# Decomposition and Insect Succession on Guinea Pig Carcass in Jaffna Sri Lanka

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**Abstract**: Carrion insects visit the carcass in a predictable order depending on the different stages of decomposition, which is referred to as insect succession. Location and the position of the carcass affect the rate of decomposition and the pattern of insect succession. The objective is to study the differences in the rate of decomposition and insect succession patterns between the carcasses of a hanging and a ground-lying guinea pig. Two six-month-old, 500-gram-weighing male guinea pigs (*Cavia porcellus*) were sacrificed using identical methods. One (C1) was kept on the ground 100m away from the insectary, and the other (C2) was kept in a hanging position, 1.5m above the floor of the outside insectary. All the environmental parameters are similar except the roof shade for the hanging carcass. Morphological changes in the decomposing carcasses were noted, and insects visited the carcasses were collected twice a day till the carcasses were fully decomposed. Five stages of decomposition were differentiated, and the time taken for each stage was noted. The decomposition rate was higher in C1- ground lying carcass when compared with hanging carcass C2. A total of 27 species belonging to 15 families of the same orders were collected from C1, and 13 species of insects representing eight families of 4 orders were collected from C2. The insect succession on both C1 and C2 throughout the decomposition stages showed a similar pattern as *Musca domestica* was the first visitor at the fresh stage, followed by *Chrysomya megacephala* and *Chrysomya rufifacies* at their bloat stage. Coleopterans reached decay and post-decay stages. However, their arrival time was varied. C1 quickly changed into the following decomposition stage, completed the process, and reached the skeletonized stage in 31 days, but C2 took 37 days to complete. *Dermestes maculatus* is the only representative of Coleoptera for C2, but 07 Species of 6 families were found to be associated with C1. Differences in decomposition rate between hanging and ground-lying carcasses could be caused by the differences in drying and availability of ground-dwelling taxa in hanging carcasses.

**Keywords**: Carrion insects, Insect succession, Carcass, Decomposition

## 1. INTRODUCTION

Insects associated with decomposing remains are termed carrion insects. Decomposing carrions provide a temporary, changing site of concentrated resources that are exploited by a wide range of organisms, of which arthropods are the first arrivers and the major exploitive group.

In 1994, Goff and Lord, proven that hanging affects the insect colonization of the remains. They observed that hanging changed the insect colonization pattern by avoiding soil insects and also changing drying pattern of the body and limited the activities of fly species. So that the number of insects collected may be reduced, it is suggested that hanging the carcass increases the contact with air, causing drying and increasing the decomposition rate (Goff *et al.*, 2000). Differences in decomposition between hanging and ground lying carcass are caused by the differences in drying, exclusion of ground dwelling taxa in hanging carcasses and gravitational pull. In hanging carcasses decomposition process is increased initially by the natural bacterial processes which occur during decomposition and may be increased due to the increase in blood transportation around the body directly prior to asphyxiation (Gennard,2012). Late in the decomposition of hanging carcass is caused by the lack of insect activity on the carcass (Goff and Lord,1994). This study's findings contribute to our understanding of carrion insects and provide essential information regarding the cause and time of death of an animal, which has practical implications in forensic investigations.

Therefore, in order to fill the gap in the data base on diversity and succession of carrion insects in Sri Lanka, this initial study was aimed to explore the insects associated with decomposing animal carcass placed in two different positions in the University premises in Jaffna.

## 2. METHODOLOGY

Two six months old male guinea pigs weighing 500 grams were sacrificed and one was allowed to decompose on the ground (site 1). The other was hanging in the nearby external insect-rearing facility room, fully closed with netting material. However, insects can reach the carcass through the mesh (site 2) and allowed to decompose fully. Both carcasses were placed at the proposed site at 6 pm on the 30th of October 2020, and they were allowed to decompose in the same environment until skeletonized completely. All possible precautions were made to avoid vertebrate scavenger attacks on decomposing carcasses. A protective cage of 60cm x 65cm x 65cm was made (modified from Kinnaird 2016) to protect the carcass that was lying on the ground from predators like birds, dogs, etc. Sampling consisted of a daily assessment of the decomposition stage of the carcass and insect collection from the carcass. Sampling was conducted daily between 9 am and 12 noon and in the evening from 3 pm and 5 pm during weekdays and 9 am and 12 noon during weekends until the carcasses reached the post-decay stage and when no considerable maggot activity was found. Collected specimens were preserved and identified up to possible taxa using available taxonomic keys. Weather conditions, including temperature, rainfall, and humidity, were recorded during the present study.

