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Unraveling Time of Death: The Role of Forensic Entomology in Crime Scene Investigation

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Forensic (or medico-legal) entomology is the study of the insects associated with a human corpse in an effort to determine appropriate time since death. Insect evidence can also reveal if a body has been moved to a different location after death or if it has been disturbed, either by animals or by someone revisiting the crime scene. Nonetheless, the main goal of forensic entomology today is to estimate the time that has passed since death. Forensic entomology was first documented in 13th century in China and saw occasional use in the 19th and early 20th centuries, contributing to several significant cases. In the past 20 years, forensic entomology has increasingly been used in police investigations. The American Board of Forensic Entomology was established in 1966, a certification Board for Forensic Entomologists, similar to the Board certification available for forensic odontologists and forensic anthropologists. Most cases involving a forensic entomologist are typically 72 hours or older because, within this timeframe, other forensic methods are often as accurate or more reliable than insect evidence. However, beyond three days, insect evidence frequently becomes the most accurate-and sometimes the only-method for determining the time elapsed since death.

There are two primary methods for using insects to determine elapsed time since death:

1. Analyzing the succession of insect species over time.
2. Examining the age and development of maggots.

The choice of method depends on the circumstances of each case. Typically, the first method is used when the corpse has been dead for between a month up to a year or more, and the second method is used when death occurred less than a month prior to discovery.

The first method relies on the fact that a human body, or any type of carrion, supports a very rapidly changing ecosystem, transitioning from a fresh state to dry bones within weeks or months, depending on the geographic region. During decomposition, the remains undergo rapid physical, biological and chemical changes. Different stages of the decomposition are attractive to different species of insects. Certain species of insects often become the first witnesses to a crime.

They typically arrive within 24 hours of death, if the season is favorable, such as spring, summer or fall in Canada and can appear within minutes if there is blood or other body fluids.

Fig.1 Blow Fly larvae eating corpse

The initial insects to arrive are usually Calliphoridae (Blowflies) and Sarcophagidae (Flesh flies). Other species like Piophilidae (Cheese skippers), are not attracted to a fresh corpse but come later during protein fermentation. Some insects are drawn to feed on the other insects at the scene rather than the body itself. Each stage of decomposition attracts different insect species, and these stages overlap somewhat. By understanding the regional insect fauna and the timing of carrion colonization, the insect population on the remains can help estimate the time of death.

This Primary method is used for bodies that have been dead from a few weeks to several years, with the accuracy of the time window decreasing as the time since death increases. It can also help determine the season of death, such as early summer. Successful application of this method requires knowledge of insect succession, regional and seasonal variations, habitat, and meteorological factors.

The second method, which involves analyzing the age and development of maggots, can provide a date of death accurate to within a day or a range of days. This method is typically used within the first few weeks after death. Maggots are the larvae or immature stages of Dipteran, or two-winged flies. The primary insects used in this method are the Calliphoridae, or Blowflies, which are among the first to arrive at a corpse. They are attracted to the body soon after death and lay their eggs on it, usually in wounds if present, or in natural orifices if not. The development of these eggs follows a predictable cycle.

The process begins when eggs are laid in batches on the corpse. After a set period, the eggs hatch into first instar larvae. These larvae feed on the corpse and then moult into second instar larvae. They continue feeding and develop into third instar larvae, which can be identified by their size and the number of spiracles (breathing holes). Once in the third instar, the larvae feed for a while before stopping and wandering away from the corpse, either into surrounding clothes or soil, to find a place to pupate. This non-feeding wandering stage is called a prepupa. During pupation, the larva sheds its outer skin, which hardens into a protective pupal case. Freshly formed pupae are pale but darken to a deep brown within a few hours. After several days, an adult fly emerges from the pupa, and the cycle starts anew. The empty pupal case left behind serves as evidence of the fly's development and emergence. Each of these developmental stages takes a set, known time. This time period is based on the availability of food and the temperature. In the case of a human corpse, food availability is not usually a limiting factor.

