

DISPERSAL OF *PHLEBOTOMUS PAPTASI* (SCOPOLI) AND *P. LANGERONI* NITZULESCU IN EL HAMMAM, MATROUH GOVERNORATE, EGYPT ¹

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SUMMARY

The dispersal of *Phlebotomus papatasi* (Scopoli) and *P. langeroni* Nitzulescu was studied using the mark-release-recapture techniques in the summer of 1987, at El Hammam, Matrouh governorate. In one experiment, 739 specimens (472 *P. papatasi* and 267 *P. langeroni*) were marked with fluorescent powders and released in 5 batches at one point. In a 2nd experiment, 1,524 specimens (571 *P. papatasi* and 953 *P. langeroni*) were marked and released in 6 batches at the same point. In the 1st exp., 116 (15.7 %) marked sand-flies were recaptured 1-9 nights after release. In the 2nd exp., 218 (14.3 %) marked sand-flies were recaptured 1-13 nights after release. All recaptured flies were examined by UV lamp. Male sand-flies stayed near

the release point and were not captured at distances > 600 m in the 1st exp., but in the 2nd exp., they travelled a longer distance > 1,400 m. This was also true for blood fed females which generally remained within 400 m for the first three nights then dispersed to distance of 600 m in the 1st exp. and > 1,400 m in the 2nd exp. Unfed females quickly moved away from the release point, sometimes to distances of 900 m or more in the 1st exp. and 1,500 m in the 2nd exp. Sandfly movement was affected by wind velocity, wind direction and presence of hosts. The dispersal of *Phlebotomus* sandflies confirms that leishmaniasis can be dispersed readily by the movement of the vector.

RÉSUMÉ : La dispersion de *Phlebotomus papatasi* (Scopoli) et *P. langeroni* Nitzulescu à El Hammam, Province de Matrouh, Égypte.

La dispersion de *Phlebotomus papatasi* (Scopoli) et *P. langeroni* Nitzulescu a été étudiée avec les techniques de marquage-relâchage-recapture pendant l'été 1987, à El Hammam, Province de Matrouh, Égypte. Dans une expérience, 739 spécimens (472 *P. papatasi* et 267 *P. langeroni*) ont été marqués avec des poudres fluorescentes et relâchés en 5 lots en un endroit. Dans une seconde expérience, 1 524 spécimens (571 *P. papatasi* et 953 *P. langeroni*) ont été marqués et relâchés en 6 lots au même point. Dans la première expérience, 116 phlébotomes marqués (15,7 %) ont été recapturés 1 à 9 nuits après leur relâchage. Dans la seconde expérience, 218 phlébotomes marqués (14,3 %) ont été recapturés 1 à 13 nuits après leur relâchage. Tous les phlébotomes ont été exa-

minés à la lampe à ultra-violets. Les mâles sont restés près du point de relâchage; ils n'ont pas dépassé 600 m dans la première expérience et 1 200 m dans la seconde. Il en est de même pour les femelles gorgées qui, en général, sont restées à 400 m pendant les trois premières nuits, puis se sont dispersées à 600 m dans la première expérience et plus de 1 400 m dans la seconde. Les femelles à jeun se dispersent rapidement à partir du point de relâchage, parfois jusqu'à 900 m et plus dans la première expérience et 1 500 m dans la seconde. La mobilité des phlébotomes est influencée par la force du vent, sa direction et la présence des hôtes. La dispersion des phlébotomes confirme que l'expansion de la leishmaniose est favorisée par la mobilité du vecteur.

INTRODUCTION

Since the appearance of infantile Kala-azar in 1982, at El Agamy, Alexandria Governorate (Tewfik *et al.*, 1983), entomological field studies were conducted to incriminate sandfly species responsible for *Leishmania* transmission

(Beier *et al.*, 1986 *a* and *b* and El Said *et al.*, 1986). Initial survey, following detection of the 1st human visceral leishmaniasis (VL) case, reported the existence of two sandfly species *Phlebotomus papatasi* and *P. langeroni* (El Sawaf *et al.*, 1984). *Phlebotomus papatasi* is the vector of cutaneous leishmaniasis (CL) in Egypt (Khalil, 1934 and Cahill *et al.*, 1966) and *P. langeroni* was considered to be the probable vector of VL based on its taxonomic position in the subgenus *Larroussi*, its behaviour in the field, its association with man and dogs (El Sawaf *et al.*, 1989) and its experimental susceptibility to *L. donovani* (Beier *et al.*, 1986 *b*).

