Tropical Biomedicine 22(1): 53–61 (2005)

Determination of the flight range and dispersal of the house fly, *Musca domestica* (L.) using mark release recapture technique

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Abstract. In order to control any pest it is essential to study the life cycle, biology and bionomics of the target pest under control. With this respect, we have studied the flight range of the house fly *Musca domestica* (L.). The flight range of the house fly from two sites i.e, the poultry farm and a stable farm has been studied. The flight range study was conducted using a mark release technique. The approach we used in this study was that the flies collected from the respective farms were marked and released at different distances from the farms. The flies were then re-captured from the poultry farm and the stable farm. Studies conducted elsewhere use the technique of releasing the insect species at one spot and recapturing the insect species with the help of baited traps placed at various locations from the release point. The advantage of the approach used in this study was that the flight range as well as the homing effect was determined. From this study, the flight range of house flies released at the poultry farm was 7 km whereas flight range for flies release from stable farm was 5 km. The recovery rate of house flies at the poultry and stable farm was 0.05% and 0.016%, In this study, marked specimens has been detected up to 8 days in field conditions indicating that under field condition the life expectancy could be in the range of 1-2 weeks.

INTRODUCTION

Studies pertaining to the life history, ecology and bionomics of vector species are important as basic tools to any effective methods of control and, for which flight range and life-span both have an important bearing (Stage *et al.*, 1937). In view of the epidemiological importance of disease transmission and basic biology, Mutinga *et al.* (1992) and Hagler *et al.* (2001) stated that mark-release-recapture studies provided an understanding of the behavior, their basic biology, demography and ethology and patterns of disease transmission in vectors and therefore necessitate the mounting of appropriate control measures in endemic areas. Animal marking dates back to 218 B.C., and insect marking for scientific study began around 1920 (Dudley & Searles, 1923; Geiger *et al.*, 1919). Marking procedures have been described into two broad categories that is, mark-release-recapture and mark capture (Reynolds *et al.*, 1997). In the mark - release recapture studies the insects are collected from the field or laboratory and then marked and released into the designated area. The population of both the marked and unmarked individuals are sampled at given time and distance intervals after their release. In the mark - capture studies the insects mark themselves by contacting marking materials.

The house fly, *Musca domestica* has long been considered a potential agent for disease transmission ever since its existence. Flight range of this pest has previously been studied (Saccà, 1964, WHO, 1986, Womedorf & Peck, 1975). The house fly *M. domestica* is a serious nuisance pest in Malaysia. Its nuisance role is obvious especially in the North-South highway restaurants in Peninsular Malaysia. There are also poultry farming activities in the village areas (parallel) cutting across the highways. In Malaysia wayback in 1962, Wharton *et al.* had recovered marked specimens up to 7.5 km from sites of release but had also noticed the flies having 'hitched a ride' on vegetable lorries stopping and travelling between the points of release and recapture. Hence, the present study was conducted to investigate the flight range of the house fly, *M. domestica* in an isolated location.

MATERIALS AND METHODS

The study was conducted in an isolated poultry and stable farm, in Kalumpang, Hulu Selangor, 63 km north from Kuala Lumpur and the horse racing club viz Selangor Turff Club located in Sungei Besi, Selangor, 30 km south from Kuala Lumpur, respectively. The poultry farm covers an area of 120 acres while the Selangor Turff Club covers an area of 265 acres.

Collection and Fly Estimate

Laboratory reared flies were aspirated with a battery operated aspirator and released into a 12" x 12" x 12" fly cage. Each aspirator load was counted and released into the cage until all facets of the cage were densely covered with resting flies. The density of landed flies for the cage were counted and estimated to be approximately 2,000 in numbers. This criterion was then used to estimate field caught densities as it was not feasible to count the exact numbers of flies in the poultry farm to be released. Flies for marking were caught by means of sweep net and released in batches into 12" x 12" x 12" fly cages until all lateral and top sides of each cage was covered with flies. The total landed flies per cage was hence approximately 2,000 flies. Ten such cages with a total of approximately 20,000 flies were then marked at each release site for poultry farm fly release and 5,000 flies were also marked and released at each site for stable farm. All collection and marking of flies were conducted in the morning.

