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Narrative Review: The Influence of Carcass Placement on Insect Arrival

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Abstract. Forensic entomology is crucial in providing information related to insects and legal cases involving both animals and humans. Insects serve as indicators of the time of death, with their presence influenced by the cause and placement of the corpse. This study aims to examine the effect of carcass placement on insect arrival. The method used in this narrative review involves searching for articles with the same or similar topics to obtain data relevant to the topic under discussion. The results of this narrative review revealed that insects arriving on rabbit carcasses placed both indoors and outdoors, as well as on pig carcasses placed outdoors in Warri, Southern Nigeria, belong to seven orders: Diptera (*Muscidae*, *Calliphoridae*, *Sarcophagidae*, *Formicidae*, *Tachinidae*), Coleoptera (*Chrysomelidae*, *Staphylinidae*, *Scarabaeidae*, *Silphidae*, *Cleridae*, *Dermestidae*, *Histeridae*), Hymenoptera (*Formicidae*), Hymenoptera, Lepidoptera, Blataria, and Orthoptera (*Grillidae*). Additionally, the difference in placement affected larval growth, with carcasses placed in enclosed spaces showing higher larval growth compared to those placed in open spaces.

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1. Introduction

Recently, cases of death involving abandoned bodies have become more frequent. The Head of the Forensic Medicine Installation at Sanglah General Hospital, Dr. Kunthi Yulianti, Sp.KF, reported that the hospital received 4,829 abandoned bodies in 2019 and 3,886 in 2020 (Utami, 2020). These bodies were found in various locations such as in water, mountains, indoor and outdoor environments, with different conditions and causes of death. These varying conditions require identification to obtain information about who, when, where, and how the person died (Laksmita *et al.*, 2011). Several methods can be used to determine the time of death, including studies on physical, chemical, histological, biochemical, and enzymatic changes that occur in a deceased body (Gautam, 2015). One branch of forensic science that has been developed for determining the time of death is forensic entomology (Laksmita *et al.*, 2011). Forensic entomology is a branch of forensic science that uses insects to assist in

death investigations by measuring the length and weight of larvae. These insects can help determine the time of death and whether the body has been moved by observing the succession of insect and other arthropod species on the corpse (Wulandari *et al.,* 2020).

Several studies have concluded that insects can be used as indicators in determining the time of death, with their presence influenced by the cause and placement of the body, from the initial decomposition process to the destruction of the corpse. The insects that play a major role in this process are flesh flies (*Sarcophagidae*) and blowflies (*Calliphoridae*) (Gautam *et al.,* 2015). Insects from the *Calliphoridae* family are the first colonizers to arrive on human remains and serve as the most accurate indicators for estimating the post-mortem interval (PMI) by observing their developmental stages (Vélez & Wolff, 2008). An early forensic study conducted by Tuzun *et al.,* 2010 in Iran found five insect orders: Diptera, Coleoptera, Dermaptera, Blattaria, and Hymenoptera (Badenhorst & Villet, 2018). The arrival of insects on a corpse corresponds to the stages of decomposition, which are influenced by environmental factors such as temperature, humidity, rainfall, lighting, geographical location, and contaminants (Switha *et al.,* 2019).

Based on the explanation above, I am interested in discussing this issue with the title "Narrative Review: The Influence of Carcass Placement on Insect Arrival." The purpose of this paper is to observe the diversity of insect species on carcasses placed in different locations, which can be used to estimate the time of death by examining insect arrival patterns on carcasses according to their decomposition phases. The results of this study are expected to provide information on the use of forensic entomology methods that can be applied in criminal investigations and help estimate the time of death.

2. The Methods

The method used in writing this narrative review involves searching for articles with the same or similar topics to obtain data relevant to the subject under discussion. The keywords used were: forensic entomology, decomposition, and insects. Articles were searched on trusted websites, including Google.com, Google Scholar, and Semantic Scholar, with a publication date restriction from 2019 to 2024, and inclusion and exclusion criteria were applied. All selected articles were read in detail to determine whether they were suitable to be used as primary data sources. Subsequently, data analysis was conducted on the articles obtained, and arguments/discussions were developed based on each data source. Additionally, the strengths and weaknesses of the articles were considered to consolidate the data into a unified analysis.

