

ATTRACTIVENESS OF SENTINEL ANIMALS TO VECTORS
OF LEISHMANIASIS IN PANAMA

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Abstract. Phlebotomine sandfly collections were made in one eastern and three central Panamanian localities from July 1967 to April 1971 in conjunction with concurrent studies on the use of sentinel animals as a determinant of cutaneous leishmaniasis endemic foci. A total of 21,171 individuals representing 34 species was collected from light traps (4,621), man (1,882), horses (12,409), sentinel dogs (424), and rodents (1,835). Three anthropophilic species incriminated as vectors of *Leishmania braziliensis* in Panama, *Lutzomyia panamensis*, *L. sanguinaria*, and *L. trapidoi*, dominated most collections in the central Panamanian localities. *L. olmeca*, a mildly anthropophilic vector of *Leishmania mexicana*, dominated collections from sentinel rodents in eastern Panama. Results indicate that sentinel hamsters may be useful for detecting foci of *Leishmania mexicana* but not *L. braziliensis*, since vector species of the latter show little interest in rodents in Panama. Sentinel dogs were found to be fairly attractive to *Lutzomyia sanguinaria* but showed no significant attraction to other vector species. A total of 1,435 sandflies comprising 17 species were dissected. Although 40 trypanosomatid flagellates were found among 7 species, only a single isolate from *L. panamensis* proved to be *Leishmania*.

The use of sentinel animals for the detection and isolation of arthropod-transmitted disease agents is most germane to virology, but the value of this technique in epidemiological studies of cutaneous leishmaniasis was first recognized in 1946.¹ We are currently using this technique as an integral part of such studies at Gorgas Memorial Laboratory.² Sentinel animals must be susceptible to endemic strains of the disease as well as attractive to vector species. Dogs and two species of rodents, used in our sentinel work,³ are susceptible to Panamanian cutaneous leishmaniasis. Host-preference studies of New World phlebotomines have shown that some species feed rather indiscriminately on a wide variety of vertebrate hosts, while a few species have stenophagous habits.⁴⁻⁹ Host relationships of most species are still unknown. The present study concerns the attractiveness of sentinel dogs and rodents, as well as man and horses, to the phlebotomine species involved in the transmission of cutaneous leishmaniasis in Panama. Sandfly species incriminated as vectors of the disease in Panama have been discussed previously.^{10,11} The present work,

conducted from July 1967 to April 1971, also involved dissections of wild-caught sandflies collected from sentinel animal baited traps and other sources for isolation of *Leishmania*. A description of the four study areas surveyed, Sasardi in eastern Panama and Achioté, Gaspar Sabanas and Quebrada Bonita in central Panama, was presented previously.⁸

MATERIALS AND METHODS

Light trap collections were made with CDC miniature light traps 1 to 20 m above the ground during various periods of the evening. Results are limited to those traps set 1 to 6 m above the ground from 1800 to 0600 hours to standardize data gathered from the four study areas (Table 1). Of all the methods used for collecting sandflies, light traps attracted the greatest number of species and provided a rough guideline of the species composition of phlebotomine populations in the study areas. Castor-oil traps¹¹ baited with dogs (Fig. 1) or rodents were also operated from 1800 to 0600 hours to collect sandflies attracted to sentinel animals.

Rodents used in the sentinel animal study³ were restricted to hamsters *Mesocricetus auratus* and cotton rats *Signodon hispidus*. A variety of rodents were used as bait animals in the present study including hamsters, cotton rats, climbing

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TABLE 1
Sandflies collected in light traps 1-6 meters above ground level in four localities in Panama