Marking Techniques

Poultry and stable farm caught flies were brought immediately to the respective sites of release starting at 1 km distance. The release point in this study for flies collected from poultry farm was 1, 2, 3, 5, 7, 9, 11 and 13 km in distance. On the other hand, release point for stable farm was 1, 2, 3, 5 and 7 km. The field collected flies were marked by inserting an insufflator through the netting cage and blowing dust directly into the cages of flies (Howard *et al.*, 1989). A large polyethylene bag was used in the process to ensure close contact with dust. Cages were left enclosed until all ten cages were dusted. They were then uncovered and flies released in the order they were marked. They were marked with different colors according to the distance of release. Earlier study had shown that fluorescent dust did not affect the survival rate (Chiang *et al.*, 1991).

Marked-Release Sites

The common approach used by researchers (Chiang *et al.*, 1991, Howard *et al.*, 1989; Smith & Wall, 1998) was to set trap and different distances and trap the marked insects (Figure 1). The approach in this study was to release marked flies at different distances and catch the flies from one spot that is the poultry or the stable farm (Figure 2).

Releasing of flies caught from poultry farm was carried out along the paved road. There were 8 respective sites within the range of 1 to 13 km distances. The distances were indicated from the speedometer reading of a car moving along

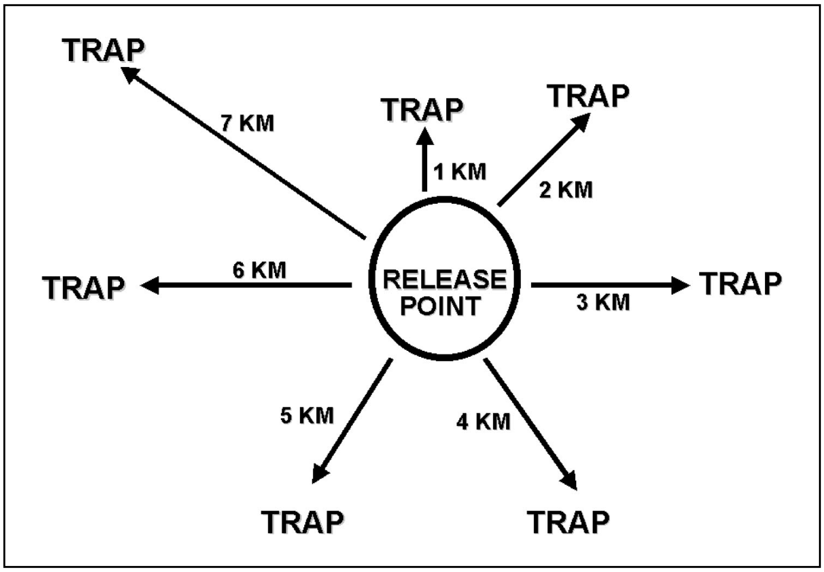

Figure 1. Schematic diagram describing the mark, release and recapture of insects normally employed for flight range studies elsewhere.

