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Short Communication

Behavior of *Calliphora vicina* (Diptera, Calliphoridae) Under Extreme Conditions

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If a dead human body is left exposed above the ground it will attract blowflies, which will rapidly lay eggs. The maggots found may contribute to police investigation in several ways. One of them is the estimate of postmortem interval (PMI) (see Greenberg, 1991; Erzinçlioglu, 1996). But as discussed by different authors (e.g., Erzinçlioglu, 1996), we are missing data about several aspects such as flight activity and egg-laying behavior under extreme conditions.

Temperature is one of the most important factors affecting fly oviposition activity and rate of larval development. It is generally accepted that activity of necrophagous flies stops below an air temperature of 10°C (Williams, 1984) or 12°C (Erzinçlioglu, 1996). Nevertheless, some authors showed that during the cold season, sun is probably more important than ambiant air temperature (see Green, 1951; Nuorteva, 1965; Greenberg, 1973). Deonier (1940) indicated that *Calliphora* spp. were active at a minimum of 1.7°C with the usual minimum being between 4.5 and 10°C. Nuorteva (1959) found that *Calliphora vicina* and *C. vomitoria* were active when exposed to sun with an air temperature measured in the shade of 5–6°C (a typical winter situation). Moreover, during winter, most of the captured species belongs to the genus *Calliphora* (Wyss, 1997; C. Wyss, personal observation). Some of these species seem more cold-adapted than species of *Lucilia*. Meyer and Schaub (1973) demonstrated that *Calliphora* species had a higher metabolic rate for identical temperatures compared to warm-adapted species (see also Greenberg, 1991). According to Greenberg (1991) this

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could be responsible for the lower-limit activity of *Calliphora* (2.5–4°C) compared to *Lucilia sericata* (10–12.5°C). But flight activity and oviposition are also dependent on other factors. Generally, blowflies are not active and do not lay eggs at night or during bad weather (Greenberg, 1985; Catts, 1992; Erzinçlioglu, 1996). Nevertheless, some species have been found to lay eggs during the day in shady or dark places such as chimneys and cellars (Erzinçlioglu, 1996) or in car trunks (Greenberg, 1990). Observations made by Green (1951) and Greenberg (1990) showed, however, that some species such as *L. sericata*, *C. vicina*, and *Phormia regina* could be active at night.

The literature about the influence of temperature on larval development is quite abundant, but there are surprisingly few studies on egg-laying and larval development at low temperatures. It has been said that eggs of *C. vicina* will not hatch at or below 4°C (Nielsen and Nielsen, 1946). But Davies and Ratcliffe (1994) indicated that complete larval development was possible at 5°C and that embryogenesis started even at 3.5°C. This research was conducted under laboratory conditions where flies were allowed to oviposit at higher temperatures (17–20°C).

We report here a case where *C. vicina* was able to fly and oviposit under extreme conditions.

The body of a 77-year-old male was discovered on 25 July 1997, 18 days after being reported missing, in a 10-m-deep cave located in a forest, in the Swiss Jura mountains at an altitude of 1260 m. He was lying on his back and dressed without visible injuries. The location of the body in the cave was in total darkness and the ambient temperature was constant (5°C). Following the local investigations made by the police, the body was carried to the Institute of Forensic Medicine (University of Lausanne) and kept for 3 days in a cold room (4°C) until postmortem investigations started. At that time, we collected several batches of eggs (a total of about 70) on the top of the head and in the mouth. Reared under laboratory conditions (26°C, 70% RH), the first eggs hatched about 6 h later and all reached the adult stage (see Fig. 1) and belonged to *C. vicina*, a common blowfly in Europe (Rognes, 1991). The autopsy of the corpse could not estimate the day of death but revealed that death was due to an epidural ematoma subsequent to the downfall.

