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The Tiny Investigators of Forensic Entomology

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Forensic entomology is the science of using insects and other arthropods to assist in legal investigations. By analysing the types of insects found on a body or at a crime scene—and understanding their biology and behaviour—experts can estimate the time since death, determine the crime location, and sometimes infer the cause of death. Although insect evidence has been used in investigations for decades, forensic entomology has recently become a distinct and widely recognized branch of forensic science. This field is divided into three main areas: urban, stored product, and medico-legal entomology. Insects colonize bodies in a predictable order depending on the stage of decomposition, and identifying these species provides vital clues about the timeline of death. Blowflies (Calliphoridae) are particularly important for determining time since death when other methods are not effective. Two common approaches in forensic entomology involve examining maggot development and the succession of insect species on remains. Recent advances, such as integrating toxicology, pollen analysis, and DNA-based identification of insects, have enhanced the accuracy and usefulness of forensic entomology. These developments have made it an increasingly valuable tool for criminal investigations and have boosted its popularity among forensic scientists. (1)

Types of Forensic entomology

1) **Medicolegal entomology:** This branch studies insect activity on human remains to estimate the time since death, known as the post-mortem interval. By analysing the types and stages of insects present, experts can help determine when and sometimes where a death occurred, which is valuable in criminal investigations.
2) **Urban entomology:** Urban entomology focuses on insects found in human environments such as homes, buildings, and cities. It addresses issues like pest infestations, disease transmission, and the impact of insects on urban living, often helping to develop effective pest control strategies.
3) **Stored product pests entomology:** This area deals with insects that infest and damage stored food products like grains and dried fruits. Experts in this field work to identify, prevent, and control these pests to protect food supplies and reduce economic losses in storage facilities and households.

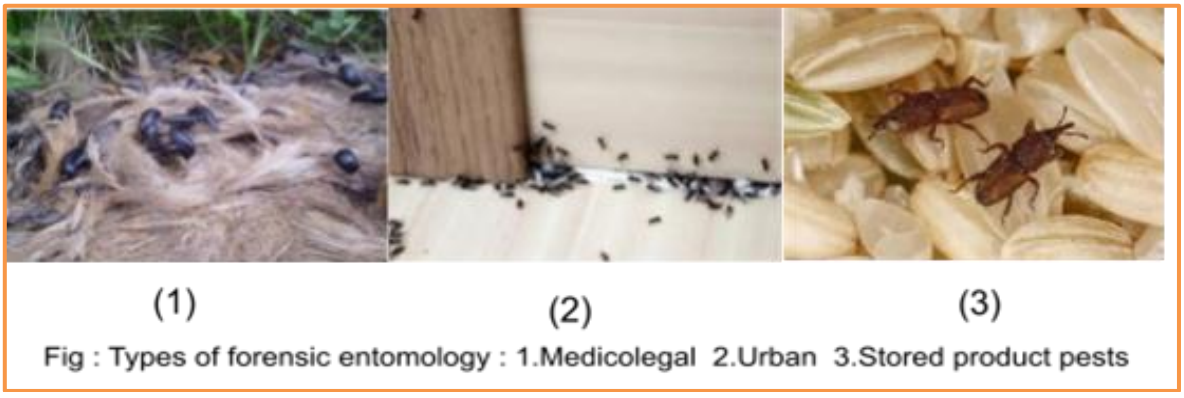


Fig : Types of forensic entomology : 1.Medicolegal 2.Urban 3.Stored product pests

How Forensic Entomologists Work?

When a body is discovered in an advanced state of decomposition, traditional methods like checking body temperature or rigor mortis often can't pinpoint the time of death. This is where forensic entomologists step in and let the insects do the talking.

- **Identifying Insect Species:** Different types of insects arrive at a body in a predictable order as it decomposes. For example, blowflies are usually the first to show up, while beetles and other scavengers arrive later. By identifying which insects are present, experts can get a sense of the timeline.
- **Examining the Life Cycle:** Insect larvae-commonly known as maggots grow and develop at consistent rates depending on the environment. By studying the age and development stage of these insects, forensic entomologists can estimate how long the body has been there.
- **Considering External Factors:** Things like weather, location, and even the presence of drugs or toxins can influence insect activity. Forensic entomologists take all these factors into account to make the most accurate estimation of the time since death.

Modern Trends in Entomological Research

Entomo-toxicology: Entomo-toxicology is the art of the detection of poisons, toxins, or drugs at different phases of insect development. It uses entomological data collected from crime scenes to determine if poisoning was the cause of death. J.C. Beyer's 1980 contribution highlighted the potential of utilizing arthropods on corpses or at crime scenes to establish the presence of toxins at the time of death. This has led to the formulation of Forensic entomotoxicology as a branch of forensic entomology. Immense scientific efforts performed in Western countries, including France, have confirmed the significant role that insects play in identifying poisons. In other cases, drugs were not detectable in tissues examined two months after death, but the liquid chromatography technique developed by Kintz permitted the detection of triazolam in maggots. Surprisingly, research suggests that maggot tissues may be better suited to toxin detection compared to muscular tissues. In some instances, poisons can even be identified from the diapause stage of an insect. Experimental studies have confirmed the detection of a wide variety of toxic compounds (abused drugs) during the ontogenetic stages of corpse-eating insects. Additionally, toxins can also be present in insect shed casings and feces. Advanced techniques are employed to determine and investigate the presence of these poisons (12;13)

