8 FRUIT FLY POPULATION DENSITIES IN THE VICINITY OF HOME COMPOST BINS

8.1 INTRODUCTION

Fruit fly (*Drosophilae*) nuisance was identified by Homeowners as one of the main problem encountered in the first year of the HC study (although this was not reported as a problem in the second year) (Section 10). There is a worldwide public health burden associated with insect borne disease. Insects can transmit diseases mechanically, by carrying pathogens on body parts, or biologically, by acting as a growth or development medium for the parasite (Leppla, 1984). Fruit flies are considered a major pest damaging fresh fruit and fruiting vegetables and they have successfully adapted their lifecycles to most cultivated fruits resulting in an endemic (Lemontey, 1995). For example, the Mediterranean fruit fly (*Ceratitis capitata*), commonly called Medfly is one of the world's most destructive agricultural pests, attacking ripening fruit, piercing the soft skin and laying eggs within the puncture. Subsequently, the eggs hatch into larvae (maggots), which feed inside the fruit pulp resulting in spoilage (Boller *et al.*, 1981)

A monitoring study was therefore designed to quantify the association of fruit flies with HC activity. Proprietary insect fly traps were placed inside the compost bins and at various positions from the bins and were removed after set time periods. The effects of open and closed lids and small or large garden size were assessed in relation to numbers of flies within the vicinity of the bins.

8.2 MATERIALS AND METHODS

Twenty compost bins participating in the HC Study Trial were selected for the vector attraction study. Ten were from the large garden size group and ten from the small garden size category. Each garden size group was further divided into two sets where the compost bin lid was either closed or removed. The insect traps (Bio fly catcher-double sided trap, pbi Home & Garden Limited) were placed immediately inside the bins and outside the HC containers at distances of 1 m and 2 m. Traps were removed after 1, 3, 5, and 10 days. Day 1 of the assessment occurred on 1st April 2002.

Following collection, the traps were wrapped in cling film and stored in a freezer until enumeration. The number of flying insects on the traps were counted and recorded. Larvae were identified as legless maggots and adult *drosophilae* were identified by the following criteria (Gullan and Cranston, 1986);

- 0.05-50 mm (0.02 – 2 inches) long
- one pair of membranous wings (max span 80 mm/3.2 in)
- hindwings are club-like balancers (halteres)
- second segment of thorax is much enlarged
- first and third reduced mouthparts for liquid feeding

The sampling times were selected to reflect the major growth stages of the *drosophilae* life cycle as shown in Figure 8.1. Insect growth is discontinuous and size increase occurs by moulting, which is the periodic formation of new cuticle of greater surface area and shedding of old cuticle between one instar (growth stage, or the form of the insect between two successive moults) and the next. The second component of growth is the intermoult period or interval or instar duration (stadium), which is the time between two successive moults or between successive ecdyses (Leppla, 1984). The magnitude of both moult increments and intermoult periods may be affected by food supply, temperature, larval density and physical damage (Gullan and Cranston, 1986).

