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EXPLORATION OF THE SIGNIFICANCE OF HISTERIDAE BEETLES ON CARCASSES IN THE FIELD OF FORENSIC ENTOMOLOGY

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Utilizing blowfly maggots to estimate PMI is a widely accepted method employed by professionals in the field. It is widely recognized that decomposing carcass serve as temporary resources in terrestrial ecosystems. It is worth mentioning that there are several other insects that are specialized in the decomposition stage of carcasses, including Histeridae, Dermestidae, Cleridae, Scarabaeidae, Silphidae, and Staphylinidae. These insects play a crucial role in the decomposition process as they consume the soft tissues of the carcass. They also assist in the breakdown of the carcass and accelerate the decomposition process. Our study revealed that the Histeridae beetles are the coleopterans that are commonly found alongside blowflies. They consume dipteran eggs, maggots, and decaying or rotting carcasses. The populations rely entirely on the various stages of decomposition of carcasses. At the initial stages of decomposition, a handful of Histeridae can be observed on carcasses. However, following the initial phase progress, the variety of organisms experienced a rapid and exponential growth during the active decay stage, eventually tapering off. Only a refined selection of Histeridae beetle species were found on the remains and beneath the soil. The study also examined the impact of temperature, humidity, and pH on the abundance and diversity of Histeridae beetles. The findings indicate a significant correlation between pH levels and the beetle species. Indicating its importance in controlling the behaviour of Histeridae. Nevertheless, temperature and humidity Overall, there was no notable impact observed throughout the duration of the study. Histeridae play a crucial role as natural predators and decomposers, contributing to the development of solutions for environmental and public health issues related to health and ecological conservation.

Keywords. Forensic entomology, Histeridae, Ecology, Succession, Post-mortem interval (PMI), forensic science, insects, forensic death investigations, PMI estimations, India

INTRODUCTION

Forensic entomology plays a pivotal role in legal investigations, particularly in estimating the minimum post-mortem interval (m-PMI) through the analysis of insect evidence attracted to decomposing carcasses. An in-depth understanding of the diverse insect species drawn to cadavers in different geographical regions is essential for accurate forensic assessments. Buffalo carcasses are utilized as experimental models in this field, facilitating the study of faunal succession, which helps in understanding the patterns of insect colonization on decomposing remains.

Various factors, including temperature, humidity, rainfall, pH levels, seasonal variations, and micro-climate, significantly influence the process of insect colonization on carcasses. Flies and beetles, particularly from the Dipteran and Coleopteran orders, are among the primary organisms attracted to cadavers due to the unique smells and gases they emit. Flies are commonly used for assessing the initial stages of decomposition and estimating the early m-PMI, while beetles become particularly valuable in later stages.(Introna Jr et al., 1998; Ivanov, 2018; Jarmusz et al., 2020; Kulshrestha & Satpathy, 2001; Leccese, 2004)

However, the utilization of beetles in forensic investigations presents challenges due to limited data on their ecology and behaviour. Beetles typically inhabit cadavers during more advanced decomposition stages, possibly to reduce competition with flies. This behaviour underscores the importance of understanding beetle biology, life cycles, and systematic evidence to accurately estimate the m-PMI.

Different beetle families exhibit varying preferences for cadavers, and the extent of their attraction can differ depending on the geographical location. Therefore, localized research focusing on specific areas is crucial for developing precise forensic entomological techniques.(Wenzel, 1936)

This study focused on observing Histeridae beetle succession on buffalo carcasses aimed to gather essential data for forensic investigations. By closely monitoring the presence of various beetle species linked to specific stages of decomposition, researchers sought to enhance their understanding of insect dynamics and ecological factors influencing m-PMI estimation.

Material and Methods

Study Area and Experimental Design

The study area and experimental design were conducted in Mullanpur Garibdass near Hadda-Roddi. Covering approximately 0.5 square kilometers within the Farmland region (30.79425° N, 76.74646° E), the aim was to utilize buffalo carcasses as a model for collection from June 2022 to December 2022. The area experiences tropical, semi-arid weather with high temperatures and subtropical monsoon patterns. The average yearly rainfall is 617 mm, and the temperature ranges from 4ºC in winter to 45ºC in summer. High relative humidity, averaging around 70% during the monsoon season, was observed. The area is surrounded by flora *including Ficus religiosa,* Acacia*, Dalbergia sissoo*, Kans grass, *Achyranthes aspera, Calotropis procera, and Lantana camara*. The fauna includes Crows, Heron, Dogs, and *Boselaphus* (Nilgai).

