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Forensic Entomology

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Introduction

The scientific study of insects or other arthropods colonizing dead bodies during criminal investigations is known as forensic entomology (particularly in cases of unexplained death and to determine the time of death) (Amendt *et al.,* 2011). To determine the exact moment of death by examining the insects that have colonized a body, forensic entomology is crucial. When other techniques for determining the time of death, such as rigor mortis or lividity, are not feasible because of the body's decomposition, forensic entomology is very helpful. Determining the period since death in cases where victims have been dead for longer than three days presents difficulties for forensic pathologists. Thus, a forensic entomologist can determine the minimum post-mortem interval by analyzing the species and developmental stages of the insects, which gives crucial information for a criminal inquiry or other legal actions (Al-Shorman, Alakkam 2024). The use of entomology in criminal investigations is expanding quickly on a global scale. A private company, IFF Lab (Incognito Forensic Foundation), is active in India; it has locations in Bangalore and Chennai (Banerjee, 2024).

History

The study of forensic entomology is still in its infancy. Since the first scientific publication on forensic entomology was published in 1883, forensic entomology has only existed for 140 years. The value of forensic entomology for forensic casework was not recognized until the early 1900s. The entomological laboratories of the Belgian Institute National de Criminalistique et Criminologie and

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the French Institut de Recherche Criminelle de la Gendarmerie Nationale, two of the best forensic institutions in Europe, have certified forensic entomology in the last 20 years, marking significant advancements and significant breakthroughs (Chen, 2024).

Importance

A growing subject in forensic sciences, forensic entomology encompasses branches such as biology, chemistry, and physics and focuses mostly on identification and evaluation based on the presence of physical evidence (Anitha *et al.*, 2024). Understanding the various types of insects with forensic significance, figuring out the corpse's death time and stages of decomposition, knowing the right procedures for gathering and preserving data, and being aware of the most recent advancements in forensic entomology in solving murder cases are all essential for forensic entomology investigations (Al-Rahimy *et al*., 2024). This science is also used in several other situations, such as identifying food infestations by examining the debris, analysing drugs found in the bodies, faeces, and dead skin of insects that feed on corpses, or extracting DNA from insects that consume blood (Banerjee, 2024). The length of time that insects were active on the body can be estimated using a forensic entomology investigation (Amendt *et al.*, 2011).

- **Branches of Forensic entomology**

Forensic entomology can be grouped under 3 categories

1. **Medico-legal or medico-criminal**

Among the cases investigated by medico-legal entomology are those involving homicide, suicide, physical abuse, etc. The sort of crime is depicted by the existence of these insects and their developmental stages (Anitha *et al.*, 2024). It focuses on the criminal justice system's part and addresses the necrophagous insects that usually infest human bodies (Budilok 2024).

2. **Urban and in-house entomology**

According to Anitha *et al.* (2024), pest infestation in gardens and buildings is connected to urban entomology. It addresses the insects that harm humans and their surroundings. Given that urban pests can feed on both the living and the dead, this area contains both criminal and civil components. Due to the significant economic impact of urban pests, forensic entomologists may be involved in civil lawsuits involving claims for monetary damages (Buadilok, 2024).

3. **Stored product entomology**

The entomology of stored products is concerned with insect infestation or contamination of foods that are sold commercially (Anitha *et al.*, 2024). Due to the frequent occurrence of these insects in food, forensic entomologists are frequently called upon as expert witnesses in criminal and civil cases involving food contamination (Buadilok, 2024).

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Insects in forensic science

Insects belonging to orders such as Hymenoptera, Diptera, and Coleoptera in the class Insecta are known to frequently carry out life activities on corpses. As a result, the majority of forensic entomology-related research and practice involves Diptera, Coleoptera, Hymenoptera, and other necrophilic insect groups. Forensic entomology study and practice require an understanding of the physiological growth rates, ecological succession, molecular species identification, and biochemical profiling of these necrophilic insect groups (Chen, 2024).

❖ **A sequence of insects that infest the corpse is as follows:**

Flies: Their maggots are adapted to feed on moist remains, and they are the first to attach themselves to the dead body. Blow flies have a 16-kilo meter range for detecting the scent of decomposing meat.

