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Comparison of Insect Species Associated with Decomposing Remains Recovered Inside Dwellings and Outdoors on the Island of Oahu, Hawaii

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ABSTRACT: A comparison of insects collected from 35 cases of decomposing remains on the island of Oahu, Hawaiian Islands (14 from indoor situations and 21 from outdoors), yielded a total of 22 species of insects in 3 orders and 12 families. Of these, five species were recovered in both indoor and outdoor situations. Remains recovered indoors had a greater variety of Diptera larvae associated with them, while remains discovered outdoors had a greater variety of Coleoptera species present. Some species of insects were restricted to remains discovered indoors, while others were found only associated with remains in outdoor situations. Knowledge of the species of insects associated with different habitats may serve to provide information concerning the history of the remains.

KEYWORDS: pathology and biology, insects, postmortem interval, indoor habitats, outdoor habitats, arthropod succession

Goff et al. [1] listed 149 species of arthropods associated with decomposing remains on the island of Oahu, Hawaii. Since that time, there have been records of additional species, and the number of arthropod taxa currently stands at approximately 200 species (unpublished data). These species do not occur on remains at the same time, but in successional patterns [2,3], and some variations are observed between different habitats [4]. While there have been several succession studies conducted in outdoor habitats on the island of Oahu to establish baseline data for use in estimation of postmortem intervals [2,3], similar studies have not been possible in indoor situations. As noted by Povolny [5], relationships of flies to humans and human dwellings are complicated. Among carrion-breeding flies, some species will frequent human dwellings and readily breed inside these dwellings. Other species are restricted to outdoor habitats and rarely enter human dwellings. Still other species may show varying relationships to humans through their geographic ranges. A species that is closely associated with human activities in temperate areas (eusynanthropic) may be relatively independent of man in tropical areas (hemisynanthropic) [5]. The present study attempts to determine differences in insect populations associated with decomposing remains in indoor and outdoor situations in the Hawaiian Islands through analyses of cases from the Forensic Entomology Laboratory, University of Hawaii at Manoa, Honolulu, Hawaii, from 1983 through May 1990. During this time period, over 60 cases were referred to the laboratory by the Department of the

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Cases Analyzed

Of the cases submitted, 14 were indoor situations and presented sufficient data to allow comparisons. The confirmed postmortem intervals in these cases ranged from 2 to 21 days. For purposes of comparison, 21 cases were selected from outdoor situations in which the postmortem intervals corresponded to those of the indoor cases. The cases considered in both groups included accidental deaths, suicides, homicides, and unattended deaths due to natural causes. Cases from the two groups (indoor and outdoor) were compared with regard to the species present and the numbers of taxa present. Estimates of the total numbers of insects present on remains were not possible, although personal observations by the author indicate that there are generally greater numbers of insects associated with remains in outdoor situations. It was also observed that insects are not generally associated with decomposing remains discovered indoors above the sixth floor.

Results

A total of 22 species of insects, representing 3 orders and 12 families, were recovered from decomposing remains in the 35 cases considered here. Of these, 10 species, representing 2 orders and 5 families, were collected from remains in indoor situations (Table 1) and 17 species, representing 3 orders and 11 families, were from remains in outdoor situations (Table 2). There were 5 species encountered in both types of situations. A single species of Coleoptera (beetles), *Dermestes maculatus*, was recovered from remains indoors in 2 cases (14%) and in 10 cases outdoors (43%). The other 4 species were Diptera (true flies), and the predominant species involved were 2 species of Calliphoridae, *Chrysomya megacephala* and *Chrysomya rufifacies* (Tables 1 and 2). The Sarcophagidae *Boettcherisca peregrina* was also recovered from both types of habitats, although less frequently. *Musca domestica*, the house fly, was recovered from a single case in each type of situation and was of minor significance in estimations of postmortem intervals.

Among those taxa restricted to either indoor or outdoor habitats in these cases, more Diptera species were associated with indoor situations: 6 species were found only on remains indoors and only 2 were found exclusively in outdoor situations. In contrast, Coleoptera were well represented in remains recovered outdoors, with 10 species in 6 families, in comparison with the single species found on remains indoors.

Tables 3 and 4 detail the species related to postmortem intervals in indoor and outdoor situations. In both types of situations, the initial colonizing taxa were Calliphoridae,

TABLE 1—Classified list of insects recovered from 14 cases of decomposing remains found indoors from 1983 through 1990.

