The Taxonomy of Brazilian Insects Vectors of Transmissible Diseases (1900-2000) – Then and Now

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A brief historical overview is given of the most relevant taxonomic studies of insect groups vectors of transmissible diseases in Brazil, from the "heroic" times of the foundation of the Instituto Oswaldo Cruz in Rio de Janeiro up to the present. The following orders are considered: Phthiraptera (Anoplura, Amblycera and Ischnocera), Hemiptera (Reduviidae: Triatominae), Siphonaptera and Diptera (Culicidae, Ceratopogonidae, Psychodidae: Phlebotominae, Simuliidae, Tabanidae, Chloropidae and Muscidae). The most important Brazilian collections of each group are cited.

Key words: Brazil - insect vectors - taxonomy - history of studies - 20th century

PHTHIRAPTERA

Three suborders occur in Brazil: Anoplura, Amblycera, and Ischnocera, the latter two united before under the Order Mallophaga, which Lyal (1985) showed to be paraphyletic.

Anoplura - Over 550 species in 49 genera and 15 families are known in the world. Hopkins (1949) presented a list of the hosts of all the species of Anoplura described until then. The family classification was studied by Kim and Ludwig (1978), and Kim (1988) studied the evolutionary parallelism in Anoplura and eutherian mammals. Barker (1994) published the phylogeny and classification, origins and coevolution of host associations of the lice. Durden and Musser (1994a,b) produced a checklist for the species of the world, with a list of the hosts. For the taxonomy of the world Anoplura, the works of Ferris (1919, 1921, 1951) are still the standard references. The study of this group among us had its main authority in FL Werneck (1932a, 1933, 1934, 1937, 1952, 1953a,b, 1955), researcher of the Instituto Oswaldo Cruz. The Haematopinidae parasitize ungulates; the Linognathidae, dogs and ruminants; the Pediculidae, primates; the Hoplopleuridae are in general parasites of rodents; the Echinophthiridae parasitize marine mammals; and the Neolignathidae are parasites of insectivorous mammals. There are no Anoplura parasitic upon birds.

Amblycera - The Amblycera are ectoparasites of birds, marsupials, carnivores and rodents. Clay's works (1969, 1970) are classical references for this group. In Brazil, Werneck (1948) contributed to our knowledge of the Amblycera of mammals.

Ischnocera - Over 600 species, in 106 genera distributed among three families are known for the world. The only monograph available for Brazilian Ischnocera parasitic on mammals is still Werneck's treatise (1948, 1950).

A basic work on all the Phthiraptera of Brazil (and all other arthropods) of veterinary importance is being prepared by Guimarães, Tucci, Barros-Battesti ("Ectoparasitas de Importância Veterinária", manusc. in preparation).

There are no large and organized collections of this order in Brazil, except for those of the Instituto Oswaldo Cruz and the Museu de Zoologia da Universidade de São Paulo.

HEMIPTERA (REDUVIIDAE, TRIATOMINAE)

Taxonomically speaking, this is by far the best known group of insects of medical and veterinary importance, whose study has been traditional at the Instituto Oswaldo Cruz throughout this century. Two monumental works on these insects, vectors of Chagas disease, were prepared by Lent and Wygodzinsky (1979) and most recently by Carcavallo et al. (1998). All the information available is given in those outstanding revisions.

SIPHONAPTERA

The pioneer study of Brazilian Siphonaptera was undertaken by AR Cunha, in a thesis prepared in the Instituto Oswaldo Cruz, and published in 1914. In 1946 appeared the classical monograph by Lima and Hathaway, another contribution from

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the same Institute. Hopkins and Rothschild (1953-1971) published a monograph of the order, based on the Rothschild collection. Holland (1964) contributed to our knowledge of the evolution, classification and host relationships of the Siphonaptera. The most recent survey of the fleas of Brazil was prepared by Linardi and Guimarães (2000), in whose book 50 species, distributed among 20 genera and 8 families, are treated (cf. Table I). In addition to the taxonomy of the group, the authors dealt with the parasitological importance of fleas, the methods of study, the interactions fleas/hosts, considering also the biology, control, morphology and systematics of the Siphonaptera; in appendices they included the geographic distribution of the species and subspecies of fleas per Brazilian state and a list of their known hosts.

