OAK RIDGE NATIONAL LABORATORY
operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

ORNL-TM-1432

ANIMAL SPECIES ASSOCIATED WITH PIG CARRION

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ORNL-TM- 1432

Contract No. W-7405-eng-26

HEALTH PHYSICS
Radiation Ecology Section

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APRIL 1966

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee
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UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

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ABSTRACT

Following a nuclear attack, carrion remains of domestic animals could pose difficulties for human survival because of public health and sanitation problems associated with carrion. Insects influence the course and rate of decomposition, and radiation effects on insect populations could alter the normal decomposition pattern. A study was made of the animal community in pig carrion, preliminary to experimental research on the influence of radiation and other factors on succession in carrion. A total of 522 animal species representing 3 phyla, 9 classes, 31 orders, 151 families, and 359 genera were found associated with various decomposition stages. A systematic list of all species, their abundance, microhabitat, and food relationships is given.

INTRODUCTION

In the aftermath of nuclear attack the death of large numbers of domestic animals appears inevitable. Decomposing carcasses would create sanitation problems in and around cities. Water supplies which survived direct atomic attack might become polluted because of the increased organic load from wastes and micro-organisms entering from decomposing carcasses. Since carrion is the breeding site for many insect vectors of disease, a potentially serious public health hazard could arise. Stonier (1963) reported outbreaks of enormous populations of flies (presumably houseflies) following the atomic bombings of Hiroshima and Nagasaki. He credits prompt assistance from surrounding communities with preventing epidemic outbreaks of diseases. In circumstances where remedial action would be precluded, epidemics of insect-borne diseases might be a major impediment to the important early attempts at social and economic recovery.

Carrion decomposition is a natural process involving a succession of organisms which, under normal circumstances, quickly reduce a fresh carcass to a dry remainder of skin, cartilage, and bone. Further degredation of these remains is slow, requiring several years to complete. The initial, rapid period of reduction of fresh carrion is of importance in a civil defense context, since it is then that critical sanitation and disease problems would arise. If disposal or treatment of carrion could not be accomplished during the initial weeks, the organisms associated with carrion would reduce it. A succession of animals, especially insect species, strongly influences the rate and course of decomposition. Carrion shielded from insect attack decomposed at a markedly slower rate and different sequence than unshielded carrion (Payne 1963, 1965). Carrion protected from insects underwent a stage of slow dehydration and flaccidity, whereas carrion exposed to insects underwent rapid, active decay. Insects, particularly dipterous larvae, hastened liquefaction of the carrion by the mechanical process of their tunneling and burrowing, by dissemination of bacteria, and by their own digestive processes. Consequently, if radiation dose rates in an area subjected to nuclear attack were sufficient to sterilize or kill insects or their eggs, then a slower decomposition of carrion might follow.

A large number of insect species are involved in the community succession in carrion. Many different species may be capable of facilitating decomposition, although some species of insects may be more important than others. This report presents a detailed consideration of the species associated with pig carrion in the Southeastern United States. During the summers of 1962 and 1963 a study of carcasses exposed to

arthropods provided information on the microseral succession. Special attention was focused on the carrion fauna with respect to their relative abundance, food habits, sequence of occurrence, and distribution in carrion. This information is preliminary to a series of controlled experiments now in planning on rates of carrion decomposition under different environmental conditions (including ionizing radiations) and with various arthropod species. This work should provide information on the magnitude of the carrion problem to be anticipated in a postattack situation, and on possible remedial measures.

MATERIALS AND METHODS

Normal collecting methods were of little use for sampling the species present at pig carcasses. Diptera, Lepidoptera, and Hymenoptera could usually be taken by carefully sweeping the carcass with a nylon net. However, most arthropods remained concealed in the depths of the carrion and had to be collected by forceps or fingers. Aspirators were used for some of the smaller fragile species such as Collembola and Psocoptera. The mass of decomposing flesh, fluids, and odors sometimes prevented meticulous handling of the carrion. Occasionally carrion was taken to a Berlese funnel and left for a period of time. Most of the arthropods then left the carrion and large-scale collections could be made.

Even with these methods several species were often observed but seldom collected from the carrion. Sprinkling or painting a pig carcass with phosdrin, a phosphate insecticide, permitted nearly complete collections of arthropods from all stages of decay. All arthropods which

visited the phosdrin-coated carrion were immediately immobilized or killed. Protective cages kept birds and mammals from feeding on the phosdrin-coated carrion and dead insects. Extreme care was necessary during application and use of this insecticide because of hazard to humans.

Data collected with each specimen included date, stage of decay of carcass on which collected, and the feeding habits of the species if observed. Much information was accumulated by careful observation of the carcass and its fauna during each stage of decomposition. All specimens were preserved by appropriate conventional methods and the majority were sent to specialists for determination or verification.

MAJOR ANIMAL GROUPS

A total of 522 species representing 3 phyla, 9 classes, 31 orders, 151 families, and 359 genera were collected and identified from the various stages of pig carrion decomposition during the summers of 1962 and 1963. A systematic list of all 522 species and their relative abundance during the different stages of decomposition is given in the Appendix.

The organisms visiting the carcasses fall into five groups: those only scavenging on the carcass (necrophagous species), those parasitic and predaceous on various arthropods and scavengers of the carrion also (omnivorous species), those feeding on arthropods only (predaceous and parasitic species), those which used the carcass for shelter of concealment, and those whose presence is accounted for only by chance (accidental species). A brief synopsis of the major groups and their food habits follows. It is hoped that some of the complexities of carrion succession and food interrelationships can be explained by a summary discussion of the major groups.

Mollusca

1. Gastropoda

Seven species of snails were collected from beneath the drying carcasses. Evidence of snail activity (slime tracks) was sometimes seen on the surface of the carrion; however, actual feeding was not observed. Wurtz (personal communication) has given a reasonable explanation for their attraction to carrion.

> "Many snail species would be attracted to carrion simply as a food source. Land snails tend to be omnivorous. Also, the bones would represent a direct mineral source for snails. In addition to food supply, the snails could be responding to a carcass because it provides cover during daylight hours and because of the higher humidity of the atmosphere between the carcass and the ground surface. In these latter instances, of course, they are responding as they would to a log or large stone."

Arthropoda

1. Arachnida

Order Acarina

The habits of the Acarina vary greatly. These small arachnids were present on all carcasses during most stages of decomposition. The nonparasitic forms eat small animals, including each other, and also decaying plant or animal matter (Pratt, 1927). One species of tick, *Dermacentor variabilis* (Say) was collected from dried carcasses. This species of tick and many of the mites were present throughout the study area. Carrion may have served to concentrate some species which were scavengers.

Order Araneida

The presence of spiders in connection with pig carrion is attributable to the presence of insects, since all of the species are commonly found in quite different situations. Marcellina piccatoria (Hentz) and Xysticus transversatus (Walckenaer) were observed eating calliphorid adults. Only Lycosa rabida Walckenaer was noted feeding on dipterous larvae. All spiders are carnivorous (Comstock and Gertsch, 1948). No evidence of feeding on carrion or on decomposing fluids was recorded.

Order Phalangida

Several species of phalangids were collected at night from pig carcasses in the bloated and decay stages of decomposition. As many as five individuals were sometimes observed feeding on the juices collected on the abdomen of a bloated pig. No instances of predation were observed.

There have been many different observations and opinions concerning the food habits of this group. Walker (1928) stated that their food consisted of fruit juices and other vegetable matter. Pratt (1927) reported that these nocturnal animals feed principally on small insects, spiders, and mites, but also occasionally on decaying substances. They appear willing and able to feed on nearly any material that they encounter (Goodnight, personal communication).

Order Pseudoscorpionida

Pseudoscorpions live under stones, beneath the bark of trees, in moss and under leaves and debris on the ground (Comstock and Gertsch, 1948). One species was observed in abundance in the skin folds of a dried carcass while others usually appeared under the carcass. Pseudoscorpions feed on small animals such as mites, ants, and a variety of other insects (Hoff, 1949). Graham-Smith (1916) reported pseudoscorpions

clinging to the legs of flies; in some instances these small arachnids killed and ate the flies.

Order Scorpionida

One species, Vejovis carolinus Koch, was collected from beneath dried carrion. This species was observed only on the dried carcasses at night. Pratt (1927) reported that these nocturnal animals feed on insects and spiders which they often kill with the sting. Owens (personal communication) stated that they will feed in captivity upon small pieces of fresh beef and upon dead insects which they did not kill. He also believed that scorpions were not merely predaceous but would feed upon any carrion or other substances soft enough to be fed upon.

2. Crustacea

Order Isopoda

Six species of isopods were collected from beneath dried pig carrion. Clysticus convexus (DeGeer) was a frequent inhabitant of the carcasses. It was likely that they were simply seeking the shelter and moisture afforded by the pig carcass. Terrestrial isopods generally feed on decaying vegetation and are known to feed on decaying flesh (Henson, personal communication). Many of these same species can be found under logs, stones, and pieces of boards which have lain on the ground for some time (Van Name, 1936).

3. Chilopoda

Seven species of centipedes were found associated with the carrion. These forms live for the most part on insects and other small animals encountered in their habitat (Bailey, 1928). Centipedes are found in a variety of places, but usually occur in a protected situation such as

under bark, stones, or in rotten logs (Borror and DeLong, 1957). Consequently, the carrion served as a shelter for this group as well as a source of prey.

4. Diplopoda

Millipedes are inhabitants of damp places and may be found under stones, planks, in rotten timber, in fallen leaves, and moss (Bailey, 1928). Ten species were collected from beneath the pig carcasses. They are generally accepted as feeders on decaying vegetable matter. Pratt (1927) lists them as feeding on decaying vegetable and animal matter, and in some cases on living roots. A small snake left in a culture of *Cambala* was picked to the bones by these so-called phytophagous millipedes (Williams and Hefner, 1928).