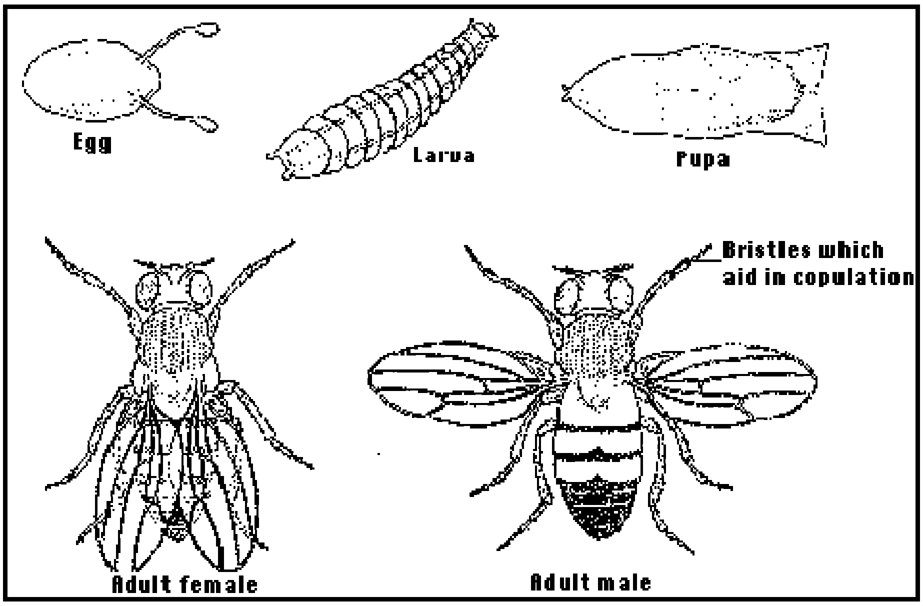

Figure 8.1 Life-cycle of *Drosophila* (Gullan and Cranston, 1986)

Drosophila, as do all flies, go through a complete metamorphosis, that is they progress from egg, to larva, to pupa, to adult (Figure 8.1). The adults emerge from eggs in 8-10 days; the adults may live for up to three months and lay from 500 to 2,000 eggs in their lifetime. *Drosophila* eggs are deposited as long as a food source is available, and resultant adults will emerge until the food source or the fly population is eliminated. The adults also carry fungi spores that are deposited with the eggs and continue to and hasten fermentation (Drew *et al*., 1989).

The phases of *drosophilae* ontogeny (development from egg to adult) are distinguished as:

- embryonic phase during which embryonic development is triggered by fertilisation;
- egg stage, which begins as soon as female deposits the mature egg;
- larval stage occurs after eclosion from the egg which marks the beginning of the first stadium and ending at the first ecdysis when the old cuticle is shed to reveal the insect in its 2nd instar; 3rd and subsequent instars generally follow;
- metamorphosis represents the growth from immature larvae to adult form due to change in body shape triggered by altered hormone levels. Moulting is a complex process involving hormonal, behaviouaral, epidermal and cuticular changes that lead up to the shedding of the old cuticle.

The lifecycle of Drosophilae follows the sequence (Calkins, 1989):

Day 0: female lays eggs;
Day1: eggs hatch into worm-like larvae. Larvae eat and grow continuously moulting
Day 2: first instar (one day in length);
Day 3: second instar (one day in length);
Day 5: third and final instar (two days in length);
Day 7: larvae begin roaming stage to form an immobile pupa. Pupariation (pupal formation) occurs 120 hours after egg laying;
Day 11-12: eclosion (adults emerge from the pupa case). The body is completely remodelled to give the adult winged form, which latches from the pupal case. Females become sexual mature 8-10 hours after eclosion.

The time from egg to adult is temperature dependent and the above cycle is for a temperature range of 21 – 23 ºC. The higher the temperature, the faster the generation time, whereas a lower (to 18 ºC) temperature causes a longer generation time. Females can lay up to 100 eggs per day (Zahradnik and Chvala,, 1989). Fruit flies lay their eggs near the surface of fermenting foods or other moist, organic materials. Upon emerging, the tiny larvae continue to feed near the surface of the fermenting mass. Fruits are rich in sugars and decomposition by microorganisms attracts the larva maggots, which thrive on yeasts. (Tsitsipis,1989). Fruit-fly maggots possess an enzyme, which enables them to break down alcohols. The larvae continue to develop and grow in fermenting fruit (Zahradnik and Chvala, 1989).

8.3 RESULTS

Numbers of fruit flies collected on the sticky traps are shown in Appendix 7, although due to the enormity in species variation between the study traps the insects were not individually identified. In addition, the different growth stages of drosophilae were difficult to differentiate on traps and each insect was counted as one entity regardless of its growth stage.

