THE ASSOCIATION OF BLOWFLIES WITH WHEE LIE-BINS IN DARWIN

Medical Entomology
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For more information contact:

Department of Health and Community Services
Medical Entomology
PO Box 40596
Casuarina NT 0811

Telephone:  08 8922 8901
Fax:          08 8922 8820
Email:       peter.Whelan@nt.gov.au
The Association of Blowflies with Wheelie-bins in Darwin
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There has been some public concern over a possible increase in blowfly numbers since the introduction of Wheelie-bins. Some opinion attributes this possible increase in blowfly numbers to the reduction in bin collection frequency from twice per week to once per week.

To aid in resolving the issue the Medical Entomology Branch of the NT Department of Health and Community Services, set up an experiment to determine what link existed between Wheelie-bins and blowfly numbers. This experiment was supplemented by a number of smaller trials as well as a phone survey of Palmerston and Karama residents and a bin survey of part of Malak and Karama.

The results of the investigation can be summarised as follows:-

Blowflies can lay eggs on exposed meat scraps either in bins or outside of bins. Blowflies enter bins when the bin lid is opened. Bin lids that are intact and closed are blowfly proof but do not prevent larvae from crawling out of the bin.

An experiment was conducted to determine the blowfly production from garbage under different exposure and packaging regimes. Kitchen refuse containing meat weighing 2.2 kg in total, and wrapped in supermarket bags and placed in a Wheelie-bin can produce more than 5000 blowfly larvae in a week. Many of these larvae will escape from the bin, principally overnight, and pupate in soil in the immediate vicinity of the bin. Dependent on species blowflies will emerge 5-7 days later. The significant result linking blowfly production with Wheelie-bins is given below.

fig.1 Numbers and species of blowflies collected from emergence traps set on sites previously occupied by Wheelie-bins. Wheelie-bins contained garbage packaged in different ways.

![Diagram showing numbers of blowflies collected in emergence traps]
The bin survey of parts of Malak and Karama showed that large numbers of bins contained some level of infestation (Table 1). These levels of maggot infestation can lead to large numbers of blowflies. A high proportion of these bins still contain maggots after collection.

Table 1. Overall summary of results from the Wheelie-bin inspection survey of part of Malak and Karama on 8 November 1991.

<table>
<thead>
<tr>
<th>Suburb</th>
<th>Karama</th>
<th>Malak</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Houses</td>
<td>Flats</td>
</tr>
<tr>
<td>Bins checked before and after collection</td>
<td>163</td>
<td>11</td>
</tr>
<tr>
<td>With larvae/pupae before collection</td>
<td>93 [57%]</td>
<td>6 [6.5%]</td>
</tr>
<tr>
<td>With larvae/pupae after collection</td>
<td>86 [52.7%]</td>
<td>4 [5.4%]</td>
</tr>
</tbody>
</table>

The phone survey showed that blowfly problems are perceived to be more frequent in Karama than in Palmerston. Only a fifth of phone survey respondents in Palmerston (21%) felt that they sometimes or often had a blowfly problem in their own home. However more than half (55%) of the phone survey respondents in Karama sometimes or often had problems with blowflies. This difference corresponds with the perception of a problem in other areas of their city (Table 2).

Table 2. Percentage of phone survey respondents in Karama and Palmerston who believe their city has a blowfly problem.

<table>
<thead>
<tr>
<th>Type of residence</th>
<th>City of Residence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Darwin (Karama)</td>
</tr>
<tr>
<td>House</td>
<td>64.10% (n=78)</td>
</tr>
<tr>
<td>Flat</td>
<td>42.80% (n=21)</td>
</tr>
<tr>
<td>Combined Total</td>
<td>59.50%</td>
</tr>
</tbody>
</table>

From fly-trapping data and phone survey data it can be concluded that blowflies constitute a lesser problem in Palmerston than in Karama and probably in other parts of Darwin.

The report concludes that the major blowfly prevention measure is for food waste to be sealed properly in a plastic container. Most households use supermarket bags to wrap food scraps. As
currently used, supermarket bags are generally not adequate to prevent maggot infestation. It is essential, that bags contain no holes or sharp objects to cause holes, to prevent blowfly entry to bags containing food scraps, and that supermarket bags be tied in a tight knot below the handles. Once generated, food scraps should be sealed in plastic containers and placed in a bin. Bins that do contain maggots after collection should be washed out in a place or manner that will inhibit the survival of maggots.

Increasing bin collection frequency is likely to reduce the opportunities for maggot and adult blowfly production but will not eliminate the problem. The report recommends that the public be educated on proper food waste management. To ensure that education programs have an impact, Wheelie-bins need to be subject to a regular surveillance program. The current Darwin City Council plans to prosecute continuing 'offenders' can be backed up by provisions in the Public Health regulations. If this system fails to have a significant influence on bin infestation, the Darwin City Council will need to reassess the frequency of bin collection.
1.0 **BACKGROUND**

Wheelie-bins were introduced to Darwin between March and May 1990 by the Darwin City Council (DCC). Since their introduction there has been a perception on the part of at least some of the public that blowfly numbers have increased in the Darwin urban environment. This has been attributed to the reduction in bin collection frequency from twice per week prior to the introduction of Wheelie-bins to once per week. In response to the public concerns the DCC contacted the Medical Entomology Branch (MEB) of the Department of Health and Community Services for assistance.

An extensive fly monitoring survey was undertaken in Darwin and Palmerston by the MEB during September and October 1990. This survey used a sticky trap baited with a synthetic lure called Swormlure. The survey was carried out to determine species prevalence and composition in Palmerston and Darwin. This survey found that numbers of the green blowfly *Lucilia cuprina*, which was the major species trapped, were almost seven times greater on average at the twenty trap sites in Darwin than at the four trap sites at Palmerston. Since Palmerston did not have Wheelie-bins this difference in the number of *L. cuprina* was considered to be a result of the introduction of Wheelie-bins to Darwin. However, the numbers of *Chrysomya megacephala* were similar in both Palmerston and Darwin.

A survey of Wheelie-bins in Darwin was carried out during September 1990 by staff of the Darwin City Council. During this survey 1319 randomly-selected Wheelie-bins were inspected for levels of maggot infestation and for methods of household garbage management. The survey found that 73.4% of all Wheelie-bins had some level of maggot infestation.

As a result of these surveys the DCC decided, on advice from the MEB, to carry out a weekly monitoring survey of the blowfly population to determine seasonal prevalence of different blowfly species. The DCC commenced a survey in early April 1991 with professional support provided by the MEB. Due to the high labour component involved with the sticky traps an alternative trap, the Efekto fly trap, using a different attractant, is being used. Initially planned for 6 months, the survey has been extended to 12 months duration.

In August 1991 the MEB provided the DCC with a preliminary report on the monitoring survey. This report indicated that numbers of the large blue blowfly *C. megacephala*, the major species trapped, fluctuate from week to week with no overall trend to increase or decrease seasonally. Numbers of the green blowfly *L. cuprina* trapped were more than twenty times less the number of *C. megacephala* trapped. There were no significant differences between *L. cuprina* catches at different sites. There was a significant difference in the *C. megacephala* catches at different
sites but the catch at Palmerston lay in the median range of trap catches.