Besides the collection of the Instituto Oswaldo Cruz, where the Costa Lima collection is housed, the most important collections of fleas are deposited in the Museu de Zoologia, Universidade de São Paulo, in São Paulo (organized by Lindolpho Rocha Guimarães) and in the Departamento de Parasitologia, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Belo Horizonte (organized by Pedro Marcos Linardi).

DIPTERA

From the publication of the tenth edition of Linnaeus' *Systema Naturae*, in 1758, up to the first four years of the 20th century, 40 authors (C Linnaeus, C Linnaeus Jr, JC Fabricius, PA Latreille, KP Thunberg, WF Erichson, JAM Perty, CRW Wiedemann, FE Guérin-Méneville, GA Olivier, JB Robineau-Desvoidy, PJM Macquart, CH Blanchard, JA Laboulbène, JMF Bigot, JO Westwood, F Walker, RA Philippi, CG Thomson, FM Brauer, CEA Gerstaecker, H Loew, J Mik, V von Roeder, E Rübsaamen, IR Schiner, D Bilimek, the brothers Félix and Enrique Lynch Arribálzaga, C Rondani, L Bellardi, E Giglio-Tos, H Weyenbergh, FM van der Wulp, Fritz Müller, Emil A Goeldi, EE Austen, CR Osten Sacken, SW Williston and JM Aldrich) have studied the taxonomy of Neotropical Diptera. The types of the species were deposited in the various museums of Europe and the United States (cf. Papavero, 1971-1973). In Brazil, up to the foundation of the Instituto Oswaldo Cruz, practically there existed neither collections nor specialized literature. In the turn of the century (1900-1901), the first catalogue of Neotropical Diptera was published by WD Hunter, albeit incomplete, as it only contemplated

TABLE I

Families, Subfamilies, Tribes and Genera of Brazilian Siphonaptera (number of species in parentheses) (after Linardi & Guimarães 2000)

Family	Subfamily	Tribe	Genus
Pulicidae (5)	Pulicinae (1)	Pulicini	*Pulex* (1)
	Xenopsyllinae (2)		*Xenopsylla* (2)
	Archaepsyllinae (2)		*Ctenocephalides* (2)
Tungidae (7)			*Tunga* (5)
			Hectopsylla (1)
			Rhynchopsyllus (1)
Ceratopsyllidae (1)			*Notopsyllus* (1)
Leptopsyllidae (1)			*Leptopsylla* (1)
Ischnopsyllidae (5)			*Hormopsylla* (1)
			Myodopsylla (1)
			Ptilopsylla (1)
			Sternopsylla (1)
			Rothschildopsylla (1)
Stephanocircidae (5)	Craneopsyllinae (1)		*Craneopsylla* (1)
	Ctenophthalminae (4)	Tritopsyllini (4)	*Adoratopsylla* (2)
			Tritopsylla (2)
Rhopalopsyllidae (26)	Rhopalopsyllinae (26)	Rhopalopsyllini (11)	*Rhopalopsyllus* (7)
			Gephyropsylla (1)
			Hechtiella (3)
		Polygenini (15)	*Neotropopsylla* (1)
			Polygenis (14)
			Total: 50

the Nematocera and part of the Brachycera (only the Homoeodactyla and the Mydidae). Between 1902 and 1910, Kolomán Kertész published his world catalogue of Diptera, which was also left incomplete.

This was the picture met with by the researchers of the Instituto Oswaldo Cruz (and Emil August Goeldi in Belém, Pará), in the first years of the 20th century, when, pressed by serious problems of public health, they had to begin studying the Brazilian species of Diptera that were vectors of several diseases.

