Species Composition of Carrion Beetles in a Mixed-Oak Forest

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Abstract. A total of 7059 carrion beetles was collected in Hutcheson Memorial Forest from early April to late November in 1975. Represented were 68 species plus 2 sub-families and 1 genus which could not be classified to species. The latter were treated as species. Over 99% of the individuals belong to 6 families: Silphidae; Staphylinidae; Nitidulidae; Histeridae; Leiodidae; and Scarabaeidae. Silphidae was the most important family, accounting for over 55% of all beetles collected. *Silpha noveboracensis* was the most abundant individual species making up 28.80% of all beetles and *S. inaequalis* the second most abundant making up 10.71% of all Coleoptera. A species list by rank order for the top 15 species (including two higher taxa) indicated that these species account for over 91% of all beetles collected.

Introduction

Fortunate is the ecologist who has available to him suitable species lists, covering his taxonomic area of interest, for the habitat in which he conducts his studies. Such has not been the case for the senior author of this paper who has conducted field studies on carrion beetles in a mixed-oak forest for more than a decade. Although it is true that the most conspicuous and abundant beetles found in the carrion microsere are Silphidae (which are not difficult to identify), the species within the other families usually require the assistance of specialists for identification. The senior author was very fortunate to be able to obtain the services of his three co-authors to identify species from several difficult families. Dr. Norman M. Downie of Purdue University identified all Staphylinidae and several other difficult taxa. Dr. Rupert L. Wenzel of the Field Museum of Natural History, Chicago, identified all Histeridae, and Dr. Stewart B. Peck of Carleton University, Canada, identified all Leiodidae. Six additional specialists were helpful in identifying or confirming other taxa, and their names are given in the Acknowledgements. The books and papers that were especially helpful in identifying the species were: Arnett (1963), Dillon and Dillon (1961), Leng (1920), Leonard (1928), Moore and Legner (1975), Parsons (1943), Payne and Crossley (1966), Peck (1973), Vaurie (1955), and Wenzel (1944).

The specific purpose of this study was to determine all species of Coleoptera which are attracted to carrion in a New Jersey mixed-oak forest. The study was conducted in Hutcheson Memorial Forest (HMF) from the first Saturday in April to the last Saturday in November in 1975.

Methods

The collecting station was located about 70 meters southeast of the weather instrument shelter which is located at the north edge of the forest. The beetles were trapped in four No. 10 (3.78 l) food cans, each of which was concealed in a wooden box having 1.27 cm wire mesh at the top and a rain cover above that. These traps have been described elsewhere (Shubeck, 1976) and detailed instructions have been duplicated and are available upon request from the senior author. The traps were situated in a circle on the forest floor so that there was a north, an east, a south, and west trap along the arc of a circle having a radius of 5 meters. The north and south traps were baited with fish while the east and west traps were baited with chicken legs (drumsticks). Carrion bait in each trap consisted of one "fresh" fish or chicken leg in a styrofoam cup (.258 l) and one "stale" fish or chicken leg in a styrofoam cup (.258 l). These traps were initially baited with "fresh" carrion on the first Saturday of April, 1975 and on the second Saturday (when the first collection was made) "fresh" carrion was added to the "stale" carrion. Each trap was serviced once per week, throughout the study, at which time the oldest carrion (and cup) was replaced with fresh carrion (and cup), and all beetles were collected and preserved in jars containing 70% alcohol. At all times, therefore, there were two traps baited with fish, each having a fish 1-7 days old (fresh) and one 8-14 days old (stale), and two traps baited with chicken legs, each having a leg 1-7 days old and one 8-14 days old. This technique (Pirone, 1974) resulted in the presence of fairly uniformly "attractive" carrion on a continual basis. The weight of each fish (smelt) and each chicken leg was about 90 grams. On occasion fresh smelt was not available and packaged frozen smelt (whole) was substituted. The latter were about 1/3 the size of the former so when used, three small fish (about 30 grams each) were substituted.

Results and Discussion

A total of 7059 beetles was collected in the four carrion-baited traps during the months of April through November in 1975 (Table 1). Although these beetles are representatives of 71 species within 12 families, over 99% of the individuals belong to 6 families which are designated the major families of carrion beetles in Hutcheson Memorial Forest. Of the remaining families, 2 are iden-

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Table 1. List of families of order Coleoptera showing for each family the number of individuals trapped and the percentage of the order this represents, and also the number of species (by family) and the percentage of all Coleoptera species that this represents.

