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THE SEASONAL ABUNDANCE OF SYNANTHROPIC FLY POPULATIONS IN TWO SELECTED FOOD OUTLETS IN PULAU PINANG, MALAYSIA

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Abstrak: Kajian kelimpahan bermusim lalat sinantrofik dewasa dijalankan dari Julai 2003 sehingga Julai 2004 di sebuah kafeteria di kampus induk Universiti Sains Malaysia (USM) dan di sebuah restoran di luar kampus. Spesies yang telah dikenal pasti ialah *Musca domestica, Musca sorbens, Chrysomya megacephala* dan *Lucilia cuprina.* Restoran di luar kampus mempunyai kelimpahan lalat yang secara signifikannya lebih tinggi ($p < 0.05$) berbanding kafeteria universiti dengan spesies lalat yang dominan di kedua-dua lokasi ialah *M. domestica*. Kelimpahan lalat paling tinggi direkodkan di kedua-dua lokasi kajian pada April 2004. Kelimpahan lalat paling rendah di kafeteria universiti dan di restoran luar kampus masing-masing pada Mac 2004 dan Oktober 2003.

Abstract: The seasonal abundance study of adult synanthropic flies in two selected food outlets was conducted from July 2003 to July 2004. The two urban locations were a cafeteria in the Universiti Sains Malaysia (USM) main campus and an adjacent restaurant. Four synanthropic flies were identified from both study sites and they were *Musca domestica* (house fly)*, Musca sorbens, Chrysomya megacephala* and *Lucilia cuprina*. The off-campus restaurant had a significantly higher ($p < 0.05$) fly abundance than the university cafeteria and the dominant fly species at both sites was the *M. domestica*. The highest fly abundance recorded at both sites was in April 2004. Total fly abundance was lowest in the university cafeteria and in the off-campus restaurant in March 2004 and October 2003 respectively.

Keywords: Seasonal Abundance, Synanthropic Fly, Food Outlets

INTRODUCTION

Studies around the world have shown that almost all fly species population, including the house fly, fluctuate even when no control measures are used (Greene 1989). This fluctuation in abundance can be attributed to natural factors such as weather, predators, parasites and diseases (Moon & Meyer 1985). Elements such as humidity, temperature and rainfall can also greatly influence the conditions of breeding sites, the period of oviposition and the feeding habits of adult flies as well as the survival of eggs and larvae (WHO 1986). In the tropics, wet conditions increase the number and size of breeding sites thereby increasing fly population numbers, whereas the opposite is true for dry weather (Bay & Harris 1988). Weather conditions also influence rates of population increase and this in turn influences the number of flies available for trapping (Wall *et al.* 1992, 1993; Wardhaugh *et al.* 1994). In Papua New Guinea and Iraq,

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increases in myiasis incidences have been observed during or after periods of rainfall, suggesting that one or more weather descriptors may be useful for predicting changes in fly activity (Norris & Murray 1964; Al-Izzi 2002).

Understanding the seasonal fluctuations of adult synanthropic fly populations is a crucial step before any control program can even be considered (Greene 1989). Therefore, the aim of this study was to determine the seasonal abundance of adult synanthropic flies in two selected food outlets with varying sanitation practices and examine the influence of weather on the abundance of synanthropic flies there.

MATERIALS AND METHODS

Study Sites

This seasonal abundance study was conducted for a period of 13 months, beginning from July 2003 to July 2004. The food outlets in Pulau Pinang chosen for this study were a cafeteria in the Universiti Sains Malaysia (USM) main campus and an off-campus restaurant. The cafeteria chosen for this study is the Desa Bakti-Permai cafeteria and the restaurant is located in a row of shop houses outside the USM campus.

The sanitation of the cafeterias in the university campus is kept in check by the university authorities and regular checks are done to ensure that the cafeteria operators follow the standard operating regulations. The cafeteria operators are also required to discard the accumulated daily kitchen garbage outside the campus, they are not allowed to leave the garbage in the cafeteria overnight. However, the garbage bins used to keep the garbage at the cafeteria is not cleaned out properly and food scraps and other kitchen residue are still left in the bins which provide a place for flies to breed. Therefore, flies can still be seen within the cafeteria although the general level of sanitation at the university cafeteria is considered high.

