

Short Communication

Preliminary observation on the lepidopteran colonization on rat and rabbit carcasses in Malaysia

Singh, S.¹, Yong, S.K.^{2,3}, Jalaludin, N.H.³, Brau, E.³, Shamsudin, N.N.³, Keawbaingam, N.⁴ and Heo, C.C.^{1,5*}

¹Department of Medical Microbiology and Parasitology, Faculty of Medicine, Universiti Teknologi MARA, Sungai Buloh Campus, 47000 Selangor, Malaysia

²Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

³Soil Assessment and Remediation (SAR) Research Group, Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

⁴Department of Environmental Science, School of Energy and Environment, University of Phayao, Phayao 56000, Thailand

⁵Institute of Pathology, Laboratory & Forensic Medicine (I-PPerForM), Universiti Teknologi MARA, 47000 Sungai Buloh, Selangor, Malaysia

*Corresponding author e-mail: chin@uitm.edu.my

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Abstract. The immature stages of necrophagous insects such as Diptera and Coleoptera play a vital ecological role in carrion decomposition. These invertebrates reduce the necromass significantly through consumption and recycle nutrients into organic forms which are readily being used by autotrophs or served as an abiotic storage in the soil ecosystem. Fly and beetle larvae are frequently encountered decomposers on ephemeral resource patches; however, lepidopterans associated with carrion decomposition is seldom reported. Here, we report colonization of *Monopis* sp. (Tineidae) and an unknown species of Psychidae on a rat carcass, and a Lithosiini caterpillar (Arctiidae) on a rabbit carcass in Peninsular Malaysia for the first time. The feeding behaviour and their potential forensic implications are discussed.

Animal decomposition is an ecological process involving breakdown of complex molecules into simpler forms and to be re-absorbed by the producer (Swift *et al.*, 1979; Parmenter & MacMahon, 2009). In Malaysia, the primary carrion colonizers are usually blow flies (family Calliphoridae), especially the genus *Chrysomya* (Lee *et al.*, 2004; Silahuddin *et al.*, 2015; Syamsa *et al.*, 2017). The first colonizers will be succeeded by secondary colonizers such as flesh flies (*Boettcherisca*, *Parasarcophaga*), and subsequent carrion consumers of the families Muscidae, Fanniidae, Piophilidae, and Stratiomyidae (Nazni *et al.*, 2008; Heo *et al.*, 2015; Silahuddin *et al.*, 2015). Other than

Diptera, beetles, for instance, Dermestidae, are also involved in the process of insect succession on carrion, albeit they are late colonizers compared to carrion flies (Kumara *et al.*, 2009). Due to its predictive sequence in insect arrival on carrion, this natural phenomenon has prompted the use of insect succession on carrion in the application of forensic entomology (Anderson & Vanlaerhoven, 1996; Michaud & Moreau, 2009; Perez *et al.*, 2014).

Lepidopterans collected from decomposing remains have been scarcely recorded. Thus far, no specific literature emphasizes on forensically important lepidopterans other than Payne & King (1969) who

documented nine families and 21 species of Lepidoptera collected from pig carrion during summer months (1962, 1963, and 1966) at Clemson, South Carolina, USA. These lepidopteran families include Papilionidae, Satyridae, Nymphalidae, HesperIIDae, Sphingidae, Noctuidae, Geometridae, Pyralidae and Tineidae. These lepidopterans were attracted to the pig carrion due to several factors, primarily: (1) attracted to the odours of carcass decomposition; and (2) feed on the carrion fluid, dried tissue, skin and hairs/furs (Payne & King, 1969). Adults of many lepidopteran species frequently visit moist ground, perspiration, tears, excrements, or animal carcasses to suck water and dissolved nutrients.

Arnaldos *et al.* (2004) presented a forensic case in Spain where two live caterpillars of Tineidae were collected during the autopsy of a male corpse in the skeletal stage. The presence of Tineidae was an indicator for a long post-mortem interval (PMI) since the tineids are commonly found in exposed and desiccated cadavers. In Malaysia, five species of adult nymphalid butterflies were recorded visiting pig carcasses placed in an oil palm plantation in Selangor (Heo *et al.*, 2010). These adult butterflies were attracted to the pig carcasses at different stages of decomposition, and there was no immature of Lepidoptera found on the carcass remains. Hence, their roles in forensic investigations remain unclear.

