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SHORT REPORT

Nocturnal oviposition of the forensic scuttle fly, *Megaselia scalaris* (Loew) (Diptera: Phoridae), indoors

A.B. Siti Zulaikha, Raja M. Zuha *

Forensic Science Program, School of Diagnostic and Applied Health Sciences, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur, Malaysia

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Abstract In forensic entomology, nocturnal oviposition of flies could reduce discrepancy of minimum post mortem interval (PMI_{min}) estimation which is due to assumption that oviposition only occurs during day time hours. Previous records indicate that some forensic species of Calliphoridae and Sarcophagidae displayed nocturnal oviposition and larviposition but such occurrences can be inconsistent. Apart from blow flies and flesh flies, the scuttle flies (Diptera: Phoridae) are known to be forensically important indoors and they exhibit diurnal and nocturnal behaviour. To investigate if oviposition by scuttle flies occurs during night or day time hours, baited scuttle fly traps consisting decomposed cow's liver were placed inside Forensic Entomology Laboratory, Faculty of Health Sciences, Universiti Kebangsaan Malaysia on diurnal and nocturnal intervals. The traps were divided into two groups, i.e. light-exposed and total dark conditions. It was discovered that all specimens collected were *Megaselia scalaris* (Loew) and they were active and performed oviposition during day and night times. Light exposure did not affect oviposition activity during diurnal and nocturnal periods. Therefore, it is recommended that nocturnal oviposition must be taken into consideration when using this fly as reference for PMI_{min} estimation.

1. Introduction

In forensic entomology, estimation of time elapsed since death refers to the minimum post-mortem interval (PMI_{min}) based on the age of the oldest insects found on corpses. Therefore, this estimation is greatly influenced by the time of fly oviposition. The methodology to determine PMI_{min} is based on the assumption that blow flies (Diptera: Calliphoridae) are inactive at night, and whenever PMI_{min} is estimated to begin at night time, the actual oviposition is presumed to happen during earlier day.[1] This assumption could mislead PMI_{min} calculation up to 12 h when the flies being referred to were actually nocturnal and deposited their eggs at night.

Nocturnal oviposition by forensically important flies has been a subject of discussion as few observations over the years

* Corresponding author. Tel.: +60 19 3930366.
E-mail address: rmzuha@ukm.edu.my (R.M. Zuha).
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contradicted this assumption. There were reports indicating some Calliphoridae exhibited nocturnal activities including oviposition,[2,3] and in rare occurrences, larviposition by Sarcophagidae could also be observed during the night.[4] However, it can be concluded that nocturnal activities of blow flies depend on experimental settings. In some cases, nocturnal oviposition of Calliphoridae may occur under high temperatures at night such as indoors,[5] or it may not happen at all in natural outdoor conditions.[6] Furthermore, the relationships between parameters involved during nocturnal oviposition (e.g. temperatures, relative humidity, illuminance and type of baits) in the context application for forensic entomology are not extensively studied.

Other than family Calliphoridae and Sarcophagidae, Phoridae or the scuttle flies from the genus *Megaselia* have been previously reported to be active at night.[7] One of the species in the giant genus *Megaselia* is the cosmopolitan *Megaselia scalaris* (Loew). It has been documented in forensic cases as a very useful reference when investigating PMI_{min} of corpses found indoors and in enclosed environments.[8–10] Life histories and developmental rate of this species have been summarized[11] but there were limited attempts to highlight its nocturnal activity for forensic application. This article highlights the nocturnal activity of *M. scalaris* indoors including its oviposition using decomposed animal tissues as baits.

2. Methodology

This study took place indoors at Forensic Entomology Laboratory, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur from 5 to 14 March 2014. The location is a facility for forensic entomology research with a dimension of 7.6 m × 3 m. During the study period, there was no other entomological research being conducted simultaneously and the room was checked clear from any possible sources of contamination by flies such as organic waste and food. Access to the room was also restricted except during sampling.