The report made clear that the survey of blowfly numbers contributed little on its own to the debate on whether and to what extent Wheelie-bins were contributing to blowfly numbers. Consequently the MEB proposed a number of changes to assist in the resolution of the problem. The major proposal was an experiment to determine whether Wheelie-bins produced blowflies and, in that instance, what factors might influence numbers of blowflies produced. The DCC did not see these additional investigations as being part of the original proposals and the MEB has subsequently carried out these investigations. Further work including a Wheelie-bin survey and phone-survey have also been carried out by the MEB. This report details the results of the experiments and the Wheelie-bin and phone survey.

2.0 AREA OF STUDY

The weekly survey of blowfly numbers is based on seven sites in Darwin and one in Palmerston. These sites are suburban yards in the suburbs of Nakara, Karama, Alawa, Milner, Wagaman, Anula, Parap and Gray. The experimental work was carried out mainly in a suburban yard in Karama. The phone survey included residents from Karama and from all suburbs in Palmerston. The Wheelie-bin survey was undertaken for part of Karama and part of Malak.

3.0 AIM OF REPORT

The report aims to clarify and resolve some of the more important questions under discussion regarding the Wheelie-bin/blowfly association in Darwin. These questions are:—

1. What is the nature of the blowfly problem in Darwin?
2. Is there a Wheelie-bin/blowfly association and if so what is the nature and extent of that association?
3. Are there solutions to the blowfly problem?

4.0 INVESTIGATION METHODS

4.1 Wheelie-bin/blowfly Association Trial

4.1.1 Estimated larval production from Wheelie-bins under different garbage packaging regimes

A series of trials commenced in October 1991 and completed in November 1991 sought to define the relationship between Wheelie-bins and blowflies. The major trial aimed to link blowfly larvae production in Wheelie-bins with adult blowfly numbers. The experimental design (Table 1) was based on having two main treatments of bin exposure time within which
were three sub-treatments of different garbage handling methods. Each sub-treatment was replicated six times.

The term garbage in Table 1 refers to an open 1L plastic container holding an average of 272g of mixed Chinese take-away and 93g of beef rib. Each of the six sub-treatments consisted of six such containers (six replicates). All containers were frozen prior to the experiment to destroy any eggs that may have been present. Sub-treatment 3 garbage was then exposed to blowflies for two hours to simulate placing pre-struck garbage into Wheelie-bins.

Garbage containers in each sub-treatment were placed in a supermarket bag tied by the handles. Garbage containers in sub-treatment 1 were subsequently placed in a second supermarket bag tied by the handles. All supermarket bags used contained no holes. Each sub-treatment of six bagged garbage containers was placed within an empty Wheelie-bin. The Wheelie-bins were positioned in a 2 x 3 grid of 2m x 2m squares in a grassed suburban backyard in Karama. Sub-treatments were randomly allocated within treatments. Bins within treatment 1 had their lids lifted for half an hour each day at 4.30 pm for six days. Bins within treatment 2 had their lids lifted for two minutes each day. On the final day bins were removed to the laboratory and weight loss for each garbage container measured.

The control trial, to determine loss to evaporation only from single-bagged and double-bagged containers, followed the methodology of treatment 1 except that insects were excluded by a screen placed between the lid and the bin receptacle. The average weight of mixed Chinese take-away and beef rib garbage was approximately the same as the main trial (275g and 97.0g respectively).

Temperature and relative humidity conditions within bins and external to bins were monitored at intervals in the trials by using thermohygrographs.

A laboratory trial was run to estimate individual larval consumption. In this trial seventy-two newly emerged first instar C. megacephala larvae were removed from the same egg batch and placed in groups of six on standard quantities of mince. Larvae were kept under a temperature regime of 30.5°C for 14 hours and 26°C for 10 hours. Controls were maintained for each batch of six larvae. The estimate of weight loss due to individual larval feeding was made by determining the final mean body weight for each larva and adding to it the mean net weight loss in the diet due to individual larval feeding.
4.1.2 Adult Emergence Trapping

Following observation of wandering stage blowfly larvae in Wheelie-bins on day 3, emergence trap bases (1m x 1m) were placed around Wheelie-bins of treatment 2. A fourth emergence trap base was placed adjacent to the experimental site (approx 2m away) to act as a control trap. On removal of the Wheelie-bins, covers were secured over the trap bases. Each trap cover held a plastic container with an inverted cone designed to trap blowflies flying from emergence sites toward the light. These plastic containers were checked daily for nine days after removal of the Wheelie-bins. Plastic containers holding flies were removed and replaced with empty containers. The flies were later identified to species level in the laboratory.

4.2 Additional Trials

4.2.1 Time of Escape and Total Blowfly Larval Production from a Wheelie-Bin

A trial was undertaken to confirm observations made during the Wheelie-bin/blowfly association trial that blowfly larvae mainly escape from Wheelie-bins overnight and to determine the total number of larvae produced from a certain volume of organic matter. Six 1 litre plastic containers holding an average of 277.9g of mixed Chinese take-away and 92.75g of beef rib were exposed for four hours to blowflies in the field. Each container was then placed in a supermarket bag, containing no holes and tied by the handles. All six bags were then placed in an empty Wheelie-bin. To trap wandering-stage larvae the Wheelie-bin was positioned in a 1mx1m water trap. Detergent and Abate 100E insecticide were added to kill escaped larvae. The water trap was emptied each morning at 9.00am and each afternoon at 4.30 pm from day 3 after diet exposure to blowflies until day 7. Larvae found in the water trap at each of these periods were categorized and counted. At day 7 all remaining larvae within the bin were counted.

4.2.2 Fly Pupation in a Wheelie-bin

To determine whether wandering stage larvae would pupate within a Wheelie-bin and what level of survival could be expected, one hundred wandering stage C. megacephala larvae were introduced to a bin containing damp paper. Larvae were prevented from escaping by a masonite board placed over the bin receptacle. Any emerging flies were directed into a plastic trap container at the top of the Wheelie-bin. The experiment was monitored daily until no further flies emerged.
4.3 Seasonal Blowfly Occurrence

4.3.1 Efekto Fly Trap Survey

The survey of blowflies in Darwin and Palmerston is a DCC project with MEB assistance. The methodology has been previously described in the Preliminary Blowfly Survey Report (Logan 1991). Briefly, an Efekto fly trap is set at each of seven locations in Darwin and one in Palmerston each week. The traps are collected after two days. An estimate of total flies caught per trap is made by comparing the trap volume of flies with known standard volumes. A subsample of fifty flies is identified to species level from each trap. This report provides an update of the results of the survey.