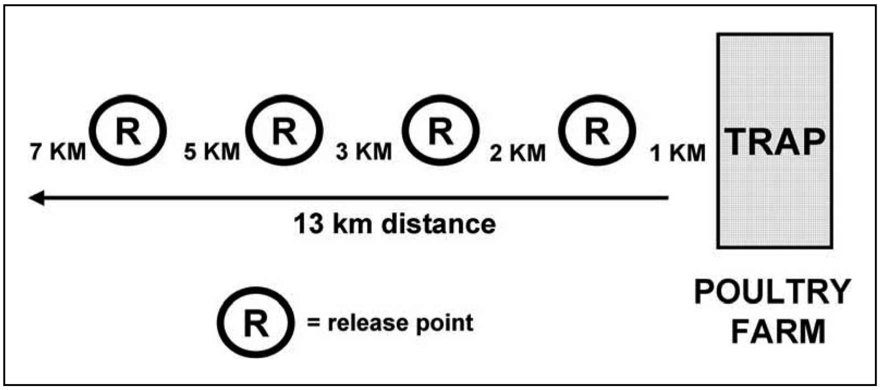

Figure 2. Schematic diagram describing the mark, release and recapture of house fly study design employed in the flight range study in poultry and stable farm.

the highway from the poultry farm as well as the stable farm. A Geographical Positioning System (GPS) gadget was also used to determine the precise radius of the flight range (Figure 3).

The 1 km distance (Release Site 1) was characterized by dense secondary vegetation of shrubbery and grassy under-story with trees of 10 to 15 meters tall. This part of the road runs alongside an oil palm plantation bordering to the south of poultry farm. The shady vegetation provides much shelter for the marked flies, which tend to settle on leaves, vines and the green floor immediately after release. The 2 km distance (Release Site 2) was located further along the oil palm plantation, which stretches several km away from the poultry farm. The 3 km distance (Release Site 3) was located at a high wooded area of rubber forest and not far from the oil palm plantations which was cleared and burnt clean. This made it a much open space for the flies to scatter

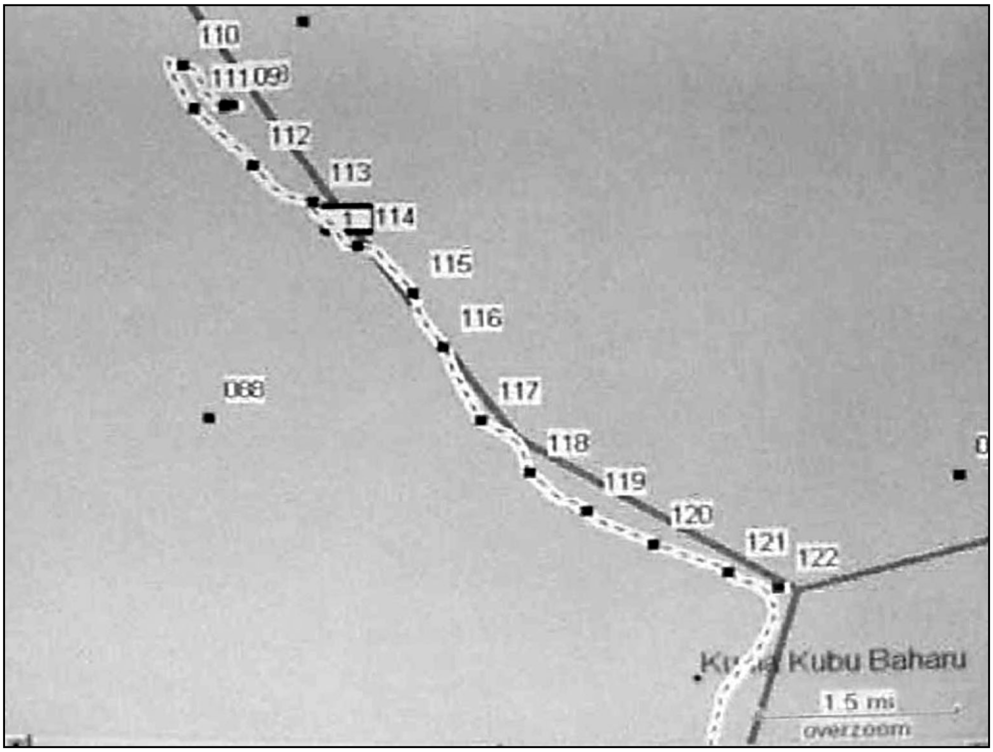

Figure 3. Flies released from varied distances as indicated by the vehicle speedometer.

out after release. The 5 km distance (Release Site 4) was also well vegetated on both sides of the road and is located near a clear cemetery yard. The dense green shrubbery growth provided much shelter for the marked flies. The 7, 9, and 11 km distances (Release sites 5, 6, and 7) were within Kerling and Kerling - Kuala Kubu town areas. The 13 km distance (Release Site 8) also the furthest was characterized by dense wooded rubber forest on both sides of the highway road.

