Review Article

iMedPub Journals
www.imedpub.com

Journal of Animal Sciences and Livestock Production
ISSN 2577-0594

2021
Vol.5 No.5:9091

Application of Forensic Entomology to Estimating Time since Death

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Received date: June 26, 2021; **Accepted date:** October 12, 2021; **Published date:** October 22, 2021

Citation: Agrawal V, Das G , Mehta H K , Shakya M, Jayraw A K, Jatav G P (2021) Application of Forensic Entomology to Estimating Time Since Death . J Anim Sci Livest Prod Vol: 5 No: 5.

Abstract

Forensic entomology relates primarily to determination of time (time since death or post mortem interval) or site of human death and possible criminal misuse of insects. Estimation of time since death is the length of time between death and corpse recovery. Post mortem determination becomes more difficult for pathologist with the elapsed of time. Insect life cycles act as precise clocks which begin within minutes of death. They can be used to closely determine the time of death, especially useful when other methods are useless. They can also show if a body has been moved after death. The time of death, can usually be determined using insect evidence gathered from and around a corpse. One of the first groups of insects that arrive on a dead body is the blowflies (Diptera: Calliphoridae). However, after three days, insect evidence is often the most accurate and sometimes the only method of determining elapsed time since death. Therefore they are used as evidence in a criminal investigation to determine postmortem interval (PMI). The use of insects to investigate cases of wrongful deaths has increased dramatically in the recent years globally but unfortunately in India it has not received much attention as investigative tool. Based on literature it can be concluded that, the field of Forensic entomology plays a vital role in determination of PMI and thus, we cannot leave such an important perspective.

Keywords: Time since Death; Forensic Entomology; Calliphoridae

Introduction

Since the inception of human species, man has tried to dominate this planet by sheer intelligence. This dominance led to the concept of noosphere and he started interfering with natural processes. But nature has her own ways and one of its finest intricacies is the food web i.e. the process of eating and being eaten. This cycle is so immaculate that even dead bodies of animals, including that of humans, are decomposed by other creatures with insects playing a predominant role. And who knew that one day these so called natural scavengers would act as witness to man's mud-paddling strategies for personal ambitions, jealousy and gains. Practical use of these organisms in solving crime led to the development of a separate branch of science now-a-days known as Forensic Entomology. To find out the answer when did the death take place is most critical query to solve the puzzle of medico-legal death investigations (Schoenly et al., 1992). Forensic entomology relates primarily to determination of time (post- mortem interval) or site of human death and possible criminal misuse of insects. Insect life cycles act as precise clocks which begin within minutes of death. They can be used to closely determine the time of death, especially useful when other methods are useless. They can also show if a body has been moved after death. The time of death, can usually be determined using insect evidence gathered from and around a corpse. One of the first groups of insects that arrive on a dead body is the blowflies (Diptera: Calliphoridae). Usually the females lay eggs within hours after death. The blowfly goes through the following stages during its life history: egg, 3 instars larvae, pre-pupae, pupae within puparium, imago. If we know how long it takes to reach the different stages in an insect's life, we can calculate the time since the egg was laid. This calculation

of the age of the insects can be considered as an estimate of the minimum time of death. But even if the estimate of the insect age is correct, the death of the victim (usually) occurred before the eggs were laid. This period is quite variable and depends on temperature, time of day the death occurred, time in year the death occurred, whether the corpse is exposed or buried in soil or immersed in water. As a general rule insects will lay eggs on a corpse within few hours after the corpse is available for insects. Insects can also be of help in establishing whether the corpse has been moved after death, by comparing local fauna around the body, and the fauna on the body (Lord, 1990). However, after three days, insect evidence is often the most accurate and sometimes the only method of determining elapsed time since death (Anderson).

Insects of forensic importance:

Besides their ecological importance in decomposition, the insects particularly blowflies represent important tools in criminal investigations serving as a biological clock in measuring the time since death for weeks or even for months. From forensic-entomological point of view, the necrophagus species and their predators & parasites are the important insects to be attracted to the body immediately after death even within minutes. Insect specimens may be treated as physical evidence just like blood-stains, hair, fingerprints or any other biological material and hence should be processed as evidence at crime scene, at autopsy and at the laboratory. Various necrophagus insects are selectively attracted by the decomposing status of the carrion and form complex communities or biocenosis within necrophagus or sarcophagus species and their predators, parasites and parasitoids competing each with one another. Knowledge of distribution, biology and behavior of insects found in, on, or nearby a cadaver can assist many types of forensic investigations by providing information on when, where and how under certain circumstances a crime was committed or a person died.

