REPORT

COMPUTER AIDED IDENTIFICATION SANDFLIES (DIPTERA, PSYCHODIDAE PHLEBOTOMINAE) IN FRENCH GUIANA

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THEME OF RESEARCH

Taxonomic review of Diptera groups of medical interest with a view to standardizing their systematics by micro-computer.

1) - CURRENT OBJECTIVES

- To construct a reference collection of sandflies in French Guiana adapted to the modern application of taxonomy
- To establish a description model of sandflies
- To create a knowledge base for the XPER software describing the morphological characters of sandflies in French Guiana in order to :
  - achieve computer-aided identifications (C.A.I.)
  - analyse the knowledge base for the purpose of trying to reconsider Sand-flies systematics.
- To develop new modules of data processing that allow a study of numerical taxonomy from an XPER knowledge base, particularly :
  - the research of the most discriminant character combinations
  - an ascending hierarchical classification
  - an analysis of correspondances
  - an analysis of the distance-chart
- To construct an image analyser permitting an entirely automatized identification.

2) - CURRENT STATE OF KNOWLEDGE

The study of sandflies in French Guiana dates back to several years. Yet new species continue to be discovered today, and with these, new potential vectors of Leishmaniasis as well. despite the high-level work that has previously been carried out, the systematic status of these species is perpetually evolving. In fact, author after author has stuck to describing one model type alone for each species in their publications, something no longer adapted to the requirements of a modern taxonomic evaluation.

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At present, it seems preferable to study and describe representative populations for each species. This helps to understand better their variability and especially to fix interspecific limits with a greater certitude.

Complexity in the living world of systematics largely overshadows every effort made in mastering it for the moment and this will remain so for a while to come. Which is the reason why the all recent application of computerization to this sort of research will really provide for excellent improvement, profitable on short term basis to all fields of life sciences for which computerization plays a fundamental role.

Today, the determination of Sand-flies, or of other Diptera groups, is done by specialized entomologists who are few in number owing to the extensive training required for carrying out reliable identifications. The use of C.A.I. software, only recently begun, can permit a scientist with only a very general knowledge of entomology to arrive at rapid and reliable determinations; and this no other method allows. For the specialist, this method permits a more advanced research through which he can support his speciation studies with solid arguments. These two advantages are indispensable to any important epidemiological study of quality.

3) - MATERIALS AND METHODS

- Biological material :

The Sand-flies caught for collection come from different sources:

- slides from previous collections, still rensable, particularly those used in the studies made by Floch and Abonnenc.
- Sans-flies preserved in tubes
- new samples collected in boxes by a mouth-suction device, then separatelly laid out, colored, set into "Euparal".
- In exchange with various entomological laboratories, mainly with :
  - Dr. RYAN of Wellcome Parasitilogy Unit, Instituto Evandro Chagas, BELEM, BRAZIL.

- Pr.VIANNA MARTINS of Centro de Pesquisas Rene Rachon, BELLO HORIZONTE, BRAZIL.

- Data processing material :

- One I.B.M. PC computer, equiped with a 256 K memory extension, 2 drives 1/4 of 360 K, one black and white monitor, one matric printer EPSON FX-80.
- The DOS PC-DOS, the BASICA interpretor, one MICROSOFT BASIC compiler.
- The XPER software has been used to grasp the knowledge base and its uses.

The computerized part was carried out thanks to the XPER software created by one of us (J.L.). This program is the first computer-aided identification system especially conceived to function on micro-computer, which allows for an incomparable versatility of equipment and a permanent access to data.

- Method :

The aim of the collection, which could well serve as a base for revision of Phlebotomi in South America, is to supply high quality data for a study in systematics. Several criteria have been fixed for this purpose.

- To have a sufficient number of specimens of varied origin for each of the species in order to compose a representative sample. Ten males and ten females per species seems a safe number. It is indispensable to diversify the source of the samples so that a correct idea of the range of their different characters may be formed.
- To keep only those slides that have been perfectly preserved and properly set, making it easy to work on the characters retained for study.
- To keep only those slides where determination is certain
- To possess a pratical reference system concerning each slide, able to cope with a possible extension of the collection.

- To structurize this collection in such a way that it may be preserved and maintained over a long period.

The establishment of a description model is an indisdensable prerequisite to the achieving of a modern systematics study. For this, it is necessary:

- that all the retained characters concerning all the species be described, so that useful comparaisons are possible
- that all discriminating characters be recorded.
- that only those characters be retained that pertain to a real and "pertinent" discrimination of the species considered.
- that the same terms be used to describe each character. A "consistant" description that may be applicable to all the species.

The creation of an XPER knowledge base demands:

- a list of individuals to be decribed (here we talk of the different species), and the making of such a list evidently needs to consider all the problems of synonymy.
- the making of a list of variables, and for each variable, a list of the modalities likely to be found existing; that is to say, in our case, all the characters and their states. Moreover, the logical relations existing between the variables should be mentioned: for example, the position of a silky tuft of coxite in the male genitals should be described only if it be found existing, and only if in reply to the variable "ornementation of coxite" the modality "presence of a silky tuft" can be applied. The use of qualitative variables necessitates a quantitative variable class-coding system.
- a description in every individual case of the list of modalities that can possibly exist within each variable.