4.3.2 Comparison of Fly Trap Methods – Sticky trap vs Efekto Trap

The fly-trapping survey undertaken by the MEB in conjunction with DCC during September-October 1990 utilized a sticky trap baited with Swormlure. That survey found a predominance of L. cuprina. The fly-trapping survey currently in operation, using the Efekto fly trap, predominantly catches the large, blue blowfly C. megacephala. The difference in species predominance between trap types led to speculation that traps sampled different sections of the blowfly population. To test this hypothesis a sticky-trap was placed in a suburban yard in proximity to an Efekto fly trap at each of the eight regular trap sites. This trial ran for two alternate weeks in October 1991.

4.4 Wheelie-bin inspection survey in Karama & Malak

On 8 November 1991 an inspection was made of Wheelie-bins positioned on suburban kerbs ready for collection in areas of the suburbs of Karama and Malak. Inspections commenced at 6.30 am (on bin collection day) at the end of the bin collection run for the suburb. The aim was to inspect at least one hundred bins before and after collection in each suburb. Inspection involved determining the packaging type used, the presence of larvae and pupae and the presence of organic matter (refer Table 2, Appendix A for the type of data collected). Bins were inspected within one to two hours after the first inspection. Post-collection inspections were made of the same bins previously inspected. Results are described under 5.8.

4.5 Blowfly telephone survey

A telephone survey of 100 residents of Karama and 100 residents of Palmerston was carried out between November 12 and November 14 1991. The survey was aimed principally at determining whether the public perceived that a blowfly
problem existed in their area. The phone survey protocol and list of questions is presented in Appendix B.

5.0 RESULTS

5.1 Larval Production From Wheelie-bins Under Different Garbage Exposure Regimes

A statistical analysis was made of garbage weight loss over six days (Table 2). The analysis indicates that there is no significant difference in weight loss per container between the two main treatments. There are significant differences between subtreatments within treatments. In treatment 1 (lid lifted 30 mins/day) garbage that was single-bagged showed a significant reduction in weight compared to double-bagged garbage and pre-exposed garbage. In treatment 2 (lid lifted 2 mins/day) double-bagged garbage lost significantly less than single-bagged garbage and pre-exposed.

The mean garbage weight loss for each of the six subtreatments can be converted to an estimate of total larval production from each Wheelie-bin by the formula given below:-

\[
\text{(Total garbage mean wt. loss - mean loss of volatiles)} \\
\text{Mean wt loss due to individual larval feeding} \\
= \text{Estimate of total production of larvae per bin}
\]

Mean loss of volatiles from garbage containers is dependent on whether the container was single-bagged (mean loss = 23.9g over six days) or double bagged (mean loss = 13.4g over six days). The mean weight loss due to individual larval feeding was calculated as 0.17g. The estimate of total blowfly larvae production per bin range from 1000 to 6250 (refer to figure 1).

The time taken for each garbage container to become struck (having eggs laid in it) was noted during the course of the trial. Eleven of the twelve containers (excluding those pre-exposed) in treatment 1 (exposed for half an hour) were struck a day after being placed in Wheelie-bins. Double-bagging only prevented one container from being struck on the first day but this container was found to be struck the following day. For containers in treatment 2 (exposed for two minutes) eight of the twelve, that were not pre-exposed, were struck a day after being placed in the wheelie-bin and a further two more struck the next day.

An average of 24.4 larvae were sampled from each bin on days 4, 5 and 6 of the trial. Larval samples from the bin containing sub treatment 1(3) (pre-exposed + 2 mins) included 50.7% (n=71) Chrysomya rufifacies. All remaining larvae
sampled, except for two identified as Chrysomya saffranaea, were C. megacephala.

5.2 Adult Emergence Trapping

The numbers of adult blowflies trapped were 725, 1556 and 57 for traps placed over bin sites and 0 for the control trap (figure 2). The number of blowflies trapped for each treatment is an underestimate of the total number of blowflies that emerged. This is because blowflies were observed to escape from the emergence traps on day 4 of the emergence trapping period.

5.3 Temperature and Relative Humidity conditions within Wheelie-bins

Temperatures within Wheelie-bins follow a similar pattern of rise and fall to external temperatures. The minimum temperature is reached between 6.00am and 8.00am after which temperatures rapidly rise to a peak between 2.00pm and 4.00pm. The fall in temperature after 4.00pm is more gradual than the preceding rise after 8.00am. In Wheelie-bins temperatures during 2.00pm and 4.00pm may exceed external temperatures by 5°C or more. If Wheelie-bins are positioned in full sun temperatures within the Wheelie-bin can reach more than 40°C between 2-4 pm.

Relative humidity within Wheelie-bins follows a modified pattern in comparison to externally measured relative humidities (figure 3). Within Wheelie-bins, containing a moisture source relative humidity rises faster than external relative humidities in the period after 2.00pm and plateaus between 8.00pm and 10.00pm at 85-95% relative humidity. Externally measured relative humidities do not plateau but gradually rise until a maximum between 6.00am and 8.00am.

5.4 Time of escape and total blowfly larval production from a Wheelie-bin

The total number of blowfly larvae produced from approximately 2.2 kg of food scraps was 6583 (Table 3). The overwhelming majority of maggots crawled out of bins overnight. A breakdown of the species and time of escape of wandering stage larvae from the bin is provided in figure 4.

5.5 Fly pupation in a Wheelie-bin

Of 100 C. megacephala larvae at wandering stage introduced to a Wheelie-bin with moist paper, twelve died before reaching the pupal stage and eight pupae failed to successfully develop into adults. The remaining eighty completed pupation and escaped into the emergence trap container.
If larvae are provided with relatively dry top soil the percentage that successfully develop to adulthood is high. Of 284 C. megacephala larvae 263 (92.6%) developed into adult flies. For L. cuprina 24 (96%) of 25 larvae successfully completed pupation. For C. rufifacies 35 (85.4%) of 41 larvae successfully completed pupation.

5.6 Seasonal blowfly occurrence

An analysis of Efekto trap catches of C. megacephala over the period from early April to early August 1991 provided in the Preliminary Blowfly Report indicated that numbers of this blowfly fluctuate with no overall trend to increase or decrease. This pattern has been maintained to date (see Fig 11).

Analysis of mean numbers of L. cuprina trapped at the seven Darwin sites for the period of trapping up to 9-11 July 1991 and for the period of trapping from 16-18 July 1991 to 22-24 October 1991 indicates that for the latter period numbers of L. cuprina trapped was significantly higher than for the earlier period (t-calc = 4.379 significance level 0.01).

The numbers of C. megacephala using Efekto traps are lower in Palmerston than the average of all the traps in Darwin (see fig 5).

The numbers of L. cuprina using Efekto traps indicated low numbers of L. cuprina in Palmerston when compared with the average of all the traps in Darwin (see fig 6).

Corresponding peaks in blowfly numbers trapped in Palmerston and in Darwin by Efekto traps (17-19 Sept, 15-17 Oct) may be coincidental. Generally the variation in weekly occurrence of C. megacephala and L. cuprina in traps set in both Darwin and Palmerston are independent of each other.

