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CASE REPORT

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Determining time of death using blow fly eggs in the early postmortem interval

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Abstract A forensic entomology case is presented which is interesting for two reasons; firstly, it uses egg development, but secondly, it involves a case which is over 20 years old, and was recently re-opened. The only entomological evidence was in the form of photographs. Usually, it is not possible to make any determinations from photographs alone, as species and age cannot be determined. However, this case was particularly unusual, as close up photographs taken by police at the crime scene showed the first egg eclosion. Weather records, developmental data and degree day accumulations, together with a knowledge of local species and their habitats, allowed determination of the time since death. Time of death was affirmed when the defendant was convicted of first degree murder more than 20 years after the killing.

Keywords Eggs · Calliphoridae · Forensic entomology · Time since death

Introduction

Forensic entomology is usually used to determine time of death in the later postmortem interval, when medical parameters are no longer of value. This usually occurs around 72 h or more after death [1]. However, insects can be used to determine the minimum time since death as soon as the first blow fly (Diptera: Calliphoridae) eggs are laid, often very soon after death. Insect eggs are often laid on the body within minutes of death [2, 3], so can be valuable in cases in which a pathologist wants corroboration of the estimate of time since death, in situations in which only body parts are present, or in specific cases in which time of death is under dispute.

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It is usually not possible to perform an entomological analysis retrospectively, without actual insect specimens, as the insect species must be identified and their stage determined. In particular, photographs of larval insects cannot usually be used to determine species and age. The size of insects can be misleading as many factors other than developmental age such as nutrition and competition can influence size [4, 5].

This case is most atypical in that, not only did it involve insect eggs, but due to extremely fortuitous circumstances, the author was also able to determine time since death despite the fact that the only evidence was from photographs taken over 20 years ago.

Case history

A young women disappeared during a very large outdoor party in a rural field in British Columbia. The victim was last seen alive just before midnight on 13 October. Due to a lack of communication, friends did not realise that she was missing until the following day, when searches began. The body was discovered 38 h after she was last seen alive, at 14.00 h on the 15 October, some distance from the nearest road. The remains were fresh and partially clothed. Sexual assault was suspected.

The police, a coroner and a forensic pathologist all attended the scene, but forensic entomology was not routinely used in homicide investigations in Canada at that time [6], so no entomological evidence was collected. However, extensive and very clear police photographs were taken.

The case remained unsolved for years, until the newly formed Unsolved Homicide Unit of the Royal Canadian Mounted Police and Vancouver City Police re-opened the case. With the use of DNA fingerprinting, a suspect was identified and arrested more than 20 years after the crime.

Time of death became an issue as the defendant argued that, although he had sex with the victim, it was consensual, which explained the presence of his DNA. The defendant stated that the victim was alive and well when he left her after having consensual sex prior to midnight on the 13 October. He claimed that she must have been killed a day or more after the party, otherwise the search parties would have easily seen her in the field. Photographs taken at the time of discovery indicate that the victim was lying in a field of relatively short grass, but was not easily visible from a distance. Extensive searches had been undertaken from noon the day after she went missing, but the searchers had only searched along roads and ditches and had not yet entered the fields themselves. Even

Table 1 Temperatures close to the crime scene from Environment Canada weather records

Date	Max (°C)	Min (°C)	Mean (°C)
13 October	17.8	2.2	10
14 October	21.1	2.8	12
15 October	20.8	4.4	12.6

when found, photographs showed that her body was very hard to see from the road. In fact, her remains were only discovered when a searcher climbed to the top of a farm building and was able to get an elevated view of the area. However, the defense counsel's argument that, had she been there since midnight on the 13 October she would have been found by the searchers, did result in some doubt as to time of death.

Analysis

Three main pieces of data are required in order for an entomologist to use insects to determine time of death. These are 1) the temperature at the crime scene, 2) the stage of development of the oldest insects on the body, and 3) the species of insect.

Crime scene temperatures were easily obtained as Environment Canada maintains long-term records, and the crime scene was relatively close to a weather station. Hourly temperature data were available. The mean temperatures for the 14 and 15 October were 12°C and 12.6°C, respectively, however, daytime maximum temperature was in the low 20s (Table 1).

Insect stage is determined by examining specimens under a microscope. However, the only insect evidence was from photographs, so no direct examination could be done. Normally, it is not possible to determine stage from a photograph. However, in this case, close-up photographs had been taken of the neck region. The victim had been strangled and contusions in this area had attracted insect activity. Several masses of eggs had been laid close to the contusions and a close examination of this region showed that a small percentage had hatched and moved to the contusions. This was clearly evident in the photographs provided to the author as, although most of the insects were still in the egg stage, approximately 10% had hatched and had moved from the egg masses towards the contusions. The presence of maggots was corroborated by the coroner at the crime scene who noted seeing "eggs and maggots". Therefore, the insect stage can, in this rare instance, be determined from photographs and included eggs and 1st instar larvae.

One of the photographs did include a picture of an adult blow fly, but the eggs were not necessarily oviposited by this one species. However, the crime scene was in a region which the author has studied extensively [2, 5, 7, 8, 9] so some assumptions can be made. Although several blow fly species are common to this area, only *Phormia regina* (Meigen), *Lucilia illustris,* (Meigen) and *Eucalliphora latifrons* (Hough) are commonly found in rural, open pasture land, with no shade. Therefore, it is likely, although not certain, that the eggs belong to one or several of these species.

Egg development and hatch would have been governed by ambient temperature, and ambient temperature fluctuated dramatically from 3–4°C at night to 21°C during the day, so developmental data were converted to thermal units or accumulated degree hours. The required accumulated degree hours would have accumulated between midnight on the 13 October and 10.00 h on the 14 October for these three species. Of course, the actual species present is unknown and cannot be determined, and it is possible the eggs belong to species outside these three. However, as development at this temperature is reasonably similar for all three species [4], it can be estimated that the insects were laid by early to mid-morning 14 October at the latest.

Flies do not usually lay eggs at night, and would not have laid eggs at the cooler night-time temperatures, so were probably laid early in the morning of 14 October. Therefore, death could have occurred anytime before ~10.00 h that morning. Death could have occurred during the previous night, however eggs would not have been laid until the following morning. Therefore, it is unlikely that death could have occurred after early to mid-morning 14 October.

Conclusions

The insect evidence refuted the defendant's claim that death had occurred much later, after the party. DNA and other evidence linked him to the body. The insects linked him to the time frame. He was convicted of first degree murder, and sentenced to life imprisonment. Justice was finally served more than 20 years after the murder.

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