## 3. RESULTS AND DISCUSSION

Decomposition had five stages in both carcasses: Fresh, bloat, decay, post-decay, and skeletal (Table 1). Decomposition took 31 days for the carcass on the ground – C1 and 37 days for the hanging carcass – C2. The hanging carcass was protected from sun and rain because it was placed inside the External insect-rearing facility room, which had a roof. The absence of direct sunlight could have delayed the decomposition process, as sunlight plays a significant role in decomposition. Necrophagous insects play a major role in decomposition. The more necrophagous species lead to faster decomposition.

Dipteran flies such as: *Musca domestica* (Family: Muscidae), *Chrysomya megacephala, Chrysomya rufifacies* (Family: Calliphoridae), Coleopteran beetles such as: *Dermestes maculatus* (Family Dermestidae), *Chaetocnema confinis* (Family Chrysomelidae), *Camponotus compressus*, *Leptogenys peuqueti*; *Tetramorium smithi, Trichomyrmex destructor, Meranoplus bicolor, Monomorium pharaonis* (Family Formicidae) and *Euborellia annulipes* (Family Forficulidae) of order Dermaptera were collected from both C1 and C2.

*Sarcophaga dux* (Family sarcophagidae), *Aleochara (Aleochara) postica*, *Oxytelus puncticeps*; (Family: staphylinidae), *Onthophagus cervus* (Family scarabaeidae), *Sisyphus longipes*; *Rhyssemus inscitus* (Family scarabaeidae) *Pterostichus melanarius, Brachinus* sp. (Family Carabidae), *Saprinus (Saprinus) splendens* (Family histeridae) *Diacamma indicum* (Family formicidae) *Chalybion bengalense*, *Sphex* sp. (Family sphecidae), *Polistes wattii* (Family Vespidae), *Trissolcus* sp. (Family Platigastridae) and *Crossocerus* sp. (Family Crabronidae) were collected from C1. *Sarcophaga haemorrhodalis* (Family: Sarcophagidae) was collected from C2. (See plates 1, 2 and 3).

Colonization species of most significant importance in the early stages of decomposition are those from the three dipteran families: Calliphoridae, Sarcophagidae, and Muscidae. The study confirmed this as the Muscids were the first to arrive at the carcasses, followed by ther families. Calliphorids were more abundant in carcasses than others.

**Table 1:** Comparison between decomposition stages of ground dwelling carcass (carcass C1) and hanging carcass( carcass C2).

| Stage | C1 | C2 |
|---|---|---|
| **Fresh** |  No signs of decomposition visible. This is the stage during which the blow flies (Calliphoridae) and flesh flies (Sarcophagidae) arrive at the corpse and begin laying eggs or larvae. |  The body was hanging towards the ground. Limbs hung toward the ground with the hind limbs were in close position. Due to the pressure caused by the thread around the neck the eyes and mouth were open. |
| **Time duration** | 1 day | 2 days |
| **Bloat** |  Prominent bloat stage was observed. Abdomen was bloated and it was very big due to the accumulation of excess amount of gas. |  When the hanging carcass reached the full bloat stage, livor mortis occurred in the lower body regions. Greenish discolouration is caused by the reaction of hydrogen sulphide with the haemoglobin. Hydrogen sulphide is a significant component of the gases excreted during decomposition. From day2, the anus of the hanging carcass was distended and exposed from pressure inside the abdomen. Liquids began to seep through the skin. Liquid from mouth also seeped out. Maggot masses were observed. Lower legs were pushed slightly outwards. |
| **Time duration** | 1-2 days | 1-2 days |

