

STUDIES OF PHLEBOTOMINE SANDFLIES USING CASTOR OIL TRAPS BAITED WITH PANAMANIAN ANIMALS¹

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Abstract: A new type of phlebotomine sandfly trap is described which utilizes 2 moats of castor oil around a bait animal.

The use of 2 such traps in Panama, 1 in the canopy and 1 near the ground, resulted in the capture of more than 8000 sandflies. A vertical distribution of species was shown since *Phlebotomus panamensis*, *P. pessoana*, and *P. apicalis* fed near the ground while *P. trapidoi*, *P. sanguinarius*, and *P. gomezi* preferred to feed in the canopy. The largest 1-night catch for a single trap was 671 sandflies using a common opossum (*Didelphis marsupialis* L.) as bait.

Only the common man-biting species of sandflies were regularly caught with animal bait, and no definite host preferences could be demonstrated.

For several years attempts have been made at this laboratory to elucidate the natural feeding habits of phlebotomine sandflies. These studies have comprised an aspect of the search for natural reservoir hosts of human cutaneous leishmaniasis since any information concerning the feeding habits of man-biting sandflies would be likely to provide suggestive evidence as to the reservoir hosts. These efforts in the past have been somewhat hampered by the lack of a suitable trap that could be baited with an animal and left out overnight (Thatcher & Hertig 1966). The present paper reports the results of trapping carried on between July 1965 and June 1967, using a different and more effective sandfly trap.

DESCRIPTION OF THE TRAP

The trap used in the present study utilizes the principle of a castor oil moat surrounding a caged bait animal. The same principle was used in the sandfly trap reported by Disney (1966) which he tried in British Honduras. We learned of the nature of the Disney trap during conversations with Paul Williams when he visited this laboratory in 1965, and subsequently, we constructed a trap which represents a modification of the Disney method. In the Disney Trap a single pan (or moat) surrounded the bait animal while in our trap, from 1 to 3 pans were used. It was found in practice that 2 pans gave maximal results. The caged bait animal was suspended within 1 pan,

and the other pan was situated below the level of the animal.

The aluminum moat pans measured 66 × 94 cm on the outside, and had a rectangular hole, 15 × 43 cm, in the center through which the caged animal could be inserted. A rim, 2.5 cm high, inside and outside of the moat pans served to contain the oil. The pans thus provided a moat, 25 cm wide, which completely surrounded the bait animal. The rest of the trap unit consisted of a roof to keep out the rain, and a framework from which to suspend the pans and the bait animal. The aluminum roof measured 89 × 117 cm which provided eaves of 11.4 cm on all sides. A rectangular framework, 66 × 94 cm, of angle-iron, .317 × 1.58 cm, attached to the roof with metal screws provided the necessary rigidity to suspend the other components. At each corner of the angle-iron framework a piece of stainless steel, 25 × .63 × 2.5 cm, was suspended. Each of the corner pieces had a longitudinal slot, .63 cm wide. The moat pans were bolted to the corner pieces by inserting bolts with wing nuts through the slots. The slots in the corner pieces made it possible to slide the moat pans up and down to any desired height. The caged animal was suspended in the upper moat pan on aluminum brackets. The central aperture in the lower pan was left open as it had been found previously that sandflies often approach caged animals from below.

The entire trap unit was suspended from 4 eye bolts which passed through the roof and were attached to the angle-iron supporting framework. A suspension harness of .32 cm steel cable equipped with turnbuckles was attached to the eye bolts. The turnbuckles served to facilitate leveling of the trap in the field.

A scant liter (.946) of castor oil was used in each of the moat pans, and it was necessary to strain the oil through a cloth about every second day to remove accumulated debris and miscellaneous insects.

