

**The morphology and possible function  
of abdominal patches in males  
of two forms of the leishmaniasis vector  
*Lutzomyia longipalpis*  
(Diptera : Phlebotominae)**

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**Summary**

*The leishmaniasis vector Lutzomyia longipalpis has two forms of males : one with a pair of pale patches on the fourth abdominal segment and the other with patches on both the third and fourth segments. The patches are characterised by numerous small papules 3-3.5 µm diameter with central pores 0.25 µm diameter, and the two forms differ in the shape and distribution of the papules. It is suggested that a sex pheromone is secreted through the pores before and during mating and is distributed by the rapid wing beats made by the males at this time. The taxonomic implications of these findings are discussed.*

**Key words :** Phlebotomines — Morphology — *L. longipalpis* — Pheromones.

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**Résumé**

**MORPHOLOGIE ET FONCTION POSSIBLE DES TACHES ABDOMINALES CHEZ LES MÂLES DE DEUX FORMES DU VECTEUR DE LEISHMANIOSE *Lutzomyia longipalpis* (DIPTERA : PHLEBOTOMINAE).** *Les auteurs démontrent qu'il existe deux formes chez les mâles du vecteur de leishmaniose, Lutzomyia longipalpis : l'une possède une paire de taches pâles au quatrième segment abdominal, tandis que l'autre possède des taches aux troisième et quatrième segments. Les taches se composent de petites papules nombreuses, de 3 à 3,5 µm de diamètre avec un pore central de 0,25 µm de diamètre, et les deux formes se distinguent par la configuration et la répartition des papules. Les auteurs suggèrent qu'une phéromone sexuelle est sécrétée par les pores avant et pendant l'accouplement et qu'elle est à ce moment disséminée par les rapides coups d'aile des mâles. Enfin, les auteurs discutent les résultats taxonomiques potentiels de ces conclusions.*

**Mots-clés :** Phlébotomes — Morphologie — *L. longipalpis* — Pheromones.

**Introduction**

The sandfly *Lutzomyia longipalpis* is widely distributed in South and Central America and is the accepted vector of visceral leishmaniasis in the New World. It was first described by Lutz

and Neiva in 1912 from specimens collected in southern Brazil (São Paulo and Minas Gerais) and later, Mangabeira (1969) recognised two morphological forms of the species. He noted that male *L. longipalpis* from Pará State, N. Brazil, had a pair of pale patches on the fourth abdominal ter-

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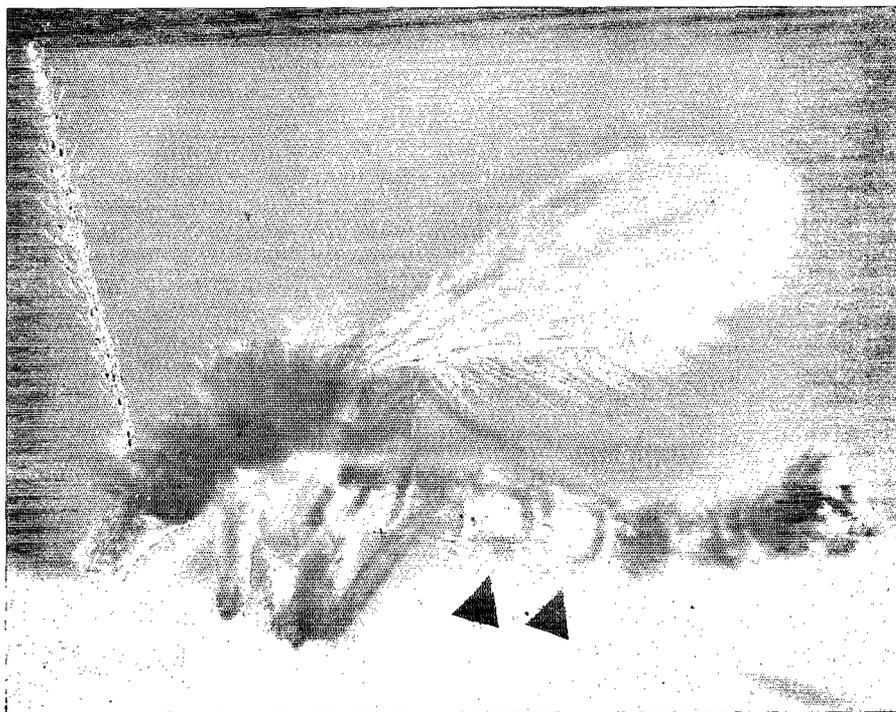


PHOTO 1. — Male of *Lutzomyia longipalpis* from Sobral, Ceará, Brazil showing the pale patches on the third and fourth abdominal segments.

