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Monitoring some muscoid fly populations on Massey University sheep farms in the Manawatu

Y.H. COTTAM, H.T. BLAIR AND M.A. POTTER.

College of Sciences, Massey University, Palmerston North, New Zealand.

ABSTRACT

Over three summers (1993-94, 1996 and 1996-97), four fly-traps were placed at each of two locations on Massey University farms. Caught flies comprised eight species, of which four are commonly involved in flystrike. Australian sheep blowfly *(Lucilia cuprina)* numbers caught varied dramatically between years. At the season peak, numbers in 1996 and 1996-97 were three and one and a half times higher, respectively, than in the first year. Average weekly fly catch increased rapidly over a 2-3 week period from near zero to a peak (in years 1996 and 1996-97) of about 30 flies for *L. cuprina* and from near zero to a peak (in 1996-97) of about 75 flies for *Chrysomya rufifacies* in February/early March. Peaks presumably reflected emergence of adult flies from the previous year's pupae that overwintered in the soil. Five of the eight species showed a second peak about four weeks after the first. The second peak most likely reflects emergence of a second generation. Minimum temperature explained a significant proportion of variation (up to 48%) in fly numbers. Rainfall and wind run were less important. Further work is required to provide robust indicators of potential rises in fly numbers.

Keywords: *Lucilia cuprina, sericata; Calliphora stygia, hilli, vicina, quadrimaculata; Chrysomya rufifacies;* Sarchophagidae; flystrike; seasonality; blowfly.

INTRODUCTION

Flystrike in sheep is a major animal health expense in terms of control and lost production. Other costs include animal welfare problems, which may ultimately impact on our ability to market sheep products. Heath (1994) estimated the annual cost to New Zealand to exceed $30 million dollars. Fly resistance to current control chemicals is increasing (as are costs of chemicals), so alternative means of fly control are needed urgently to integrate with existing control procedures.

In the North Island, the four blowfly species known to initiate most flystrikes on sheep are *Calliphora stygia* (Fabricius), *Lucilia sericata* (Meigen), *Chrysomya rufifacies* (Macquart) and *Lucilia cuprina* (Wiedemann) (Heath and Bishop 1995), the latter three being a distinctive metallic green colour. In Australia, *L. cuprina* (the Australian sheep blowfly) is involved in over 90% of all strikes on sheep. This species was first detected in New Zealand in 1988, when it was involved in 20% of strikes (Heath and Bishop 1995) with this figure up to 64% in the 1991-92 season as its range moved south (to south of Christchurch). *Ch. rufifacies*, a secondary flystrike species that cannot initiate strikes on sheep, becomes involved following strike by one of the primary flystrike species (Kettle 1995).

Warmth and moisture increase the incidence of flystrike (Heath and Bishop 1995) with flystrike potentially present in all months in New Zealand. The effects of temperature, rainfall and other weather conditions on fly populations have been studied mainly in Australia and United Kingdom (Vogt *et al*., 1983, Wardhaugh and Morton 1990, Wall *et al*., 1993). In Australia, *L. cuprina* has well defined emergence periods and preferred habitats (Anderson *et al*., 1990), and there are regular increases in numbers in late winter/early spring when the soil temperatures rise and flies emerge from pupae overwintering in soil (Anderson *et al*., 1984).

An important factor to consider in monitoring fly populations is how the numbers of flies caught relate to incidence of flystrike in sheep flocks. The implications of a study by Wardhaugh and Morton (1990) were that the incidence of flystrike increased with increased density and activity of gravid *L. cuprina,* with rainfall determining the overall strike levels. Anderson *et al*.,(1984) found that peak *L. cuprina* numbers trapped were "broadly coincident with the highest strike frequency", which occurred in September to November and in March, in the arid zone of New South Wales, Australia. In New Zealand, *L.cuprina* was the dominant strike initiator, although *L. sericata* was the species most prevalent in trap catches (D.M. Leathwick, pers. comm.).

Carrion-baited traps have been used in many studies to sample field populations (e.g., Vogt *et al*., 1985, Dymock and Forgie 1995). Trap efficiencies vary due to differences in the needs of each fly species and needs of different cohorts within a species (Heath 1994). *L .cuprina* catches are much lower than its level in flystrike representation, whereas *L. sericata* and *C. stygia* appear over-represented (Heath 1994). Heath (1994) recommended that farmers install an "early warning" system using simple fly traps to monitor fly numbers and detect the arrival of blowflies. If a simple weather predictor could be used, it could provide an earlier indicator than rise in fly numbers, without the need for trapping.

