An illustrated guide for characters and terminology used in
descriptions of Phlebotominae (Diptera, Psychodidae)

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Abstract – Phlebotomine (Diptera, Psychodidae, Phlebotominae) taxonomy has been studied extensively, primarily due to the role of these flies as vectors of various parasites, including species of Leishmania, Bartonella and arboviruses that cause diseases in humans and other vertebrates. We present some topics discussed at a round-table on phlebotomine taxonomy held at the Ninth International Symposium on Phlebotomine Sandflies (ISOPS IX) in Reims, France, in June 2016. To date, approximately one thousand phlebotomine species have been described worldwide, although in varying languages and mostly without standardization of characters and terminology. In the interest of standardization, we list the characters that should minimally be considered in the description of new phlebotomine taxa as well as annotated illustrations of several characters. For these characters, multiple illustrations are provided to show some of the variations. The preferred terms for all pertinent characters are listed as well as their synonyms in English, Portuguese, and French. Finally, we offer an updated list of abbreviations to be used for generic and subgeneric names.

Key words: Phlebotominae, Taxonomy, Morphology, Species description.

Résumé – Guide illustré des caractères et de la terminologie utilisés dans les descriptions de Phlebotominae (Diptera, Psychodidae). La taxonomie des phlébotomes (Diptera, Psychodidae, Phlebotominae) a été largement étudiée, principalement en raison du rôle de ces diptères comme vecteurs de divers parasites, y compris des espèces de Leishmania, Bartonella et des arbovirus qui causent des maladies chez l’homme et d’autres vertébrés. Nous présentons certains thèmes abordés lors d’une table ronde sur la taxonomie des phlébotomes tenue lors du 9ème Symposium international sur les phlébotomes (ISOPS IX) à Reims, France, en juin 2016. À ce jour, environ mille espèces de phlébotomes ont été décrites dans le monde entier, bien que dans des langues variées et surtout sans standardisation des caractères et de la terminologie. Dans l’intérêt de la normalisation, nous énumérons les caractères qui devraient être considérés lors de la description de nouveaux taxons de phlébotomes et fournissons des illustrations légendées de nombre d’entre eux. Pour ces caractères, plusieurs illustrations sont fournies pour montrer une partie de la variabilité. Les termes préférés pour tous les caractères pertinents sont répertoriés ainsi que leurs synonymes en anglais, portugais et français. Enfin, nous proposons une liste actualisée des abréviations à utiliser pour les genres et sous-genres.

Introduction

Phlebotomine (Diptera, Psychodidae, Phlebotominae) taxonomy has been studied extensively, primarily due to the role of these flies as vectors of various agents, including species of Leishmania, Bartonella and arboviruses that cause infections in humans and other vertebrates. To date, approximately one thousand phlebotomine species have been described worldwide, although in varying languages and mostly without standardization of characters and terminology. During the
Table 1. Suggestion of the characters and the respective terminology used for the description of a new phlebotomine fly species. L = length; W = width; M = male; F = female; X = include the information.

| Structures       | Characters                                      | Measurements | Description | Drawing |
|------------------|-------------------------------------------------|--------------|-------------|---------|
| Head (MF)        |                                                  |              |             |         |
| Clypeus          | Distribution of the setae                       | X            |             |         |
| Clypeus          | L, W                                            | X            |             |         |
| Eyes             | L, W                                            | X            |             |         |
| Eye facets       |                                                 |              |             |         |
| Interantennal suture |                                               | X            | X          |         |
| Interocular sutures |                                               | X            | X          |         |
| Flagellomeres    | f1, f2, f3, f12, f13, f14                       | L            | X          |         |
| Flagellomeres    | Position of the internal and external asroids on f1 |              | X          |         |
| Flagellomeres    | Ascoideal formula                               |              | X          |         |
| Flagellomeres    | Number and position of papilla(e)               | X            | X          |         |
| Flagellomeres    | Simple setae: position                          | X            | X          |         |
| Palpi            | p1, p2, p3, p4, p5                              | L            | X          |         |
| Palpi            | Palpal formula                                  | X            |             |         |
| Palpi            | p2, p3 – Newstead’s sensilla: presence and position/absence |              | X          |         |
| Palpi            | p3, p4: Numbers of spiniform setae              | X            | X          |         |
| Labrum-epipharynx| L                                                |              |             |         |
| Hypopharynx (F)  | Apical teeth                                    | X            | X          |         |
| Maxillary lacinia (F) |                                              | X            | X          |         |
| Labium (MF)      | Labial suture: open or in furca                 | X            | X          |         |
| Cibarium (F)     | Anterior teeth: horizontal/vertical/lateral position |              | X          |         |
| Cibarium (F)     | Posterior teeth: numbers                        | X            | X          |         |
| Cibarium (F)     | Lateral teeth: presence/absence                 | X            | X          |         |
| Cibarium (F)     | Sclerotized arch                                | X            | X          |         |
| Cibarium (F)     | Sclerotized area                                | X            | X          |         |
| Pharynx (MF)     | Teeth: presence/absence                         | X            | X          |         |
| Cervix (MF)      | Number                                          | X            |             |         |
| Cervical sensilla| Presence/absence                                | X            |             |         |
| Thorax (MF)      | Coloration                                      | X            |             |         |
| Sclerites        | Post-alar setae: presence/absence               | X            |             |         |
| Mesonotum        | Paratergital setae: presence/absence            | X            |             |         |
| Pleural sclerites| Proepimeral setae: presence/absence             | X            |             |         |
| Pleural sclerites| Upper anepisiternal setae: presence/absence     | X            |             |         |
| Pleural sclerites| Lower anepisiternal setae: presence/absence     | X            |             |         |
| Pleural sclerites| Anepipimeral setae: presence/absence            | X            |             |         |
| Pleural sclerites| Metaepisternal setae: presence (number)/absence | X            |             |         |
| Pleural sclerites| Metaepimeral setae: presence/absence            | X            |             |         |
| Pleural sclerites| Setae on the anterior region of the katepisternum: presence/absence | X |         |
| Suture between mesepimeron and metaepisternum | Presence/absence                                | X            |             |         |
| Metafurca: vertical arms | United/separated                           | X            |             |         |
| Wing r5          |                                                 | L            |             |         |
| Legs             | L                                               |              |             |         |
| Legs             | Alpha, beta, gamma, delta, pi                   | L            |             |         |
| Legs             | Coxa, femur, tibia, tarsomeres (ti, sum of tii, tiii, tv, tv) | L          |              |         |
| Legs             | Metamemur-spines: presence/absence              | X            |             |         |
| Legs             | Metatarsomere iii number of verticils with spines | X            |             |         |
| Abdomen          | Setae forming or not two bands                  | X            |             |         |
| Tergites ii–v (MF) |                                              | L            |             |         |
| Tergites ii–vii (M) |                                              | L            |             |         |