To carry out a determination with XPER software implies a step-by-step description of an unknown specimen leading to its identification. After several stages, the result may be:

- *arriving at a determination*
- *arriving at an impossible combination of characters*
- *arriving at an impossible discrimination among several individuals*

The following method has been employed for the developments envisaged:

- *drawing out a process-chart on paper*
- *Program acquisition on BASICA integrated editor*
- *testing and debugging on BASIC interpretor*
- *compiling*

4) - PARTICULARITIES OF XPER SOFTWARE

- Comparison of computer-aided identification methods (C.A.I.) with the dichotomic key :

- Simplicity of work

The setting up of a dichotomic key is usually done within a group monograph. On may wonder why such a key is required since all the information is already stored in the monograph. Its because, in reality, the data is practically unusable in the form of a text. Since the describer mostly notes only that which is noteworthy, the building of a key often demands extra work.

In the XPER system this double work is eliminated because the simple creation of a knowledge base corresponding to monographic descriptions supplies the means of determination. Moreover, should there be a correction or modification in the knowledge base, the repercussion on determination is immediate and automatic; whereas in most cases the key needs to be reset.

- Multiple access

In the case of a classic key, it is imperative to reply to the proposed question at every stage in determination. Thus the key imposes the unalterable way to be followed. In quite a number of cases, the choice in the order of characters would be irremplaceable especially if the data are missing

or if characters are difficult to observe, which often results in an impossibility in determination.

The XPER system assures, at all times, a freedom in the order and choice of variables to be described. If necessary, it can indicate, at every stage, the list of individuals compatible with the specimen. This is very important: it implies that determination can always continue and will end either in a result, or in an impossibility of discrimination between such and such individual, or again, in a combination of characters unforseen in the created knowledge base. One always obtains a result, at whichever level it may be, and which is always amendable according to fresh information received.

Determination is carried out step-by-step with the possibility of reversing at any moment without having to wait.

Access to the classic key imposes the sole use of characters always present or absent in a given unalterable order, otherwise it becomes very difficult, even impossible, to use.

The XPER system allows the use of all the possible characters at the start, since the user has a choice of variables at his disposition, which are accessible for his own specimen. Then again, discrimant variables alone are proposed independantly during determination, and this guarantees enormous determination efficiency. With the same aim in mind, it is possible to ask the system to propose the most efficient variables in order to arrive at a supposed taxon.

- Doubt

During a classic determination no doubt is possible; or else two or more ways are proposed for examination to solve it. Should such a situation occur again the number of ways to examine becomes soon unbearable, and this can happen frequently. Hesitations due to poor vocabulary, between nuances in color, the ratio between lengths or the fact of missing characters, for example on rubbed insects are frequent. In all such cases, the XPER system allows room for doubt. Once we indicate the different modalities over which there is hesitation, the program takes over. This ease permit the use of finer characters than those used in a classic key. A great asset in a number of cases.

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- *Validity of results*

One may notice an erroneous result obtained from a classic dichotomic key if, after an error during determination, the following steps seem to be in order.

The XPER system offers a result security :

- at any given moment during determination, it will indicate if a given response arrives at a character combination unforseen in the knowledge base or not.

- at every step it can justify as to why an individual has been eliminated.

- it permits :

- an automatic calculation of the number of differences between the description of a specimen and the other individuals from the knowledge base

- a comparison of the specimen with an individual or group individuals from the knowledge base

- to extract the existing differences for each case.

- *Training*

This system works as a good trainer because at any given time it can justify its actions, particulary the elimina tion of such and such individual.

- *Elements of analysis*

The XPER software supplies several implements to analyse a knowledge base, in particular:

- a calculation of the Jaccard distance between individuals, allowing for an appreciation of resemblance between different taxons.

- an analysis of characters common to a group of individuals, in order to help define supraspecific taxons.

- an analysis of characters differentiating one group from another to define a differential diagnosis

5) - RESULTS

- Collection:

A bibliographic study concerning South American sandflies has been made and a starting list of 156 species retained (annex 1). A study of the different synonymies and of indications dealing with the population breakdown of the different species has led us to preserve 76 species (annex 2) as those replying to fixed criteria. At present, 40 species in the collection are represented by at least one sample, and out of the 1520 samples that the finished collection will contain, around 500 have been found and identified. This collection represents most of the frequently discovered species.

- Model description:

We have made a model description of the male genitals. 10 quantitative variables and 12 qualitative variables have been retained (annex 3). The same goes for the model description of palps, legs and antenna. The description of antenna, wings and the female genital organs is currently underway.

- XPER knowledge base:

A knowledge base concerning the male genital organs is underway; out of the total 16720 bits of information necessary, around 8000 have been supplied, in particular 2330 measured on micrometer. Most of the missing information was completed by bibliographic data and the rest has been distributed among the different species, which already makes this base perfectly capable of functioning, despite everything (annex 4). An introductory basic project concerning the female palps has also been completed thanks to the literature data.

- Determination:

Several determinations have been carried out with the knowledge base of the male genitals, and these show the rapidity and great reliability with which an identification can be made.

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- *New developments:*

A module has been fixed: it permits us to calculate the distance-index, picked from among 13 such indexes, between individuals and groups of individuals, the creation of distance histograms and a safeguard of tables calculated for a numerical taxonomy study.

A hierarchically ascending classification module is in the process of being completed.

- *Conference:*

During the first meeting of the "Société française de Systématique", a conference was organised to inform an international systematician public of this work. This was followed by demonstrations, during which numerous fresh contacts were made, and which, hopefully, will lead to fruitful collaborations.

6) - DISCUSSION

The XPER knowledge base, which has been charged with the work of describing male genital organs of French Guiana's Phlebotomi, permits not only specimen determinations but also their individual or group comparison by immediately treating a huge mass of information, something classically impossible to achieve.

This comparison, followed by its analysis, will incite the specialist to reconsider such and such systematic position of a species or group of species according to its morphology, and similarly, according to other criteria, for example, iso-enzymatic, genetic, behavioural, pertaining to geographic distribution, etc..., fed on to the same or another knowledge base.