5. Insecta

Order Collembola

These small insects are usually very common under stones, decayed leaves, wood, in the chinks and crevices of bark, among moss, and on herbage in damp places (Comstock, 1960). *Entomobrya corticallis* Nicolet was found in abundance on several dry carcasses. Most species of Collembola are vegetarians, feeding on algae, fungi, lichens, and dead plant materials; however, some species feed on dead fish, molluscs, and worms or other small invertebrates (Maynard, 1951). Folsom (1902) believed that several species found with exhumed cadavers constituted a distinct grave fauna.

The springtails encountered in this study appeared to be the normal inhabitants of the leaf litter and not the carrion. Fuller (1934) reported that Collembola and mites were frequently present in carrion in damp situations.

Order Orthoptera

Blattidae--Most cockroaches are omnivorous. They live chiefly upon animal and vegetable refuse. Wood roaches, predominantly Parcoblatta spp., were represented at the decomposing carrion. Feeding was only observed during darkness. During the daylight hours the roaches remained hidden beneath the carcass.

Gryllacrididae--This family was represented by the genus Ceuthophilus. They are nocturnal in their habits and during the day seek concealment beneath logs, stones, and in this case dry pig carrion. Blatchley (1920) fed Ceuthophilus in confinement upon meat as well as pieces of fruits and vegetables. This may indicate that carrion served as a place of shelter and a food supply for Ceuthophilus.

Gryllidae--The members of this family usually feed upon plants but are sometimes predaceous on other insects. Clausen (1940) reported that a number of species of Oecanthus thrived upon a diet of insect food. Species in the genera Gryllus and Nemobius also occasionally fed on insects at the carrion site. The insects and carrion which may have been eaten by these transients would be considered insignificant. The carcasses probably only served as temporary shelter or place of concealment for the Gryllacrididae and Gryllidae. However, the fluids and decomposing tissues of the carcass served as food for the Blattidae.

Order Hemiptera

Cydnidae--One species, Sehirus cinctus cinctus (Beauvois), was frequently collected from the carrion. On several occasions as many as five individuals were observed on one pig carcass. They were more abundant during the late decay stages when the carcass were drying out. No

explanation can be offered for their attraction to carrion. They are usually found burrowing beneath sticks and stones, or at the roots of grass (Comstock, 1960). In summer they occur on milkweed, flowers of wild plum and other foliage, in sandy or alluvial soils, and along fence rows (Blatchley, 1926).

Coreidae--Three species, Megalotomus quinquespinosus (Say), Alydus eurinus Say, and Alydus pilosus (Herrich-Schaeffer) were common inhabitants of the carrion. All were observed feeding on the carrion. Alydus eurinus was collected from carrion by McAtee (1919) and from the dried skins and other remains of a dead cow by Blatchley (1926). Bromley (1937) observed Alydus eurinus on mouse, cow, and chicken carcasses; the specimens were presumably feeding. He also recorded observations of Megalotomus quinquespinosus with beak inserted in a dead mouse, human excrement, and raccoon dung. Coreids in general are plant feeders; however, carrion should be added as a source of food for these three species.

Lygaeidae--Insects of this family are for the most part phytophagous, feeding upon the juices of plants. However, the members of the subfamily Rhyparochrominae are thought to be mainly predatory (Blatchley, 1926). Ozophora picturata Uhler and Myodocha serripes Olivier, members of this subfamily, were collected from the carrion on several occasions. They were present at the carcasses when insect activity was at a maximum. These two species were very secretive and usually remained concealed beneath the carcass.

Reduviidae--The members of this family are considered predaceous, mainly living on the blood of insects or other animals (Comstock, 1960). Three species, Oncocephalus geniculatus (Stal), Melanolestes picipes var.

abdominalis (Herrich-Schaeffer) and Sinea diadema (Fabricius), were collected from carrion during the late stages of decomposition. They were observed feeding on calliphorid adults. Bornemissza (1957) recorded Pirates sp. hunting around guinea pig carcasses in Australia.

Miridae--Fulvius occurs on fungus-covered dead trees or logs (Blatchley, 1926). This genus was represented by Fulvius imbecilis (Say). Several specimens were collected from the drying carrion, the odors of which may have served as an attractant. They were normally found in the folds of the dried pig carcasses.

Order Neuroptera

This order was represented at the carrion by the brown lacewings (Hemerobiidae), and the green lacewings (Chrysopidae). Both adults and larvae are predaceous and feed on aphids and other small insects (Clausen, 1940). They are found in grass, weeds, and on the foliage of trees and shrubs (Borror and DeLong, 1957). The adults and larvae of the genus Hemerobius were collected from carrion in the advanced decay and dry stages.

Order Lepidoptera

One species of butterfly, Asterocampa celtis (Boisduval and LeConte), was a regular visitor to the moist carrion. This species and many others were observed sucking fluids from the carrion. Three species of moths, Amphion nessus (Cramer), Anavitrinella pampinaria (Guenee) and Desmia funeralis (Huebner), were common visitors to the decaying carcasses. Amphion nessus arrived at the soupy carrion in the late afternoon before sunset, while the other moths were night visitors only. Many of these same species of Lepidoptera were collected by Reed (1958) from dog carcasses in Tennessee. According to Holland (1903) rotten bananas, cane

trash, odor of carnivorous animals, putrid fish, and dead snakes attract certain species of butterflies. Pig carrion could certainly be added to this list.

Order Diptera

Psychodidae--These small moth like flies were present during the late stages of carrion decomposition. They were observed feeding on some of the fluids trapped in the carcass folds. Comstock (1960) stated that most of the species feed on nectar or other fluid matter other than blood. Only one adult species, Telmatoscopus albipunctatus (Williston), was collected. The larvae live in decaying matter, dung, or water (Curran, 1934). No larvae were collected.

Mycetophilidae--These small dull-colored gnats were also observed at the carrion site during late decomposition. No feeding by adults was observed. They were probably attracted to the odors of the carrion. This family was represented by a single genus, Mycomya. These fungus gnats often occur in great numbers on fungi and in damp places where there is decaying vegetable matter (Comstock, 1960).

Sciaridae--This family of dark-winged fungus gnats was represented at the carrion by the genus Bradysia. No feeding by adults was observed. They were present during the late stages of decomposition. The adults of this family inhabit moist places or any place where fungus growth occurs (Curran, 1934).

Stratiomyidae--This family was represented by Hermetia illucens (Linnaeus) and Ptecticus trivittatus (Say). Adults were observed feeding on juices during the early stages of decay when fluids were present. Larvae were collected from one carcass. Comstock (1960) listed decaying matter as a source of food for larvae.

Tabanidae--Only three adult specimens of Tabanus sackeni Fairchild were collected. Carrion has never been reported as a source of food for tabanids. They were observed walking on the carcasses and occasionally stopping as if sampling the moist carrion. Hays (personal communication) suggested that tabanids may have come into the area in search of water or other liquids. One larval tabanid was collected from beneath carrion in the advanced decay stage.

Asilidae--These predaceous insects were visitors to the carrion on many occasions. They preyed upon the calliphorid and muscid flies. The genera Erax, Asilus, and Cerotainia were commonly collected. They were usually present at the carcass between 1:00 p.m. and 3:00 p.m., the period when insect activity and population size were at a maximum.

Syrphidae--Five species, Baccha clavata (Fabricius), Baccha costata Say, Mesograpta polita (Say), Xylota pigra (Fabricius), and Milesia virgiensis (Drury), were collected from the decomposing carrion. All of the above were observed feeding on the carrion fluids. The adults of this family frequent flowers and feed upon nectar and pollen (Comstock, 1960). It may be possible that some odors from carrion closely approximate those of flowers.

Tachinidae--Larvae of members of this family are parasitic on other insects, particularly Lepidoptera, Hymenoptera, and Coleoptera larvae (Curran, 1934). Very few specimens were collected at the carrion. Very little is known about the feeding habits of the adults. Presumably they feed on nectar.

Sarcophagidae--Sarcophagid larvae have a wide variety of food habits ranging from scavengers of manure and carrion to parasites and predators on other insects. The scavenger role was more dominant among

the larvae and adults which inhabited the carrion. Sarcophagids played a minor role in carrion removal in comparison to that of calliphorids. They were usually the first insects to be attracted to the fresh carcass.

Calliphoridae--The blow fly species encountered at the carrion were all scavengers. The calliphorid larvae were the most prominant species during active and advanced decay while adults were the dominant species during the fresh, bloated, and active decay stages. Calliphorid larvae have been collected by many investigators from cow manure, human feces, decaying animals, and wounds of animals. Phaenicia regina (Meigen) and Cochliomyia macellaria (Fabricius) often attack living as well as dead tissue. These two species often deposited eggs on still-frozen carcasses.

Muscidae--This family contains so many flies of such diverse habits that it is very difficult to generalize concerning their food habits. Many of the muscids feed on filth of all kinds (decaying vegetation, animal dung, human excrement, and carrion). The genus Fannia contained the only muscid larvae collected from the carrion. They usually completed their development on the dried remains of the carcass after the other dipterous larvae (Calliphoridae) had entered the soil. Adults of the house fly, Musca domestica Linnaeus, and the latrine fly, Fannia scalaris (Fabricius), were observed feeding on the decomposing flesh.

Anthomyiidae--The members of this family have diverse habits also, which range from parasites to plant feeders to scavengers. Most larvae live in decaying vegetable matter and excrement (Comstock, 1960). Hylemya cinerella (Fallen), an adult carrion visitor, was reared from feces by Howard (1900). Clausen (1940) considered adults of Scatophaga stercoraria

(Linnaeus) as predators upon certain small Diptera. The anthomyiids, including Scatophaga stercoraria, collected during this study were feeding on carrion. Scatophaga are commonly called dung flies and are placed in a separate family by some writers.

Sphaeroceridae--These small black dung flies were present during all stages of decomposition but were more abundant during the dry stage. They often occur in great numbers around excrement or near water (Comstock, 1960). Reed (1958) observed these flies on the moist body regions of dog carcasses. They appeared to be regular carrion inhabitants; however, no larvae were collected.

