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CASE REPORT

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Insect Successional Pattern of a Corpse in Cooler Months of Subtropical Southeastern Texas

ABSTRACT: Here, we characterize the cool weather insect fauna found associated with partially skeletonized and desiccated human remains recovered from an abandoned house in an urban area of subtropical, coastal Galveston County, Texas, and use the information to conclude an approximate postmortem interval of 7–10 months. The predominant factors that allow for a confident assessment of the postmortem interval include climatological data, entomological data, and anthropological data. The documented insect fauna represents a unique assemblage present in a particular environment (an urban abandoned house in coastal Texas) at a particular time of year (winter) and includes expected forensically significant insects such as calliphorid flies, muscid flies, and dermestid beetles but also includes less commonly encountered insects such as an unusually dense population of live case-making clothes moths.

KEYWORDS: forensic science, forensic entomology, forensic anthropology, postmortem interval, subtropical, urban Texas

The human body and organisms that feed on it after death are very useful pieces of physical evidence. In general, determining postmortem interval (PMI) within hours or a couple of days after death can be obtained from decomposition characteristics present on the body. But as time progresses and soft tissue disappears via the decomposition process, PMI becomes less accurate and the probability of uncertainty increases. This is when other factors, such as insect succession evidence can be very helpful. Even after 6–8 months, if a body is kept in a fairly controlled environment with minimal animal scavenging or weathering, evidence of the succession of carrion insects can be documented. This case report documents the unique cool weather insect fauna found associated with predominantly skeletonized and desiccated human remains recovered from an abandoned house in the subtropical, coastal location of Galveston County, Texas, and uses that information to conclude an approximate PMI.

Case Report

In August of 2007 the predominantly skeletonized and desiccated remains of an individual were found in an abandoned house in an urban area of Galveston County, Texas. The house was in poor condition and had been boarded up but still had various cracks and openings allowing easy access for insects. Most rooms in the house were still carpeted but were strewn with debris. The individual, found in the house, was clothed in a long-sleeved thermal undershirt, black sweatshirt and a blue nylon jacket with a light-blue polyester lining. Dark sweatpants and black leather boots were still on the lower limbs. The remains were transported to the Galveston County Medical Examiner's Office and subsequently transported to the Forensic Anthropology Laboratory at Sam Houston State University, Huntsville, Texas. The skull and upper torso were mainly skeletonized with small amounts of dried tissue adhering around joint areas. The pelvic girdle was encased in desiccated tissue. Straight, dark blonde head hair that had sloughed off during decomposition was found adhered to the back of the collar on the jacket.

Witness statements made to the death investigator of Galveston County Medical Examiner's office disclosed that the individual had not been seen in over 1 year. The Galveston County Medical Examiner's Office therefore determined the PMI as approximately 1 year. After examination of the remains, clothing, literature review of decomposition rates in warm, moist climates (1), and daily temperatures for Galveston County, Texas during 2006–2007, the PMI was narrowed down to a window of 7–10 months. Entomological evidence further corroborated this estimation.

Galveston County is located in the Gulf Coast geographical region of Texas and the climate is considered to be subtropical and humid. The annual mean temperature is 21.8°C with typically no freezing temperatures. During the months of September and October of 2006 the low temperature never fell below 20°C. The high temperatures for both months were 27°C–31°C. In November, low temperatures ranged from 5 to 20°C. There was only 1 day in November that the temperature fell to 3.3°C. Highs reached 27.2°C with most days ranging between a high of 15–21°C. In January and February of 2007 the average low temperature was 8.9°C with average high temperatures of 15°C. In March and April

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temperatures began to warm again with an average low of 16–17°C and an average high temperature of 22–24°C (2). Based on this information, it is more likely that the deceased individual would have been wearing thermal undergarments in the coolest months of January and February than during the other warmer months.

There are various articles that discuss insect succession and decomposition rates in warm, moist climates (1,3–10). However, the succession pattern of insects in urban or rural environments of Southeast subtropical, coastal Texas is not found in the literature. This case report addresses the succession pattern of insects in such an environment during the cooler months of the year and addresses some atypical entomological findings.