7) - CONCLUSIONS

This work responds to three main poles of interest:

- *A practical interest, by arriving at rapid and reliable determinations.*

- *A methodological interest, by showing all that data processing and derived techniques can help achieve in the study of elements in parasitic cycles.*

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- A theoretical interest, by introducing the important element of consideration into the quality of taxonomic descriptions.

8) - FUTURE PROSPECTS

To start with, we have tackled the systematic of male sandflies in French Guiana by describing some of the most remarkable features in the constitution of their genital organs (morphology and chaetotaxy), thus allowing specialized or unspecialized entomologists to arrive at rapid and reliable determinations.

For the systematician specialist in his group, the fact of being able to create a knowledge base grouping together the near totality of the constitutive elements of such and such part of the insect, along with the chimio-taxonomic and genetic data, allows him to move from the stage of determination and comparison of the species through their differences on to a stage where an analysis of the speciation itself is possible.

For this, the data memorized by the XPER system allows for a number of different calculations (cladograms, dendrograms, multi-dimentional analysis, automatic generation of keys), thus facilitating the analysis and thereafter the formation of classification hypotheses. These hypotheses, in turn, can be confirmed or not, thanks to the interactions between the different knowledge bases dealing with the same topic.

The use of the micro-computer, its permanent access and the immense flexibility it proposes are invaluable assets in facilitating these studies from now on.

We could, in the immediate future, not only carry out serious revisions of the species and the groups lacking a clear definition, but also, at the same time, start on the appropriate analysis for speciation.

Cayenne, 1985-7-22

ANNEXE 1

CORRESPONDANCE DES PHLEBOTOMES DE GUYANE FRANCAISE

	BONNES ESPECES
abonnenci (M) (Floch & Chassignet, 1947)	Lutzomyia abonnenci (M) (Floch & Chassignet, 1947)
acutus (M) (Floch & Abonnenc, 1942)	Lutzomyia whitmani (M&F) (Antunes & Coutinho, 1939)
acutus (Floch & Abonnenc, 1942)	Lutzomyia antunesi (M&F) (Coutinho, 1939)
anduzei (M&F) (Rozeboom, 1942)	Lutzomyia anduzei (M&F) (Rozeboom, 1942)
anduzei (Floch & Abonnenc, 1944)	Lutzomyia umbratilis (M&F) (Ward & Fraiha, 1977)
anduzei (Martins, 1963)	Lutzomyia umbratilis (M&F) (Ward & Fraiha, 1977)
antunesi (M&F) (Coutinho, 1939)	Lutzomyia antunesi (M&F) (Coutinho, 1939)
apicalis (Floch & Abonnenc, 1943)	Lutzomyia flaviscutellata (M&F) (Mangabeira, 1942)
aragaoi (F) (Floch & Abonnenc, 1943)	Lutzomyia inflata (M&F) (Floch & Abonnenc, 1944)
aragaoi (M&F) (Costa-Lima, 1932)	Lutzomyia aragaoi (M&F) (Costa-Lima, 1932)
arborealis (F) (Floch & Abonnenc, 1944)	Lutzomyia furcata (M&F) (Mangabeira, 1941)
atroclavata (M&F) (Knab, 1913)	Lutzomyia atroclavata (M&F) (Knab, 1913)
ayrozai (M&F) (Barretto & Coutinho, 1940)	Lutzomyia ayrozai (M&F) (Barretto & Coutinho, 1940)
baduelensis (Floch & Abonnenc, 1941)	Lutzomyia trinidadensis (M&F) (Newstead, 1922)
balourouensis (Floch & Abonnenc, 1944)	Lutzomyia antunesi (M&F) (Coutinho, 1939)
barrettoi (M&F) (Mangabeira, 1942)	Lutzomyia barrettoi (M&F) (Mangabeira, 1942)
basispinosus (Barretto & Coutinho, 1943)	Lutzomyia ubiquitalis (M&F) (Mangabeira, 1942)
bigeniculatus (Floch & Abonnenc, 1941)	Lutzomyia shannoni (M&F) (Dyar, 1929)
bispinosa (M&F) (Fairchild & Hertig, 1951)	Lutzomyia bispinosa (M&F) (Fairchild & Hertig, 1951)
brachipyga (M&F) (Mangabeira, 1942)	Lutzomyia brachipyga (M&F) (Mangabeira, 1942)
brachyphalla (M) (Mangabeira, 1941)	Lutzomyia brachyphalla (M) (Mangabeira, 1941)
brasiliensis (M&F) (Costa-Lima, 1932)	Lutzomyia brasiliensis (M&F) (Costa-Lima, 1932)
brumpti (Floch & Abonnenc, 1942)	Brumptomyia travassosi (M&F) (Mangabeira, 1942)
bursiformis (F) (Floch & Abonnenc, 1944)	Lutzomyia bursiformis (F) (Floch & Abonnenc, 1944)
campbelli (M&F) (Damasceno, Causey & Arouck, 1945)	Lutzomyia campbelli (M&F) (Damasceno, Causey & Arouck, 1945)
carrerai (Barretto, 1946)	Lutzomyia paraensis (M&F) (Costa-Lima, 1941)
carvalhoi (M) (Damasceno, Causey & Arouck, 1945)	Lutzomyia carvalhoi (M) (Damasceno, Causey & Arouck, 1945)
cauchensis (Floch & Abonnenc, 1943)	Lutzomyia ubiquitalis (M&F) (Mangabeira, 1942)
cavernicola (M&F) (Costa-Lima, 1932)	Lutzomyia cavernicola (M&F) (Costa-Lima, 1932)
cayennensis (M&F) (Floch & Abonnenc, 1941)	Lutzomyia cayennensis (M&F) (Floch & Abonnenc, 1941)
chassigneti (M&F) (Floch & Abonnenc, 1944)	Lutzomyia chassigneti (M&F) (Floch & Abonnenc, 1944)
choti (M&F) (Floch & Abonnenc, 1941)	Lutzomyia choti (M&F) (Floch & Abonnenc, 1941)
christophersoni (Damasceno & Causey, 1944)	Lutzomyia punctigeniculata (M&F) (Floch & Abonnenc, 1944)
claustrei (M) (Lepont & Pajot, 1980)	Lutzomyia claustrei (M) (Lepont & Pajot, 1980)
colasbelcouri (Floch & Chassignet, 1947)	Lutzomyia hirsuta (M&F) (Mangabeira, 1942)
complexus (Mangabeira, 1942)	Lutzomyia squamiventris (M&F) (Lutz & Neiva, 1912)
corossoniensis (M) (Lepont & Pajot, 1978)	Lutzomyia corossoniensis (M) (Lepont & Pajot, 1978)
cruciatus (Dyar, 1929)	Lutzomyia trinidadensis (M&F) (Newstead, 1922)
davisi (M&F) (Root, 1934)	Lutzomyia davisi (M&F) (Root, 1934)
davisi (Pifano, 1943)	Lutzomyia panamensis (M&F) (Shannon, 1926)
davisi (F) (Coutinho, 1939)	Lutzomyia ayrozai (M&F) (Barretto & Coutinho, 1940)
deanei (Damasceno, Causey & Arouck, 1945)	Lutzomyia sericea (M) (Floch & Abonnenc, 1944)
dendrophila (M&F) (Mangabeira, 1942)	Lutzomyia dendrophila (M&F) (Mangabeira, 1942)
dorlinsis (M) (Lepont & Desjeux, 1982)	Lutzomyia dorlinsis (M) (Lepont & Desjeux, 1982)
dreisbachi (M&F) (Causey & Damasceno, 1945)	Lutzomyia dreisbachi (M&F) (Causey & Damasceno, 1945)
dubia (Martins, Falcao & Silva, 1965)	Lutzomyia odax (M&F) (Fairchild & Hertig, 1961)
dubitans (Sherlock, 1962)	Lutzomyia walkeri (M&F) (Newstead, 1914)
edwardsi (M&F) (Mangabeira, 1942)	Lutzomyia edwardsi (M&F) (Mangabeira, 1942)
eliensis (M&F) (Lepont & Desjeux, 1983)	Lutzomyia eliensis (M&F) (Lepont & Desjeux, 1983)
elongatus (Floch & Abonnenc, 1944)	Lutzomyia whitmani (M&F) (Antunes & Coutinho, 1939)
equatorialis (M) (Mangabeira, 1942)	Lutzomyia equatorialis (M) (Mangabeira, 1942)

