A Survey of the Coleoptera Associated with Carrion at Sites with Varying Disturbances in Cuyahoga County, Ohio[1]

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ABSTRACT. Human activity disrupts the natural environment to varying degrees and can lead to differences in biodiversity among localities. It was hypothesized that a site with low anthropogenic disturbances would have higher carrion-associated beetle diversity than sites exhibiting increased disturbance. Carrion beetle diversity was measured at three sites in northeast Ohio, and a total of 71 species were collected from among the three sites in July and August of 1995 from chicken and pig carrion. Luce Creek, the least disturbed site, had the highest number of specimens, families, species, and unique species while Euclid, the most disturbed site, had the lowest. Staphylinidae was the most abundant family at all three sites. The most commonly collected species at Dike and Euclid was the staphylinid *Aleochara bimaculata*, while at Luce Creek, it was the silphid *Silpha noveboracensis*. The Simpson and Shannon indices indicate that the less disturbed environment had the highest diversity of beetles associated with carrion.

OHIO J SCI 105 (2):17–20, 2005

INTRODUCTION

Anthropogenic disturbances contribute to the loss of habitat and have been described as "the primary cause of the decay of organic diversity" (Ehrlich 1988). Human activities disrupt natural ecosystem functions and negatively impact living organisms (Murphy 1988). For example, human activity can have a direct or indirect impact on the relative abundance of beetles associated with carrion. Pesticides and other synthetic chemicals can directly kill insect populations. In an indirect manner, human activity can affect the organisms upon which beetles associated with carrion depend, such as amphibians, reptiles, birds and mammals. The impact of human activity on these vertebrate organisms has been extensively researched (Burger 1981; Hosier and others 1981; Ehrlich 1988; Murphy 1988). Thus, the presence or absence of such vertebrate carrion will influence the relative abundance of the beetles that use them as a food source. A similar argument applies to invertebrates as well: although rove beetles (Coleoptera: Staphylinidae) are found in many types of decaying organic matter, such as carrion, they do not actually consume carrion, but prefer to feed upon the larvae of muscoid flies (Diptera) (Reed 1958).

Besides its importance to biologists as a reflection of anthropogenic disturbances, the relative abundance of beetles associated with carrion interests other scientists as well. The presence of rare carrion beetle species such as the federally endangered American burying beetle (*Nicrophorus americanus* Olivier) concerns conservationists who want to preserve their habitats. Also, the presence or absence of beetles associated with carrion is useful to the forensic entomologist who applies this information to help determine the time, location, and cause of death in criminal cases (Kulshrestha and Satpathy 2001).

In general, areas with high human disturbance are positively correlated with lower diversity (Eggleton and others 2002; Roy and others 2003), but there are exceptions (Pospelova and others 2002). This study measures carrion-associated beetle diversity at three sites that vary in human disturbance to test the hypothesis that the least disturbed site will have the highest taxonomic diversity.

MATERIALS AND METHODS

Carrion beetle sampling occurred at three sites in Cuyahoga County, Ohio. Luce Creek is located in Hunting Valley near the Chagrin River. It is a secluded, wooded area on private land. The site is part of a sixty-year-old field, which was partially planted with pines in the 1930s by the Civilian Conservation Corps, with dark, moist soil that is typical of a floodplain woodland area. The first 7.5 cm of ground contains soil and 7.5 cm below that is clay. The study site occurs in a small clearing and is defined by the rectangular perimeter of four pitfall traps (1.8 × 1.2 × 0.86 × 0.84 m). A wild cherry tree grows in the middle of the site and dense vegetation consisting of large shrubs and small trees surrounds the site. The site is approximately 23.0 m from Luce Creek, and represents the undisturbed site. Note that the designation of "disturbed" and "undisturbed" is relative to the three sites and was decided upon by the author.

The moderately disturbed site, referred to as Dike, is located behind a chain-link barbed wire fence on a dike along Lake Erie adjacent to the Cleveland Lakefront Park. The view of the lake is completely blocked by the dike on the north side of the site. Lakeshore Boulevard and Interstate Highway 90 are near the site on the south side of the fence. Thus, the immediate area of the site is relatively isolated while many human disturbances surround it. The site itself is on a fill with sandy topsoil and defined by the rectangular perimeter of four pitfall traps (1.4 × 1.1 × 1.3 × 1.2 m). The clay stratum begins 7.5 cm below the surface. Grasses typically found near beaches cover most of the ground and a tree grows in

[1]Manuscript received 30 June 2003 and in revised form 5 June 2004 (#03-12).

the middle of the site.