Releasing of flies caught from stable farm was also carried out along the paved road. There were 6 respective sites within the range of 1 to 7 km distances. The 1 km, 2 km, 3 km and 4 km distance (Release Site 1, 2, 3 and 4) was characterized by an open field with dense secondary vegetation of shrubbery and grassland. The 4 km distance was very much closer to a 5 star hotel. The 5 km and 7 km distance was along the north - south highway which was highly urbanised with well vegetated road-side trees.

Recapture

Sampling at both the experimental locations began the following day after flies were released and continued for 10 days when no marked flies had been recovered for two consecutive sampling periods. A final sample was collected on day 15 after release to reconfirm detection of marked specimens. Field caught flies were brought to laboratory on each sampling day and total catch was estimated by the weight factor of a known number of individuals. This method was used due to the large numbers of flies involved making it impractical to count each and every fly. Flies were then examined for fluorescence under ultra violet light in a darkened room

RESULTS

A total number of about 160,000 and 25,000 house flies were marked and released at

Table 1. Mark release re-capture data obtained in poultry farm Kalumpang, Selangor for *Musca domestica*

Days	Total Number of flies released and re-captured									Total flies screened
	1km (Magenta)	2km (Green)	3km (Orange)	5km (Blue)	7km (Yellow)	9km (Magenta)	11km (Blue)	13km (Orange)		
0	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	160,000	–
1	0	2	0	0	0	0	0	0	2	67,000
2	0	3	0	0	1	0	0	0	4	114,000
3	3	6(3)	0	1	0	0	0	0	10	133,000
4	1	0	1	0	0	0	0	0	2	131,000
5	7	0	4	0	0	0	0	0	11	99,000
6	0	2	1	0	–	–	–	–	3	94,000
7	0	3	0	0	0	0	0	0	3	135,000
8	1	1	0	0	–	–	–	–	2	131,000
9	0	0	0	0	0	0	0	0	0	221,000
10	0	0	0	0	–	–	–	–	0	184,000
15	0	0	0	0	–	–	–	–	0	64,000
Total	12	20	6	1	1	0	0	0	40	1,373,000

Note:The number recaptured and released is indicated on day 0.
The dash signs (-) indicate that no sampling was conducted on those days.
The number in paranthesis (3) is a recaptured specimens 200 m away from release site
In stable farm 36,529 flies were screened
Only 4 flies were recaptured from 5km distance 5th day after release in stable farm

poultry farm and stable farm respectively. Despite the large numbers of flies released, the recapture rates were relatively low in both the farms. During the 11 days of sampling, 1.37 million *M. domestica* were captured at the poultry farm (Table 1) and 36,529 flies from the stable farm. Only 37 and 4 marked specimens were recaptured from the poultry farm and stable farm, respectively This gives a recovery rate of 0.023% from the poultry farm and 0.016% from the stable farm.

It is noted with interest that the single specimen recovered in the poultry farm from 7 km distance was recaptured within 48 hr and the house flies from the 1 km distance was re-captured after 72 hr. Five re-captures from 2 km distance occurred within 24 hr. The 2 km distance was closest to the farm and this is confirmed by the geographical positioning system (GPS). On the other hand in the stable farm the four re-captures from the 5 km distance occured within 96 hrs (4 days).

