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Comparative study of the phlebotomine sand fly species (Diptera: Psychodidae: Phlebotominae) of the genera *Nyssomyia* Barretto, 1962, *Bichromomyia* Artemiev, 1991, and *Migonemyia* Galati, 1995, vectors of American cutaneous leishmaniasis in Brazil

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Abstract

Phlebotominae, a group of insects with great medical importance especially in Brazil, are responsible for transmitting causal agents of cutaneous and visceral leishmaniasis. In Brazil, the most important species of *Leishmania* Ross, 1903 are *L. (Viannia) braziliensis* Vianna, 1911, whose main vectors are *Nyssomyia intermedia* Lutz & Neiva, 1912, *Ny. neivai* Pinto, 1926, *Ny. whitmani* Antunes & Coutinho, 1939 and *Migonemyia migonei* França, 1920; and *L. (Leishmania) amazonensis* Lainson & Shaw, 1972, for which *Bichromomyia flaviscutellata* Mangabeira, 1942 is the main vector. The present study sought to investigate the morphological as well as geometrical and linear morphometric characteristics of these five sand flies in an attempt to cluster these species. Our aim was to reveal some of the characters that might help identify these phlebotomine species and also be useful in future phylogenetic studies. Comparative analyses by linear and geometric morphometric characters allowed us to distinguish the genera of these sand flies and assess the taxonomic position of *Ny. intermedia* and *Ny. neivai*, the so-called "cryptic species". Significant differences were observed in several of the analyzed structures, including the centroid size of the wings and the ratio between the ejaculatory filament and its tip. Based on the linear morphometric analytical results, the size of the centroids of the wings and their shapes indicated that these three species of *Nyssomyia* are phenetically more similar to *Mg. migonei* (all vectors of *L. (V.) braziliensis*) than to *Bi. flaviscutellata* (vector of *L. (L.) amazonensis*). These results are in agreement with the division of the genera *Nyssomyia* and *Bichromomyia*.

Key words: linear morphometric; geometric morphometric; morphology; discriminant analysis

Introduction

Phlebotomine sand flies (Diptera, Psychodomorpha, Psychodidae) are of great medical importance due to their capacity to transmit etiologic agents such as protozoans of the genus *Leishmania* Ross, 1903, bacteria of the genus *Bartonella* Strong *et al.*, 1915, in addition to numerous arboviruses (Rangel & Lainson 2009). The most recent classification of New World Phlebotominae includes more than 500 species divided into two tribes: Hertigiini Abonnenc & Léger, 1976 and Phlebotomini Rondani, 1840. All the Brazilian species belong to four subtribes included in Phlebotomini: Brumptomyiina Artemiev, 1991, Sergentomyiina Artemiev, 1991, Lutzomyiina Abonnenc & Léger, 1976, and Psychodopygina Galati, 1995 (Galati 2003). Moreover, all the species that transmit *Leishmania* in Brazil are from the Lutzomyiina or Psychodopygina subtribes.

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genera *Brumptomyia*, *Migonemyia*, *Bichromomyia,* and *Nyssomyia*, in support of the separation of the *Bichromomyia* and *Nyssomyia* genera proposed by Galati (2005).

Among all the characters observed in our linear morphometric evaluations, those that most significantly contributed to species differentiation were the lengths of the ejaculatory pump, body, and common ducts of the spermathecae. The ratio between the ejaculatory filament and its tip is a useful structure for species differentiation of *Ny. intermedia* and *Ny. neivai*. We also observed that the morphometric data of the male genitalia contributed additional information regarding species separation than the characters of the female genitalia.

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