

ECOLOGICAL ASPECTS OF AMERICAN CUTANEOUS LEISHMANIASIS

4. OBSERVATIONS ON THE ENDOPHILIC BEHAVIOR OF THE SANDFLY AND THE VECTORIAL ROLE OF *PSYCHODOPYGUS INTERMEDIUS* IN THE RIBEIRA VALLEY REGION OF THE S.PAULO STATE, BRAZIL.

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GOMES, A. de C. et al. Ecological aspects of American cutaneous leishmaniasis. 4. Observations on the endophilic behavior of the sandfly and the vectorial role of *Psychodopygus intermedius* in the Ribeira Valley region of the S.Paulo State, Brazil. *Rev. Saúde públ.*, S. Paulo, 20: 280-7, 1986.

ABSTRACT: The invasive tendency of *Psychodopygus intermedius* in the home environment, observed initially by Forattini et al. (1976), has now been confirmed by the demonstration of its high endophilic ability and by the use of human residences for shelter. Populations such as *Lutzomyia migonei* and *Pintomyia fischeri* were also present in that environment, though their low densities registered during this investigation could be an indication of their poor ability to overcome the barriers raised by the artificial environment. An objective epidemiological analysis based on the variables here given showed that human infection takes place in the extraforest environment, and the principal vectorial function falls, without doubt, on *P. intermedius*.

UNITERMS: Leishmaniasis, mucocutaneous, transmission. Leishmaniasis, mucocutaneous, occurrence. Ecology. *Psychodopygus intermedius*. Insect vectors.

INTRODUCTION

It has been generally observed that ecological knowledge of the American Phlebotominae is related to a primary forest environment. Information about the activity of these populations in environments that have undergone intensive human activity is still rudimentary. In Brazil, *Lutzomyia longipalpis* and *Psychodopygus intermedius* have received greater attention because of their high frequency in extraforest environments (Deane and Deane², 1957; Forattini^{4,6}, 1960, 1973; Forattini et al.⁷, 1976; Gomes et al.¹², 1980; and Souza et al.²³, 1981).

Endemic cutaneous leishmaniasis in the Ribeira Valley region increased practically to epidemic proportions in the seventies, though absent before. So the time of human primary colonization, carried out over extensive areas of plain and scarp, does not permit the establishment of a direct relationship as between process of devastation and cutaneous leishmaniasis. Thus the immediate contact between man and forest is not an essential condition for the occurrence of the disease. This means then that this parasitosis in the region does not manifest itself under the classic epidemiological aspect, imposed on South America. On the contrary, it leads to the admission that the risk of man's contracting it when he enters the primeval forest seems nil. This is the

same as saying that conditions of local transmissibility are related to the extraforest environment.

Forattini et al.⁹ (1976), when investigating the mode of leishmaniasis transmission in the Ribeira Valley observed that *P. intermedius* presented a strong tendency to invade the local human habitations. Consequently, he suggested the hypothesis that this sandfly was a vector in the area under study. The preference of this species for artificial experimental environments was demonstrated by Gomes et al.^{12,13} (1980, 1982) which, added, further, to other information on their considerable presence in rural zones (Araújo Filho¹, 1978; Leopoldo e Silva et al.¹⁶, 1984; Lima et al.¹⁷, 1981; Mattos¹⁸, 1981; Nery-Guimarães¹⁹, 1955; and Souza et al.²³, 1981), justifies the quantification of their frequency, specially in the domiciliary environment.

The intention of the present study is to clarify the presence of sandflies of endophilic habits in the Ribeira Valley region and what kind of factors might be involved in this process. It is intended to establish a comparative analysis between the density of *P. intermedius* and the occurrence of recorded human cases, particularly as regards the reaffirmation of the vectorial role of this species.

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MATERIAL AND METHODS

The region known as the Ribeira River Valley has been described in detail in previous publications (Forattini et al.¹⁰, 1978 and Gomes¹¹, 1985).

