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### Entomology in Forensics - Multidisciplinary Character During Forensic Research

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#### Abstract

Forensic entomology is a scientific discipline which has a multidisciplinary character due to the use of entomology in solving a variety of problems that arise during forensic research. It includes the identification of individual species and developmental stages of insects, the relationship between insects and external factors, determining the time of death, etc. This paper aims to briefly describe the role of forensic entomologists in court proceedings.

**Keywords:** Entomology; Insects; Forensics; Forensic Entomology; PMI

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#### Introduction

Anyone involved in death investigations quickly becomes aware of the connection between dead bodies and maggots [1].

#### Insects

A decomposing body is in some ways like a barren volcanic island that has recently emerged from the ocean [1]. The island is a resource, isolated from similar areas, waiting to be colonized by plants and animals. The first plants establish a beachhead and begin to change the island, making it habitable for later arrivals. Similarly, a dead body is a resource that is usually isolated from other dead bodies by dissimilar patches of habitat, such as fields, ponds, and woodlots. Unlike an island, though, a decomposing body is a temporary

microhabitat, a rapidly changing and disappearing food source for a wide variety of different organisms, ranging from microscopic bacteria to fungi to large vertebrate scavengers, such as feral dogs and cats. Of course some organisms, such as the bacteria present in the intestines, exist in the living body, but the animals that invade and consume a dead body form a distinct group. Like the island, the dead body has definite boundaries, and all the changes that occur take place within or very close to the body. The majority of the carrion animals are arthropods, and among those arthropods found on a decomposing body, the insects are the predominant group in terms of numbers of individuals present, biomass (total weight of the individuals), and diversity (number of different species). On average, about 85 percent of the species reported in decomposition studies are insects.



Insects and other arthropods can be associated with a corpse in many ways, but forensic entomologists agree on four main types of direct relationships and categorize the carrion species accordingly. The first category consists of the necrophagous species, those that feed directly on the corpse, primarily flies (Diptera) and beetles (Coleoptera).

Flies, especially the blow flies and flesh flies, depend on decomposing matter for food. These flies are aggressive in their search for human and animal remains and frequently arrive mere minutes after death. During the first 2 weeks of decomposition, the blow flies and flesh flies are usually the most precise indicators of the postmortem interval. Many beetles are no less dependent on decomposing matter, but they usually arrive later in the decomposition process, after the body has begun to dry. The insects associated with human cadavers belong to one of four ecological groups: necrophagous species (feeding on the body); predators and parasites (of the necrophagous species); omnivorous species (feeding on the body and its inhabitants); and adventive species (using the body as an extension of their environment) [2].

### Entomology

Entomology is the study of insects, involving, among other topics, their biology, locations, mutations, and their control in relation to the world's environment [3]. Determining the time of death can be critical to a homicide investigation as it helps to establish a timeline of events that can tie a suspect directly to a murder [4]. For example, if a medical examiner called to the scene of a homicide determines that the victim has been deceased for 2 h, the police can compare that information with an apprehended suspect's account of his whereabouts. Does the suspect have an alibi that would place him elsewhere when the murder was committed? If not, then the suspect becomes far more interesting. But what of the decaying corpse discovered under a pile of leaves in the forest—a body long cold and

lifeless? Knowing the time of death of that corpse can, for example, tie a serial killer to their presence in the area during the window of time when the body was disposed of. In such cases, it may be time to bring in the forensic entomologist—a scientist who knows bugs.

A blowfly can detect a decaying corpse from miles away. The female lays her eggs, up to 200 of them, in the nose, mouth, or lacerated flesh of the decomposing body. In as little as 8–24 h, the eggs hatch into larvae (maggots). Within another 5–11 days, the maggots morph into their pupa stage. Within another 1–2 weeks, adult flies emerge. Knowing the life cycle of the blowfly and the conditions of temperature and daylight that affect it, the forensic entomologist can extrapolate the time of death. Insects lay their eggs on the rotting flesh of the body of a deceased [5]. The eggs soon mature and turn into larvae before in turn becoming adult insects such as beetles and flies. A study of the stage of growth of the larvae or insect by a forensic entomologist can indicate how long a body has been in a particular location. It is better for the entomologist to see the actual larvae, flies, etc. than a photograph. So, after thoroughly photographing the scene, the CSI should use a fine net to capture a selection of flies and/or beetles on and around the body. These should be securely packaged and labelled in a suitable specimen jar. The ambient air temperature should be taken above the body and recorded before taking the temperature of any masses of larvae.

A large selection of the larvae should be recovered from across the body and they should be fixed in a preservative, such as Isopropyl alcohol, within a screw top pot or jar. The preservative is required so that the state of the larvae does not change before it is examined by the forensic expert. Then a second sample of the larvae should be collected and placed alive in a plastic pot that will become a rearing container; the pot should contain a suitable source of food, such as a small quantity of cat or dog food. Finally, after the body has been removed, a number of samples of the soil and flora should



be recovered from where the body had been lying; these should then be packaged in solid containers, such as plastic pots or jars, and labelled. These samples will allow the forensic entomologist to recover insects from the fluids shed by the body during decomposition. The samples should be transported to the entomologist as soon as possible after collection. It is important to note that the identification of insects has proven to be one way that the time of death can be determined [6]. Examining the larvae of insects found on the body accomplishes this. Investigators should consider contacting an entomologist for advice at this stage of the investigation.