Family	Individuals		Species	
	No.	% of all beetles	No.	% of all beetles
Silphidae	3918	55.50	7	9.86
Staphylinidae	1554	22.015	26	36.62
Nitidulidae	705	9.99	5	7.04
Histeridae	397	5.62	8	11.27
Leiodidae	277	3.925	8	11.27
Scarabaeidae	184	2.61	6	8.45
Hydrophilidae	12	.17	3	4.22
Dermestidae	5	.07	1	1.41
Curculionidae	3	.04	3	4.22
Carabidae	2	.03	2	2.82
Ciidae	1	.015	1	1.41
Mycetophagidae	1	.015	1	1.41
TOTALS	7059	100.00	71	100.00

tified as minor families and 4 are clearly accidental families. Individual numbers of species collected are given in Table 2. These data show numbers collected during four periods of time: April and May; June and July; August and September; October and November.

Silphidae

The most important major family of beetles in the carrion microsere studied was Silphidae—the large carrion beetles (Table 2). The 3918 individuals comprised 55.5% of all Coleoptera. Of the 7 species, *Silpha noveboracensis* was the most abundant, accounting for over 51% of the family and over 28% of all Coleoptera, making it the most abundant beetle collected (Table 3). This species was taken in small numbers in April and May and in large numbers during June and July. The second most abundant silphid, *Silpha inaequalis*, was also the second most abundant beetle, making up over 10% of all beetles collected (Table 3). This species was often found together with *S. noveboracensis* and was taken only during April through July when *S. noveboracensis* was common. These two species together accounted for virtually 40% of all beetles taken during the study. It is entirely possible that *Silpha inaequalis* is at, or near, its northernmost range in HMF: Pirone did not collect a single specimen in his eight months study at Armonk, N.Y. (1974). Armonk is about 96 km northeast of HMF, and this species has been mentioned in many studies that were conducted south of New Jersey. The larger silphid, *Silpha americana*, was the third most abundant species in this family (Table 2) and the fourth most abundant beetle overall (Table 3). Although most specimens were taken from April through July, about 12% of the total was collected in late summer and in the fall (Table 2). The fourth most abundant silphid, *Nicrophorus orbicollis*, ranked number 8 among all beetles and this burying beetle was collected in greatest numbers from June through September, but small numbers were also taken during the first and last quarter of study (Table 2). *Nicrophorus tomentosus* was the fifth most abundant member of this family and ranked ninth among all Coleoptera (Table 2). This species was most abundant in early summer and then gradually decreased in numbers through the fall. The remaining silphids, *Necrodes surinamensis* and *Nicrophorus pustulatus*, together accounted for less than 1% of the family (Table 2). These two species were also present in Pirone's study (1974) where their numbers were also very small.

Staphylinidae

The second largest family of beetles collected was Staphylinidae—the rove beetles. The 1554 specimens made up 22.01% of all beetles collected and the 26 species provided the greatest diversity of species of any family—more than 3 times the number of Histeridae, or Leiodidae, which had 8 species each (Table 1). It must be noted that Staphylinidae is a very difficult family to work with, taxonomically, and three of the 26 "species" are actually higher taxa (*Aleochara* spp., Aleocharinae, and Omaliinae). *Aleochara* spp. accounted for over 29% of all rove beetles, and over 6% of all Coleoptera (Table 2). This "species" was sufficiently abundant to rank number 5 among all species (Table 3). Five additional staphylinid species were sufficiently abundant for each of them to comprise a minimum of 5% of the family and minimum of 1% of Coleoptera. The species, and rank order within Coleoptera are as follows: *Ontholestes cingulatus*, 7; *Tachinus luridus*, 10; *Creophilus maxillosus*, 13; *Aleocharinae*, 14; and *T. fimbriatus*, 15 (Table 3). According to Arnett (1963), staphylinids are predaceous on other arthropods present in the carrion community.