The mean numbers of C. megacephala trapped by weekly Efekto traps for each suburb show that the trap catches at Palmerston were not significantly different from four Darwin suburbs, but were significantly less at the 5% level than four others (see Fig 10). Parap recorded the least numbers of C. megacephala for all sites sampled, but the numbers trapped increased over the last six weeks compared with the earlier period (see Fig 12).

5.7 Comparison of Fly-trapping methods

A series of t-tests were used to determine whether there was any significant difference in the proportion of different blowfly species trapped by the Efekto-fly trap and the swormlure-baited sticky trap (Table 4). There were highly significant differences between the traps in both periods of
trapping for the two major blowfly species L. cuprina and C. megacephala. A visual breakdown of the species spectrum captured by each trap type is given in fig 7a and 7b. The pie-graphs indicate that Efekto-trap-catches are made up of a higher proportion of C. megacephala than L. cuprina. In terms of the ratios of blowfly species caught the Efekto flytrap is 2.15 times more likely to capture an individual C. megacephala than is the sticky trap. However it is six times less likely to capture a single L. cuprina than is the sticky-trap.

The ratio of C. megacephala to L. cuprina in the Efekto fly trap was on average 10.3:1. By comparison the ratio of C. megacephala to L. cuprina in the sticky traps was on average 0.9:1.

In numerical terms the Efekto-fly trap may catch up to 100 times more C. megacephala over the same time period than the sticky-trap. However it is likely to catch an equivalent number or less of L. cuprina over the same time period. Table 5 provides a comparison of results of sticky-trap data from September and October 1990 with results of Efekto fly trapping during September and October 1991. Figures for sticky-trap captured C. megacephala are transformed by multiplying by 33 to compare with Efekto fly data. Figures for sticky-trap captured L. cuprina are multiplied by 0.48.

5.8 Wheelie-bin survey of Karama and Malak

An overall summary of results from the Wheelie-bin inspection survey is given in Table 6. There were 272 households in Karama checked (approx 20% of all households in Karama) and 252 households in Malak checked (28% of all households in Malak). More than half (57%) of all bins checked before and after collection for houses in Karama had some level of larval and/or pupal infestation. For houses in Malak 72.7% of all bins checked before and after collection had some level of larval and/or pupal infestation.

5.9 Blowfly Telephone Survey

The phone survey had the principle aim of determining whether members of the Public in Karama and Palmerston believed blowflies occurred at nuisance levels. The frequency at which blowfly problems occurred as perceived by phone respondents in Karama and Palmerston is shown graphically in fig. 8. Information from questions 3 and 4 of the phone survey is summarised in the form of regression lines for Karama and Palmerston (fig.9). These lines represent the proportion of phone respondents in each area who consider x number of blowflies tolerable. For example no respondents in Karama would be tolerant of 17 blowflies either inside or outside their home on any given day but
3.4% of respondents in Palmerston would tolerate this number of blowflies. Half (50%) of the respondents in Karama consider more than 4.7 (=5) blowflies per day at home is a nuisance. However two-thirds (66.8%) of respondents in Palmerston would tolerate the same level of blowflies at home per day.

Phone respondents were asked whether they felt that their city had a blowfly problem. Of those respondents from Karama 59.5% felt that their city (Darwin) had a problem. By comparison only 16.3% of respondents from Palmerston felt that their city had a problem (refer Table 8).

6.0 DISCUSSION

6.1 The Wheelie-bin/blowfly Association

There is no doubt that refuse containing meat scraps placed in Wheelie-bins can lead to significant blowfly production (fig 2). From the data collected in the series of experiments described in this report, a reasonably accurate picture of the Wheelie-bin/blowfly association can be given.

Vegetable and meat scraps can lead to blowfly production if placed in Wheelie-bins in the first four days after Wheeliebin collection. Blowflies need only enter Wheelie-bins once during those four days to produce large numbers of maggots. Dependent on species and the size of the female, 100-400 eggs can be laid in a single batch. If the bin lid is intact and kept shut blowflies are not able to enter bins. However blowflies will gain access to bins once the lid is opened, even if only for a short period of time. Adult females are attracted by volatiles coming from decomposing meat and vegetable matter and can locate the source within the Wheelie-bin if it is accessible. Meat and vegetable scraps contained in supermarket bags are generally accessible to blowflies which will readily crawl into the bags to lay eggs. In the trial double-bagging garbage resulted in fewer maggots being produced than single-bagging garbage (refer fig 1) but did not preclude garbage from becoming struck reasonably quickly. For example most garbage containers contained blowfly eggs one day after being placed in wheelie-bins (see Results section 5.1).

In the laboratory C. megacephala develops from egg to wandering stage larva in 72 hours when temperatures are constant at 30.5°C for 14 hours during the day and 26°C for ten hours overnight. This period may be shorter with increased temperatures. For L. cuprina the minimum period of development from egg to wandering stage larva is less than 36 hours at 39°C (Kitting 1981). Within Wheelie-bins temperatures often reach high levels. Where organic matter contains high moisture levels these temperatures are not likely to restrict larval growth. Occasionally within a bin
blowfly larvae will be attacked by carnivorous associates. Such an event occurred in the Wheelie-bin/blowfly trial when carnivorous C. rufifacies larvae probably destroyed large numbers of other blowfly larvae in treatment 1 (exposed for half an hour) subtreatment 3 (pre-exposed) (fig 1).

When larvae reach wandering stage they begin to search for a suitable pupation site. Some pupation sites are found in the Wheelie-bin, either on the inner walls or on relatively dry waste surfaces. Alternatively many larvae escape from bins to pupate in the surrounding lawn or open soil areas. When escaping from bins larvae are not impeded by closed lids. Larvae leave bins principally overnight. This larval migration is assisted by two coincidental factors. Overnight the air in Wheelie-bins, which is at 90% relative humidity (fig. 3), is cooled to below dew point by a drop in temperature of less than 2°C. The resultant moisture film on the bin wall in combination with the lack of strong light provides good conditions for larvae to migrate up the bin wall and escape.

Once escaped, larvae may wander several metres if suitable pupation sites are not immediately available. Larvae burrow into cracks within soil where they contract to form prepupae. This stage lasts less than a day before development into the pupal stage occurs. Successful pupation is most likely if soil conditions are relatively dry. The length of pupation differs for different blowfly species. In containers in the laboratory at 31°C C. megacephala and C. rufifacies remain in the pupal stage for four days. The green blowfly L. cuprina pupates for six days at 31°C.

The total length of the lifecycle from egg to the end of pupation is eight days for C. megacephala at 31°C and ten days for L. cuprina at 31°C. The length of these lifecycles may vary by one or two days throughout the year in Darwin depending on temperatures.