USE OF THE TRAPS

Starting on 1 March 1966, 2 identical trap units were used each night, and each was baited with the same species of animal. The traps were suspended at 13.4 and 1.2 m, with a separation of about 6 m

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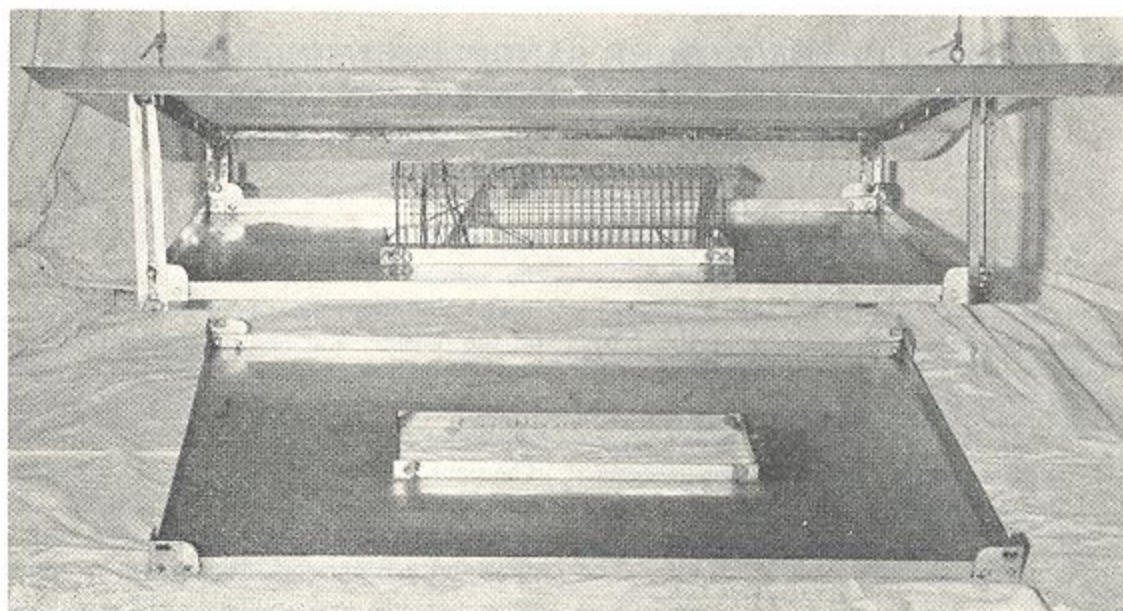


FIG. 1. View of expanded castor oil sandfly trap with the lower moat pan removed.

measured horizontally. The canopy trap was hung from a pulley so that it could be easily raised and lowered. The bait animals were placed in the traps in the late afternoon, and the sandflies were removed from the oil on the following morning and placed in vials of alcohol. Flies showing the abdomen extended with blood were counted as fed females.

STUDY AREAS

Quebrada Bonita

Early trials with a single castor oil trap (from July to December 1965) and some collections using 2 traps (during September and October 1966) were made at Quebrada Bonita in Colon Province. This area is located near the Trans-isthmian Highway, and a description of it was provided by Thatcher & Hertig (1966).

Achiote

Most of the present study was conducted in the Achiote area of Colon Province near the Caribbean coast of Panama. The traps were put out in a single location, in a forested area near the Canal Zone boundary. This area is contiguous with a large forested tract which forms a part of the Fort Sherman training area. Both the town of Achiote in Panama and the Fort Sherman area of the Canal Zone are known to be endemic for human cutaneous leishmaniasis.

RESULTS

Initial Trials

From July to September 1965, preliminary trials

at Quebrada Bonita were made using a single trap unit (2 pans). During 14 nights, the trap was hung at .914 m from the ground, and baited with a common opossum. Results of these attempts are shown in TABLE 1. Although the trap was near the ground, more *Phlebotomus trapidoi* Fairchild & Hertig than *P. panamensis* Shannon were caught. Females outnumbered males by about 10 to 1 which suggested that the sandflies were being attracted by the bait animal. In these tests about 20 to 30% of the females showed evidence of a blood meal. Disney (1966) ran a series of trials with his trap in British Honduras that showed rather conclusively that sandflies were attracted to the bait animal and that some of them fed on it. Disney's trap caught only an occasional sandfly when left in the forest unbaited. It was not considered necessary to run similar tests in the present study, but 1 trap left out unbaited at Quebrada Bonita failed to produce any sandflies after 4 days and nights.

TABLE 1. Sandflies caught with a single castor oil trap (2 pans) near the ground baited with a common opossum, during 14 nights from July to September 1965.

PHLEBOTOMUS	♂♂	♀♀	(Fed)	TOTALS
<i>panamensis</i>	14	100	(27)	114
<i>trapidoi</i>	17	183	(40)	200
<i>sanguinari</i>	0	32	(8)	32
Totals:	31	315	(75)	346

Vertical Distribution of Species

Starting in March 1966, when 2 identical trap units (2 pans each) were available, 2 traps with the same bait species were set out each trap-night.