The present study was conducted to determine the dispersal of both *P. papatasi* and *P. langeroni* by the use of mark-release-recapture techniques, at El Hammam town, Matrouh governorate. This may help to estimate the lon-

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1. This study was supported by Research contract No. 1 Al 22667/NIH-NIAID, between Research and Training Center on Vectors of Diseases, Ain Shams University, and the National Institute of Allergy and Infectious Diseases (NIAID), USA.

Accepted le : 13 mars 1991.

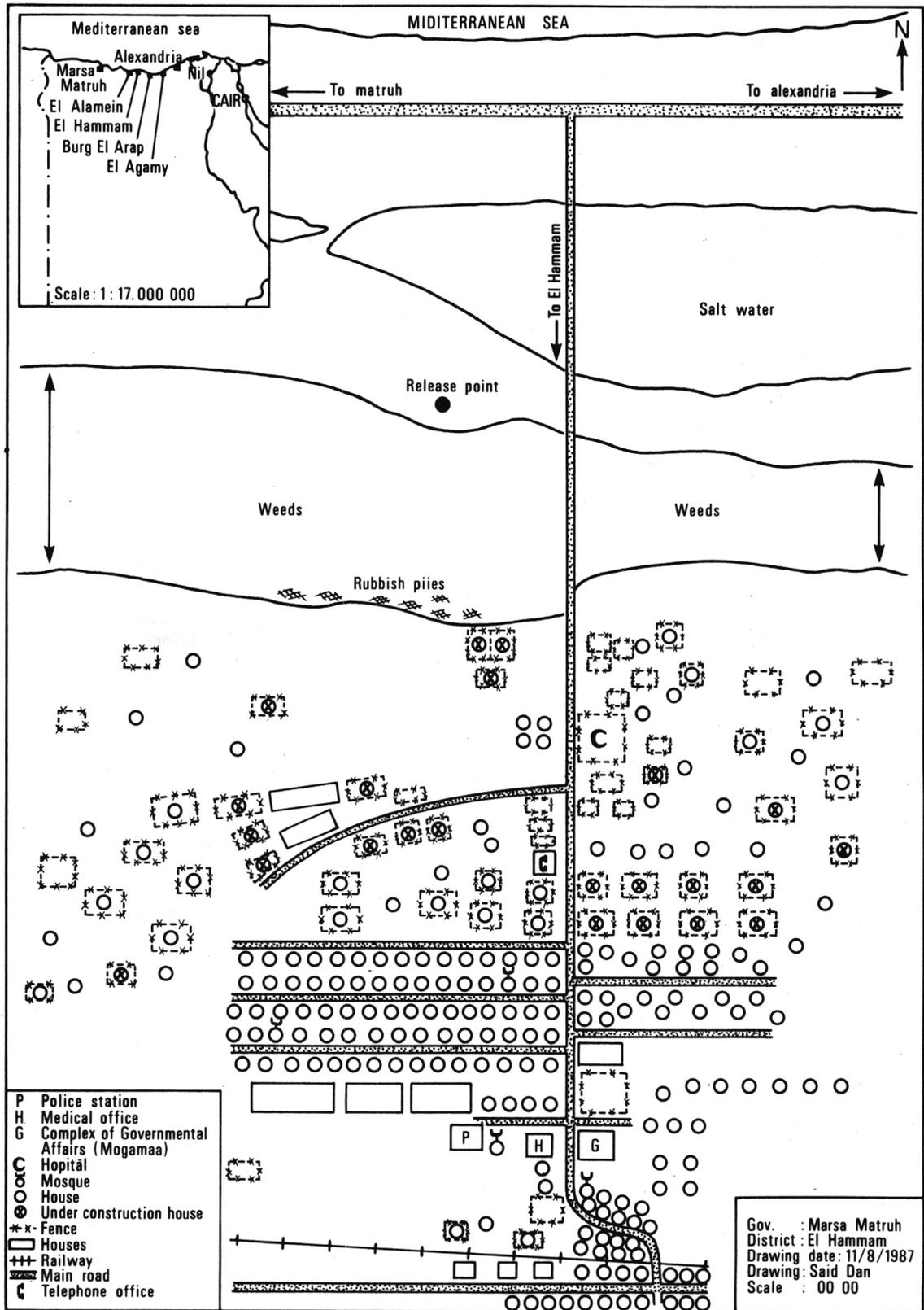


FIG. 1. — Map showing the locality of El Hammam and the release point.

gest distance travelled by each species during its flight, as a factor affecting the spread of CL or VL in any endemic area. Estimation of such distance will determine the total area around the inhabitants that should be covered by insecticides for controlling sandflies.