6.2 The Blowfly problem in Darwin

Most respondents in the phone survey (60% Karama) felt that Darwin had a problem with blowflies. Much fewer phone survey respondents (16%) from Palmerston felt that there was a blowfly problem in Palmerston. The opinions reflect the type of response given to the question 'Do you feel there is a problem with blowflies at your home?' (fig 8). Less than half of the phone respondents from Karama (45%) felt that there was rarely or never a problem compared with a majority of phone respondents from Palmerston (79%). Only 5% of phone respondents from Palmerston believed there was often a problem but 25% of phone respondents from Karama felt there was often a problem. This represents a clear difference in the perception of the frequency of blowfly problems between
respondents in Palmerston and Karama. These differences may be related to reduced blowfly catches by fly traps in Palmerston compared with Darwin.

The trap comparison study indicates that Efekto fly traps have a bias toward catching *C. megacephala* in comparison with the swarmlure-baited sticky traps. Sticky-traps have a bias toward capturing *L. cuprina*. Transforming fly-trapping data from September and October 1990 into Efekto trap data (Table 5) implies that numbers of *L. cuprina* and *C. megacephala* have increased in Darwin since last year. For Palmerston the implication is that numbers of *L. cuprina* and *C. megacephala* remain at comparable levels. These conclusions must be regarded with some reservation however as there is variation in the numbers and species of blowflies trapped over time and a large variation between particular sites.

The analysis of the Efekto trap results from April to October 1991 indicates that *C. megacephala* numbers at Palmerston are not statistically different to the numbers in Parap where the least number of flies were recorded. The reason for the relatively low numbers recorded in Parap is unclear. The overall low numbers are largely due to the trap results for the first three quarters of the trap period. Later trap catches show a rise, indicating that the reasons for the low numbers in Parap is not consistent. The lower numbers of *C. megacephala* trapped in Palmerston is seen as an indication that twice weekly collection of garbage leads to lower numbers of blowflies. The fact that there are still a certain level of blowflies in Palmerston indicates that there are either some non bin sources of flies, or more probably, that even with a twice weekly collection of standard bins, there is still blowfly breeding occurring due to inadequate management of garbage by the residents.

There is considerable variation between trap catches of *C. megacephala* from week to week in some sites (eg see fig 12). This may be due to local conditions of garbage management near the trap site or local disruptions to the Trap. The explanation of this variation will require coordinated bin surveys in each trap locality and a better knowledge of the effective flight range of this species in suburban areas.

Although the phone survey indicates that respondents in Palmerston have fewer blowfly problems than respondents in Karama, the latter are less tolerant of blowflies than the former (fig 9). For example, while five blowflies at home will constitute a blowfly problem to 50% of households in Karama, eight blowflies at home will be a blowfly problem to 50% of households in Palmerston. This higher tolerance level to blowflies in Palmerston could be arguably due to a higher or a lower level of flies. It is however more
probable that the latter is true, as there were less blowflies in Palmerston on average than in Darwin. An explanation is that a blowfly problem encountered rarely can be tolerated better than an equivalent blowfly problem encountered often.

Phone respondents were most likely to regard their city as having a problem if they themselves encountered blowflies often at home. This reflects what is most likely to be the core of the blowfly problem — individual kitchen waste management. The most important contributing factor to blowfly breeding in Wheelie-bins is ineffective wrapping of kitchen waste containing meat scraps. This source of blowfly breeding is exacerbated the longer the kitchen meat scraps are available for blowflies to strike. Other habits which may contribute to the blowfly population include the failure to destroy pupae and wandering stage larvae remaining in bins after bin collection. In the Wheelie-bin survey of Malak 112 of 194 bins checked after bin collection, contained over 3000 pupae and wandering stage larvae. In Karama 81 bins of 163 checked after collection contained around 2000 pupae and wandering stage larvae. Washing bins containing wandering stage larvae onto lawn or open soil, with water, is likely to be another source of blowflies. Since blowfly larvae are virtually semi-aquatic they will readily survive being washed out of bins and given suitable sites will burrow into soil to pupate.

The Wheelie-bin survey of part of Malak and Karama found considerable numbers of bins with larvae and/or pupae present (72.7% and 57% respectively). These figures are comparable to the level of Wheelie-bin infestation found in the DCC Wheelie-bin survey of Darwin in September 1990. In that survey 73.4% of 1319 randomly selected bins had some level of blowfly larval infestation. One interpretation is that the results of the current non random bin survey in Karama and Malak (the area of higher blowfly numbers), when compared to the results of the previous random bin survey, indicates that the level of infestation in bins may have been reduced. However as mentioned previously, the transformed results of the previous sticky trap results into Efecto trap data indicates that the numbers of adult flies of both species may have increased in Darwin since last year while the numbers of both species in Palmerston have remained approximately the same. This indicates that while there may have been some improvement in the public handling of waste, this has made little difference to total fly numbers.

The levels of bin infestation found in this bin survey should be of concern. They will certainly contribute significant numbers to Darwin’s blowfly problem. Considerable changes in garbage management are needed if blowfly numbers are to be reduced to below current levels.
6.3 Solutions

The major household blowfly prevention measure is for food waste to be immediately and properly sealed in a container. Currently supermarket bags are the predominant form of packaging used (Table 7). Tying the bag handles in most cases results in an ineffective barrier to flies if kitchen meat scraps are present. These scraps must be placed in small quantities in bags containing no holes and tied below the handles (if a supermarket bag). Objects with sharp edges should not be placed in bags or adjacent to bags containing organic waste. If bags contain no holes adult flies cannot enter to lay eggs or if garbage is already flyblown, larvae cannot escape to pupate. Householders also should endeavour to reduce the amount of liquid placed in Wheelie-bins as this assists larval survival by increasing humidity levels. Wrapping garbage in newspaper before placing in plastic bags provides an additional barrier to blowflies laying eggs. Wrapping garbage in newspaper alone is likely to be less effective than plastic bags since such wrapping can fall apart once thrown into a bin.

If there are maggots remaining in the bin after collection, they should be killed by an insecticide or a physical method.

Washing out the bins with water so that the liquid runs onto the road surface or concrete should reduce larval survival.

Some comment has been made regarding bin design, for example raising the lip to sit flush with the lid. However, any impact of design changes will be lost if the bin is overfilled or if larvae are washed out of the bin after bin collection.

The effectiveness of a slow release insecticide strip placed in bins is dependent on a number of factors including the amount of garbage within the bin and the dose of insecticide available to kill larvae. Protection from wrapping and the mass of the food refuse are likely to prevent maggots coming into contact with lethal doses of insecticide.

Inserting a repellant, insecticidal block inside Wheelie-bin lids may deter adult blowflies from entering bins to lay eggs and kill larvae within bins. Without trialing such an approach, its effectiveness in reducing blowfly numbers and its cost are largely unknown.

There has been some public discussion on the frequency of bin collection and its relationship to blowfly numbers. According to the data provided in this report Wheelie-bins need to be emptied three times per week to prevent blowfly breeding (unless food scraps are already fly-blown before being put into the bin). Twice weekly collection will not
prevent breeding but would have a major effect by reducing the opportunity for eggs to develop to wandering larva stage. With once weekly collection much more emphasis needs to be placed on correct packaging to prevent kitchen refuse from becoming fly-blown.