TABLE 2. Species of *Phlebotomus* caught in traps at different heights using larger bait animals.

	ANIMAL BAIT									TOTALS		
	<i>Didelphis marsupialis</i> L. (common opossum)			<i>Potos flavus</i> (Schreber) (kinkajou)			<i>Coendou rothschildi</i> Thomas (porcupine)					
Number of nights:	43			29			2			74		
CANOPY TRAP AT 10.3 TO 13.4 M												
<i>Phlebotomus</i>	♂♂	♀♀	(fed)	♂♂	♀♀	(fed)	♂♂	♀♀	(fed)	♂♂	♀♀	(fed)
<i>panamensis</i>	0	71	(4)	6	12	(0)	0	36	(0)	6	119	(4)
<i>sanguinarius</i>	2	106+	(153)	3	81	(12)	0	1	(0)	5	1146	(165)
<i>trapidoi</i>	151	3592	(286)	10	47	(4)	1	8	(0)	162	3647	(290)
<i>apicalis</i>												
<i>gomezi</i>	1	6	(2)	2	4	(0)				3	10	(2)
<i>pessoana</i>	0	3	(0)	0	1	(0)				0	4	(0)
Sub-totals:	154	4736	(445)	21	145	(16)	1	45	(0)	176	4926	(461)
GROUND LEVEL TRAP AT 1.2 M												
<i>panamensis</i>	142	1070	(76)	139	363	(2)	106	362	(48)	387	1795	(126)
<i>sanguinarius</i>	0	124	(32)	0	6	(0)				0	130	(32)
<i>trapidoi</i>	6	80	(7)	0	6	(0)	0	1	(0)	6	87	(7)
<i>apicalis</i>	0	6	(1)	0	9	(0)	0	2	(0)	0	17	(1)
<i>gomezi</i>	0	1	(0)							0	1	(0)
<i>pessoana</i>	1	29	(2)	0	1	(0)				1	30	(2)
Sub-totals:	149	1310	(118)	139	385	(2)	106	365	(48)	394	2060	(168)
Totals:	303	6046	(563)	160	530	(18)	107	410	(48)	570	6986	(629)

The high trap was suspended in the canopy at 10.3 or 13.4 m above the ground while the low trap was hung about 1.2 m from the forest floor. The same species of bait animal was used in the traps in order to investigate the vertical feeding preferences of the sandfly species. In previous work at this laboratory it had been found that *P. panamensis* fed near the ground on man and horses but was seldom caught on human bait in the trees (Johnson et al. 1963).

The common opossum and the kinkajou were the bait animals most often used since both of these species had been found to be attractive by direct collecting (Thatcher & Hertig 1966). Other species tried occasionally were the arboreal white-tailed rat, the woolly opossum, the prehensile-tailed porcupine, and the domestic chicken. TABLES 2 & 3 present the results of the 82 trap nights during which 7706 sandflies were caught including 630 fed females. The dominant species in these collections were: *P. trapidoi* (51%), *P. panamensis* (32%), and *P. sanguinarius* (17%). Small numbers of the species *apicalis*, *gomezi*, and *pessoana* were also obtained, but these represented less than 1% of the total catch.

It can be seen from TABLE 2 that some sandfly species were more active in the canopy while other species were usually caught near the ground. Of the 3 dominant species, 95% of the *P. panamensis* were taken in the low trap while 97% of the *P. trapidoi* and 90% of the *P. sanguinarius* Fairchild & Hertig

were from the high trap. Of the less common species, 17 specimens of *P. apicalis* Floch & Abonnenc were from the low trap, but none was seen in the high trap. Only 1 *P. gomezi* Nitzulescu was caught in the low trap, but 13 specimens were found in the high trap. Only 4 *P. pessoana* Barretto came from the high trap while 32 were caught in the low trap. It would appear, therefore, that *P. panamensis*, *P. pessoana*, and *P. apicalis* by preference feed near the ground while *P. trapidoi*, *P. sanguinarius*, and *P. gomezi* prefer to feed in the canopy. Williams (1965) reported that *P. apicalis* can be found in British Honduras resting under leaves on the forest floor, and that it is commonly caught in rat-baited traps near the ground but only occasionally in the trees.