MATERIALS AND METHODS

DESCRIPTION OF EL HAMMAM TOWN

El Hammam is 55 km west of El Agamy on the Mediterranean coast. Most of the houses are built with white limestone. Some houses have gardens, poultry sheds or pigeon towers. No cultivation is present, but sheep, cows, camels and donkeys are raised. Dogs, cats and wild rodents are common around houses.

TIME AND PLACE OF RELEASE

Two field experiments were undertaken in August and September, 1987. This period coincided with the population peak of *P. papatasi* and *P. langeroni* at El Agamy (Beier *et al.*, 1986 *a*). The release point was plain area 1,100 m North from the housing area (Fig. 1) and covered with desert plants (*Salicornia fruticosa*).

The two releases and the captures were done in El Hammam town; this is because: 1) *P. papatasi* and *P. langeroni* have been recorded inside and outside houses (Doha, 1986, 2) and there was a wide plain area without any barriers for sand-fly dispersal towards the housing.

DESCRIPTION OF FIXED CAPTURE STATIONS

a — THE 1ST EXPERIMENT STATIONS

As shown in Figure 2a, all capture stations (CS) were fixed down wind and the sticky paper traps (SPT) were distributed in a half circle around the release point (RP). The distances between the station and the RP varied from 100 m to 1,200 m. Stations (1 to 4) were fixed inside a weedy area which contained rodent burrows, bird nests and reptile burrows. Station No. 5, at the end of the plantation area contained rubbish piles and rodent burrows; and the SPT were set up randomly at about 850-900 m from the RP. Stations No. 6, 7 and 8 were fixed at the beginning and inside the housing area where rodent burrows existed.

b — THE 2ND EXPERIMENT STATIONS

As shown in Figure 2b, all CS were fixed down wind except station No. 1, a, b and c which were fixed up towards the wind. All CS were in the same area as in the 1st exp. except CS 8 to 11 were inside the housing area. Each CS had a fixed number of SPT (75) set up every day before sunset and collected in the next morning at sunrise during the period August 25 to September 6, 1987.

MARK-RELEASE-RECAPTURE TECHNIQUE

Laboratory colonies of both *P. papatasi* and *P. langeroni* originated from El Agamy area, were taken to the field as pupae in covered clay pots. Sand-flies to be marked were released daily from the clay pots, in two cages (60 × 60 × 60 cm), one cage for each species. The flies age ranged from 1 to 4 days. A piece of cotton saturated with water was placed in each cage to provide humidity. Two other pieces of cotton saturated with sugar solution were provided to the flies of the 2nd experiment. A pigeon was introduced into each cage for 4 hours for feeding females. Flies of each species were then divided into three groups (males, unfed females and blood fed females). Each group was placed into a small cage (20 × 20 × 20 cm) and then marked with fluorescent powders. The powders were distributed by puffing air through small hand powder sprayers. The flow current of the fluorescent dust covered different parts of the fly body. Samples of flies were examined by UV lamp to ensure the marking. To differentiate between the mark-released fed and unfed flies in the experiments, four different colours of the fluorescent powder were used (green, pink, blue and silver), each in a separate small cage to avoid contamination. Marked flies were left to settle for 2 to 3 hours. For release, cages were taken to the RP at sunset and then opened to allow the flies to escape. Open cages were left at the RP till the next morning. Recapture of marked flies started out on the first night after release and continued during the rest of the study period by the use of sticky traps, aspiration inside houses and CDC light traps. Collections of marked flies were conducted daily between the hours 0700 pm and 0930 am. All flies were examined, sexed and identified to species.

Wind velocity was recorded, during the 2nd exp. only, from the night of 25th August to the 6th of September, using a cup anemometer.

