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NEW RECORDS OF PHLEBOTOMINE SAND FLIES (DIPTERA: PSYCHODIDAE) FROM ECUADOR

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*The phlebotomine sand fly fauna of Ecuador was surveyed in two 3-month collecting trips made in 1988 and 1990. A total of 12 provinces were visited, including three (Bolivar, Loja and Morona Santiago) from which no previous records of phlebotomines existed. Forty-six species were collected, 13 of which, together with 1 subspecies and 1 genus (*Warileya*) represented new records for the country. This survey increases the known number of species in Ecuador to 60. The distribution of Ecuadorian sand flies is discussed in the light of these new findings.*

Key words: phlebotomine sand flies – Ecuador – *Lutzomyia* – *Brumptomyia* – *Warileya* – leishmaniasis – bartonellosis – new records

The phlebotomine sand fly (Diptera: Psychodidae) fauna of Ecuador and the role of certain species in the transmission of *Leishmania* and *Bartonella* in the country have until recently been little studied. Young & Rogers (1984) published the most recent checklist, listing 46 species, of which one, *Lutzomyia carrerai* (Barretto), is represented by two subspecies. Young & Rogers (1984) considered three of the species they listed as recorded by previous authors to be misidentifications, however. Earlier studies include those of Rodriguez (1950, 1953, 1956), Arzube (1960) and Young (1979).

Ecuador is one of the smaller South American republics, with an area of 280,000 square kilometers. Nevertheless the topography and types of habitat encountered within its frontiers are extremely varied. The country can be divided into three regions, consisting of a coastal plain extending from the Colombian to the Peruvian borders, an Andean plateau that rises in places to over 6,000 m, and the "Oriente" or Amazon Basin region extending eastward from the foothills of the Andes. Leishmaniasis is endemic in all three regions (Hashiguchi et al., 1985a, b, 1987; Armijos et al., 1990) and bartonellosis cases have been recorded from several provinces (Carvajal et al., 1978). Both pathogens are known to be transmitted by phlebotomine sand flies of the genus *Lutzomyia* and suspected vectors of *Leishmania* in Ecuador include *Lu. ayacuchensis* Caceres & Bianchi Galati (Takaoka et al., 1990), *Lu. hartmanni* (Fairchild & Hertig) and *Lu. trapidoi* (Fairchild & Hertig) (Hashiguchi et al., 1987). Several other species that are proven or suspected vectors of *Leishmania* in other parts of their ranges have also been recorded in Ecuador, including *Lu. gomezi* (Nitzulescu), *Lu. flaviscutellata* (Mangabeira), *Lu. shannoni* (Dyar), *Lu. panamensis* (Shannon) and *Lu. carrerai carrerai* (Barretto) (WHO 1984; Le Pont et al., 1988). None of the suspected vector species of *Bartonella bacilliformis* (the causative organism of bartonellosis) have been recorded from Ecuador to date.

In the study reported here we visited 27 localities where human cases of leishmaniasis or bartonellosis had been reported, in 12 provinces of Ecuador. Collections were made by a

