

# Review Paper on Forensic Entomology

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**Abstract—** Forensic entomology, a critical subdiscipline of forensic science, involves the study of insects and arthropods associated with decomposing remains to assist in legal investigations. This review explores the development, methodologies, and applications of forensic entomology in estimating the post-mortem interval (PMI), detecting cases of neglect or abuse, and aiding in criminal investigations. It also highlights recent technological advancements and the role of DNA analysis, insect succession, and environmental influences on insect colonization patterns. The paper concludes with a discussion of challenges and future directions in the field.

## I. INTRODUCTION

Forensic entomology applies the principles of insect biology to criminal and civil cases, particularly in determining the time since death or post-mortem interval (PMI). The earliest documented use of insects in crime investigation dates back to 13th-century China, as described in Song Ci's "The Washing Away of Wrongs." Modern forensic entomology emerged in the late 19th and early 20th centuries, with scientists like Jean Pierre Mégnin laying the foundation for the systematic study of insect succession on corpses. Today, forensic entomology is an essential aspect of medico-legal investigations, offering evidence in cases involving homicide, neglect, and illegal trafficking.

## II. APPLICATIONS IN FORENSIC INVESTIGATIONS

The most common application of forensic entomology is in estimating the PMI based on the developmental stages of insects colonizing a body. Blowflies (Calliphoridae) and flesh flies (Sarcophagidae) are among the first colonizers of decomposing tissue. Their life cycles egg, larva, pupa, and adult are temperature-dependent, allowing forensic experts to calculate the minimum time since death. In addition, insects can provide evidence about body movement,

concealment, and cause of death. For example, insect presence on buried or wrapped bodies differs significantly from exposed remains, giving insights into post-mortem handling.

Forensic entomology also extends beyond PMI estimation. In cases of neglect, such as in elder or child abuse, infestations by insects like maggots can indicate the duration of neglect. Similarly, entomological evidence can help identify toxic substances when larvae feed on tissues containing drugs or poisons this branch is known as forensic entomotoxicology. Wildlife crime investigations also benefit from entomological data, particularly in poaching or illegal trafficking of animal products.

## III. NOTABLE CASE STUDIES

One landmark case highlighting the importance of forensic entomology occurred in Tennessee, USA, where insect evidence helped determine that a victim's body had been moved after death. Similarly, in India, forensic entomology has been used to determine PMI in outdoor homicide cases where environmental conditions accelerated decomposition. These examples demonstrate how entomological evidence can complement traditional forensic analyses such as pathology or toxicology.

## IV. TECHNOLOGICAL ADVANCEMENTS IN FORENSIC ENTOMOLOGY

Recent advances have integrated molecular biology and digital imaging into forensic entomology. DNA barcoding now allows precise identification of insect species, even from partial samples. Environmental DNA (eDNA) and next-generation sequencing techniques are emerging tools that expand the scope of insect-based evidence. Geographic information systems (GIS) and machine learning models are also being developed to predict insect colonization patterns

based on climate and geography. These technologies enhance the accuracy and reliability of PMI estimation.

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## V. CHALLENGES AND LIMITATIONS

Despite its progress, forensic entomology faces challenges such as regional variations in insect fauna, lack of standardized databases, and limited expertise in certain regions. Environmental factors like temperature, humidity, and access to the body significantly influence insect activity. Legal admissibility of entomological evidence can also be problematic due to inconsistent documentation and lack of awareness among law enforcement personnel. Continued research, education, and interdisciplinary collaboration are crucial to overcoming these barriers.

## VI. CONCLUSION

Forensic entomology bridges the gap between biology and law enforcement by providing scientific insights into the timeline and circumstances of death. As technology advances, the field continues to expand its forensic relevance, offering improved accuracy and broader applications. With further standardization, training, and integration into investigative protocols, forensic entomology will remain an indispensable tool in criminal justice systems worldwide.

## REFERENCES

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