Nitidulidae

The third largest family of beetles was Nitidulidae—the sap beetles (Table 2). The 705 specimens accounted for 9.99% of all beetles and the 5 species comprised 7.04% of all species collected. *Omosita colon* was the most important species, accounting for virtually 98% of the family and ranking third among all species collected in this study (Table 3). It was collected during each of the 8 months of the study. *Omosita discoidea*, the second most abundant nitidulid, is found in Europe, Asia, Alaska, western Canada and the USA, and since 1930, has been found in New Jersey and New York (Parsons, 1943). Parsons believes that the species may have been introduced into New Jersey directly from Europe. According to W.A. Connell (personal communication), *Nitidula* and *Omosita* are the true carrion-feeding genera of the family, but carrion apparently gives off esters that occasionally attract some members of other genera. Of the 2 species collected from 2 other genera, *Stelidota geminata* is rarely taken at carrion. One was taken in this study and 1 in New York by Pirone (1974). Two specimens of *Glischrochilus quadrisignatus* were also taken in this study but none (at carrion) by Pirone.

Histeridae

Although Histeridae—the hister beetles—represented the fourth largest family, the 397 specimens collected made up less than 6% of the total beetle population. In number of species, however, this family was tied with Leiodidae for second place with 8 species each. *Euspilo-*

Table 2. A list, by family, of all species (or nearest taxon) trapped on carrion in HMF during 1975. Numbers captured are listed for April and May (A-M), June and July (J-J), August and September (A-S), and October and November (O-N). For the major families, the total number of each captured with the percentage that this is of the family and of all beetles is also given.

Silphidae	**A-M**	**J-J**	**A-S**	**O-N**	**Total**	**% of Family**	**% of Order**
Silpha noveboracensis Forster	131	1901	-	1	2033	51.89	28.80
S. inaequalis Fabricius	272	484	-	-	756	19.29	10.71
S. americana Linnaeus	277	225	62	8	572	14.60	8.10
Nicrophorus orbicollis Say	18	102	159	39	318	8.12	4.51
N. tomentosus Weber	-	139	47	15	201	5.13	2.85
Necrodes surinamensis (Fabricius)	-	18	7	-	25	.64	.35
Nicrophorus pustulatus Herschel	-	8	5	-	13	.33	.18
					3918	100.00	55.50
Staphylinidae							
Aleochara spp.	105	125	73	155	458	29.47	6.49
Ontholestes cingulatus (Gravenhorst)	37	129	152	12	330	21.24	4.68
Tachinus luridus Erichson	-	174	-	-	174	11.20	2.47
Creophilus maxillosus (Linnaeus)	12	35	42	39	128	8.24	1.81
Aleochara lata Gravenhorst	47	37	4	15	103	6.63	1.46
T. fimbriatus Gravenhorst	-	76	8	7	91	5.86	1.29
T. flavipennis Dejean	7	50	5	-	62	3.99	.88
Aleocharinae	12	12	8	18	50	3.22	.71
Philonthus politus (Linnaeus)	1	13	18	13	45	2.90	.64
Omalium rivulare (Paykull)	25	-	-	6	31	1.99	.44
P. brunneus (Gravenhorst)	-	11	5	5	21	1.35	.30
P. cyanipennis (Fabricius)	-	14	2	1	17	1.09	.24
Belonuchus rufipennis Fabricius	2	-	1	4	7	.45	.10
Staphylinus fossator Gravenhorst	-	1	5	-	6	.39	.08
P. blandus (Gravenhorst)	1	-	1	3	5	.32	.07
S. viridanus Horn	-	4	1	-	5	.32	.07
P. sericinus Horn	-	1	2	2	5	.32	.07
Rugilus angularis Erichson	-	3	1	-	4	.26	.06
P. lomatus Erichson	-	1	-	3	4	.26	.06
S. maculosus Gravenhorst	1	-	-	1	2	.13	.03
T. pallipes Gravenhorst	-	-	1	-	1	.06	.01
T. memnonius Gravenhorst	-	-	-	1	1	.06	.01
P. rectangulus Sharp	-	1	-	-	1	.06	.01
Hesperus baltimorensis (Gravenhorst)	-	-	-	1	1	.06	.01
Omaliinae	-	-	-	1	1	.06	.01
P. laetulus (Say)	-	-	-	1	1	.06	.01
					1554	99.99	22.01
Nitidulidae							
Omosita colon (Linnaeus)	255	267	127	41	690	97.87	9.78
O. discoidea (Fabricius)	5	6	-	-	11	1.56	.16
Glischrochilus quadrisignatus (Say)	2	-	-	-	2	.28	.03
Nitidula carnaria (Schaller)	1	-	-	-	1	.14	.01
Stelidota geminata (Say)	-	1	-	-	1	.14	.01
					705	99.99	9.99