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TABLE

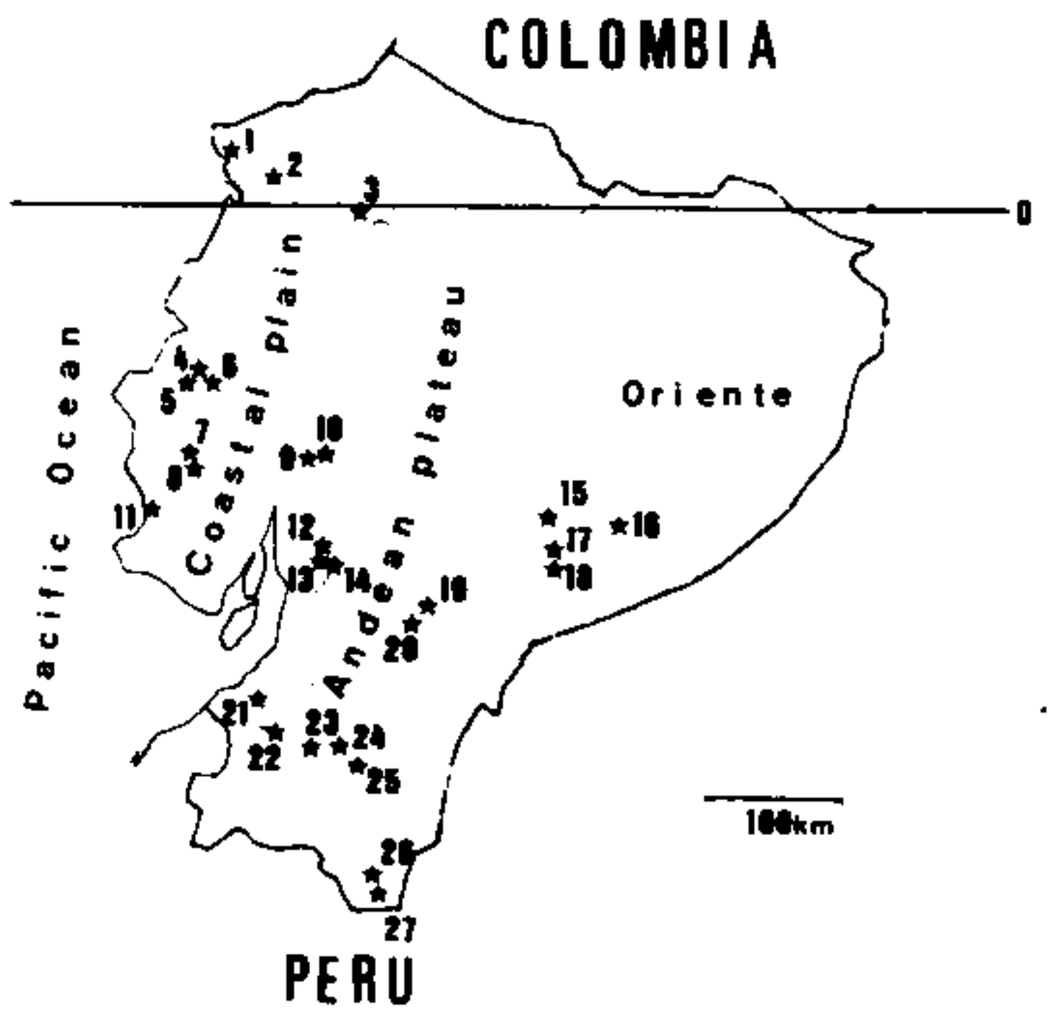
Updated list of phlebotomine species from Ecuador, incorporating the records presented in Young & Rogers (1984) together with those from our collections made in 1988 and 1990. Provinces for which no records existed prior to the present study are shown in capital letters, and new species records for Ecuador are shown with an asterisk