As for the locality chosen: the "Pariquera-Açú" county, covering the districts of "Caieira" and "Vila Maria" of the town of "Pariquera-Açú" (Fig. 1), was selected. The former suburb lies on the right side of the SP 476/230 highway which links this town to "Jacupiranga", at km 11.4. Although this locality

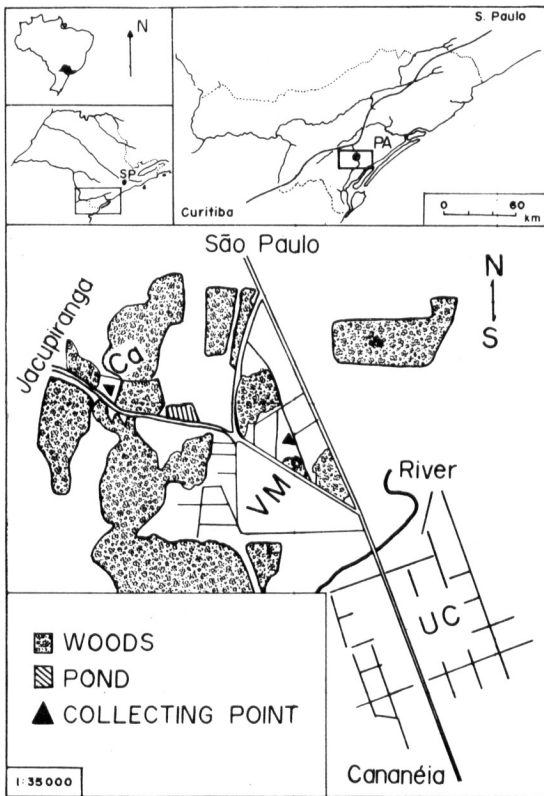


Figure 1 Geographical location of the areas studied and distribution of the collecting points for the sandfly.
CA - "Caieira" district
VM - "Vila Maria" district
UC - Urban center

lies outside the urban zone, it is only 3.0 km from the town center. The mesological conditions here are of predominantly rural character, with habitations in a precarious state of conservation and with domestic fowls in the peridomestic area; there is also an abandoned orchard and a narrow strip of residual forest. Human excreta are left in the open and electric light had still not yet been installed in

the neighborhood. On the other hand, the district called "Vila Maria" possesses utilities such as public illumination, water supply and municipal rubbish collection. However, basic sanitary conditions were deficient and many residences were interspersed with empty plots of land.

The methods of capture used corresponded to the CDC miniature trap (Sundia and Chamberlain²⁴, 1962) of general use in entomological research, though adapted for the purpose of this investigation (Gomes et al.¹⁵, 1985), and traps of the luminous New Jersey type, appropriate for the capture of the hematophagous Diptera of the urban zone, particularly of mosquitoes (Forattini⁵, 1962).

In the "Caieira" district only the miniature CDC was used, concomitantly in indoor and outdoor environments, while in the "Vila Maria" district only the New Jersey trap was used.

The catches were made weekly, in the period between 18.00 and 06.00 hours. There was some variation, though never such as to affect the previously established twelve-hour time interval.

The period of investigation in the "Caieira" district extended from August 1979 to July 1982. That in the "Vila Maria" district lasted from January 1979 to July 1982.

The calculation of the densities of the sandflies was based on Williams' geometrical average (\bar{X}_w). For the application of the values in graphical form, the device of transforming them into percentages was used.

Once the densities had thus been calculated it became possible to establish a comparative analysis with the human cases registered.

The human data on cutaneous leishmaniasis for the period from 1973 to 1984 were obtained from the Regional Health Department of the Ribeira Valley (DEVALE), an organ belonging to the Health Department of the S. Paulo State.

For the purpose of presenting the relationship between sandfly density and human cases, the respective periods from 1979 to 1982 and 1977 to 1984 were used. However, to explain the fact that investigation was begun with a high density of *P. intermedius*, recourse is had to the results obtained by Gomes et al.¹³, 1982, after applying the calculations of Williams' average to them.

RESULTS

Table 1 presents the overall results of the collection of those sandflies most frequently to be found

in the domiciliary environment of the two districts studied. Of a total of 18,002 specimens, 14,715 (81.7%) were collected in the "Caieira" district and 3,287 (18.3%) in "Vila Maria".