The vertical separation of sandfly species may be somewhat more complete than the tables show. On several individual nights there was a complete separation between *P. panamensis* in the low trap and *P. trapidoi* in the high trap. It should be kept in mind that the upper trap had to be lowered near the ground to inspect it for sandflies and to change the bait animal. It was sometimes necessary to work with the high trap in lowered position for an hour or more. While the trap was lowered, it is quite possible that some specimens of *P. panamensis* may have fallen into the oil by accident.

It should also be considered that although *P. trapidoi* and *P. sanguinarius* prefer to feed in the trees, they are among the common manbiters in Panama

TABLE 3. Species of *Phlebotomus* caught in traps at different heights using smaller bait animals.

	ANIMAL BAIT									TOTALS		
	<i>Tylomys panamensis</i> Gray (white-tailed rat)			<i>Caluromys derbianus</i> Waterhouse (woolly opossum)			<i>Gallus domesticus</i> L. (chicken)					
Number of nights:	2			2			2			6		
CANOPY TRAP AT 10.3 TO 13.4 m												
<i>Phlebotomus panamensis</i>	♂♂	♀♀	(fed)	♂♂	♀♀	(fed)	♂♂	♀♀	(fed)	♂♂	♀♀	(fed)
<i>trapidoidi</i>				0	1	(0)				0	2	(0)
<i>peessoana</i>										0	2	(0)
Sub-totals:				0	1	(0)	0	2	(0)	0	3	(0)
GROUND LEVEL TRAP AT 1.2 m												
<i>panamensis</i>	40	67	(1)	1	5	(0)	1	32	(0)	42	104	(1)
<i>trapidoidi</i>												
<i>peessoana</i>							0	1	(0)	0	1	(0)
Sub-totals:	40	67	(1)	1	5	(0)	1	33	(0)	42	108	(1)
Totals:	40	67	(1)	1	6	(0)	1	35	(0)	42	108	(1)

at ground level. TABLE 1 shows that these species can be caught with a common opossum near the ground, but TABLE 2 indicates that when the same bait species was available in the trees on the same night, these sandflies did not appear in the lower trap in numbers.

Miscellaneous Species

In addition to the sandflies listed in the tables, a few specimens each of 9 other species were found in the traps. In the case of *P. zephiletor* Fairchild & Hertig, 3 females (1 of which had fed) were caught in the high trap baited with a common opossum. Two unfed females of the same species were found in the low trap baited with a kinkajou. One male of *P. arborealis* Floch & Abonnenc and 6 males of *P. undulatus* Fairchild & Hertig were taken, but since no corresponding females were present, it can be assumed that the presence of the males in the traps was accidental. A single female of each of the following species was obtained: *P. trinidadensis* Newstead, *P. camposi* Rodriguez, and *P. cruciatus* Coquillett. One male and 1 female of *P. dasymerus* Fairchild & Hertig and 3 males and 1 female of *P. shannoni* Dyar were also trapped. At least some of the latter species were probably attracted to the bait animal, in which case they must be uncommon in the study areas.

Large Catches

In the present study, individual nightly catches varied greatly from only 1 or 2 sandflies to several hundred. These extreme fluctuations are probably caused by the weather and by variations in the sandfly population levels. It has been observed in direct collecting from man and animals that heavy rain, wind, or the presence of smoke in the

air will reduce or eliminate sandfly biting activity. At present, little is known of sandfly population dynamics, but presumably there may be natural cycles and peaks caused by the simultaneous hatching of adults and other factors. In using the castor oil traps large 1-night catches of *P. panamensis* and *P. trapidoi* have been noted. In some cases peak catches of the 2 species coincided on the same night while on other occasions 1 species was abundant and the other rare on the same night.

The largest single catch from 1 trap was made on the night of 20 October 1966 at Quebrada Bonita. On that occasion, the high trap was baited with a common opossum and the collection contained a total of 671 sandflies as follows: 485 ♀♀ (4 fed) and 2 ♂♂ of *P. trapidoi*, and 184 ♀♀ (5 fed) of *P. sanguinarius*. It will be noted that of 669 ♀♀ only 9 showed evidence of a blood meal. On the same night the trap near the ground, baited with the same species of opossum, caught only 12 sandflies (3 ♀♀ *P. trapidoi*; 8 ♀♀ (2 fed) *P. sanguinarius*; 1 ♀ *P. panamensis*.)