Order	Family	Genus and Species	Number of Cases	
Coleoptera	Dermestidae	<i>Dermestes maculatus</i> (DeGeer)	2	
Diptera	Calliphoridae	<i>Chrysomya megacephala</i> (Fabricius)	3	
		<i>Chrysomya rufifacies</i> (Macquart)	3	
	Muscidae	<i>Fannia pusio</i> (Wiedemann)	1	
		<i>Musca domestica</i> Linnaeus	2	
		<i>Ophyra chalcogaster</i> (Wiedemann)	1	
			<i>Stomoxys calcitrans</i> (Linnaeus)	2
	Phoridae	<i>Megaselia scalaris</i> Loew	5	
	Sarcophagidae	<i>Bercaea haemorrhoidalis</i> (Fallen)	3	
		<i>Boettcherisca peregrina</i> (R-D)	3	

TABLE 2—Classified list of insects recovered from 21 cases of decomposing remains found outdoors from 1983 through 1990.

Order	Family	Genus and Species	Number of Cases
Coleoptera	Cleridae	<i>Necrobia ruficollis</i> (Fabricius)	2
		<i>Necrobia rufipes</i> (DeGeer)	5
	Dermestidae	<i>Dermestes ater</i> DeGeer	3
		<i>Dermestes maculatus</i> DeGeer	10
	Histeridae	<i>Saprinus lugens</i> Erichson	2
	Nitidulidae	sp.	1
	Staphylinidae	<i>Creophilus maxillosus</i> Linnaeus	3
		<i>Philonthus longicornis</i> Stephens	2
		<i>Philonthus rectangularis</i> Sharp	1
	Trogidae	<i>Trox suberosus</i> Fabricius	1
Dermaptera	Labiduridae	<i>Euborellia annulipes</i> (Lucas)	1
Diptera	Calliphoridae	<i>Chrysomya megacephala</i> (Fabricius)	14
		<i>Chrysomya rufifacies</i> (Macquart)	20
		<i>Phaenicia cuprina</i> (Wiedemann)	3
	Muscidae	<i>Musca domestica</i> Linnaeus	1
	Piophilidae	<i>Piophila casei</i> (Linnaeus)	2
	Sarcophagidae	<i>Boettcherisca peregrina</i> (R-D)	3

TABLE 3—Species of insects associated with 14 cases of remains found indoors from 1983 through 1990.

Number of Days Postmortem	Number of Cases in Postmortem Interval	Species of Insects	Number of Cases in Which Species is Found
2	1	<i>Chrysomya rufifacies</i>	1
3	1	<i>Chrysomya megacephala</i>	1
4	1	<i>Boettcherisca peregrina</i>	1
5	1	<i>Chrysomya rufifacies</i>	1
6	3	<i>Bercaea haemorrhoidalis</i>	1
		<i>Chrysomya rufifacies</i>	1
		<i>Bercaea haemorrhoidalis</i>	1
		<i>Boettcherisca peregrina</i>	2
		<i>Fannia pusio</i>	1
		<i>Ophyra chalcogaster</i>	1
		<i>Stomoxys calcitrans</i>	2
7	1	<i>Dermestes maculatus</i>	1
		<i>Chrysomya megacephala</i>	1
		<i>Chrysomya rufifacies</i>	1
		<i>Musca domestica</i>	1
		<i>Stomoxys calcitrans</i>	1
8	1	<i>Dermestes maculatus</i>	1
		<i>Chrysomya megacephala</i>	1
		<i>Musca domestica</i>	1
14 to 21	5	<i>Bercaea haemorrhoidalis</i>	2
		<i>Megaselia scalaris</i>	5

followed by the Sarcophagidae. In indoor situations, the greatest species diversity occurred between Days 6 and 7; after that time, a decrease in the numbers of species present on the remains was seen. In outdoor situations, there was a peak in the numbers of taxa seen between Days 8 and 10, followed by a slight decrease in the numbers of species, although 9 taxa were recovered from remains in the 19 to 20-day postmortem interval stage. This greater species diversity in outdoor situations can be attributed to the Coleoptera species, which are not found in indoor situations.

