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Research Article

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Forensic Entomology: Insects as a Toxicological Indicator and Impact of Drugs and Toxins on Insect Development

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Abstract

Entomotoxicology is a modern branch of forensic entomology. The use of insects to determine the possible presence of drugs, toxins or any other pollutants in the corpse. It moreover studies the effects of drugs or toxins on the development of arthropods and thereby to estimate the post mortem interval. Post mortem interval determination is one of the most important aspects in legal medicine. Use of insects as an alternative matrix for drug detection is well documented and recommended when conventional matrices such as blood, urine or internal organs are no longer available. Drugs within a corpse may affect the development rate of insects that feed on them. Carrion flies feed on dead bodies and may consume the toxic substances found within them. The toxic substances can further be extracted from those insects and can be analysed by gas chromatography /mass spectrometry.

Keywords: Forensic Entomotoxicology; Post Mortem Interval; Drugs; Toxic Substances; Arthropods; Accumulated Degree Days (ADD); Accumulated Degree Hours (ADH).

1. Introduction

Forensic entomotoxicology is a branch of medicine, which applies entomology, toxicology and other related studies to solve the poisoning cases [1]. The consequences due to pills and pollutants on arthopods development is also studied under it. The cause and manner of death of the victim can be determinedby the application of entomotoxicology in forensics [2]. Insect specimens collected from dead bodies by the entomologists can also be used to estimate the minimum post-mortem interval (PMI) of the corpse. There will be variation in the developmental stages of the insects feeding on the corpse depending on the type of poison or toxic present within them. These variations makes it easier for the entomologists to find the cause and time of death of the victim [3].

Beetles (Order: Coleoptera) and beetle feces are often hired in entomotoxicology, but the presence of pollution is commonly the consequences of the beetles feeding on the fly larvae which might be feeding at the carrion containing toxious materials. This overview is aimed towards presenting a top level view to forensic odontologists about the benefits of the usage of the entomological evidences in estimating the time, cause and manner of death [4].

2. Material and Method

Accumulated degree days or hours (ADD/ADH) can be of use when it comes to estimating the post mortem interval of any corpse. The ADH value represents the number of “energy hours” needed for the insect larvae to develop. The concept of degrees of days or hours suggests that the rate of development is proportional to the temperature within the temperature range of a particular species. Forensic entomologists making use of forensic entomology to offer data for death investigation. The following steps are followed while applying entomology in forensic investigations.

1. Identification of insect's developmental cycle i.e. eggs, larva and adult.
2. Storage (collection and preservation) of entomological evidences.
3. Estimation of post mortem interval by calculating ADH/ ADD.
4. Testifying in courtroom to give an explanation for insect associated proof observed at the crime scene [5].

Insects are attracted to a dead body immediately after death. The insect’s colonization pattern occurs in a predictable manner [6]. A corpse,i.e human or animal is a food resource for insects, so they usually initiates the decomposition of the dead body. Physical, chemical and biological changes are observed in a corpse during

their decomposition [7].

Collection and preservation of Entomological evidences:

Materials required:
Cadaver, sampling jars or vials, forceps, fine brushes, entomological nets, thermo- hygrometer, gloves, mask, labels [8].

Chemicals required:
• Preservative made from Kerosene: Acetic acid: Alcohol in the 7:2:1 [8].
• Cannon Insecticide (Toxin):-
Chemical Composition: Chlorpyriphos50% w/wcypermethrin 5% w/w

Procedure:
1. The face mask and gloves were worn prior to the collection of entomological evidences.
2. The temperature and humidity of the cadaver were noted.
3. With the help of forceps, the openings of the cadaver like eyes, mouth, wounds, and other traumas were carefully observed for eggs, larvae, pupa and insects periodically.
4. For collecting eggs and larvae, fine brushes were used and they were stored in vials containing the preservative. Half of the eggs and larvae are kept as it is to observe their growth cycle.
5. Entomological nets were used to catch the insects found on the dead remains and they were later stored in containers with small openings.
6. All the collected entomological evidences were properly packed and labelled.
7. Photos were taken to document the entire procedure.

Observation table:
A. Specimen without toxin/ control.