There were two types of traps for this study, the light-exposed and the dark traps. They were made of 600 ml cylindrical plastic containers filled with approximately 3 cm of sawdust. An approximately 100 g cow's liver were placed in each trap. Liver was purchased fresh from a local market, washed and left to decompose for 3 days in sealed containers at room temperature. The openings were later sealed with 1.5 mm holes gauze to allow small adult scuttle flies entering the traps. For dark traps, black papers were used to cover the outer trap walls, and covered with 18 × 18 cm black cardboard boxes, elevated approximately 20 cm from the base leaving gaps for fly entrance. A total of five replicates were prepared for each diurnal and nocturnal studies.

Diurnal and nocturnal periods were based on time of sunrise and sunset which were obtained from http://timeanddate.com. Trapped adult scuttle flies were transferred into a different container, killed and preserved in 70% ethanol. Remaining eggs left on the baits were counted and reared until adult stage to confirm their species. Throughout studies, fluorescent lamps were switched-on continuously for diurnal and nocturnal periods. During diurnal period, illuminance (lux) was recorded every 2 h because the lighting of the room was influenced by sunlight coming from the glass windows. At night, illuminance was measured once. Temperature and relative humidity of the room were recorded hourly using EL-USB-2 (Lascar Electronics, UK) data logger. This study was repeated four times.

3. Results and discussion

The mean room temperature during day time (25.11 ± 1.24 °C) was just slightly higher than night time (24.89 ± 1.12 °C) whilst relative humidity was higher at night time (63.72 ± 5.28%) compared to day time (61.50 ± 3.43%). The gradient range of illuminance inside the room during day time is displayed in Table 1 which peaked at 1345 h. Illuminance during nocturnal periods was steadier and ranged approximately 156–164 lux.

In nocturnal environment, oviposition of *M. scalaris* occurred in both light-exposed and dark environments. Out of overall 20 light-exposed traps prepared, 5 were found containing *M. scalaris* eggs whilst in dark traps, 6 out of 20 were found with eggs. Total number of eggs were higher in light exposed traps (160) compared to dark traps (127). In diurnal environment, both light-exposed and dark environments showed similar number of oviposition activities with 7 out of 20 traps containing *M. scalaris* eggs. Similar to nocturnal environment, total number of eggs in light-exposed traps was higher (173) compared to dark traps (152). Based on the number of eggs laid by the female *M. scalaris*, oviposition during day time is higher than night time. It was believed that the main point of entry by scuttle flies to the baits was through the gaps beneath the main door and the unused exhaust fans.

The findings show that *M. scalaris* was active in both diurnal and nocturnal conditions to oviposit indoors. The results are important as oviposition activity by *M. scalaris* during night time could further reduce the disparity between the actual time of death and PMI_{min} derived from insects' development. It has been reported that in the tropics, Phoridae were active at night and day [7] but further investigation related to its application in forensic entomology has not been fully studied. Local survey on nocturnal activities of dipterans did not include the presence of scuttle flies[12,13] as it was a 'frequent and dominant species' found indoors.[14,15] In the absence of other species, *M. scalaris* has already been a better PMI_{min} indicator for corpses found indoors or in enclosed environments because it gains access through narrow gaps faster due to its small size.[8,9]

Thus, when estimating PMI_{min} using *M. scalaris* development, we suggest to consider the nocturnal oviposition. To increase the reliability and validity of these findings and to understand oviposition preference of this species, we suggest further studies using different types of indoor environments

Table 1 Illuminance in the Forensic Entomology Lab during diurnal period.

Time (h)	Illuminance (×10 lux)
0745	18–22
0945	35–44
1145	37–61
1345	45–76
1545	40–60
1745	25–42
1920	17–22

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such as in urban and rural locations. Efforts to correlate various factors contributing nocturnal oviposition of this species such as temperature, relative humidity and type of baits can be very rewarding.

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Conflict of interest

There is no conflict of interest.

Ethical approval

Necessary research permission has been acquired from the funding institution.

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