TABLE 4—*Species of insects associated with 21 cases of remains found outdoors from 1983 through 1990.*

Number of Days Postmortem	Number of Cases in Postmortem Interval	Species of Insects	Number of Cases in Which Species is Found
2	1	<i>Chrysomya rufifacies</i>	1
		Nitidulidae	1
3	2	<i>Chrysomya megacephala</i>	2
		<i>C. rufifacies</i>	1
4	2	<i>C. megacephala</i>	2
		<i>C. rufifacies</i>	2
		<i>Phaenicia cuprina</i>	1
5	6	<i>Boetcherisca peregrina</i>	1
		<i>C. megacephala</i>	4
		<i>C. rufifacies</i>	6
		<i>Euborellia annulipes</i>	1
8 to 10	6	<i>Creophilus maxillosus</i>	1
		<i>Dermestes maculatus</i>	1
		<i>C. megacephala</i>	5
		<i>C. rufifacies</i>	6
		<i>B. peregrina</i>	1
		<i>P. cuprina</i>	1
		<i>Dermestes ater</i>	1
		<i>D. maculatus</i>	6
		<i>C. maxillosus</i>	1
		<i>Philonthus longicornis</i>	2
		<i>Philonthus rectangularis</i>	1
		<i>Necrobia ruficollis</i>	1
		<i>Necrobia rufipes</i>	3
		<i>Saprinus lugens</i>	2
<i>Trox suberosus</i>	1		
12	1	<i>C. megacephala</i>	1
		<i>C. rufifacies</i>	1
		<i>D. ater</i>	1
		<i>D. maculatus</i>	1
19 to 20	3	<i>C. maxillosus</i>	1
		<i>C. rufifacies</i>	3
		(empty pupa cases)	
		<i>P. cuprina</i>	1
		<i>B. peregrina</i>	1
		<i>Musca domestica</i>	1
		<i>Piophilha casei</i>	2
		<i>D. ater</i>	1
		<i>D. maculatus</i>	3
		<i>N. ruficollis</i>	1
		<i>N. rufipes</i>	2

Discussion

While this study is an analysis of only a limited number of cases and deals with a limited time period, it does serve to demonstrate significant differences in the colonization of remains in indoor and outdoor situations. Of the 22 taxa recovered, only 5 were common to both types of situations. Certain taxa, such as *Megaselia scalaris*, *Stomoxys calcitrans*, and *Bercaea haemorrhoidalis*, appear to be sufficiently restricted to indoor situations in the Hawaiian Islands to serve as indicator species. Recovery of these taxa from remains in outdoor situations should serve to alert the entomologist to the possibility that the remains had originally been colonized in an indoor situation.

Indoor colonizations appear to be characterized by a wider variety of Diptera species

during the initial stages of decomposition, followed by other Diptera appearing later in the process. Outdoor situations have fewer numbers of species in the initial colonization, although the numbers of individuals appear to be greater than those for indoor situations (unpublished personal observations). Coleoptera, which increase in both numbers of species and numbers of individuals during the later stages of decomposition in remains outdoors, are generally absent or poorly represented in indoor situations. In these cases, the only species found indoors associated with remains was *Dermestes maculatus*, a species of Dermestidae also associated with stored products.

Characteristic of the early stages of decomposition in outdoor situations were the 2 species of Calliphoridae, *Chrysomya megacephala* and *Chrysomya rufifacies*. These 2 taxa dominate the fauna during the first 2 weeks of decomposition and are present in numbers great enough to obscure the presence of larvae of other Diptera, notably the Sarcophagidae species. In contrast, species of Sarcophagidae are readily observed in indoor situations. Sarcophagidae are frequently observed larvipositing in outdoor situations at approximately the same time as the 2 species of Calliphoridae [2]; however, Sarcophagidae are only rarely recovered from remains outdoors in Hawaii. In addition to the differences in numbers of larvae produced by the Sarcophagidae in comparison with the large numbers of eggs laid by the Calliphoridae, the feeding habits of *C. rufifacies* may also account for the absence of Sarcophagidae larvae in samples from outdoor situations. *Chrysomya rufifacies* is an aggressive colonizer of remains outdoors and, after the first instar, will feed on other Diptera larvae present in the remains as well as on decomposing tissues [6].

The numbers of taxa present on remains indoors appear to decrease rapidly. This is in marked contrast to the situation outdoors, where there is an increase in the numbers of taxa through the first 3 to 4 weeks of decomposition [2,3,7]. After this period, the number of taxa actually associated with the remains begins to level off. Returning taxa, representing the normal fauna of the area, serve to actually increase the number of different taxa present in the remains stage, as defined by Early and Goff [2].

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