The sanitation control of the restaurant is up to the proprietor of the restaurant. At the restaurant, the kitchen scraps and other garbage are collected in a large bin in the alleyway behind the kitchen and the garbage is only removed when the municipal council workers come to collect it but the bin is never fully cleaned out and maggots can be seen in the garbage left at the bottom of the bin. This provides a place for the flies to breed in even when the municipal workers empty out the bin. The accumulation of garbage in the bin when the municipal workers are late in collecting the garbage also provides a suitable place for flies to breed. The general level of sanitation at the restaurant is considered lower than the university cafeteria.

Fly Sampling Methods

Fly abundance was measured on a weekly basis using baited sticky paper traps. Baited sticky traps have been widely used for assessing fly densities indoors and outdoors (WHO 1986).

Non-repellent sticky paper traps measuring 30 × 21 cm were attached by double-sided adhesive tape to a 36 × 27 cm cardboard base. The sticky traps were baited with slightly mashed pieces of salted fish (1 $cm^3 \times 4$ pieces) preserved in oil. The bait was chosen based on a previous bait preference study conducted by Nurita (2006) that showed salted fish to be more effective in attracting flies of different species compared to the other baits.

Once a week, five baited sticky paper traps were placed inside the food outlets and placed in horizontal positions on the floor to trap the flies. Traps were placed 1 meter apart and trap locations were not varied from week to week. Collection of flies using the method was conducted during the peak of fly activity, which was from 1200 to 1600 hours (Habibah 1997). After the allocated four hours, traps were collected and brought back to the laboratory. The flies that were caught on the sticky traps were counted and fly species was identified using keys given by McAlpine *et al.* (1981–1989). The number of flies caught on the traps was used as an index of fly abundance.

In this study, weekly mean meteorological measurements of relative humidity, temperature and rainfall were regarded as the measurements recorded on the days when sampling was conducted. Relative humidity, rainfall and temperature measurements were obtained from the Malaysian Meteorological Service weather station in Bayan Lepas, Pulau Pinang.

Data Analysis

The number of synanthropic flies caught by the sticky traps each month and the monthly meteorological measurements were tested for normality by using the Kolmogorov-Smirnov statistic. The number of synanthropic flies trapped per month at the two study sites was compared using a t-test for two independent samples to determine whether the sanitation practises of the two locations affects fly abundance. Correlation of the abundance of synanthropic flies of different species with monthly meteorological measurements (humidity, temperature and rainfall) were assessed by using the Spearman Rank Correlation Coefficient (r_s). Statistical analysis was conducted by a PC version of Statistical Packages for the Social Sciences version 12.0.

RESULTS

The total number of synanthropic flies of different species caught from the study sites from July 2003 to July 2004 is shown in Figure 1. Overall, there were four synanthropic fly species trapped from both the university cafeteria and the off-campus restaurant and they were *Musca domestica* (house fly), *Musca sorbens, Chrysomya megacephala* and *Lucilia cuprina*. *Musca domestica*, was the principal fly pest at both sites and *M. sorbens* was the second most abundant species. At the end of the study period, the off-campus restaurant had a higher abundance of flies from all species compared to the university cafeteria. In total, the off-campus restaurant yielded 3,118 house flies, 1,900 *M. sorbens*, 1,096 *C. megacephala* and 868 *L. cuprina*, whereas the university campus yielded 1,769 house flies, 1,210 *M. sorbens,* 721 *C. megacephala* and 515 *L. cuprina*.

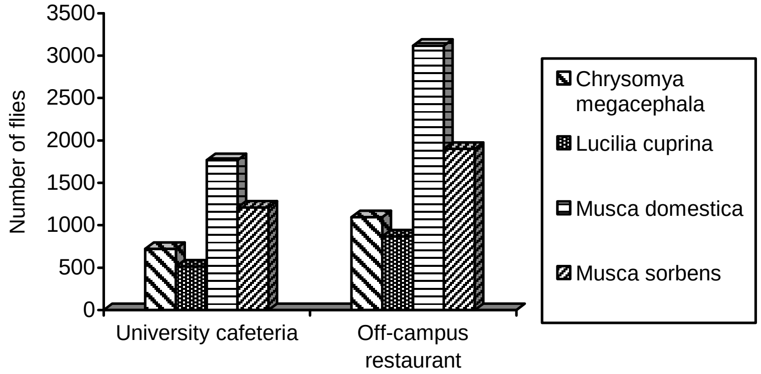

Figure 1: Total number of synanthropic flies of different species caught from the study sites from July 2003 to July 2004.