gite whereas those from Ceará State in north-eastern Brazil had an additional pair of patches on the third abdominal tergite (photo 1). Mangabeira observed that the two forms lived under completely contrasting ecological conditions and felt that they might represent two separate taxa (either varieties or species). These two forms have different geographic distributions in the New World. The form with a single pair of patches is the most widespread, occurring from Argentina in the south to Mexico in the north. The form with a double pair of patches is restricted to eastern Brazil, particularly the states of Ceará and Bahia in the north-east. This difference in geographic distribution of the two forms is important epidemiologically. Visceral leishmaniasis occurs from Mexico to Argentina, with about 87 % of human cases recorded from Brazil, particularly the north-eastern states (Ward, 1977). Ward *et al.* (1983) have tentatively suggested that the form with a double pair of patches may be a more important vector of visceral leishmaniasis and that the focality of the human disease is linked to the distribution of this form.

Ward *et al.* (1983) have attempted to determine the status of the two morphological forms by cross mating studies between colonies derived from both

allopatric and sympatric populations. They concluded that there are at least two different sexually isolated forms of *L. longipalpis* which may represent members of a species complex. However they refrained from formally assigning the forms to specific taxa until further crossing experiments and morphological studies are made.

As the two forms appear to be biologically distinct, attempts have been made to find reliable characters for distinguishing them. Differences in the structure of the female genitalia suggested by Mangabeira (1969) and others have not been substantiated. There is some evidence of morphometric differences in wing and hind femur measurements of the female (Ward, in prep.). The distribution of pale patches on the male abdomen remains the only reliable means of separating these forms. It is the objective of this paper to determine the structure and possible function of these pale patches so that their taxonomic significance can be evaluated.

#### Materials and methods

Males of both forms from the colonies des-

cribed by Ward *et al.* maintained in the Liverpool School of Tropical Medicine and the British Museum (Natural History) were used : the form with a double pair of patches originated in Sobral, Ceará, Brazil and the form with a single pair of patches in Lapinha, Minas Gerais, Brazil. The dense covering of long setae on the abdomen was removed with a light brush to reveal the large sockets of these macrotrichia and thus show their detailed distribution on each tergite. The specimens were examined by scanning electron microscopy (SEM) in the BMNH.

### Results

Morphological differences were found between the abdominal tergites with pale patches (modified tergites) and those without patches (unmodified). The form with a single pair of patches has modified tergites on segment four only and the form with a double pair of patches has modified tergites on segments three and four. The remaining segments are unmodified.

The unmodified tergites are evenly covered with microtrichia, usually in rows. Larger socketed setae (macrotrichia) are present all over the sclerite, but are concentrated in the posterior half.

In both forms, the modified tergites have socketed setae on the posterior margin only, not on the area corresponding to the pale patch. Therefore, under the scanning electron microscope, the patches appear as areas without macrotrichia, the shape of the patches corresponds to the saddle shape seen under the light microscope. More significantly, the patches are characterised by the presence of small papules each with a central pore. In both forms, the papules are 3-3.5  $\mu\text{m}$  diameter with central pores approximately 0.25  $\mu\text{m}$  diameter.

### Differences between the two forms of *L. longipalpis*

In addition to the number of patches present, the two forms differ in the micromorphology of the patches in three ways : shape of the papules, spacing of the papules, and spacing of the microtrichia. In the form with two pairs of patches (Sobral) the papules are distinctly convex, almost hemispherical (photos 2 and 3), while in the single patch form (Lapinha) the papules are almost flat (photo 4) and therefore barely discernible.

There is no measurable difference in the diameter of the papules between the two forms.

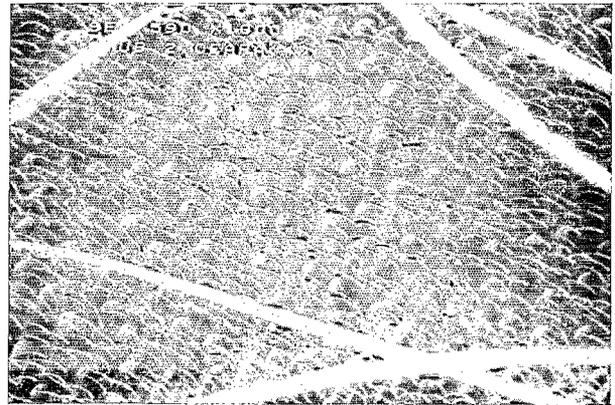


PHOTO 2. — Surface morphology of the pale patch in form from Sobral, Ceara (double patch form).