There were a number of living and dead forensically significant insects recovered from the death scene. On gross examination, large quantities of dead insect species and shed puparia were found inside the jacket, in the pants and socks and boots. With further entomological analysis insects from the orders Diptera, Coleoptera, and Lepidoptera were discovered. Several insects collected, primarily beetles and moths along with a few other species (see Table 1), were still living. These were killed by freezing and then pinned for identification. Identification of specimens was according to texts and specific keys (11–14), as well as through comparison to an available reference collection. A list of species recovered, life stage, condition of the specimen upon recovery, and percent of total insect diversity (not taking into account shed fly puparia and oothecae) is presented in Table 1.

Results and Discussion

The succession pattern of insects is consistent with patterns seen in other tropical and subtropical parts of the world (1,3–10) except for a few exceptions that are documented here for the first time. The entomological data suggests that the decedent died during the cooler months of the year when fly diversity was low and places the PMI between 7 and 10 months, corroborating anthropological data. The clothing is also consistent with a death occurring in late fall or winter. Over 80% of the nonpuparial diversity of insects recovered were living and represented by only one generation (primarily the beetles and moths) suggesting that, aside from the flies, insect colonization was delayed, further corroborating a PMI of 7–10 months. The presence of many dead larvae and adults would have suggested multiple generations of activity and evidence of a longer association between the insects and the corpse. Additionally, these data suggest that insect activity was slow during the cooler months and then picked up once the average temperatures increased. The urban species are consistent with the urban setting in which the individual died; however; the presence of several species not typical of urban areas is consistent with the open nature of the abandoned house and the coastal, subtropical nature of the death scene and are recorded here for the first time, most likely due to the open condition of the abandoned house in which the decedent was found.

Approximately 300 puparia were recovered from the death scene. Several hundred more were trapped between the layers of clothing of the decedent, as well as embedded in maggot-generated

TABLE 1—*Diversity of insects recovered from remains.*

	Species	Life Stage Present	Condition	% of Total Diversity
Diptera				
	Unidentifiable further	Puparia*	Exuvia	N/A
Calliphoridae	*Calliphora vicina* Robineau-Desvoidy	Adults	Dead	3.3
Muscidae	*Musca domestica* Linnaeus	Adults	Dead	8.1
	Hydrotaea aenescens (Wiedemann)	Adults	Dead	1.6
Piophilidae	*Piophila casei* (Linnaeus)	Adults	Dead	2.4
Tachinidae	Unidentifiable further	Adult	Dead	0.8
Coleoptera				
Dermestidae	*Dermestes ater* De Geer	Adult	Alive	2.4
		Larvae	Alive	1.6
	Dermestes maculates De Geer	Adult	Alive	3.3
		Larvae	Alive	2.4
Cleridae	*Necrobia rufipes* (De Geer)	Adult	Alive	3.3
Tenebrionidae	Unidentifiable further	Adults	Alive	1.6
		Larvae	Alive	4.1
Lepidoptera				
Tineidae	*Tineola bisselliella* (Hummel)	Adult	Dead	0.8
		Pupae	Alive	1.6
	Tinia pellionella Linnaeus	Larvae	Alive	44.7
Acari				
	Unidentifiable further[†]	Adult	Alive	0.8
Blattaria				
	Unidentifiable further	Oothecae*		N/A
Blatellidae	*Blattella germanica* (Linnaeus)	Adult	Alive	4.1
		Larvae	Alive	8.1
Blattidae	*Periplaneta americana* (Linnaeus)	Adult	Alive	0.8
Hymenoptera				
Evaniidae	*Evania appendigaster* (Linnaeus)	Adult	Alive	1.6
Zygentoma				
Lepismatidae	Unidentifiable further	Larvae	Alive	3.3

Specimens are arranged according to order and then family. Life stage (egg, larva, pupa, or adult) and condition of the specimen upon recovery (dead or alive) indicated.