(continued on next page)
Table 2. Suggested terminology for main characters for the description of a new phlebotomine fly species and the most common synonyms; French and Portuguese translations.

| Suggested terminology | Synonyms | French | Portuguese |
|------------------------|----------|--------|------------|
| Head                   | Flagellomeres FI-FXIV | Antennomeres AIII–AXVI, antennal segments 3–16 | Antennomères; segments antenaires a3–a16, articles antenaires AIII–AXVI |
|                        | Ascoïdes; spines géniculées | Formule antenne | Fórmula antenal |
|                        | Sensilles | Sensilles | Papilas |
|                        | Hirsute glands; sensory papillae | Sensilles | Sensilles |
|                        | Newstead’s sensory spines; Newstead’s modified spines; hyaline sensilla | Épines de Newstead, sensilles de Newstead | Espinhos de Newstead, sensilas de Newstead |
|                        | Newstead’s sensilla | | |
|                        | Cibarium, cavity buccal | | |
|                        | Cibarium | | |
|                        | Armature cibarial | | |
|                        | Dents cibariales | | |
|                        | Dents cibariales | | |
|                        | Dents verticaux, dents antérieures | | |
|                        | Dents horizontaux, dents postérieures | | |
| Cibarium armature      | Horizontal teeth | Armature cibarial | Armadura cibarial |
| Posterior teeth        | Vertical teeth | Denticules | Dentes verticales, dents antérieures |
| Anterior teeth         | Chitinious arch | Arc chitineux | Arco esclerorado, arco esclerotinizado, arco quitinoso. |
| Sclerotized arch       | Pigmented area; pigment patch | Plage pigmentée | Área esclerotinizada, área esclerosada, área pigmentada, área quitinizada. |
| Sclerotized area       | Spines of pharynx | Dents pharyngées | Espinhos da faringe |
| Pharyngeal teeth       | | | |

Table 1. (continued)

