G155 Heat Generation in Maggot Masses and Its Effect on Larval Development

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After attending this presentation, attendees will understand the relationship between the size of a maggot mass and the temperature of its microclimate as well as how this mass-generated heat influences larval development.

This presentation will impact the forensic science community by highlighting the importance of incorporating mass temperatures into PMI estimates that are based on larval development.

Observed to arrive at a body within minutes of death, blowflies (Diptera: *Calliphoridae*) are frequently used as a biological clock in criminal investigations, aiding in the estimation of the Postmortem Interval (PMI). In forensic entomology, PMI is estimated based on the temperature-dependent developmental rates of known blow fly species. By combining temperatures recorded at the death scene with the known rates of development for larvae reared in temperature-controlled environments, it is possible to age individuals and, hence, estimate time of death. However, few studies take into consideration the mass-generated heat produced by larvae co-existing in an aggregation. This study investigates the relationship between the number of blow fly larvae in a mass and the amount of heat generated, as well as identifying the minimum mass size and elapsed time before any differences in accrued temperature achieve significance. This research also highlights the potential impact mass-generated heat may have on larval development rates and, hence, any subsequent PMI estimates.

Various sized larval masses (50 – 2,500 larvae) composed solely of *Lucilia sericata* (*Phaenicia sericata* in North America) were reared in the laboratory on racks of lamb ribs at a constant ambient temperature of 22°C. Using data loggers and a thermal imaging camera, mass temperatures were monitored and recorded at five-minute intervals for the duration of the feeding stage of development. Data was analyzed using the statistical package R (version 2.12.1). Results showed a strong positive relationship between mass size and the amount of heat generated by the aggregation, with temperatures rising as masses increased in size. A minimum mass size of 1,200 individuals was required for the microclimate temperature to increase significantly above ambient ($p \leq 0.05$), with aggregations composed of 2,500 larvae producing temperatures that exceeded ambient by as much as 14°C. Comparing Accumulated Degree Hours (ADH) for different-sized masses at specific times during development highlighted 26 hours as the point at which the 1,200 masses became significantly warmer than ambient ($p \leq 0.05$). Larger masses had ADH values that diverged from ambient after as little as ten hours into feeding and development. Preliminary data also suggests that larvae feeding in a mass experience two peaks in temperature, one shortly after reaching third instar, and a second, smaller peak immediately prior to the post-feeding phase of development.

In order to determine whether these differences in microclimate temperature affect rates of development, larvae were sampled from different-sized masses at hourly intervals. This allowed identification of the exact time at which individuals reached specific stages of development, primarily the point at which >50% larvae metamorphose from first to second instar, second to third instar, and then the onset of migration. Preliminary results suggest that there were significant differences ($p \leq 0.05$) when comparing the time (minutes) required for larvae from different-sized masses to reach these developmental junctures. Larger masses appeared to require less time to reach the third instar and post-feeding phase of development in comparison to smaller masses. However, there were no significant differences ($p > 0.05$) when comparing the ADH values for each of the aforementioned developmental points, with all larvae requiring similar levels of accrued heat energy to progress through each stage regardless of their mass size.

These results imply that the thermal output of a maggot mass is dependent on its size and has the potential to affect the rate at which larvae develop. Therefore, by incorporating maggot mass temperatures in the form of ADH values into current methods used to estimate larval age, it may be possible to increase accuracy for PMI estimates in criminal investigations. Further research is encouraged in this area in order to expand on the current understanding of maggot mass thermodynamics.

Maggot Mass, Heat, Larval Development