Culicidae - Of foremost importance were the mosquitoes. The pioneer studies of this family in Brazil were undertakewn by Goeldi (1902, 1904a,b, 1905) in Belém, Pará; by Bourroul (1904); and by several researchers in Rio de Janeiro, mainly at the Instituto Oswaldo Cruz, such as Oswaldo Cruz himself (1901, 1906, 1907a,b), Adolpho Lutz (1904, 1905b, 1921), Lutz and Neiva (1913), Neiva (1906, 1908a,b), Neiva and Pinto (1922a,b,c, 1923), Peryassú (1908, 1921a,b, 1922a,b, 1923a,b,c, 1925; about Peryassú's collection, now in the Museu Nacional do Rio de Janeiro, cf. Khoury 1995). Dyar (1928) wrote a monograph of the mosquitoes of the Americas. The first modern monograph on the Brazilian fauna was prepared by Lane (1953), who was also responsible for the formation of an extremely important collection in the now Faculdade de Saúde Pública da Universidade de São Paulo, later expanded by OP Forattini, who also has contributed to our knowledge of this group (cf. Forattini 1962-1965, 1996). The knowledge of the species of mosquitoes grew rapidly, and catalogues had to be prepared, the most important one by Stone et al. (1959), with supplements by Stone (1961, 1963, 1967, 1970, 1971) and its second revised edition by Knight and Stone (1977), followed by supplements sponsored by Knight (1978) and Ward (1992). The knowledge of immature stages of mosquitoes also grew rapidly and several important papers were published on this subject (e. g., Darsie Jr & Clark-Gill 1982, González & Darsie Jr 1996). For the identification of adults of mosquito genera of the world Rueda et al. prepared a key, appeared in CD-Rom form (1998). Consoli and Oliveira, following the tradition of the Instituto Oswaldo Cruz, prepared a basic work on Brazilian mosquitoes of sanitary importance (1994). Many sizable collections exist in the country, some of which have been catalogued (e. g., Forattini et al. 1970-1973; collection of the Faculdade de Saúde Pública da Universidade de São Paulo); Guedes et al. (1965, 1978); Marchon-Silva et al. (1996; types in the Instituto Oswaldo Cruz); Wilkem et al. (1980), and Xavier (1973) and Xavier et al. (1989) (mosquito types of Brazil).

The most recent catalogue of this family for the Neotropical Region, with an extensive list of references, was published by Guimarães (1997), including 1,013 species (cf. Table II).

TABLE II

Subfamilies, Tribes, Genera and Subgenera of Neotropical Culicidae (number of species in parentheses) (after Guimarães 1997)

Subfamily	Tribe	Genus	Subgenus
Anophelinae (95)		*Anopheles* (91)	*Anopheles* (45)
			Kerteszia (12)
			Lophodomyia (6)
			Nyssorhynchus (28)
			Chagasia (4)
Culicinae (908)	Aedomyiini (1)	*Aedomyia* (1)	*Aedomyia* (1)
	Aedini (274)	*Aedes* (173)	*Aedimorphus* (1)
			Aztecaedes (1)
			Gymnometopa (1)
			Howardina (34)
			Kompia (1)
			Ochlerotatus (63)
			Protomacleaya (36)
			Stegomyia (2)
		Haemagogus (28)	*Conopostegus* (4)
			Haemagogus (24)
		Psorophora (44)	*Grabhamia* (14)
			Janthinosoma (20)
			Psorophora (10)