The aim of this study was to define and monitor the type and seasonal fluctuations of fly populations around Massey University farms during the flystrike season, and to relate these differences to temperature, rainfall, wind, sunshine and pan evaporation, and to assess whether it is possible to predict increases in fly numbers 2-4 weeks before they occur.

MATERIALS AND METHODS

Study site

Two sites were chosen, one on each of two Massey University farms: Keebles and Haurongo. Each site was morphologically similar (approximately 46 m a.s.l.), consisting of undulating open pasture land with a few shallow gullies, with the Keebles site possibly experiencing a higher wind run. The study took place over three summer seasons (1993-94, 1996 and 1996-97). At each study site, four traps were spaced 20 m apart along a straight fence line, with the fly entrances approximately 0.5 m above the ground. Two identical white 5 litre plastic buckets were modified to construct a "Western Australian Fly Trap", comprising a fly collection chamber (top), the entry chamber and the bait chamber (bottom). The four traps were attached to fence posts and baited with 200 g of an 8:1 mixture of minced fresh liver and old bait containing live maggots, with 200 ml of water also added for the first few weeks to keep the bait moist. Maggot activity then generally prevented the bait from drying out. Weekly, pyrethroid insecticide was sprayed into the collection chamber to kill the flies, which were then collected and the bait changed.

Caught flies were identified to the family Sarcophagidae, the family Calliphoridae, (seven species: *Calliphora hilli* (Patton), *C. vicina* (Robineau-Desvoidy), *C. quadrimaculata* (Swederus), *C. stygia, Lucilia cuprina, L. sericata, Chrysomya rufifacies*) and the family Muscidae (one species: *Calliphoroides antennatis* (Hutton)), and counted weekly. Throughout the study, sheep were close to all traps (< 50 m). In 1993-94, fly trapping ran from December 24, 1993 to June 15, 1994; in 1996 from February 2 to June 14; and in 1996-97 from October 3, 1996 to June 3, 1997. In 1996-97, trapping began much earlier than in the previous years, to monitor the initial build-up of fly numbers, and concentrated on the Haurongo site.

Over the three years, weekly weather records of temperatures (maximum, minimum, soil), total rainfall (mm), mean daily wind run (km), sunshine hours (total) and total pan evaporation (mm) were collated from "Dairy and Sheep Farms Fact Sheets" (Farms Administration 1993-1997), for the actual trapping times, plus the preceding two months.

STATISTICAL ANALYSES

Few *Calliphoroides antennatis* were caught, so this species was omitted from the analyses. For the family Sarcophagidae and the seven Calliphorids, catch numbers were averaged over the four traps at each location. These average catches were then adjusted to number of flies caught over a 7-day period, to standardise the intervals between fly collection. Meteorological data, temperatures (minimum, maximum, soil), wind, sun, pan evaporation and rainfall were also adjusted to the same 7-day intervals, to enable direct comparisons between fly catch numbers and weather conditions. These weather records were subject to PROC GLM (SAS 1985) to test the effects of year, month and the year*month interaction.

Concentrating on the four blowfly species known to cause most flystrike in New Zealand, the average catches over 7-day periods were regressed against each weather record individually using PROC REG (SAS 1985). This procedure was also repeated for multiple weather records, using minimum temperature + rainfall, minimum temperature + wind, and minimum temperature + wind + rain. To examine the effects of weather before actual fly catch periods, the above analyses were repeated with weather records offset 2-weeks or 4-weeks, e.g., fly catches on week 7 regressed against weather records from week 5 and week 3. Since the minimum generation time for these fly species is 16-35 days (Waller 1984), offsetting the weather records by 2 or 4 weeks more precisely reflected the weather conditions at the time a new generation of flies is produced.

RESULTS AND DISCUSSION

Weather

The average weekly weather conditions from December to May over the three seasons of the study were similar, the one major difference being rainfall. In the second season (1996), rainfall was significantly higher than in the other two seasons (weekly rainfall (mean ± s.e.): 12.9 ± 3.6, 1993-94; 28.5 ± 3.6, 1996; 17.0 ± 3.6, 1996-97; P<0.01), with rainfall higher in every month except January.

Locations and Catches

Figure 1 presents the weekly average fly catches at Haurongo for the family Sarcophagidae, and seven species of the family Calliphoridae. There was considerable variation in average fly catches over the three years of the study.