Species	Achiote		Gaspar Sabanas		Quebrada Bonita		Sasardi	
	♂ and ♀	%	♂ and ♀	%	♂ and ♀	%	♂ and ♀	%
<i>L. aedydifera</i>	139	4.0	9	8.2	—	—	40	4.6
<i>L. camposi</i>	40	1.2	1	0.9	—	—	16	1.8
<i>L. cayennensis</i>	—	—	—	—	—	—	3	0.3
<i>L. carpenteri</i>	102	3.0	4	3.65	31	16.8	270	30.7
<i>L. cruciata*</i>	4	0.1	—	—	—	—	—	—
<i>L. dysponeta</i>	22	0.6	1	0.9	—	—	323	36.8
<i>L. furcata</i>	3	0.1	—	—	—	—	—	—
<i>L. geniculata*</i>	1	<0.1	—	—	—	—	—	—
<i>L. gomezi*</i>	50	1.5	—	—	23	12.4	20	2.3
<i>L. isovespertilionis</i>	—	—	—	—	—	—	4	0.5
<i>L. marajoensis</i>	—	—	—	—	—	—	1	0.1
<i>L. micropyga</i>	—	—	—	—	—	—	1	0.1
<i>L. nordestina</i>	3	0.1	—	—	—	—	—	—
<i>L. odax</i>	—	—	—	—	—	—	1	0.1
<i>L. olmeca*</i>	15	0.4	—	—	—	—	119	13.6
<i>L. ovallesi*</i>	7	0.2	—	—	—	—	—	—
<i>L. panamensis*</i>	2,026	58.8	11	10.0	96	51.9	19	2.2
<i>L. pessoana*</i>	92	2.7	—	—	—	—	—	—
<i>L. punctigeniculata</i>	—	—	—	—	—	—	1	0.1
<i>L. rufoides</i>	10	0.3	—	—	2	1.1	—	—
<i>L. sanguinaria*</i>	18	0.5	4	3.65	12	6.5	—	—
<i>L. sandensis</i>	1	<0.1	—	—	—	—	—	—
<i>L. serrana</i>	3	0.1	—	—	—	—	—	—
<i>L. shannoni*</i>	10	0.3	1	0.9	—	—	4	0.5
<i>L. spinosa</i>	10	0.3	—	—	—	—	—	—
<i>L. trapidoi*</i>	494	14.3	73	66.4	13	7.0	2	0.2
<i>L. trinidadensis</i>	52	1.5	1	0.9	—	—	54	6.1
<i>L. triramula</i>	184	5.3	1	0.9	4	2.2	—	—
<i>L. undulata</i>	1	<0.1	1	0.9	—	—	—	—
<i>L. vesicifera</i>	38	1.1	—	—	3	1.6	—	—
<i>L. vespertilionis</i>	12	0.4	—	—	1	0.5	—	—
<i>L. ylephiletor*</i>	110	3.2	2	1.8	—	—	—	—
<i>Brumptomyia</i> sp.	—	—	1	0.9	—	—	—	—
<i>Warileya</i> sp.	1	<0.1	—	—	—	—	—	—
Total	3,448	100.0	110	100.0	185	100.0	878	100.0
No. trap-nights	41		8		7		49	
No. ♂ and ♀/ trap-night	84.1		13.8		26.7		17.9	

* Man-biting species.

rats *Tylomys nudicaudatus*, spiny rats *Proechimys semispinosus* and rice rats *Oryzomys capito*. We have observed little if any difference in the attractiveness of small- to moderate-sized rodents to Panamanian sandflies. Plaster-of-paris-lined shell vials¹² were used to collect sandflies attracted to humans and horses during the first few hours after sunset. Wild-caught sandflies from each of the study areas were dissected according to techniques devised by Johnson et al.¹³ for the isolation of *Leishmania*.

RESULTS

In the three study areas of central Panama three anthropophilic sandfly species, *Lutzomyia panamensis*, *L. trapidoi* and *L. sanguinaria*, dominated the collections from man and horses, as well as from sentinel animals (Tables 2, 3; Fig. 2). *L. panamensis* dominated the Achiote collections from light traps (Table 1), man, horses (Table 2) and sentinel animals (Table 3). This species was also the sandfly collected most frequently from light traps in Quebrada Bonita;



FIGURE 1. Castor-oil trap baited with sentinel dog in Achote, central Panama.

there, however, *L. sanguinaria* dominated collections from man, horses and sentinel animals. *L. trapidoi* was the most abundant species in light traps and collections from man and horses in Gaspar Sabanas, the third study area of central Panama. The number of flies collected in dog-baited castor-oil traps from Achote and Quebrada Bonita differed significantly (Table 3). *L. panamensis* accounted for the bulk of material collected from Achote traps which averaged only 2.9 flies per trap-night, the bulk of which were *L. sanguinaria*. Rodents attracted relatively small numbers per trap-night in both localities. Of the

three dominant anthropophilic species only *L. sanguinaria* was collected in greater numbers per trap-night in dog-baited traps than in light traps (Table 4).

The Sasaki study area in eastern Panama was exceptional in that *L. olmeca*, a sandfly only mildly anthropophilic in Panama, dominated the rodent-baited collections to the near exclusion of all other species (Table 3; Fig. 2); the 26.3 mean number of sandflies per trap-night with rodent-baited traps was due almost exclusively to *L. olmeca*. The dominance in light traps of the non-anthropophilic species *L. dysponeta* and *L. carpenteri* (Table 1) was another unique feature of this area.