Beetles Collection and Preservation

Preservation

1 Collection

Beetles were collected from various stages of carcass decomposition. The systematic procedure was followed daily as carcasses progressed, and beetles were extracted from soil in advanced decay stages. Prompt transfer to labeled vials with details including decomposition stage, collection date, location, ambient temperature, and relative humidity was ensured.

2 Preservation

Preservation was tailored to match decomposition stages, stages, and soil samples were tested for pH. Beetles were Beetles were preserved to maintain the integrity of the the specimens and the accuracy of the data collected. collected.

Identification and Photography

Specimen Dissection

Specimens were dissected for genitalia genitalia study, and detailed examination examination and morphological studies studies were conducted using keys developed by [18, 20].

Photography

Detailed photographs were captured with Canon EOS 80D at Panjab University. Examination was conducted using a Leica S9i microscope, and high-resolution images were obtained through the stacking technique. Post-processing and editing were done in Adobe Photoshop CC.

Statistical Analysis

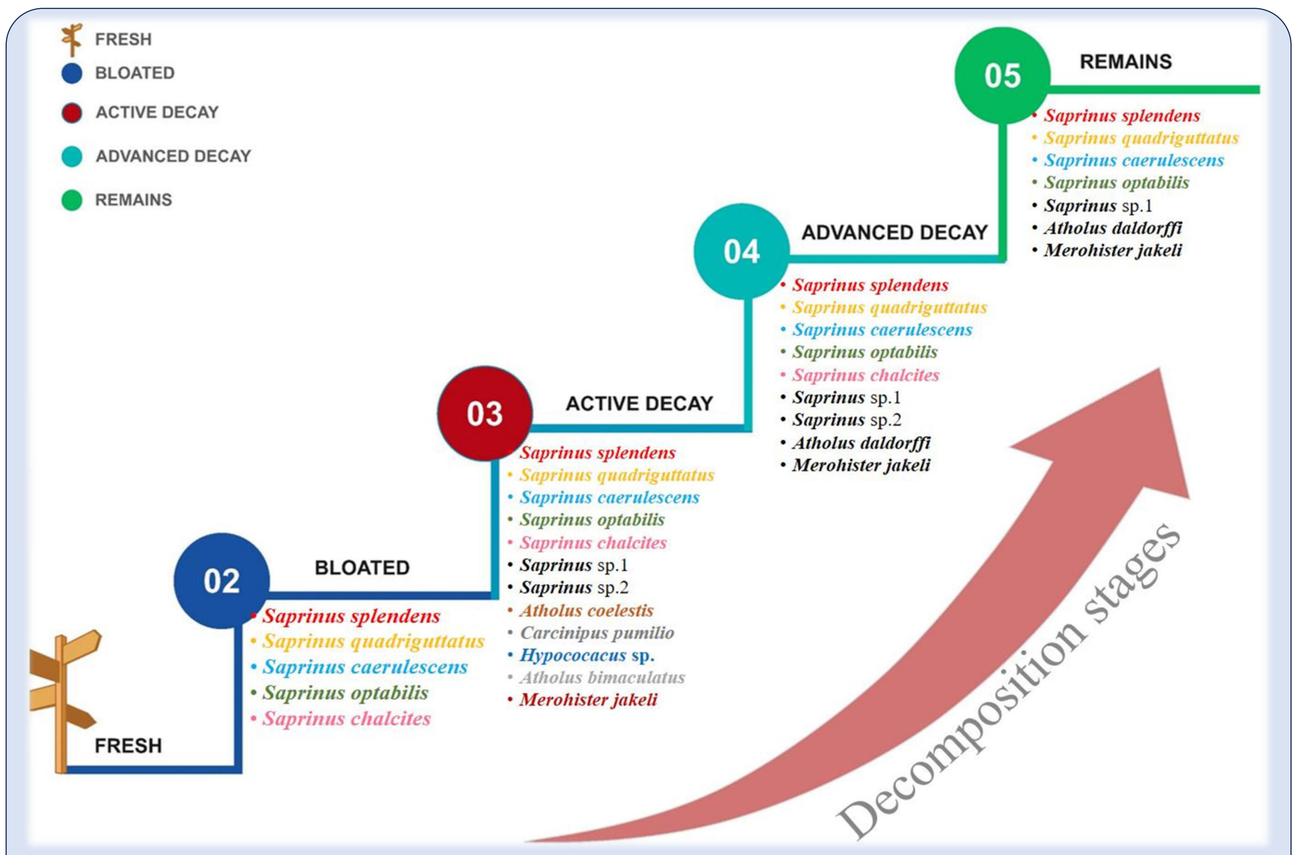
1 Diversity Indices

Diversity indices were computed for for each collecting method and decomposition stage to analyze the the variation in beetle populations.