| Structures | Characters | Measurements | Description | Drawing |
|------------|------------|--------------|-------------|---------|
| Genitalia (M) | | | | |
| Clusters of setae: presence and position/absence | L, W | X | X |
| Sclerotized band in the ventral margin/presence/absence | | | | |
| Gonostyle | Spines: number, position, and aspects (size and thickness) | | X | X |
| Parameres | Dorsal and ventral margin | | L | X | X |
| Parameral sheath | Dorsal and ventral margin | | L | X | X |
| Epaedral lobes | Permanent setae: presence/absence | | L, W | | X |
| Cerci; cercus (sing.) | | | | |
| Spermatheca | Shape | | L | | |
| Epaedral apodemes | | | | |
| Hypandrial apodemes | Presence/absence | | | | X | X |
| Genitalia (F) | | | | |
| VIII tergite | Setae: presence (number)/absence | | | X | X |
| IX tergite | Protuberance: presence/absence | | | X | X |
| Spermathecae | Shape | | | |
| Terminal knob | Shape | | | |
| Spermathecal individual ducts | Aspects: sclerotization, striation | | L, W | | X | X |
| Spermathecal common duct | Aspects: sclerotization, striation | | L, W | | X | X |
| Genital fork | Aspects of chamber and stem | | | | X | X |
| Cerci; cercus (sing.) | | | | | | |
| X sternite | Number of setae | | | | X | X |
| Suggested terminology | Synonyms | French | Portuguese |
|-----------------------|----------|--------|------------|
| **Thorax**            |          |        |            |
| Post-alar seta(e)      | Soies rétro-alaires | Cerdas pós-alares |
| Sclerites             | Sclérites | Escleritos |
| Proepimeron           | Proépimère | Proepimer |
| Proepimeral setae     | Soies mésanepistériales inférieures | Cerdas anepisternais inferiores |
| Anepisternum          | Mésanepisterne | Anepisterno |
| Upper anepisternal setae | Soies mésanepistériales supérieures | Cerdas anepisternais superiores |
| Lower anapisternal setae | Soies mésanepistériales inférieures | Cerdas anepisternais inferiores |
| **Abdomen**           |          |        |            |
| Trumpet glands         | Glandes en trompettes | Papilas tergaís |
| Tergal papillae       |          |        |            |
| **Genitalia (M)**     |          |        |            |
| Gonocoxite            | Basimere, basistyle; coxite; proximal segment of upper gonapophysis; basal segment of upper appendages; superior clasper | Coxite; gonocoxite; gonapophyse supérieure |
| **Gonostyle**         | Distimere, distal segment of upper gonapophyses; terminal segment of upper appendages; terminal segment of clasper; style | Style, gonostyle |
| **Parameres**         | Intermediate appendages; intermediate gonapophyses; claspers; claspette, middle appendages; | Paramère; appendice intermédiaire |
| **Cerci; cercus (sing.)** | Cerques, lobes latéraux; surstyles | Cercos |
| **Epandrial lobes**   | Ceri, lateral lobes; lateral lobe of IX tergite, lower gonapophyses, surstyle | Cerques, lobes latéral, surstyles |
| **Sperm pump**        | Genital pump; ejaculatory pump; pompetta | Pompe génitale |
| **Ejaculatory apodeme** | Piston; rod | Piston |
| **Sperm sac**         | Sac of pompetta, seminal pump | Pavillon de la pompe |
| **Aedeagai ducts**    | Aedeagai filaments; aedeagus; ejaculatory ducts; ejaculatory filaments genital filaments; spicules; intromitent organ, penal filaments | Filaments génitaux; canaux ejaculateurs; organes intromittents; filaments péniens |
| **Parameral sheath**  | Aedeagai sheath; aedeagus; gubernaculum; penial valve; penis, penal theca | Édège, fourreau pénién, gainé du pénis; pénis; valve pénienn |
| **Hyandrial apodemes** | Gonocoxal hyandrial apodeme of the aedeagai sheath; sclerotized rods | Baguettes abdominales |
| **Genitalia (F)**     |          |        |            |
| **Spermatheca**       | Body of spermatheca | Spermathèque; corps de la spermathèque |
| **Terminal knob**     | Head of the spermatheca | Tête de la spermathèque |
| **Spermathecal ducts** | Ducts | Conduits des spermathèques |
| **Genital fork**      | Genital furca | Furca génitale |

Table 2. (continued)
Figure 1. Dorsal view of the head and its appendages of a phlebotomine female: cl – clypeus; fl – 1st flagellomere; fII – 2nd flagellomere; hy – hypopharynx; ml – maxillary lacinia; lb – labium; le – labrum-epipharynx; md – mandible; pe – pedicel; pha – pharynx; pI – 1st palpal segment; pII – 2nd palpal segment; pIII – 3rd palpal segment; pIV – 4th palpal segment; pV – 5th palpal segment; sc – scape; most frequently used measurements: eL – eye length; eW – eye width; clL – clypeus length; fIL – 1st flagellomere length; hEL – head length; hW – head width; ioD – interocular distance; pL – palpus length – *Nyssomyia intermedia*. 
Figure 2. (A–G) Dorsal view of the head of Bruchomyiinae and Phlebotominae with the distribution of the setae on some sclerites, the relation of clypeus to eyes and aspects of some structures (A) Bruchomyiinae (Bruchomyia sp.). (B) Phlebotominae: Warileya phlebotomanica; (C) Brumptomyia brumpti; (D) Sergentomyia (Sergentomyia) minuta; (E) Pintomyia (Pifanomyia) maranonensis; (F) Lutzomyia (Helcocyrtoomyia) tejadai; (G) Lu. (Helcocyrtoomyia) blancasi; (H) Phlebotomus (Euphlebotomus) barguesae. ey – eye; fcls – frontoclypeal suture; ge – gena; ias – interantennal suture; ios – interocular suture; oc – occiput; ve – vertex.
Ninth International Symposium on Phlebotomine Sandflies (ISOPS IX) held in Reims from June 28 to July 1, 2016 [4], a round-table on Systematics was co-chaired by EAB Galati, P Lawyer, N Léger, and J Depaquit. We report in this paper the results of discussions on the following topics: the use of the informal term sandflies (or sand flies); methods for permanent preservation and mounting of phlebotomine specimens and appropriate places for deposition of type specimens; a recommendation regarding terms used in morphological descriptions of sand flies and their synonyms, illustrated by several drawings with captions; the characters to be used in taxonomic discussion and to be drawn when a new species is described, and some comments about the systematics of phlebotomines and integrative taxonomy.