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Subfamily	Tribe	Genus	Subgenus
	Culicini (350)	*Culex* (331)	*Aedinus* (4) *Allimanta* (1) *Anaedioporpa* (12) *Belkinomyia* (1) *Carrollia* (18) *Culex* (78) *Lutzia* (2) *Melanoconion* (163) *Micraedes* (7) *Microculex* (33) *Phenacomyia* (3) *Tinolestes* (3) Subgenus Uncertain (6)
		Deinocerites (18)	
		Galindomyia (1)	
	Culisetini (3)	*Culiseta* (3)	*Culiseta* (3)
	Mansoniini (26)	*Coquilletidia* (13)	*Rhynchotaenia* (13)
		Mansonia (13)	*Mansonia* (13)
	Orthopodomyiini (7)	*Orthopodomyia* (7)	
	Sabethini (213)	*Isostomyia* (4)	
		Johnbelkinia (3)	
		Limatus (9)	
		Phoniomyia (21)	
		Runchomyia (9)	*Ctenogoeldia* (2) *Runchomyia* (7)
		Sabethes (35)	*Davismyia* (1) *Peytonulus* (10) *Sabethes* (17) *Sabethinus* (4) *Sabethoides* (3)
		Shannoniana (3)	
		Trichoprosopon (13)	
		Wyeomyia (116)	*Antunesmyia* (4) *Coenomyiella* (1) *Cruzmyia* (4) *Dendromyia* (9) *Dodecamyia* (1) *Exallomyia* (3) *Menolepis* (1) *Nunezia* (2) *Wyeomyia* (41) *Zinzala* (2) Subgenus uncertain (48)
	Uranotaeniini (34)	*Uranotaenia* (34)	*Pseudoficalbia* (1) *Uranotaenia* (33)
	Toxorhynchitinae (10)	*Toxorhynchites* (10)	*Ankyllorhynchus* (4) *Lynchiella* (6)
			Total: 1,013

Ceratopogonidae - As with the Culicidae, ceratopogonid studies begun in Brazil at the Instituto Oswaldo Cruz, through the contributions of Lutz (1913b, 1914b). The species of *Culicoides* were revised by Forattini (1957) and later by Wirth et al. (1988). The genera of the family were reviewed by Wirth et al. (1974). Wirth's catalogue of the Neotropical species (1974) was superseded by the world catalogue of Borkent and Wirth (1997), which lists 920 species from the Neotropics (cf. Table III). Kettle (1977) wrote a comprehensive essay about the biology and bionomics of blood sucking ceratopogonids (Table III).

TABLE III

Subfamilies, Tribes and Genera of Neotropical Ceratopogonidae (number of species in parentheses) (adapted from Spinelli, 1998)

Subfamily	Tribe	Genus
Leptoconopinae (12)		*Leptoconops* (12)
Forcipomyiinae (213)		*Atrichopogon* (65) *Forcipomyia* (148)
Dasyheleinae (45)		*Dasyhelea* (45)
Ceratopogoninae (660)	Culicoidini (266)	*Culicoides* (265) *Paradasyhelea* (1)
	Ceratopogonini (180)	*Allohelea* (1) *Alluaudomyia* (19) *Austrohelea* (1) *Baseodasymyia* (2) *Baeohelea* (1) *Bahiahelea* (1) *Borkenthelea* (1) *Brachypogon* (10) *Cacaohelea* (1) *Diaphanohelea* (4) *Downeshelea* (17) *Echinohelea* (11) *Fittkauhelea* (1) *Isthmohelea* (1) *Leptohelea* (1) *Macrurohelea* (11) *Monohelea* (12) *Nannohelea* (1) *Nottohelea* (2) *Parabezzia* (22) *Parasitobezzia* (1) *Schizonyxhelea* (1) *Stilobezzia* (58)
	Heteromyiini (30)	*Clinohelea* (13) *Heteromyia* (11) *Pellucidomyia* (4) *Physohelea* (2)
	Sphaeromyiini (24)	*Austrosphaeromias* (2) *Groganhelea* (1) *Johannsenomyia* (2) *Lanehelea* (2) *Mallochohelea* (5) *Neobezzia* (8) *Nilobezzia* (3) *Sphaerohelea* (1)
	Palpomyiini (106)	*Amerohelea* (11) *Bezzia* (43) *Clastrieromyia* (4) *Pachyhelea* (2) *Palpomyia* (43) *Phaenobezzia* (3)
	Stenoxenini (54)	*Paryphoconus* (39) *Stenoxenus* (15)
		Total: 930