Among the species present the most numerous were *P. intermedius* (94.6%), *Lutzomyia migonei* (3.6%) and *Pintomyia fischeri* (1.5%). *Lutzomyia edwardsi*, *Psychodopygus ayrozai* and *Psychog-*

dopygus pascalei appeared but sporadically, the total numbers being, respectively, 17.9 and 11.

The result of the indoor captures was much greater than the outdoor, using the same methodology for the "Caieira" district. In this latter place, the CDC miniature trap captured ten times more in the domiciliary than in the peridomiciliary environment. Besides, the numerical superiority of males over females was remarkable. With the New Jersey

TABLE 1

Density in Williams' average (\bar{X}_w) of sandflies for domiciliary and peridomiciliary ecotopes, according to sex and with reference to residences situated in the "Caieira" and "Vila Maria" districts of the town of "Pariquera-Açú", for the period from January 1979 to July 1982.

Species	Place	Domiciliary								Peridomiciliary			
		"Caieira" District								"Vila Maria" District			
		Indoor				Outdoor				New Jersey Trap			
Sex	♀	♀	♂♂	♂♂	♀	♀	♂♂	♂♂	♀	♀	♂♂	♂♂	
	Nº	\bar{X}_w	Nº	\bar{X}_w	Nº	\bar{X}_w	Nº	\bar{X}_w	Nº	\bar{X}_w	Nº	\bar{X}_w	
<i>Lutzomyia migonei</i>		208	11.9	373	24.5	30	1.3	39	2.1	4	0.2	1	0.0
<i>Pintomyia fischeri</i>		152	10.1	73	4.6	32	1.2	9	0.6	9	0.2	-	-
<i>Psychodopygus intermedius</i>		5,447	270.1	7,357	315.8	530	25.4	428	34.7	2,832	204.3	495	38.0
Total		5,807	292.1	7,803	344.9	592	27.9	476	37.4	2,845	204.7	496	38.0

trap there was a collection of 3,287 specimens and the results of this trap, on the other hand, showed a greater proportion of females.

The calculation of the Williams' averages (\bar{X}_w) for the years 1978 and 1979 from the publication of Gomes et al.¹³ (1982) corresponded to 198.8 and 583.8 respectively. This confirmed that, for this study, collection of sandflies was begun in a period of high *P. intermedius* density. Table 1 also shows the almost total predominance, in terms of averages, of this species.

The results of the examination of the repletion with and the digestion of blood for the three most frequent species is recorded in Table 2. It may be observed from this table that phase I was that which contributed the largest number or proportion. The proportional decline from phases I to V, which was from 74.0% to 5.3%, reflects abandonment of the artificial ecotope after satisfaction of the alimentary need.

TABLE 2

Results of the examination of the state of blood repletion and digestion of the sandfly populations collected in the domiciliary environment of a residence situated in the "Caieira" district, "Pariquera-Açú" county, in the period from August 1979 to July 1982.

Species	Phases										Total	%
	I	%	II	%	III	%	IV	%	V	%		
<i>Lutzomyia migonei</i>	83	37.7	11	5.0	29	13.2	37	16.8	60	27.3	220	3.8
<i>Pintomyia fischeri</i>	79	53.0	20	13.4	35	23.5	12	0.0	3	0.0	149	2.6
<i>Psychodopygus intermedius</i>	4,120	76.0	200	3.7	458	8.5	398	7.4	241	4.4	5,417	93.6
Total	4,282	74.0	231	4.0	522	9.0	447	7.7	304	5.3	5,786	100.0

Table 3 shows the age distribution of the 642 human cases of cutaneous leishmaniasis reported between 1973 and 1984 inclusive, for the entire Ribeira Valley region. Such cases are grouped according to age and sex. This classification shows that the sum of the proportions for the 0-10 age group corresponded to 24.5% of the registered total. Though annual results have not been grouped

separately in this Table, it is reported that in 1978 and 1979 there was a considerable rise in the number of human infections, which makes it possible to suppose the occurrence of a regional epidemic (Gomes¹¹, 1985). To complete this picture it should be added that during the period 1977-1984, 556 human cases were registered, within the total number for 1973-1984.