As there is no precedent record of carrion colonization by lepidopteran larvae in Malaysia, here in we report the colonization of rat and rabbit carcasses by Lepidoptera in Malaysia for the first time.

In August 2017, two rat carcasses [*Rattus norvegicus*] were placed on the ground surface within the campus of Faculty of Medicine, UiTM (3°13'17.92" N 101°35'38.65" E, 60 m a.s.l.) for a carrion decomposition study. The study site was covered by grass [*Imperata cylindrica* (L.) and some *Mimosa pudica* L.] and was near to a garbage dumping ground (~ 10 m). During the dry/remains stage of rat carcasses, two caterpillars were collected from one of the carcasses using forceps and preserved in 70%

ethanol. In September 2017, another two rat carcasses (*R. norvegicus*) were placed on the ground surface which was partially shaded by trees. The average temperature of the site ranged from 24°C – 33°C. During the dry/remains stage, two caterpillars were collected from one of the rat carcasses. The specimens were then brought back to the laboratory and microscopic observation and identification were conducted under a stereo microscope (Olympus SZ61, Japan) at the Institute for Medical Molecular Biotechnology (IMMB), Faculty of Medicine, Universiti Teknologi MARA (UiTM). Among four caterpillars, two belonged to Psychidae (cases were made from grass segments) (Figure 1a) and the other two were identified as *Monopis* sp. (Tineidae, Lepidoptera) (cases were made from fur) (Figures 1b & 1c).

On another occasion, a forensic soil chemistry study was conducted in August 2019 where a total of three rabbit carcasses [*Oryctolagus cuniculus* (L.)] were placed on the surface of peat soil and sand soil sites in Paya Indah Wetlands, Dengkil, Selangor (2.86°N 101.62°E, 266 m above sea level (a.s.l)). The sand site was surrounded by fresh water lakes and the distance from the carcasses to the lakes was approximately 5 m from the east and 9 m from the west. The sandy site was dominated by tropical carpet grass [*Axonopus compressus* (Swartz)] and coconut trees [*Cocos nucifera* L.] where as the peat soil site was dominated by bamboos trees [*Fargesia* sp.]. We observed an adult *Vindula dejone* (Erichson) (Nymphalidae, Lepidoptera) (Figure 2a) and a Lithosiini caterpillar (Arctiinae, Erebidae, Lepidoptera) (Figure 2b) on the rabbit carcasses along the course of decomposition. *Vindula dejone* visited the bloating carcass (Day 2) which was placed on the peat soil whereas the Arctiinae caterpillar was found on the dried carcass (Day 10) on the sandy soil (Table 1).

The bagworms (Psychidae, Lepidoptera), or case moths, are known from all zoogeological regions except Antarctica and they include approximately 1,000 species, all of which complete its larval development within a self-enclosing bag, and the larvae are omnivorous scavengers or polyphagous



Figure 1. A. Dorsal view of a psychid case with a larva inside (Psychidae, Lepidoptera). B. *Monopis* sp. (Tineidae, Lepidoptera) cases and larvae associated with a rat carcass at the advanced-decay stage of decomposition. C. *Monopis* cases (black arrow) and larvae (white arrow) placed on a leaf surface after being removed from the rat carcass.

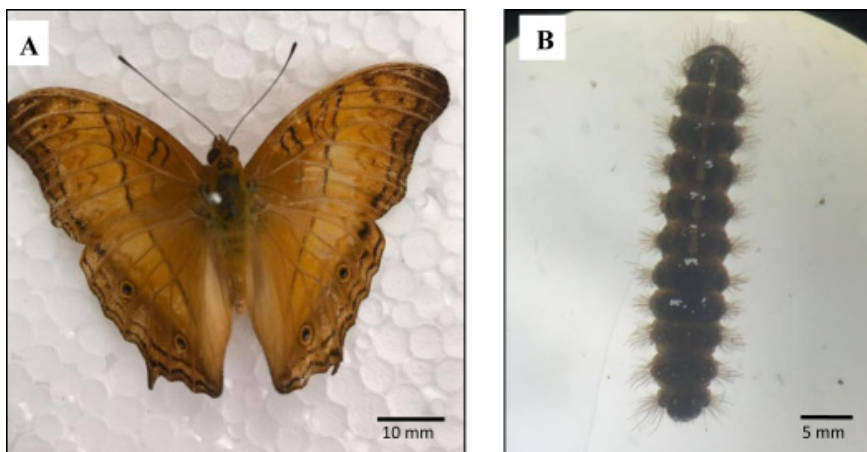


Figure 2. A. Dorsal view of adult *Vindula dejone* (Nymphalidae, Lepidoptera) collected from the rabbit carcass placed on peat soil site. B. Dorsal view of Lithosiini caterpillar (Arctiinae, Erebidae) collected from the rabbit carcass placed on sand soil site. Both study sites were located in Paya Indah Wetlands, Dengkil, Selangor, Malaysia.