Lonchaeidae--Only one species, Lonchea polita Say, was represented at the carrion. These small black flies were never numerous at any time. Lonchea polita has been reared from a decaying fungus and from human excrement (Comstock, 1960). A European species of this genus was found by Megnin on the dead body of a child (Howard, 1900).

Otitidae-Adults of this family are found in moist places (Curran, 1934). The larvae have been found under bark of dead trees, in excrement, and infesting growing plants (Comstock, 1960). The most common species, Euxesta notata (Wiedemann), was present during the decay stages. This same species was reared from feces by Howard (1900).

Sepsidae--Adult sepsids occupied the carcass during all stages of putrefaction. They preferred to feed on the moist carrion. They are found around excrement, carrion, and decaying vegetation, in which the larvae live (Curran, 1934).

Piophilidae--Comstock (1960) reported that these small black flies are found around decaying organic matter and preserved meats or cheese.

They were common feeders of the carrion from the bloated to the dry stage. Prochyliza xanthostoma Walker was the dominant species collected from the carcasses.

Chloropidae--The chloropids (Hippelates sp.), which breed in decaying vegetation and excrement, are attracted to animal secretions and feed on pus, blood, and similar materials (Borror and DeLong, 1957). Hippelates pusio Loew and Oscinella neocoxendrix Sabrosky were observed feeding on pig carrion fluids. They were present during the decay stages.

Drosophilidae--Only one species, Drosophila affinis Sturtevant, was collected from the carrion. The adults are found around decaying vegetation, flowing sap, fungi, and ripe fruit; the larvae being found in these same substances (Curran, 1934). Clausen (1940) reported that a small number of the species are predaceous or parasitic in habit, including some species of the genus Drosophila. The fruit flies were often observed feeding on moist carcasses in the dry and remains stages.

Cecidomyiidae--Several undetermined adult species were collected from dried carrion. Others were observed resting on the sides of the cages which contained decomposing carcasses. The larvae of most species live in plants, but others live under bark, in decaying vegetation, and in fungi (Curran, 1934).

Clusiidae--This family of small flies was represented at the carrion by one species, Heteromeringia nitida Melander and Argo. The adults sometimes occur in large numbers in moist places and about decaying wood (Curran, 1934).

Heleomyzidae--Adult members of this family are found in shady and damp places (Comstock, 1960). They were collected feeding on the carcasses

early in the morning before the other Diptera arrived. The larvae are scavengers and live upon decaying animal and vegetable substances (Curran, 1934). No larvae were collected during the study.

Phoridae--These small humpbacked flies were common during the late decay and dry stages of decomposition. The great majority of these flies are scavengers, feeding upon vegetable matter including fungi, decomposing insects, snails, and upon carrion (Clausen, 1940). Howard (1900) reported that some larval forms have been found breeding in cadavers and have medicolegal importance.

Rhagionidae--The snipe flies are common in woods especially near moist places and are usually found on foliage, long grass, and on tree trunks (Curran, 1934). The adult snipe fly, Chrysophilus infuscatus Leonard, was collected from carrion. They are predaceous in both the adult and larval stages (Clausen, 1940). The prey of adults consists mainly of the adults of other Diptera.

Order Hymnoptera

Braconidae--Clausen (1940) stated that this family is one of the major groups of insect parasites. Alysia ridibunda Say was collected during active decomposition when larvae were most abundant. They were often observed crawling in the cracks and crevices of the carrion. Clausen reported that Alysia is more particularly a parasite of blow flies of the genera Sarcophaga, Lucilia, and Calliphora. Aphaereta was recorded as a parasite of the pupae of Sarcophagidae (Graham-Smith, 1916).

Ichneumonidae--Townes and Townes (1951) state:

"Members of this family are all parasites. Hosts comprise larvae and pupae of holometabolous insects (including other

Ichneumonidae), immature and adult spiders, and the egg sacs of spiders and pseudoscorpions. Host selection is sometimes quite restricted but more often includes a variety of species that may be exposed to parasitism in the habitat usually explored by the ovipositing female."

Members of the genus Atractodes were collected frequently. They are believed to be parasitic on carrion-inhabiting muscoid Diptera.

Evaniidae--The evaniids are all thought to be parasitic in the egg capsules of cockroaches. Townes (1951) reported that our common native species of Hyptia were presumed to be parasites of Parcoblatta. Hyptia harpyoides Bradley was observed flying about dried pig carcasses under which Parcoblatta spp. were usually found.

Pelecinidae--Only two specimens of Pelecinus polyturator Drury were recorded during the entire study. They were crawling about the moist carrion as if in search of food or host. Present records indicate that Pelecinus parasitizes the larvae of soil-inhabiting scarabaeidae (Muesebeck and Walkley, 1951).

Proctotrupidae--Brachyserphus abruptus (Say) was collected from carrion in active and advanced decay. No observation on habits was noted. Clausen (1940) reported that a number of species of this family are parasites of the larvae of various Coleoptera and Diptera.

Diapriidae--Only the genus Aneurhynchus was represented at the carrion. These small black insects are believed to be internal parasites of the immature stages of Diptera (Clausen, 1940). No observations on parasitization were made in this study.

Mutillidae--One species, Pseudomethoca simillima (Smith), was

observed as a rather frequent visitor to the carrion. Mutillids are generally accepted as being predaceous or parasitic on other Hymenoptera, Coleptera, and Diptera (Clausen, 1940).

Formicidae--Ants were actively feeding during all stages of carrion decomposition. They were observed carrying off maggots and eggs of other insects in large quantities, and feeding on the carrion soups. Fuller (1934) believed that ants could not be considered regular carrion inhabitants of any influence since they were found on only a few carcasses near nests. The authors, however, hold the opposite opinion, since ants were found on all carcasses. Camponotus americanus Mayr and Prenolepis imparis (Say) were the numerically dominant ant species at the carrion.

Vespidae--Vespula maculifrons (Buyss.) was collected from every carcass. They too were observed feeding on dipterous eggs, larvae, and even adults. Bromley (1931) made an extensive study of hornet habits. He reported that yellow jackets fed on all sorts of organic matter and were also predaceous. Graham-Smith (1916) reported that blow flies, green-bottle flies, and other flies attracted to carrion were often captured by the common species of wasps. Davis (1919) observed Vespula maculata (Linnaeus) feeding on a dead house sparrow and a water-snake.

Pompilidae--Three species, Auplopus nigrellus (Banks), Aporus niger (Cresson), and Psorthaspis mariae (Cresson) visited the carcasses. Members of this family provision their nests with spiders. Carcasses in the dried condition usually harbored several spider species. The pompilids observed here could have been searching for spiders.

Sphecidae--One species, Trypoxylon carinatus Say, was collected. Members of this genus also provision their nests with spiders (Krombein,

1951). The carrion may have established a concentration of spiders due to the presence of the many insects.

Apidae--*Apis mellifera* Linnaeus and *Bombus impatiens* Cresson were attracted to the carrion only while fluids were present. They were observed sucking up the foul-smelling juices. Some of the odors of putrefaction may have served to orient the bees to the carrion media.

Order Coleoptera

Carabidae--This family was represented by thirteen species, present during all stages of decomposition. Carabids were seldom seen during daylight hours, but were recorded on numerous occasions at night. Most adult and immature carabids are considered predaceous (Comstock, 1960). They were probably present at carrion only because of the concentrated food supply. No immature carabids were collected during this study.

Hydrophilidae--Six adult species representing three genera were collected during the decay and dry stages. They remained concealed beneath the carcasses and often went unnoticed because of their small size. No observations were made on their food habits. Clark (1895) indicated that they were probably feeders of carrion or dung or possibly fed on microscopic larvae. Several of these species were collected from carrion by Howden (1950) and Blatchley (1910) and from cattle droppings containing dipterous larvae by Mohr (1943).

Silphidae--eleven species were represented at the carrion, all present during the decay stages. There have been many conflicting opinions concerning the food habits of silphids. Clark (1895) stated that they fed on both carrion and maggots. Steele (1927) observed adults feeding on maggots. He presented experimental evidence that adults preferred

maggots and would die if kept on a carrion diet. Abbott (1937) reported that silphid adults were partially predaceous. Dorsey (1940) observed both larvae and adults of Silpha sp. feeding on decaying flesh. He also stated that the larvae fed principally on the dried remains of the hide, sinews, and shreds of remaining meat. Cole (1942) reported larvae of S. inaequalis feeding on dog carcasses. Illingsworth (1926) reported that silphids were the chief agents in reducing the number of dipterous larvae.

In this study adult silphids were observed feeding on maggots only. No reliable observations on the feeding habits of immatures were made. The immature silphids appeared after most dipterous larvae had left the dried remains of the pig carcasses.

Leptodiridae--These small beetles were present on or under all carcasses during the decay and dry stages. They were often observed feeding on the moist, exposed areas of the carcass. Six species were collected and as many as 50 individuals have been collected from a single dead pig. A careful study of this group probably will reveal many more species from carrion.

Staphylinidae--More than sixty species of Staphylinidae were present during the various stages of decay. Voris (1934) stated that predation is the prevailing type of feeding behavior in this family. Many species of the subfamily Aleocharinae have larvae which are ectoparasitic on Diptera pupae (Edwards, 1949). In this study staphylinid adults were observed feeding on the adults and larvae of many insect species, but dipterous larvae seemed to be preferred. Immature staphylinids usually appeared too late to feed on maggots. On one occasion

a staphylinid larva was observed feeding on a dermestid larva. These beetles arrived early during the bloated stage and stayed until all insect activity had ceased. Rovebeetles are very common in carrion, in dung, in ant nests, under the bark of trees, on the moist banks of streams and ponds, and in decaying animal or vegetable matter of all sorts (Mank, 1923).

Ptiliidae--One identified species, Acratrichis sericans Heer, and one undetermined species were collected from carrion. These small featherwinged beetles have been collected from rotten wood, dung, and fungi (Borror and DeLong, 1957). Walker (1957) collected this family from cantaloupe and fish-baited traps and Park and Auerbach (1954) collected this same genus from tree-holes. Carrion should certainly be included as a possible food for this group.