Recently the DCC completed a Wheelie-bin survey of Darwin. Households whose bins contained blowfly larvae received an open letter from the Lord Mayor and a copy of appropriate Council by-laws. A subsequent survey is planned to identify 'repeat offenders' who may eventually be subject to prosecution by the DCC. This approach should certainly make food waste management a subject of public attention. The important issues are whether it is possible to change the garbage handling methods for up to seventy percent of the residents, and whether prosecution will lead to major logistic, legal or public relations problems for the Council.
0 RECOMMENDATIONS

If once weekly collection is to remain, those members of the Darwin public responsible for allowing their Wheelie-bins to generate blowflies need to be educated in proper food waste disposal methods. The principle message of prevention is simple – if kitchen refuse is placed in bins it needs to be completely sealed in plastic containers. Bins should be washed out in a place or manner that will inhibit the survival of maggots remaining in the bin after collection.

In conjunction with an education program some method of measuring its impact needs to be in place. Inspection of bins is a sound method. Such inspections should be city-wide and on a regular basis.

'Repeat' offenders need to be made aware of the potential prosecution risk they face.

If 'repeat' offenders fail to heed such notices prosecution should be proceeded with. Provisions for prosecution exist under DCC by-laws and in the Public Health regulations of the NT Government.

If, after a reasonable period of time, education and prosecution measures fail to have a significant impact on the blowfly problem, consideration will need to be given to increasing the frequency of bin collection.
1.0 REFERENCES


Acknowledgements

This report has been produced largely as a result of concerns held by the Senior Entomologist, Peter Whelan, to resolve the wheelie-bin/blowfly problem. His guidance and assistance prior to and during the course of the project are acknowledged.

Annons Waste Disposals supplied wheelie-bins for the trials and the Genghis Khan Restaurant provided kitchen scraps.

Julie Tyson and Bob Richards generously provided their backyard for the wheelie-bin/blowfly association experiment.

Staff from the Medical Entomology branch - Wendy Kelton, Paul Donaldson and Gwenda Hayes took part in the wheelie-bin survey. Wendy Kelton and Paul Donaldson were responsible for carrying out the phone survey of Palmerston and Karama.
Table 1. Experimental design of the wheelie-bin/blowfly association trial. Each subtreatment+treatment combination contained six replicates.

<table>
<thead>
<tr>
<th>Subtreatment</th>
<th>Treatment 1</th>
<th>Treatment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bin lid lifted for</td>
<td>30 minutes/day</td>
<td>2 minutes/day</td>
</tr>
<tr>
<td>Garbage double-bagged</td>
<td>1[1]</td>
<td>2[1]</td>
</tr>
<tr>
<td>Garbage pre-exposed</td>
<td>1[3]</td>
<td>2[3]</td>
</tr>
</tbody>
</table>
Table 2. Nested ANOVA of garbage weight loss for three sub-treatments of garbage packaging within two treatments of garbage exposure time. Sub-treatment means are listed with the calculated Least Significant Differences for the .01 and .05 levels of significance.

<table>
<thead>
<tr>
<th>Source var.</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F-calc</th>
<th>Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments(A)</td>
<td>1</td>
<td>4609.5</td>
<td>4609.5</td>
<td>3.318</td>
<td>NS</td>
</tr>
<tr>
<td>Subtr.(B(A))</td>
<td>4</td>
<td>114202</td>
<td>28550.5</td>
<td>20.55</td>
<td>0.01</td>
</tr>
<tr>
<td>Error</td>
<td>30</td>
<td>41680</td>
<td>1389.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>35</td>
<td>160491.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub−</th>
<th>Subtreatment description</th>
<th>mean weight loss (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1[1]</td>
<td>Double-bagged+30mins</td>
<td>93.54</td>
</tr>
<tr>
<td>1[2]</td>
<td>Single-bagged+30mins</td>
<td>164.49</td>
</tr>
<tr>
<td>1[3]</td>
<td>Pre-exposed+30mins</td>
<td>100.53</td>
</tr>
<tr>
<td>2[1]</td>
<td>Double-bagged+2mins</td>
<td>41.91</td>
</tr>
<tr>
<td>2[3]</td>
<td>Pre-exposed+2mins</td>
<td>200.42</td>
</tr>
</tbody>
</table>

Least Significant Difference (LSD) between sub-treatments (g. weight loss)

<table>
<thead>
<tr>
<th>level of significance</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>59.74</td>
</tr>
<tr>
<td>0.01</td>
<td>99.08</td>
</tr>
</tbody>
</table>

Groups with significant differences

level = .05 2[3],2[2],1[2] 1[3],1[1],2[1]

level = .01 2[3],2[2],1[2] 1[3],1[1],2[1]

2[2],1[2],1[3],1[1] 2[3]

2[2],1[2],1[3],1[1] 2[1]
Table 3. Total number and species of blowfly larvae produced by pre-exposing 2.2kg of kitchen refuse containing meat. Refuse was packaged in 6x1L containers each in a supermarket bag tied by the handles and placed in an empty wheelie-bin. Escaping larvae were trapped by a water barrier containing an insecticide.

<table>
<thead>
<tr>
<th>Species of blowfly</th>
<th>Lucilia cuprina</th>
<th>Chrysomya megacephala</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of escaped larvae</td>
<td>3689</td>
<td>1270</td>
</tr>
<tr>
<td>Number of larvae remaining in bin after 7 days</td>
<td>20</td>
<td>1604</td>
</tr>
<tr>
<td>Total</td>
<td>3709</td>
<td>2874</td>
</tr>
<tr>
<td>Combined total</td>
<td>6583</td>
<td></td>
</tr>
</tbody>
</table>
Table 4. Analysis of proportions of different blowfly species caught by Swornlure-baited sticky-traps and Efekto fly traps at 8 sites over two weeks. The method of analysis used was the t-test for paired samples where the paired sample was the number of particular species caught by each trap type.

<table>
<thead>
<tr>
<th>Paired samples</th>
<th>week</th>
<th>t-calc</th>
<th>significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.megacephala</td>
<td>1</td>
<td>4.88</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.67</td>
<td>0.001</td>
</tr>
<tr>
<td>L.cuprina</td>
<td>1</td>
<td>4.88</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4.57</td>
<td>0.01</td>
</tr>
<tr>
<td>C.varipes</td>
<td>1</td>
<td>1.65</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2.63</td>
<td>0.05</td>
</tr>
<tr>
<td>Sarcophaga spp.</td>
<td>1</td>
<td>1.68</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3.13</td>
<td>0.05</td>
</tr>
<tr>
<td>Other Diptera</td>
<td>1</td>
<td>2.82</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4.45</td>
<td>0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>level of significance</th>
<th>tabulated t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001</td>
<td>5.405</td>
</tr>
<tr>
<td>0.01</td>
<td>3.499</td>
</tr>
<tr>
<td>0.05</td>
<td>2.365</td>
</tr>
</tbody>
</table>

note: NS = not significantly different
Table 5. Comparison of fly-trapping data collected by Swarm lure-baited sticky-traps set in September and October 1990 and Efekto fly-traps set in September and October 1991. Swarm lure-baited sticky-trap data has been transformed to equivalent Efekto data using conversion figures calculated from the Sticky-trap/Efekto trap comparison trial run in October 1991.