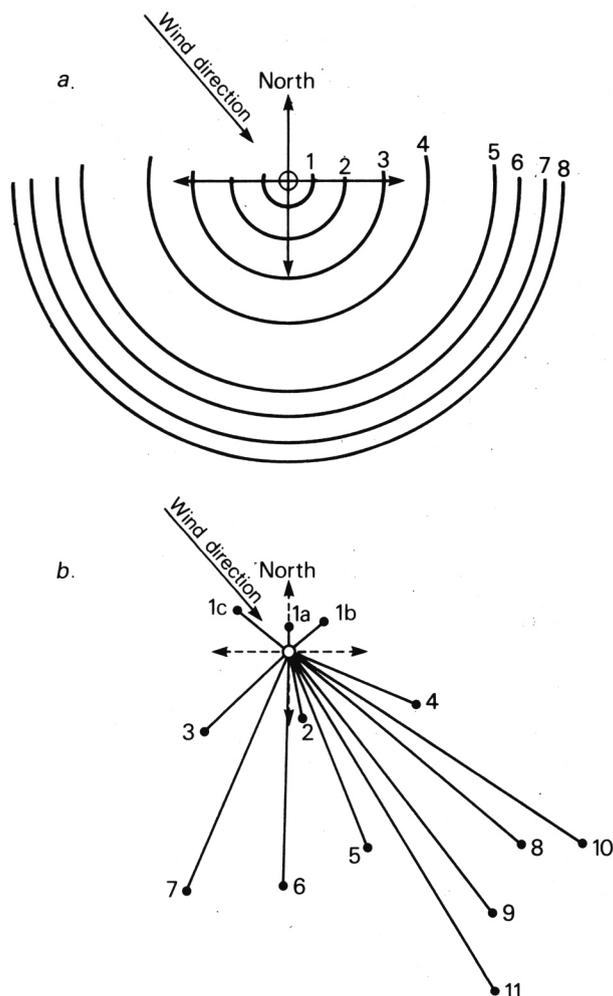


FIG. 2. — Sketching map showing the release point and the fixed capture stations. a) For the 1st experiment. b) For the 2nd experiment.

RESULTS

I — EXPERIMENT 1

One hundred and sixteen individuals (15.7 %) out of 737 *P. papatasi* and *P. langeroni* which were marked and released from 5 batches on the night of August 14th, 1987, were recovered within 11 nights after release. The proportions of recaptured flies ranged from 11.5 % to 22.4 % (Table I). The movements of recaptured flies during the first 9 nights are summarized in Table II. No flies were caught during the last 2 nights.

The recaptures of marked *P. papatasi* showed that, out of 25 marked males, 12 (48 %) were recaptured at a distance of 250 m from the RP within 1 to 3 nights after release and the longest distance (850-900 m) was recorded by only one male. Out of 33 marked unfed females, the highest number, 19 (57.6 %) was caught at a distance of

850-900 m from the RP within 3 to 6 nights after release and this was the longest recorded distance. Of the 33 released unfed females, 24 were caught unfed during 1-5 nights after release, 8 were caught blood fed during 1-6 nights and one was recaptured half gravid in the 6th night. Out of 15 marked blood fed females, the highest number, 6 (40 %), was recaptured at a distance of 600 m within 4-6 nights after release and this was the longest recorded distance. On both the 5th and 6th nights after release, one female was recaptured as half gravid with small bite of fresh blood.

The recaptures of marked *P. langeroni* showed that, out of the 18 marked males, the highest number, 9 (50 %), was recaptured at a distance of 250 m during the first two nights and the longest distance (600 m) was recorded by two males, one on the 5th night and the other on the 7th night after release. Of the 25 marked unfed females, the highest number, 9 (36 %), was collected at a distance of 400 m

TABLE I. — Composition and recapture of marked *P. papatasi* and *P. langeroni* released in El Hammam, Matrouh Governorate, during 14 to 25 August 1987 (recapture during 1-9 nights after release).

Number of batch	Composition of batch	Colours of marks under UV light	Number of flies marked and released	Number (%) of recaptured flies
1	<i>P. papatasi</i> males	Green	218	25 (11.5)
2	<i>P. papatasi</i> unfed females	Green	187	33 (17.6)
3	<i>P. papatasi</i> blood fed females	Pink	67	15 (22.4)
4	<i>P. langeroni</i> males	Pink	155	18 (11.6)
5	<i>P. langeroni</i> unfed females	Pink	112	25 (22.3)
Total			739	116 (15.7)

TABLE II. — Numbers of marked sandflies recaptured at 8 capture stations (CS) of varying distances (m) and released on August 14th 1987.