On the use of the common name sand flies

Throughout history, there have been discussions on the use of the popular term sandflies (as one word) or sand flies (two words). Beyond the problem of its true form, this common name has also been applied to other dipterans (e.g. Ceratopogonidae and Simuliidae). Furthermore, some feel that the name does not seem appropriate to the habitat of Neotropical phlebotomine species, whereas others argue that the name was originally given to reflect the color rather than the habitat of these flies. Some colleagues suggested using the term “phlebotomine flies” to replace “sand flies” or “sandflies”; others suggested using “phlebotomine sand flies.” The discussion ended without achieving a consensus.

Figure 3. Palpus of Phlebotominae. (A) 1st–5th palpal segments of phlebotomines: Newstead’s sensilla (Ns) dispersed on p3 and present from 2nd to 5th segment – Psathyromyia naftalekatzi. (B) Newstead’s sensilla concentrated on basal part of the segment and only one simple seta (ss) – Micropygomyia echinathopharynx. (C) Several simple setae on p3 – Warileya phlebotomanica.
Figure 4. Aspects on the presence and distribution of ascoids, papillae, and simple setae on flagellomeres of Phlebotominae: (A–C) apical flagellomeres (fXI–fXIV): (A) Evandromyia (Barrettomyia) tupynambai (♀); (B) Wartileya rotundipennis (♀); (C) Trichophoromyia ubiquitalis (♀). (D1–D4) First flagellomere (fl) of phlebotomine: (D1) Wartileya rotundipennis (♀); (D2) Psychodopygus squamiventris (♀); (D3) Evandromyia aroucki (♀); (D4) Sergentomyia dubia (♀). (E1–E4) 2nd and 3rd flagellomeres of phlebotomines: (E1) Wartileya rotundipennis (♀); (E2) Psathyromyia shannoni (♀); (E3) Sergentomyia dubia (♀); (E4) Sergentomyia dubia (♀). ap – Apical papilla; as – ascoid; bp – basal papilla; ias – internal ascoid; mp – median papilla; p – papilla; pap – preapical papilla; pasp – preascoidal papilla; sp – spiniform papilla; ss – simple seta.
Figure 5. Mouth parts of Phlebotominae. (A, B) Apical region of the labrum-epipharynx of phlebotomine females: (A) *Micropygomyia vexator*; (B) *Lutzomyia longipalpis*. (C–E) Apical region of the hypopharynx of phlebotomine females: (C) *Lutzomyia longipalpis*; (D) *Sciopemyia sordelli*; (E) *Micropygomyia cayennensis*. (F–K) Maxillary lacinia of phlebotomine females: (F) *Warileya phlebotomanica*; (G) *Warileya rotundipennis*; (H) *Lutzomyia cruciata*; (I) *Nyssomyia intermedia*; (J) *Micropygomyia quinquefer*; (K) *Micropygomyia longipennis*. et – External teeth of maxillary lacinia; it – internal teeth of maxillary lacinia.
**On type specimens**

In the past and even more recently, phlebotomine type specimens have been deposited in institutions or schools other than museums [1, 9, 10]. It is very important to deposit at least the holotype in a collection under the supervision of a curator; however, political or administrative changes in these institutions can affect the specimens’ preservation and availability under conditions suitable for examination. Consistent with Articles 16C and 72F of the fourth edition of the International Code of Zoological Nomenclature (ICZN), we strongly recommend that authors of species descriptions deposit type and voucher specimens in one or more institutions that maintain a research collection with proper facilities for preserving them and making them accessible for study. It is critical for every institution in which material is deposited to ensure that all name-bearing types are clearly marked and recognizable as such. Moreover, the repository must be capable of taking all necessary steps to preserve these specimens, make them accessible for study, publish lists of name-bearing types in their possession or custody and, in so far as possible, communicate upon request information concerning name-bearing types [6]. In addition to depositing type and voucher specimens, we recommend registration with Zoobank (http://www.zoobank.org).

