Foraging Behavior of Female Blow Flies Based on Visual Cues

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Abstract:

The attraction of blow flies to different resources can be affected by their ovarian development. For this study, the foraging behavior of the blow fly *Calliphora terraenovae* Macquart (Diptera: Calliphoridae) and attraction to visual cues mimicking flower colors were examined. Naïve blow flies, that have not fed on protein and do not have eggs to lay should be attracted to flower colors that represent nectar resources, such as white, pink, yellow. Naïve male and female blow flies were put into experimental cages and exposed to seven flower water representing various colors for 24 h. After 24 h, the flies were removed and assorted by sex. Based on the results, both male and female flies preferred the color purple. Female flies preferred purple as well, but also showed preference for pink. By understanding the color preference of adult blow flies, forensic entomologists can further their understanding of attraction to various resources, whether for nutrients or as potential oviposition sites.

Keywords: color, forensic, decomposition

Forensic entomology is the application of insect evidence, which can assist in investigations (Byrd and Castner 2010). In criminal investigations, insect activity can be identified within three categories. Blow flies (Diptera: Calliphoridae) are the first insects to arrive to decomposing carrion (Byrd and Castner 2010). The life cycle of blow flies begins with a mature female blow fly that lays her eggs on decomposing remains, the eggs hatch into larvae, which molt into three different stages; 1st instar, 2nd instar and 3rd instar and pupates before emerging as an adult fly (Byrd and Castner 2010). Blow flies feed on carrion and human decomposition fluids in order to mature their eggs (Brodie 2015). A certain amount of protein is required for the eggs to mature (Williams et al. 1979).

In addition to forensic entomology applications, blow flies are natural recyclers and also pollinate flowers (Brodie 2015).

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Blow flies respond to olfactory and visual cues due to the attractiveness of inflorescences, which is a cluster of flowers on a branch (Dobson 2006). Olfactory senses are the sense of smell and visual senses is the ability to detect an image clearly. Flowers that appear dark red or purple may attract gravid female blow flies seeking oviposition sites, as these colors are often associated with decomposing remains (Brodie 2015). Flowers that appear light in color, such as yellow, white and pink may attract naïve female blow flies that are not seeking oviposition sites but are foraging for nectar. Foraging behaviors based on the flower color suggests that the female blow fly uses the flower to locate and acquire the amount of protein she needs to mature her ovaries (Browne 2001).

The aim of this study was to examine how female age and development (naïve versus gravid) influence foraging decisions and visual attraction to potential resources. We predicted that naïve female blowflies would be attracted to resources that represented bright colors often associated with flowers (e.g. yellow, white and pink) and gravid females would prefer darker colors that are associated with decomposition (e.g. red, blue and purple).

Materials and Methods

Experimental cages (Bioquip 1450C collapsible cage, 46 x 46 x 46 cm) were composed of 25 females and 10 males freshly enclosed, naïve, cold-sedated *Calliphora terraenovae* Macquart (Diptera: Calliphoridae). All flies were provided with water and given an acclimation period of 2h. Blow flies were not provided with a protein source and were considered naïve, as they did not mate, and females were not carrying eggs. Each cage with flies were provided with seven water bottles modified with construction paper funnels of each tested color (white, pink, yellow, red, purple and blue) and the control (clear). All bottles contained 100mL of water and 3 drops of dish detergent to prevent the flies from escaping the bottle once they have made their selection. All flies were exposed to the various colored bottles for 24 h, after which the bottles were removed, and all flies contained in each bottle were counted and sex was determined. This was replicated five times for the naïve blow fly experimental cages.

All analyses were performed in R 3.1.1(R Project for Statistical Computing, http://www.R-project.org/). Data were natural log transformed to meet the assumptions of normality. Data for male and female flies combined were analyzed using a one-way ANOVA (aov function) to examine the effect of color on resource selection. A two-way ANOVA (aov function) was used to examine the effect of sex and color on resource selection

Results

The color that was preferred by both male and female blow flies was purple, whereas the least preferred color was blue (Figure 1).