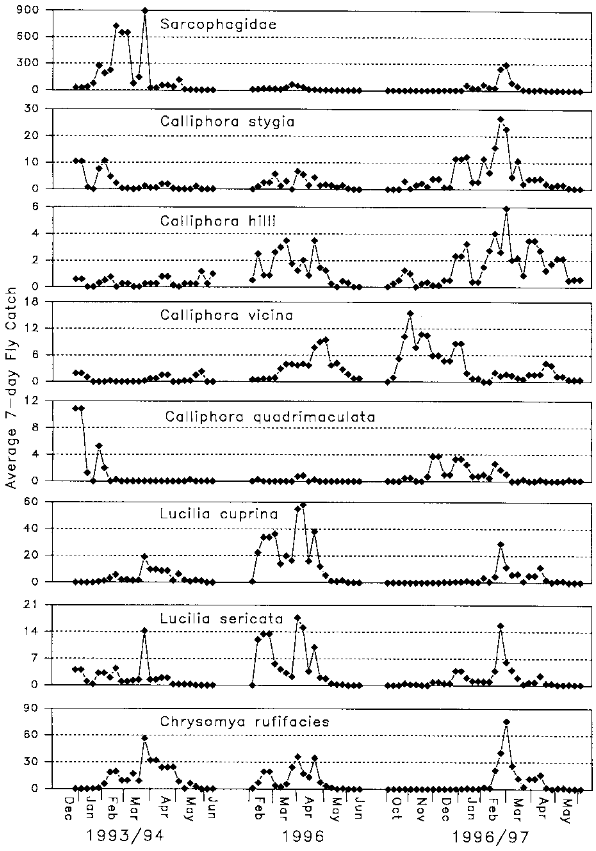
The numbers of the four flystrike species caught at each of the two locations varied considerably with fewer flies caught at Keebles than at Haurongo (Keebles 69% (1993-94) and 82% (1996) of Haurongo over the coincident 17 weeks (February-June)). Catch rates showed considerable variation between years, with total flystrike catches at Haurongo being 3170, 4978 and 3320 for 1993-94, 1996 and 1996-97, respectively, and at Keebles being 2175 and 4058 for 1993-94 and 1996, respectively. Highest weekly average catches were similar between sites for *C. stygia* and the two *Lucilia* species, with peak *Ch. rufifacies* numbers not consistent between sites.

In 1996, *L. cuprina* constituted 42-51% of flystrike flies compared with 19% for each of the other years. At the season peak, numbers in 1996 and 1996-97 were three times and one and a half times higher, respectively, than in 1993-94. There were no differences between the peak *L.*

sericata numbers in each of the three years (highest weekly average 14-18 flies, comprising 8-15% of total flystrike flies). Fewer *Ch. rufifacies* were caught in the latter two years compared with the first (25-34% less), and comprised 28-67% of total catch. The highest numbers of *C. stygia* were in 1996-97 (highest weekly average 27 flies). This was two and a half times greater than 1993-94 and four times greater than in 1996. *C. stygia* comprised 6-25% of total catch over the three years. Species composition of the total catch was similar at the two locations. The catches of the two *Lucilia* species were very different from those in western Manawatu, where the majority of flies caught were *L. sericata* (D.M. Leathwick, pers. comm.).

Average weekly fly catch increased rapidly over 2-3 weeks from near zero to a peak (in 1996-97) of about 30 flies for *L. cuprina,* broadly coinciding with a 2°C rise in minimum temperature (up to 14.4°C) three weeks previously, and from near zero to a peak of about 75 flies for *Ch. rufifacies* in February/early March (coinciding with a 3°C rise in minimum temperature from 12°C from the previous week). These peaks presumably reflect emergence of adult flies from the previous year's pupae that overwintered in the soil. Peak numbers of all four flystrike species occurred in February, with a second peak at the end of March in 1993-94 and 1996 (Fig. 1) and some showed a peak four weeks later. With a 16-35 day generation time (Waller 1984), a second or third peak most likely reflects emergence of further generations of flies.

FIGURE 1: Weekly average fly catches at Haurongo for the family Sarcophagidae and seven species of the family Calliphoridae.



Weather and Catches

For weekly average fly catches, regressions between fly numbers and weather records at Haurongo were more highly significant than at Keebles (Table 1), probably because of the higher numbers of flies caught there. Minimum temperature gave the best prediction of fly numbers (Table 1), explaining 24-43% of the variation in fly numbers in 1996 at Haurongo, and 20-48% in 1996-97. No significant predictors of fly numbers were found in 1993-94 except for *C. stygia* (18%). Vogt *et al.*,(1983) suggested that catch rates "mirror" different levels of flight activity, and they found that temperature, wind, relative humidity and solar radiation explained 77% of the within-day variation in fly catch numbers, whereas temperature alone explained 75%. With increasing temperature, log catch rates increased linearly from 16 to 26°C and remained constant from 26 to 35°C (Vogt *et al.*, 1983). Egg survival is high at 15-40°C, whereas outside this range survival declines rapidly (Vogt and Woodburn 1980). Wall *et al.*, (1993) in the United Kingdom, found temperature had a significant effect on catches of *L. sericata;* temperature explained 20 to 32% of catch variation over the three years.