equestris (Abonnenc, ???)	Lutzomyia squamiventris (M&F) (Lutz & Neiva, 1912)
fairchild (Barretto, 1966)	Lutzomyia paraensis (M&F) (Costa-Lima, 1941)
falciformis (Floch & Abonnenc, 1944)	Lutzomyia monstruosa (M&F) (Floch & Abonnenc, 1944)
fariasi (M) (Damasceno, Causey & Arouck, 1945)	Lutzomyia fariasi (M) (Damasceno, Causey & Arouck, 1945)
farili (Vargas & Dias Najera, 1959)	Lutzomyia cayennensis (M&F) (Floch & Abonnenc, 1941)
ferreirrai (Causey & Damasceno, 1945)	Lutzomyia pacae (M&F) (Floch & Abonnenc, 1943)
flaviscutellata (M&F) (Mangabeira, 1942)	Lutzomyia flaviscutellata (M&F) (Mangabeira, 1942)
flochi (M) (Abonnenc & Chassignet, 1948)	Lutzomyia flochi (M) (Abonnenc & Chassignet, 1948)
fluviatilis (M&F) (Floch & Abonnenc, 1944)	Lutzomyia fluviatilis (M&F) (Floch & Abonnenc, 1944)
furcata (M&F) (Mangabeira, 1941)	Lutzomyia furcata (M&F) (Mangabeira, 1941)
gasti (Sherlock, 1962)	Lutzomyia walkeri (M&F) (Newstead, 1914)
geniculata (Mangabeira, 1941) (Synonyme probable)	Lutzomyia guyanensis (M&F) (Floch & Abonnenc, 1941)
goiana (Martins, Falcao & Da Silva, 1962)	Lutzomyia trinidadensis (M&F) (Newstead, 1922)
gomezi (M&F) (Nitzulescu, 1931)	Lutzomyia gomezi (M&F) (Nitzulescu, 1931)
guadeloupensis (Floch & Abonnenc, 1945)	Lutzomyia atroclavata (M&F) (Knab, 1913)
guayasi (Rodriguez, 1956)	Lutzomyia serrana (M&F) (Damasceno & Arouck, 1949)
guyanensis (M&F) (Floch & Abonnenc, 1941)	Lutzomyia guyanensis (M&F) (Floch & Abonnenc, 1941)
hardisoni (Vargas & Dias Najera, 1952)	Lutzomyia cayennensis (M&F) (Floch & Abonnenc, 1941)
heckenrothi (F) (Floch & Abonnenc, 1942)	Lutzomyia aragaoi (M&F) (Costa-Lima, 1932)
hirsuta (M&F) (Mangabeira, 1942)	Lutzomyia hirsuta (M&F) (Mangabeira, 1942)
inflata (M&F) (Floch & Abonnenc, 1944)	Lutzomyia inflata (M&F) (Floch & Abonnenc, 1944)
infraspinosa (M&F) (Mangabeira, 1941)	Lutzomyia infraspinosa (M&F) (Mangabeira, 1941)
ininii (M&F) (Floch & Abonnenc, 1943)	Lutzomyia ininii (M&F) (Floch & Abonnenc, 1943)
inornata (M) (Martins, Falcao & Da Silva, 1965)	Lutzomyia inornata (M) (Martins, Falcao & Da Silva, 1965)
intermedia (M&F) (Lutz & Neiva, 1912)	Lutzomyia intermedia (M&F) (Lutz & Neiva, 1912)
intermedia (Floch & Abonnenc, 1941)	Lutzomyia umbratilis (M&F) (Ward & Fraiha, 1977)
intermedius (Floch & Abonnenc, 1942) pro parte	Lutzomyia anduzei (M&F) (Rozeboom, 1942)
intermedius (M) (Root, 1934) pro parte	Lutzomyia whitmani (M&F) (Antunes & Coutinho, 1939)
intermedius acutus (Floch & Abonnenc, 1942) pro parte	Lutzomyia whitmani (M&F) (Antunes & Coutinho, 1939)
intermedius acutus (Floch & Abonnenc, 1942) pro parte	Lutzomyia antunesi (M&F) (Coutinho, 1939)
intermedius longiductus (Floch & Abonnenc, 1942)	Lutzomyia whitmani (M&F) (Antunes & Coutinho, 1939)
japignyi (Floch & Abonnenc, 1944)	Lutzomyia gomezi (M&F) (Nitzulescu, 1931)
limai (Fonseca, 1935)	Lutzomyia shannoni (M&F) (Dyar, 1929)
longicornutus (Floch & Abonnenc, 1943)	Lutzomyia nordestina (M&F) (Mangabeira, 1942)
longiductus (Floch & Abonnenc, 1942)	Lutzomyia whitmani (M&F) (Antunes & Coutinho, 1939)
longipalpis (Newstead, 1914)	Lutzomyia walkeri (M&F) (Newstead, 1914)
longipalpis (Ristorcelli & Van Ty, 1941)	Lutzomyia trinidadensis (M&F) (Newstead, 1922)
longispina (M&F) (Mangabeira, 1942)	Lutzomyia longispina (M&F) (Mangabeira, 1942)
lutzi (Manson-Bahr, 1925)	Lutzomyia intermedia (M&F) (Lutz & Neiva, 1912)
lutziana (M&F) (Costa-Lima, 1932)	Lutzomyia lutziana (M&F) (Costa-Lima, 1932)
machicouensis (Floch & Abonnenc, 1944)	Lutzomyia antunesi (M&F) (Coutinho, 1939)
marajoensis (Damasceno & Causey, 1944)	Lutzomyia walkeri (M&F) (Newstead, 1914)
maripaensis (Floch & Abonnenc,1946)	Lutzomyia squamiventris (M&F) (Lutz & Neiva, 1912)
mazzai, (Paterson, 1926)	Lutzomyia intermedia (M&F) (Lutz & Neiva, 1912)
microcephalus (Barretto & Duret, 1935)	Lutzomyia shannoni (M&F) (Dyar, 1929)
micropyga (M&F) (Mangabeira, 1942)	Lutzomyia micropyga (M&F) (Mangabeira, 1942)
minasensis (Mangabeira, 1942)	Lutzomyia micropyga (M&F) (Mangabeira, 1942)
minutus (Bayma, 1923)	Lutzomyia intermedia (M&F) (Lutz & Neiva, 1912)
monstruosa (M&F) (Floch & Abonnenc, 1944)	Lutzomyia monstruosa (M&F) (Floch & Abonnenc, 1944)
monticola (M&F) (Costa-Lima, 1932)	Lutzomyia monticola (M&F) (Costa-Lima, 1932)
munangai (Wijers & Huisensa, 1967)	Lutzomyia tuberculata (M&F) (Mangabeira, 1941)
neivai (Pinto, 1926)	Lutzomyia intermedia (M&F) (Lutz & Neiva, 1912)