Histeridae--Twenty-six species were collected from the carrion. Histerids are found wherever there is putrefaction and decay such as animal wastes, fungi, and carrion (Edwards, 1949). They were present in the bloated, decay, and the early parts of the dry stage, being extremely abundant in the decay stages. They are almost exclusively predators (Wenzel, personal communication). Histerid adults were only observed feeding on dipterous larvae. Very few larval specimens were collected. Due to the rapidity of decomposition in summer months, their probable food was depleted before development was completed.

Holdaway (1930) regarded the histerids as the significant factor in the reduction of dipterous larvae. Fuller (1934) reported both adult and larval histerids feeding on blow-fly larvae and puparia. Howden (1950) observed the feeding of histerids on maggots in the laboratory and field.

Cleridae--Most species are predaceous in both adult and larval stages. Knull (1951) reported that specimens can be collected from flowers, vegetation, on dead and drying trees infested with borers, and on bones and skins of dead animals. Two adult species were collected from dried skin and bones. They were probably feeding on Dermestes or Nitidula larvae. Clark (1895) states that Necrobia probably feeds on maggots. This however, was not observed in this study.

Anthicidae--The adults of this family are found on flowers and foliage of various trees, beneath logs, leaves, and rubbish, while the larvae are taken in piles of decaying vegetation and rotten fruit (Edwards, 1949). One identified species, Tomoderus constrictus (Say), and one undetermined species, Anthicus sp., were collected from carrion in the advanced decay and dry stages. Fuller (1934) recorded Anthicus hoeferi Kerg. as breeding in, or associated with, carrion.

Elateridae--The adult members of this group are commonly accepted as being exclusively phytophagous. The larvae are generally considered vegetarians; however, Arnett (1960) stated that some species fed on both plant and animal material, or they were carnivorous on other invertebrates. No observations were made on their feeding habits at the carrion site. Adults were present at the carrion from advanced decay to dry stages. They were presumably attracted by the odors. An elaterid, Monocrepidius bellus Say, was collected from dog and human cadavers by Motter (1898).

Dermestidae--Two species, Dermestes caninus Germar and Dermestes marmoratus Say, were collected. Larvae and adults were abundant during the dry stage. The food habits of the group are well known. The adults and larvae fed on dried skin, sinews, and bone. As many as 50 adults

were recorded by the author on one dried pig carcass. Fuller (1934) reported that these beetles were exceedingly common during the summer months. She collected 466 larvae from half a sheep's head.

Nosodendridae--Only three specimens of Nosodendron unicolor Say were collected from carrion. According to Arnett (1960) the adults are found in wounds of elm and alder trees where they probably feed on dipterous larvae. All three specimens were collected from carrion which contained dipterous larvae. Kingsolver (personal communication) indicated that the presence of Nosodendron on earlier decay stages of carrion is not entirely unexpected because of their close relationship to the Dermestidae.

Ostomidae--One species, Tenebriodes corticalis (Melsheimer), and several other undetermined specimens were extracted from carrion by use of the Berlese funnel. They were never present in abundance on any one carcass but were collected in small numbers from several carcasses. Some members of the genus are injurious to certain stored products, being especially abundant in granaries.

Nitidulidae--The members of this family feed on the juices of decaying fruits, on fermenting or souring sap that exudes from trees; a few are found on flowers, and others on carrion or fungi (Comstock, 1960). Only ten species were collected. Larvae and adults were abundant during the dry stage at essentially the same times as the Dermestidae. Larvae and adults were observed feeding on dried skin. The nitidulids seemed to prefer the more moist skin more than the dry skin which the Dermestidae occupied.

Rhizophagidae--Monotoma americana Aube was extracted from carrion

during the late stages of decay by use of the Berlese funnel. This same species was collected from dead fish by Walker (1957) and the same genus by Howden (1950) from various dead animals. Monotoma americana was also collected from decaying fleshy fungi and flowers of Amorpha fruticosa by Blatchley (1910).

Cucujidae--Three species, Oryzaephilus mercator (Fauvel), Silvanus bidentatus (Fabricius), and Silvanus imbellis LeConte, were often collected from dried carrion. All were observed feeding on the dried carrion scraps. Members of the genera Silvanus and Oryzaephilus are commercially important since they feed on dried fruit, rice, meal, flour, and stored grain (Edwards, 1949).

Cryptophagidae--The genus Cryptophagus was collected in this study from dried carrion. Fuller (1934) collected Cryptophagus affinis Sturm. from carrion in Canberra, Australia. According to Hinton (1945) Cryptophagus actangulus Gyllenhal feed on fungi, especially Mucor and Penicillium species. These species of fungi have been identified from carcasses. If this is true a microscopic examination of the digestive tract should reveal spores of fungi instead of carrion fragments.

Mycetophagidae--Four species, Mycetophagus punctatus Say, Mycetophagus flexuosus Say, Typhaea stercorea (Linnaeus), and Litargus didesmus Say, were collected from dried carrion. These hairy fungus beetles were sometimes abundant on carcasses. Walker (1957) collected Typhaea stercorea from putrescent and mushy cantaloupe, and Park and Auerbach (1954) collected Mycetophagus flexuosus from tree-holes. These beetles are usually found near rotten and decaying fungus.

Colydiidae--One species, Namunaria guttulatus (LeConte), was

collected from dried carrion. Blatchley (1910) collected this species on dry fungi and beneath close fitting bark of beech, maple, and other trees. Kingsolver (personal communication) offers a possible explanation for some of these normally fungal feeding beetles being collected from carrion. Carrion might serve as a substrate for fungi and molds. Thus some of the beetles which superficially appear to be carrion feeders could actually be feeding on secondary growth (fungi and molds) which were present. All carrion very probably serves as a substrate for fungi (Payne, 1963, 1965).

Endomychidae--These beetles are found beneath bark, in fungi, rotton wood, dung, and in decayed fruit refuse (Arnett, 1960). Two species, Aphorista vittata (Fabricius) and Endomychus biguttatus Say, were observed on carcasses during the advanced decay stage of decomposition. From all indications these handsome fungus beetles appeared to be feeding on the putrefying flesh on which they were often seen walking.

Alleculidae--The members of this family are found on flowers, foliage, twigs, fungi, and beneath dead bark of trees and logs (Edwards, 1949). Two genera were represented at the pig carcasses during the late decay stages. They usually remained concealed under dried portions of the carcasses.

Tenebrionidae--Three species were collected from carrion. One species, Hoplocephala bicornis (Olivier), was recorded on numerous occasions on dried carrion. According to Arnett (1960) these beetles feed on decaying vegetation, animal waste products, seeds, cereals, fungi, and sometimes living plant parts. No indication of carrion feeding was observed.

Melandryidae--Most members of this family are found under bark, logs, and stones and are usually associated with fungus (Edwards, 1949). Eustrophinus bicolor (Fabricius) was collected from beneath carrion during active and advanced decay. Only three species were observed during this study.

Ptinidae--One species of spider beetle, Ptinus fur Linnaeus, was collected from dried carcasses on several occasions. Several adults were observed feeding on dried carrion; however, no larvae were collected. Most of the members of this family live in dried animal substances (Arnett, 1960).

Scarabaeidae--Eleven species were commonly found during the bloated and decay stages, and all are considered scavengers. Nearly all these species live in the dung of animals, decaying fungi, and carrion (Blatchley, 1910). The dung beetles usually constructed tunnels and burrows under the carcasses.

Geotrupidae--Members of this family are found in excrement and carrion also (Edwards, 1949). They are included in the Scarabaeidae by some authors. Large amounts of carrion were carried into tunnels constructed by the females beneath the carcass as food for young. Spector (1943) collected large numbers of Geotrupes semiopacus Jekel and Geotrupes splendidus (Fabricius) from a bait of chicken feathers and entrails. Clark (1895) stated that Geotrupes feed entirely on a carrion and dung diet and were not predaceous. No indications of predatism by the Scarabaeidae, Geotrupidae, or Trogidae were observed.

Trogidae--Vaurie (1955) reported that adult Trox were found in a variety of habitats including nests of birds, burrows of small mammals,

fungi, dung (occasionally), dry carcasses, and decayed fish. Six adult species of Trogidae were collected from carrion in the advanced decay and dry stages; however, no immatures were collected. All species were observed feeding on carrion. Clark (1895), Davis (1909), Abbott (1937), and Spector (1943) have reported Trogidae as feeders on carrion. Trogids sometimes appeared during the advanced decay stage of pig decomposition. However, they have been recorded by Howden (1950) and Reed (1958) as being present only on dry carcasses.

Chordata

1. Amphibia

Bufonidae--Toads shelter in a form or in hiding places where there is some moisture and an abundant supply of insects and other invertebrates for food (Conant, 1958). One species of toad was seen on several occasions beneath pig carcasses. No stomach analyses were made on these toads to determine if they had eaten carrion fauna. Species of Bufo and Rana often shelter from the sunshine under cattle droppings which are some days old, where they may also seek their food (Hammer, 1942).

2. Aves

Flickers, Caloptes auratus (Linnaeus); mockingbirds, Mimus polyglottos (Linnaeus); brown thrashers, Toxostoma rufum (Linnaeus); wood thrushes, Hylocichla mustelina (Gmelin); and towhees, Piplio erythrophthalmus (Linnaeus) were the most active vertebrate predators. They quickly devoured any larvae which wandered from the protective cages. They tried to enter the cage during active and advanced decay to feed on the insects and they completely cleaned the carrion of dipterous

larvae and beetles on two occasions. This was one reason the protective cages were deemed a necessity. Even so, the birds cleared a large area around each cage while scratching and searching for insects.

3. Mammalia

Pig carrion removed from the protective cages was consumed or carried off in one or two days. Dogs and opossums were the chief eaters of carrion, many times only eating the softer parts. They even dug under the cages. The possibility of the disturbances of the carrion by vertebrates warranted the use of protective cages. Pigs on which dogs or opossums had fed often failed to pass through a bloated stage because the gasses formed during the decomposition of the flesh were no longer trapped within the body cavities. This allowed other insects to gain an entrance to the carcass before the dipterous larvae, thus altering the normal succession of carrion organisms.

