

CASE REPORT

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The Use of Insects to Determine Time of Decapitation: A Case-Study from British Columbia

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ABSTRACT: A case is presented in which insects were used to determine time of decapitation. A severed human head was located on 28 June in a ditch on Vancouver Island, British Columbia, Canada. The victim had been missing since 17 June. Prepupal *Calliphora vomitoria* (L.) were found at the cut surface of the neck and no evidence of insect feeding was observed at any of the natural orifices; the eyes were intact. Meteorological and insect developmental data indicated that the insects had been oviposited on or before 20 June. The lack of feeding at the orifices, together with the evidence of feeding and presence of insects at the cut surface of the neck indicated that the eggs had been laid after decapitation. Therefore, decapitation had occurred on or before 20 June. This was consistent with later police evidence.

KEYWORDS: forensic science, forensic entomology, *Calliphora vomitoria*, blow fly development, decapitation, Canada

Forensic, or medico-legal entomology is the study of insects associated with a dead body and has been used and accepted in court around the world (1-15). The majority of forensic entomology cases involve determining time of death, based on the development rates of blow flies (Calliphoridae) and on the successional ecology of carrion insects. However, in some cases, entomology can be used to determine other factors at a scene, such as whether the victim has been disturbed after death, or has used drugs (16-23). Insects can also be used to determine presence, position, and pattern of wounds (22). Insects are primarily attracted to wound sites, to feed and lay eggs, and are secondarily attracted to natural orifices. If no wounds are present, insects will colonize the natural orifices, in particular, the facial orifices but, when present, wounds are usually more attractive. Thus, extensive maggot activity in the chest and palms of the hands, and less activity in the face, was used to indicate stab and defense wounds in the death of a young woman (22,24). Later examination of the irregularities in insect colonization led to an exhumation of the remains several years after death, which confirmed the insect evidence, and changed the manner of death to homicide.

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Forensic entomology has, therefore, been used to determine time of death and also position of wounds. This paper presents a case history in which both are combined, in that insect evidence was used to determine the time of decapitation.

Case History

The partial remains of an adult white female were discovered by her spouse at 12:30 Pacific Daylight Savings Time on 28 June. The remains were contained in an open plastic bag and were found in a roadside ditch close to her home on Vancouver Island, British Columbia, Canada. The remains consisted of a severed head. There had been no direct trauma to the cranium. The right mandible was broken, but the skin was intact. The head had been cut from the trunk above the neck at C2 and had not been cut cleanly (Fig. 1). The pathologist determined at autopsy that the decapitation had occurred after death. Cause of death was not determined as the rest of the body has not been found at time of writing. The remains were taken to the morgue shortly after discovery and were refrigerated at 4°C for 25 h, until autopsy at 14:00 29 June, 15.5 h later. The victim had been reported missing on 17 June. The area around the house, including this ditch, had been searched shortly after 17 June, and the remains were not present at that time.



FIG. 1—Severed head of decedent. Arrows show several incision wounds at neck.

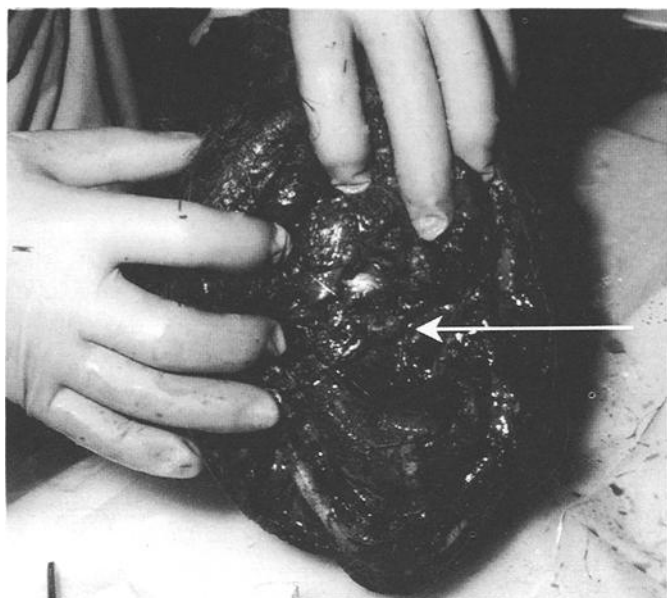


FIG. 2—Base of neck showing cut surface. Arrow indicates feeding sites of larvae.

No insects were observed in the facial orifices at the scene, and it was only at autopsy that examination of the cut surface of the neck revealed the presence of blow fly larvae or maggots. A total of 18 maggots were collected from the neck region. Three were preserved at the autopsy and the rest were placed on beef liver to be reared to adulthood for identification. The insects collected were third instar *Calliphora vomitoria* (L.) and were just entering the prepupal or post-feeding stage. The insects were taken to the forensic entomology lab at Simon Fraser University and were raised to adulthood at room temperature under secure conditions.

The insects were collected from the cut surface of the neck (Fig. 2). There was no sign of insect feeding at any of the natural orifices, in particular, the eyes and nose were completely intact (Fig. 3). This indicated that the insects had fed only at the cut surface, and therefore, had been most probably laid as eggs on the cut surface.