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**Figure 6.** Labium of phlebotomine females in ventral view. (A) *Warileya phlebotomanica*; (B) *Lutzomyia amarali*; (C) *Sergentomyia minuta*; (D) *Idiophlebotomus padillarum*; (E) *Chinius eunicegalatiae*. lbl – Labellum I; lbII – labellum II; lbs – labial suture; prem – prementum.
Figure 7. Cibarium and pharynx of phlebotomine females. (A) *Micropygomyia atroclavata*; (B) *Bichromomyia flaviscutellata*. antt – Anterior teeth; cic – cibarial chamber; f – fold; ltt – lateral teeth; pha – pharynx; pht – pharyngeal teeth; psbr – posterior bridge; ptt – posterior teeth; pp – posterior protuberance; latsc – lateral sclerite; scar – sclerotized arch; scare – sclerotized area.
Figure 8. Cibarium of phlebotome females. (A) *Edentomyia piauiensis*; (B) *Brumptomyia* sp; (C) *Micropygomyia pilosa*; (D) *Micropygomyia cayennensis*; (E) *Evandromyia walker*; (F) *Sciopemyia sordeleti*; (G) *Lutzomyia* (*Helcocytomyia*) *kiri*getiensis; (H) *Lutzomyia longipalpis*; (I) *Trichophoromyia auraensis*; (J) *Psathyromyia luziana*. 
Figure 9. Cibarium of phlebotomine females. (A) Australophilebotomus notteghemae; (B) Idiophilebotomus padillarum; (C) Sergentomyia (Vattieromyia) sclerosiphon; (D) Phlebotomus (Euphlebotomus) mascomai; (E) Phlebotomus (Madaphlebotomus) vaomalalae; (F) Sergentomyia bailyi; (G) Sergentomyia (Sergentomyia) phadangensis; (H) Sergentomyia hivernus; (I) Phlebotomus (Transphlebotomus) anatolicus; (J) Chinius eunicegalatiae; (K) Chinius samarensis; (L) Sergentomyia (Parrotomyia) babu; (M) Parvidens heishi; (N) Phlebotomus (Madaphlebotomus) vincenti; (O) Sergentomyia (Vattieromyia) nana.
Figure 10. Sclerites of cervix and thorax of Phlebotominae. anp – anepimeron; apn – antepronotum; as – anterior spiracle; at – anatergite; csc – cervical sclerite with a pair of sensilla; hal – halter; kep – katepimeron; kes – katepisternum; kt – katatergitum; las – lower anepisternum; mnt – metanotum; mscx – mesocoxa; msf – mesofurca; mtcx – metacoxa; mtf – metafurca; mtp – metepimeron; mts – metepisternum; pem – proepimeron; pes – proepisternum; pnt – postnotum; ppn – postpronotum; pps – protuberance of the prosternum; prcx – procoxa; prf – profurca; ps – posterior spiracle; psct – prescutum; pt – paratergite; sclt – scutellum; scu – scutum; uas – upper anepisternum; vesc – ventrocervical sclerite; win – wing. Deanemyia samueli.
Figure 11. Setae on the thorax of phlebotomines: anps – anepimeral setae; dcs – dorsocentral setae; lass – lower anepisternal setae; mnts – metanotal setae; mtps – metepimeral setae; mtss – metepsiternal setae; pems – proepimeral setae; pscts – prescutal setae; psus – postsutural setae; sas – supralar setae; sclts – scutelar setae; uass – upper anepisternal setae; vcs – ventrocervical sensilla. Brumptomyia pintoi.
Figure 12. Thorax in lateral view of Phlebotominae with indication of characters in plesiomorphic state: arrow – indicating the long suture separating the katepimeron and metepisternum; pas – postalar seta. Oligodontomyia toroensis.
for all nomenclatural acts (published usages of scientific names of animals, which affect their nomenclature or the typification of a nominal taxon), publications of original taxonomic descriptions, and references to authors and designation of type specimens.

**Methods of preserving phlebotomine specimens**

Many type specimens of phlebotomine species and other specimens in many reference collections were mounted in non-permanent media such as Hoyer’s Medium or Berlese and have long since deteriorated so that many of the diagnostic characters of the specimens are neither visible nor distinguishable, thereby rendering the specimen useless. It was proposed that a protocol using a permanent medium such as Canada balsam be adopted and standardized, in so far as possible, for preservations of all specimens that are to be deposited in museums for future reference.

**Suggested guidelines for the description of new phlebotomine species**

Many pertinent characters of Phlebotominae that are currently used for their identification and classification have
been described by authors using distinct terminology. This practice has been criticized by other dipterists because, in addition to hindering studies of homology within Phlebotominae, it also makes comparisons among supra-specific taxa difficult. This is particularly problematic for characters of the male terminalia. To this end, we suggest that terminology used in phlebotomine taxonomy be more closely aligned with that used in general dipterology [2, 7]. In order to standardize the descriptions and re-descriptions of phlebotomine species, a list of characters (all body parts and their appendages and sensorial structures, such as spines, setae, papillae, sensilla, sutures, etc.) deserving of comment and illustration is proposed (Table 1). Furthermore, in order to contribute to the standardization of terminology for structures that have been frequently used in phlebotomine taxonomic studies, a list is provided (Table 2) including suggested terms in English and synonyms of these terms that have been used in the past by various authors, in French and Portuguese. Some characters have been infrequently used in published descriptions and may thus be poorly known; for this reason and for the purpose of illustrating the morphological diversity of some characters, drawings have been provided with the corresponding terminology in each legend (Figures 1–28). A drawing is preferable to a photo, but sometimes for structures such as the pharyngeal armature, a photo can supplement or replace a drawing. We posit that the list of characters suggested

![Figure 14](image14.jpg)