Table 1. Caterpillar infestation and adult attraction of Lepidoptera on animal carcasses in Selangor, Malaysia in 2017 and 2019

Month / Year	Carcass species	Stages of carrion decomposition	Post-mortem (day)	Lepidoptera collected (family)	Stages of specimen collected	Number of specimen identified
August 2017	Rat (<i>Rattus norvegicus</i>)	Dry / remains	9	Unidentified sp. (Psychidae)	Larva	2
September 2017	Rat (<i>Rattus norvegicus</i>)	Dry / remains	15	<i>Monopis</i> sp. (Tineidae)	Larva	2
August 2019	Rabbit (<i>Oryctolagus cuniculus</i>)	Bloated	2	<i>Vindula dejone</i> (Nymphalidae)	Adult	1
		Dry / remains	10	Unidentified sp., Arctiinae (Erebidae)	Larva	1

defoliators with a broad range of hosts (Rhainds *et al.*, 2009; Sobczyk, 2011). In Malaysia, bagworms are commonly found in many orchard, landscape and ornamental trees (Ahmad & Ho, 1980). In this study, the cases of Psychidae were found around a rat carcass (~ 5 cm from the carcass). It is possible that these bagworms fed on lichens and mosses, as well as on small insects and organic debris of carrion origin (Rhainds *et al.*, 2009). Thus far, no Psychidae larvae have been reported from decomposing animal remains. Their role in carrion ecology and forensic entomology remains unclear and should be further explored.

Many species of the subfamily Tineinae, such as *Tinea*, *Niditinea*, and *Monopis*, have been reported in bird nests, faeces, and wool products (Lee *et al.*, 2016; Lee *et al.*, 2020). The larvae of these moths are known to feed on keratin and chitin sources, such as feathers, fur, pellets, arthropod remains, guano, and wool (Robinson, 1988; Robinson & Nielsen, 1993). The genus currently comprises approximately 100 species, which are widespread and diverse throughout the Old World (Robinson & Nielsen, 1993) but there are approximately 36 species have been recorded in the Palaearctic and Oriental regions (Xiao & Li, 2006). Recently, two species of tineid moths, *Monopis longella* (Walker) and *Monopis congestella* (Walker) have been collected using artificial feather traps in South Korea (Lee *et al.*, 2016). There was a case in Italy where the bodies of two missing children were infested with Tineidae in an enclosed underground environment (Introna *et al.*, 2011). Tineidae usually colonize bodies in the late stages of decomposition when the body is in dry stage, feeding on natural fibres such as hairs and also on clothing that contain human sweat or putrefactive fluids (Introna *et al.*, 2011). This family represents a useful biological indicator for an extended period of postmortem interval (PMI). In the present observations, the larvae of *Monopis* sp. could be feeding on the rat's fur during the dry and remains stage (they were collected on day 15 post-mortem).

On the other hand, family Erebiidae (Arctiinae) are a large and diverse subfamily of moths. The larvae of Lithosiini mostly feed on mosses and lichens instead of carcasses (Wagner, 2009). There are also a few reports of the caterpillars feeding on mushrooms (Moskowitz & Haramaty, 2012). To date, there is no report on Arctiidae larvae feeding on carcasses. In our findings, the presence of arctiid larva indicates an advanced decay stage of decomposition (it was collected on day 10 post-mortem).

From our recent observations, it is evident that some species of Lepidoptera are attracted towards animal carcasses. Caterpillar colonization on carrion should be documented more frequently as they might be useful in forensic entomology particularly in the determination of minimum postmortem interval (mPMI) or serve as locality indicators. We recommend more taxonomical and ecological studies to understand the role of caterpillars in carrion decomposition processes.

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Conflict of Interests

The authors declare that they have no conflict of interests.

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