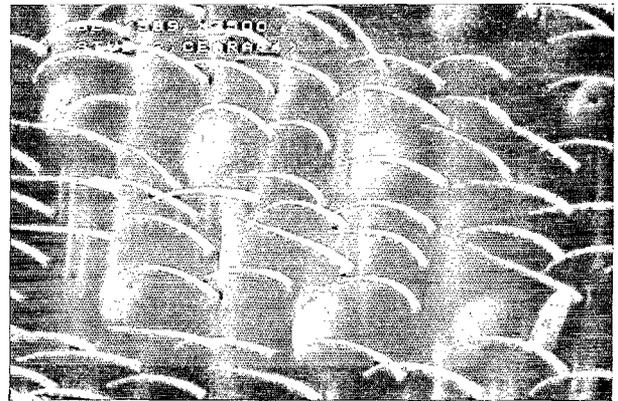


PHOTO 3. — Detail of raised papules with central pore in male with double pair of patches (Sobral, Ceara).

To measure whether there is a difference in spacing of the papules in the two forms, the distance between the centre of a pore and the nearest adjacent pore was measured within an area of 1,050  $\mu\text{m}^2$ . Comparisons were made between segment 4 of each form using photographs of a single field on an SEM at a magnification of 2,600. When the mean distance between papules is calculated by the nearest neighbour technique (Southwood, 1966), there is no significant difference between the two forms. However, there is a significant difference between forms in number of papules per unit area. In an area of 8,000  $\mu\text{m}^2$  (photo-

graph of SEM field at  $\times 1,000$ ) there was a mean of 112 pores in the form with two pairs of patches and 65 pores in the form with a single pair of patches. These results show that the papules are more clumped (contagiously distributed) in the single pair form than in the double pair form.

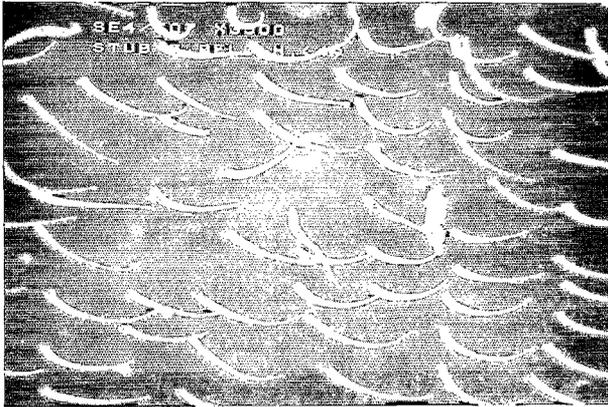


FIGURE 4. — Detail of flattened papules in the pale patches of males with a single pair of patches from Lapinha, Minas Gerais.

The microtrichia are arranged in regular rows on segments without patches, but this becomes interrupted in the region of the patches by the presence of the papules. This interruption is greater in the form with a double pair of patches than in the single pair form.

It is possible that the difference in spacing of the microtrichia between the patches and normal tergites contributes to the pale appearance of the patch seen under the light microscope (dissecting microscope). However, it is more likely that underlying tissue showing through the tergite gives the patch its pale appearance. If the paleness was due solely to a surface feature (such as microtrichia distribution) then the patches would stand out clearly at low magnifications under the scanning electron microscope, which they do not.

## Discussion

Based on morphological evidence alone any suggested function of the patches/papules is speculative. It seems unlikely that the pores are embryological relicts as these are usually found on the thorax e.g. humeral pits, they are more likely to have a sensory or secretory function. An overt sensory function is difficult to accept as the patches are in an inaccessible position to receive external stimuli, and there is no contact between the male and the female at this position on the body before or during copulation. Therefore, the patches are most likely to be secretory, especially as the pale colour is not the result of the surface features but probably due to an underlying tissue showing through the cuticle. No obvious non-pheromone substance (such as wax) has been seen associated with the papules. A pheromone secreting function for the papules is therefore suggested. This suggestion is reinforced by the observation that male flies beat their wings rapidly during courtship and copulation. The wing beating would be an effective method of distributing a pheromone to a potential mate or a posteriorly attached female.

The taxonomic significance of these findings is that the pale patches on the abdomen are not simply areas of depigmentation but complicated structures. This confirms that this character is a reliable means of distinguishing the two forms of *L. longipalpis*. When these findings are added to the results of the cross mating studies by Ward *et al.* (1983) it is clear that *Lutzomyia longipalpis* can no longer be considered as a single homogeneous species but a complex of species. The taxonomic and nomenclatural status of the 'forms' of *L. longipalpis* is currently being assessed.

## ACKNOWLEDGEMENTS

We wish to thank Miss C. Couch for technical assistance. This investigation received financial support from the UNDP/World Bank/WHO Special programme for Research and Training in Tropical Diseases (RPL) and the Wellcome Trust (RDW).

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