The percent of total insect diversity (of 123 total specimens) is also indicated not taking into account shed fly puparia and oothecae in the total count (indicated by an asterisk *).

[†]As the mite was not identified, it is impossible to determine whether it is a necrophilious species or a phoretic species.

mats in the head hair. Additionally, several adult specimens of Diptera were collected. The flies found associated with the remains are species that are common in urban areas on human carrion, are cool weather species, or are commonly associated with later stages. All adults were dead and in moderately good to very poor quality. Four complete adult specimens of the European blue bottle fly *Calliphora vicina* Robineau-Desvoidy (Calliphoridae) were recovered from the skeleton. *Calliphora vicina* is a Holarctic species with a primarily northerly distribution in the United States (8,14,15). Adults are attracted to rotting fruit, decaying meat, and excrement while the larvae primarily feed on carrion. It is extremely common on human remains throughout its range and is the most common species in urban areas. In the south, this species is active in the winter but as temperatures increase, its range is restricted to cooler, more northern latitudes (11,12). Approximately ten complete specimens of the house fly *Musca domestica* Linnaeus (Muscidae) were identified. These flies are distributed worldwide and are never found far from humans. They are attracted to garbage, excrement, and carrion and will readily enter dwellings and are active year round. Byrd and Castner (12) indicate that the presence of this species on fresh remains is rare. Two adults of the black dump fly *Hydrotaea aenescens* (Wiedemann) (Muscidae) were collected. Adults, which readily enter dwellings, are attracted to carrion and excrement and are common in urban environments (11,12). Three dead adult cheese skippers *Piophila casei* (Linnaeus) (Piophilidae) were present. They are later colonizers, associated with drier stages of decomposition, and are commonly found in urban and rural environments. They can be pests of stored foods (11,12). One dead adult fly in the family Tachinididae was also recovered (13). Several species that theoretically could be found in this area are noticeably absent including species that are specific to fresh remains (*Chrysomya megacephala* [Fabricius]) and species that are specific to warm weather (*Cochliomyia macellaria* [Fabricius] and *Lucilia cuprina* [Wiedemann]) (3,8–12).

All species of Coleoptera recovered are late stage feeders seeking dried food rich in proteins. Live adults and larvae of both *Dermestes ater* De Geer and *Dermestes maculates* De Geer (Dermestidae), along with shed larval skins, were recovered from the death scene. *Dermestes ater* and *D. maculates* are attracted to dry, protein-rich meats and other foods and are commonly found in late stages of dry decomposition (11,12,16). Four live adult red-legged ham beetles *Necrobia rufipes* (De Geer) (Cleridae) were recovered. They are pest species of stored meats and commonly found throughout the U.S. on corpses. They will enter dwellings but not commonly (11,12,16). *Necrobia rufipes* is not commonly encountered indoors in urban areas but they are commonly encountered outdoors in both rural and urban areas (12,13,16). Given the open nature of the house the decedent was found in, the presence of *N. rufipes* is not exceedingly unusual. Additionally, several live darkling beetle adults and larvae (Tenebrionidae) were collected. Species in Tenebrionidae can be common urban pests in buildings, especially in the south where they are active year round (13,16).

Living caterpillars of the case-making clothes moth *Tinia pellionella* Linnaeus (approximately 50 individuals) and living pupae of the webbing clothes moth *Tineola bisselliella* (Hummel) (two individuals) (Lepidoptera; Tineidae) were recovered from the hair of the decedent (17,18). These moths may be common in late stages of decomposition, especially *Tineola bisselliella* (17). The moth species recovered have been previously associated with dried human remains and, given the nature of the furnishing of the abandoned house, certainly not unusual in this situation. They are common textile-pests that feed on natural fibers including wool clothing, carpets, rugs, upholstered furniture, and furs (11,12,17,18). However, the population density of the actively feeding *Tinea pellionella* is unusual. In urban areas, *Tineola bisselliella* is considered to be a more common pest (17,18). In this case report, we record that they compose nearly half of the total nonpuparial insect diversity (44.7%; Table 1), and it is the first record of this kind for this species.