<table>
<thead>
<tr>
<th>Location</th>
<th>Species</th>
<th>Efekto-equivalent</th>
<th>Efekto</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>18-20</td>
<td>23-25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sep-90</td>
<td>Sep-90</td>
</tr>
<tr>
<td>Darwin</td>
<td><em>L. cuprina</em></td>
<td>131.5</td>
<td>78.2</td>
</tr>
<tr>
<td></td>
<td><em>C. megacephala</em></td>
<td>198</td>
<td>478.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27-29</td>
<td>2-4-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sep-90</td>
<td>Oct-90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14.4</td>
<td>16.3</td>
</tr>
<tr>
<td></td>
<td><em>L. cuprina</em></td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>Palmerston</td>
<td><em>C. megacephala</em></td>
<td>231</td>
<td>495</td>
</tr>
<tr>
<td></td>
<td></td>
<td>901</td>
<td>35</td>
</tr>
</tbody>
</table>
Table 6. Overall summary of results from the wheelie-bin inspection survey of part of Malak and Karama on 8 November 1991.

<table>
<thead>
<tr>
<th></th>
<th>Suburb</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Karama</td>
<td>Malak</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Houses</td>
<td>Flats</td>
<td>Houses</td>
</tr>
<tr>
<td>Bins checked</td>
<td></td>
<td>163</td>
<td>11</td>
<td>194</td>
</tr>
<tr>
<td>before and after</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>collection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With larvae/pupae</td>
<td></td>
<td>93</td>
<td>6</td>
<td>141</td>
</tr>
<tr>
<td>before collection</td>
<td>[57%]</td>
<td>[54.5%]</td>
<td>[72.7%]</td>
<td></td>
</tr>
<tr>
<td>With larvae/pupae</td>
<td></td>
<td>86</td>
<td>4</td>
<td>126</td>
</tr>
<tr>
<td>after collection</td>
<td>[52.7%]</td>
<td>[36.4%]</td>
<td>[64.9%]</td>
<td></td>
</tr>
</tbody>
</table>
Table 7. Phone survey and wheelie-bin inspection results of an enquiry into methods of foodscrap handling by the public. Results are expressed as percentages of the combined total (n) of flats and houses.

<table>
<thead>
<tr>
<th>Garbage handling method</th>
<th>Percentage of Total</th>
<th></th>
<th>Bin Survey</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Telephone Survey</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Karama n=99</td>
<td>Palmerston n=99</td>
<td></td>
</tr>
<tr>
<td>Supermarket bag</td>
<td>82.8</td>
<td>75.7</td>
<td>71.9</td>
<td>71.5</td>
</tr>
<tr>
<td>Garbage</td>
<td>34.3</td>
<td>48.5</td>
<td>31.6</td>
<td>34.8</td>
</tr>
<tr>
<td>Newspaper wrapping</td>
<td>23.2</td>
<td>30.3</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>No packaging</td>
<td>1</td>
<td>1</td>
<td>15.8</td>
<td>11.7</td>
</tr>
<tr>
<td>Compost</td>
<td>21.2</td>
<td>22.2</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Freezing prior to placing in bin</td>
<td>22.2</td>
<td>16</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Table 8. Percentage of phone survey respondents in Karama and Palmerston who believe their city has a blowfly problem.

<table>
<thead>
<tr>
<th>Type of residence</th>
<th>Darwin (Karama)</th>
<th>Palmerston</th>
</tr>
</thead>
<tbody>
<tr>
<td>House</td>
<td>64.10%</td>
<td>18.75%</td>
</tr>
<tr>
<td></td>
<td>n=78</td>
<td>n=80</td>
</tr>
<tr>
<td>Flat</td>
<td>42.80%</td>
<td>4.50%</td>
</tr>
<tr>
<td></td>
<td>n=21</td>
<td>n=18</td>
</tr>
<tr>
<td>Combined Total</td>
<td>59.50%</td>
<td>16.30%</td>
</tr>
</tbody>
</table>
Fig 1. Comparison of estimated blowfly larva production under different garbage handling and bin exposure regimes.
Fig 2. Numbers and species of blowflies collected from emergence traps set on sites previously occupied by wheelie-bins. Emergence traps covered an area of 1m square.
Fig 3. Comparison of changes in relative humidity within a wheelie-bin containing a moisture source and in the atmosphere immediately adjacent to the wheelie-bin. Relative humidity was measured using a hygrograph.
Fig 4. Numbers of different blowfly larvae species and time of escape from prestruck garbage in a wheelie-bin.

Time period from strike (approx. 4.30pm on Day 0)
Fig 5. Mean and Standard Deviation for numbers of *C. megacephala* trapped at 7 sites in Darwin compared with numbers of *C. megacephala* trapped at one site in Palmerston (using Efekto Fly-traps).

**KEY**
- Darwin mean plus/minus standard deviation
- Palmerston

Date of Efekto trapping - 1991
Fig 6. Mean and Standard Deviation for numbers of L. cuprina trapped at 7 sites in Darwin compared with numbers of L. cuprina trapped at one site in Palmerston (using Efekto Fly-traps).

**KEY**

- Squares: Darwin mean plus/minus standard deviation
- Circles: Palmerston

**Date of collection**

<table>
<thead>
<tr>
<th>9-11</th>
<th>16-18</th>
<th>23</th>
<th>30</th>
<th>7-9</th>
<th>14-16</th>
<th>21-23</th>
<th>28-30</th>
<th>4-6</th>
<th>11-13</th>
<th>18-20</th>
<th>25-27</th>
<th>1-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr</td>
<td>Apr</td>
<td>Apr</td>
<td>May</td>
<td>May</td>
<td>May</td>
<td>May</td>
<td>May</td>
<td>Jun</td>
<td>Jun</td>
<td>Jun</td>
<td>Jun</td>
<td>Jul</td>
</tr>
<tr>
<td>24</td>
<td>15</td>
<td>8-10</td>
<td>8-10</td>
<td>8-10</td>
<td>8-10</td>
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<td>8-10</td>
<td>8-10</td>
<td>8-10</td>
<td>8-10</td>
<td>8-10</td>
</tr>
</tbody>
</table>

**No. of adult trap flies per**

- 0-100
- 100-200
- 200-300
- 300-400
- 400-500
- 500-600
- 600-700
- 700-800
- 800-900
- 900-1000
Fig 7a. Mean percentage of fly species caught by Swornlure-baited sticky traps set at 8 different sites for two different time periods.