Table 2 (continued)

Histeridae							
Euspilotus assimilis (Paykull)	24	280	28	9	341	85.89	4.83
Geomysaprinus moniliatus Casey	9	15	2	2	28	7.05	.40
Margarinotus hudsonicus Casey	-	7	2	2	11	2.77	.16
Hister depurator Say	-	-	6	-	6	1.51	.085
M. cadaverinus Hoffman)	1	4	1	-	6	1.51	.085
H. abbreviatus Fabricius	2	1	-	-	3	.76	.04
M. egregius (Casey)	-	-	1	-	1	.25	.01
Saprinus subnitescens Bickhardt	-	-	-	1	1	.25	.01
					397	99.99	5.62
Leiodidae, Catopinae (=Leptodridae)							
Sciodrepoides fumatus terminans Leconte	30	93	19	1	143	51.62	2.03
Prionochaeta opaca (Say)	3	26	24	5	58	20.94	.82
Catops simplex Say	7	-	1	36	44	15.88	.62
S. watsoni hornianus Blanchard	10	-	-	2	12	4.33	.17
C. terminans LeConte	-	6	3	-	9	3.25	.13
C. egenus Horn	5	1	-	-	6	2.17	.08
Ptomaphagus brevior Jeannel	3	-	-	-	3	1.08	.04
C. americanus Hatch	2	-	-	-	2	.72	.03
					277	99.99	3.92
Scarabaeidae							
Onthophagus hecate hecate (Panzer)	5	73	67	2	147	79.89	2.08
Trox unistriatus Beauvois	-	18	6	-	24	13.04	.34
T. hamatus Robinson	9	-	-	-	9	4.89	.13
O. orpheus canadensis (Fabricius)	-	2	-	-	2	1.09	.03
Dialytes striatulus (Say)	-	1	-	-	1	.54	.015
D. truncatus (Melsheimer)	-	-	1	-	1	.54	.015
					184	99.99	2.61
Hydrophilidae							
Cercyon lateralis (Marsham)	-	2	3	1			
Cercyon sp.	-	3	1	1			
C. occallatus (Say)	-	1	-	-			
Dermestidae							
Dermestes caninus Germar	3	-	2	-			
Curculionidae							
Dryophthorus americanus Bedel	-	1	-	-			
Cossonus impressifrons Boheman	-	-	1	-			
Cyrtepistomus castaneus (Roelofs)	-	-	-	1			
Carabidae							
Pterostichus tristis (Dejean)	-	-	1	-			
Galerita bicolor (Drury)	-	-	1	-			
Mycetophagidae							
Litargus sexpunctatus Say	-	-	-	1			
Cildae							
Ceracis singularis (Dury)	-	-	1	-			

Table 3. List of species (or nearest taxon) of the 15 most abundant beetles trapped on carrion during 1975, the percentage of Coleoptera that each one represents, and the family of each.

Species	% of Coleoptera	Family
Silpha noveboracensis	28.80	Silphidae
S. inaequalis	10.71	Silphidae
Omosita colon	9.78	Nitidulidae
S. americana	8.10	Silphidae
Aleochara spp.	6.49	Staphylinidae
Euspilotus assimilis	4.83	Histeridae
Ontholestes cingulatus	4.67	Staphylinidae
Nicrophorus orbicollis	4.50	Silphidae
Nicrophorus tomentosus	2.85	Silphidae
Tachinus luridus	2.46	Staphylinidae
Onthophagus hecate	2.08	Scarabaeidae
Sciodrepoides fumatus terminans	2.03	Leiodidae
Creophilus maxillosus	1.81	Staphylinidae
Aleocharinae	1.46	Staphylinidae
T. fimbriatus	1.29	Staphylinidae