ACKNOWLEDGMENTS

Especial thanks are expressed to E. W. King, Clemson College, for his interest, invaluable suggestions, and assistance during the planning and development of this research; to P. B. Dunaway, and others, Oak Ridge National Laboratory, for the editorial advice and assistance given during the preparation of the manuscript; to D. L. Handlin, Clemson College, and B. Oswald of Allendale County, South Carolina, for providing baby pigs for the research; to Miss Frances McAlister, Clemson College, for her aid in the preparation of the specimens for identification and for her help in preparing the systematic list of species; and to E. F. Menhinick and A. F. Shinn, Oak Ridge National Laboratory, for checking the manuscript with particular reference to the scientific names.

In addition, sincere appreciation is expressed to the many specialists who identified specimens. The Mollusca were identified by C. B. Wurtz. The Arachnida were identified by R. L. Smiley (mites), C. M. Clifford (Ixodidae), W. Ivie (Araneida), C. J. Goodnight (Phalangida), W. B. Muchmore (Pseudoscorpionida), and V. H. Owens (Scorpionida). Isopoda were identified by W. B. Muchmore, Chilopoda by R. V. Chamberlin, and Diplopoda by R. L. Hoffman.

Collembola were determined by D. L. Wray; Orthoptera by A. B. Gurney and T. E. Snyder. Isoptera were also identified by T. E. Snyder. Hemiptera were identified by R. C. Foreschner, J. L. Herring, R. F. Hussey, and F. W. Mead; Homoptera by J. P. Kramer. Neuroptera were identified by O. S. Flint; Lepidoptera by H. W. Capps, W. D. Field, S. S. Nicolay,

and E. L. Todd. Diptera were identified by H. R. Dodge, R. H. Foote, K. L. Hays, H. J. Reinhard, C. W. Sabrosky, G. C. Steyskal, A. Stone, and W. W. Wirth; Hymenoptera by B. D. Burks, K. V. Krombein, C. F. W. Muesebeck, M. R. Smith, L. M. Walkley, and L. H. Weld. Coleoptera were identified by W. H. Anderson, O. L. Cartwright, W. A. Connell, N. M. Downie, J. M. Kingsolver, J. N. Knull, W. V. Miller, I. M. Moore, M. W. Sanderson, P. J. Spangler, T. J. Spilman, W. C. Stehr, G. B. Vogt, R. E. Warner, and R. L. Wenzel.

This investigation was supported in part by a National Defense Graduate Fellowship; this aid is gratefully acknowledged. Part of the work reported in this paper was submitted in a thesis to the Graduate School of Clemson College for the M. S. degree in entomology. The sponsorship and support of the Department of Entomology and Zoology, Clemson College is appreciated.

LITERATURE CITED

Abbott, C. E. 1937. The necrophilous habit of Coleoptera. Bull. Brooklyn Entomol. Soc. 46: 49-52.

Arnett, R. H. 1960. The beetles of the United States (a manual for identification). The Catholic University of America Press, Washington, 1112 pp.

Bailey, J. W. 1928. The Chilopoda of New York State, with notes on the Diplopoda. New York State Museum Bull. 276:5-50.

Bornemissza, G. F. 1957. An analysis of arthropod succession in carrion and the effects of its decomposition on the soil fauna. Australian J. Zoology 5: 1-12.

Blatchley, W. S. 1910. An illustrated descriptive catalogue of the Coleoptera or beetles known to occur in Indiana. The Nature Publishing Co., Indianapolis, 1386 pp.

_____. 1920. Orthoptera of northeastern America with especial reference to the faunas of Indiana and Florida. The Nature Publishing Co., Indianapolis, 784 pp.

_____. 1926. Heteroptera or true bugs of eastern North America. The Nature Publishing Co., Indianapolis, 1116 pp.

Borror, J. D., and D. M. DeLong. 1957. An introduction to the study of insects. Holt, Reinhart, and Winston, New York, 1030 pp.

Bromley, S. W. 1931. Hornet habits. J. New York Entomol. Soc. 39: 123-129.

_____. 1937. Food habits of alydine bugs (Hemiptera: Coreidae). Bull. Brooklyn Entomol. Soc. 32(4): 159.

Clark, C. U. 1895. On the food habits of certain dung and carrion beetles. J. New York Entomol. Soc. 3: 61.

Clausen, C. P. 1940. Entomophagous insects. McGraw-Hill, New York, 688 pp.

Cole, A. C., Jr. 1942. Observations of three species of Silpha (Coleoptera: Silphidae). Am. Midland Naturalist 28: 161-163.

Comstock, J. H. 1960. An introduction to entomology. Ninth edition. Comstock Publishing Co., Ithaca, New York, 1064 pp.

_____, and W. J. Gertsch. 1948. The spider book. Comstock Publ. Co., Ithaca, New York, 729 pp.

Conant, R. 1958. A field guide to reptiles and amphibians of the United States and Canada east of the 100th meridian. Houghton Mifflin Co., Boston, 366 pp.

Curran, C. H. 1934. The families and genera of North American Diptera. The Ballou Press, New York, 512 pp.

Davis, W. T. 1909. Owl pellets and insects. J. New York Entomol. Soc. 17: 49-51.

Davis, W. T. 1919. A remarkable note of Vespa maculata, with notes on some other wasp's nest. Bull. Brooklyn Entomol. Soc. 14: 118-123.

Dorsey, C. K. 1940. A comparative study of the larvae of six species of Silpha. Ann. Entomol. Soc. Am. 33: 120-139.

Edwards, J. G. 1949. Coleoptera or beetles east of the Great Plains. Edwards Brothers, Inc., Ann Arbor, Michigan, 181 pp.

Folsom, J. W. 1902. Collembola of the grave. Psyche 9: 363-367.

Fuller, M. E. 1934. The insect inhabitants of carrion, a study in animal ecology. Austral. Council Sci. Indus. Res. Bull. 82: 5-62.

Goodnight, C. J. 1962. (personal communication). Department of Biological Sciences, Purdue University, Lafayette, Indiana.

Graham-Smith, G. S. 1916. Observations on the habits and parasites of common flies. Parasitol. 8: 440-546.

Hammer, O. 1942. Biological and ecological investigations of flies associated with pasturing cattle and their excrement. Videnskabelige Meddelelser 105: 141-393.

Hays, K. L. 1962. (personal communication). Department of Zoology-Entomology, Auburn University, Auburn, Alabama.

Henson, E. G. 1962. (personal communication). Public Health Service DWSPC, 1014 Broadway, Cincinnati 2, Ohio.

Hinton, H. E. 1945. A monograph of the beetles associated with stored products. Volume 1. Jarrold and Sons Ltd., Norwich, 443 pp.

Hoff, C. C. 1949. The pseudoscorpions of Illinois. Illinois Nat. Hist. Survey Bull. 24: 413-498.

Holdaway, F. G. 1930. Field populations and natural control of Lucilia sericata. Nature 126: 648-649.

Holland, W. J. 1903. The butterfly book -- a popular guide to a knowledge of the butterflies of North America. Doubleday, Page and Co., New York, 382 pp.

Howard, L. O. 1900. A contribution to the study of the insect fauna of human excrement. Proc. Washington Acad. Sci. 2: 541-604.

Howden, A. T. 1950. The succession of beetles on carrion. M.S. Thesis, North Carolina State College, Raleigh, 83 pp.

Illingsworth, J. F. 1926. Insects attracted to carrion in southern California. Proc. Hawaiian Entomol. Soc. 6: 397-401.

Kingsolver, J. M. 1963. (personal communication). U. S. National Museum, Washington 25, D. C.

Knull, J. N. 1951. The checkered beetles of Ohio (Coleoptera: Cleridae). Ohio Biol. Survey Bull. 42. 8: 269-350.

Krombein, K. V. 1951. Subfamily Trypoxyloninae, p. 954-957. In C. F. W. Muesebeck, K. V. Krombein, and H. K. Townes, Hymenoptera of America north of Mexico. U. S. Government Printing Office, Washington.

Mank, H. G. 1923. The biology of Staphylinidae. Ann. Entomol. Soc. Am. 16: 220-237.

Maynard, E. A. 1951. A monograph of the Collembola or springtail insects of New York State. Comstock Publishing Co., Ithaca, New York, 339 pp.

McAtee, W. L. 1919. Notes on nearctic Heteroptera. Bull. Brooklyn Entomol. Soc. 14:8.

Milne, L. J., and M. J. Milne. 1944. Notes on the behavior of burying beetles (Nicrophorus sp.). J. New York Entomol. Soc. 52: 311-327.

Mohr, C. O. 1943. Cattle droppings as ecological units. Ecol. Monographs 13: 275-298.

Motter, M. G. 1898. A contribution to the study of the fauna of the grave. A study of one hundred and fifty disinterments, with some additional experimental observations. J. New York Entomol. Soc. 6: 201-231.

Muesebeck, C. F. W., and L. M. Walkley. 1951. Family Pelecinidae, p. 661-662. In C. F. W. Mewsebeck, K. V. Krombein, and H. K. Townes, Hymenoptera of America north of Mexico. U. S. Government Printing Office, Washington.

Owens, V. H. 1962. (personal communication). Assistant state entomologist, Department of Agriculture, Jefferson City, Missouri.

Park, O., and S. I. Auerbach. 1954. Further study of the tree-hole complex with emphasis on quantitative aspects of the fauna. Ecology 35: 208-222.

Payne, J. A. 1963. A summer carrion study of the baby pig, Sus scrofa Linnaeus. M. S. Thesis, Clemson College, Clemson, South Carolina. 123 pp.

_____. 1965. A summer carrion study of the baby pig, Sus scrofa Linnaeus. Ecology 46: 592-602.

Pratt, H. S. 1927. A manual of the common invertebrate animals, exclusive of insects. A. C. McClurg and Co., Chicago, 737 pp.