Composition of marked sand-flies	Numbers of recaptured marked sandflies in the CS and (range of nights after release)								Total
	1 100 m	2 250 m	3 400 m	4 600 m	5 850 to 900 m	6 1 000 m	7 1 100 m	8 1 200 m	
<i>P. papatasi</i>									
Males	7 (1-2)	12 (1-3)	3 (1-4)	2 (5-8)	1 (9)	—	—	—	25 (1-9)
Unfed females	2 (1-2)	4 (1-2)	6 (1-2)	2 (4-5)	19 (3-6)	—	—	—	33 (1-6)
Blood fed females	4 (1-2)	4 (1-2)	1 (3)	6 (4-6)	—	—	—	—	15 (1-6)
<i>P. langeroni</i>									
Males	5 (1-2)	9 (1-2)	2 (3-4)	2 (5-7)	—	—	—	—	18 (1-7)
Unfed females	—	3 (1-2)	9 (1-3)	5 (3-5)	7 (4-9)	1 (4)	—	—	25 (1-9)

from the RP during 1-3 nights after release and the longest distance (100 m) from the RP was recorded by one female caught on the 4th night. Of the 25 marked unfed females, 14 were recaptured as freshly blood fed (1-5 nights), one was caught as late stage fed on the 6th night and one was recaptured as gravid on the 9th night.

II — EXPERIMENT 2

Two hundred and eighteen individuals (14.3 %) out of 1,524 *P. papatasi* and *P. langeroni*, which were marked and

released from 6 batches in the night of August 25th 1987, were recovered within 13 nights after release. The proportions of captured flies of each batch ranged from 7.8 % to 21.9 % (Table III). The majority of the flies were fed on saturated sugar solution before being released. Movements of captured flies during 13 days versus stations/meter were recorded in Table IV.

The recaptures of marked *P. papatasi* showed that, out of the 28 recaptured males, the highest number, 7 (25 %) was recovered at a distance of 900 m (3-10 nights after release) ; and the same number at a distance of 1,400 m

TABLE III. — Composition and recapture of marked *P. papatasi* and *P. langeroni* released in El Hammam, Matrouh Governorate, during 25 August to 7 September 1987 (recaptured 1-13 nights after release).

Number of batch	Composition of batch	Colours of marks under UV light	Number of flies marked and released	Number (%) of recaptured flies
1	<i>P. papatasi</i> males	Blue	189	28 (14.8)
2	<i>P. papatasi</i> empty females	Blue	217	24 * (11.1)
3	<i>P. papatasi</i> blood fed females	Silver	165	21 (12.7)
4	<i>P. langeroni</i> males	Silver	290	43 ** (14.8)
5	<i>P. langeroni</i> empty females	Silver	356	78 *** (21.9)
6	<i>P. langeroni</i> blood fed females	Blue	307	24 (-7.8)
Total			1 524 ¹	218 (7.8)

1. Most of these flies were fed on sugar before release.

* Two flies were captured inside houses.

** Three flies were captured inside houses.

*** Five flies were captured inside houses.

TABLEAU IV. — Numbers of marked sandflies recaptured at 13 capture stations (CS) of varying distances (m) and released on August 25th 1987.

Composition of marked sand-flies	Number of recaptured marked sandflies in the CS and (range of nights after release)											Total
	1a * 100 m	2 350 m	3 500 m	4 600 m	5 900 m	6 1 000 m	7 1 100 m	8 1 300 m	9 1 400 m	10 1 500 m	11 1 600 m	
<i>P. papatasi</i>												
Males	1 (5)	3 (1-6)	2 (3-4)	2 (3-5)	7 (3-10)	3 (3-9)	—	3 (5-10)	7 (4-8)	—	—	28 (1-10)
Unfed females	1 (1)	1 (3)	1 (2)	1 (5)	5 (5-12)	3 (8-11)	1 (4)	5 (2-12)	3 (4-9)	3 (10-12)	—	24 (1-12)
Blood fed females	1 (1)	2 (3-5)	2 (2-4)	3 (9-13)	4 (5-13)	5 (3-11)	2 (3-9)	—	2 (5-12)	—	—	21 (1-13)
<i>P. langeroni</i>												
Males	—	2 (5)	2 (3-4)	1 (3)	5 (5-12)	11 (2-11)	4 (2-5)	11 (2-11)	3 (6-8)	4 (10-11)	—	43 (1-12)
Unfed females	—	2 (1-2)	2 (1-2)	4 (2-13)	12 (2-13)	16 (5-13)	4 (2-10)	17 (2-12)	10 (5-13)	11 (10-13)	—	78 (1-13)
Blood fed females	1 (9)	2 (3-5)	2 (2-4)	1 (10)	4 (3-9)	6 (3-10)	1 (2)	3 (9-11)	3 (5-13)	1 (12)	—	24 (1-13)