Also using the common opossum as bait, another large catch was made on the night of 24 June 1966 at Achiote. On that occasion, the catch in the high trap was as follows: 314 ♀♀ (130 fed) of *P. trapidoi*; 4 ♀♀ (1 fed) of *P. sanguinarius*; and 4 ♀♀ of *P. panamensis*. The low trap on the same night caught only 15 sandflies as follows: 10 ♀♀ (3 fed) of *P. panamensis*; 2 ♂♂ and 3 ♀♀ (1 fed) of *P. trapidoi*. The distribution of the females of *P. trapidoi* in the pans of the high trap is also of interest. The upper pan contained 113 ♀♀ of which 6 fed while the lower pan of the same trap contained 201 ♀♀ of which 124 (62%) had fed.

TABLE 4. Sandflies caught using 2 traps near the ground baited with different species of animals. Eight nights kinkajou-opossum and 2 nights kinkajou-marmoset (*Saguinus geoffroyi* Pucheran).

	KINKAJOU-COMMON OPOSSUM						KINKAJOU-MARMOSET						TOTALS		
	8 nights			8 nights			2 nights			2 nights			10 nights		
	♂♂	♀♀	(fed)	♂♂	♀♀	(fed)	♂♂	♀♀	(fed)	♂♂	♀♀	(fed)	♂♂	♀♀	(fed)
<i>Phlebotomus panamensis</i>	18	51	(0)	65	147	(7)	7	21	(1)	1	14	(0)	91	233	(8)
<i>sanguinarius</i>	0	1	(0)	0	1	(0)							0	2	(0)
<i>trapidoi</i>	1	1	(0)	1	3	(0)							2	4	(0)
<i>apicalis</i>	0	2	(0)	0	2	(0)	0	8	(0)				0	12	(0)
<i>peoana</i>	0	1	(0)	1	2	(0)	0	1	(0)				1	4	(0)
Totals:	19	56	(0)	67	155	(7)	7	30	(1)	1	14	(0)	94	255	(8)

This catch represents the highest percentage of fed females obtained in the castor oil traps during the present study. Since the lower pan was slightly below the level of the feet of the bait animal, the large number of fed females in the lower pan was probably a result of sandflies feeding on the feet of the animal and then, being heavy with blood, flying downward into the lower pan. Thatcher & Hertig (1966) noted that most of the sandflies obtained from caged animals by direct collecting were attempting to bite the feet.

The contrast between the 2 nights with regard to the percentage of sandflies that fed (1% for 20 October; 41% for 24 June) is of interest. It is possible that the physiological state of the sandflies may influence their feeding. Chaniotis (1967) found that California sandflies began to feed 20 hr after emergence. It may be that female sandflies after emerging are attracted to the vicinity of the host before they are able to feed. Perhaps the large unfed catch of 20 October represented a population of newly emerged sandflies. Of the 3 common species caught using the opossum as bait, 8% of 3672 *P. trapidoi* fed, while 15% of 1188 *P. sanguinarius* and 7% of 1141 *P. panamensis* had taken a blood meal. Nearly half of all the fed females of *P. trapidoi* were obtained on 24 June.

Host Preferences

On 8 nights, both traps were hung near the ground about 6 m apart in a line at right angles to the direction of the prevailing winds. One trap was baited with a common opossum while a kinkajou was placed in the other. It was hoped that this method might show some host preference on the part of the

sandflies even though Thatcher & Hertig (1966) were unable to do so in direct collecting from caged animals. TABLE 4 shows the results of these trials. It can be seen that considerably more *P. panamensis* were attracted to the common opossum than to the kinkajou. Small numbers of 4 other species were taken with each bait animal in about equal quantity. On 2 additional nights, a marmoset and a kinkajou were placed in the traps. On the latter nights only a few sandflies were taken, but there were more *P. panamensis* taken with the kinkajou than with the marmoset. Also, 8 females of *P. apicalis* were attracted to the kinkajou while none was caught with the marmoset. It cannot be said that these few trials have demonstrated any definite host preference on the part of the sandflies, but TABLES 2, 3 & 4 indicate that several of the species have a rather wide feeding range. Of the sandflies obtained, however, only *P. panamensis* was attracted to all of the bait animals used, including the chicken.

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