**Figure 14.** Wing of Phlebotominae. (A) Main indices; (B) wing with of fusion of R2 and R3: Chinius eunicegalatiae.
Figure 15. Abdominal tergites of Phlebotominae, showing arrangements of the deciduous bristles and tergal papillae and aspects of the tergal papillae and “trumpets glands”. (A, B) 2nd–5th male tergites with the arrangement of the deciduous bristles. (A) Two transverse bands: *Warileya phlebotomanica*. (B) Randomly: *Nyssomyia intermedia*. (C, D) Distribution and aspects of the tergal papillae on 4th tergite; (C) restricted to the central area: *Lutzomyia longipalpis*; (D) dispersed over the surface of the tergite, among the deciduous bristle scars: *Pintomyia fischeri*. (E–G) Aspects of the papillae on the 6th tergite: (E) papillae without hair and without clear demarcation of their borders; (F) papillae with hair: *Brumptomyia cardosoi*; (G) papillae without hair and with clear demarcation of their borders: *Evandromyia walkeri*. (H) “Trumpet glands” of the fourth abdominal tergite: *Chinius samarensis*. 
Figure 16. Abdomen and genitalia of Phlebotomine female. (A) abdomen in lateral view; (B) genitalia in lateral view; (C) 8th segment in ventral view; (D) 9th segment, 10th segment and cerci in ventral view. *Nyssomyia neivai*. gon – gonopod; st – sternite; stem – fork stem; terg – tergite.
Figure 17. Some structures of the abdomen and the genitalia of phlebotomine females. (A) 3rd–6th abdominal segments showing the pleural setae: *Lutzomyia (Tricholateralis) sherlocki*. (B, C) 10th sternite showing non-deciduous setae in the median region: (B) *Micropygomyia vexator*, (C) *Sergentomyia minuta*. (D) 9th segment showing a sclerotized protuberance on the tergite: *Migonemyia (Migonemyia) rabelloi*. (E) spicules in 9th and 10th tergites: *Lutzomyia (Tricholateralis) cruciata*. (F) 9th tergite with short bristles: *Sciopemyia sordellii*. 
Figure 18. Spermathecae and genital fork aspects of Phlebotominae. (A) Brumptomyia brumpti; (B) Migonemysia (Blancasmyia) gorbizi; (C) Viannamia tuberculata; (D) Phlebotomus (Phlebotomus) papatasi; (E) Lutzomyia (Lutzomyia) longipalpis; (F) Dampomyia (Coromyia) vespertilionis; (G) Dampomyia (Dampomyia) anthophora; (H) Micropygomyia (Coquillettimyia) vexator; (I) Evandromyia (Evandromyia) saulensis; (J) Ev. (Eva.) infraspinosa.
permits a detailed description of the species and provides elements for species distinction and phylogenetic studies.

Lastly, an update to the previous proposal for abbreviating the names of genera and subgenera [8] is presented in Table 3.

**Other taxonomic approaches**

It is becoming more straightforward to distinguish phlebotomine taxa using modern techniques. The use of statistical approaches, such as models based on discriminant or multivariate analyses used in morphometric studies, may also contribute to the identification of intra- and inter-specific differences.

Concerning the identification of species using methods other than traditional dichotomous keys, the development of cybertaxonomy may facilitate this task for non-specialists or when many specimens need to be identified. The limited number of characters used by this tool may restrict its application in the case of a diverse fauna on a large scale.

One of the significant challenges facing phlebotomine taxonomists is the adoption of an integrative taxonomic
Figure 20. Spermathecae and genital fork aspects of Phlebotominae. (A) Australophlebotomus notteghemae; (B) Chinius eunicegalatiae; (C) Chinius samarensis; (D) Phlebotomus (Madaphlebotomus) vincenti; (E) Ph. (Paraphlebotomus) sergenti; (F) Idiophlebotomus padillarum; (G) Parvidens heishi; (H) Ph. (Euphlebotomus) barguesae; (I) Ph. (Par.) chabaudi; (J) Phlebotomus (Larroussius) major; (K) Spelaeomyia moucheti; (L) Sergentomyia (Rondanomyia) goodmani comorensis; (M) Se. hivernus; (N) Ph. (Transphlebotomus) economidesi; (O) Se. (Vattieromyia) namo; (P) Se. (Sergentomyia) phadangensis; (Q) Sergentomyia (Ron.) goodmani; (R) Ph. (Par.) mireillae.
approach, with an increase in attention to identifying characters to be used for accurate and efficient delimitation of species. Well-known, common adult morphological and morphometric characters are important; however, others such as behavioral, biochemical, ecological, and molecular data need to be considered, as well as morphological or developmental characters related to eggs, larvae, and pupae. It is highly recommended that markers used in molecular analysis for the delimitation of taxa be standardized and gene sequences should be deposited in free-access databases to permit the analysis of species or populations, especially for widespread taxa. This information is also valuable for phylogenetic studies.