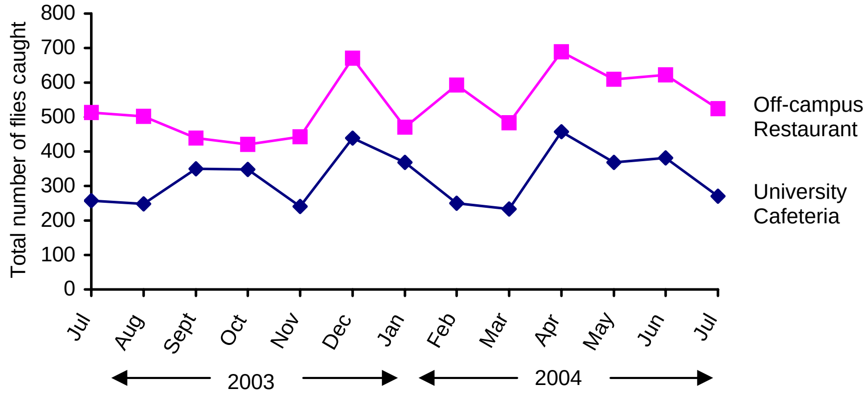

Figure 2: Comparison of monthly abundance of synanthropic flies between study sites.

Figure 2 shows the comparison of the monthly abundance of synanthropic flies between the two study sites. The lowest number of fly catch was in March 2004 for the university cafeteria and October 2003 for the off-campus restaurant. The highest abundance of flies was recorded in April 2004 for both study sites. During this month, 458 and 689 flies were caught at the university cafeteria and the off-campus restaurant respectively. However, it is clear that the abundance of flies at the university cafeteria was relatively lower than that of the off-campus restaurant ($p < 0.05$). Figures 3 and 4 show the weekly abundance of different synanthropic fly species with relation to meteorological conditions at the university cafeteria and the off-campus restaurant respectively. The range of weekly mean rainfall, relative humidity and temperature were 0.0–94.6 mm, 68.1%–91.1% and 25.0ºC–30.3ºC respectively.

Figure 3 shows that house fly abundance increased gradually from July 2003 to October 2003 at the university cafeteria. In average the number of house fly caught at the university cafeteria was above 100. There was a drop in house fly abundance at the university cafeteria in November 2003 and another in March 2004, where a total of only 95 flies were caught. However, the weekly mean rainfall, relative humidity and temperature were from 1.0–7.8 mm, 79.5%–84.0% and 27.0ºC–28.5ºC respectively for November 2003, and 0.0–3.4 mm, 61.4%–77.8% and 28.2ºC–29.6ºC respectively for March 2004. This indicates that there does not seem to be a clear correlation between rainfall, relative humidity and temperature with the low house fly abundance (Fig. 3). In December 2003, there was a sharp increase in house fly abundance in the university cafeteria but this was not the highest, because the peak of house fly abundance (189 house flies) was not until April 2004. In December 2003 and April 2004, rainfall was low (4.2 mm and 0.2 mm respectively) but not the lowest rainfall amount. The lowest rainfall reading was in July 2003 (0.0 mm). The mean relative humidity in December was 68.1%, which was the lowest mean relative humidity reading throughout the study period; however, house fly abundance peaked in April 2004 and not December 2003. The mean relative humidity in April 2004 was 79.4%.

Figure 4 shows that the house fly abundance at the off-campus restaurant decreased gradually from July 2003 up to October 2003, where the lowest number of house flies was recorded. The highest weekly mean rainfall throughout the study period was recorded in October 2003 at 94.6 mm and mean temperature during this month was the lowest throughout the study period at 26.0ºC. House fly numbers at the off-campus restaurant started to increase in November 2003 and December 2003. The house fly abundance at the off-campus restaurant did not peak until April 2004, where a total of 290 flies were caught. Population levels of *M. domestica* at the university cafeteria remained above 100 flies throughout the study period except in November 2003 and March 2004. As for the off-campus restaurant, house fly populations remained above 200, with just one exception in October 2003, where house fly counts dropped to only 180.