- ✓ **Beetles:** Beetles inhabit the corpse during the later phases of decomposition; they typically arrive after flies. As soft tissues are consumed by other species, hide or skin beetles, scientifically known as Dermestid beetles, infest a decaying corpse.
- ✓ **Mites and Moths:** Tyroglyphidae and Oribatidae are thought to enter the final phases of decomposition since they are skin-dwelling organisms. According to Banerjee (2024), these are some of the final animals that join the body for decomposition.

❖ Smith (1986) grouped the insects that come to the corpse into 4 categories according to their feeding preferences and ecological roles.

1. **Necrophage species:** They are the first to settle and feed on dead bodies. Orders employed in post-mortem time determination are Diptera (Calliphoridae, Sarcophagidae) and Coleoptera (Staphylinidae, Dermestidae, and Histeridae).
2. **Predators and Parasites:** They do not consume the corpse directly. They consume the pupae and larvae of other arthropods and insects. This group includes Chrysomya sp. (Diptera: Calliphoridae), Histeridae, and Staphilinidae.
3. **Omnivorous Species:** They consume other species, as well as corpses and larvae. This category includes the Hymenoptera, Tineidae, and Dermestidae.
4. **Incidental species**: They do not consume the corpse, as they are incidental species. Seeking an appropriate place to stay that is an extension of their surroundings, they approach the body. comprises other species such as the Diplopoda, Araneae, and Collembola.

Hodecek *et al*., (2024) reported about the different families of insects in dipteran order, which are mainly used in forensic entomology.

- ✓ **Calliphoridae:** Because they arrive at the body early, blowflies are the most frequent colonists of cadavers and are utilized by forensic entomologists to calculate the PMI min.
- ✓ **Sarcophagidae:** Sometimes referred to as flesh flies. This family of elusive flies holds great promise for forensic entomology.

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- ✓ **Muscidae:** It is home to many species that may be important to forensics.
- ✓ **Phoridae:** The family of little flies, also known as "the scuttle flies," is significant to forensics because it is frequently identified in interior situations where blowflies have limited access. *Megaselia* sp. has been shown to colonize cadavers by phorids both in the very late stages of decomposition and a few days after death.
- ✓ **Fanniidae:** The family Fanniidae includes 20 examples (12.5%) of flies. The family Fanniidae consists of rather small flies, which can be found in both indoor and outdoor cases.

❖ **Uses of insects in forensic science**

Al-Rahimy *et al.*, 2024 have explained the forensic entomology applications: -

- ✓ **Post Mortem Interval (PMI):** The term "post-mortem interval" (PMI) describes the period after a death that a body is found. The PMI can be estimated using several naturally occurring decomposition processes, such as rigor mortis or livor mortis, however many of them are reciprocal functions, which lead to application errors, and they are only applicable for the first 72 hours following death. Insects, however, can be a very useful tool for determining the minimal time since death both during and after those 72 hours (Amendt *et al.*, 2011). It entails calculating the amount of time that has passed after the death, which is frequently the case with decaying bodies. This is accomplished by calculating the longest-lived larvae's duration and how it relates to the fly egg hatching date, as well as by utilizing a chart showing the growth of this type of fly larvae at temperatures that correspond to the crime scene, which helps determine the egg hatch date (Al-Rahimy *et al.*, 2024). By examining the accumulated degree hours (ADH) of blowfly larvae discovered on the body, forensic entomologists can compute PMI and ascertain the time of oviposition. According to Al-Shorman and Alakkam, (2024), ADH provides a quantifiable way to evaluate the progress of insect colonization on a deceased person by taking into account the total thermal energy or heat units needed for the growth and development of insect larvae.
- ✓ **Location of Death:** The location of death is determined in cases where the corpse's original location is altered. This is accomplished by examining the geographic distribution of insects in various environments and by analyzing incidents that provide evidence of the insects' involvement in manipulating the crime scene to evade justice.
- ✓ **The murder:** This is accomplished by the presence of the bug or a portion of it, adhered to the accused's clothing or equipment.
- ✓ **Crimes involving suicide:** This is accomplished by observing the assembly of insects in advanced stages of decomposition or muddled corpses, which is the reason for identifying the site of the wound that caused the death or suicide and, consequently, the type of suicide.

