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An Experimental Study of Small Animal Remains in Archaeological Pit Features

Thomas R. Whyte
University of Tennessee, Knoxville

To the Graduate Council:

I am submitting herewith a dissertation written by Thomas R. Whyte entitled "An Experimental Study of Small Animal Remains in Archaeological Pit Features." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Anthropology.

Gerald F. Schroedl, Major Professor

We have read this dissertation and recommend its acceptance:

Walter E. Klippel, David A. Etnier, Paul W. Parmalee

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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AN EXPERIMENTAL STUDY OF SMALL ANIMAL REMAINS IN ARCHAEOLOGICAL PIT FEATURES

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Thomas R. Whyte

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ABSTRACT

Shells of terrestrial snails and bones of small vertebrates such as toads, frogs, shrews, and mice are often recovered from pit features on archaeological sites in eastern North America. Attempts by archaeologists to reconstruct human subsistence behavior are impeded by an inability to determine whether these small animal remains represent cultural refuse or natural entrapment. An exploratory experimental program aimed at mitigating this dilemma was conducted along the Tennessee River near Knoxville, Tennessee from May 1985 to June 1986. The goals of this experimental program were to determine (1) the causes of natural entrapment of animals in pits, (2) the spatial and physical characteristics of remains of small animals trapped in pits, and (3) the seasonal and climatological variability of small animal occurrences in pits.

Fifteen cylindrical pits measuring 75 cm in diameter by 75 cm deep were excavated on the experimental site and were varied according to content, the presence or absence of a pit covering, and clearing of the pit margin. In addition, two pits were gradually filled with soil and refuse and then reexcavated at the end of the entrapment experiment. Weekly observations of vertebrate trappings and biweekly observations of land snail abundance in pits were made.

During the 378 day experiment, at least 267 vertebrates were trapped and 811 terrestrial snails were encountered in pits. Vertebrates included seven species of amphibians, six species of reptiles, one bird, and eight species of mammals.

The experimental program provided the basis for making predictions about the archaeological record of the natural entrapment of small animals in pits on sites in eastern North America. Most important among these are the following:

1. Remains of entrapped small vertebrates, if preserved, will tend to occur in deeper pit features that remained open after their abandonment and during their filling, and primarily in the lower levels of those features.

2. shells of naturally introduced terrestrial snails, if preserved, will occur on pit walls and floors and between depositional zones.

3. Remains of entrapped cold-blooded animals will usually occur only in pits that were open during warm seasons.

4. Remains of entrapped mice will be more abundant in deep open pits that contained seeds or other vegetable materials attractive to mice.

5. Remains of entrapped small animals, especially land snails, will be more abundant in pits that were surrounded by vegetation or debris.

Small animal remains from pit features on five late prehistoric and early historic Native American village sites in eastern North America were studied with reference to the experimental entrapment data. Conclusions drawn are that most of the small animal remains in pits on these sites represent natural entrapment, and that the pits were open to receive these animals at least in spring and summer. In

addition, the former contents and environmental settings of pit features are predicted from the kinds and numbers of small animals represented.

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CHAPTER I

INTRODUCTION

A first order of business in the analysis of materials recovered from archaeological sites is determining which items are of cultural origin and which are not. While studying the faunal remains from the Addington site (44VB9), a late prehistoric habitation on the Virginia coast, the author was faced with the problem of distinguishing naturally from culturally deposited animal remains (Whyte 1986, 1988). Several pit features on this site contained the shells of many small terrestrial snails and the bones of toads, frogs, shrews, mice, and rats. Recognizing that such small animals could have become trapped in pits while they were open or in the process of being filled with cultural refuse, and realizing that the same small animals may at times have served as human food suggested the need for an experimental study of the process of natural entrapment in pits.

In eastern North America, where refuse-filled pits are a common feature on late prehistoric and historic period Native American village sites, the occurrence of small animal remains in pits is quite common. Many archaeologists and specialists (Quitmyer 1985; Reitz 1982; Reitz et al. 1987; Runquist 1979) studying these small animal remains routinely include them along with those of probable food species such as deer and raccoon in prehistoric human dietary statistics. Others (Parmalee and Klippel 1983; Parmalee et al. 1972; Whyte 1986) recognize the possibility that such remains represent naturally entrapped or

intrusive small animals and, therefore, deliberately omit them from tabulations of dietary components or biomass and meat-yield statistics. Presently, however, there are no empirically defined criteria for distinguishing remains of naturally entrapped small animals from those culturally introduced into archaeological deposits.