Species	Distribution by Province
Brumptomyia galindoi (Fairchild & Hertig)	MORONA SANTIAGO, Sucumbios
B. pentacantha (Barretto)	Sucumbios
B. leopoldoi (Rodriguez)	Cañar, EL ORO, Esmeraldas, Guayas, Los Rios, Manabi, Pichincha
*Warileya phlebotomanica** Hertig	LOJA
*Lutzomyia lichyi** (Floch & Abonnenc)	MORONA SANTIAGO
Lu. gomezi (Nitzulescu)	Azuay, BOLIVAR, CAÑAR, EL ORO, Esmeraldas, Guayas, LOJA, Manabi, MORONA SANTIAGO, Pichincha, Sucumbios
*Lu. saulensis** (Floch & Abonnenc)	PICHINCHA
*Lu. spathotrichia** (Martins, Falcão & Silva)	MORONA SANTIAGO
Lu. serrana (Damasceno & Arouck)	BOLIVAR, CANAR, EL ORO, Guayas, ESMERALDAS, LOJA, LOS RIOS, MANABI, Pichincha, Sucumbios, ZAMORA CHINCHIPE
Lu. nevesi (Damasceno & Arouck)	GUAYAS, MORONA SANTIAGO, Sucumbios, ZAMORA CHINCHIPE
Lu. vespertilionis (Fairchild & Hertig)	CAÑAR, Guayas, PICHINCHA
Lu. dysponeta (Fairchild & Hertig)	AZUAY, BOLIVAR, CANÃR, EL ORO, Esmeraldas, Guayas, Los Rios, MANABI, PICHINCHA
Lu. camposi (Rodriguez)	BOLIVAR, CAÑAR, Los Rios, Pichincha
Lu. triacantha (Mangabeira)	Sucumbios
*Lu. furcata**(Mangabeira)	PICHINCHA
*Lu. gorbitzi**(Blancas)	GUAYAS, ESMERALDAS, MANABI
Lu. baityi (Damasceno, Causey & Arouck)	Sucumbios
Lu. walkeri (Newstead)	Sucumbios
Lu. sericea (Flock & Abonnenc)	Zamora Chinchipe
Lu. sallesi (Galvão & Coutinho)	Guayas, MANABI
Lu. (Evandromyia) sp.	Sucumbios
Lu. shannoni (Dyar)	BOLIVAR, CAÑAR, EL ORO, ESMERALDAS, Guayas, LOS RIOS, Manabi, MORONA SANTIAGO, Pichincha, Sucumbios
*Lu. abonnenci** (Floch & Chassingnet)	EL ORO, ESMERALDAS, GUAYAS, LOS RIOS, MANABI
Lu. dendrophyla (Mangabeira)	MORONA SANTIAGO, Sucumbios
*Lu. dasymera** (Fairchild & Hertig)	CAÑAR, MANABI, PICHINCHA
Lu. undulata (Fairchild & Hertig)	CAÑAR, ESMERALDAS MANABI, Pichincha
*Lu. triramula** (Fairchild & Hertig)	CAÑAR, PICHINCHA
*Lu. aragaoi**(Costa Lima)	CAÑAR
*Lu. barrettoi barrettoi** (Mangabeira)	MORONA SANTIAGO
Lu. barrettoi majuscula Young	BOLIVAR, CAÑAR, Guayas, Los Rios, Manabi, Pichincha
Lu. abunaensis (Martins, Falcão & Silva)	Sucumbios
Lu. aclydifera (Fairchild & Hertig)	CAÑAR, Pichincha
Lu. reburra (Fairchild & Hertig)	CAÑAR, El Oro, Pichincha
Lu. cellulana Young	MORONA SANTIAGO, Sucumbios
*Lu. ubiquitalis** (Mangabeira)	MORONA SANTIAGO
Lu. napoensis Young & Rogers	Sucumbios
Lu. wilkersoni Young & Rogers	Zamora Chinchipe
Lu. (Trichophoromyia) sp.	Pastaza
Lu. trapidoi (Fairchild & Hertig)	BOLIVAR, CAÑAR, El Oro, ESMERALDAS, Guayas, Los Rios, Pichincha
Lu. flaviscutellata (Mangabeira)	PICHINCHA, Sucumbios
Lu. olmeca bicolor Fairchild & Theodor	CAÑAR, Los Rios, Sucumbios
Lu. yuilli Young & Porter	MORONA SANTIAGO, Sucumbios
Lu. panamensis (Shannon)	BOLIVAR, CAÑAR, MANABI, Pichincha
Lu. carrerai carrerai (Barretto)	MORONA SANTIAGO, Sucumbios

Species	Distribution by Province
Lu. carrerai thula Young	CAÑAR, BOLIVAR, Pichincha
Lu. amazonensis (Root)	BOLIVAR, Pastaza, Sucumbios
Lu. davisi (Root)	MORONA SANTIAGO, Pastaza, Sucumbios
Lu. geniculata (Mangabeira)	MORONA SANTIAGO, Pastaza, Sucumbios
Lu. hirsuta hirsuta (Mangabeira)	MORONA SANTIAGO
Lu. ayrozai (Barretto & Coutinho)	El Oro
Lu. bispinosa (Fairchild & Hertig)	Sucumbios
Lu. nocticola Young	Sucumbios
Lu. paraensis (Costa Lima)	Pastaza
Lu. hartmanni (Fairchild & Hertig)	BOLIVAR, CAÑAR, El Oro, ESMERALDAS, Guayas, LOJA, Pichincha
Lu. tortura Young & Rogers	MORONA SANTIAGO, Sucumbios
*Lu. ayacuchensis** Caceres & Bianchi Galati	AZUAY
*Lu. osornoi** (Ristorcelli & Van Ty)	AZUAY
Lu. strictivilla Young*	ZAMORA CHINCHIPE
Lu. cayennensis (Floch & Abonnenc)	EL ORO, Esmeraldas, Guayas, LOJA, Los Rios, MANABI
Lu. micropyga (Mangabeira)	EL ORO, GUAYAS, LOS RIOS, MANABI, PICHINCHA, Sucumbios
Lu. trinidadensis (Newstead)	ESMERALDAS, PICHINCHA, Sucumbios
Lu. sordellii (Shannon & Del Ponte)	Cañar, Guayas, Los Rios, Pichincha, Sucumbios

variety of methods from July to October in 1988 and 1990. Details of collection sites and methods used are presented in the Table. Areas where sand flies were collected are shown in the Figure. In addition to the insects collected in 1988 and 1990, slides containing specimens purported to *Lu. monticola* (Costa Lima) and *Lu. sallesi* (Galvão & Coutinho) collected by Rodriguez (1956) and Arzube (1960) respectively were examined and compared with examples from the reference collection of Dr D. G. Young at the University of Florida, Gainesville, Florida, USA.