3. Result and Discussion

The arrival of insects on rabbit carcasses placed outdoors consisted of 601 adult insects from 6 orders: Diptera (*Muscidae*, *Calliphoridae*, *Sarcophagidae*, *Tachinidae*), Coleoptera (*Chrysomelidae*, *Staphylinidae*, *Scarabaeidae*, *Silphidae*), Hymenoptera (*Formicidae*), Hemiptera, Blattaria, and Orthoptera (*Grillidae*). Meanwhile, indoors, insects were found from the orders Diptera (*Muscidae*, *Calliphoridae*, *Sarcophagidae*, *Tachinidae*), Coleoptera (*Chrysomelidae*, *Staphylinidae*, *Scarabaeidae*, *Silphidae*), Hymenoptera (*Formicidae*), Hemiptera, and Lepidoptera. During the early stages of death and decomposition, the insects that arrived on the animal remains both indoors and outdoors belonged to the order Diptera (*Calliphoridae*, *Tachinidae*, *Muscidae*, and *Sarcophagidae*). From post-decomposition to the skeletal phase, the arriving insects belonged to the order Coleoptera (*Staphylinidae*, *Chrysomelidae*, *Scarabaeidae*, and *Silphidae*). Hymenoptera insects (*Formicidae*) were present from the initial stages of death until the skeletal phase (Supriyono, 2019).

In a study on pig carcasses placed outdoors in Warri, Southern Nigeria, the insects that arrived belonged to 3 orders: Diptera (*Muscidae*, *Calliphoridae*, *Sarcophagidae*, Fannidae, Drosophilidae, Stratiomyidae) and Coleoptera (*Staphylinidae*, *Cleridae*, *Chrysomelidae*, *Dermestidae*, *Histeridae*, *Scarabaeidae*). During the early stages of death and decomposition, the insects arriving on the animal remains were primarily from the order Diptera (*Muscidae*, *Calliphoridae*, *Sarcophagidae*). From post-decomposition to the skeletal phase, the arriving insects included Diptera (*Muscidae*, *Calliphoridae*, *Sarcophagidae*, Stratiomyidae), Coleoptera (*Staphylinidae*, *Cleridae*, *Dermestidae*, *Histeridae*), and Hymenoptera (*Formicidae*), which were present from the initial stages of death until the skeletal phase (Odo & Iloba, 2020).

In a study examining the effect of different carcass placements on fly larval growth in rats (Rattus norvegicus), where each rat carcass was placed (1) on the ground surface, (2) inside a wooden box, (3) inside a bag, then placed in a wooden box, and (4) inside a wooden box filled with soil to a depth of 15 cm, two species from the order Diptera (family *Calliphoridae*) were found: *Chrysomya megacephala* (on carcasses placed on the ground surface, inside a bag and then placed in a wooden box, and inside a wooden box filled with soil to a depth of 15 cm) and *Chrysomya bezziana* (on carcasses placed inside the wooden box). Additionally, the difference in placement influenced larval growth, with carcasses placed in enclosed spaces showing higher larval growth compared to those placed in open spaces (Swita *et al.*, 2019).

Based on these studies, carcasses placed indoors, outdoors, on the ground surface, inside a wooden box, inside a bag and then placed in a wooden box, and inside a wooden box filled with soil to a depth of 15 cm resulted in the arrival of insects from 7 orders: Diptera (*Muscidae*, *Calliphoridae*, *Sarcophagidae*, *Formicidae*, *Tachinidae*), Coleoptera (*Chrysomelidae*, *Staphylinidae*, *Scarabaeidae*, *Silphidae*, *Cleridae*, *Dermestidae*, *Histeridae*), Hymenoptera (*Formicidae*), Hemiptera, Lepidoptera, Blattaria, and Orthoptera (*Grillidae*), corresponding to the decomposition stages of the carcass. Insects from the orders Diptera, Coleoptera, and Hymenoptera were the most dominant on carcasses in different locations. In contrast, insects from the orders Hemiptera, Lepidoptera, Blattaria, and Orthoptera (*Grillidae*) arrived according to the placement of the carcass.

The arrival of insects on carcasses is influenced by several environmental factors such as temperature, humidity, rainfall, lighting, geographical location, and contaminants. Additionally, the difference in placement also affected larval growth, with carcasses placed in enclosed spaces showing higher larval growth compared to those placed in open spaces (Switha *et al.*, 2019).

4. Conclusion

The results of this narrative review conclude that the diversity of insect species on carcasses placed in different locations consists of 7 orders: Diptera (*Muscidae*, *Calliphoridae*, *Sarcophagidae*, *Formicidae*, *Tachinidae*), Coleoptera (*Chrysomelidae*, *Staphylinidae*, *Scarabaeidae*, *Silphidae*, *Cleridae*, *Dermestidae*, *Histeridae*), Hymenoptera (*Formicidae*), Lepidoptera, Blattaria, and Orthoptera (*Grillidae*). Additionally, the placement of the carcass affects larval growth, with carcasses placed in enclosed spaces showing higher larval growth compared to those placed in open areas. The stages of decomposition on the carcass attract insects, so the insects arriving at the carcass correspond to its decomposition stages.

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