Generally, the largest numbers of fruit flies were collected by insect traps inside the bins and flies became less numerous with increasing distance from the bin (Figure 8.2). Fruit flies were particularly attracted to compost bins at properties with small garden size compared to large gardens (Figure 8.2). Sticky traps inside the compost bins from large garden sized groups achieved almost 50 % saturation between day 1 and 3 and 100 % saturation by day 10 (Figure 8.2 a and b). In all cases, number of flies at 2 m, were small and ≤20 flies were trapped over the 10 day period. This therefore, suggests that flies remain in close proximity of the bin and nuisance will be limited to the area around the bin. Furthermore, flies are unlikely to cause problem to homeowners when bins are positioned away from areas of garden that are regularly used.

The majority of sticky traps inside the compost bins under small garden management treatment (Figure 8.2 c and d) became saturated between days 3 and 5. Thus, indicating a greater association of fruit flies with compost bins from small garden size groups. In addition, numbers of fruit flies at increasing distances from the compost bins were greater in comparison to compost bins from large garden size group, further supporting small garden size association with fruit flies.

There was a statistically significant effect of garden size on *drosophilae* numbers (determined by ANOVA) and they were consistently larger for small gardens compared to the large garden group (Table 8.1). As would be expected opening the compost bins lid increased the numbers of flies within the vicinity of HC bins compared to when bin lids were closed (Table 8.1). The F. probabilities indicated that the compost bin lid presence on compost bins was found to be significantly associated with vector attraction at different locations after day 3, 5 and 10 (Table 8.1). Mean values confirmed that the correlations were associated with lid absence (Table 8.1), suggesting that the removal of lids from compost bin may contribute to vector attraction. However, as vector attraction varied with regard to compost bin locations, the relationship between lid presence/absence and vector attraction is not established.