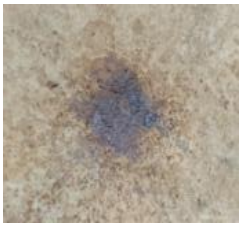
| | | |
|---|---|---|
| **Decay** |  <br>Gasses escape and the remains deflate. Maggot masses were very predominant. Coleopterans also begin to arrive. Body was open at the abdominal area and insect activities were prominent. By the end of this stage, most of the flesh was removed from the carcass and most of the Calliphoridae and Sarcophagidae left the carcass to pupate. |  <br>Abdominal splitting was observed. Chest and the abdomen region of the carcass started to slowly extend towards the ground lengthening the carcass. Maggot mass were found on the mouth. Flesh flies were found on the anal region of the carcass. |
| **Time duration** | 15 days | 16 days |
| **Drip zone** | Was not prominent because the carcass was placed on the ground. | Drip zone is formed when the abdomen split open. Ants were feeding on the drip zone. Maggots fell from the carcass  |
| **Time duration** | - | 16 days |
| **Post decay** |  <br>Very dry. Most of the previous taxa of insect visitors were disappeared. |  <br>Very dry. Skin in the abdominal region is very stretched and it gave the carcass an elongated shape. The skin was hard and mummified. After the dry decay stage carcass was allowed to decompose on the ground. |
| **Time duration** | 5 days | 6 days |
| **Skeletal** | Remains were skeletonized | Remains were skeletonized |
| **Time duration** | 8 days | 11 days |

Table 2: Comparison between insect successions between carcasses.

| Insect taxa | | | Ground lying carcass | | | | | Hanging carcass | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Days and stage of decay | | | | | Days and stage of decay | | | | |
| | | | 0-1 | 1-3 | 3-18 | 18-23 | 23-31 | 1-2 | 2-4 | 4-20 | 20-26 | 26-37 |
| Order | Family | Species | Fresh | Bloat | Decay | Post decay | Skeletal | Fresh | Bloat | Decay | Post decay | Skeletal |
| Diptera | Muscidae | *Musca* sp. | x | x | - | - | - | x | - | | - | - |
| | Calliphoridae | *Chrysomya megacephala* | - | x | x | - | - | - | x | x | - | - |
| | | Chrysomya rufifacies | - | x | x | - | - | - | - | x | - | - |
| | Sarcophagidae | *Sarcophaga dux* | - | - | x | - | - | - | - | - | - | - |
| | | *Sarcophaga aemorrhodalis* | - | - | - | - | - | - | - | x | - | - |
| Coleoptera | Staphylinidae | *Aleochara (Aleochara) postica* | - | - | - | x | x | - | - | - | - | - |
| | | *Oxytelus puncticeps* | - | - | - | x | x | - | - | - | - | - |
| | Histeridae | *Saprinus splendens* | - | - | x | - | - | - | - | - | - | - |
| | Dermestidae | *Dermestes maculatus* | - | - | x | - | - | - | - | - | - | x |
| | Scarabaeidae | *Onthophagus* cervus | - | - | - | x | x | - | - | - | - | - |
| | | *Sisyphus longipes* | - | - | - | x | x | - | - | - | - | - |
| | | *Rhyssemus inscitus* | - | - | - | x | x | - | - | - | - | - |
| | Carabidae | *Pterostichus melanarius* | - | - | - | - | x | - | - | - | - | - |
| | | *Brachinus* sp. | - | - | - | - | x | - | - | - | - | - |
| | Chrysomelidae | *Chaetocnema confinis* | - | - | x | x | - | | - | - | x | x |
| Hymenoptera | Formicidae | *Camponotus compressus* | - | x | - | x | - | | x | x | x | x |
| | | *Leptogenys peuqueti* | x | x | - | - | x | | - | - | - | x |
| | | *Diacamma indicum* | - | x | - | - | | | - | - | - | - |
| | | *Tetramorium smithi* | x | x | x | - | - | x | x | - | x | x |
| | | *Trichomyrex destructor* | x | x | x | - | - | x | x | - | - | x |
| | | *Meranoplus bicolor* | x | x | x | - | - | x | x | - | - | x |
| | | *Monomorium pharaonis* | x | x | x | - | - | x | - | - | - | x |
| | Sphecidae | *Chalybion bengalens* | - | - | x | - | - | - | - | - | - | - |
| | | *Sphex* sp. | - | - | x | - | - | - | - | - | - | - |
| | Vespidae | *Polistes wattii* | - | - | x | - | - | - | - | - | - | - |
| | Platygastridae | *Trissolcus* sp. | - | - | x | - | - | - | - | - | - | - |
| | Crabronidae | *Crossocerus* sp. | - | x | - | - | - | - | - | - | - | - |
| Dermeptera | Forficulidae | *Euborellia annulipes* | - | - | x | - | - | - | - | - | - | x |