Clearly, in areas where animal protein was scarce, small animals may have played a critical role in the adaptations of prehistoric human societies (Dansie 1984; Michelsen 1967; Stahl 1982; Thomas 1969). In eastern North America, however, where animal protein sources have probably been abundant throughout prehistory, the importance of small animals in the human diet is questionable. Undoubtedly, small animals such as frogs and mice were occasionally eaten by native eastern North Americans (Watson 1969:55; 1974:46). It is also evident that some small animals were occasionally hunted or collected for reasons other than consumption (Swanton 1979:511). Ethnohistoric references to aboriginal use or consumption of small animals in this region, however, are scarce (Robinson 1978:542).

The common use of pitfall traps by zoologists to monitor small animal distributions and activities (Gibbons and Semlitsch 1982) indicates that pitfalls are an effective means of trapping and containing small animals, and suggests the possibility that many small animal remains recovered from archaeological pit features in eastern North America represent natural entrapments rather than cultural refuse. It is also likely that remains of small animals living among surficial refuse deposits on active or abandoned archaeological sites

were often introduced to those deposits when the animals died. One simply needs to review lists of "commensal" species represented in middens on historic Euroamerican sites in the region to appreciate this fact (e.g., Reitz and Scarry 1985; Reitz 1986).

Despite indications that many or perhaps most small animal remains recovered from prehistoric archaeological contexts in eastern North America represent intrusive or entrapped individuals, archaeologists must always consider the possibility that the remains recovered do represent food animals. For this reason, we need empirically defined criteria for distinguishing remains of entrapped or intrusive fauna from those of animals utilized or consumed (Thomas 1969:398-399).

The purpose of this dissertation is to investigate the natural entrapment of small animals in archaeological pit features on prehistoric and historic Native American village sites in eastern North America. It is predicted that natural entrapment produces an archaeological pattern that is physically and contextually distinguishable from cultural deposition of small animal remains and that the pattern is time and space (from site to site) independent, whereas cultural deposition of small animal remains is not. For example, remains of naturally trapped small animals should generally show no evidence of butchery or consumption, such as breakage, burning, pitting, or differential skeletal representation. Furthermore, the remains of entrapped vertebrates should more often occur in the lower levels of deep, steep-walled pit features. On the contrary, remains of

small animals utilized or consumed by humans should show some evidence of preparation or consumption (see Dansie 1984), and should indicate a depositional pattern similar to that of remains of other, larger food species.

Specifically, this research develops criteria that enable archaeologists working in eastern North America to distinguish remains representing natural faunal accumulations in pits from those representing cultural refuse deposition. Furthermore, the information potential of small animal remains with regard to assessing the seasonality of site use and pit feature abandonment and pit feature environment is explored. This is achieved through experimentation with the natural entrapment of small animals in pits and by researching studies of small animal behavior and ecology.

As Binford (1981) and Schiffer (1983) have strongly urged, we must, through experimentation and observation in the present, develop tools for linking the contemporary facts of the archaeological record to the dynamic processes of the past which produced them. It is a fact that small animal remains commonly occur in archaeological pit features in eastern North America. There are two reasonable hypotheses for explaining their occurrence in these pits: (1) they were deposited as refuse by humans using the pits; and (2) they resulted from animals naturally accumulating in the pits or in midden deposits dumped in them.

With these considerations in mind, the following chapter gives a brief review of archaeological and ethnohistorical evidence for the use

or consumption of small animals such as land snails, anurans, insectivores, and small rodents by native eastern North Americans. Then follows the presentation of an experimental program of small animal entrapment aimed at determining (1) the causes of entrapment of animals in pits, (2) the spatial and physical characteristics of remains of small animals trapped by pits, and (3) seasonal and climatological patterns of small animal occurrences in pits. The entrapment data produced by this experimental program are supplemented with data produced by zoological experiments in small animal entrapment, behavior, and ecology to provide a number of criteria necessary to identify the "signature pattern" (Binford 1981:26) of natural small animal entrapment in pits.

The final chapters apply this information to the analysis of faunal data from five prehistoric and historic period Native American village sites in eastern North America. Each of these sites contained pit features which yielded numerous remains of small animals among accumulations of human food refuse, posing the problem of distinguishing food species from those occurring naturally in the pits. The evidence for entrapment versus the human use or consumption of small animals and the subsequent deposition of their remains in pits is examined in each case. In addition, based on the presence and abundance of remains of certain species and their contextual placement within pits on each site, attempts are made to infer the seasonality of pit feature abandonment and site use, and the nature of the ground surface surrounding pits at the time of their filling.