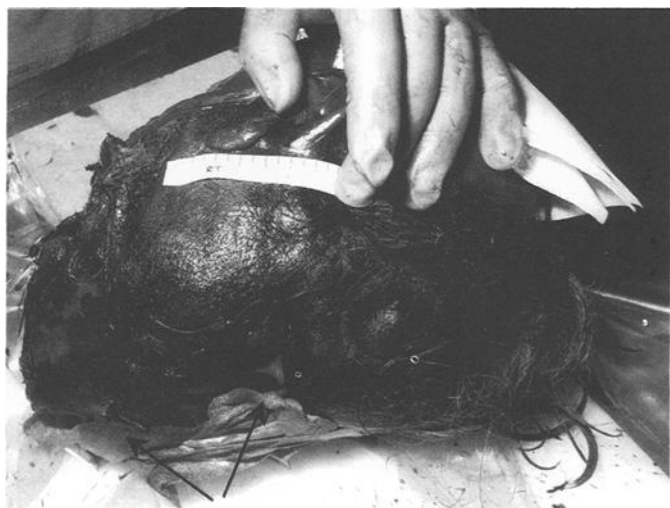


FIG. 3—Severed head at autopsy, showing right profile, face down. Intact eyes and other facial features indicated by arrows.

Analysis

Insects of a given species develop at a predictable rate, within a particular range of temperatures and, because the normal metabolic rate is increased with increased temperature, the duration of development decreases with increased temperature (25). Therefore, the age of the insects found on remains can be determined by careful examination of meteorological data, together with the identification of the species and stage of development of the insects associated with the remains.

Meteorological records from the closest Environment Canada weather station indicated a mean temperature of 18.4°C between 17–28 June. The remains were in a ditch, in an open plastic bag. The ditch was dry, with little overgrowth, but the bag with the remains was partially in a culvert, so received no direct sunlight. It is possible that the ditch environment could have been slightly lower than the temperatures recorded at the weather station, but the presence of the plastic bag, although open, could have slightly increased the temperature and it was considered that the presence of the ditch and the plastic bag probably canceled each other out, and that insects associated with the remains would be subjected to temperatures close to those recorded by the Environment Canada weather station. *Calliphora vomitoria* has been reported to take a minimum of 8.1 days to reach the beginning of the prepupal stage at 23°C (26). This is higher than that of the death scene but can be converted to a thermal measure, accumulated degree days (ADD). This has been used to predict time of death accurately (5). ADD were calculated for *Calliphora vomitoria* by multiplying the developmental duration (in days) for each life stage by the rearing temperature (5). Based on Greenberg's data (26), *C. vomitoria* would require a minimum of 186.3 ADD to reach the prepupal or post-feeding stage of the third instar. The date of oviposition is calculated by a simple reverse summation process. Table 1 shows the meteorological data.

The time spent under refrigeration was excluded from the calculation as recent work has shown that maggots do not continue to develop when refrigerated for 24 h under morgue conditions when low numbers of maggots are present (27). Large numbers of maggots can maintain a high metabolic temperature even when refrigerated when they form a maggot mass, and this can reduce the effects of refrigeration. However, in this case, a total of 18 maggots were present, which is too few to cause an increase in temperature above ambient. Davies and Radcliffe showed that *Calliphora vicina* Robineau-Desvoidy can continue to develop down to 4°C, but not

TABLE 1—Meteorological records and accumulated degree days (ADD) obtained from Environment Canada for the time the victim was missing.

Date	Mean Temperature (°C)	ADD	Comments
17 June	14.8	220.6	victim last seen alive
18 June	15.8	205.8	
19 June	17.5	190	probable time of oviposition
20 June	17.8	172.5	
21 June	20	154.7	
22 June	20	134.7	
23 June	19.8	114.7	
24 June	17.8	94.9	
25 June	20	77.1	
26 June	18.3	57.1	
27 June	19.8	38.8	
28 June	19	19	victim's severed head found

below, and at that temperature, development is extremely slow (263–286 h for eggs to hatch) (28), 186.3 ADD would have been reached on 20 June (Table 1).

Calliphora vomitoria is one of the most dominant species found in rural regions in the coastal area of B.C. and prefers shaded areas, although is not limited to shade (29). It is also found in more northern regions of B.C. but is then not usually the predominant species (30). It is one of the most common species found on buried carcasses (31), indicating its willingness to burrow into small or enclosed areas.

Conclusions Based on Insect Analysis

The insect evidence indicates that: 1. the eggs were laid on the cut surface of the neck on or before 20 June. 2. the insects were laid after decapitation as, had the remains been intact when exposed to insect colonization, insects would have been laid first in the orifices, and later at the neck. Some might have moved from the orifices to the neck, when decapitation occurred later, but feeding damage would have been evident, and the majority would have remained at the orifices as these are suitable feeding sites. 3. therefore, decapitation occurred on or before 20 June. 4. as decapitation occurred after death, death must have occurred before 20 June.

Case Overview

The victim and her husband owned valuable property with a large mortgage. The mortgage was insured such that, should either party die, the debt was canceled. On 17 June, the victim was reported missing. On 20 June the husband met with the insurance brokers to cancel the mortgage debt. He was informed that his wife's disappearance for 3 days wasn't enough to prove that she was dead. Either her body, or a recognizable body part, had to be found to prove that she was dead, or it would be seven years before she would be considered legally dead.

Based on the insect evidence, on that same day, 20 June, the head, the most easily identified body part, was severed from the rest of the body (which has never been found). On 28 June the head was discovered, by the husband, in the ditch outside their house. The victim's husband was later convicted of second degree murder.

Although insects are most valuable in death investigations as indicators of time of death, in rare cases, such as the one described here, insects can be used to determine other factors.

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