The highly disturbed site, referred to as Euclid, is located inside (and immediately outside) an abandoned trailer behind the City of Euclid's service garage off of Interstate Highway 90. Centrally located, Euclid is 18.5 km from Luce Creek and about 11.3 km from Dike. There is a railroad track about 3.0 m south of the trailer behind a fence, and a dog pound is about 6.0 m northwest of the trailer behind a fence. The outside site is 1.4 m from the trailer and is defined by the rectangular perimeter of four pitfall traps (1.2 × 1.2 × 1.1 × 1.2 m). The soil is mostly clay, beginning 1.0 cm from the surface, and difficult to dig through. The vegetation consists of grasses and miscellaneous herbaceous vegetation.

Two baits at each site were utilized in the study to ensure a wide sampling of beetles. The first bait consisted of a decayed pig carcass placed in a dog cage, except at Euclid where it was locked in the trailer. Thus, each pig carcass was accessible to insects and small wildlife, but protected against the weather only at Euclid. The average weight of the three pig carcasses was 5.5 kg, although they originally averaged 13.7 kg. Each pig carcass was surrounded with various passive traps to catch flying insects. Two Mason® jars (diameter = 8.4 cm) containing anti-freeze were sunk into the ground near each pig to serve as pitfall traps. In the trailer, traps consisted of two small plastic trays (32.0 × 6.4 cm) placed in the floor vents. Because they had been exposed to the environment for 9 months before the survey began on 7 July 1995, the pigs were stripped of flesh at sampling time so additional bait was used.

The second bait used in the study utilized similar traps. Freshly thawed killed chicks were placed in Mason® jars with funnels covered by a wire gutter mesh. Four jars at each site, buried to the neck in the ground and covered with a piece of wood to protect against rain, served as baited pitfall traps. A net trap was centered above the four pitfall traps. It was baited with a chick placed in a shallow Rubbermaid® bowl (15.0 × 15.0 × 5.0 cm) with a hole cut into its top that was covered by a gutter mesh wire. All chicks were replaced weekly.

Traps were serviced weekly for five weeks from 20 July 1995 to 17 August 1995. Samples were stored in a freezer and retrieved five to six days later. Beetles were cleaned in soapy water and stored in 80% ethanol.

The identification method was designed for consistency such that any errors that may have occurred in identification would be consistent. Taxonomic keys were used for all identifications (Dillon and Dillon 1961; Arnett 1973; Entomological Information Services 1996). The simplest measure of diversity is a simple count of species, but it assumes each species has equal weight (Humphries and others 1995). Thus, a better measure accounts for the relative rarity of a species (Begon and others 1990). The Simpson and Shannon diversity indices are two such measures. When compared to each other, the Simpson's index gives less weight to the rare species and more weight to the common species (Krebs 1978). Because the presence of rare species can influence these indices, both measurements were calculated and reported for each site (Krebs 1978).

RESULTS

Luce Creek had the highest number of specimens, families, species, and unique species, whereas Euclid had the lowest. Both Simpson and Shannon diversity indices as well as their respective equitability values were higher at Luce Creek and lower at Dike. Luce Creek had the most unique species followed by Dike, while Euclid had the fewest unique species (Table 1).

TABLE 1

Beetle diversity from carrion at three sites in Cuyahoga County showing Simpson's and Shannon's diversity indices as well as their respective equitability.

	Site		
	Luce Creek	Dike	Euclid
No. specimens	361	243	226
No. families	15	10	7
No. species	49	24	19
No. unique species	36	11	8
Diversity indices and equitability			
Simpson's	14.2	3.48	3.83
equitability	0.28	0.14	0.20
Shannon's	3.07	1.83	1.75
equitability	0.78	0.57	0.59

Staphylinidae was the most abundant family at all three sites. The most commonly collected species at Dike and Euclid was the staphylinid *Aleochara bimaculata* Gravenhorst, while at Luce Creek it was the Silphid *Silpha noveboracensis* (Forster). A checklist of identified beetles shows how they were distributed at the three sites (Table 2).