The release distances marked by GPS is shown in Figure 3 and Figure 4. Figure 3 shows the overall distance covered for the release points from 1 km to 13 km. Figure 4 shows a closer view of the initial marking and release of house flies from the site 1 km to 3 km. This was conducted to obtain the precise radius of the flight range of 2 km and 7 km if the flies had flown back to the poultry farm, not following the vehicle track. The marked point of 2 km is actually 0.48 km; and the 7 km distance is 4.2 km. Hence, the exact route the fly had used was not known, either the vehicle route or the track across the vegetation.

Of the re-captured flies, more than three quarters (78%) were recovered within 5 days after release. After 8th day marked specimens were no longer detected although sample collection continued up to 15th day in the poultry farm. This implies that the longevity of the marked flies is only about 1- 2 weeks under field conditions. In the stable farm only 4 marked flies were caught from the 5 km release point on day 5 after release throughout the study period of 10 days. There were no marked flies caught after then.

Table 2 shows cumulatively the number of house flies re-captured from various distances at the poultry farm and stable farm. In the poultry farm 32% were recaptured from 1km release point, 78% within 1- 2 km distance and 95% within 1-3 km distance. However, the mean

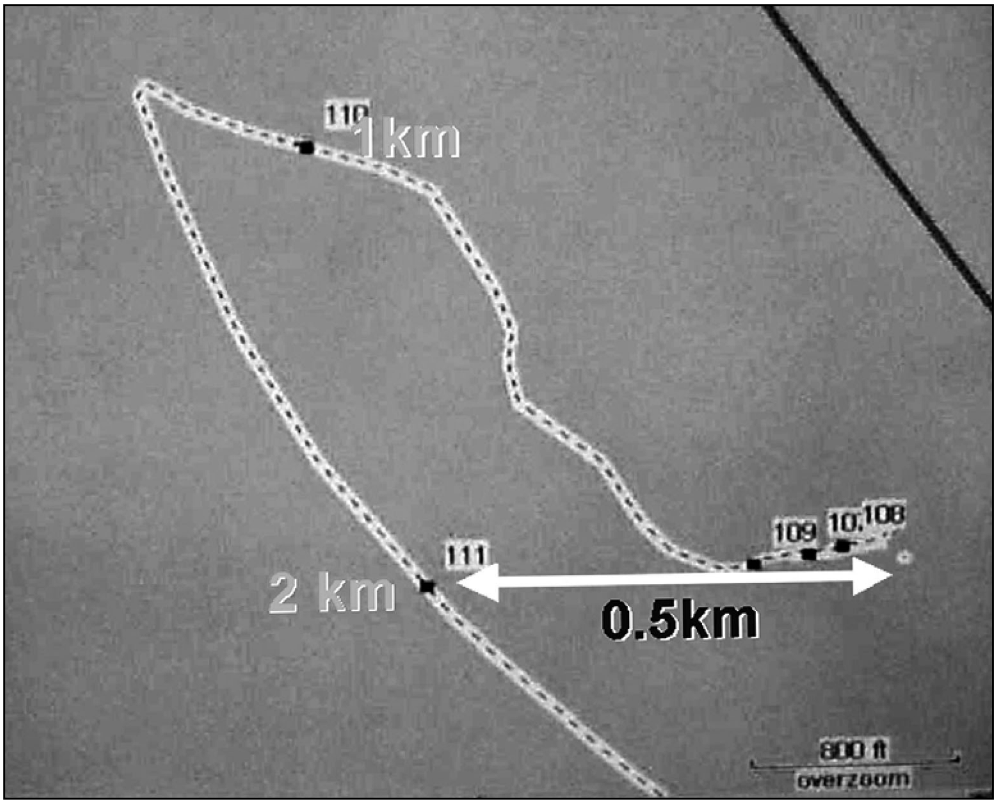

Figure 4. Diagram describing the 1 km and 2 km release points.