Figures 3 and 4 show the existence of similar trends in abundance of *M. domestica* and *M. sorbens* at both sites. Abundance of *M. sorbens* at the two study sites never exceeded that of the house fly. The abundance of *M. sorbens* remained lower than numbers of *M. domestica*. The highest abundance of *M. sorbens* recorded at the university cafeteria and the off-campus restaurant were both in April 2004. There were relatively no sharp differences in *M. sorbens* abundance at the two study sites. *Musca sorbens* population remained above 100 flies in each month at the off-campus restaurant but the same cannot be said about the *M. sorbens* population at the university cafeteria where population levels fluctuated above or below 100 flies. The lowest abundance of *M. sorbens* was recorded in August 2003 (63 flies) for the university cafeteria and in November 2003 (114 flies) for the off-campus restaurant. The mean rainfall for August 2003 was 0.2 mm, which is the same as in April 2004 where *M. sorbens* abundance was high.

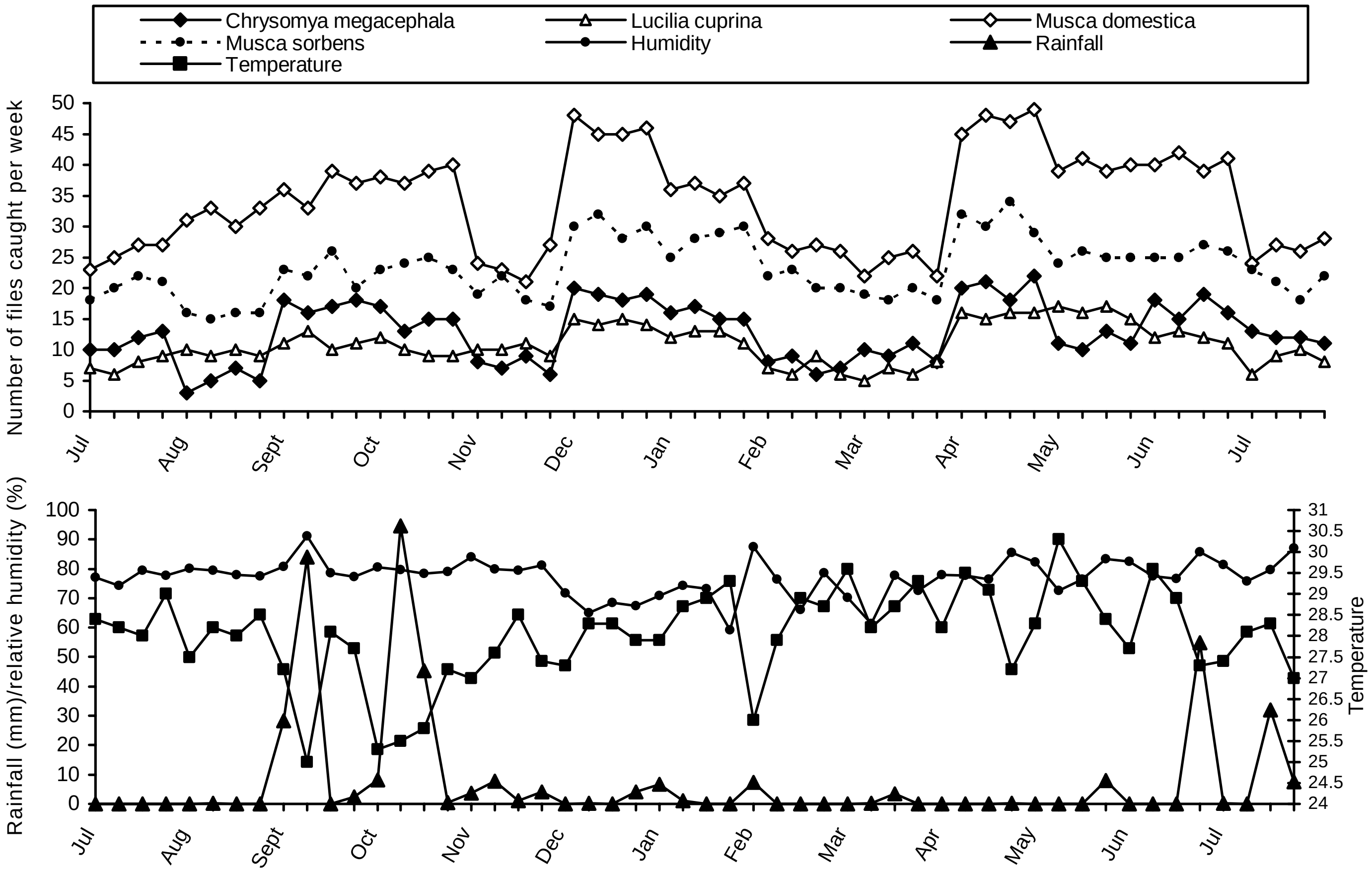

Figure 3: Weekly abundance of different synanthropic fly species with relation to meteorological conditions at the university cafeteria site.