Fig : Corpse decomposition via entomological investigation

Identification of Insect Species

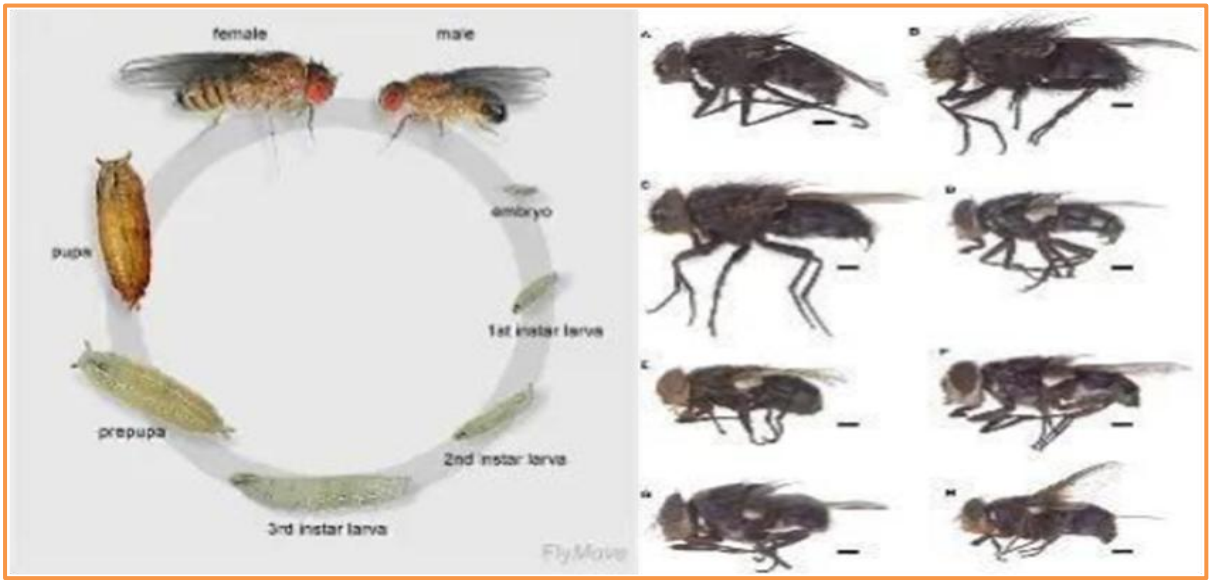
Traditional morphological identification methods have become outdated and challenging for certain species, particularly in immature life stages. Scientists have developed a molecular technique known as Polymerase Chain Reaction-Restriction fragment length polymorphism (PCR-RFLP) of mtDNA. Molecular markers like mitochondrial COI and COII genes, which exhibit high genetic diversity, are used for accurate and efficient species identification. DNA barcoding and PCR-RFLP techniques are preferred over phenotypic identification because they are reliable and fast. Molecular biological methods are used to distinguish between insect species and assist in approximating the postmortem interval. PCR-RFLP analysis is

also used for the identification of closely related species at various stages of life, providing a simple, quick, and economical method for routine diagnostics.

Focusing and naming insects is a interesting pastime or a useful scientific pursuit. First, you want some of the basics such as a net, forceps and a killing jar. As you obtain insects, assure that you're gentle to their environment and adopt moral standards. To identify, a good Use a guidebook or the Internet to learn to recognize. Those invertebrates you've collected. You could also want to consider joining local insect enthusiast groups or reaching insect experts for help in determining more troublesome species. Take care to List the day, location, and some relevant information When you collect insects, this information can be relevant for research or personal records. Have a wonderful insect collecting experience.

Table 1: Stages of decay and ecological succession information of certain fly species.

	Fresh	Bloated	Decay	Post Decay
Day After Death	1-4	3-6	5-20	19+
Appearance on body	Natural	Bloated	Deflated Odiferous	Mummified or Skeletal
Calliphora Vomitoria larva	Yes	Yes	Yes	No
Sarcophaga Carnaria Larvae	Yes	Yes	Yes	No
Musca Domestica Larvae	No	Yes	Yes	No
Piophila Nigriceps Larvae	No	No	Yes	No
Location of Larvae	Orifices Wound	Orifices Wound	Throughout body	None
Pupae are present	No	No	Yes	Possible



Conclusion

Forensic entomology has become an essential part of modern crime investigation, offering valuable clues about the time, place, and sometimes even the cause of death through the study of insects. By carefully examining insect life cycles and how different species appear during decomposition, experts can estimate the post-mortem interval with greater accuracy, especially when traditional methods fall short. With the introduction of advanced techniques like DNA barcoding, PCR-RFLP, and entomotoxicology, the field has become more precise and reliable, helping investigators uncover details that might otherwise remain hidden. Beyond criminal cases, forensic entomology also plays an important role in areas like urban pest management and stored product protection, showing how versatile and interdisciplinary this science truly is. As research and technology continue to grow, forensic entomology will keep evolving-making insect evidence an increasingly powerful and trusted tool in the pursuit of truth and justice.

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