Table 2. Daily re-captures of marked *M. domestica* in relation to distance from the release point at the poultry farm and stable farm

Distance from Release point (km)	Number Recaptured in Poultry farm	Number Recaptured Stable farm
1	12	0
2	17	0
3	6	0
5	1	4
≤7	1	0

Mean dispersal distance $a = \frac{\Sigma r_i d_i}{\Sigma r_i}$

Where r_i = number recaptured at each site (i),

d_i = distance in kilometers from release point.

dispersal distance (a) estimated was 2.054 km (Table 2). The dispersal was calculated based on the formula used previously by Reisen & Aslamkhan (1979). In the stable farm all the 4 marked specimens were collected from the 5 km distance only.

The maximum flight range recorded from our study for flies from the poultry farm was 7 km. Figure 5 shows the regression of the number of re-captured houseflies on distances in the poultry farm. Daily recaptures of marked *M. domestica* transformed to ln (y + 1) and plotted as function of distance at release (r^2 = coefficient of determination).

The distribution of re-captures between the near (≤ 2 km) and far (≥3 km) distances is shown in Table 3 for the poultry farm. Using the non parametric test, Mann – Whitney test for 2 independent sample the results showed there is a significant difference of mean between the near and far flight range of the house flies (t=2.384, p =0.032). Of the total re-captures, 22 (59.46%) were recovered by 5th day after release for the near distance. Only 7 flies (18.92%) were recovered over the same period for the far distance. By 8th day 78.38% were recovered

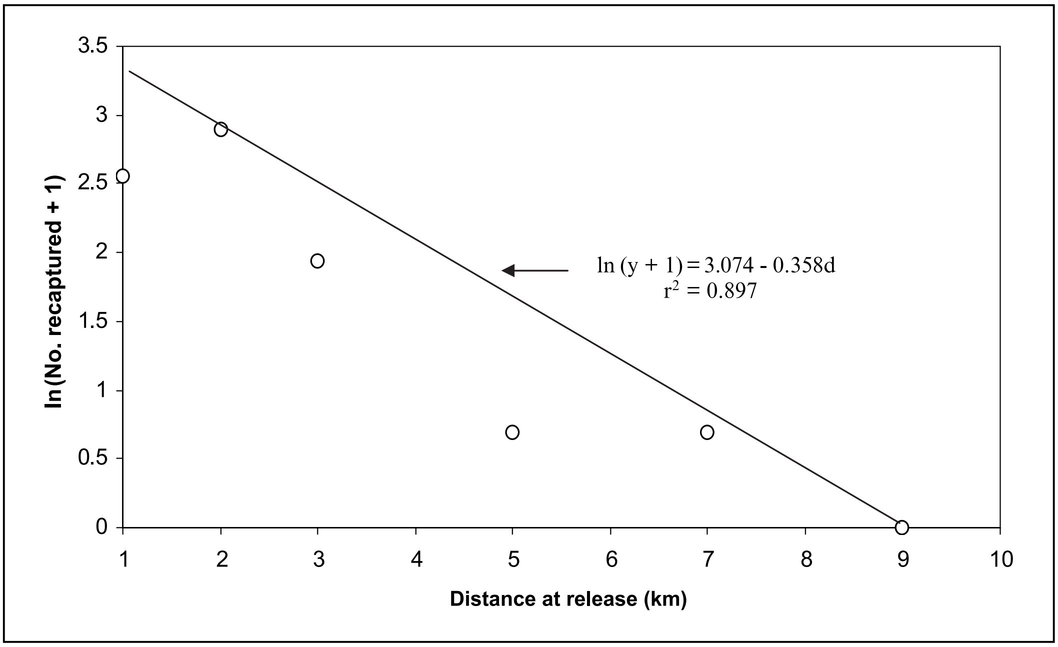

Figure 5. The relationship between the number of recaptured house flies and their distance of flight.