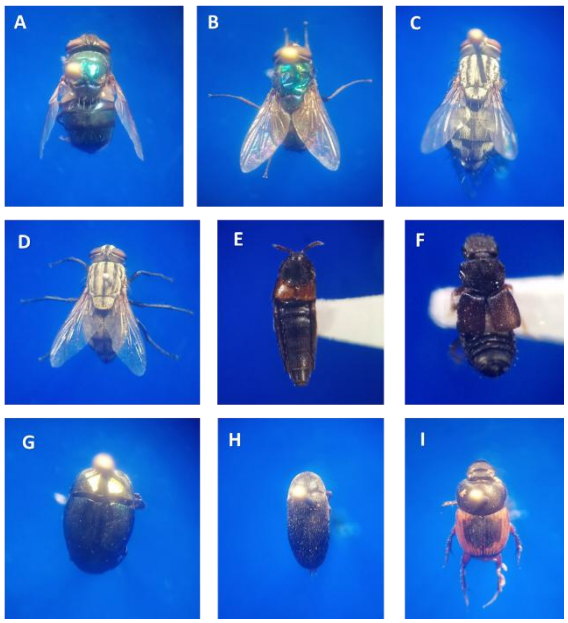



**Plate 01:** Insects species collected from decomposing guinea pig carcass.
Order: Diptera (Fam: Calliphoridae A: *Chrysomya megacephala*; B: *Chrysomya rufifacies*; Fam.: Sarcophagidae C: *Sarcophaga dux*; D: *Sarcophaga haemorrhodalis*;
Order: Coleoptera family: Staphylinidae E: *Aleochara (Aleochara) postica*; F: *Oxytelus puncticeps*; Fam. Histeridae G: *Saprinus (Saprinus) splendens*; Fam. Dermestidae H: *Dermestes maculatus*; Fam. Scaravaeidae I: *Onthophagus cervus.*

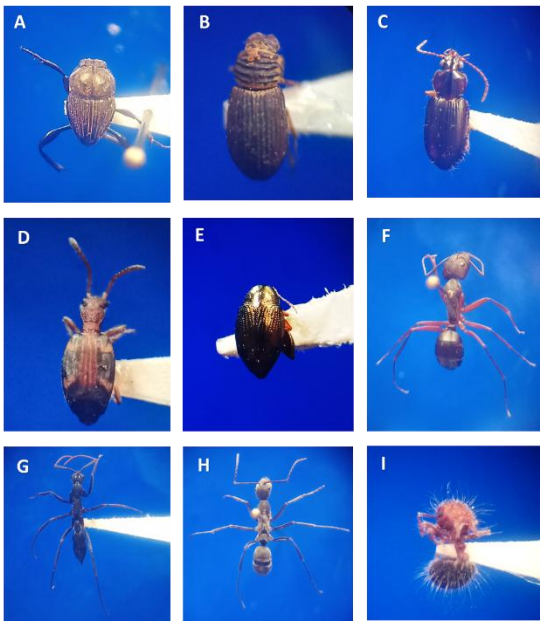



**Plate 02:** Insects species collected from decomposing guinea pig carcass.

Order Coleoptera: Fam Scarabaeidae A: *Sisyphus longipes*; B: *Rhyssemus inscitus*; Fam: Carabidae C: *Pterostichus melanarius*; D: *Brachinus* sp.; Fam. Chrysomelidae E: *Chaetocnema confinis*; Hymenoptera Fam. Formicidae F: *Camponotus compressus*; G: *Leptogenys peuqueti*; H: *Diacamma indicum*; I: *Tetramorium smithi.*