Reed, H. B. 1958. A study of dog carcass communities in Tennessee, with special reference to the insects. Am. Midland Naturalist 59: 213-245.

Spector, W. 1943. Collecting beetles (Trox) with feather bait traps (Coleoptera: Scarabaeidae). Entomol. News 54: 224-229.

Steele, B. F. 1927. Notes on the feeding habits of carrion beetles. J. New York Entomol. Soc. 35: 77-81.

Stonier, T. 1964. Nuclear disaster. World Pub. Co. (Meridian Books) Cleveland and New York. 225 pp.

Townes, H. K. 1951. Family Evaniidae, p. 655-657. In C. F. W. Musebeck, K. V. Krombein, and H. K. Townes, Hymenoptera of America north of Mexico. U. S. Government Printing Office, Washington.

Townes, H. K., and M. Townes. 1951. Family Ichneumonidae, p. 184-409. In C. F. W. Muesebeck, K. V. Krombein, and H. K. Townes, Hymenoptera

of America north of Mexico. U. S. Government Printing Office, Washington.

Van Name, W. G. 1936. The American Land and Fresh-water Isopod Crustacea. Bull. Am. Museum Nat. Hist. 71: 1-535.

Vaurie, P. 1955. A revision of the genus Trox in North America (Coleoptera, Scarabaeidae). Bull. Am. Museum Nat. Hist. 106: 1-90.

Voris, R. 1934. Biologic investigations on the Staphylinidae. Trans. Acad. Sci. St. Louis. 28: 233-261.

Walker, M. E. 1928. Phalangida of Ohio. Ohio Biol. Survey Bull. No. 194. 4: 153-175.

Walker, T. J., Jr. 1957. Ecological studies of the arthropods associated with certain decaying materials in four habitats. Ecology 38: 262-276.

Wenzel, R. L. 1962. (personal communication). Chicago Natural History Museum, Roosevelt Road and Lake Shore Drive, Chicago 5, Illinois.

Williams, S. R., and R. A. Hefner. 1928. The millipedes and centipedes of Ohio. Ohio Biol. Survey Bull. No. 18. 4(3): 93-147.

Wurtz, C. B. 1962. (personal communication). Consulting Biologists, Inc., Bethlehem Pike, Spring House, Pennsylvania.

APPENDIX

Systematic list of species collected from dead pigs in the various stages of decomposition during the summer months of 1962 and 1963, Clemson, South Carolina. The relative abundance of each species during the different stages of decomposition is indicated by a solid line (abundant) or a broken line (scarce).

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
PHYLUM MOLLUSCA					
Class Gastropoda					
Order Pulmonata					
Family Zonitidae					
Ventridens intertextus (Binney)					
Ventridens elliotti (Redfield)					
Zonitoides arboreus (Say)					
Family Polygyridae					
Stenotrema (sp. unknown-immature)					
Mesodon thyroidus (Say)					
Triodopsis vannostrandi (Bland)					
Triodopsis (sp. unknown-immature)					
PHYLUM ARTHROPODA					
Class Arachnida					
Order Acarina					
Family Ixodidae					
Dermacentor variabilis (Say)[1,2]					

[1] Indicates that insufficient information was present to determine a seral distribution.

[2] Indicates species of arthropods for which there was no evidence of attraction by conditions present in the carrion community.

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Erythraeidae					
Erythraeus sp.					
Leptus species #1					
Leptus species #2					
Family Macrochelidae					
Macrocheles sp.					
Family Parasitidae					
Parasitus sp.					
Order Araneida					
Family Uloboridae					
Uloborus glomosus (Walckenaer)					
Uloborus octonarius Muma					
Family Gnaphosidae					
Herphyllus vasifer (Walckenaer)					
Family Gnaphosidae					
Litophyllus liber Chamberlin & Gertsch					
Cesonia bilineata (Hentz)					
Cylphosa sericata Chamberlin					
Family Theridiidae					
Episinus truncatus Latreille					
Theridion tepidariorum C. Koch					
Theridion lyricum Walckenaer					
Dipoena nigra (Emerton)					
Achaearanae tepidarioria (Koch)					
Family Linyphiidae					
Meioneta barrowsi Chamberlin & Ivie					
Family Araneidae					
Tetragnatha versicolor Walckenaer					
Eustala anastera (Walckenaer)					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Thomisidae					
Coriarachne brunneus (Banks)			— — —	— — —	— — —
Coriarachne floridana (Banks)				— — —	— — —
Xysticus fraternus (Banks)			— — —	— — —	— — —
Xysticus transversatus (Walckenaer)	— — —	— — —	— — —	— — —	— — —
Xysticus sp.			— — —	— — —	— — —
Family Ctenidae					
Anahita animosa (Walckenaer)	— — —	— — —	— — —	— — —	— — —
Family Clubionidae					
Marcellina piscatoria (Hentz)			— — —	— — —	— — —
Clubiona pallens Hentz	— — —	— — —	— — —	— — —	— — —
Phrurotimpus illudens Gertsch			— — —	— — —	— — —
Castaneira cingulata (L. Koch)	— — —	— — —	— — —	— — —	— — —
Family Anyphaenidae					
Anyphaena fragilis Banks				— — —	— — —
Family Pisauridae					
Dapanus mirus (Walckenaer)				— — —	— — —
Family Lycosidae					
Lycosa aspera Hentz			— — —	— — —	— — —
Lycosa rabida Walckenaer				— — —	— — —
Schizocosa saltatrix (Hentz)			— — —	— — —	
Family Salticidae					
Phidippus audax (Hentz)				— — —	— — —
Phidippus sp.			— — —	— — —	— — —
Habrocestum pulex (Hentz)			— — —	— — —	— — —
Maevia inclemens (Walckenaer)				— — —	— — —
Zyogoballus nervosus Peckham				— — —	— — —

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Order Phalangida					
Family Phalangiidae					
Leiobunum speciosum Banks					
Leiobunum (sp. unknown-immature)					
Hadrobunus sp.					
Order Pseudoscorpionida					
Family Chthoniidae					
Kewochthonius species #1					
Kewochthonius species #2					
Family Neobisiidae					
Microbisium species #1					
Microbisium species #2					
Microcreagris species #1					
Microcreagris species #2					
Microcreagris species #3					
Family Chernetidae					
Parachernes new sp. ?[1]					
Family Cheliferidae					
Chelifer cancroides (Linnaeus)					
Genus? (Undet.)[1]					
Genus? (Undet.)[1]					
Order Scorpionida					
Family Vejovidae					
Vejovis carolinus Koch					
Class Crustacea					
Order Isopoda					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Oniscidae					
Porcellio laevis Latreille					
Metaponorthrus pruinosus (Brandt)					
Clysticus convexus (DeGeer)					
Tracheoniscus ratheki (Brandt)					
Family Armadillidae					
Armadillidium vulgare (Latreille)					
Armadillidium nasatum Budde-Lund					
Class Chilopoda					
Order Anamorpha					
Family Lithobiidae					
Nampabius carolinensis Chamberlin					
Nampabius sexspinosus Chamberlin					
Sozibus tuobukus Chamberlin					
Order Epimorpha					
Family Cryptopidae					
Cryptops hyalinus (Say)					
Theotops spinicauda (Wood)					
Scolopocryptops sexspinosus (Say)					
Family Geophilidae					
Arenophilus watsingus Chamberlin					
Class Diplopoda					
Order Polyxenida					
Family Polyxenidae					
Polyxenus ? fasciculatus (Say)					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Order Platydesmida					
Family Platydesmidae					
Brachycybe lecontei Wood					— — —
Order Lysiopetalida					
Family Lysiopetalidae					
Abacion magnum highlandense (Hoffman)					— — —
Order Chordeumida					
Family Cleidogonidae					
Cleidogona sp.					— — —
Order Polydesmida					
Family Strongylosomatidae					
Oxidus gracilis (Koch)					— — —
Family Euryuridae					
Euryurus erythropygos (Brandt)					— — —
Family Xystodesmidae					
New species in an undefined genus					
Order Spirostreptida					
Family Cambalidae					
Cambala annulata (Say)				— — —	— — —
Order Julida					
Family Parajulidae					
Ptyoiulus impressus (Say)					— — —
Uroblanuslus ? *atlantus* Chamberlin					— — —
Class Insecta					
Order Collembola					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Entomobryidae					
Entomobrya corticalis Nicolet					
Order Orthoptera					
Family Blattidae					
Cariblatta lutea (Saussure & Zehntner)					
Blatella germanica (Linnaeus)					
Parcoblatta bolliana (Saussure & Zehntner)					
Parcoblatta virginica (Brunner)					
Parcoblatta lata (Brunner)					
Parcoblatta spp.					
Family Phasmatidae					
Diapheromera sp.[1,2]					
Family Gryllacrididae					
Ceuthophilus sp.					
Family Gryllidae					
Cycloptilum sp.					
Nemobius confusus Blatchley					
Nemobius sp.					
Gryllus sp.					
Cyrtoxipha columbiana Caudell					
Crocharis saltator Uhler					
Order Isoptera					
Family Rhinotermitidae					
Reticulitermes virginicus (Banks)					
Reticulitermes sp.					