Week 1 (1-3 Oct)

- **C. megacephala**: 26.79%
- **Other Diptera**: 48.43%
- **Sarcophaga spp.**: 3.85%
- **C. varipes**: 3.34%
- **L. cuprina**: 4.15%

Week 2 (15-17 Oct)

- **C. megacephala**: 47.40%
- **Other Diptera**: 35.95%
- **Sarcophaga spp.**: 8.70%
- **C. varipes**: 4.10%
- **L. cuprina**: 3.85%
Fig 7b. Mean percentage of fly species caught by Efekto fly traps set at 8 different sites for two time periods.

Week 1 (1-3 Oct)

- C. megacephala: 14.25%
- L. cuprina: 71.25%
- C. varipes: 4.50%
- Sarcophaga spp.: 4.50%
- Other Diptera: 5.50%

Week 2 (15-17 Oct)

- C. megacephala: 10.00%
- L. cuprina: 10.50%
- C. varipes: 1.00%
- Sarcophaga spp.: 1.25%
- Other Diptera: 77.25%
Fig 8. Phone survey response to the question 'Do you feel there is a problem with blowflies at your home?' for residents in Karama and Palmerston.

Number of respondents

Frequency of blowfly problems at home

- None
- Rarely
- Sometimes
- Often

Palmerston
Karama
Fig 9. A comparison of the blowfly tolerance level of phone survey respondents from Palmerston and Karama. The lines indicate the proportion of respondents able to tolerate different levels of blowflies at home on any given day.

Percent of tolerant respondents

Number of blowflies per day encountered at home by respondents

--- Palmerston --- Karama
\[ y = 91.12 - 4.16x \]  \[ y = 69.17 - 4.05x \]
FIG. 10  MEAN NOS. OF C. MEGACEPHALA TRAPPED BY WEEKLY EFECTO TRAPS AT ALL SITES
9 APRIL TO 24 OCTOBER 1991
LSD = 571

TRAP SITE

Alawa
Karama
Nakara
Milner
Wagaman
Anula
Palmerston
Parap

Mean NOS. of C. Megacephala

0  500  1000  1500  2000  2500  3000
Average Number of Files (C. megacephala)

All Sites
Fig. 12  Weekly collection of Flies (C. megacephala)

Parap
Table 1. Data categories used in the wheelie-bin inspection of part of Malak and Karama on 8 Nov 1991.

Pre-collection inspection

<table>
<thead>
<tr>
<th>Map ref.#</th>
<th>time</th>
<th>residence</th>
<th>Bin out</th>
<th>Bin not out</th>
<th>Organic matter observed</th>
<th>not obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pupae</th>
<th>Larvae</th>
<th>Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>many (&gt;30)</td>
<td>many</td>
<td>many</td>
</tr>
<tr>
<td>moderate (6-30)</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>few (1-5)</td>
<td>few</td>
<td>few</td>
</tr>
<tr>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Post-collection inspection

<table>
<thead>
<tr>
<th>Pupae</th>
<th>Bin available</th>
<th>Larvae</th>
<th>Bin not available</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>large</td>
<td>small</td>
<td></td>
</tr>
<tr>
<td>many</td>
<td>many</td>
<td>many</td>
<td>many</td>
</tr>
<tr>
<td>moderate</td>
<td>moderate</td>
<td>moderate</td>
<td></td>
</tr>
<tr>
<td>few</td>
<td>few</td>
<td>few</td>
<td>few</td>
</tr>
<tr>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
</tbody>
</table>
BLOWFLY TELEPHONE SURVEY PROTOCOL

Interviewees should be selected from the listing of private telephone customers in the 1991 Telecom white pages. No business listings should be included in the survey.

Two telephone surveys are to be conducted. The first telephone survey will be of residents of Karama. The second survey will be of residents in Palmerston.

1. Open the 1991 white pages to the first page number in the list of randomly selected page numbers given below.

2. Start at the first listing on the top, left hand column of the page. Proceed down the column until a resident of Karama/Palmerston is listed.

3. Phone the resident and conduct the interview.

4. Continue down the column contacting all residents of Karama/Palmerston listed. When the end of the column is reached, start at the top of the next column to the right. Continue to the end of the page.

5. Select the next page number in the list. Proceed as directed in 1 - 4.

6. Continue the survey until 100 responses have been received from both Karama and Palmerston.

Randomly selected page numbers

KARAMA

149 184 88 173 124 111 151 58 175 132
198 68 112 160 101 97 100 129 110 194
129 195 72 179 174 84 108 123 82 102

PALMERSTON (Moulden, Woodroffe, Driver, Gray)

112 160 60 63 173 166 61 95 188 196
115 149 197 74 108 73 71 94 55 141
170 106 167 136 134 122 96 127 154 58
BLOWFLY TELEPHONE SURVEY

Good morning/afternoon, my name is .............. and I work for the Department of Health and Community Services. We are conducting a telephone survey on the presence of blowflies in your area. Could I speak with someone in your household over the age of 18, for a few minutes. Are you a resident of Karama (or Palmerston)?

Q1 What type of dwelling do you live in?
   - house
   - townhouse/duplex
   - flat/unit
   - other

Q2 Is your home fitted with insect screens?
   - completely (screened windows & doors)
   - partially
   - no

Q3 Do you feel that there is a problem with blowflies at your home?
   - often
   - sometimes
   - rarely
   - none

Q4 Would you encounter at least 1 blowfly per day?
   - Yes / No
   If yes what figure would you put on it?
   - 1 - 5
   - 6 - 10
   - 11 - 20
   - > 21
   If No would you encounter at least 1 blowfly every 2nd day?
   - Yes / No
   If No would you encounter at least 1 blowfly every week?
   - Yes / No

Q5 Do you consider blowflies a nuisance?
   - inside your home? Yes / No
   - outside your home? Yes / No
   - when you visit other homes? Yes/No
   - when you visit public places? Yes/No
   If No to all then go to question 7.
Q6 Under what circumstances do you consider blowflies are a nuisance?
   - everyday
   - BBQ/outside meals
   - weekends
   - evenings/mornings

Q7 Where do you store your (wheelie) bin?
   - on the lawn
   - on cement
   - in a wheelie bin bay

Q8 Have you missed a (wheelie) bin collection in the last month?
   - Yes / No

Q9 How do you handle your foodscrap?
   - wrap in newspaper before putting in (wheelie) bin
   - freeze before putting in (wheelie) bin
   - compost
   - supermarket plastic bag before putting in (wheelie) bin
   - garbag tied at top before putting in (wheelie) bin

Q10 If food scraps are placed in wheelie bins do you wash your wheelie bin out after collection?
   - regularly
   - sometimes
   - no

Q11 Do you feel that (wheelie) bins produce blowflies?
   - Yes / No

Q12 Do you feel that your (wheelie) bin produces blowflies?
   - Yes / No

Q13 Do you feel that Darwin has a blowfly problem?
   (Palmerston)
   - Yes / No

Thank the respondent
Record telephone number of respondent
Record address (ensure respondent presently residing in Palmerston or Karama).
Phone no: ....................

Address: ..........................................................