Carcass size also affects the colonization of insects. Some species or specific groups of insects are generally found only on carcasses of a certain size. Braack (1981) found the flies of the genus *Sarcophaga* on smaller carcasses only. Carcasses used in this research are smaller than other vertebrate carcasses like Pigs, so *Sarcophaga* flies were collected. In this study, no Silphid carrion beetles were collected. If we compare the insect abundance in C1 and C2, it was higher in C1 as it was placed in the outside open environment, but C2 was inside the external insectary. When the carcass was placed indoors, it had fewer insects than outdoors. Geographical location and habitat affect insect succession and depend on the amount and the type of resources available (Anderson, 2019). For example, Ants feed on flesh, and skin beetles feed on the skin (table 2). Ground-dwelling insect taxa were not found in C2. Soil-dwelling insect taxa play a significant role in decomposition. So, the decomposition rate was slower in C2 than in C1.

## 4. CONCLUSION

In conclusion, this research provides data on the decomposition process of ground-dwelling and hanging carcasses and the role of carrion insects in the ecosystem. The five stages of decomposition - fresh, bloat, decay, post-decomposition, and skeletal - were consistent in both types of carcasses.

The hanging carcass's extended decomposition duration, attributed to its protection from direct sunlight and rain, indicates the significance of environmental factors in influencing the

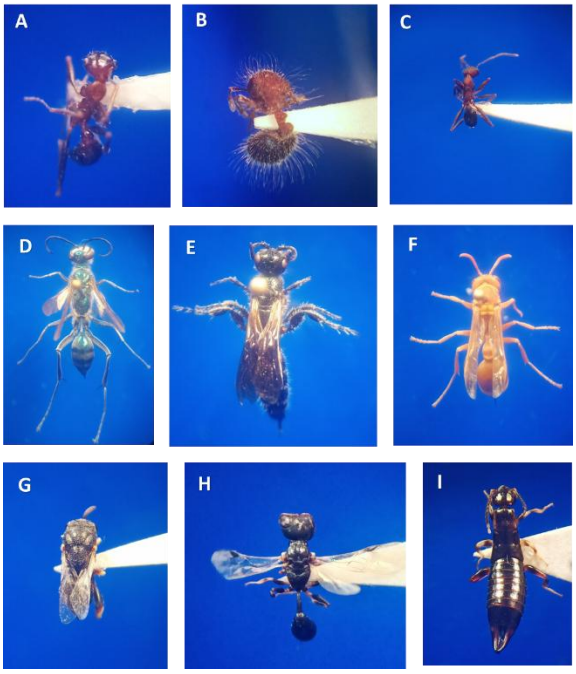



**Plate 03.** Insects species collected from decomposing guinea pig carcass.
Order Hymenoptera Fam Formicidae A: *Trichomyrmex destructor*; B: *Meranoplus bicolor*; C: *Monomorium pharaonis*; Fam. Sphecidae D: *Chalybion bengalense*; E: *Sphex* sp.; Fam.Vespidae F: *Polistes wattii*; Fam. Plastigastridae G: *Trissolcus* sp.; Fam. Cabronidae H: *Crossocerus* sp.; Order Dermaptera Fam. Forficulidae I: *Euborellia annulipes.*

decomposition rate. The presence of necrophagous insect species, particularly the dipteran families Calliphoridae, Sarcophagidae, and Muscidae, significantly facilitated carrion breakdown. The absence of ground-dwelling insect taxa in the hanging carcass emphasizes the importance of soil-dwelling insects in the decomposition process.

While acknowledging the limitations, such as the use of smaller carcasses and the inability to control temperature variations, the findings of this research have direct and significant implications for forensic entomology, ecology, and wildlife management, providing practical insights for these fields.

This study significantly contributes to the broader understanding of carrion insect ecology and its impact on decomposition dynamics. The comprehensive analysis of decomposition stages and insect colonization patterns provides a foundation for future research in related areas and opens up new avenues for exploration in the field.

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