A total of 1,435 sandflies comprising 17 species from the study areas have been dissected in an attempt to isolate *Leishmania* (Table 5). Although flagellates have been found in 7 species of sandflies on 40 occasions, only those from a single infection, in *Lutzomyia panamensis*, proved to be *Leishmania*.¹⁰

DISCUSSION

Less than 25% of the 34 species of sandflies collected in light traps from the study areas showed any attraction to man, horses, dogs or rodents. Five of these species have been implicated as vectors of cutaneous leishmaniasis in

TABLE 2
Sandflies collected from man and horses in three localities of central Panama

Species	Man						Horses					
	Achote		Gaspar Sabanas		Quebrada Bonita		Achote		Gaspar Sabanas		Quebrada Bonita	
	♂ and ♀	%	♂ and ♀	%	♂ and ♀	%	♂ and ♀	%	♂ and ♀	%	♂ and ♀	%
<i>L. camposi</i>	—	—	—	—	—	—	—	—	2	0.2	—	—
<i>L. gomezi</i>	—	—	11	6.7	184	12.5	64	2.4	6	0.7	908	10.3
<i>L. isovespertilionis</i>	—	—	2	1.2	—	—	—	—	—	—	—	—
<i>L. olmeca</i>	—	—	1	0.6	—	—	1	<0.1	9	0.9	—	—
<i>L. ovallesi</i>	—	—	—	—	4	0.3	—	—	—	—	4	<0.1
<i>L. panamensis</i>	213	83.8	17	10.3	350	23.8	2,290	85.7	87	9.5	935	10.6
<i>L. pessoana</i>	1	0.4	4	2.4	10	0.7	59	2.2	—	—	1	<0.1
<i>L. sanguinaria</i>	22	8.7	41	24.9	639	43.4	27	1.0	206	22.5	4,221	47.8
<i>L. shannoni</i>	5	2.0	4	2.4	—	—	—	—	—	—	5	0.1
<i>L. trapidoi</i>	—	—	70	42.4	279	18.9	217	8.1	587	64.1	2,690	30.5
<i>L. trinidadensis</i>	12	4.7	7	4.3	2	0.1	—	—	—	—	—	—
<i>L. vesicifera</i>	—	—	—	—	1	0.1	2	0.1	—	—	1	<0.1
<i>L. vespertilionis</i>	—	—	2	1.2	—	—	—	—	—	—	1	<0.1
<i>L. ylephiletor</i>	1	0.4	5	3.6	3	0.2	12	0.5	19	2.1	55	0.6
Totals	254	100.0	165	100.0	1,472	100.0	2,672	100.0	916	100.0	8,821	100.0
No. collections	12		2		68		35		12		83	

TABLE 3

Sandfly collections from castor-oil traps baited with dogs and rodents in three localities in Panama

Species	Dogs				Rodents					
	Achiote		Quebrada Bonita		Achiote		Quebrada Bonita		Sasardi	
	♂ and ♀	%	♂ and ♀	%	♂ and ♀	%	♂ and ♀	%	♂ and ♀	%
<i>L. dysponeta</i>	—	—	—	—	—	—	—	—	1	0.1
<i>L. gomezi</i>	—	—	12	3.4	—	—	3	7.3	2	0.1
<i>L. olmeca</i>	1	1.5	—	—	1	1.8	1	2.4	1,721	99.1
<i>L. panamensis</i>	51	73.9	20	5.6	44	77.2	16	39.0	10	0.6
<i>L. pessoana</i>	—	—	—	—	8	14.0	—	—	—	—
<i>L. sanguinaria</i>	13	18.8	308	86.8	4	7.0	17	41.5	—	—
<i>L. trapidoi</i>	4	5.8	12	3.4	—	—	4	9.8	—	—
<i>L. trinidadensis</i>	—	—	1	0.3	—	—	—	—	3	0.1
<i>L. ylephiletor</i>	—	—	2	0.5	—	—	—	—	—	—
Totals	69	100.0	355	100.0	57	100.0	41	100.0	1,737	100.0
No. trap-nights	24		23		18		33		70	
No. ♂ and ♀/ trap-night	2.9		15.4		3.2		1.2		26.3	