Figure 21. Lateral view of male genitalia of Phlebotominae. (A) *Nyssomyia neivai*; (B) *Warileya nigrosaccula*.
Figure 22. (A–C) Ventral view of the epandrium and of epandrial lobes and cerci of Phlebotominae. (A) Bruchomyiinae (Bruchomyia sp); (B, C) Phlebotominae: (B) Warileya nigrosaccula; (C) Psychodopygus chagasi. (D–I) Lateral view of epandrial lobe and cercus of Phlebotominae: (D) Hertigia hertigi; (E) Sciopemyia sordellii; (F) Psychodopygus chagasi; (G) Trichopygomyia longispina; (H) Evandromyia (Aldamyia) walkeri; (I) Evandromyia (Evandromyia) infraspinos.
Figure 23. (A–C) Lateral view of gonoxites of Phlebotominae. (A) Brumptomyia brumpti; (B) Phlebotomus papatasii; (C) Migonemyia (Blancasmyia) gorbitzi; (D) Trichophoromyia auraensis; (E) Micropygomyia (Micropygomyia) pilosa; (F) Psychodopygus chagasi; (G) Lutzomyia (Tricholateralis) carvalhoi; (H) Lutzomyia (Lutzomyia) almerioi; (I) Pintomyia (Pifanomyia) verrucarum; (J) Phlebotomus hindustanicus; (K) Sergentomyia dentata; (L) Phlebotomus mireilliæ.
Figure 24. Lateral view of gonostyles of Phlebotominae. (A) Micropygomyia chiapanensis; (B) Brumptomyia cardosoi; (C) Sergentomyia minuta; (D) Phlebotomus papatasi; (E) Edentomyia psauiensis; (F) Oligodontomyia toroensis; (G) Deanemyia samueli; (H) Micropygomyia pilosa; (I) Pintomyia (Pifanomyia) sauroida; (J) Migonemyia (Blancasmyia) gorbitzi; (K) Pintomyia (Pifanomyia) servana; (L) Evandromyia (Evandromyia) correalmata; (M) Pressatia triacantha; (N) – Evandromyia saulensis; (O) Chinius samarensis; (P) Parvidens heishi; (Q) Sergentomyia – Sergentomyia (Sergentomyia) dentata; (R) Phlebotomus (Transphlebotomus) economidesi; (S) Idiophlebotomus padillarum; (T) Phlebotomus (Paraphlebotomus) andrejevi; (U) Phlebotomus (Legeromyia) multihamatus.
The taxonomy of American phlebotomines has recently been updated regarding the number of described species/subspecies (502: 17 fossil and 485 extant). Additionally, it was commented that there has been an increase of 16.5% in the number of species described since Galati’s classification [3] and of 22.5% since that of Young and Duncan [11], though, in this latter case, only for the groups that these authors included in Lutzomyia. It was also commented that some taxa had been resurrected, some other species had been included as junior synonyms and two artificial taxa had been excluded from the species list. It is important to note that Galati’s classification has been updated annually and is available on the website: www.fsp.usp.br/~egalati [5].

Finally, the need to strengthen the training of taxonomist groups around the world was emphasized in view of the fact that taxonomy is the basis of the eco-epidemiological studies of vector-borne diseases. In recent years, with the advances of new technologies, particularly the molecular approach, a low level of interest on the part of young researchers in classical taxonomy has been observed that could lead to a significant loss of knowledge because expertise in this field depends on the strength of training and mentorship over successive generations.

Figure 25. Lateral view of gonostyles of Phlebotominae. (A) Viannamyia tuberculata; (B) Psathyromyia lanei; (C) Bichromomyia flaviscutellata; (D) Trichophoromyia auranensis; (E) Martinsmyia alphabetica; (F) Psychodopygus panamensis; (G) Psychodopygus bispinosus; (H) Psychodopygus geniculatus; (I) Psychodopygus chagasi.
Figure 26. Lateral view of paramere and parameral sheath of Phlebotominae. (A) Migonemyia (Blancasmyia) gorbitzi; (B) Evandromyia (Aldamia) walkerii; (C) Lutzomyia (Helcocyrtomyia) guderianii; (D) Psathyromyia (Psathyromyia) laneii; (E) Psychodopygus panamensis; (F) Psychodopygus chagasi; (G) Trichopygomyia longispina; (H) Trichopygomyia dasypodogeton; (I) Viannamyia tuberculata; (J) Pressatia triacantha; (K) Lutzomyia (Lutzomyia) longipalpis; (L) Lutzomyia (Lutzomyia) dispar; (M) Sergentomyia (Sergentomyia) dentata; (N) Phlebotomus (Legeromyia) multihamatus; (O) Idiophlebotomus padillarum; (P) Phlebotomus (Euphlebotomus) barguesae; (Q) Parvidens heishi; (R) Phlebotomus (Paraphlebotomus) andrejevi.
Figure 27. (A–R) Lateral view of terminal region of aedeagal ducts of Phlebotominae. (S) Genital pump, aedeagal ducts and hypandrial apodemes (abdominal rods). (A) Blunt apex: Lu. longipalpis; (B) striated duct with blunt apex: Ev. brachyphalla; (C) apex beveled: Pa. shannonii; (D) curved and toothed apex: Ma. gasparviannai; (E) curved and beveled apex: Mi. longipennisi; (F) duct curved in its preapical region and apex provided with appendix: Vi. tuberculata; (G) lozenge apex: Pa. runoides; (H) apex with barbs: Ny. yuilli pajoti; (I–J) bifurcated apex: (I) Ny. whitmani; (J) Nyssomyia anduzei; (K) ladle-shaped apex: Ny. intermedia; (L) spoon shaped or knife to eat fish shaped: Ny. neivai; (M) clavate apex: Ev. walkeri; (N) duct with curved preapical region and blunt apex: Pa. aragaoi; (O) strongly sclerotized bifurcated apex: Ev. lenti; (P) irregular side: Se. anka; (Q) enlarged at the top: Se. sclerosiphon; (R) with apical inflated portion: Id. padillarum. (S) Terminal region of aedeagal ducts with blunt apex: Id. nicolegerae.
Figure 28. Parameral sheath of Phlebotominae. (A) With a transparent inferior top: *Phlebotomus perfiliewi*; (B) rounded with a knob at the top: *Idiophlebotomus nicolegerae*; (C) wide and short: *Chinius eunicegalaitae*; (D) with transparent top: *Phlebotomus (Euphlebotomus) barguesae*; (E) pointed: *Phlebotomus (Paraphlebotomus) chabaudi*; (F) rounded at the top: *Sergentomyia (Vattieromyia) anka*; (G) drumstick-like: *Phlebotomus (Larroussius) major*; (H) finger-like: *Phlebotomus (Madaphlebotomus) vaomalalae*; (I) with hooked top: *Phlebotomus (Paraphlebotomus) mongolensis*.
Table 3. Proposed abbreviations for genera and subgenera of Phlebotominae.