2 Correlation Test

A correlation test was used to quantify associations between ambient temperature, humidity, soil pH, and beetle diversity, providing valuable insights into the environmental factors affecting beetle populations.

RESULTS



Diversity Indices	July	August	September	October	November	December
D	0.384	0.534	0.756	0.574	0.563	0.743
1 - D	0.616	0.466	0.244	0.426	0.437	0.257
H	1.279	0.978	0.618	0.874	0.728	0.482
E	0.555	0.546	0.318	0.488	0.525	0.439

Table 1. Shows the results of Simpson's Index (D), Index of Similarity (1 - D), Shannon-Wiener Index (H), and Evenness (E) for the Histeridae beetles found on the studied carcasses between July and December

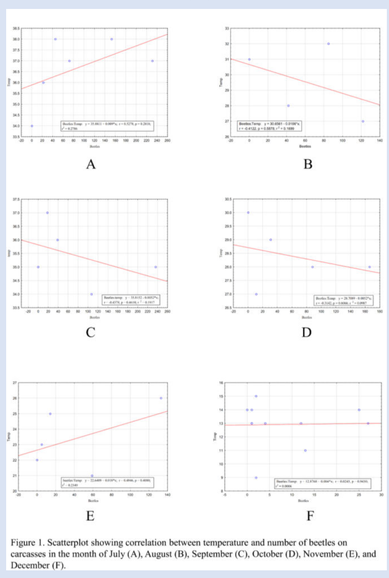


Figure 1. Scatterplot showing correlation between temperature and number of beetles on carcasses in the month of July (A), August (B), September (C), October (D), November (E), and December (F).

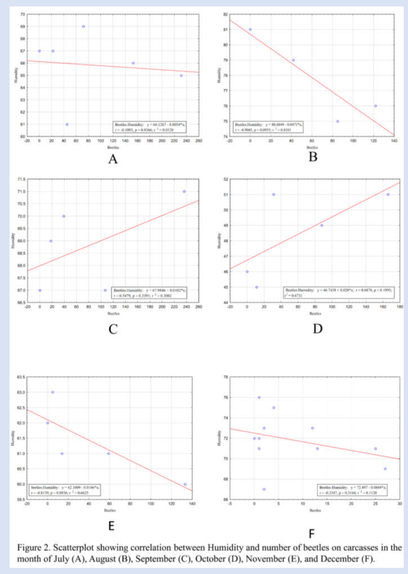


Figure 2. Scatterplot showing correlation between Humidity and number of beetles on carcasses in the month of July (A), August (B), September (C), October (D), November (E), and December (F).

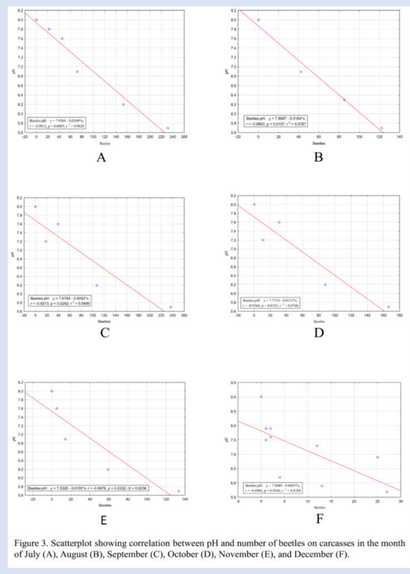


Figure 3. Scatterplot showing correlation between pH and number of beetles on carcasses in the month of July (A), August (B), September (C), October (D), November (E), and December (F).

DISCUSSION

The study investigates the role of Histeridae beetles in the decomposition process of animal carcasses in Mullanpur Garibdas, India, during different stages of decomposition from July to December. It identifies several Histeridae species involved in scavenging carrion during the bloated and active decay stages, including *Saprinus splendens, S. quadriguttatus, S. caerulescens, S. optabilis, and S. chalcites.* Additionally, during the advanced decay stage, these species along with others like *Atholus daldorffi* and *Merohister jakeli* continue to feed on the carcasses. The findings underscore the significant role of Histeridae beetles throughout various stages of decomposition in the studied ecosystem.

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