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Direct monitoring of the electrostatic charge of house-flies (*Musca domestica* L.) as they walk on a dielectric surface

Chris Jackson*, Daniel McGonigle

Division of Ecology & Evolutionary Biology, School of Biological Sciences, University of Southampton, Southampton, Hampshire SO16 7PX, UK

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Abstract

Charge build-up on walking *Musca domestica* was monitored in real time using an electrostatic voltmeter attached to an individual fly by a fine copper wire. Simultaneous video recording of behavioural movement was analysed by Inchworm©. Charge accumulation by the fly moving on PVC was positive and directly proportional to distance walked; as a consequence the rate of charge accumulation was directly related to the walking speed. Plateauing (saturation) of charge was prevented from occurring due to the increased capacitance caused by the large amounts of conductive material attached to the flies and the short distances travelled. This technique also allowed the effect of small surface charges to be observed; a positively charged acetal surface caused a rapid positive charge increase relative to distance walked, while negative charges acted against the tribocharging and reduced rate of positive charge accumulation. This work provides important information about the relationship between insect behaviour and charge accumulation with implications for the development and design of novel control strategies utilising electrostatic powders to adhere to the charged surfaces of insects or other organisms.

Keywords: *Musca domestica*; Electrostatic; Triboelectrification; Insect control; Behaviour

*Corresponding author. Tel.: +44 (0) 2380593205; fax: +44 (0)238059595159.
E-mail address: cwj@soton.ac.uk (C. Jackson).

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1. Introduction

The interdisciplinary interaction between electrostatics and entomology is becoming increasingly important in a number of areas including the effects on insect behaviour [1] and the electrostatic attraction and attachment of particles to insects for insecticide application (Roach prufe®), traps (Exoroach™) and dissemination devices (Exolure™, Exosex™). Previous work [2,3] has shown that insects accumulate electrostatic charge when walking on certain dielectric surfaces. The experiments described here investigated the process by which this charge builds up on a walking fly. Rather than measuring the net charge of a fly using a Faraday pail as in previous work [2,3], here charge on live, walking flies has been monitored continuously by directly connecting flies to an electrostatic fieldmeter and simultaneously recording its behaviour.

2. Method

Flies were anaesthetised using carbon dioxide gas. Aluminium foil (1.5 cm × 0.5 cm) was then glued to the dorsal side of the thorax. A 15 cm length of un-insulated 0.08 mm diameter copper wire was connected to the foil, the other end being attached to an inverted aluminium base plate of the Faraday Pail apparatus (JCI Instrumentation: JCI 147) suspended 12 cm above the surface upon which the fly was to walk. A JCI 140 electrostatic fieldmeter was fixed to the base plate and connected to a microcomputer to allow real-time data collection. The apparatus was contained within an earthed Faraday cage and the flies earthed before recording. A video camera positioned directly above the surface recorded fly behaviour and was subsequently analysed using motion tracking software (Inchworm [4]). Distance moved during the time of the experiment was plotted graphically alongside the charge on the plate. Uncharged PVC surfaces and acetal surfaces carrying slight positive and negative charges were tested.

3. Results

Figs. 1–4 each show the charge accumulated and distance walked against time for individual tethered flies on sheets of dielectric material. Over the first centimeter, there was a rapid drop in recorded charge; the subsequent 7 cm exhibited a more gradual decline relative to distance moved. This phenomenon is not observed on untethered flies [3], thus was probably a consequence of the experimental set up. On uncharged PVC (Figs. 1 and 2), after the initial dip in charge, a positive charge accumulated on the fly and there was a significant ($p < 0.001$) correlation between charge accumulation and distance moved (Fig. 5). Consequently, the rate of charge accumulation was directly proportional to the speed of walking. Tethered flies on positively charged acetal (Fig. 3) exhibited the initial dip in readings, and after 8 cm the positive charge accumulation with walking was rapid (slope 0.012). When acetal