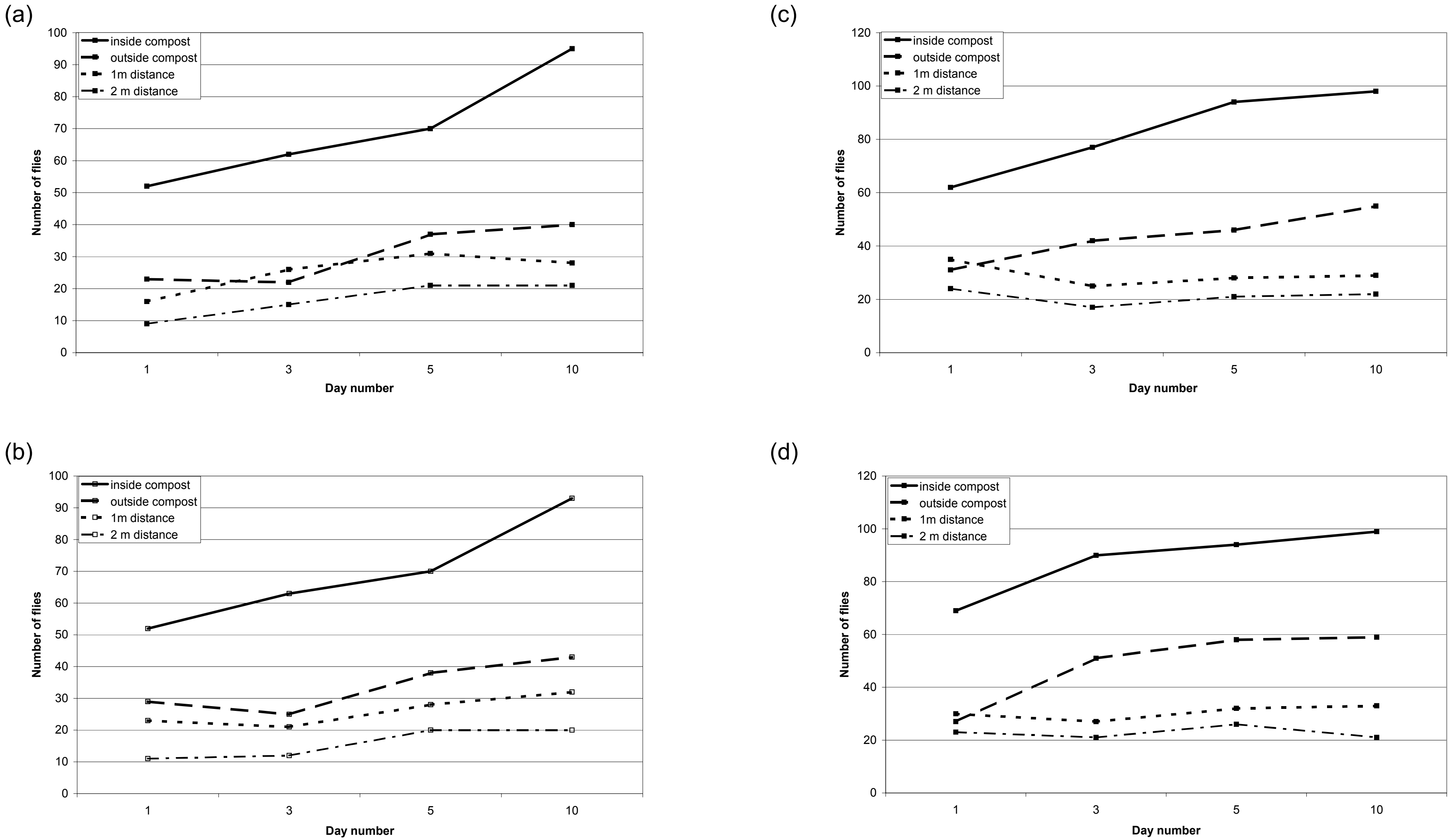

Figure 8.2 **Mean number of fruit flies collected from compost bins (a) lids sealed in large gardens, (b) lids removed in large gardens, (c) lids sealed in small gardens and (d) lids removed in small gardens**

Table 8.1 Mean values and F. probabilities for garden size and bin lid factors in relation to fruit flies

Property	Garden size			Lid		
	Large	Small	F. probability	Open	Closed	F. probability
Day 1						
Inside compost bin	51.7	65.2	<0.01	60.2	56.7	0.30
Outside compost bin	25.9	28.9	0.22	27.8	27.0	0.74
1m distance from bin	19.3	32.4	<0.01	26.1	25.6	0.78
2m distance from bin	10.1	23.7	<0.01	16.9	16.9	1.00
Day 3						
Inside compost bin	62.3	83.8	<0.01	76.3	69.3	0.05
Outside compost bin	23.5	46.4	<0.01	37.9	32.0	0.02
1m distance from bin	23.5	26.0	0.31	23.6	25.9	0.35
2m distance from bin	13.4	18.8	0.01	16.4	15.8	0.75
Day 5						
Inside compost bin	69.9	93.6	<0.01	81.8	81.7	0.97
Outside compost bin	37.8	52.1	<0.01	48.2	41.7	0.02
1m distance from bin	29.5	30.1	0.82	29.8	29.8	1.00
2m distance from bin	20.7	23.3	0.30	23.1	20.9	0.38
Day 10						
Inside compost bin	94.0	98.8	0.03	95.9	96.9	0.62
Outside compost bin	41.8	56.7	<0.01	50.9	47.6	0.28
1m distance from bin	30.2	31.0	0.66	32.6	28.6	0.04
2m distance from bin	20.7	21.3	0.62	20.3	21.7	0.26

8.4 DISCUSSION

Fruit flies are associated with HC activity and may be present in large numbers inside compost bins. Small sized gardens were statistically independent of lid presence/absence and their numbers decrease with increasing distance from the bins. This could be attributed to the predominance of kitchen waste in these home composters, which provides a food source and a favourable environment for insect life cycle sustainability. The heat generated during the composting process increases the metabolism and rate of growth of fruit flies, thus increasing the fly population. Composting is more active during warm ambient-temperature conditions and hence fruit fly populations expand during these periods. This study was carried out on one occasion (3rd – 13th April 2002) and did not reflect the potential effects of seasonal factors and ambient temperatures on fruit fly activity.

Fly nuisance was the main complaint of homeowners regarding problems experienced with composting waste (Section 10), but most considered it to be tolerable because the flies were only present in the immediate vicinity of the compost bin. Fruit flies are advantageous to waste degradation in the bins, however, and increase organic matter decomposition by feeding on fermenting fruit and vegetation.