nordestina (M&F) (Mangabeira, 1942)	Lutzomyia nordestina (M&F) (Mangabeira, 1942)
odax (M&F) (Fairchild & Hertig, 1961)	Lutzomyia odax (M&F) (Fairchild & Hertig, 1961)
oliveiroi (Barretto & Coutinho, 1941)	Lutzomyia brasiliensis (M&F) (Costa-Lima, 1932)
oswaldoi (Mangabeira, 1942)	Lutzomyia rorotaensis (M&F) (Floch & Abonnenc, 1944)
pacae (Floch & Abonnenc, 1943)	Lutzomyia pacae (M&F) (Floch & Abonnenc, 1943)
panamensis (M&F) (Shannon, 1926)	Lutzomyia panamensis (M&F) (Shannon, 1926)
papatasi (Bayma, 1923)	Lutzomyia intermedia (M&F) (Lutz & Neiva, 1912)
paraensis (M&F) (Costa-Lima, 1941)	Lutzomyia paraensis (M&F) (Costa-Lima, 1941)
peresi (M&F) (Mangabeira, 1942)	Lutzomyia peresi (M&F) (Mangabeira, 1942)
pessoana (Barretto, 1955)	Lutzomyia paraensis (M&F) (Costa-Lima, 1941)
pessoanus (Strangway-Dixon & Lainson, 1966)	Lutzomyia panamensis (M&F) (Shannon, 1926)
pifanoi (Ortiz, 1972)	Lutzomyia shannoni (M&F) (Dyar, 1929)
pilosa (Damasceno & Causey, 1944)	Lutzomyia pilosa (M&F) (Damasceno & Causey, 1944)
pinealis (F) (Floch & Abonnenc, 1944)	Lutzomyia saulensis (M&F) (Floch & Abonnenc, 1944)
pintoi (M) (Costa-Lima, 1932)	Brumptomyia pintoi (M) (Costa-Lima, 1932)
punctigeniculata (M&F) (Floch & Abonnenc, 1944)	Lutzomyia punctigeniculata (M&F) (Floch & Abonnenc, 1944)
quadrispinosus (Floch & Abonnenc, 1947) (Synonyme probable)	Lutzomyia micropyga (M&F) (Mangabeira, 1942)
robini (M&F) (Abonnenc, Arias, Leger & Young, 1980	Lutzomyia robini (M&F) (Abonnenc, Arias, Leger & Young, 1980
rooti (M) (Mangabeira, 1942)	Lutzomyia davisi (M&F) (Root, 1934)
rorotaensis (M&F) (Floch & Abonnenc, 1944)	Lutzomyia rorotaensis (M&F) (Floch & Abonnenc, 1944)
runoides (Fairchild & Hertig, 1953) (Synonyme probable)	Lutzomyia inflata (M&F) (Floch & Abonnenc, 1944)
saulensis (M&F) (Floch & Abonnenc, 1944)	Lutzomyia saulensis (M&F) (Floch & Abonnenc, 1944)
sericea (M) (Floch & Abonnenc, 1944)	Lutzomyia sericea (M) (Floch & Abonnenc, 1944)
serrana (M&F) (Damasceno & Arouck, 1949)	Lutzomyia serrana (M&F) (Damasceno & Arouck, 1949)
shannoni (M&F) (Dyar, 1929)	Lutzomyia shannoni (M&F) (Dyar, 1929)
souzacastroi (Damasceno & Causey, 1944)	Lutzomyia peresi (M&F) (Mangabeira, 1942)
sp. (F) (Mangabeira, 1938)	Lutzomyia whitmani (M&F) (Antunes & Coutinho, 1939)
sp. (Floch & Abonnenc, 1942)	Lutzomyia spinosa (M&F) (Floch & Abonnenc, 1942)
sp. I de Baduel (Floch, 1947) (= quadrispinosus)	Lutzomyia micropyga (M&F) (Mangabeira, 1942)
sp. II de Baduel (Floch, 1947)	Lutzomyia hirsuta (M&F) (Mangabeira, 1942)
sp. 260 (Ward, 1973)	Lutzomyia umbratilis (M&F) (Ward & Fraiha, 1977)
sp. 768 (F) (Floch & Chassignet, 1948)	Lutzomyia sp. 768 (F) (Floch & Chassignet, 1948)
sp. 780 (Floch & Chassignet, 1948)	Lutzomyia hirsuta (M&F) (Mangabeira, 1942)
sp. A du Gallion (Floch & Abonnenc, 1942)	Lutzomyia spinosa (M&F) (Floch & Abonnenc, 1942)
sp. b du Galion (F) (Floch & Abonnenc, 1942)	Lutzomyia ininii (M&F) (Floch & Abonnenc, 1943)
sp. c (Velasco, 1973)	Lutzomyia hirsuta (M&F) (Mangabeira, 1942)
sp. de Baduel (F) (Floch & Abonnenc, 1945)	Lutzomyia sp. de Baduel (F) (Floch & Abonnenc, 1945)
sp. de Cayenne (F) (Floch & Abonnenc, 1945)	Lutzomyia lutziana (M&F) (Costa-Lima, 1932)
sp. de Crique Anguille (F) (Floch & Abonnenc, 1945)	Lutzomyia dreisbachi (M&F) (Causey & Damasceno, 1945)
sp. de Maripa (F) (Floch & Abonnenc, 1946)	Lutzomyia barrettoi (M&F) (Mangabeira, 1942)
sp. de Saul (F) (Floch & Abonnenc, 1944)	Lutzomyia peresi (M&F) (Mangabeira, 1942)
sp. de Souvenir (F) (Floch & Abonnenc,1944)	Lutzomyia whitmani (M&F) (Antunes & Coutinho, 1939)
sp. x (Floch & Abonnenc, 1944)	Lutzomyia tuberculata (M&F) (Mangabeira, 1941)
spinosa (M&F) (Floch & Abonnenc, 1942)	Lutzomyia spinosa (M&F) (Floch & Abonnenc, 1942)
spinosipes (F) (Floch & Abonnenc, 1943) (Synonyme probable)	Brumptomyia pintoi (M) (Costa-Lima, 1932)
squamipennis (Lutz & Neiva, 1912)	Lutzomyia squamiventris (M&F) (Lutz & Neiva, 1912)
squamiventris (Costa-Lima, 1932)	Lutzomyia panamensis (M&F) (Shannon, 1926)
squamiventris (M&F) (Lutz & Neiva, 1912)	Lutzomyia squamiventris (M&F) (Lutz & Neiva, 1912)
suis (Rozeboom, 1940)	Lutzomyia gomezi (M&F) (Nitzulescu, 1931)
sylvestris (Floch & Abonnenc, 1944)	Lutzomyia monticola (M&F) (Costa-Lima, 1932)
sylvicolus (Floch & Abonnenc, 1945)	Lutzomyia monticola (M&F) (Costa-Lima, 1932)
tejerae (Larousse, 1921)	Lutzomyia atroclavata (M&F) (Knab, 1913)
travassosi (M&F) (Mangabeira, 1942)	Brumptomyia travassosi (M&F) (Mangabeira, 1942)
triacantha (M&F) (Mangabeira, 1942)	Lutzomyia triacantha (M&F) (Mangabeira, 1942)

