FORENSIC ENTOMOLOGY OR HOW TO USE INFORMATIVE CADAVER INHABITANT

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ABSTRACT: When a corpse is discovered, investigators have to identify the victim to determine the cause of the death and to estimate the post mortem interval.

If the corpse is in an advanced decay, estimating the post mortem interval using common techniques becomes rather difficult.

In this regard, insects picked up by the cadaver can be of great help. Forensic entomology studies the successive arrivals of insects on a cadaver. One after the other, eight screwworms, first attracted and then repulsed by release of new odours, colonise corpses from death to skeletal reduction.

All insects collected on the crime scene are identified and their biology used to estimate the post mortem interval.

With an accuracy of one day per month of age of the cadaver, this technique has been shown to be really useful for investigators, therefore becoming more popular.

KEY WORDS: Entomology; *Post mortem* interval; Decomposition; Entomological evidence.

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WHAT IS FORENSIC ENTOMOLOGY

Forensic entomology consists in studying the links which exist between the presence of insects and the state of decomposition of a corpse.

This technique is useful when it becomes difficult to estimate the post mortem interval using common methods, especially when the corpse is in an advanced decay. In this case, the insects collected on and around the corpse are the only indicators of the moment of death.

This original technique is based upon the chronological arrival of insects onto the cadaver. The knowledge of their biologies makes it possible to estimate a post mortem interval [3, 9, 10] and to give information on a possible handling of the body.

Insects importance

Insects are very important on Earth. Over one million species have been described so far and there is probably one more million to be discovered.

It is the most important animal reign. In comparison, mammals are only represented by approximately 4000 species.

Their medical or economical importance will not be addressed.

Our interest in insects stems from the fact that they are the main gravediggers in our altitudes.

Pig experimentation

To illustrate this, we laid down a 25 kilograms pig in a periurban forest close to Paris. The body was protected by a cage, to avoid animals bits. Only environmental conditions and insects participated in the decomposition.

Nine days later, the body was inflated under the action of gas produced by the process of putrefaction. At this moment, larval activity was already intense.

Two days later, the body did no longer exist. It was totally covered with larvae.

After two more days (i.e. 13 days after the pig has been deposited) all larvae apparently gone. There was no more nutritive substrate and yet larvae had to continue their development. In fact, they buried themselves under the corpse to be protected from light and predators. Only bones, teeth and skin fragments remained.

Several factors influence the speed of decomposition. The temperature, the humidity, the weather, the body weight, the orientation and the position of the corpse, the nature of the soil, etc. For instance the same state of decomposition could be reached after 3 months with a lower temperature, a dryer soil, a higher altitude, etc.

It is obvious that the physical aspect of the corpse is not good enough to give an accurate *post mortem* interval. Insects, which development is controlled by climatic conditions are the most accurate indicators of the time of death.

ENTOMOLOGICAL METHOD

The entomological method is based on the order of arrival of the successive squads on the feeder substrate [5, 8] but also on a perfect knowledge of each species biology.

Squad principle

At each state of decomposition specific odours are released. Each one selectively attract different species of arthropods. This progressive invasion has been described by Megnin at the end of the 19th century [8].

The first insects are detected immediately after the death. They are attracted by particular odours that we cannot smell. They lay their eggs in natural openings and on wounds.

Then, each new type of internal fermentation will release new odours which will attract other species and will repulse previous ones.

One after the other, eight screwworms, will colonise a corpse from death to skeletal reduction.

Development cycle of *Diptera*

Each species of insects has a specific biology which has to be well known. Because of their short development time, Dipterous are preferably used by forensic entomologists.

Their development cycle includes four phases which have different durations. The insect has a different morphology for each phase (egg, larvae, pupae, adult). It is important to know that both the pupation and the metamorphosis occur away from sunlight and predators, generally in the soil under the body.

The time required for a complete development depends on several factors but temperature is the most important one [4, 7]. The higher the temperature, the faster the development.

COLLECTION OF EVIDENCE

All kinds and form of insects have to be collected on and around the dead body [1] because each insect is important and may be informative.

First, there are necrophagous insects which are cadaver-fed. These insects are specific of a decomposing corpse. Second, necrophilous insects which are predators eat the necrophagous ones. Third, opportunists find in the cadaver a place to shelter. Finally, omnivores such as wasp or ants can be present too. Only necrophagous insects are specific of a decomposing corpse and may be used to estimate the time of death. All other insects or arthropods are not specific of a cadaver but can be representative of the place of discovery of the corpse.

As there is no problems of contamination, samples should be collected at the end of the crime scene investigation, just before and after the removal of the corpse.

To be representative of the entomological fauna, the collection has to be exhaustive. Outdoors, soil will be collected under and around the corpse, because it contains insects which are doing their metamorphosis as well as their remains. Indoors, insects have to be searched behind furniture, under carpets... More evidence shall be collected during the autopsy.

Half of the insects in immature stages are fixed in alcohol in order to have a picture of their state of development at the moment of the discovery. The other half is kept alive to be raised in the laboratory.

To facilitate the study, samples have to be taken as soon as possible to the laboratory. If it is impossible, they have to be refrigerated in order to stop or slow down the insect development.