Warileya phlebotomanica Hertig 1948 – The ranges of the six described members of the genus *Warileya* are known to include French Guiana, Costa Rica, Panama, Peru, Colombia and Bolivia. The two females caught in a tree hole in dry scrub forest covering a mountainside near the Parroquia of Zambi, Loja province on 14.ix.1990 and later identified as *W. phlebotomanica* therefore represent the first records of this genus from Ecuador. Hertig (1948) first described *W. phlebotomanica* from Peru and until the present study the known range of this species had not been increased since that time. Although little is known of its habits Hertig (1948) demonstrated that man was one of its hosts and successfully fed one female on a bartonellosis patient, suggesting that *W. phlebotomanica* might be one of the vectors of *Bartonella bacilliformis* in endemic areas of Peru. No further studies have been done to confirm this.



Location of collection sites of phlebotomine sand flies (province in parentheses). 1: Muisne. 2: El Mamey/La Correntada (ESMERALDAS). 3: Puerto Quito (PICHINCHA). 4: El Progreso. 5: Pueblito Rocafuerte. 6: Junin. 7: Pajan. 8: Campozano (MANABI). 9: Gramalote Chico (LOS RIOS). 10: Echeandia (BOLIVAR). 11: Manglaralto (GUAYAS). 12: Barranco Chico. 13: Ocaña. 14: Zhucay (CAÑAR). 15: Macas. 16: Taisha. 17: Huambi. 18: Lograño (MORONA SANTIAGO). 19: Paute. 20: Challuabamba (AZUAY). 21: La Avanzada. 22: Zaruma. 23: Rio Pindo (EL ORO). 24: El Prado. 25: Zambi (LOJA). 26: Zumba. 27: La Chonta (ZAMORA CHINCHIPE).

Lutzomyia lichyi (Floch & Abonnenc) – Four males of this species were collected on a tree trunk in partially cleared primary forest near Taisha, Morona Santiago on 30.viii.1988. According to Young & Duncan (unpublished), *Lu. lichyi* has been reported from several departments of Colombia as well as Costa Rica, Panama, Venezuela, Trinidad and Brazil and its presencein eastern Ecuador is therefore not surprising.

Lutzomyia saulensis (Floch & Abonnenc) – A single female of this species was collected in an illuminated Shannon trap in secondary forest near Recinto Paraiso Escondido on 14.viii.1990. This is the first record of this species from Ecuador, although its presence in the country is probably to be expected, in view of its wide geographical distribution, already known to extend from Costa Rica to Peru and east to Brazil and French Guiana (Young & Duncan, unpublished). According to Young (1979), the females of *Lu. saulensis* and *Lu. wilsoni* (Damasceno & Causey) are almost identical, although the latter occurs further south, the ranges of the two species overlapping in northern Brazil. Ward et al. (1973) reported that females of *Lu. saulensis* were attracted to rodents and man in Brazil, and Shaw & Lainson (1972) found flagellates (not *Leishmania*) in the guts of wild-caught specimens.

Lutzomyia spathotrichia (Martins, Falcão & Silva) – A single male of this species was discovered in the same collection as the *Lu. lichyi* males described above. Previous collections of *Lu. spathotrichia* have been made from Brazil (Vianna Martins et al., 1978) and French Guiana (D. G. Young, personal communication) so that this specimen represents the westernmost record to date. Ready et al. (1986) considered this species to be a potential vector of *Leishmania* in Brazil because of its behaviour in the forest canopy.