* Stations 1b and c are omitted from the table.

from the RP. This was the longest recorded travelling distance for males. Out of 24 recaptured marked unfed females, 5 (20.8 %) were caught at 900 m (5-12 nights) and 1,300 m (2-12 nights). The longest distance (1,500 m) was recorded by 3 females in a period of 10-12 nights after release. Of the 24 marked unfed females; 6 were caught empty (1-11 nights); 4 were fresh blood fed (2-10 nights); 4 were half gravid (8-12 nights) and two were gravid (8-12 nights). From 21 marked blood fed females, the highest number 5 (23,8 %) was collected at a distance of 1,000 m in a period of 3-11 nights and the longest travelling distance (1,400 m) was recorded by two females on the 5th and 12th nights after release. Of the 21 recaptured marked blood fed females, 7 were caught unfed after a period of 7-13 nights, 3 were fresh blood fed (9-11 nights), 2 late stage fed (1-2 nights), 6 half gravid (3-13 nights) and 3 were gravid on the 5th night after release.

The recaptures of marked *P. langeroni* showed that from 43 marked males, the highest number, 11 (25.6 %) was caught at a distance of 1,000 and 1,300 m within 2-11 nights and the longest distance (1,500 m) was recorded by 4 males on the 10th and 11th night after release. Out of 78 marked unfed females, the highest number, 17 (21.8 %) was recaptured at a distance of 1,300 m (2-12 nights) and the longest in a period of 10-13 nights after release. Of the 78 females, 30 were caught as unfed in a period of 1-13 nights, 7 were fresh blood fed (2-11 nights); one was late stage on the 9th night, 13 were half gravid (5-12 nights) and 27 were gravid (7-13 nights). Of the 24 marked blood fed females, the highest number 6 (25 %) was caught at a distance of 1,000 m (3-10 nights) and the longest distance (1,500 m) was recorded by one female on the 12th night after release. Of the same 24 marked blood fed females, 12 were captured empty in a period of 8-13 nights, 3 were fresh blood fed on the 9th night, one late stage fed on the 2nd night, 5 half gravid (2-4 nights) and 3 were gravid on the 5th night after release.

III — INDOOR COLLECTION

Examination of the nearest house to the RP was done from the 1st to the 7th September; and sandflies were found in only two houses. On the 4th of September, 9 marked sandflies were captured inside a house at a distance of 1,500 m from the RP. These flies included one blood fed female *P. papatasi* which was released unfed, 3 males *P. langeroni*, one female blood fed and 4 half gravid females *P. langeroni* which were released unfed too. On the 5th of September only one female *P. papatasi* was recaptured half gravid in a house at a distance of 1,300 m, this female was released unfed. All marked sandflies recaptured inside houses were from the flies which were released on the night of 25 August (2nd exp.).