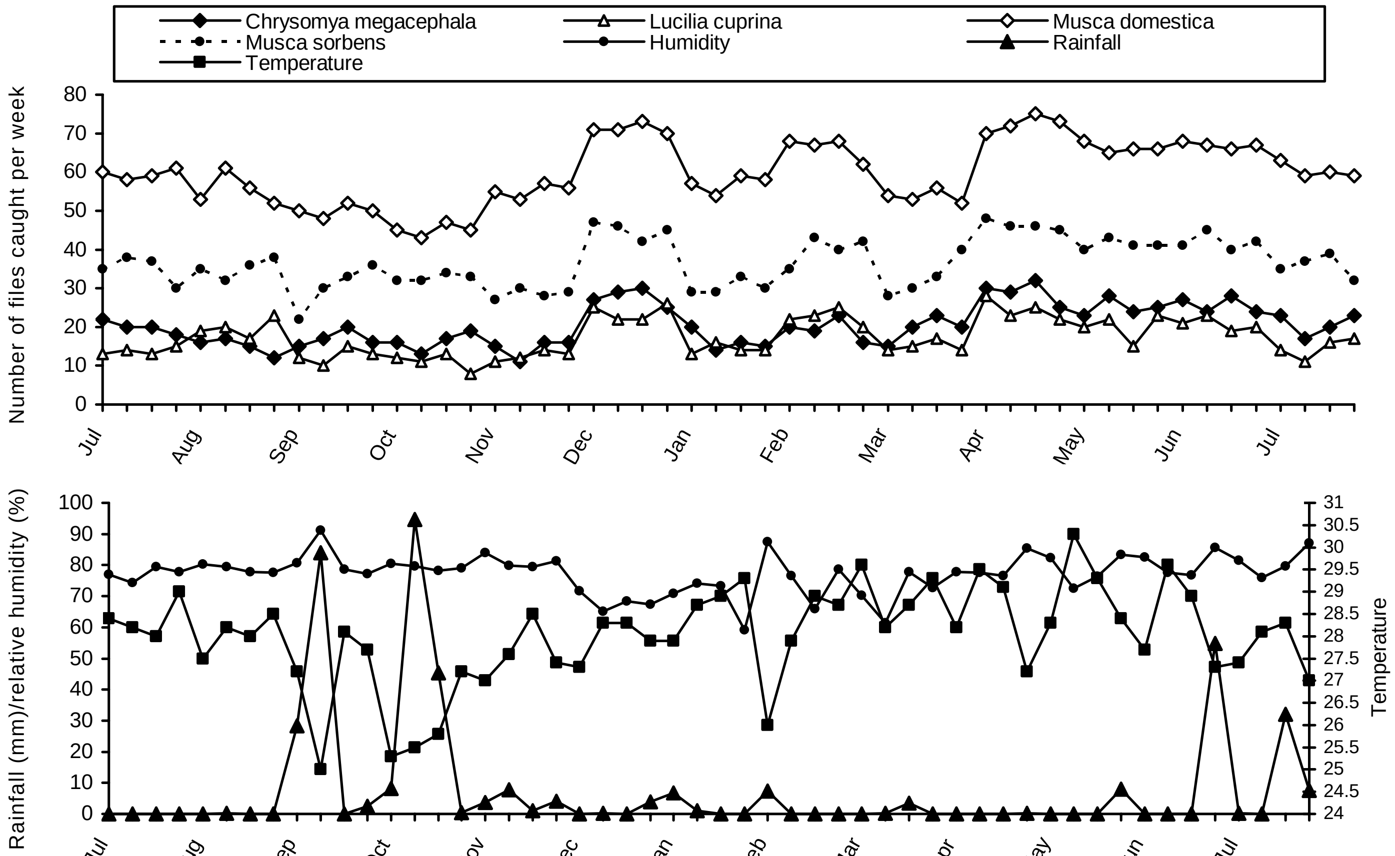

Figure 4: Weekly abundance of different synanthropic fly species with relation to meteorological conditions at the off-campus restaurant.