Sr. No	Developmental stages of the insects	Date of collection	Time of collection	Average Temperature (°C)	Average Humidity (%)
1	Insects	4/5/22	4:00pm	39.5	17.6
2	Eggs	5/5/22	10:00am	40.3	14.3
3	First instar	6/5/22	1:00pm	38.3	16
4	Second instar	7/5/22	10:00am	39.8	16
5	Third instar	8/5/22	10:00am	36	18.7
6	Pupa	13/5/22	1:00pm	37.1	17.7

Table 1: Collection Details of Insects with Respect to Their Developmental Stage from the Cadaver without Toxin

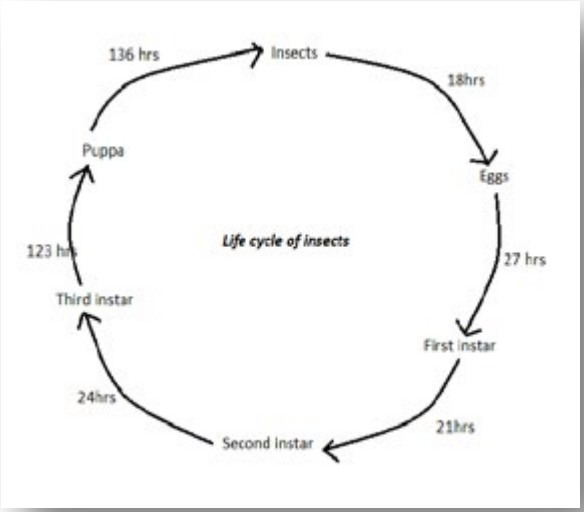

Figure 1: Life Cycle of Insects from Cadaver without Toxin

Figure 2: Stages of Larvae from Cadaver without Toxin Sample

B. Specimen with toxin:-

Sr. No	Developmental stages of the insects	Date of collection	Time of collection	Average Temperature (°C)	Average Humidity (%)
1	Insects	18/4/22	1:00pm	38.8	15
2	Eggs	18/4/22	4:00pm	38.8	15
3	First instar	19/4/22	1:00pm	37.3	16.7
4	Second instar	20/4/22	10:00am	36.3	17.6
5	Third instar	21/4/22	10:00am	34.5	21.3
6	Pupa	25/4/22	10:00am	37	20.3

Table 2: Collection details of insects with respect to their developmental stage from the cadaver with toxin:-

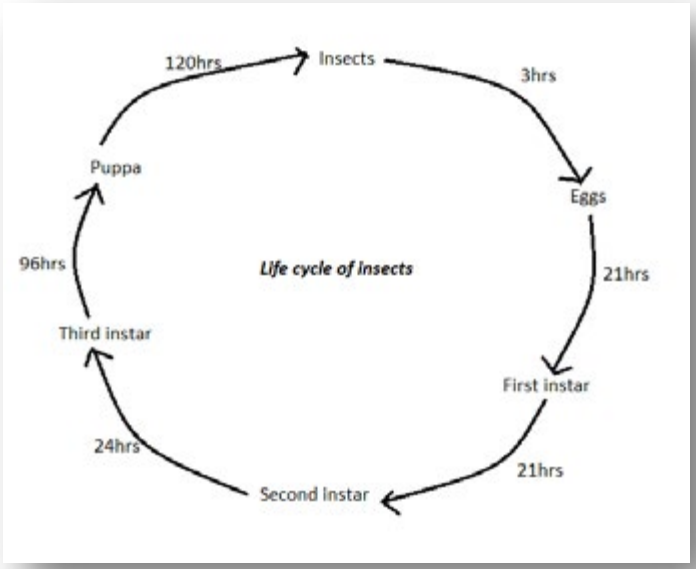

Figure 3: Life Cycle of Insects from Cadaver with Toxin

Figure 4: Stages of Larvae from Cadaver with Toxin

Figure 5: 1st,2nd,3rd Instar

Figure 6: Pupa

Figure 7: Adult Fly

Observation:

The toxin in the cadaver was found to be enhancing the development of the insects till a certain level of their growth cycle. (i.e. pupal stage). Afterwards their growth was inhibited by the action of the toxin present on the cadaver.

Developmental stages Of the insects	Specimen without toxin ADH Accumulated degree days/hours (ADD/ ADH):	ADD	Specimen with toxin ADH	ADD
Insects	-	-	_	-
Eggs	18hrs	Half day	3hrs	Half day
First instar	27hrs	1 day	21hrs	1 day
Second instar	21hrs	1day	21hrs	1 day
Third instar	24hrs	1 day	24hrs	1 day
Pupa	123hrs	5 days	96hrs	4 days
Insect	136hrs	5 and half days	120hrs	5 days

Table 5: Comparison Between with Toxin and Without Toxin Sample

2. Conclusion

The insect succession pattern can vary with the chemical characteristics of the toxin or the poison present in the cadaver.The developmental stages of the insects in and around the dead body can be closely examined for determining their post-mortem interval. The possible intake of any toxic substance prior to the death of the victim can also be determined based on the variation in the developmental cycle of the flies or insects feeding on those corpse. Further those substances can also be extracted from them. So to conclude, entomological evidences play a crucial role in finding the time, cause and manner of death in criminal investigations.

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