Lutzomyia gorbitzi (Blancas) – This species has been recorded previously from Costa Rica, Panama and Peru (Vianna Martins et al., 1978) as well as Colombia (Barreto et al., 1989). During the present study specimens were collected from tree trunks at El Refugio and Dos Mangas, near Manglaralto (Canton Santa Elena, Guayas); on castor oil traps placed between the roots of kapok (*Ceiba pentandra* (L.)) trees at Pueblito Rocafuerte, near Porto Viejo, Manabi; from tree trunks in a coffee plantation at Recinto El Toro, near Junin, Manabi; and from the same habitat type and microhabitat at Campozano, Manabi and La Correntada (near San Gregorio, Canton Muisne, Esmeraldas). The range of this species therefore appears to extend down the Pacific coast of Ecuador, perhaps linking the populations in Colombia and Peru.

Lutzomyia abonnenci (Floch & Chassignet) – This species is easily confused with its close relative *Lu. shannoni* (Dyar) and may have been overlooked prior to the present study for this reason. It has already been recorded from Panama, Colombia, Peru, French Guiana and Brazil (Young 1979). Collections of males were made from tree trunks and in Shannon traps at Dos Mangas, Guayas on 6.x.1988; on tree trunks at Gramalote Chico, Los Rios on 2.viii.1988; from the same microhabitat at Campozano, Las Anonas and El Aji, Manabi on 20-21.ix.1988; from tree trunks at El Mamey and La Correntada, Esmeraldas on 17.viii.1990; from a Shannon trap at Recinto El Progresso, near Porto Viejo, Manabi on 28.viii.1990; from tree trunks in primary forest at Balneario "El Recreo" near La Avanzada, El Oro on 14.ix.1990; from tree trunk and Shannon trap collections at Campozano, Manabi on 4.x.1990; from trees at Recinto El Toro, near Junin, Manabi on 2.x.1990; and from trees at La Tablada de Mendoza, also near Junin, on 3.x.1990. Females of *Lu. abonnenci* are identical to those of *Lu. shannoni* and were probably also collected.

Lutzomyia dasymera (Fairchild & Hertig) – Young & Duncan (unpublished) recorded this species as occurring from Mexico south to Brazil, although the two females collected on tree trunks in a cacao plantation near Zhucay, Cañar on 7.viii.1988 and 27.viii.1988 represent the first records of this species from Ecuador. Other collections included those of a single male from a tree trunk at Las Anonas, Manabi, on 21.ix.1988; a female, also from a tree trunk at Recinto Paraiso Escondido on 14.viii.1990; and eight males and one female from trees at La Tablada de Mendoza, Manabi on 3.x.1990.

Lutzomyia triramula (Fairchild & Hertig) – According to Young & Duncan (unpublished) and Murillo & Zeledon (1985) this species has been recorded previously from Guatemala, Belize, Costa Rica, Panama and Colombia, so that the large numbers of both sexes collected from armadillo burrows at Zhucay and Bar-

ranco Chico, Canar on 8.viii.1988, 26.viii.1988 and 6.ix.1988 represent the southernmost records to date. A single male was also collected from a tree trunk at Paraiso Escondido, near Puerto Quito, Pichincha on 14.viii.1990.

Lutzomyia furcata (Mangabeira) – This species has been recorded from Panama, Colombia, Venezuela, French Guiana, Brazil and Peru (Young & Duncan, unpublished). Three males and one female captured from tree trunks at Paraiso Escondido on 11.viii.1990 represent the first records for the subgenus *Viannamyia* from Ecuador. Although the feeding habits of this species in the wild are unknown, Ryan et al. (1987) were able to infect this species with *L. amazonensis* from lesions of hamsters in the laboratory.

Lutzomyia aragaoi (Costa Lima) – Young (1979) reported that the range of this species extended from Panama south to Peru and Paraguay, although the males and females collected in an armadillo cave and in CDC light traps at Barranco Chico, Cañar represent the first records of *Lu. aragaoi* from Ecuador. A single female was collected in a Shannon trap at El Caoni, near Puerto Quito, Pichincha on 12.viii.1990 and a male on trees at Paraiso Escondido, also near Puerto Quito, on 14.viii.1990.

Lutzomyia barrettoi barrettoi (Mangabeira) – According to Young & Duncan (unpublished), this subspecies occurs in Colombia, Peru, Brazil, French Guiana, Surinam and Trinidad, and is replaced west of the Andes by *Lu. barrettoi majuscula,* which was also collected during the present study at several localities (see Table). The two females collected in a Shannon trap in secondary forest near Macas, Morona Santiago, on 29.viii.1988 represent the first records of this subspecies from Ecuador.