This technique studies the various stages of growth of each larva before it develops into an adult insect. Houseflies, for example, deposit eggs on the remains of the corpse, usually in the area of the eyes, mouth, nostrils, and wounds. The eggs then become maggots and feed on the body. Typically, the time span for the hatching of the maggot is 24 hours. The developmental stage depends on the type of insect in question. An entomologist can identify the specific insect and determine an estimated time span for its development as well as the season in which the death occurred. The recommended procedure is for all insects to be placed into alcohol for preservation.

### PMI

Why do insects play such an important role in estimating the PMI (postmortem interval) [7]? The reason is that their life cycles predictably move from the egg to an adult in a process known as metamorphosis.

### Forensics

Crime scene investigation is based on the principles of transfer theory, in particular, Locard's Exchange Principle [8]. Locard's Exchange Principle states that any time two or more surfaces come in contact with each other, there is a mutual exchange of trace matter between the two surfaces. A common

generalization from this principle is "every contact leaves a trace." This concept is critical for considering how evidentiary samples can be utilized to link a suspect to a victim, a victim to a crime scene, or a suspect to a scene. Crime scene investigation can be further considered as the first and most critical step of any forensic investigation. If evidence is not recognized or is improperly collected or packaged, it may be inadmissible in court. For all physical evidence, including botanical samples, there are three crucial steps that must be adhered to at a crime scene: recognition of the evidence, appropriate collection methods, and adequate preservation of the evidence for later testing and use at trial. Once the physical evidence has been collected at a crime scene, it is delivered to a forensic testing laboratory where identification of the evidence and further individualization of evidentiary samples is performed. The identification of evidence means classification of a sample into a physical, biological, or chemical category.

Depending on the assigned category, identification of a sample (e.g., hair) would place it into a biological grouping where a microscopic comparison to known reference samples would be made to determine if a person could be a possible contributor of the biological hair sample. The microscopic comparison to known reference samples in the case of hair examination would be useful but not considered an individualizing test. To individualize a sample, DNA analysis (STR typing) would then be performed on any epithelial cells from the hair root. Sample identification followed by individualization, when possible, is a general practice in all areas of forensic science regardless of testing specialization. In addition, pattern recognition and comparison to known reference samples is a common forensic theme that applies to DNA, latent prints, document examination, and so forth. Forensic entomology is the subfield of forensic science that relies on insects and related arthropods for use in the judicial system [9]. An examination of the traditional and emerging uses of insects in forensic situations amply shows the breadth of



knowledge required by entomologists, opportunities for further development of the field, and in parallel, the potential intellectual capital available from scientific studies of insects and their arthropod relatives for applications to the courts [10].

The breadth of potential uses for insects in legal cases and the capacity to utilize the accuracy of information derived from such applications offer seemingly boundless opportunities for forensic entomologists. If we accept science as a communal and globalizing activity, then increased international collaboration is certainly an aspirational goal for our widespread community in realizing the opportunities and challenges available in this field. Indeed, collaborators, regardless of language, time differences, location, and economic background are able to use a spectrum of technologies to combine diverse forms of expertise for the benefit of bringing novel mixes of knowledge, products, and solutions to problems.

### Crime Scene

When the forensic entomologist arrives at the death scene, a detailed overview of the physical surroundings, location and placement of the remains, and routes of ingress and egress must be developed [11]. From an entomological viewpoint, it is desirable for the remains to be undisturbed and that limited numbers of individuals have entered the confines of the scene. Excessive activity can impact the presence of both flying and crawling insects on and around the remains. Therefore, immediate consultation and coordination with the ranking investigator as to who and how many individuals have already been in close proximity to the remains is crucial. Also, the forensic entomologist must be advised of the routes to and from the body, what physical evidence is in place, what has been recovered, and what not to disturb. All such information is critical during the initial stages of the entomological assessment. Entomologists work as a part of a forensic team and may be required

to coordinate all collection and preservation activities with the assistance of either the primary investigator or a designated subordinate. In either case, the forensic entomologist should contact the primary investigator immediately upon arriving at the scene.

Protection of the scene is required to preserve the integrity of all types of evidence. Sampling of entomological evidence is somewhat intrusive and can result in minor unavoidable disturbance to the remains. Utmost caution, care, and coordination with other crime scene personnel is required in this endeavor. By effectively coordinating with the investigator in charge before proceeding with the entomological collection, any disturbance can be documented by written and photographic record. Crime scene personnel should thoroughly brief the forensic entomologist as to the circumstances surrounding the death scene, and provide all available information regarding past events at the scene. Likewise, the forensic entomologist should be in constant communication with other crime scene personnel about the entomological collection procedures that need to take place. In many cases crime scene personnel assist with the entomological collection procedures. Once proper briefings have been obtained and appropriate coordination and approval granted, the forensic entomologist can begin the entomological portion of the investigation.

### Evidence

Evidence is anything that can be used to probe the events and identify the participants of a crime [2].

Circumstantial evidence usually refers to items such as blood, fingerprints, hair, fibers, and DNA. This type of evidence is more amenable to scientific examination than is direct evidence.



## Court

The investigative and legal processes, from the discovery of a crime to the verdict of the court, should ultimately ensure that the guilty person is correctly identified and that the innocent are exonerated [12].

## Conclusion

Entomology is a scientific discipline which deals with the study of insects, and forensic entomology is a scientific discipline which deals with insects found at crime scenes and on dead bodies. Since insects are the most numerous group of living beings and can be found in almost all places, they are very important for studies in forensic medicine. The main task of any forensic entomologist is to determine the time of death using samples found on or near the body. Due to the multidisciplinary approach to solving the most serious types of crimes, but also his professional knowledge, a forensic entomologist can provide a number of useful information necessary in criminal investigations of the most serious types of crimes.

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