Panama, *L. panamensis*,¹⁰ *L. trapidoi*,^{14,15} *L. gomezi*,²⁵ *L. ylephiletor*,¹⁷ and *L. olmeca*.¹¹ *L. sanguinaria* should be included in this group because of its anthropophily and ecological associations with known reservoir hosts of the disease, and because Panamanian strains of the parasite develop in this species under experimental conditions.^{16, 18} Concerning the other species collected from animal baits, *L. vespertilionis* and *L. isovespertilionis* are principally bat feeders. The only known host of *L. trinidadensis* is the forest gecko *Thecadactylus rapicandus*. The host-feeding proclivities of *L. camposi*, *L. dysponeta*, and *L. vesicifera* are virtually unknown; however the field data we have gathered to date indicate that these species play little if any role in the epidemiology of cutaneous leishmaniasis in Panama. *L. pes-*

soana, *L. ovallesi* and *L. shannoni* are known to feed on man and a variety of other animals, and must be regarded as potential natural vectors.

L. olmeca has been implicated as the vector of *Leishmania mexicana* in Mexico,¹⁰ British Honduras,⁷ and recently in Panama.¹¹ This sandfly appears to be rodentophilic. The use of hamsters as sentinel animals in areas endemic for *L. mexicana* therefore may provide a useful technique for the evaluation of leishmanial activity. The remaining vector species in Panama, cited above, do not appear to be rodentophilic, and all but *L. sanguinaria* show little attraction to dogs. *Leishmania braziliensis*, the only etiological agent of human cutaneous leishmaniasis we have encountered in Panama to date, appears to be maintained in the forest principally among arboreal mammals.

TABLE 4

The frequencies of the three most common sandflies collected in light traps and sentinel-animal-baited castor-oil traps in central Panama

Species	Locality	Light trap	Dog	Rodents
		No./t-n*	No./t-n*	No./t-n*
<i>L. panamensis</i>	Achiote	49.4	2.1	2.5
	Quebrada Bonita	13.7	0.9	0.5
<i>L. sanguinaria</i>	Achiote	0.4	0.5	0.2
	Quebrada Bonita	1.7	13.4	0.5
<i>L. trapidoi</i>	Achiote	12.1	0.2	0.0
	Quebrada Bonita	1.9	0.5	0.1

* Number of sandflies collected per trap-night (a 12-hr period from 1800-0600 hrs).

