

On Maggots and Murders: Forensic Entomology

Editor's Introduction | Insects, particularly blowflies and their larvae, can provide important evidence in the investigation of a crime. Information about the size and age of blowfly larvae on a corpse can be used to identify the time, and sometimes place, of death. Martin Hall, a forensic entomologist who has worked as an expert witness on over 30 criminal cases, presents a fascinating overview of the ways in which insects can provide vital clues about a murder.

Forensic entomology is the interpretation of entomological evidence to help resolve a criminal investigation. Recently, the level of awareness of forensic entomology within the entomological community, especially in the United States, has increased. The insects that have been most extensively studied in relation to their forensic uses are the blowflies--members of the Calliphoridae fly family--in particular their larvae or maggots, because: They are the insects most commonly associated with corpses. They colonise the body most rapidly after death and in greater numbers than most other insect groups. They usually provide the most accurate information regarding the post-mortem interval--the time that has elapsed since death, a major objective in forensic entomology.



The Natural History Museum
Maggots of the bluebottle blowfly *Calliphora*.

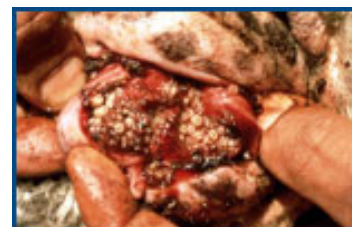


The Natural History Museum
Adult bluebottle blowfly,
Calliphora vicina.

Blowfly larvae featured in the first successful use of entomological evidence in the UK, when they were discovered on decaying human remains dumped in a small ravine in Dumfriesshire, Scotland, in September 1935. The remains were later identified as those of the wife and maid of Dr Buck Ruxton of Lancaster. The maggots were aged by Dr A.G. Mearns and provided a vital clue as to when the murders took place. Dr Ruxton was subsequently found guilty of the murders and hanged.

While the ageing of maggots on corpses represents the most common application of forensic entomology, insects can also be used to assist in many other types of forensic investigation. In another case, an accurate knowledge of the distributions of insects found on cannabis plants imported into New Zealand was used to determine the geographical origin of the plants.

Adult blowflies have a finely tuned sense of smell and are attracted in large numbers by the odours of decay, often within a few hours of death. The odours that attract them are mainly created by the action of bacteria on dead tissues. They sometimes swarm to wounds or open sores and ulcers on living vertebrates including humans--the action of larvae feeding on living people causes a disease condition known as myiasis.



The Natural History Museum
Maggots feeding on a live
sheep--an example of myiasis.

Entomologists use precise methods to collect and present the evidence correctly--a vital precursor to accurate interpretation. They determine facts about the location of the body and its accessibility to flies at the scene of the crime. The largest and therefore oldest maggots are the most important specimens but the complete range of maggots present will be sampled because they may shed light on different aspects of the investigation. If the entomologist cannot be present at the scene of the crime, the maggots will be collected by crime officers or pathologists who need to provide accurate

information on their location on the body, times of collection and ambient temperatures.

The maggots are killed by being immersed for 10-15 seconds in water heated to just below boiling point. They are then transferred to a solution of 80% ethanol. These techniques prevent the discolouration and shrinkage that occurs if living maggots are placed directly into common preservative solutions such as ethanol and formaldehyde. Shrinkage would make the maggots appear younger than they actually are.

Taxonomic identification of the insects found on corpses is essential to the reconstruction of events surrounding criminal cases involving death. Systems of classification of biological organisms are used to facilitate their identification.

In the case of maggots, their location on the body can provide important information because on an uninjured body, blowfly eggs are usually laid at the openings of body orifices and it is in those areas that the emerging maggots start to feed. However eggs can also be laid at sites of injury, hence maggots found at sites other than the body orifices might indicate that some traumatic wounding took place before death.

Scientists then determine the age of the specimens to provide evidence as to when the female flies first found the dead body and laid their eggs--the minimum estimate of the post-mortem interval. This can be taken as the latest time by which death must have occurred. The estimation of maggot age relies on detailed knowledge of the fly lifecycle and the factors that influence it.

Blowflies have four life stages--egg, larva (maggot), pupa and adult. The larval stage is divided into three instars and between each instar the larva sheds its cuticle (skin) to allow for growth in the next instar. The pupa is a transition stage between larva and adult. It is found inside a barrel-shaped puparium, which is actually the hardened and darkened skin of the final instar larva. The immature stages of blowflies are poorly documented in comparison to the adults.

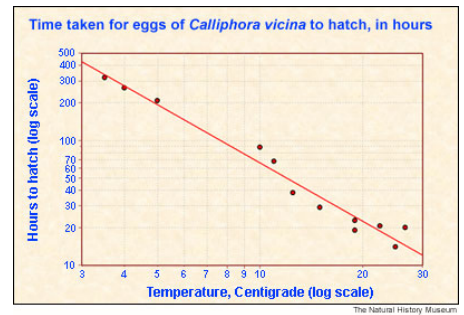


The Natural History Museum
Life cycle of a typical blowfly.



