Attractiveness of different light wavelengths, flicker frequencies and odours to the housefly (Musca domestica L.)
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The housefly, *Musca domestica* L. (Diptera: Muscidae), is an abundant cosmopolitan which causes nuisance and, moreover, is a potential vector of pathogens of humans and animals. Present control measures have several negative side-effects or do not suffice to reduce fly populations to acceptable levels (Chapter 1). Since recent European legislation demands zero levels of insects in food processing factories (Howard, 1999), new or improved control methods for houseflies are required which are environmentally friendly, not hazardous to humans, and species-specific.

A biological approach of control is to use stimuli that repel houseflies or attract them towards a trapping or killing device. In the past years, several studies have been conducted to determine attractive stimuli, visual as well as olfactory. However, results of these studies are often contradictory, because of differences in experimental set-up or physiological state of the flies investigated. Besides, many studies were done with tethered flies or with flies from which the wings had been removed. In the experiments described in this thesis visual and olfactory stimuli were investigated for their attractiveness to free-moving *M. domestica* flies. In addition, several physiological and environmental factors were taken into account.

Electrocuting traps provided with fluorescent lamps are promising devices for indoor control of houseflies. The lamps usually emit light in the ultraviolet range to attract the insects towards an electric grid. Unfortunately, the effectiveness of these traps is often not as high as required to reduce the fly populations to acceptable levels (Bowden, 1982; Pickens and Thimijan, 1986; Muirhead-Thomson, 1991). In Chapter 2 results are described of behavioural experiments in a flight chamber in which the attractiveness was tested of ultraviolet lamps with different spectral compositions. In addition, lamps emitting blue, green, and white light were tested. The responses of the flies to the various lamps appeared to depend on the origin, sex and age of the houseflies, the spectral composition and irradiance of the test lamps, and on ambient illuminance. Overall, flies younger than 3 days were hardly or not attracted to the test lamps, whereas older flies were positively phototactic. Recordings of the locomotor activity of the flies showed that young flies were less active than older ones. In the dark, larger numbers of flies were attracted to the light sources than when the flight chamber was illuminated by a white tube. In general, ultraviolet light attracted more flies than blue, green, and white light. Within the ultraviolet region no preferences were found.

The above results were obtained during five-minutes experiments in a flight chamber of 210 cm long, 60 cm wide, and 60 cm high. We considered experiments during longer periods and in a larger room more realistic. Therefore, experiments of 2½ hours were done in an experimental room of 310 cm long, 200 cm wide, and 240 cm high. The results of these experiments
are also discussed in Chapter 2. The experiments were done with mature female flies only. Again, differences in light responses between flies of different strains were found. Both in the dark and in the light, the blue, green, and white lamps were less attractive than the ultraviolet lamps when tested alone (1-choice tests) or in competition with an ultraviolet lamp (2-choice tests), although they attracted a reasonable amount of flies when on their own in the dark (55%). Recordings in time by a personal computer of the numbers of flies hitting electrocuting grids in front of the test lamps showed that the flies were caught more quickly in the dark than in a room illuminated by a white tube.

The possibility to improve the attractiveness of ultraviolet lamps by manipulating their flicker frequency was examined during 1- and 2-choice trapping experiments, which are described in Chapter 3. ‘Flickering’ and ‘non-flickering’ (i.e. below and above the flicker fusion frequency of houseflies, established by Vogel (1956) to be 270 Hz) light sources were equally attractive, to both male and female flies. A frequency of 40 and 175 Hz attracted females and males, respectively, the most rapidly. Interestingly, frequencies of 4 and 10 Hz seemed to repel males and females towards a non-flickering light.

Adding a second stimulus that affects another type of the flies' behaviour may increase the effectiveness of light traps. Therefore, the attractiveness of olfactory stimuli was examined, initially when present alone and secondly in combination with ultraviolet light. The results of these experiments, which were conducted in the flight chamber, are presented in Chapters 4 and 5. Odours did not elicit any response in the flies when tested in the dark (Chapter 5). However, when the room was illuminated by a white fluorescent tube, flies of all ages, also those younger than 3 days, were attracted to several odour sources. Both young and mature houseflies, well-fed or deprived of food during 24 to 32 hours were attracted to the odours of chicken manure, tainted pork, tainted chicken meat, fly food (a mixture of skim milk powder, sugar and yeast), and bread soaked in water or milk. Marmite, bread alone, and various fruits attracted food-deprived flies, whereas foul eggs of houseflies attracted only young flies (Chapter 4). Experiments described in Chapter 5 showed that both male and female houseflies (well-fed and mature) are attracted to marmite and tainted meat (pork, beef, and chicken). Bread soaked in beer or vinegar only attracted males, whereas moist yeast and chicken manure were only attractive to females. A mimic of manure made of a mixture of synthetic chemicals appeared to attract female flies, although natural (chicken) manure was more attractive when presented simultaneously. Single chemicals seldomly evoked a response (Chapter 4). Unfortunately, ultraviolet light suppressed the attractiveness of several attractive odours, with the exception of those of moist yeast and marmite which were still attractive to females (Chapter 5).
Because of the fact that background odours are always present in areas in which housefly control devices are used, we carried out experiments in the flight chamber in which the odour of chicken manure was present as a background odour (Chapter 4). Natural odour sources which were found to be attractive to houseflies in other experiments (Chapters 4 and 5) were tested for their attractiveness in the presence of this attractive background odour. Only the combination of chicken manure with tainted chicken meat attracted significantly more food-deprived females than chicken manure alone.

Summarizing, during daytime ultraviolet light is the best attractant to be applied in killing devices to lure houseflies in dark rooms. In contrast, odours should be used in illuminated rooms. Possible applications of the research results are discussed in more detail in the general discussion (Chapter 6).