Species	Stage of Decomposition: Fresh	Bloated	Active Decay	Advanced Decay	Dry
Order Psocoptera					
Family Psocidae					
Genus and species?					
Order Hemiptera					
Family Cydnidae					
Sehirus cinctus cinctus (Beauvois)					
Family Coreidae					
Megalotomus quinquespinosus (Say)					
Alydus eurinus (Say)					
Alydus pilosulus (Herrich-Schaeffer)					
Family Lygaeidae					
Myodocha serripes Olivier					
Ozophora picturata Uhler					
Family Tingidae					
Corythucha aesculi Osborn & Drake[1,2]					
Melanorhopala infuscata Parshley[1,2]					
Family Reduviidae					
Oncocephalus geniculatus (Stal)					
Melanolestes picipes var. *abdominalis* (Herrich-Schaeffer)					
Sinea diadema (Fabricius)					
Family Miridae					
Fulvius imbecilis (Say)					
Family Fulgoridae					
Thionia bullata (Say)[1,2]					
Thionia sp.[1,2]					
Ormenoides venusta (Melichar)[1,2]					
Anormensis septentrionalis (Spinola)[1,2]					

Species	Stage of Decomposition: Fresh	Bloated	Active Decay	Advanced Decay	Dry
Order Neuroptera					
Family Hemerobiidae					
Hemerobius stigmaterus Fitch					
Hemerobius sp.					
Family Chrysopidae					
Chrysopa carnea Stephens					
Order Lepidoptera					
Family Papilionidae					
Battus philenor (Linnaeus)					
Papilio glaucus Linnaeus					
Family Satyridae					
Minois alope (Fabricius)					
Family Nymphalidae					
Melitaea mycteis Doubleday & Hewitson					
Phyciodes tharos (Drury)					
Asterocampa celtis (Boisduval & LeConte)					
Family Hesperiidae					
Epargyreus clarus (Cramer)					
Atrytone ruricola metacomet (Harris)					
Wallengrenia otho (J. E. Smith)					
Family Sphingidae					
Amphion nessus (Cramer)					
Family Noctuidae					
Palthis asopialis (Guenee)					
Family Geometridae					
Mellilla xanthometata (Walker)					
Anavitrinella pampinaria (Guenee)					
Epimecis virginaria (Cramer)					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Pyraustidae					
Desmia funeralis (Huebner)					
Anageshna primordialis (Dyar)					
Order Diptera					
Family Psychodidae					
Telmatoscopus albipunctatus (Williston)					
Family Mycetophilidae					
Mycomya sp.					
Family Sciaridae					
Bradysia sp.					
Family Cecidomyiidae					
Genus and species?					
Family Scatopsidae					
Scatopse notata (Linnaeus)					
Family Stratiomyidae					
Hermetia illucens (Linnaeus)					
Ptecticus trivittatus (Say)					
Genus and species-unknown immature					
Family Tabanidae					
Tabanus sackeni Fairchild					
Tabanus (sp. unknown-immature)[1]					
Family Rhagionidae					
Chrysophilus infuscatus Leanard					

Species	Stage of Decomposition: Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Asilidae					
Atomosia puella Wiedemann					
Cerotainia macrocera (Say)					
Laphria sp.					
Erax interruptus Macquart					
Erax spp.					
Asilus novae scotiae Macquart					
Asilus sp.					
Family Phoridae					
Triphleba subfusca (Malloch)					
Megaselia species #1					
Megaselia species #2					
Pulicophora sp.					
Family Syrphidae					
Baccha clavata (Fabricius)					
Baccha costata Say					
Mesograpta polita (Say)					
Xylota pigra (Fabricius)					
Milesia virgiensis (Drury)					
Family Cuterebridae					
Cuterebra horripilum Clark[1]					
Family Tachinidae					
Copecryptia ruficauda (Wulp)					
Archytas aterrimus Desvoidy					
Genus and species?					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Sarcophagidae					
Gymnoprosopa argentifrons Townsend					
Sarcophaga bullata Parker					
Sarcophaga haemorrhaidalis Fallen					
Sarcophaga misera sarracenioides Aldrich					
Sarcophaga repax Walker					
Sarcophaga sarracenioides Aldrich					
Sarcophaga sueta Wulp					
Sarcophaga sutilis Reinhard					
Sarcophaga triplasia Wulp					
Sarcophaga utilis Aldrich					
Sarcophaga ventricosa Wulp					
Sarcophaga spp.					
Genus and species?[1]					
Ravinia derelicta (Walker)					
Ravinia latisetosa (Coquillett)					
Ravinia ochraces (Aldrich)					
Ravinia pusiola (Wulp)					
Oxysarcodexia cingatus (Aldrich)					
Boettcheris latisterna Parker					
Mecynocorpus salva (Aldrich)					
Family Calliphoridae					
Cochliomyia macellaria (Fabricius)					
Cynomyopsis cadaverina (Desvoidy)					
Calliphoria vomitoria (Linnaeus)					
Calliphoria livida Hall					
Calliphoria vicina Desvoiday					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Phaenicia caeruleiviridis (Macquart)					
Phaenicia cuprina (Wiedemann)					
Phaenicia sericata (Meigen)					
Phormia regina (Meigen)					
Family Muscidae					
Morellia micans (Macquart)					
Musca domestica Linnaeus					
Stomoxys calcitrans Linnaeus					
Muscina assimilis (Fallen)					
Muscina stabulans (Fallen)					
Hydrotaea houghi Malloch					
Hydrotaea occulata (Meigen)					
Hydrotaea sp.					
Ophyra leucostoma (Wiedemann)					
Coenosia sp.					
Fannia howardi Malloch					
Fannia scalaris (Fabricius)					
Fannia spp.					
Gymnodia arcuata (Stein)					
Family Anthomyiidae					
Anthomyia oculifera Bigot					
Hylemya cinerella (Fallen)					
Pegomyia gilva (Zetterstedt)					
Scatophaga furcata Say					
Scatophaga stercoraria (Linnaeus)					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Clusiidae					
Heteromeringia nitida var. *nigripes* Melander & Argo					
Family Heleomyzidae					
Genus and species?					
Family Sphaeroceridae					
Leptocera fontinalis (Fallen)					
Leptocera hirtula (Rondani)					
Leptocera spp.					
Copromyza atra (Meigen)					
Family Lonchaeidae					
Lonchae polita Say					
Family Otitidae					
Rivellia steyskali Namba					
Tritoxa incurva loew					
Euxesta notata (Wiedemann)					
Euxesta pechumani Curran					
Family Micropezidae					
Rainieria antennaepes (Say)					
Family Sepsidae					
Sepsis neocynipsea Melander & Spuler					
Sepsis punctum (Fabricius)					
Meroplius stercorarius (Robineau-Desvoidy)					
Family Piophilidae					
Piophila fovelata Meigen					
Piophila latipes Meigen					
Prochyliza xanthostoma Walker					
Genus and species?[1]					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Chloropidae					
Hippelates pallipes (Loew)					
Hippelates pusio Loew					
Oscinella neocoxendix Sabrosky					
Family Drosophilidae					
Drosophila affinis Sturtevant					
Order Hymenoptera					
Family Tenthredinidae					
Periclista sp.[1,2]					
Family Braconidae					
Apanteles sp.					
Aphaereta pallipes (Say)					
Aphaereta sp.					
Alysia ridibunda Say					
Rogas sp.					
Bucculatriplex bucculatricis (Ashmead)					
Family Ichneumonidae					
Gelis spp.					
Endasys spp.					
Atractodes sp.					
Ischnus cinctipes (Walsh)					
Cratichneumon paratus (Say)					
Cratichneumon spp.					
Cremastus spp.					
Habrocryptoides rufifrons (Walsh)					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Ibaliidae					
Ibalia ensiger Norton[1,2]					
Family Cynipidae					
Neuroterus sp.[1,2]					
Andrious flavohirtus Beutenmueller[1,2]					
Callirhytis futilis (Osten Sacken)[1,2]					
Callirhytis sp.[1,2]					
Family Evaniidae					
Hyptia harpyoides Bradley					
Family Pelecinidae					
Pelecinus polyturator (Drury)[1]					
Family Proctotrupidae					
Brachyserphus abruptus (Say)					
Codrus sp.					
Family Diapriidae					
Aneurhynchus sp.[1]					
Family Bethylidae					
Pseudisobrachium sp.					
Family Mutillidae					
Pseudomethoca simillima (Smith)					
Family Formicidae					
Stenamma sp.					
Aphaenogaster rudis Emery					
Aphaenogaster lamellidens Mayr					
Pheidole bicarinata vinelandica (Forel)					
Pheidole sp.					
Crematogaster cerasi (Fitch)					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Crematogaster sp.					
Monomorium minimum (Buckley)					
Leptothorax curvispinosus Mayr					
Dorymyrmex sp.					
Camponotus americanus Mayr					
Camponotus pennsylvanicus (DeGeer)					
Camponotus ferrugineus (Fabricius)					
Camponotus nearticus Emery					
Camponotus sp.					
Prenolepis imparis (Say)					
Formica sp.					
Family Vespidae					
Vespula maculifrons (Buysson)					
Vespula maculata (Linnaeus)					
Family Pompilidae					
Auplopus nigrellus (Banks)					
Aporus niger (Cresson)					
Psorthaspis mariae (Cresson)					
Family Sphecidae					
Trypoxylon carinatus Say					
Family Halictidae					
Lasioglossum sp.					
Family Apidae					
Xylocopa virginica (Linnaeus)					
Bombus impatiens Cresson					
Apis mellifera Linnaeus					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Order Coleoptera					
Family Carabidae					
Anillus carolinae Casey					
Tachys flavicauda Say					
Cyclotrachelus vinctus (Leconte)					
Evarthrus americanus (Dejean)					
Galerita bicolor Drury					
Lebia ornata Say					
Lebia ashevillensis Casey					
Coptodera aerata (Dejean)					
Pinacodera limbata (Dejean)					
Harpalus compar Leconte					
Harpalus pennsylvanicus DeGeer					
Stenolophus conjunctus (Say)					
Agonoderus lecontei Chaudoir					
Family Noteridae					
Suphisellus sp.					
Family Hydrophilidae					
Tropisternus lateralis nimbatus (Say)					
Cercyon haemorrhoidalis (Fabricius)					
Cercyon navicularis Zimmermann					
Cercyon maculatus Melsheimer					
Cercyon spp.					
Cryptopleurum minutum (Fabricius)					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Silphidae					
Nicrophorus carolinus (Linnaeus)					
Nicrophorus orbicollis (Say)					
Nicrophorus marginatus Fabricius					
Nicrophorus pustulatus Herschel					
Nicrophorus vespilloides Herbst					
Nicrophorus tomentosus Weber					
Necrodes surinamensis (Fabricius)					
Silpha inaequalis Fabricius					
Silpha noveboracensis Forster					
Silpha americana Linnaeus					
Necrophilus pettiti Horn					
Family Leptodiridae					
Catops simplex Say					
Catops spp.					
Prionochaeta opaca Say					
Ptomaphagus consobrinus LeConte					
Ptomaphagus spp.					
Dissochaetus oblitus LeConte					
Family Orthoperidae					
Sacium sp.					
Family Staphylinidae					
Proteinus new sp. ?					
Megarthrus sinuaticollis Lacordaire					
Megarthrus americanus Sachse					
Megarthrus sp.					
Omalium caesum Gravenhorst					