Psychodidae (Phlebotominae) - Lutz and Neiva (1912), and Lima (1932), and other authors, were responsible for the first studies of phlebotomine sandflies in Brazil. The knowledge of the group grew exponentially, and modern contributions include the catalogue of the subfamily by Martins et al. (1978), the main tentatives of a classification by Theodor (1965), Forattini (1971, 1973), Young and Fairchild (1974), Lewis et al. (1977) and Williams (1993). Revisions were made by Young and Fairchild (1974) and Young and Duncan (1994). An article on the biology of Phlebotominae in relation to leishmaniasis was prepared by Lewis (1974). The most important collections are deposited in the Universidade Federal de Minas Gerais in Belo Horizonte, Faculdade de Saúde Pública, Universidade de São Paulo in São Paulo, Instituto Oswaldo Cruz in Rio de Janeiro and Museu de Zoologia, Universidade de São Paulo in São Paulo.

Simuliidae - Around 1500 species of blackflies are known in the world, 250 of which in the Neotropical Region. The family inludes only two subfamilies: Parasimuliinae (with 1 genus), and Simuliinae, with two tribes – Prosimuliini (with 16 genera) and Simuliinae (with 2 genera, but the genus *Simulium* with 45 subgenera, comprising approximately 90% of the species of the family).

As usual with medically important Diptera, the first contributions to the taxonomy of this group in Brazil were made by Lutz (1909, 1910, 1917). There is no recent, comprehensive revision of this group for the Neotropics. Coscarón (1987) published, however, an important paper, in which he reviewed most of the species described by earlier authors, and examined material collected by him in Brazil in the most important localities explored by those authors. Vulcano's catalogue of the Neotropical species (1967) is now outdated; it was replaced by the world catalogue of Simuliidae by Crosskey (1981). For the biology of this group, see, for example, Wenk (1981).

A really good collection of this family is still lacking in Brazil. The most important ones, however, are in the Instituto Oswaldo Cruz and in the Museu de Zoologia, Universidade de São Paulo.

Tabanidae - Not surprisingly, Adolpho Lutz was the responsible for the commencement of the studies of horseflies in Brazil (Lutz 1905a, 1909a,b, 1911, 1912, 1913a, 1913c, 1914a, 1914c, 1915, Lutz & Neiva 1914), inclusive of their immature stages (a study which, unfortunately, never had followers among us), most of the species superbly illustrated in colours, of a quality never more equalled; his collection was throroughly revised by Fairchild (1961). Many other authors contributed to the knowledge of the taxonomy of the group. In 1969 Fairchild prepared an excellent key to the Neotropical genera, preliminary to his catalogue of the species appeared in 1971. His keys served as a basis for Coscarón and Papavero's manual for the Neotropical genera (1993) and the most recent catalogue was sponsored by Fairchild and Burger (1994).

Important collections, besides the historical Lutz material at the Instituto Oswaldo Cruz, exist in the Museu de Zoologia, Universidade de São Paulo (in São Paulo), Museu Paraense Emílio Goeldi (Belém, Pará) and Instituto Nacional de Pesquisas da Amazônia (Manaus, Amazonas).

Chloropidae - It has recently been demonstrated that representatives of the genera *Hippelates* and *Liohippelates* are associated with Brazilian purpuric fever (Paganelli & Sabrosky 1993, Tondella et al. 1994). No recent revision of the species of those chloropid genera exist.

Muscidae (*Musca domestica*, *Stomoxys calcitrans*) - Three "classics" must be consulted with reference to the two mentioned species of Muscidae: Greenberg (1971), Zumpt (1973) and Skidmore (1985).

Of general interest for all families of Diptera, should be cited Sabrosky's recently published book on family-names in Diptera, with many novelties about nomenclature (1998, in CD-Rom 1999).

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