The Natural History Museum
A maggot mass feeding on a dead sheep.

The major external factor is temperature, a parameter with which the metabolic activity of maggots, which are 'cold-blooded', is strongly correlated. They develop slower at lower temperatures and more rapidly at higher temperatures. If the hourly temperatures can be estimated at the site of discovery of the body for the period over which the maggots were developing, then the overall thermal input can be determined and the time of egg-laying can be estimated taking account of the varying daily temperatures. However, calculations are complicated by the fact that metabolic activity can cause temperatures within the maggot mass to rise by 5-20°C compared to the ambient and ground temperatures.



The effect of ambient temperature on the duration of egg development for the common bluebottle blowfly, *Calliphora vicina*, illustrating the acceleration of development at raised temperatures.

Size is generally a function of age in that, up to the post-feeding stage, the larger the maggot the older it is. However, size can also be affected by the amount of food available and by the numbers of competing maggots i.e. decreasing the food resources and increasing the numbers of maggots can result in a reduction of the average size of maggots.

Toxic substances in or on a dead body can be accumulated by feeding larvae and can affect their rate of development. For example, cocaine and heroin significantly increase the rate of development of larvae, thereby affecting the accuracy of post-mortem interval estimates if not taken into account. In contrast, insects may take much longer to colonise and decompose a body if it is wearing clothes permeated with lubricants, paints or combustibles.

Various stages of insect succession are recognised in the decomposition of corpses and a different spectrum of invertebrate fauna is associated with each. However strict adherence to the succession timetable can be misleading as there is considerable variability with respect to season, geographical location, body size and other variables.

The geographical location of the site of discovery of a body can have a major effect on the diversity of insects found on it. They can vary over just a few metres if for example comparing the fauna of a corpse placed in a hedgerow to one placed in nearby woodland or open pasture.

Burial effectively isolates the corpse from many of the usual insects, in particular from blowfly species which have a profound effect on the rate of decomposition. Even a soil layer of just 2.5cm can significantly delay decomposition, because only exceptionally do blowflies lay their eggs on the soil surface rather than on the corpse itself. Insect colonisation of a buried corpse will also be affected by the soil type, its permeability to odours of decay and the ease with which insects can move through it. Although insect evidence may be of little use in determining the post mortem interval in many burial cases, it may be of value in explaining what happened to the body before burial, for example, for how long it was exposed above ground.

There are circumstances where a lack of entomological specimens on a body should be noted. For example, the lack of blowfly larvae on a week-old corpse found outside during the summer months would indicate that the body had been shielded from insect activity for several days and therefore that it had possibly been dumped at that site only recently.

Each forensic case is unique due to the high number of variables involved and this can make it extremely difficult to assess often scanty data with great accuracy.

Although much is already known about the life cycle of the blowfly, there is considerable scope for future morphological, biochemical and molecular research to improve identification and refine estimates of the post mortem interval. Areas for investigation include details of the influence of corpse location and covering on fly access, the influence of diurnal cycles of light and dark and of temperatures on fly and maggot activity, and ways in which the metabolic activity of a mass of maggots raises temperatures and affects their development. Scanning electron microscopy is

increasingly being used for routine identification purposes and will be of considerable value in the future, especially for eggs and immature larvae.

Future research will enhance forensic entomology as a genuine, quantitative scientific discipline, and improve the quality and accuracy of the case reconstructions that it makes.

[Forensic Entomology Pages, International
\(folk.uio.no/mostarke/forens_ent/forensic_entomology.html\)](http://folk.uio.no/mostarke/forens_ent/forensic_entomology.html)

[Forensic-Entomology.com \(www.forensic-entomology.com/\)](http://www.forensic-entomology.com/)

[Forensic Entomology at the University of Alabama at Birmingham
\(www.dpo.uab.edu/~jwells/forensic.html\)](http://www.dpo.uab.edu/~jwells/forensic.html)

Books:

Title: Forensic Entomology : Utility of Arthropods in Legal Investigations

Format: Hardcover

Author: Byrd, Jason H.; Castner, James L.

Date: 01-SEP-00

ISBN: 0849381207

Title: A Fly for the Prosecution : How Insect Evidence Helps Solve Crimes

Format: Paperback

Author: Goff, M. Lee

Date: 07-MAR-96

ISBN: 0674007271

Title: Entomology and Death, a Procedural Guide

Format: Spiral-bound

Author: Haskell, Neal; Catts, E. Paul; Editors

Date: 01-DEC-90

ISBN: 0962869600