TABLE 3

Distribution of human cutaneous leishmaniasis cases registered according to age and sex, in the Ribeira Valley region, in the period from 1973 to 1984.

Age	Masculine	Feminine	Total	%
0 — 3	9	22	31	4.8
4 — 5	15	10	25	3.9
6 — 10	54	35	89	13.8
11 — 25	121	128	249	38.8
26 — 50	89	84	173	27.0
51 +	45	30	75	11.7
Total	333	309	642	100.0

Source: Regional Health Department of the Ribeira Valley, 1985.

DISCUSSION

Starting from the landscape aspect, it is to be noted that, since the first reports of human cases of cutaneous leishmaniasis in the Ribeira Valley region, a relationship between the disease and the modified or degraded environment has been observed. This fact, together with the knowledge that the man-made process of devastation always has its effect on the fauna, decimating a large part of its component populations and at the same time creating new niches, has guaranteed the survival of the populations gifted with greater ecological adaptability. As far as this is concerned, with regard to the American Phlebotominae, there seems to be no doubt that in the southeast of Brazil *P. intermedius* is benefited by anthropic alterations (Table 1). To a lesser extent this behavior is shared by *L. migonei* and *P. fischeri*. However, the same thing does not happen in the "Vila Maria" district, the dominant characteristics of which are urban. Here the tendency of *P. intermedius* to persist is evident, while other species did not have the same success. Therefore this demonstrates the existence of natural and artificial barriers unfavorable to *L. migonei* and *P. fischeri*.

It is worth pointing out that *P. intermedius* once more demonstrates its ability to adapt to an artificial environment. Its behavior, illustrated by the

density of 270.1 for females and 315.8 for males, indoors ("Caieira" district), and 605.8 and 85.8 respectively outdoors ("Vila Maria" district) is solid proof for the identification of anthropic factors responsible for their dominance in the domiciliary environment (Table 1). On the other hand, it must be remembered that the activity of the sandfly to disperse is limited, that is, they have little tendency to move away from the places of natural shelter (Forattini⁶, 1973). When they are found beyond an average limit of 200 meters, with the simultaneous presence of both sexes and, further, with considerable density, and a predominance of male over female, they certainly have their breeding ground in this same environment. According to Table 1 we appear to have a genuine phenomenon, at least for *P. intermedius*. As for *L. migonei* and *P. fischeri*, apart from an interspecific competitive aspect, their dispersion could be limited to those environments which are characteristically rural, as were exemplified.

Thus our study of the presence of *P. intermedius* in the two districts investigated, both of which are completely dissociated from the primary forest ecosystem, makes it possible to concede that the species may be undergoing evolution towards synanthropy. Such behavior could account for the indiscriminate ease of invasion which it shows in

relation to extraforest biotopes, including the domiciliary one, as has already been suspected by Forattini et al.⁹ (1976).

With regard to endophily, it is observed that *P. intermedius*, *L. migonei* and *P. fischeri* were the only species which showed some activity in the residence researched in the "Caieira" district. For this reason it was thought opportune to determine the endophilic ability of each of them separately. In Figure 2 it is seen that *P. intermedius* is demonstrated to be markedly endophilic, seeing that the density of the female population found indoors was