Estimating time since death:

Most cases that involve a forensic entomologist are 72 h or more old, as up until this time, other forensic methods are equally or more accurate than the insect evidence. However, after three days, insect evidence is often the most accurate and sometimes the only method of determining elapsed time since death. There are two main ways of using insects to determine elapsed time since death and these are using successional waves of insects and using maggot age and development.

The method used is determined by the circumstances of each case. In general, 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.

Using successional waves of insects

It is based on the fact that a human body, or any kind of carrion, supports a very rapidly changing ecosystem going from the fresh state to dry bones in a matter of weeks or months depending on geographic region. During this decomposition, the remains go through rapid physical, biological and chemical changes, and different stages of the decomposition are attractive to different species of insects. Certain species of insects are often the first witnesses to a crime. They usually arrive within 24 h of death if the season is suitable i.e. spring, summer and can arrive within minutes in the presence of blood or other body fluids. These first groups of insects are the Calliphoridae or blowflies and the Sarcophagidae (fleshflies). Other species are not interested in the corpse when the body is fresh, but are only attracted to the corpse later such as the Piophilidae or cheese skippers which arrive later, during protein fermentation. Some insects are not attracted by the body directly, but arrive to feed on the other insects at the scene. Many species are involved at each decomposition stage and each group of insects overlaps the ones adjacent to it somewhat. Therefore, with knowledge of the regional insect fauna and times of carrion colonization, the insect assemblage associated with the remains can be analyzed to determine a window of time in which death took place. This method is used when the decedent has been dead from a few weeks up to a year, or in some cases several years after death, with the estimated window of time broadening as time since death increases. It can also be used to indicate the season of death e.g. early summer. Knowledge of insect succession, together with regional, seasonal, habitat and meteorological variations, is required for this method to be successful (Amendt). Major challenges are identification of species of insects present on the remains and the succession patterns are typical for seasonal periods.

Using maggot age and development

Maggot age and development can give a date of death accurate to a day or less, or a range of days, and is used in the first few weeks after death. Maggots are larvae or immature stages of Diptera or two-winged flies. The insects used in this method are those that arrive first on the corpse, that is, the Calliphoridae or blowflies. These flies are attracted to a corpse very soon after death. They lay their eggs on the corpse, usually in a wound, if present, or if not, then in any of the natural orifices. Their development follows a set, predictable, cycle (Smith).

The insect egg is laid in batches on the corpse and hatches, after a set period of time, into a first instar (or stage) larva. The larva feeds on the corpse and moults into a second instar larva. The larva continues to feed and develop into a third instar larva. The stage can be determined by size and the number of spiracles (breathing holes). When in the third instar, the larva continues to feed for a while then it stops feeding and wanders away from the corpse, either into the clothes or the soil, to find a safe place to pupate. This non-feeding wandering stage is called a prepupa. The larva then loosens itself from its outer skin, but remains inside. This outer shell hardens, or tans, into a hard protective outer shell, or pupal case, which shields the insect as it metamorphoses into an adult. Freshly formed pupae are pale in colour, but darken to a deep brown in a few hours. After a number of days, an adult fly will emerge from the pupa and the cycle will begin again. When the adult has emerged, the empty pupal case is left behind as evidence that a fly developed and emerged.

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 (Catts and Haskell). The effect of ambient temperature on the duration of egg development for the common bluebottle blowfly, Calliphora vicina, illustrating the acceleration of development is at raised temperatures.

An analysis of the oldest stage of insect on the corpse and the temperature of the region in which the body was discovered leads to a day or range of days in which the first insects oviposited or laid eggs on the corpse. This, in turn, leads to a day, or range of days, during which death occurred. For example, if the oldest insects are 7 days old, then the decedent has been dead for at least 7 days. This method can be used until the first adults begin to emerge, after which it is not possible to determine which generation is present. Therefore, after a single blowfly generation has been completed, the time of death is determined using the first method, that of insect succession (Anderson).

Conclusions

Despite 150 years of use, forensic entomology is still a young discipline. One of the most important challenges for the future is to combine experimental data and practical case work. Due to the wide variations in biotic and abiotic factors which occur at death scenes, improvement of the existing understanding can only be established through an increased number of detailed and quantified observations. Forensic entomologists are always presented with the task of reconstructing the death scene conditions as closely as possible. Thus, it is the need of time to make an effort and develop more expertise in this particular field.

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