trichopyga (M&F) (Floch & Abonnenc, 1945)	Lutzomyia trichopyga (M&F) (Floch & Abonnenc, 1945)
trinidadensis (Mc Callan, 1947)	Lutzomyia gomezi (M&F) (Nitzulescu, 1931)
trinidadensis (M&F) (Newstead, 1922)	Lutzomyia trinidadensis (M&F) (Newstead, 1922)
trinidadensis (Theodor, 1932)	Lutzomyia gomezi (M&F) (Nitzulescu, 1931)
trispinosus (Mangabeira, 1942)	Lutzomyia choti (M&F) (Floch & Abonnenc, 1941)
tuberculata (M&F) (Mangabeira, 1941)	Lutzomyia tuberculata (M&F) (Mangabeira, 1941)
ubiquitalis (M&F) (Mangabeira, 1942)	Lutzomyia ubiquitalis (M&F) (Mangabeira, 1942)
umbratilis (M&F) (Ward & Fraiha, 1977)	Lutzomyia umbratilis (M&F) (Ward & Fraiha, 1977)
viannamartinsi (Sherlock & Guitton, 1970)	Lutzomyia brachipyga (M&F) (Mangabeira, 1942)
villelai (Mangabeira, 1942)	Lutzomyia trinidadensis (M&F) (Newstead, 1922)
volcanensis (M&F) (Fairchild & Hertig, 1951)	Lutzomyia volcanensis (M&F) (Fairchild & Hertig, 1951)
walkeri (M&F) (Newstead, 1914)	Lutzomyia walkeri (M&F) (Newstead, 1914)
whirthi (Vargas & Dias Najera, 1951)	Lutzomyia cayennensis (M&F) (Floch & Abonnenc, 1941)
whitmani (M&F) (Antunes & Coutinho, 1939)	Lutzomyia whitmani (M&F) (Antunes & Coutinho, 1939)
yencanensis (Ortiz, 1965)	Lutzomyia cayennensis (M&F) (Floch & Abonnenc, 1941)
yucatanensis (Gaillard, 1934)	Lutzomyia trinidadensis (M&F) (Newstead, 1922)
yuilli pajoti (M&F) (Abonnenc, Leger & Fauran, 1978)	Lutzomyia yuilli pajoti (M&F) (Abonnenc, Leger & Fauran, 1978)