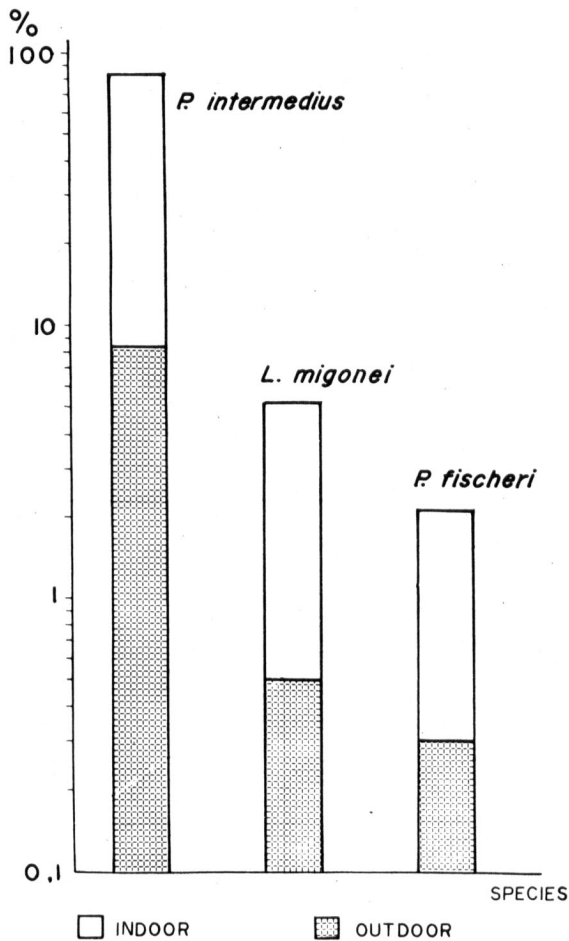


Figure 2 - Degrees of endophilia and exophilia determined for the populations of *Psychodopygus intermedius*, *Lutzomyia migonei* and *Pinetomyia fischeri*, "Pariquera-Açú".

ten times greater than outdoors. *L. migonei* and *P. fischeri* behaved similarly, though their lower densities make it difficult to comment further.

When the results of the study of repletion and digestion of blood on the part of the female specimens captured indoors with the miniature CDC are analysed, it is found that, in general, there is a clearer tendency to the collection of fasting insects (phase I), which may bespeak a preference for the practice of endophagy. The fact that a proportional decline occurred from phase I to V makes it possible that this is due to the abandonment by the females after meeting the needs of feeding and indoor-rest following feeding (Table 2). Thus, taking into account the greater representativity of *P. intermedius*, it is reasonable to concede that this picture is compatible with the endophilic character of the species and to suggest, further, that despite its eclectic habits the use of man as a host is viable seeing that its tendency is endophagic. On the other hand, despite the presence of a small percentage of pregnant females (phase V) the possible colonization of the artificial biotopes cannot be excluded, principally because the occurrence of this colonization has already been detected in a pig-stye (Forattini³, 1953).

From the methodological point of view it should be added that the miniature CDC trap was efficient for the capture of sandflies, and the results obtained in human habitations were compatible with those from the experimental hen-house (Gomes et al.¹³, 1982) for the same county. It is concluded that the experimental model in practice serves for ecological studies of the sandfly.

As regards the question of the vector, it became clear that *P. intermedius* was the only species in the study which showed an epidemiological density significant for the transmission of cutaneous leishmaniasis. Taking into consideration, then, that the level endemic for the Ribeira Valley region shows marked irregularity in its spacial and temporal distribution reflected, now in situations of more significant isolated events, now in a quiescent or regressive tendency, it is to be supposed that the transmission takes place under transitory conditions. If, as was seen above, *P. intermedius* is a sandfly of synanthropic characteristics, associated with a daily activity rhythm which is predominantly nocturnal, that is to say, from 20 to 02 hours, and associated with confirmed natural infections (Forattini et al.⁸, 1972 and Rangel et al.²¹, 1984), it would seem possible to admit that the occurrence of human infections can be more closely related to special circumstances in the dispersal of the agent towards dwellings, simultaneously with the high density of the vector, rather than to the movement of the human population into the forest environment. An argument that comes in to confirm this reasoning has to do with the fact that there was an abnormal

drought in the region in 1978-1979, during which there were indications of intensive migrations of forest rodents (Rocha e Silva et al.²², 1980). Whether it be coincidence or not, the only epidemic in the region occurred during that same period. When the annual density of *P. intermedius* and the annual number of human cases in Figure 3 are compared it is discovered that the epidemic peak of disease coincides with that of the density of this species. Therefore these observations lead to the hypothesis that the *Leishmania* may spread beyond the frontiers of the natural foci and thus trigger off ephemeral secondary biological cycles, in which man becomes a passive victim, thanks to the ecological success of *P. intermedius*. The high proportion of 24.5% of the individuals suffering from the disease in the age group between 0 and 10 years of age and the equality of the occurrences as between the two sexes corroborate this (Table 3). One other isolated event could have the same cause. That event was the some few human cases in the city of S. Paulo (Proença and Müller²⁰, 1979). This occurred because, during small-scale devastation carried out in the "Cantareira" hill range, the disease manifested itself not among the workmen, but in people who lived close to the devastated area. Thus the possibility of natural reservoirs having migrated to the residences in search of shelter or food cannot be ruled out.