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- ✓ **Unexpected demise:** It entails looking into potential reasons for unexpected death, such as drug or alcohol overdose poisoning. This is accomplished by looking at the food that the insect consumes, as the poison that larvae eat from dead bodies is the same.
- ✓ **Pattern of blood spot distribution:** This is accomplished by tracking the movement of insects on blood traces at the crime scene. Some of the blood traces on the surfaces change due to their blood, contaminated legs, vomit, or excrement, which may cause false analyses of the spread of blood at the crime scene.
- ✓ **Neglecting children and the elderly:** When infections and suppurations of wounds that have worsened because of flies multiplying in them can be identified, care facilities look into this kind of negligence to assess the extent of the physical harm that was inflicted on the victims, even if they were still alive.
- ✓ **Rape crimes:** This is accomplished by examining the human DNA that the insect consumed; this allows for the identification of the dead body and the person who killed it. According to research, it can be challenging to collect samples of semen from a sexually violated woman's body when it is in a highly decomposed state. This makes it impossible to identify the DNA fingerprint of the corpse. Fly larvae found in the raped woman's genital area, however, may be proof that the victim had been sexually assaulted before her death, by the perpetrator. In addition, the fly larvae can keep the genetic fingerprint of the perpetrator in her stomach because, even in cases where the raped woman has semen in her intimate area, the offender's genetic fingerprint is passed on to the fly larvae that feed on her body.
- ✓ **Trafficking:** Classifying the species of insects that are smuggled with drugs can help identify the source of the smuggling and provide evidence of the substance's smuggling, as the original home of these drugs can be identified due to the differences in the geographical distribution of the insect species.
- ✓ **Detecting terrorist operations and war crimes:** Since fly larvae are known to preserve the remnants of the explosive chemicals used in terrorist incidents, detection is accomplished by chemical examination of the contents of the fly larvae trails detected on the corpses of explosives victims. The quality of these explosives can also be determined by contrasting the explosive type's chemical analysis results with those from earlier occurrences; if the results match, this indicates that a terrorist cell was responsible for the explosion.
- ✓ **Entomotoxicology:** A subspecialty of medicine known as forensic entomotoxicology uses toxicology, entomology, and other relevant fields to solve poisoning cases. Depending on the kind of poison or poison contained within them, the developmental phases of the insects feeding on the body will vary. The entomologists can more easily determine the victim's cause of death and time of death (Bhujbal *et al.*, 2024). Analyses of maggots can identify the majority of drugs implicated in

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drug-related deaths: amphetamines, tricyclic antidepressants, steroids, barbiturates, several salicylates (like paracetamol), opiates (like morphine and codeine), cocaine, and benzoylecgonine. Analysis of empty puparial cases, beetle exuviae, and fecal material have also revealed the presence of drugs and poisons. According to certain research, toxins can be found in larvae but not in the soft tissues that are connected with them (Amendt *et al.*, 2011).

Constraints

1. Insufficient lab space, reagents, and scientific tools for identifying insect species.
2. A shortage of personnel skilled in correctly removing bug specimens from dead bodies at crime scenes and transferring them to a lab for additional identification.
3. A shortage of entomologists with forensic entomology knowledge and expertise, can result in data corruption through incorrect photography, storage, and other methods. **(Buadilok, 2024):**

Conclusion

Forensic entomology is an emerging field within forensic sciences that examines insects feeding on corpses. It has proven to be a crucial tool in criminal investigations, solving numerous cases that would otherwise remain unsolved. Despite its potential, India currently faces technological shortcomings in this area. Addressing these gaps could significantly enhance the effectiveness of forensic investigations, leading to the resolution of more cases and the apprehension of criminals. Thus, with advancements and improvements, forensic entomology holds the promise of making a remarkable impact on criminal justice and medical history.

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