Referring to figures 3 and 4, the abundance of *C. megacephala* and *Lucilia cuprina* remained relatively low at both sites compared to *M. domestica* and *M. sorbens*. Populations of the two blowfly species at the university cafeteria remained below 100 flies. Unlike *M. domestica* and *M. sorbens* the seasonal fluctuations of the two blowfly species did not follow the same trend. *Chrysomya megacephala* population levels at both sites at certain times dropped below the population levels of *L. cuprina* and the same is true for the population of *L. cuprina*.

Chrysomya megacephala abundance at the university cafeteria and the off-campus restaurant peaked in April 2004, with 81 and 116 flies respectively. The lowest recorded abundance of *C. megacephala* was in August 2003 (20 flies) for the university cafeteria and in November 2003 (65 flies) for the off-campus restaurant. Mean rainfall for August 2003 and April 2004 was low at 0.2 mm. Therefore, as it is with the *M. sorbens* population in the university cafeteria; low rainfall also does not seem to affect *C. megacephala* abundance at the university cafeteria. *Lucilia cuprina* abundance exceeded that of *C. megacephala* in August 2003, November 2003 and May 2004 at the university cafeteria and in August 2003 and February 2004 at the off-campus restaurant.

It is apparent that fly abundance at the university cafeteria and the off-campus restaurant did not follow any of the weather trends that were measured. The Spearman Correlation analysis further proved that there was no correlation between the abundance of flies of different species and weather conditions ($p > 0.05$).

DISCUSSIONS

There were four synanthropic fly species sampled from both the university cafeteria and the off-campus restaurant and they were *Musca domestica, Musca sorbens, Chrysomya megacephala* and *Lucilia cuprina*. The *M. domestica* (house fly), was the principal fly pest at both study sites and *M. sorbens* was the second most abundant species at both the study sites. The abundance of all synanthropic fly species at both sites peaked in April 2004 with the exception of the *Lucilia cuprina* population at the university cafeteria, which peaked in May 2004. This result is almost similar to a study conducted by Nazni *et al.* (2003) at a poultry farm in Kundang, Selangor. In their study, house fly densities peaked in May 1998, which is one month later than the seasonal peak in this study. However, comparison between this study and the study by Nazni *et al.* (2003) would be inaccurate due to differences in type of location. The blowflies, *Chrysomya megacephala* and *L. cuprina* populations were lower than that of *M. domestica* and *M. sorbens* at both study sites. This could be due to the fact that both study sites lacked an optimum breeding site for the blowfly species. Most blow fly larvae prefer to feed on carrion but they can feed on other decaying organic matter. They often infest wounds of sheep, goats, cattle and other animals. Unkempt sheep are particularly subject to attack. Adult blowflies are more attracted to carrion and soggy, bloody or soiled hair, fur, or wool (Service 1997).

The abundance of synanthropic flies between the university cafeteria and the off-campus restaurant differed significantly. Fly abundance at the university cafeteria was relatively lower than the off-campus restaurant. This result shows the possibility of a connection between sanitation and fly abundance because the two food outlets have such differing sanitation levels.

As weather conditions were proven not to affect fly abundance, other factors must be considered to explain this similarity. Usually, the garbage at the off-campus restaurant is collected every two days but in April this schedule was not followed and the garbage accumulated to the point where it spilled onto the road and into the drain. This provided an excellent breeding site for flies and thus could explain the increase in the number of flies caught on the sticky traps.

As for the university cafeteria, during the third week of April 2004, cafeteria cleaners scooped out kitchen scraps and food residue from blocked drains around the cafeteria and dumped it in a pile at one side of the building under the shade of a tree where it was left for at least a week. This is not unusual because the cafeteria cleaners will clean out the drains once a month and the usual practice is to leave it near the same area before the grounds keeper sweeps it up and throws it away. When it was cleared away, flies seemed to cluster around the residue that was left there.

Various designs of baited fly traps have been used for detecting the presence of pest Diptera and as a basis for assessing species abundance (Vogt *et al.* 2001). From an analysis of catches of *Lucilia cuprina*, Vogt *et al.* (1983) has shown that, after allowing for the effects of ambient weather on fly activity, variations in trap catch over time provide a realiable measure of species abundance. Similar findings have been reported for the *Musca vetustissima* (bush fly) (Vogt 1986) and the *Chrysomya rufifacies* (carrion fly) (Vogt 1988). For each of the species, temperature was the key factor determining the number of flies caught. These findings appear to be inconsistent with those of the present study, in which no significant effects could be assigned to any of the weather variables tested. However, those previous studies were conducted in temperate environments in which diurnal and seasonal variations in temperature would be substantial, compared with those prevalent in an equatorial location such as Pulau Pinang. In the tropical environment of Pulau Pinang, weather has been shown to have no detectable effect on the number of flies caught.