Table 3. Daily recaptures of marked *M. domestica* as defined by the near and far distances at release (near = 1 – 2 km, far = 3 – 7 km)

Days	Number of flies			
	1 - 2 km		3 - 7 km	
1	2		0	
2	3		1	
3	9		1	
4	1		1	
5	7	(22)	4	(7)
6	2		1	
7	3		0	
8	2	(7)	0	(1)

Note: *The broken line indicates daily recaptures by and after 5th day of sampling. Numbers in parenthesis are pooled data for recaptures according to distance and time factors.*

over the near distance while only 21.62% from the far distance.

DISCUSSION

Mark- release -recapture studies have been used to determine dispersal (Ginsberg, 1986), population density (Haramis & Foster, 1983) adult survivorship (Walker *et al.*, 1987) and to monitor the movement of disease vectors (Milby *et al.*, 1983).

Coloured fluorescent powder has been used in mark - release recapture studies on house fly (Wharton *et al.*, 1962). The maximum durability on laboratory held flies was 30 days (Pickens *et al.*, 1967; Lillie *et al.*, 1981). This marking technique proved successful in our study with 0.023% and 0.016% of marked flies re-captured from poultry farm in Kalumpang, Selangor and stable farm in Sg Besi, Selangor, respectively. In a previous study, a 0.3% re-capture rate was obtained in Cameron Highlands (Wharton *et al.*, 1962) and about 4.4% re-capture rate has been reported by Pickens *et al.* (1967). However, the low re-capture rate in our study was not unexpected due to the terrain which is secondary vegetation in the poultry farm site in Kalumpang, Selangor and the highly urbanised setting in the stable farm which is a Turf Club in Sg Besi, Selangor. It could also be due to the large area of coverage of 120 acres in the poultry farm and 265 acres in the stable farm. Passive dispersal by moving vehicles was documented in Cameron Highlands when it was noted that most of the recaptures at distance of 3.6 km from release point occurred in this manner (Wharton *et al.*, 1962).

Marked flies were not detected beyond 8 days after release in the poultry farm. On the other hand, marked specimens in the stable farm were only detected on the 4th day after release not because the fly dust was removed from the fly body as fluorescent dust was detected on flies up to 2 weeks under natural conditions in similar studies elsewhere (Pickens *et al.*, 1967).

Maximum flight distance estimates for house fly differed widely in varied regions: 32 km in California (Womendorf & Peck, 1975); and 20 km in studies elsewhere (WHO, 1986); and 7.5 km in 24 hr in the Cameron Highlands of Malaysia (Wharton *et al.*, 1962). Our investigations reaffirmed the Cameron Highlands record with a single marked specimen flying over 7.0 km within 2 days in the poultry farm.

The approach employed in our study (Figure 2) was slightly different from other studies (Figure 1) as mentioned above. From our study, the recovery of marked flies from natural populations might also indicate a homing effect in flies in poultry farm and stable farm.

Information available from this study might be helpful in assessing fly problem areas such as in poultry farms, dumping grounds, stable and cattle farms, food processing factories, fertilizer processing plants and in recreational areas in towns and cities. However, as stated by the report of Wharton *et al.* (1962) that although flies moved easily up to 2 km (with exception of a few instances) fly problems are usually localised and the source is very often within the immediate surroundings. In this regard, local authorities must not overlook the epidemiological significance of the house fly in disease transmission. For example, the construction of housing estates must be clear of the way from fly breeding sources such as poultry farms and dumping grounds. In the same respect, food and recreational facilities such as the popular highway food courts must be located distance away from poultry farms.

The results of this study remain as preliminary findings and are valuable only for comparative purposes. Further investigations must be conducted to ascertain such findings since such study is scarce in this part of the world.

Acknowledgement. The authors wish to thank the Director of Institute for Medical Research, Dr Ng Kok Han for his support and encouragement. Thanks are also due to the staff of Medical Entomology Unit, Infectious Disease Research Centre, Kuala Lumpur and Vector Borne Disease Control Unit of Selangor for their assistance in conducting the field survey. This research was supported by the Seameo Tropmed Research Grant No. 10 - 02.

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