DISCUSSION

Results from Luce Creek supported the hypothesis that the least disturbed site would have the highest diversity, the highest species count, and equitability. This is consistent with literature indicating that human disturbance has a negative effect on biodiversity (Novacek and Cleland 2001; Wilson 1988). Although unique species does not necessarily mean rare species, the high number of unique species at Luce Creek in conjunction with its high diversity and species count suggests it is the most environmentally sound habitat. Differences among the three sites may be due to differences in soil and vegetation. Or, the differences in soil and vegetation may be driven by human activity. This seems especially true at Euclid where soil and vegetation were absent near baited traps in the trailer.

Results from the most disturbed site (Euclid) did not

TABLE 2

List of beetles identified to species found at three sites in Cuyahoga County.

Family	Genus and Species	Luce Creek	Dike	Euclid
Carabidae	*Chlaenius nemoralis* Say		X	X
	Cyclotrachelus sodalis (LeConte)	X		
	Poecilus chalcites (Say)	X		X
	Pterostichus corvina (Dejean)	X		
	Pterostichus ebenina (Dejean)	X		
	Pterostichus stygica (Say)	X		
	Stenolophus ochropezus (Say)	X		
Cleridae	*Necrobia violacea* (Linnaeus)		X	
	Necrobia rufipes (DeGeer)			X
Dermestidae	*Dermestes lardarius* Linnaeus			X
	Dermestes maculatus Fabricius			X
	Dermestes nubilus Germar		X	X
Geotrupidae	*Geotrupes blackburnii* (Fabricius)	X		
	Geotrupes splendidus (Fabricius)	X		
Histeridae	*Atholus sedecimstriatus* (Say)	X		
	Euspilotus assimilis (Paykull)	X	X	X
	Euspilotus conformis (LeConte)	X		
	Hister abbreviatus Fabricius	X	X	X
	Hister foedatus LeConte	X		
	Margarinotus interruptus (Beauvois)	X		
	Saprinus pennsylvanicus Paykull		X	
Nitidulidae	*Omosita colon* (Linnaeus)	X	X	X
	Stelidota geminata (Say)		X	
Scarabaeidae	*Onthophagus hecate* (Panzer)	X	X	
	Onthophagus orpheus (Panzer)	X		
	Onthophagus pennsylvanicus Harold	X		
	Onthophagus striatulus (Beauvois)	X		
Silphidae	*Necrophila americana* (Linnaeus)	X		
	Nicrophorus orbicollis Say	X		
	Nicrophorus tomentosus Weber	X	X	
	Oiceoptoma inaequalis (Fabricius)	X		
	Oiceoptoma noveboracensis (Forster)	X		
Staphylinidae	*Aleochara lata* Gravenhorst	X		X
	Aleochara bimaculata Gravenhorst	X	X	X
	Aleochara sculptiventris (Casey)	X	X	
	Coproporus ventriculus (Say)	X		
	Creophilus maxillosus (Linnaeus)	X	X	X
	Ontholestes cingulatus (Gravenhorst)	X		
	Philonthus cyanipennis (Fabricius)	X		
	Philonthus fusiformis Melsheimer	X	X	
	Philonthus lomatus Erichson		X	
	Philonthus longicornis Stephens	X		X
	Philonthus politus (Linnaeus)		X	X
	Staphylinus violaceus Gravenhorst		X	
	Staphylinus vulpinus Nordmann		X	
	Tachinus fimbriatus Gravenhorst	X		

support the hypothesis. Although it had the lowest species richness, it did not have the lowest diversity because of the high species equitability. Dike had the lowest diversity *and* equitability. Although it had more species richness than Euclid, the species at Dike were not as evenly distributed as they were at Euclid. Relative to Luce Creek, however, the results from Euclid and Dike are similar. Finally, detailed checklists of insects associated with carrion in a variety of geographical locations provide an invaluable tool to the forensic entomologist. This is because forensic entomology uses the knowledge of arthropods in criminal investigations and can be used to help determine the time of death, place of death, and cause of death (Kulshrestha and Satpathy 2001). Further research into the relative abundance of beetles associated with carrion will benefit ecologists, conservationists, and forensic entomologists.

ACKNOWLEDGMENTS. I would like to thank the late Dr. Sonja Teraguchi for her wonderful advice as a mentor and friend. I thank Dr. Miles Coburn (John Carroll University) for his time and effort. I gratefully acknowledge the Cleveland Museum of Natural History for use of its resources. Also, thanks to Eric Chapman (Kent State University) for his help in identification, and Patrick Dulzer for his artistic help. Finally, thanks to my mom who put up with my mess.

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