ANNEXE 2

*** XPER ***

Liste des individus de : Phlebotomes de Guyane francaise / Appareil male 1+2

1 Brumptomyia pintoi
2 Brumptomyia travassosi
3 Lutzomyia abonnenci
4 Lutzomyia anduzei
5 Lutzomyia antunesi
6 Lutzomyia aragaoi
7 Lutzomyia atroclavata
8 Lutzomyia ayrozai
9 Lutzomyia barretoi
10 Lutzomyia bispinosa
11 Lutzomyia brachypyga
12 Lutzomyia brachyphalla
13 Lutzomyia brasiliensis
14 Lutzomyia bursiformis
15 Lutzomyia campbelli
16 Lutzomyia carvalhoi
17 Lutzomyia cavernicola
18 Lutzomyia cayennensis
19 Lutzomyia chassigneti
20 Lutzomyia choti
21 Lutzomyia claustrei
22 Lutzomyia corosseniensis
23 Lutzomyia davisi
24 Lutzomyia dendrophila
25 Lutzomyia dorlinsis
26 Lutzomyia dreisbachi
27 Lutzomyia edwardsi
28 Lutzomyia eliensis
29 Lutzomyia equatorialis
30 Lutzomyia fariasi
31 Lutzomyia flaviscutellata
32 Lutzomyia flochi
33 Lutzomyia fluviatilis
34 Lutzomyia furcata
35 Lutzomyia gomezi
36 Lutzomyia guyanensis
37 Lutzomyia hirsuta
38 Lutzomyia inflata
39 Lutzomyia infraspinosa
40 Lutzomyia ininii
41 Lutzomyia inornata
42 Lutzomyia intermedia
43 Lutzomyia longispina
44 Lutzomyia lutziana
45 Lutzomyia micropyga
46 Lutzomyia monstruosa
47 Lutzomyia monticola
48 Lutzomyia nordestina
49 Lutzomyia odax
50 Lutzomyia pacae
51 Lutzomyia panamensis
52 Lutzomyia paraensis
53 Lutzomyia peresi
54 Lutzomyia pilosa
55 Lutzomyia punctigeniculata
56 Lutzomyia robini
57 Lutzomyia rorotaensis
58 Lutzomyia saulensis
59 Lutzomyia sericea
60 Lutzomyia serrana
61 Lutzomyia shannoni
62 Lutzomyia sp. 768
63 Lutzomyia sp. de Baduel
64 Lutzomyia spinosa
65 Lutzomyia squamiventris
66 Lutzomyia triacantha
67 Lutzomyia trichopyga
68 Lutzomyia trinidadensis
69 Lutzomyia tuberculata
70 Lutzomyia ubiquitalis
71 Lutzomyia umbratilis
72 Lutzomyia volcanensis
73 Lutzomyia walkeri
74 Lutzomyia whitmani
75 Lutzomyia yuilli pajoti
76 Warileya fourgassiensis