The documented insect fauna represents a unique assemblage present in a particular environment and particular time of year. Findings include expected forensically significant urban insects such as calliphorid flies, muscid flies, and dermestid beetles but also include less commonly encountered insects consistent with the open nature of the abandoned house and the coastal, subtropical nature of the death scene. The predominant factors that allow for a confident assessment of PMI of 7–10 months include climatological data, entomological data of dead early feeders and living late feeders, and anthropological data of skeletonized remains and cool-weather clothing.

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References

1. Bass WM. Outdoor decomposition rates in Tennessee. In: Haglund WD, Sorg MH, editors. Forensic taphonomy. Boca Raton: CRC Press, 1997;181–6.
2. National Oceanic and Atmospheric Administration. Galveston, TX. Climate Data, http://www.srh.noaa.gov/hgx/climate/gls.htm
3. Goff ML. Comparison of insect species associated with decomposing remains recovered inside dwellings and outdoors on the island of Oahu, Hawaii. J Forensic Sci 1991;36:748–53.
4. Carvalho LML, Thyssen PJ, Linhares AX, Palhares FAB. A checklist of arthropods associated with pig carrion and human corpses in southeastern Brazil. Mem Inst Oswaldo Cruz 2000;95:135–8.
5. Carvalho LML, Linhares AX. Seasonality of insect succession and pig carcass decomposition in a natural forest area in southeastern Brazil. J Forensic Sci 2001;46:604–8.
6. Carvalho LML, Thyssen PJ, Goff ML, Linhares AX. Observations on the succession patterns of necrophagous insects on a pig carcass in an urban area of southeastern Brazil. Anil Aggrawal's Internet Journal of Forensic Medicine and Toxicology 2004;5(1):33–9.
7. Centeno N, Maldonado M, Oliva A. Seasonal patterns of arthropods occurring on sheltered and unsheltered pig carcasses in Buenos Aires province (Argentina). Forensic Sci Int 2002;126:63–70.
8. Goddard J, Lago PK. Notes on blowfly (Diptera: Calliphoridae) succession on carrion in Northern Mississippi. J Entomol Sci 1985;20:312–7.
9. Oliva A. Insects of forensic significance in Argentina. Forensic Sci Int 2001;120:145–54.
10. Wendler K. A seasonal faunal succession study in east Texas and development of the green bottle fly, Phaenicia coerleiviridis (Diptera: Calliphoridae). [thesis]. Huntsville (TX): Sam Houston State University, 2004.
11. Catts EP, Haskell NH. Entomology and death: a procedural guide. South Carolina: Clemson, 1990.
12. Byrd JH, Castner JL, editors. Forensic entomology: the utility of arthropods in legal investigations. Boca Raton: CRC Press, 2000.
13. Johnson NF, Triplehorn CA. Borror and DeLong's introduction to the study of insects, 7th ed. Belmont, CA: Thomson Brooks/Cole, 2005.
14. Whitworth TL. Keys to the genera and species of blow flies (Diptera: Calliphoridae) of America north of Mexico. Proceedings of the Entomological Society of Washington 2006;108(3):689–725.
15. Hall DG. The blowflies of North America. Lafayette: Thomas Say Foundation, 1948.
16. Pankaj K, Satpathy DK. Use of beetles in forensic entomology. Forensic Sci Int 2001;120:15–7.

17. Robinson GS. Clothes-moths of the *Tinea pellionella* complex: a revision of the world's species (Lepidoptera: Tineidae). Bulletin of the British Museum (Natural History): Entomology 1979;38:57–128.
18. Cox PD, Pinniger DB. Biology, behaviour and environmentally sustainable control of *Tineola bisselliella* (Hummel) (Lepidoptera: Tineidae). J Stored Prod Res 2007;43(1):2–32.

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