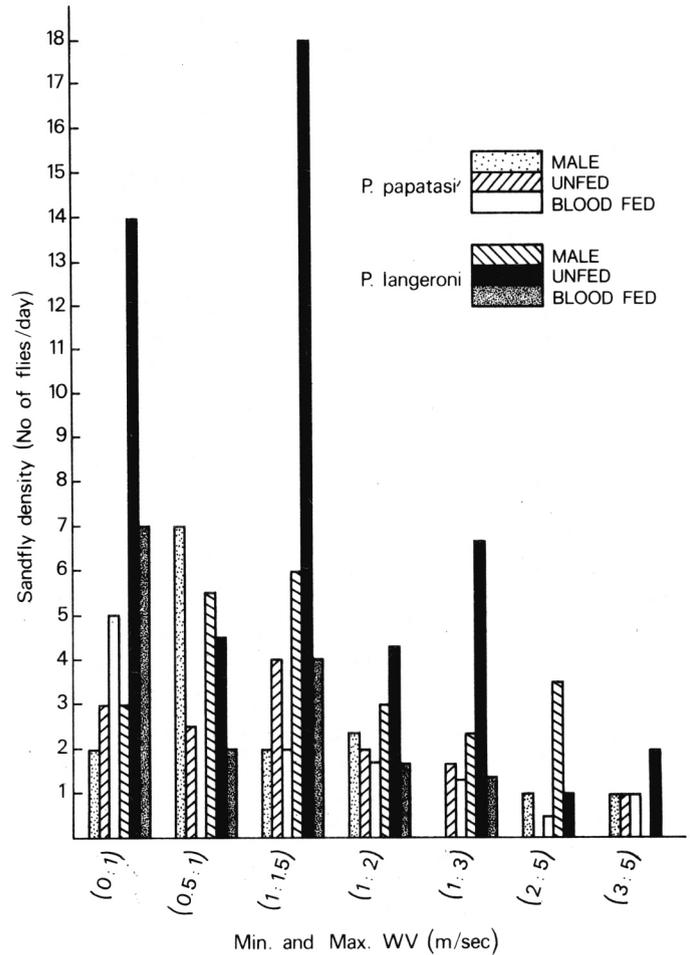


FIG. 3. — Histogram showing the influence of wind velocity on sandfly activity.

IV — THE INFLUENCE OF WIND VELOCITY ON SAND-FLY ACTIVITY

The activity of sandflies, especially males and blood fed females, was less and considerably decreased when the wind velocity (WV) was more than 2 m/sec (Fig. 3) based on the total number of collected flies, the optimal WV for the activity varied from 0 to 1 m/sec for *P. papatasi* and varied from 1 to 1.5 m/sec for *P. langeroni*.

However, 3 flies were recaptured (one ♂ + one ♀ unfed *P. papatasi* and one ♀ blood fed of *P. langeroni*) at a distance of 100 m against the wind direction.

DISCUSSION

Earlier series of mark-recapture experiments on sandflies have concentrated on Old World species in arid or semi-arid environments, where different species of sand-flies were recovered at varying distances from the release point

(Hoogstraal and Hyneman, 1969; Rioux *et al.*, 1979 and Killick-Kendrick *et al.*, 1984). However, the physiological status of the released and recaptured flies was not largely investigated. The results of the present work, illustrate the tendency of unfed laboratory reared males of *P. papatasi* and *P. langeroni* to remain near the release point by a distance of 250 m. Although a maximum travelling distance of 900 and 600 m, were respectively recorded by one male *P. papatasi* and two males of *P. langeroni*. This distance increased to reach ~ 1,400 m when the males were provided with a sugar-meal before release. The travelling distance, recorded for males of both species was longer than that recorded for *P. ariasi* in southern France (Killick-Kendrick *et al.*, 1984) this is largely attributed to the younger age of the flies (1-4 days) used in this investigation and/or to species differences.

Unfed females of *P. papatasi* and *P. langeroni* were mainly recaptured at distances of ~ 900 m and 400 m respectively. However, a travelling distance of 1,000 m was recorded by one female *P. langeroni*. This distance increased to reach 1,500 m when the females were provided with sugar-meal.

Most females released engorged remained near the release point (~ 250 m) for the first three nights until they complete blood digestion, and then, they disperse seeking oviposition site and a second bloodmeal. The travelling distance of these females increased from 600 m to reach more than 1,400 m with the provision of sugar before release. The importance of sugar on the sandfly activity was discussed by many authors, as a source of energy (*e. g.* Killick-Kendrick, 1978 and Shehata *et al.*, 1988).

Previous works on the dispersal of sandflies revealed travelling distances shorter than those recorded here, *e. g.* 300-730 m recorded by *P. orientalis* (Quate, 1964), 289 m for *P. longipes* (Foster, 1972). However, Killick-Kendrick *et al.* (1984) recaptured one female *P. ariasi* at 2,200 m from the release point and Strelkova and Kruglov (1985) recovered one female, *P. papatasi* at 4 km. These distances were considered uncommon.

The relatively long travelling distance (1,500 m) recorded here, for both species is probably due to the capability of newly emerged flies to sustain travelling in plain area to reach human dwellings, which are distant from the release point by CA. 1,100 m. Further, travelling distances, might have been achieved by field populations of *P. papatasi* and *P. langeroni* an assumption that, could be experimentally investigated.

The recovery of half gravid females of *P. papatasi* and *P. langeroni* with a small bite of fresh blood, together, with an old bloodmeal, demonstrates gonotrophic discordance of both species (Schmidt, 1965 and El Said *et al.*, 1986) and explains multiple-host feeding (Javadian *et al.*, 1977; Dhanda and Gill, 1982 and El Sawaf *et al.*, 1989).