ANNEXE 3

*** XPER ***

Liste des Modalites de : Phlebotomes de Guyane francaise / Appareil male 1+2

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1 > Longueur totale de la pompe genitale
  1 <100
  2 100-120
  3 120-140
  4 140-160
  5 160-180
  6 180-200
  7 200-220
  8 220-240
  9 240-260
  10 260-280
  11 280-300
  12 >300

---

2 Largeur du piston de la pompe genitale en son milieu
  1 <5
  2 5-10
  3 10-15
  4 15-20
  5 20-25
  6 >25

---

3 Spicule central du pavillon de la pompe genitale
  1 absent
  2 present

---

4 Largeur du pavillon de la pompe genitale
  1 <15
  2 15-25
  3 25-35
  4 35-45
  5 45-55
  6 55-65
  7 65-75
  8 75-85
  9 >85

---

5 Forme generale du trajet des filaments genitaux
  1 droit ou courbe ne formant pas de boucle
  2 formant une boucle

---

6 Trajet de la portion terminale des filaments genitaux
  1 droite ou courbee
  2 coudee ou bouclee

---

7 Forme de l'extremite terminale des filaments genitaux
  1 sans aucune structure particuliere
  2 particuliere soit bifide/en massue/en lame/en cuilliere

---

8 Striation des filaments genitaux
  1 absente
  2 presente

---

9 > Longueur des filaments genitaux
1 <150
2 150-250
3 250-350
4 350-450
5 450-550
6 550-650
7 650-750
8 750-850
9 850-1000
10 1000-1150
11 1150-1300
12 1300-1450
13 >1450

---

10 Extremite du lobe lateral
1 sans forte soie differenciee
2 avec quelques fortes soies differenciees

---

11 Longueur du lobe lateral
1 <150
2 150-200
3 200-250
4 250-300
5 300-350
6 350-400
7 400-450
8 450-500
9 500-550
10 550-600
11 600-650
12 650-700
13 700-750
14 >750

---

12 Largeur du lobe lateral en son milieu
1 <15
2 15-20
3 20-25
4 25-30
5 30-35
6 35-40
7 >40

---

13 > Forme du paramere
1 simple et unilobee sans forte soie differentiee
2 simple et unilobee avec fortes soies differentiees
3 complexe ou multilobee

---

14 > Ornementation de la face interne du coxite
1 sans touffe ni rangee longitudinale de soies
2 sans touffe avec rangee longitudinale de soies
3 une touffe sans rangee longitudinale de soies
4 une touffe avec rangee longitudinale de soies
5 plus d'une touffe sans rangee longitudinale de soies
6 plus d'une touffe avec rangee longitudinale de soies

---

15 Disposition de la touffe de la face interne du coxite
1 basale
2 mediane
3 pre-apicale

---

16 Longueur du coxite
1 <150
2 150-200
3 200-250
4 250-300
5 300-350
6 350-400
7 400-450
8 450-500
9 500-550
10 550-600
11 600-650
12 650-700
13 700-750
14 >750

---

17 Largeur du coxite en son milieu
1 <40
2 40-60
3 60-80
4 80-100
5 100-120
6 120-140
7 140-160
8 160-180
9 180-200
10 200-220
11 220-240
12 >240

---

18 Forme du style
1 simple sans tubercule saillant
2 simple avec tubercule saillant
3 bifide

---

19 > Nombre d'epines du style
1 une
2 deux
3 trois
4 quatre
5 cinq

---

20 Disposition de l'insertion des epines du style
1 3/1
2 2/2
3 2/1/1
4 1/2/1
5 1/1/2
6 1/1/1/1

---

21 > Longueur du style (sans les epines)
1 <80
2 80-110
3 110-140
4 140-170
5 170-200
6 200-230
7 230-260
8 260-290
9 290-320
10 320-350
11 350-380
12 380-410
13 410-440
14 >440

---

22 Largeur du style en son milieu
1 <20
2 20-25
3 25-30
4 30-35
5 35-40
6 40-45
7 45-50
8 50-55
9 55-60
10 60-65
11 65-70
12 70-75
13 75-80
14 >80

ANNEXE 4

*** XPER ***

Description de : Lutzomyia umbratilis

> Longueur totale de la pompe genitale : soit 140-160 soit 160-180 soit 180-200
Largeur du piston de la pompe genitale en son milieu : soit 5-10 soit 10-15 soit 15-20
Spicule central du pavillon de la pompe genitale : present
Largeur du pavillon de la pompe genitale : soit 35-45 soit 45-55 soit 55-65
Forme generale du trajet des filaments genitaux : droit ou courbe ne formant pas de boucle
Trajet de la portion terminale des filaments genitaux : droite ou courbee
Forme de l'extremite terminale des filaments genitaux : particuliere soit bifide/en massue/en lame/en cuilliere
Striation des filaments genitaux : absente
> Longueur des filaments genitaux : soit 150-250 soit 250-350
Extremite du lobe lateral : sans forte soie differenciee
Longueur du lobe lateral : soit 150-200 soit 200-250
Largeur du lobe lateral en son milieu : soit 15-20 soit 20-25 soit 25-30 soit 30-35
> Forme du paramere : simple et unilobee sans forte soie differentiee
> Ornementation de la face interne du coxite : sans touffe ni rangee longitudinale de soies
Longueur du coxite : soit 150-200 soit 200-250
Largeur du coxite en son milieu : soit 40-60 soit 60-80
Forme du style : simple sans tubercule saillant
> Nombre d'epines du style : quatre
Disposition de l'insertion des 4 epines du style : soit 2/2 soit 1/1/2
> Longueur du style (sans les epines) : soit 80-110 soit 110-140
Largeur du style en son milieu : soit 20-25 soit 25-30 soit 30-35