In order to demonstrate that blowflies were able to fly and lay eggs in this cave and to estimate the PMI, on 12 August (Day 1, fig. 1) we placed, at the previous body location, 1.5 kg of fresh meat and 1 kg of pork liver. We also recorded temperatures close to the meat. The bait was checked each day to detect the presence of eggs. On 23 August (day 12), the first eggs were found (about 50). They were left for 6 days, corresponding to the same interval of 18 days between the disappearance of the victim and his discovery, and then transported and left another 3 days in the cold room at the institute. Afterward, eggs were collected and reared as mentioned above. The first eggs hatched the same day, corresponding to day 21. All emerged adults belonged to *C. vicina*.

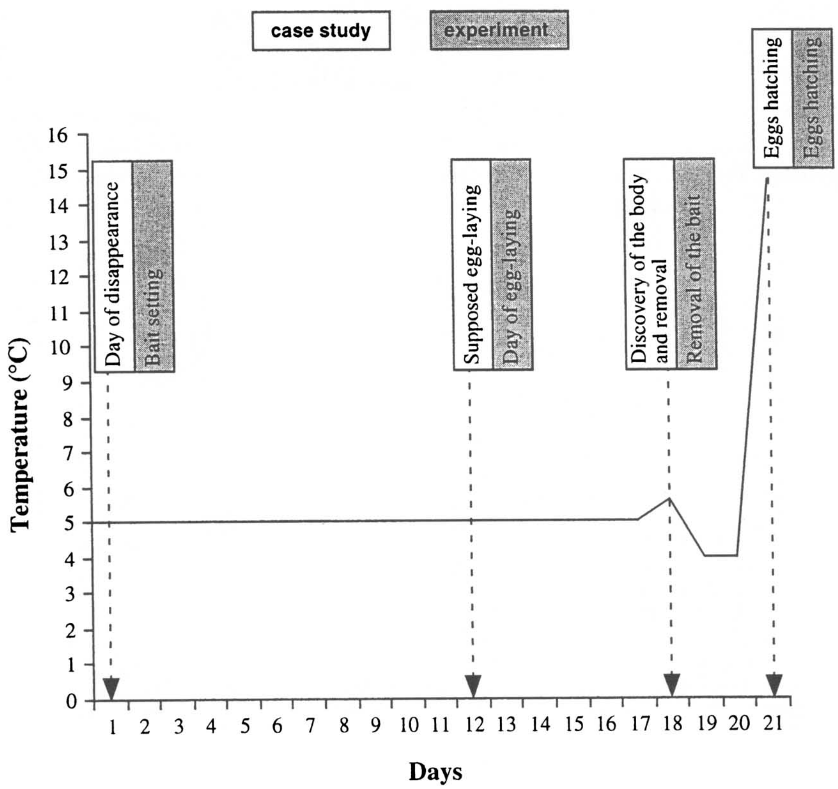

Fig. 1. Succession of the main events.

Comparing both set of data, we have good evidence that the man died the day he was reported missing (8/7/97) or 1 day later. This assumption is supported on the following bases. First, according to Davies and Ratcliffe (1994), eggs of *C. vicina* need about 9 days at 5°C to hatch. We can reasonably assume that the mean temperature supported by eggs during the case study was about 5–5.5°C. Therefore from 28 July (hatching day), we cut off 9 days and estimated the egg-laying day as the 19th. Second, in our experiment 12 days was needed to attract blowflies to the bait. This delayed attractivity of our bait is due partly to the low-temperature limiting decomposition. Cutting 12 days off the egg-laying day we get 8 July. This is exactly what the results of our experimental case showed.

This brings new limits to forensic entomology because, as mentioned previously, it was generally assumed that blowflies did not fly and lay eggs under 10–12°C and normally not in total darkness. But females were nevertheless attracted to the corpse or the bait, coming from outside and flying downward about 10 m until they reached the substrate. We suppose that the higher metabolic rate of *C. vicina* and the heat stored by sunlight could explain the possibility of entering a cold cave to oviposit. However, in a series of experiments done under laboratory conditions with *C. vicina*, when females (collected in winter) were left at different temperatures, ranging from 5 to 21°C, they stopped ovipositing at about 8°C (unpublished).

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