It is worth mentioning, that no marked flies were recap-

tured after 13 nights of the release where, normally most of the laboratory bred sandflies die directly after oviposition, a phenomenon well known to all workers in the field of sandfly colonization.

Observations on the direction and velocity of nocturnal wind suggested that, the maximum travelling distances of *P. papatasi* and *P. langeroni* had not been mainly assisted by wind. Since, few flies were recaptured at WV 3 m/sec and more flies were recovered at WV 1.5 m/sec. In spite, of these observations, it cannot be said that, sandflies are never carried by wind (Killick-Kendrick, 1984).

Since, leishmaniasis may be spread between reservoir hosts or from a reservoir host to man by the movement of female sandflies (Foster, 1972; Rioux *et al.*, 1979). The maximum distance of displacement of *P. papatasi* and *P. langeroni* was about 1,500 m. This travelling distance must be taken into consideration in vector control program at any focus of leishmaniasis in Egypt by estimating the total area around human settlements, that should be covered by insecticide.

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Analyse.

J. EUZEBY. **Protozoologie médicale comparée**, Vol. III, fascicule 2 « *Piroplasmés (fin)* ». *Leucocytozoïdes — Garniidés*. Fondation Mérieux édit., Lyon, 1990. 338 p., 98 fig.

Le présent ouvrage, second fascicule du 3^e tome de « Protozoologie médicale et comparée », constitue l'élément final du traité entrepris. Fin de la 5^e partie de celui-ci, il est consacré aux Hémoporiidés et comprend 4 divisions principales :

- 1 — Étude spéciale des Babésioses (section III)
- 2 — Theilériidés et Theilériidoses (section III)
- 3 — Leucocytozoïdés et Leucocytozoïdoses (section IV)
- 4 — Garniidés (section V)

Ces 4 grands chapitres sont de développement inégal, les deux premiers étant des composantes majeures.

Le premier (146 p.) traite des Babésioses des différentes espèces animales, l'étude générale figurant dans le fascicule précédent. L'auteur offre une présentation détaillée, conçue selon le plan classique adopté jusqu'alors, des Piroplasmoses s.s. des ruminants domestiques, du porc, des équidés, du chien et de l'Homme. De plus, les Babésioses des ruminants sauvages, des félidés, des singes... ainsi que des oiseaux, sont mentionnées. Une part non négligeable (10 p.) est attribuée aux rongeurs, en raison du modèle d'études constitué par ceux-ci.

Le deuxième chapitre (169 p.), consacré aux Theilériidés et Theilériidoses, comporte une étude générale de celle-ci, puis les aspects particuliers aux diverses espèces animales, notamment bovins, autres

ruminants, équidés, rongeurs et Homme. A noter, en ce qui concerne les équidés, que les deux entités regroupées sous le vocable de piroplasmose s. l. et considérées naguère toutes deux comme des babésioses, sont distantes de quelques 200 pages. Cela est dû au respect, par l'auteur, de considérations de systématique, séparant nettement *Babesia caballi* de *Theileria equi*.

La fin de l'ouvrage est consacrée aux Leucocytozoïdés, parasites d'oiseaux, (3^e chapitre, 28 p.), et les toutes dernières pages (4^e chapitre) traitent de parasites de Sauriens, rattachés, par leur morphologie et leur cycle évolutif, aux Garniidés.

Tout comme les précédents, ce dernier ouvrage est rédigé avec beaucoup de clarté et traduit le souci permanent de l'auteur d'être aussi complet que possible. Pour harmoniser le volume de pages des différents fascicules, l'auteur a été conduit à pratiquer une césure au sein des Babésioses, l'étude générale de celle-ci n'étant pas présentée dans le même fascicule que l'étude spéciale. On peut le regretter, mais il n'en résulte pas à proprement parler une gêne importante pour le lecteur car de nombreux renvois de pages facilitent les reports.

On ne peut qu'être admiratif devant la réalisation, par le Professeur J. Euzéby, en moins de quatre ans, d'un traité complet de protozoologie. Celui-ci collationne un grand nombre d'informations éparses jusqu'alors dans la littérature, les rend facilement accessibles, et les rassemble dans un ouvrage, comme il n'en était point paru en langue française depuis près d'un siècle.

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