CHAPTER II

BACKGROUND RESEARCH

Ethnohistorical Literature Review

One would think that the use or consumption of land snails, anurans, insectivores, and rodents by Native eastern North Americans would have been of sufficient novelty to European colonists and explorers to have "made the headlines" of the ethnohistorical literature, considering that these were not common items of the average European diet of the time. There are, however, few references to the aboriginal use or consumption of these animals. A review of many available sources (Hudson 1976, the Human Relations Area File, Lefler 1967, Swanton 1946, Van Doran 1928, Williams 1930) produced only four references to the possible consumption of frogs. Newcomb (1956:16) citing the notes of Van der Donk, mentions that the Delaware Indians "use all kinds of fish, which they commonly cook without removing the entrails, and snakes, frogs and the like." A second reference by Schwarze (1923:55) indicates that the Lower Cherokee referred to the Upper Cherokee as "frog eaters." Although this may represent a derogatory generalization, it at least suggests that some Native Americans disdained the consumption of frogs. Hudson (1976:411), also referring to the Cherokee, mentions that a ball player was not allowed to eat a frog's meat because its bones are easily broken. This may imply that those who were not ball players did consume frog meat. John Lawson (Lefler 1967:137), referring to Indians of the North

Carolina area, gives us the following: "The common land frog is likest to a toad, only he leaps, and is not poisonous. He is a great devourer of ants, and the snakes devour him. These frogs baked and beat to a powder, and taken with orrice-root cures a tympany." Lawson may have been collectively referring to toads (Bufo spp.) or perhaps the eastern narrow-mouthed toad (Gastrophryne carolinensis) which is noted for its consumption of ants (Conant 1975:334). Nevertheless, assuming that these animals were eaten by some Native Americans as a medicinal cure, their preparation for consumption as cited by Lawson (Lefler 1967) would certainly have diminished their archaeological visibility!

Ethnohistorical references to the consumption or use of insectivores, mice, or rats by Native eastern North Americans is all but absent (Robinson 1978:542). Swanton (1979:511), citing William Strachey, indicates one possible occasion of the use of rats:

> ...and some of their [Powhatan] men there be who will weare in these [pierced ear] holes a small greene and yellow-coloured live snake, neere half a yard in length, which crawling and lapping himself about his neck oftentymes familiarly, he suffereth to kisse his lippes. Others weare a dead ratt tyed by the tayle, and such like conundrums.

Mention of the use of land snails by Native Americans of the region is equally rare. Hester and Hill (1975) cite Alvar Nunez Cabeza de Vaca as referring to the consumption of snails by Indians of southern Texas. There is no indication, however, as to whether Nunez Cabeza de Vaca's reference was to land snails or to freshwater snails. It is certain that at least some species of North American land snails

are edible (Allen 1916), but ethnohistorical documentation of their consumption by native eastern North Americans is inconclusive.

There are nearly as many references to the avoidance of or disdain for small animals by Native Americans of the region as there are to their use or consumption. Swanton (1979:290) relates the following:

> Adair, interested in establishing a series of food restrictions which would bear out his theory on an Isrealitish origin for the Indians, says that, in ancient times, they would not eat the beaver or opossum, and in later times they would not touch eagles, ravens, crows, bats, owls, flies, mosquitoes, worms, wolves, panthers, foxes, cats, mice, rats, moles, snakes or horses, though the Choctaw ate the last two mentioned. In general the Chickasaw would touch no birds of prey or birds of night, no beast of prey except the bear, and no aquatic animals including frogs.

Adair also noted (Williams 1930:139) that the Indians "...abhor moles so exceedingly, that they will not allow their children ever to touch them, for fear of hurting their eyesight; reckoning it contagious."

While these references are provocative and perhaps entertaining, they must be considered for what they are--experiences interpreted and possibly embellished by explorers, not ethnographers. On the one hand writers may have consciously or unconsciously emphasized the "savage" or "vulgar" habits of the Indians, and on the other, they may have ignored information not relevant to their particular interests.