TABLE 1: R-squared values from fitting the regression of weekly fly numbers from both Haurongo (H) and Keeble (K) farms, against corresponding weekly minimum temperatures in 1993-94, 1996 and 1996-97.

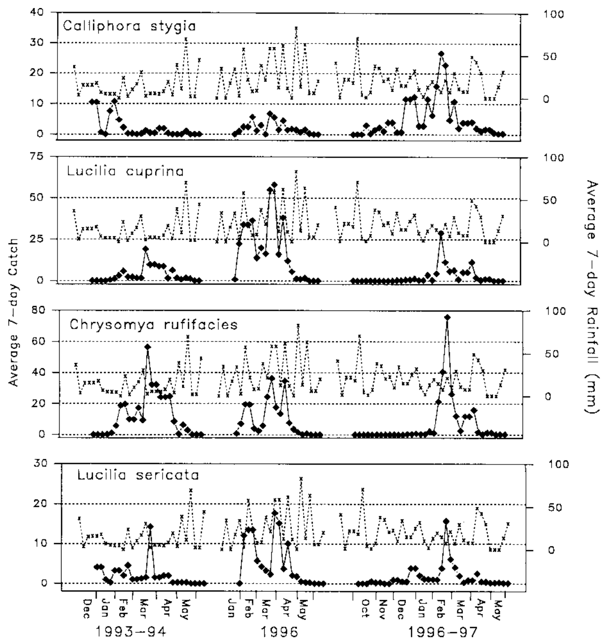
	1993-94		1996		1997
Fly Species:	H	K	H	K	H
Calliphora stygia	0.18*	0.18*	0.24*	0.11	0.48***
Lucilia cuprina	0.00	0.00	0.41**	0.20*	0.20**
Lucilia sericata	0.03	0.02	0.43**	0.24*	0.32***
Chrysomya rufifacies	0.01	0.01	0.25*	0.14†	0.28**

†P<0.10, *P<0.05, **P<0.01, ***P<0.001 probability of the regression model.

Including rainfall and wind run in the regression model increased the 1993-94 explained variation, explaining 20-32% additional variation for three of the four species *(L. cuprina, L. sericata, Ch. rufifacies),* but only 3% for *C. stygia.* Similar result was obtained from the Keeble site (17-25%), with the exception of *Ch. rufifacies* where only 2% further variation was explained. In 1996, the explained variation rose by 1-20%, increasing the explained variation to 35-45% (Haurongo) and by 7-22%, to a total of 28-33% (Keebles). In 1996-97, adding rain and wind run to the model increased explained variation by a further 5-9%, increasing total explained variation to 29-54%.

Figure 2 presents the average weekly rainfall overlaid on weekly average fly catches at Haurongo for the four flystrike species *(C. stygia, L. cuprina, L. sericata* and *Ch. rufifacies).* This shows a possible relationship between rainfall and average fly catches for these four species. In both 1993-94 and 1996-97, rainfall was relatively low compared with 1996, and numbers of *C. stygia* were much higher than in 1996. This phenomenon was apparent, although to a lesser extent, in *Ch. rufifacies,* which also showed the fewest numbers in 1996. The two *Lucilia* species showed the opposite trend, with average numbers much higher in 1996, especially for *L. cuprina.*

FIGURE 2: Average weekly rainfall overlaid on weekly average fly catches at Haurongo for Calliphora stygia, Lucilia cuprina, Chrysomya rufifacies and L. sericata.



Temperatures (minimum, maximum, soil), sunshine hours and pan evaporation regressed against fly catch numbers did not significantly explain variation in catch numbers for either coinciding weeks or weather records offset by two weeks. When weather records were offset by four weeks, less variation was explained by temperature, whereas sunshine hours and pan evaporation explained significant amounts of variation in catch numbers. Sunshine hours explained 12-22% ($P<0.05$) of variation over the four species in 1996-97, with pan evaporation explaining 14-42% ($P<0.05$).

CONCLUSION

There was considerable variation in fly numbers trapped within and between years. Minimum temperature was the most useful predictor of fly numbers trapped. However, the proportion of variation explained does not make it sufficiently robust to promote for predictive use. More complex statistical analyses may uncover more useful predictors of fly numbers.

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