Species	Stage of Decomposition: Fresh	Bloated	Active Decay	Advanced Decay	Dry
Omalium foraminosum Maklin					
Omalium quadripenne Casey					
Omalium repandum Erichson					
Omalium rivulare Paykull					
Omaliinae					
Genus and species #1					
Genus and species #2					
Oxytelus insignitus Gravenhorst					
Oxytelus pennsylvanicus Erichson					
Oxytelus tetracarinatus Block					
Oxytelus species #1					
Oxytelus species #2					
Pinophilus latipes Gravenhorst					
Pinophilus opacus LeConte					
Pinophilus sp.					
Homeotarsus sp.					
Achenomorphus corticinus Gravenhorst					
Rugilus angularis Erichson					
Rugilus biarmatus LeConte					
Rugilus sp.					
Hypongrus pusillus Sachse					
Philonthus politus Linnaeus					
Philonthus chalceus Stephens					
Philonthus asper LeConte					
Philonthus varians Paykull					
Philonthus alumnus Erichson					
Philonthus brunneus Gravenhorst					

Species	Stage of Decomposition: Fresh	Bloated	Active Decay	Advanced Decay	Dry
Philonthus cyanipennis Fabricius					
Philonthus filicornis Horn					
Philonthus ventralis Gravenhorst					
Philonthus rectangulus Sharp					
Philonthus spp.					
Hesper baltimorensis Gravenhorst					
Belonuchus rufipennis Fabricius					
Belonuchus formosus Gravenhorst					
Belonuchus sp.					
Staphylinus vulpinus Nordmann					
Staphylinus maculosus Gravenhorst					
Staphylinus femoratus Fabricius					
Staphylinus tomentosus Gravenhorst					
Staphylinus fossator Gravenhorst					
Staphylinus cinnamopterus Gravenhorst					
Staphylinus maxillosus Linnaeus					
Ontholestes cingulatus Gravenhorst					
Quedius capucinus Gravenhorst					
Quedius sp.					
Tachinus fimbriatus Gravenhorst					
Tachinus fumipennis Say					
Tachinus pallipes Gravenhorst					
Tachinus sp.					
Atheta sp.					
Aleodorus bilobata Say					
Falagria dissecta Erichson					
Aleocharini-undetermined species					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Aleochara lustrica Say					
Aleochara lata Gravenhorst					
Aleochara bipustula Linnaeus					
Aleochara nitidicollis Casey					
Aleochara spp.					
Barydoma sp.					
Pteronius species #1					
Pteronius species #2					
Family Ptiliidae					
Acratrichis sericans Heer					
Genus and species?					
Family Histeridae					
Hister coenosus Erichson					
Hister abbreviatus Fabricius					
Hister incertus Marseul					
Hister depurator Say					
Hister osculatus Blatchley					
Hister indistinctus Say					
Hister densicauda Casey					
Atholus sedecimstriatus (Say)					
Platysoma carolinum Payskull					
Phelister subrotundus Say					
Phelister vernus Say					
Margarinotus cadaverinus (Hoffman)					
Margarinotus stygicus LeConte					
Margarinotus marginicollis LeConte					
Margarinotus confusus Wenzel					

Species	Stage of Decomposition: Fresh	Bloated	Active Decay	Advanced Decay	Dry
Xestipyge conjunctum Say					
Carcinops pumilio Erichson					
Onthophilus alternatus Say					
Onthophilus new sp.?					
Acritus fimetarius LeConte					
Acritus strigosus LeConte					
Saprinus lugens Erichson					
Saprinus semistriatus Scriba					
Euspilotus assimilis (Paykull)					
Euspilotus conformis LeConte					
Gnathoncus sp.					
Family Lycidae					
Calopteron reticulatum (Fabricius)[1,2]					
Family Lampyridae					
Lucidota sp.[1]					
Pyractomena (sp. unknown immature)[1]					
Family Cantharidae					
Podabrus basillaris (Say)[1]					
Genus and species?[1]					
Family Cleridae					
Phyllobaenus sp.[1]					
Necrobia rufipes DeGeer					
Family Anthicidae					
Tomoderus constrictus (Say)					
Anthicus sp.					

Species	Stage of Decomposition: Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Elateridae					
Conoderus lividus (DeGeer)[2]					
Limonius sp.[2]					
Athous fossularis (LeConte)[2]					
Orthostethus infuscatus (Germar)[2]					
Megapenthes rufilabris (Germar)[2]					
Ischiodontus fuscus (LeConte)[2]					
Melanotus sp.[2]					
Family Eucnemidae					
Perothrops mucida (Say)[1,2]					
Family Dermestidae					
Dermestes marmoratus Say					
Dermestes caninus Germar					
Family Nosodendridae					
Nosodendron unicolor Say[1]					
Family Ostomidae					
Tenebroides corticalis (Melsheimer)					
Tenebroides spp.					
Family Nitidulidae					
Carpophilus pilosellus Motschulsky					
Carpophilus mutilatus Erichson					
Carpophilus lugubris Murray					
Nitidula rufipes (Linnaeus)					
Omosita colon (Linnaeus)					
Stelidota geminata (Say)					
Stelidota strigosa (Gyllenhal)					
Stelidota sp.					
Glischrochilus fasciatus (Olivier)					
Glischrochilus quadrisignatus (Say)					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Rhizophagidae					
Monotoma americana Aube					
Monotoma spp.					
Family Cucujidae					
Oryzaephilus mercator (Fauvel)					
Silvanus bidentatus (Fabricius)					
Silvanus imbellis LeConte					
Laemophloeus filiger Casey[1]					
Family Cryptophagidae					
Cryptophagus sp.					
Family Mycetophagidae					
Mycetophagus punctatus Say					
Mycetophagus flexuosus Say					
Typhaea stercorea (Linnaeus)					
Litargus didesmus Say					
Litargus sp.					
Family Colydiidae					
Namunaria guttulatus (LeConte)					
Family Endomychidae					
Aphorista vittata (Fabricius)					
Endomychus biguttatus Say					
Family Phalacridae					
Phalacrus sp.[1]					
Family Coccinellidae					
Brachyacantha quadripunctata Melsheimer[1,2]					
Axion tripustulatum (DeGeer)[1,2]					

Species	Stage of Decomposition: Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Alleculidae					
Isomira sp.					
Mycetochara sp.					
Family Tenebrionidae					
Hoplocephala bicornis (Olivier)					
Tarpella undulata (LeConte)[1]					
Helops aereus Germar[1]					
Family Melandryidae					
Eustrophinus bicolor (Fabricius)[1]					
Family Ptinidae					
Ptinus fur Linnaeus					
Family Scarabaeidae					
Glyphyrocanthon viridis (Beauvois)					
Deltochilum gibbosum (Fabricius)					
Ataenius figurator Harold					
Ataenius spretulus (Haldeman)					
Ataenius platensis (Blanchard)					
Ateuchus histeroides Weber					
Ateuchus lecontei (Harold)					
Copris minutus (Drury)					
Onthophagus hecate Panzer					
Onthophagus striatulus (Beauvois)					
Onthophagus pennsylvanicus Harold					
Serica vespertina (Gyllenhal)[2]					
Serica sp.[1,2]					
Family Geotrupidae					
Geotrupes blackburnii blackburnii (Fabricius)					
Beotrupes blackburnii excrementi Say					
Geotrupes splendidus splendidus (Fabricius)					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Family Trogidae					
Trox aequalis Say					
Trox monachus Herbst					
Trox asper (LeConte)					
Trox suberosus Fabricius					
Trox unistriatus Beauvois					
Trox variolatus Melsheimer					
Family Lucanidae					
Platycerus virescens (Fabricius)[1,2]					
Family Cerambycidae					
Xylotrechus sagittatus (Germar)[1,2]					
Family Chrysomelidae					
Oedionychus sp.[1,2]					
Rhabdopterus sp.[1,2]					
Family Curculionidae					
Brachyrhinus ovatus (Linnaeus)[1,2]					
Hypera meles (Fabricius)[1,2]					
Centrinaspis penicellus (Herbst)[1,2]					
Cyrtepistomus castaneus Roelofs[1,2]					
Family Scolytidae					
Hylastes tenius Eichhoff[1,2]					
PHYLUM CHORDATA					
Class Amphibia					
Order Salientia					
Family Bufonidae					
Bufo fowleri Hinckley					

Species	Stage of Decomposition				
	Fresh	Bloated	Active Decay	Advanced Decay	Dry
Class Aves					
Order Piciformes					
Family Picidae					
Caloptes auratus (Linnaeus)			- —	— -	
Order Passeriformes					
Family Mimidae					
Mimus polyglottos (Linnaeus)			- - —	—	- -
Toxostoma rufum (Linnaeus)			- - —	—	-
Family Turdidae					
Hylocichla mustelina (Gmelin)			- - —	— -	- -
Family Fringillidae					
Pipilio erythrophthalmus (Linnaeus)			- - —	—	- -
Class Mammalia					
Order Marsupialia					
Family Didelphidae					
Didelphis marsupialis Linnaeus	- - - -	—	—	— - -	

Internal Distribution

1-50	S. I. Auerbach
51	B. G. Blaylock
52	Carl Bell
53	J. C. Bresee
54	G. N. Brown
55-104	D. A. Crossley, Jr.
105	J. W. Curlin
106-155	P. B. Dunaway
156	W. H. Jordan
157	N. R. Kevern
158	Lovell L. Lewis
159	J. Liverman
160	K. Z. Morgan
161	D. J. Nelson
162	J. S. Olson
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