Lutzomyia ubiquitalis (Mangabeira) – According to Young (1979) this species occurs across northern South America from Caqueta, Colombia to French Guiana and south to Brazil and Peru. During the present study one male was caught on a tree trunk near Huambi, Morona Santiago on 20.viii.1988 and a further 12 males from trees in partially cleared primary forest near Taisha (also in Morona Santiago) on 30.viii.1988, representing the first records of this species in Ecuador. Ryan et al. (1987) found 11 females of this species from Para, Brazil to be naturally infected with *Leishmania.* This is the only record to date of such infections in sand flies of the subgenus *Trichophoromyia.*

Lutzomyia cellulana Young – Prior to the present study, published records of this species had only been made from Caqueta, Colombia (Young 1979). The first recorded specimen from Ecuador (a male) was collected by D. Duckhouse in a light trap at Puerto Misahuali, near Santa Rosa, Napo, on 26.viii.1982 (D. G. Young, personal communication). During the present study a total of five males were collected in Shannon trap and CDC light traps in damp secondary forest near the airfield at Macas, Morona Santiago on 29.viii.1988.

Lutzomyia trapidoi (Fairchild & Hertig) – This widespread anthropophilic species (already listed by Rodriguez, 1956) was collected in 8 of the 12 provinces visited during the present study. Arzube (1960) reported the closely related species *Lu. ylephiletor* (Fairchild & Hertig) from Barranco Chico, Cañar (formerly pertaining to the province of Guyas). No examples of the latter species were taken by any of the five methods used to sample the sand fly fauna at this site on 6.ix.1988, although *Lu. trapidoi* was abundant and may have been mistaken for *Lu. ylephiletor* by Arzube.

Lutzomyia ayacuchensis Caceres & Bianchi Galati – This species was described from specimens collected in the Department of Ayacucho, Peru (Caceres & Bianchi Galati, 1988). During the present study specimens formerly identified as *Lu. peruensis* (Hashiguchi et al., 1987) at a focus of *Leishmania* in Paute, Department of Azuay, were found to in fact belong to two other *Lu. vexator* group species, i. e., to *Lu. ayacuchensis* and the closely related *Lu. osornoi* (Ristorcelli & Van Ty) (see below). Collections were made 1988 and 1990 using protected human bait, sticky traps and illuminated Shannon traps, and several specimens were also collected by direct aspiration from rock crevices.

Lutzomyia osornoi (Ristorcelli & Van Ty) – This species was previously known only from the Department of Nariño, Colombia (Young, 1979). Collections of a morphologically similar species were made from protected human bait, Shannon trap and sticky traps at Paute and Challuabamba during July and August 1988. The biology of this species in the area appears to be similar to that of *Lu. ayacu-*

chensis, at least with respect to resting sites and techniques by which it can be sampled.

Lutzomyia strictivilla Young – This species was described by Young (1979) from specimens collected at Rio Anori, Department of Antioquia, Colombia and was one of three collected off protected human bait at Izimanchi, near Zumba, Zamora Chinchipe on 2.viii.1990. These specimens represent the first records of this species from Ecuador.

Lutzomyia monticola (Costa Lima) – A male collected at Estero Claro, Guyas and identified by Rodriguez (1956) as belonging to this species, was examined during the course of this study. According to Young & Rogers (1984) this species has been recorded previously only from Brazil and Argentina and its presence in western Ecuador seems unlikely. The specimen examined, now in the collection of the Parasitology Department of the Instituto Nacional de Higiene y Medicina Tropical in Guayaquil, appears to be a misidentified *Lu. trapidoi*, or perhaps belongs to a darker sibling species (R. D. Kreutzer, personal communication).

Lutzomyia sallesi (Galvão & Coutinho) – This species was first reported from the province of Guayas by Arzube (1960). Young & Rogers (1984) considered its presence in Ecuador to be doubtful, at least west of the Andes, as all other records of *Lu. sallesi* had been made from Brazil and eastern Bolivia. Some of the specimens collected by Arzube at Santa Lucia, near Palestina, Guayas in June 1956 were examined during the present study and confirmed as *Lu. sallesi* based on comparison with prepared material from Brazil. Specimens from Peru formerly identified as *Lu. cortallezzii* (Brethes) also probably belong to this species (D. G. Young, personal communication). Several examples of *Lu. sallesi* were collected in 1990 from tree trunks and in illuminated Shannon traps at Recintos "El Toro" and "La Tablada de Mendoza" near Junin in the province of Manabi, confirming the presence of this species in Ecuador.