Insects are 'cold blooded', so their development is extremely temperature dependent, their metabolic rate is increased with increased temperature, which results in a faster rate of development, so that the duration of development decreases in a linear manner with increased temperature and vice-versa.

By analyzing the oldest stage of insects found on the corpse and considering the local temperature, one can estimate the number of days since the insects first laid eggs on the body. This estimate helps determine the time of death.

For example, if the oldest insects are 7 days old, the body has been dead for at least 7 days. This method remains effective until the first adult insects emerge, as it then becomes difficult to identify which generation is present. Once a single blowfly generation has completed, the time of death is estimated using the first method, which involves analyzing insect succession. The first and most crucial step in forensic entomology is the careful and precise collection of insect evidence at the scene. This requires an understanding of insect behavior, making it ideally performed by an entomologist. They are always ready to visit the scene if possible. However, entomologists are often called only after the body has been removed from the site. In such cases, they usually examine the remains at the morgue or, in some instances, may not see the remains at all.

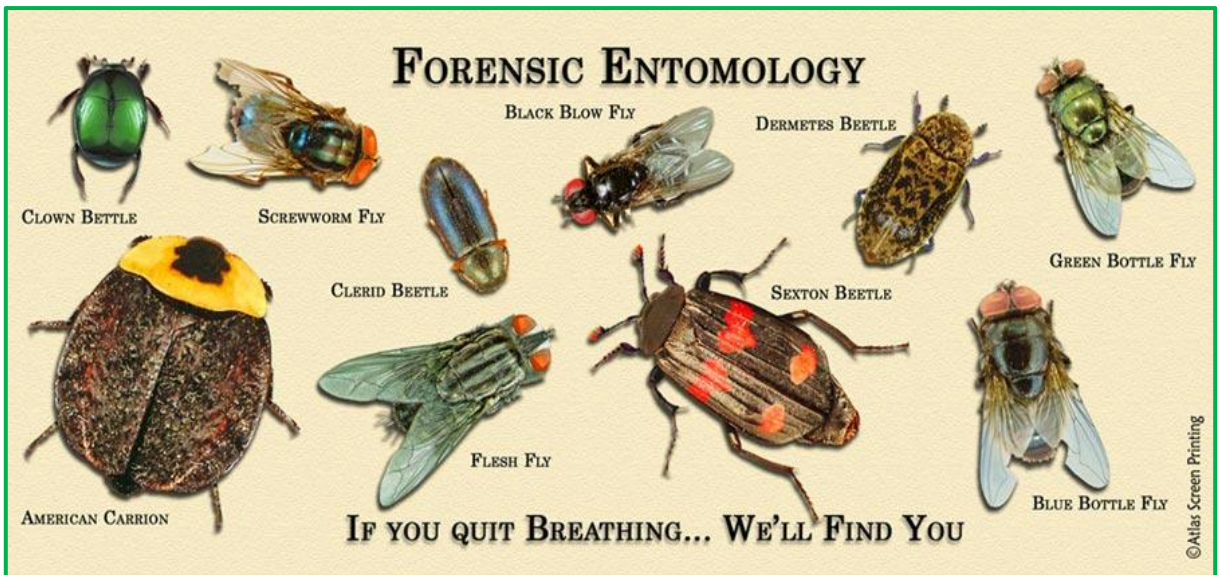

Fig.2 Forensic Insects

Conclusion

Forensic entomology provides crucial insights into the time elapsed since death by analyzing insect activity and development. The two primary methods-examining insect succession and assessing maggot development-offer complementary approaches depending on the time since death and the condition of the remains. The first method is valuable for long-term cases, helping to determine decomposition stages and the season of death, while the second method, focusing on maggot age, is ideal for more recent deaths within the first few weeks. Accurate collection of insect evidence is essential, and while entomologists ideally examine the scene, they often rely on the quality of evidence collected by investigators. As forensic entomology continues to advance, it remains a vital tool in criminal investigations, providing critical data that often cannot be obtained through other forensic methods.