tus assimilis was the most abundant species comprising almost 86% of the family and 4.83% of the order (Table 2). The species was, nevertheless, abundant enough to be in sixth place for all species (Table 3). *Geomysaprinus moniliatus* Csy. was second in numbers within the family but comprised less than 0.5% of the order. Wenzel has pointed out to the senior author that this species has, in the past, almost always been interpreted as *Geomysaprinus (Priscosaprinus) posthumus* (Mars). Examination of the type has shown that this interpretation is incorrect and that *G. moniliatus* Csy. is correct. Wenzel has also found, after restudy of original descriptions and illustrations, that *Hister circinans* Csy. (used in recent papers) is actually a synonym of *Hister depurator* Say. Wenzel pointed out too that all specimens of *Margarinotus hudsonicus* Csy. which he has collected have been taken only in manure. According to Arnett, histerid beetles in the carrion community are predaceous on other arthropods that are present (1963).

Leiodidae, Catopinae (=Leptodiridae)

The fifth major family collected was Leiodidae, subfamily Catopinae (=Leptodiridae—the small carrion beetles), which accounted for almost 4% of all beetles taken and for 8 species (Table 2). Peck has done (1973), and is doing, extensive revision with this group and the family designation is unresolved. The most abundant species in this family was found to be *Sciodrepoides fumatus terminans* which accounted for almost 52% of the family, and this ranked it 12th among all beetles collected (Table 3). The largest leiodid collected was *Prionochaeta opaca* and it comprised almost 21% of the family but less than 1% of all Coleoptera. This is probably the best known species of Leiodidae found on carrion. It is fairly easy to identify and it has been mentioned in many papers dealing with the carrion microsere. Unfortunately for the ecologist, the other species of Leiodidae found on carrion are small and difficult to identify (requiring dissection by a specialist).

Scarabaeidae

The sixth (and last) major family in this study was Scarabaeidae, the scarab beetles, and it accounted for 184 individuals, or less than 3% of all Coleoptera (Table 2). Of the 6 species of scarabs which were attracted to carrion in HMF only *Onthophagus hecate* (which made up almost 80% of the family) accounted for more than 1% of all Coleoptera. Although not very abundant, overall, this species was taken during each of the four periods and it was most common from June through September. It ranked eleventh among all species collected (Table 3). This species is commonly found on dung and is, in fact, called a dung beetle. *Trox unistriatus* and *T. hamatus* were not found in large numbers, but the senior author has collected these species, on carrion, regularly at HMF for 15 years and there is no question in his mind that they are a part of the carrion beetle community. According to Arnett (1963), Troginae feed upon dry carrion.

Minor Families

The senior author has designated two families as "Minor Families" and the rationale for this interpretation is based on two considerations. (1) In spite of the fact that the numbers of specimens taken were very low (12 and 5), the majority of species in each family included more than one individual (Table 2). (2) Previous studies have indicated that these individuals are commonly found on carrion.

Family Hydrophilidae—the water scavenger beetles—contained 12 specimens of 3 species (Table 2). In correspondence with the senior author Connel has stated, "We ordinarily think of Hydrophilidae as being aquatic, but one subfamily [Sphaeridiinae] is not. In such forms the legs are not adapted for swimming and they are generally reported as associated with carrion or dung. The genus *Cercyon* is in this subfamily and contains about 40 species." Ales Smetana of the Biosystematics Research Institute (Canada) is currently revising this genus and graciously identified our specimens (Table 2). We are not using the complete name of "*Cercyon* sp." in deference to Dr. Smetana whose monograph has not yet been published.

Family Dermestidae—the skin beetles—accounted for but 5 specimens of 1 species, *Dermestes caninus* (Table 2). This species is well known as a scavenger, feeding on dried animal remains. It has been collected in larger numbers (in previous years) by the senior author.

Accidental families

Of the 7059 specimens collected during this study, 7052 belong to the 6 Major and 2 Minor Families as presented thus far. The remaining 7 specimens represent 7 different species within 4 additional families. Since none of these families contained any species where more than 1 individual was collected during the 8 months of study, the senior author considers the individuals to have been trapped "accidentally" and has designated the families Accidental Families. They are Curculionidae—the snout beetles (Weevils); Carabidae—the ground beetles;

Ciidae—the minute tree-fungus beetles; and Mycetophagidae—the hairy fungus beetles (Table 2).

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