

## CASE REPORT

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### Determination of Postmortem Interval by Arthropod Succession: A Case Study from the Hawaiian Islands

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**ABSTRACT:** A postmortem interval of 34 to 36 days was established for remains recovered on the island of Oahu, Hawaii, based on interpretations of patterns of arthropod succession on the remains. This interval was primarily based on the presence of adult specimens of *Philonthus longicornis* (family Staphylinidae), mature larvae of *Piophilidae casei* (family Piophilidae), and empty puparial cases of *Chrysomya rufifacies* (family Calliphoridae). Species and developmental stages of two additional Coleoptera species and three additional Diptera species were also present, which was consistent with the estimated interval, although not definitive.

**KEYWORDS:** pathology and biology, postmortem interval, entomology, decomposition, arthropod succession

Over the past several years, there has been a renewed interest in estimation of post-mortem interval by entomological techniques. This renewed interest has resulted in the publication of results of decomposition studies [1,2] and various case studies demonstrating application of these results [3-7]. Although various combinations of data from laboratory rearings of selected species and data from decomposition studies have been used, the majority of these cases have dealt with remains discovered during the earlier stages of decomposition (within the first 14 days). For this reason, the majority presented estimates based primarily on developmental patterns for individual taxa, and relatively few were based on arthropod succession patterns. The case presented here deals with remains in the later stages of the decomposition process, and the postmortem interval estimate is based primarily on interpretation of succession patterns. These patterns were determined from decomposition studies conducted in various habitats on the island of Oahu, Hawaii, by workers and graduate students in the Forensic Entomology Laboratory, University of Hawaii at Manoa, Honolulu, Hawaii [1,2].

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### Case History

The remains were those of a well-nourished, well-developed, 23-year-old Caucasian male, recovered from a sandy area in brush and tall grasses near the ocean, approximately 8 m on the seaward side of Farrington Highway in Mokeleia, Oahu, Hawaii, on 28 March 1987. The body was in a prone position and was wearing a blue-green tee shirt around the right upper arm and bunched at the shoulder and blue denim jeans pulled down to the ankles.

Examination of the remains at the City and County Morgue on the morning of 30 March 1987 showed that their condition was physically consistent with the dry stage of decomposition, as defined by Early and Goff [1]. The length of the body was 1.78 m and the weight was 39 kg. The skin showed mummification and decomposition, with areas of partial skeletonization. The head was almost completely skeletonized, with portions of scalp remaining on the right posterior and lateral aspects. There was a bullet entrance wound in the right medial superior orbit, measuring 2.0 by 1.6 cm on the internal surface of the skull with internal beveling. An irregularly circumscribed, outwardly displaced skull fracture of the midvertex on the sagittal suture, 4 cm above the lambdoid suture, was present. The bullet was found within the cranial cavity, adjacent to the frontal bone. Most of the brain tissue was absent. The neck was decomposed with the cervical vertebrae displaced and accompanying the body in the body bag. The hyoid bone and thyroid cartilage were not identified. The arms were partially skeletonized and the hands were detached from the body. One hand was located within the tee shirt and the other with the remains in the body bag. The abdomen was obese, flattened, and pushed toward the right side. Internal examination of the body cavities revealed that all the internal organs were markedly desiccated and decomposed but in their usual anatomical positions, without evidence of injury. Arthropods were present on exterior of the body and in the body cavities.

### Entomological Collections

Collections of arthropods were made from the remains during the autopsy at the City and County Morgue on the morning of 30 March 1987. At that point, the remains had been refrigerated for approximately 57 h. Specimens were recovered representing three families of Coleoptera (beetles) and four families of Diptera (true flies) from the remains. The family Cleridae was represented by adults of the red-legged ham beetle, *Necrobia rufipes* (DeGeer) (Fig. 1), and the Histeridae by adults of the predatory *Saprinus lugens* Erichson (Fig. 2). There were two species of Dermestidae, present both as adults and larvae; the black larder beetle, *Dermestes ater* DeGeer; and the hide beetle, *Dermestes maculatus* DeGeer (Fig. 3). The predominant maggots observed were those of the black soldier fly, *Hermetia illuscens* (L.) (family Stratiomyidae) (Fig. 4). These were quite evident over the external and internal surfaces of the remains. Also evident were numerous mature maggots of the cheese skipper, *Piophilidae casei* (L.) (family Piophilidae) (Fig. 5). These maggots were observed to be in the process of leaving the remains for pupation. Their manner of departure from the remains is quite distinctive. The body of the maggot arches and the mouthparts grasp the anal papillae. When the mouthparts release, the maggot is propelled 5 to 6 cm into the air and several centimetres horizontally. Third instar maggots of a species of flesh fly (family Sarcophagidae) (Fig. 6) were recovered from the body cavities. Species level identification was not possible from this stage, and rearings of specimens to the adult stage were unsuccessful, although pupation was observed on 31 March 1987. This situation is not unusual for specimens of Sarcophagidae which have been exposed to low temperatures in Hawaii. The maggots in this case were similar in appearance to those of *Sarcophaga occidua* (Fabricius), which is frequently associated with decomposing remains in Hawaii [8]. Empty, weathered