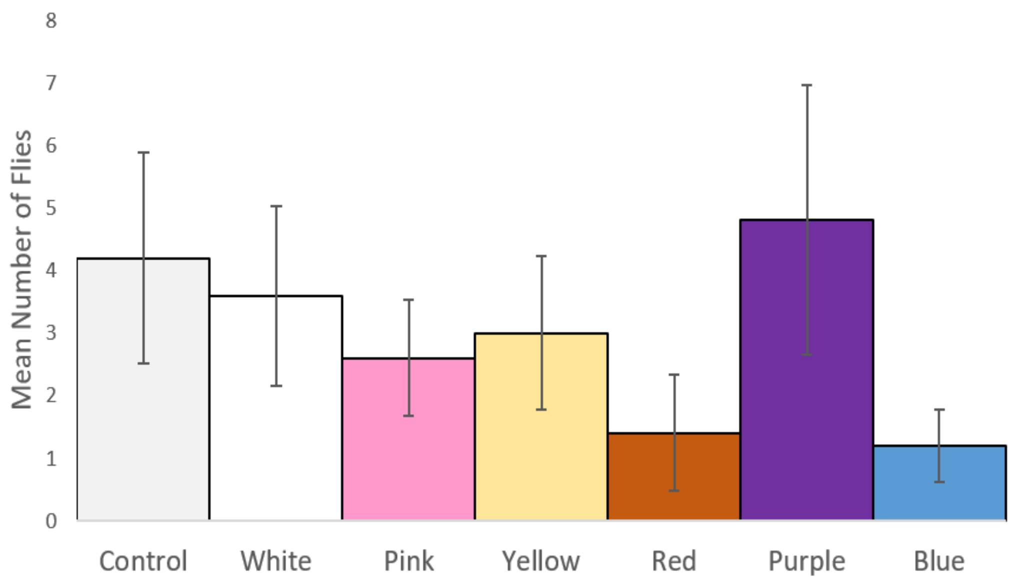

Figure 1. Total blow flies (Male and Female) and color preferences. The most preferred flower color for both male and female blowflies was purple, although there was no significant difference among color selection by adult blow flies. ANOVA: $F_{6.28} = 0.985$, $p > 0.05$, N = 5.

There was no significant difference in the color of the resource selected by male and female blow flies ($F_{6,\ 28} = 0.985$, $p > 0.05$; Figure 2).

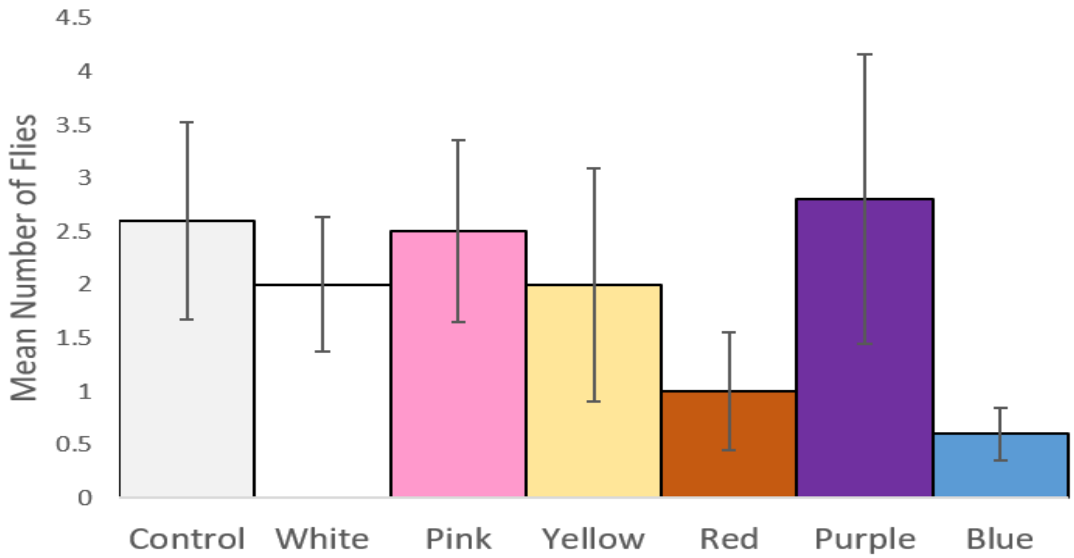

Figure 2. Female blow fly color preference. The most preferred color by female flies were purple, clear(control) and pink, although there were no differences among the color groups. ANOVA: $F_{6,28} = 0.694$, $p > 0.05$, N=5

There were no differences in the resource selection due to sex or color ($F_{6, 56} = 0.185$, $p > 0.05$). Resource selection by female blow flies was not significantly affected by color ($F_{6, 28} = 0.694$, $p > 0.05$; Figure 2). Selection by male blow flies were not significantly influenced by color of the resource ($F_{6,28} = 0.94$, $p>0.05$; Figure 3).