The present study increases the known number of sand fly species in Ecuador to 60, although it is almost certain that many more species remain to be identified within the country's borders. Few provinces have been surveyed adequately and no records exist from Chimborazo, Cotopaxi, Tungurahua, Imbabura, Carchi and Napo (it is assumed that no phlebotomines exist on the Galapagos Islands). The "Limoncocha" records of Young & Rogers (1984) now pertain to Sucumbios since the creation of this twenty-first province of Ecuador in 1989 from territory formerly administered by Napo. Several other provincès, notably Bolivar and Pastaza, have received only a cursory sampling treatment based on single collections.

The importance of the Andean plateau in restricting the distribution of certain species in Ecuador deserves further consideration in the light of the findings of this study. The discovery of *Lutzomyia (Psychodopygus) amazonensis* (Root) in Bolivar is interesting since this species was thought to be restricted to the eastern side of the Andes, it being assumed that the subgenus *Psychodopygus* originated in the Amazon basin (Young, pers. comm.), the area from which most of its members have been recorded. Among the other *Lutzomyia (Psychodopygus)* species known from Ecuador, only one, i. e., *Lu. (P.) carrerai* (Barretto), has been found both in the coastal plain and the Oriente, with the former population consisting of the subspecies *Lu. carrerai thula* Young and the latter of *Lu. carrerai carrerai* (Barretto). A similar situation exists with regard to *Lu. barrettoi* (Mangabeira), with *Lu. barrettoi barrettoi* (Mangabeira) found in the Oriente and *Lu. barrettoi majuscula* Young in the coastal plain.

Several other species have now been collected on both sides of the Andean plateau. These include the reptile-feeder *Lu. micropyga* (Mangabeira), the man-biting species *Lu. gomezi* (Nitzulescu) and four other somewhat anthropophilic species, i. e., *Lu. nevesi* (Damasceno & Arouck), *Lu. shannoni, Lu. flaviscutellata* (Mangabeira) and *Lu. olmeca bicolor* Fairchild & Theodor. The last of these has a wide geographical distribution extending from Costa Rica to southern Ecuador and has been found on both sides of the Andes in Colombia. The capture of two females of a species similar to *Lu. dysponeta* (Fairchild & Hertig) at Taisha, Morona Santiago and Izimanchi, Zamora Chinchipe, together with that of two males at Paute, Azuay (altitude ca. 2300 m) suggests that this species at least was able to cross the plateau and spread over much of the country. Several other species recorded from Ecuador have been recorded from both sides of the Andean region in Colombia

(Young, 1979), where the chain divides into three cordilleras separated by the Magdalena and Cauca river valleys.

The above exceptions notwithstanding, the three regions of Ecuador appear to support distinct sand fly faunae. Little is known of *Leishmania* transmission in the Oriente but in the coastal region the important man-biting species and potential vectors include *Lu. hartmanni, Lu. trapidoi, Lu. serrana, Lu. carrerai, Lu. panamensis* and *Lu. gomezi.* The information available from the Andean plateau implicates *Lu. ayacuchensis* and possibly *Lu. osornoi* as vectors of *Leishmania* to man in this region (Takaoka et al., 1990).

Young (1979) discussed the spread of *Lutzomyia* species in Colombia and suggested that most originated in forest "refugia" east of the Andes (the cis-Andean region) during the Pleistocene. This idea follows the theory first proposed by Haffer (1969) to explain speciation in Neotropical birds. The largest of these refugia, consisting of islands of primary forest surrounded by dry grassland, is thought to have occupied the region containing the provinces of Sucumbios, Napo, Pastaza, Morona Santiago and Zamora Chinchipe in present-day Ecuador. Young (1979) suggested that some *Lutzomyia* species may have crossed the Andes in southern Ecuador and northern Peru during interglacial periods, when primary forest occupied river valleys that are now dry.

More complete surveys of the phlebotomine fauna of Ecuador are likely to discover many more species, particularly in the Oriente where much primary forest remains. In addition it may be that the Andean region supports several more members of the *Lu. vexator* Theodor and *Lu. verrucarum* Theodor species groups, both of which include sand flies adapted to mountainous environments involved in the transmission of *Leishmania* and *Bartonella.*

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