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REFERENCES

Al-Izzi M A J. (2002). Work by the Arab Organization for Agriculture Development to control the Old World screw-worm fly. *Proceedings of the Screw-worm fly Emergency Preparedness Conference*, Agriculture Fisheries and Forestry Australia, Canberra, November 2002.

Bay D E and Harris R L. (1988). *Introduction to veterinary entomology*. 2^{nd} ed. Bryan, Texas: Stonefly Publishing, 54–55.

Greene G L. (1989). *Seasonal population trends of adult stable flies.* Miscellaneous Publication 74. Lanham, MD: Entomological Society of America.

Habibah R. (1997). *Kajian kelimpahan, ritma harian dan kesan penarikan feromon seks (Z)-9-Tricosene terhadap lalat rumah (Musca domestica* Linnaeus) *disebuah tempat pembuangan sampah di Sungai Dua, Pulau Pinang.* B.Sc. thesis, Universiti Sains Malaysia, Pulau Pinang.

McAlpine J F, Peterson B V, Shewell G E, Teskey H J, Vockeroth J R and Wood D M. (1981–1989). *Manual of Neartic Diptera.* Vol. 1, Monograph. No. 27, 674 (1981). Vol. 2, Monograph. No. 28, 675–1332 (1987). Vol. 3, Monograph. No. 32, 1333–1581 (1989). Research Branch, Agriculture Canada.

Moon R D and Meyer H J. (1985). Non-biting flies. In R E Williams, R D Hall, A B Broce and P J Scholl (eds.). *Livestock entomology.* New York: John Wiley and Sons, 70–79.

Nazni W A, Lee H L, Sofian M A and Sadiyah I. (2003). Guidelines for fly control. *Trop. Biomed*. 20(1): 59–63.

Norris K R and Murray M D. (1964). Notes on the screw-worm fly, *Chrysomya bezziana* (Diptera: Calliphoridae) as a pest of cattle in New Guinea. *CSIRO Division of Entomology Technical Paper*, Number 6, 1–26.

Nurita A T. (2006). *Seasonal abundance and species composition of synanthropic flies in northern peninsular Malaysia and field evaluations of fly baits.* M.Sc. thesis, Universiti Sains Malaysia, Pulau Pinang.

Service M. (1997). *Medical entomology for students.* London: Chapman and Hall, 278.

Vogt W G. (1986). Influences of weather and time of day on trap catches of bush fly, *Musca vetustissima* Walker (Diptera: Muscidae). *Bulletin of Entomological Research* 76: 359–366.

________. (1988). Influence of weather on trap catches of *Chrysomya rufifacies* (Macquart) (Diptera: Calliphoridae). *Journal of the Australian Entomological Society* 27: 99–103.

Vogt W G, Woodburn T L, Morton R and Ellem B A. (1983). The analysis and standardisation of trap catches of *Lucilia cuprina* (Wiedemann) (Diptera: Calliphoridae). *Bulletin of Entomological Research* 73: 315–319.

Vogt W G, van Gerwen A C M and Walker J. (2001). Estimating population densities of the Australian sheep blowfly Lucilia cuprina (Wiedemann) (Diptera: Calliphoridae) from catches in wind-oriented traps. In S Champion (ed.) *FLICS flystrike and lice IPM control strategies*. Launceston: University of Tasmania, 302–308.

Wall R, French N P and Morgan K L. (1992). Effects of temperature on the development and abundance of the sheep blowfly, *Lucilia sericata* (Diptera: Calliphoridae). *Bulletin of Entomological Research* 82: 125–131.

_______. (1993). Predicitng the abundance of the blowfly, *Lucilia sericata* (Diptera: Calliphoridae). *Bulletin of Entomological Research* 83: 431–436.

Wardhaugh K G, Bedo D and Vogt W G. (1994). Management model for the control of flystrike in sheep. In Into the future. *Proceedings of the Australian Veterinary Association Conference,* Canberra, March 1994, 70–74.

World Health Organization (WHO) (1986). *Vector control series: The housefly training and information guide*. Geneva: WHO, 62.