMANIAE OF THE NEW WORLD

B. The Leishmania braziliensis complex.

2. Leishmania braziliensis guyanensis	
Known Geographic Areas:	The Guyanas; Amapa, Roraima, Pará, and Amazonas in north Brazil.
Natural Hosts:	Unknown.
Vectors:	Promastigotes found in Lutzomyia anduzei, but not yet proven to be L. b. guyanensis by inoculation of hamsters.
Disease in Man:	"pian - bois". Single skin lesions frequently with metastatic spread along lymphatics to give ulcers all over the body. Rare cases of the mucocutaneous disease probably due to overlap of L. b. braziliensis.

TABLE IX

LEISHMANIAE OF THE NEW WORLD

B. The Leishmania braziliensis complex.

3. Leishmania braziliensis panamensis	
Known Geographic Areas:	Panama. possibly extending into Central America in the north, and Colombia in the south.
Known Natural Hosts:	Forest rodents Proechimys semispinosus, Hoplomys gymnurus; marmoset Saguinus geoffroyi; procyonids Potos flavus, Bassaricyon gabbii; sloth Choeloepus hoffmanni, Bradypus infuscatus. Not certain if all infected with same parasite.
Vectors:	Proven by inoculation of hamsters with flagellates from infected sandflies: Lutzomyia trapidoi, Lu. ylephiletrix, Lu. gomezi, Lu. panamensis.
Disease in Man:	Usually single ulcer but may sometimes spread via lymphatics. Nasal involvement rarely reported and may be due to bite on nose rather than metastatic spread.

TABLE X

LEISHMANIAE OF THE NEW WORLD

B. The Leishmania braziliensis complex.

4. Leishmania peruviana	
Known Geographic Areas:	Western Peruvian Andes; the only known form of New World cutaneous leishmaniasis *not* associated with forest.
Known Natural Hosts:	Domestic dog. No wild hosts known.
Vectors:	Uncertain. Lutzomyia verrucarum and Lu. peruensis are suspected.
Disease in Man:	"uta". Single or limited skin lesions which are self healing. No naso-pharyngeal involvement.

TABLE XI

LEISHMANIAE OF THE NEW WORLD

B. The *Leishmania braziliensis* complex

5. *Leishmania hertigi*.	
Known Geographic Areas:	Panama.
Known Natural Hosts:	The porcupine *Coendou rothschildi*.
Vectors:	Unknown.
Disease in Man:	Not yet described.

TABLE XII

ISOLATION OF LEISHMANIA MEXICANA AMAZONENSIS FROM WILD FOREST ANIMALS ALONG THE NEW TRANS-AMAZON HIGHWAY, PARÁ STATE, BRAZIL

Species.	Number examined	Tissue from which isolated			% infected
		Skin lesions on tail	Apparently normal skin	Viscera	
RODENTIA:					
Proechimys guyannensis	166	5	21	0	15.7
Oryzomys capito	64	0	7	0	10.9
Nectomys squamipes	16	0	1	0	6.3
Neacomys spinosus	9	0	0	0	-
Sciurus sp.	1	0	0	0	-
MARSUPIALIA:					
Metachirus nudicaudatus	4	0	1	0	25.0
Didelphis marsupialis	25	0	0	0	-
Marmosa sp.	8	0	0	0	-
Monodelphis sp.	2	0	0	0	-
Philander opossum	1	0	0	0	-