| Genus | Abbreviation | Subgenus | Abbreviation |
|-------|--------------|----------|--------------|
| Australophlebotomus Theodor | Au. | | |
| Brumptomyia França & Parrot | Br. | | |
| Chinius Leng | | | |
| Dampfomyia Addis | Da. | | |
| Deanemyia Galati | De. | | |
| Edentomyia Galati, Andrade Filho, Silva & Falcão | Ed. | | |
| Evandromyia Mangabeira | Ev. | | |
| Expallata Galati | Ex. | | |
| Grassomyia Theodor | Gr. | | |
| Hertigia Fairchild | He. | | |
| Idiophlebotomus Quate & Fairchild | Id. | | |
| †Libanophlebotomus Azar | Lb. | | |
| Lutzomyia França | Lu. | | |
| Martinsmyia Galati | Mt. | | |
| †Mesophlebotomites Azar | Me. | | |
| Micropygomyia Barretto | Mi. | | |
| Coquillettimyia Galati | Cas. | | |
| Lutzomyia | Lut. | | |
| Helcocyrtomyia Barretto | Hel. | | |
| Tricholateralis Galati | Trl. | | |
| Migomemyia Galati | Mg. | | |
| Nyssomyia Barretto | Ny. | | |
| Oligodontomyia Galati | Ol. | | |
| †Palaeomyia Poinar Jr. | Pl. | | |
| Parvidens Theodor & Mesghali | Pv. | | |
| †Phlebotoicella Solórzano Kraemer & Wagner | Pb. | | |
| †Phlebotomiella Hennig | Pe. | | |
| †Phlebotomites Meunier | Pt. | | |
| Phlebotomus Rondani & Berté | Ph. | | |
| Abonnencius Morillas Marquez, Castillo Remiro & Ubeda | Abo. | | |
| Ontiveros | Adl. | | |
| Adlerius Nitzulescu | Ad. | | |
| Anaphlebotomus Theodor 1948 | Ana. | | |
| Euphlebotomus Theodor, 1948 | Eup. | | |
| Kasaulius Lewis | Kas. | | |
| Larroussius Nitzulescu | Lar. | | |
| Legeromyia Rahola, Depaquit, Makanga & Paupy | Leg. | | |
| Madaphlebotomus Depaquit, Leger, Randrianambinintsoa | Mad. | | |
| Paraphlebotomus Theodor | Par. | | |
| Phlebotomus | Phl. | | |
| Synphlebotomus Theodor | Syn. | | |
| Transphlebotomus Artemiev | Tra. | | |
| Pintomyia Costa Lima | Pi. | | |
| Pifanomyia Ortiz & Scorza | Pif. | | |
| Pintomyia | Pin. | | |
| Pressatia Mangabeira | Pr. | | |
| Psathyromyia | Pa. | | |
| Forattiniella Vargas | For. | | |

(continued on next page)
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Table 3. (continued)

| Genus                          | Abbreviation | Subgenus                      | Abbreviation |
|-------------------------------|--------------|-------------------------------|--------------|
| *Psathyromyia*                | *Ps*         |                               |              |
| *Xiphopsathyromyia* Ibañez-Bernal & Marina | *Xip*     |                               |              |
| *Psychodopygus* Mangabeira    | *Ps*         |                               |              |
| *Sciopemyia* Barretto         | *Sc*         |                               |              |
| *Sergentomyia* França & Parrot | *Se*     |                               |              |
| *Capensomyia* Davidson, 1979  | Cap.         |                               |              |
| *Demeillonius* Davidson       | Dem.         |                               |              |
| *Grassomyia* Davidson         | Gra.         |                               |              |
| *Neophlebotomus* França & Parrot | Neo.     |                               |              |
| *Parrotomyia* Theodor         | Par.         |                               |              |
| *Rondonomyia* Theodor         | Ron.         |                               |              |
| *Sergentomyia*                | Ser.         |                               |              |
| *Sintonius* Nitzulescu        | Sin.         |                               |              |
| *Trouilletomyia* Depaquit, Léger & Randrianambintsoa | Tro. |                               |              |
| *Vattieromyia* Depaquit, Léger & Robert | Vat. |                               |              |

* If considered as a subgenus; † Fossil.

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