ANALYSIS

Required documents

To perform an accurate analysis, reliable meteorological data as well as reports and photographs of the crime scene investigation are required. Other information contribute to the accuracy of the expert conclusion: the temperature on the crime scene at the arrival of investigators, the heating system in use and the position (open/closed) of windows and doors in the case of a discovery in a house, the storage conditions of the corpse before autopsy and the storage conditions of the samples between their collection and the sending to the laboratory.

Sorting of samples and rearing

As soon as the laboratory as received the evidences, the seals are first verified and then broken. All the samples and the soil collected under the body are sorted in order to pick up every entomological evidence.

Diptera at different immature stages are reared on beef meat. Then boxes are placed in incubators at known and controlled hygrometry and temperature [2]. Adults and other immature are placed into 70% alcohol before identification.

This rearing will facilitate the identification and will allow us to determine the age of insects at the moment of the corpse discovery.

Identification

All insects are identified after birth. This identification procedure is mainly based on morphological criteria using stereomicroscopy. But when necessary, scan electron microscopy or genetic analysis [6, 11] may be used.

Analysis

In the lab, the moment when adults emerge is determined. Then, the temperature and time spent in the incubator, in the fridge and the meteorological data combined to an extended knowledge of the biology of each species will allow us to estimate the oviposition. Since 1st insects lay their eggs during the few minutes following the death, this estimation is very close to the time of death.

Temperature variation over time and the principle of the analysis are presented in Figure 1.

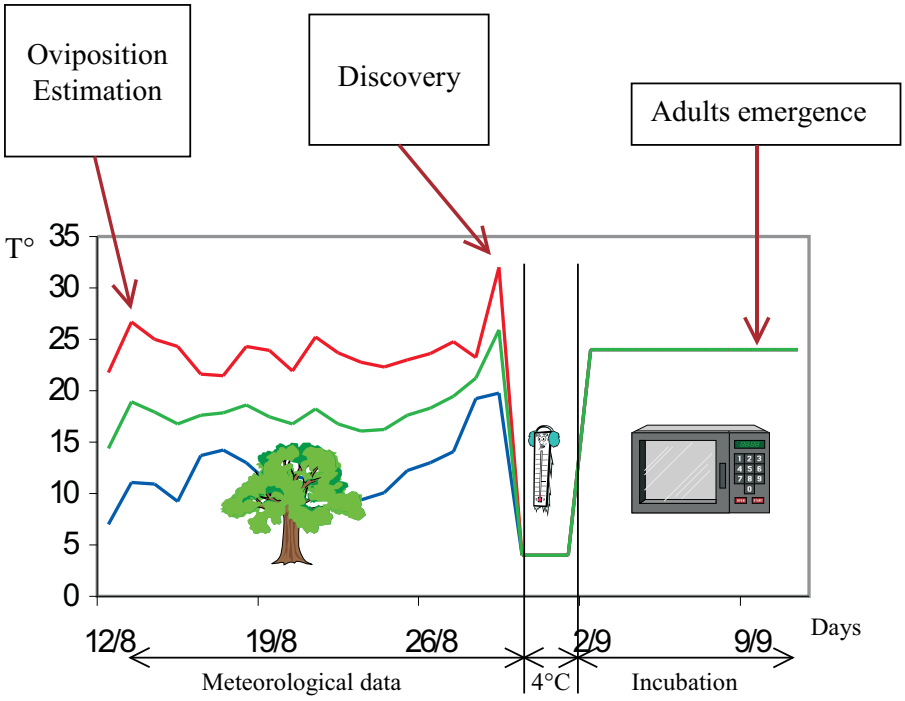

Fig. 1. Temperature variation over time.

Nature of conclusions

In our reports, first we give an estimation of the time of oviposition which can be very close to the time of death.

As all insects and other arthropods are identified, we make sure that their presence is compatible with the state of decomposition and the place where the corpse has been found.

The presence or absence of some insects may also give information on a putative move or handling of the corpse.

CASE REPORT

Low temperatures

A corpse was discovered in mountains, at the beginning of the winter. There was some snow.

The corpse had been put under a canvas cover by the perpetrator.

The body did not look decomposed. The forensic pathologist gave a time of death of one week. Some maggots were picked up in a wound. Their development was studied. The post mortem interval calculated by the forensic entomologist was about one month. This estimation was indeed confirmed later by the investigation. In fact the temperature was high enough a few hours per day for insects to develop.

Handling of a corpse

The dead body of a baby was discovered in a carton box near a house. This box was sealed by an adhesive tape. Only some pupae and old maggots were found. But because of the state of decomposition, young maggots should have been detected.

The rearing of the pupae allowed us to estimate the time since death. The rearing of the larvae enabled us to calculate the time when the body was no more accessible to insects.

When we gave this information to investigators they informed the suspect who then confessed the crime and the *modus operandi*.

Conclusion

In conclusion, forensic entomology is a reliable method, complementary to forensic medicine. It enables experts to estimate the time of death with an accuracy of one day per month. This means that an interval of 5 to 6 days for a 6-month-old cadaver, 3 days for 3 months, etc. can be given.

All these information about the time since death or a putative move or handling of the corpse can be the determining factor for further investigations and then help investigators and judges to find the truth.

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