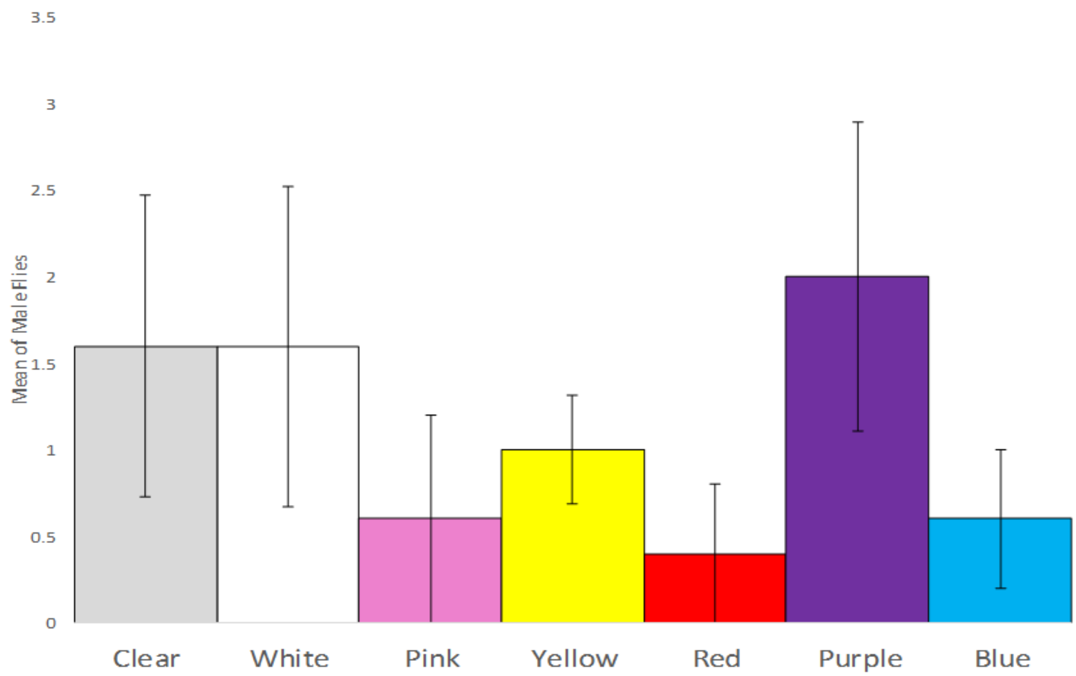

Figure 3. Male blow fly color preference. The male blow flies preferred the purple flower, followed by clear(control) and white. There was so significant difference in color preference**.** ANOVA $F_{6,28} = 0.94$, $p > 0.05$, N=5.

Discussion

For *C. terranovae*, the two colors that were most preferred by males and females were purple and clear (control). This was surprising as purple is a color we predicted was associated with decomposition and would not be attractive to the naïve flies. The control color (clear) was unexpected as a selection; perhaps the naïve flies are merely seeking out water reserves rather than actively seeking food resources.

Different fly species may demonstrate different flower color preferences. Previous work by Frazao and VanLaerhoven (2016, unpublished) showed that *Lucilia sericata* Meigen and *Phormia regina* Meigen (Diptera: Calliphoridae) selected different flower colors. The L. *sericata* blow flies were attracted to the yellow, whereas *P. regina* preferred blue and red. Yellow was preferred because it is commonly seen in the wild, representing nectar and blue is not as common in the wild but it represents carrion decomposition stages and lividity. Compared to the Frazao and VanLaerhoven experiment, our results were the exact opposite. The *Calliphora terraenovae* Macquart (Diptera: Calliphoridae) blow flies were attracted to the purple and least attracted to the blue. The reasoning for the change in color preference could be due to the different life stages the blow flies were in and the different blow fly species. Frazao and VanLaerhoven used gravid blow flies that were fed pig liver for both the *L. sericata* and *P. regina*, while we used naïve *C. terraenovae,* that did not feed on anything.

Future studies could examine a longer time period for exposure of blow flies to various color resources. In addition, the incorporation of olfactory cues, such as honey or sugar, would add another element to examine, which would provide information regarding how visual and olfactory cues work in conjunction when blow flies make their foraging decisions. Lastly, future studies should compare the foraging decisions should compare the foraging decisions made by experienced blow flies that have fed on protein, matured their eggs and are looking for oviposition medium, to see if there are differences in the colors that are preferred.

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