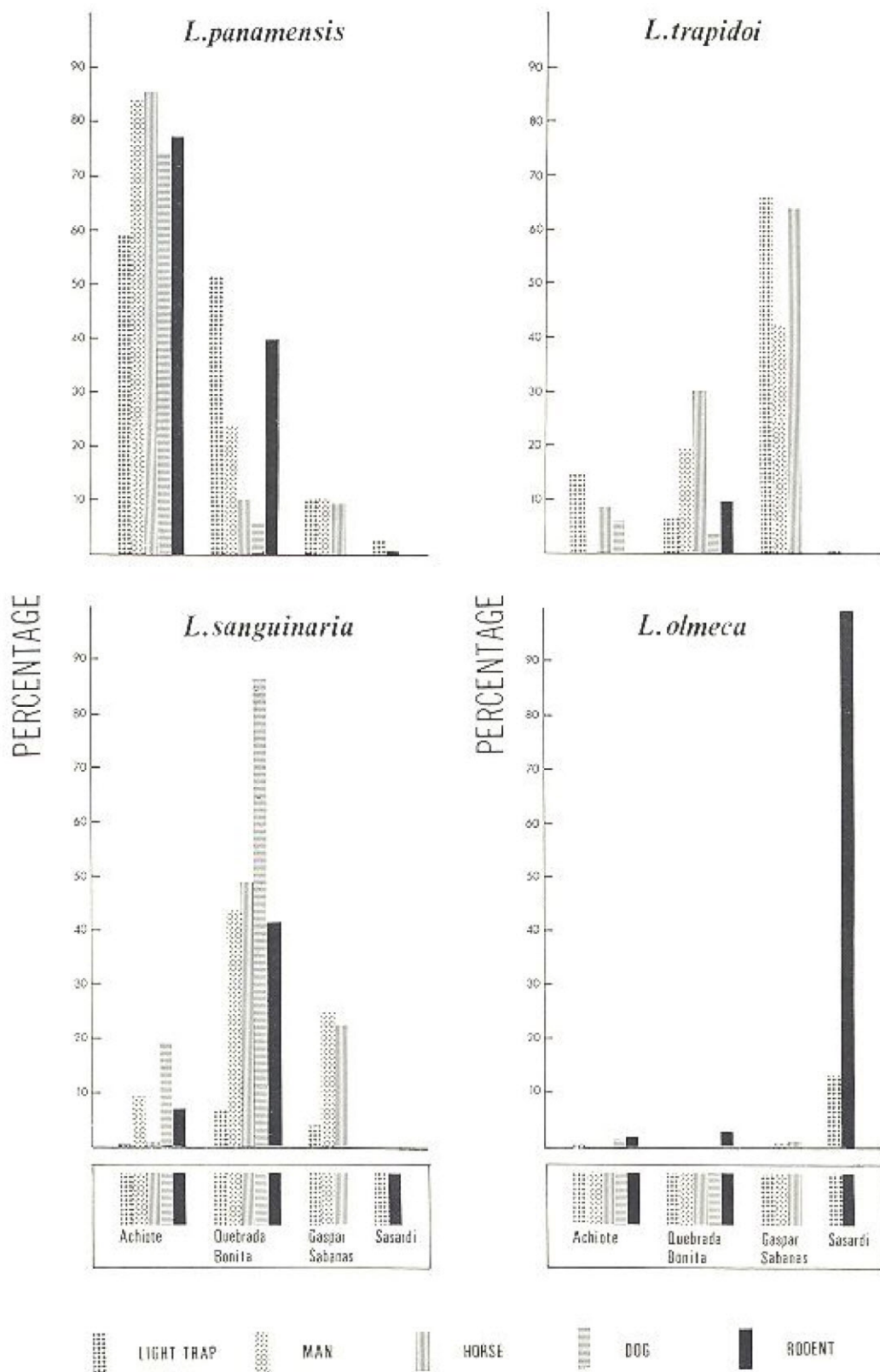


TABLE 5

Trypanosomatid infections in sandflies dissected from the four study areas in Panama July 1967 to April 1971

Species	Total ♀♀ dissected	Flagellate morphology			Total ♀♀ infected
		Epimastigote/ trypomastigote	Promastigote	Undetermined	
<i>L. aclydifera</i>	2	0	0	0	0
<i>L. camposi</i>	3	0	0	0	0
<i>L. carpenteri</i>	30	0	0	0	0
<i>L. dysponeta</i>	20	0	0	0	0
<i>L. gomezi</i>	28	0	0	1	1
<i>L. micropyga</i>	2	1	0	0	1
<i>L. odax</i>	1	0	0	0	0
<i>L. olmeca</i>	438	0	0	0	0
<i>L. panamensis</i>	225	2	1	1	4*
<i>L. pessoana</i>	5	0	0	0	0
<i>L. punctigeniculata</i>	1	0	0	0	0
<i>L. sanguinaria</i>	252	2	0	1	3
<i>L. shannoni</i>	11	0	0	0	0
<i>L. trapidol</i>	524	0	2	4	6
<i>L. trinidadensis</i>	39	4	0	0	4
<i>L. vespertilionis</i>	48	21	0	0	21
<i>L. ylephiletor</i>	26	0	0	0	0
Totals	1,435	30	3	7	40

* Includes one *Leishmania braziliensis* infection.

Our findings point out the need to select a susceptible sentinel animal with greater attractiveness to vectors and potential vectors than the dog. The most effective sentinel animal in Panama would be one that is highly susceptible to both *L. mexicana* and *L. braziliensis* and also highly attractive to all vector species.

It is obvious that the host-preferences of the vector and potential vector species must be investigated further before a critical evaluation can be made of the usefulness of various mammalian host species as sentinel animals. The isolation of *L. mexicana* from a sentinel hamster in Sasaki and *L. braziliensis* from a sentinel dog in Achiote² have prompted us to continue this line of investigation. We are seeking a model system for determining the prevalence of cutaneous leishmaniasis in different Panamanian localities.

Reports on the presence of flagellates in wild-caught sandflies must be evaluated carefully, since four different trypanosomatid genera may infect Panamanian sandflies.²⁰ All such flagellate isolations should be shown to produce amastigote forms in a vertebrate host, such as hamsters, as

a prerequisite for *Leishmania* classification. The demonstration of a leishmanial infection in a wild-caught sandfly species is one of the strongest evidences for considering that species a vector of the disease. This condition demonstrates that the fly 1) was ecologically associated with and attracted to and had fed upon a reservoir host, and 2) was capable of acquiring and nurturing the disease agent. We are continuing our dissections of wild-caught sandflies from other study areas as an essential part of our epidemiological investigations of cutaneous leishmaniasis.

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FIGURE 2. Incidence of the most common vectors of cutaneous leishmaniasis from central and eastern Panama in light traps and animal bait collections.

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