One important aspect has to do with the demonstration of there being a proportionate annual correlation between the decline of the number of human cases and the density of *P. intermedius* (Figure 3). It must be made clear, however, that the reduction in the density of the vector was spontaneous, because the area studied had not been submitted to any kind of control. With regard to this detail, it seems clear that if measures for the control of this parasite were assessed systematically by means of vectorial density, possibly success would be achieved with smaller resources and at less cost to the environment.

CONCLUSIONS

By the analysis of this study it is to be considered that:

1 - The anthropic alterations evidenced by the high density of *P. intermedius* represent important factors in the evolution of the species towards synanthropy.

2 - The process of urbanization in the area under study seems to involve natural and artificial factors unfavorable to *L. migonei* and *P. fischeri*.

3 - The confirmation of the endophagic character of *P. intermedius* proves that invasive tendency with regard to human habitations already suspected by Forattini et al.⁹ (1976).

4 - The larger proportion of the *P. intermedius* indoors, still in a state of fasting, clearly shows the high endophilic ability of the species.

5 - The epidemiological analysis of the relation between the behavior of *P. intermedius* and the human cases registered allows no room for doubt as to the leading vectorial role of this species.

6 - If *P. intermedius* plays a vectorial role in the region and its density only showed itself to be high in the extraforest environment, this means that human infections are acquired outside the forests and, particularly, in the domiciliary environment.

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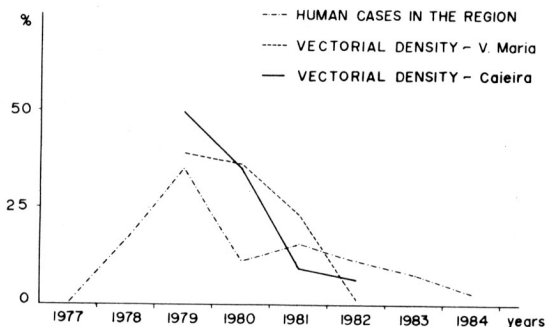


Figure 3 Annual percentual correlation between the density of *Psychodopygus intermedius* in the domiciliary environment in the county of "Pariquera-Açú" and overall human cases registered for the Ribeira Valley region.

GOMES, A. de C. et al. Aspectos ecológicos da leishmaniose tegumentar americana. 4. Observações sobre o comportamento endófilo de flebotomíneos e papel vetorial de *Psychodopygus intermedius* na região do Vale do Ribeira, Estado de São Paulo, Brasil. *Rev. Saúde públ.*, S. Paulo, 20: 280-7, 1986.

RESUMO: A tendência invasiva de *Psychodopygus intermedius* ao ambiente domiciliar, observada inicialmente por Forattini e col. (1976), foi agora confirmada através de comprovação da sua elevada capacidade endófila e uso da habitação humana como abrigo. Populações como *Lutzomyia migonei* e *Pintomyia fischeri* também estiveram presentes naquele ambiente, porém suas baixas densidades assinaladas nesta investigação poderão indicar pouca capacidade para vencerem as barreiras impostas pelo ambiente artificial. Uma análise epidemiológica objetiva, baseada nas variáveis incluídas, demonstrou que a infecção humana ocorre em ambiente extraflorestal, cuja função vetorial principal recaiu sobre *P. intermedius*.

UNITERMOS: Leishmaniose tegumentar, transmissão. Leishmaniose tegumentar, ocorrência. Ecologia. *Psychodopygus intermedius*. Insetos vetores.

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