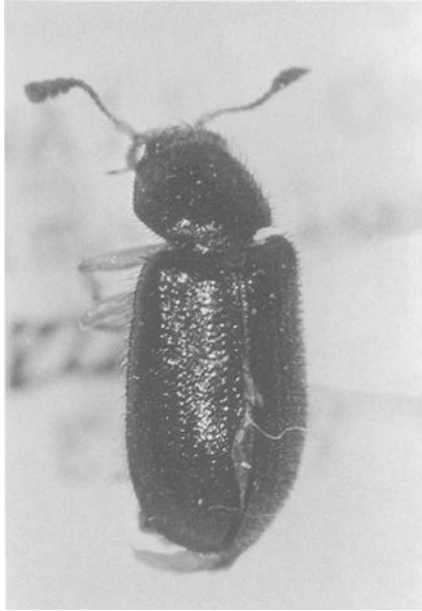


FIG. 1—Adult of the red-legged ham beetle, *Necrobia rufipes* (DeGeer) (family Cleridae).

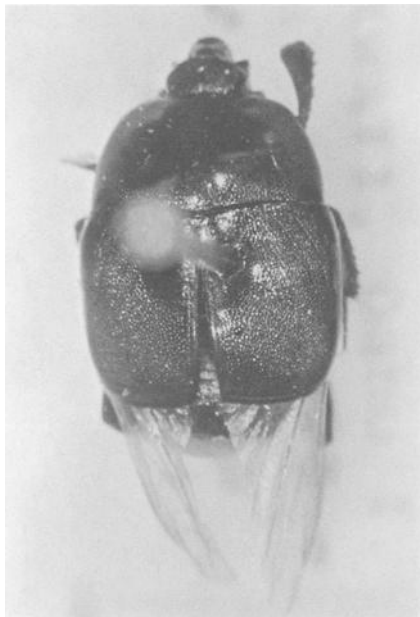


FIG. 2—Adult of *Saprinus lugens* Erichson (family Histeridae).

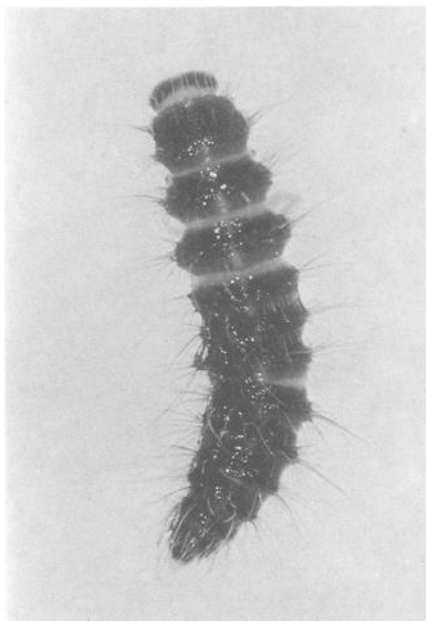


FIG. 3—*Larva of the hide beetle, Dermestes maculatus DeGeer (family Dermestidae).*

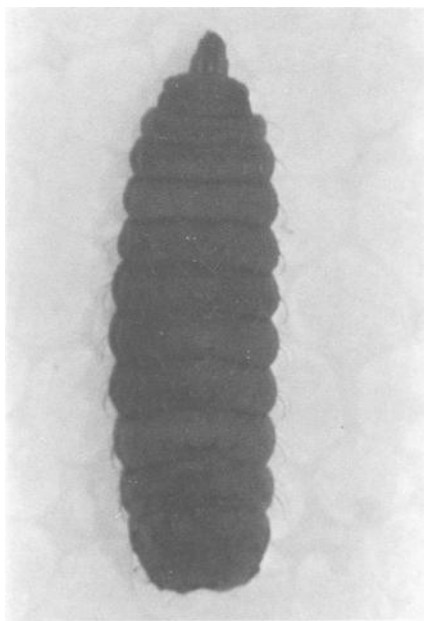


FIG. 4—*Maggot of the black soldier fly, Hermetia illucens (L.) (family Stratiomyidae).*

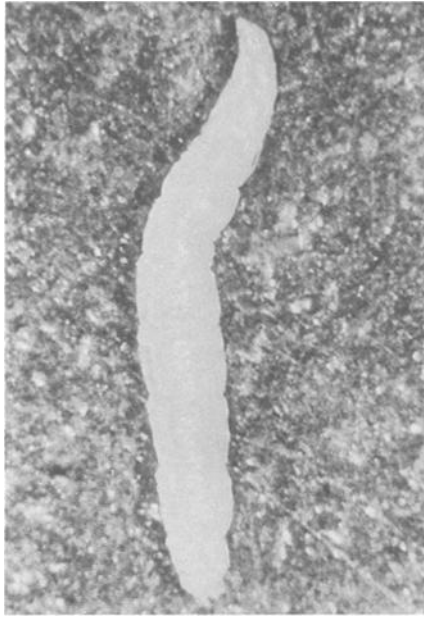


FIG. 5—Maggot of the cheese skipper, *Piophila casei* (L.) (family *Piophilidae*).



FIG. 6—Posterior spiracles of a third instar larva of a flesh fly (family *Sarcophagidae*).

puparial cases of the blowfly *Chrysomya rufifacies* Macquart (family Calliphoridae) were collected from the external surfaces of the remains.

Soil and litter samples were removed from the area on which the body had lain during a site visit on 30 March 1987. These samples were processed using Berlese-Tullgren funnel extraction to collect arthropods in the soil associated with the decomposition process. These collections yielded larvae of *Necrobia rufipes*, *Dermestes maculatus*, *Piophilidae casei*, and *Hermetia illuscens* and maggots of the unidentified Sarcophagidae species. In addition to these taxa, a species of rove beetle, *Philonthus longicornis* Stephens, was also recovered in the adult stage (Fig. 7). This Staphylinidae species is predatory and frequently associated with decomposing remains [8].

### Analysis and Discussion

These collections were compared with computerized records of decomposition studies conducted in similar habitats on the island of Oahu. These comparisons for taxa and developmental stages resulted in a postmortem interval estimate of 34 to 36 days prior to placement of the remains in the refrigerated crypt on 28 March 1987. This estimate was primarily delimited by three species: *Chrysomya rufifacies*, *Philonthus longicornis*, and *Piophilidae casei*. Based on rearing studies and results of decomposition studies [1,9] and on the presence of only empty puparial cases of *C. rufifacies*, an interval greater than 17 days was established. The staphylinid *P. longicornis* has an extended period of association with decomposing remains, but varies as to the developmental stages present at a given time. Adult activity for this species begins on Day 4 and continues well into the remains stage (Day 40+). In contrast, larval activity for this species, when associated with remains under Hawaiian conditions, appears to be restricted to Days 15 through 33. Thus, with the combination of empty puparia of *C. rufifacies* and adults of *P. longicornis* present, a minimum of 34 days was established. The Piophilidae species *P. casei* serves to establish the upper limit for the estimate. This species arrives at remains early in the decomposition process, although the point of its first appearance varies. In contrast, the departure of this taxon under Hawaiian conditions occurs with remarkable regularity between Days 33 and 36, with all maggots having left by Day 37 in all studies conducted to date. With this combination of taxa and developmental stages, the estimate of 34 to 36 days was determined.



FIG. 7—Adult of the rove beetle, *Philonthus longicornis* Stephens (family Staphylinidae).

The other taxa associated with the remains and the soil and litter samples were not by themselves definitive for this period but were consistent with it. The histerid *Saprinus lugens* was recovered only as adult specimens. This taxon has been recorded on remains as both adults and larvae until Day 31, after which time it has been recovered from remains only as adults. Dermestidae species have been recovered from remains in the Hawaiian Islands from Days 6 to 58, with peaks in larval activity recorded between Days 30 and 33 and adult activity around Day 25. The relative proportion of adults to larvae in this case was consistent with the 34 to 36-day estimate. The presence of the clerid *Necrobia rufipes*, both as adults and larvae, was also consistent with the estimated interval. This taxon is present on remains as larvae from Days 14 to 71 and as adults from Days 10 to 76. Only a single species of Sarcophagidae, *Sarcophaga occidua*, was recovered from the remains during the interval of this case. This species is present as maggots from Days 13 to 37. Regrettably, the maggots in this case could not be used for definition of the postmortem interval because of a lack of species identification, although their presence does lend support to the estimate. In like manner, the predominant taxon present on the remains, *Hermetia illuscens*, was of limited value in the estimate. This taxon has only rarely been recovered from remains in the Hawaiian Islands and other geographic areas. In those cases where it has been recovered the postmortem intervals have been over 30 days.<sup>3,4</sup> Thus, the presence of this species is consistent with the estimate.

The 34 to 36-day postmortem interval in this case fit well with the last sighting of the decedent, 37 days prior to discovery of the remains.

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