Archaeological Literature Review

Although small animal remains are common in archaeological faunal assemblages in eastern North America, it is difficult to argue that they represent food remains unless they occur in human paleofeces. These are exceedingly rare items in this region, found only in dry shelters and caves. The largest and best studied samples come from Salts and Mammoth Caves, Kentucky (Watson 1969, 1974). Of 27 paleofeces studied from Mammoth Cave, two contained animal bones (Watson 1974:43-47). One of these, Specimen 24, contained frog (*Rana* sp.) and snake (subfamily Colubrinae) bones. Nine of the 100 specimens examined from Salts Cave contained vertebrate remains (Watson 1969:55), including bones of fish, a salamander, a small bird, and small rodents (*Microtus* sp. and *Peromyscus* sp.).

Accepting these paleofeces as being of human origin, it is a fact that small mammals and amphibians were consumed by prehistoric Indians of eastern North America. However, these paleofecal data provide no insights concerning the circumstances or regularity of consumption of these small animals by visitors to the caves, and they probably do not reflect the diets of all eastern North American Indian societies throughout prehistory. Nevertheless, they do illustrate the fact that analyses of human diets based upon faunal assemblages that include small animal remains must distinguish those introduced naturally from those introduced culturally.

Other kinds of archaeological evidence for small animal consumption in eastern North America are limited. Robinson (1978)

identified a mole radius from the Banks V site (40CF111) in Tennessee as having butchering marks near its proximal end. This evidence, of course, does not necessarily indicate that the mole had been eaten, but does suggest that the animal or parts of it were used for some purpose (Parmalee 1975).

Shells of terrestrial snails are very common in archaeological deposits throughout the world when carbonate levels in deposits are sufficient to preserve them (Evans 1972). In most cases they are disregarded as potential food refuse. It has been proposed by some researchers (Hubricht 1954; Parmalee et al. 1972) that land snail shells naturally occur in some archaeological deposits because the snails were attracted to the calcium of aquatic mollusk shells occurring as food refuse in those deposits and died there. Others have assumed that land snail shells found in archaeological deposits represent human food refuse.

Hester and Hill (1975) suggest that the occurrence of large numbers of unbroken terrestrial snail shells in archaeological middens in southern Texas is evidence that they were eaten by the Indians living there. Intrigued by the fact that the shells were often unbroken, they experimentally replicated a means of cooking the snails and extracting the meat without damaging the shells to support their hypothesis that the archaeological specimens represent food refuse. They also provide an ethnographic account by Alvar Nunez Cabeza de Vaca of "snail" consumption by Indians of southern Texas in support of their

argument, but Nunez Cabeza de Vaca's account may have been in reference to aquatic snails.

Blakeslee (1945:109) studied land snail shells from archaeological pit features on a site on Fontenac Island, New York, excavated by William A. Ritchie, and reported the following:

> The pits in which the shells were found were two and one half to three feet deep and averaged three feet in diameter. There were seven of them, placed irregularly over the island. The shells and artifacts occupied the lower two thirds of the pits and soil the upper third. The Doctor [Ritchie] is assuming the snails were used for food but has no explanation nor conjecture as to why they were thrown into the pits instead of being disposed of by tossing into the lake waters.

Bobrowsky (1984:82), who provides a thorough analysis of reports of both aquatic and terrestrial gastropods from archaeological sites, correctly indicates that "since certain archaeologists remain skeptical of the suggestion that gastropods served as a prehistoric food source in North America, the burden of proof is on the proponents of the food model to provide several convincing indications to support their interpretations." Klippel and Morey (1986) responded to this call with an excellent case for the prehistoric human use of freshwater gastropods in the Duck River valley, Tennessee. However, no convincing cases for archaeological evidence of terrestrial gastropod consumption in prehistoric eastern North America, Hester and Hill (1975) included, have been presented.

Summary

The ethnohistorical and archaeological evidence for the consumption or use of small rodents, insectivores, anurans, and terrestrial snails by eastern North American Indians is not sufficient to explain the regular occurrence of large numbers of remains of these animals in archaeological contexts. It does, however, indicate that certain of these animals were at times eaten or used by some Indians in the region and points to the need for developing criteria for distinguishing naturally occurring faunal remains from those of cultural origin.

The fact that small vertebrate remains were found in prehistoric human feces from Salts and Mammoth Caves (Watson 1969, 1974) indicates that small vertebrates were sometimes consumed whole or, at least, that their bones were sometimes consumed. If this was the case, then remains of consumed small animals recovered from archaeological pit features may show splintering, pitting, or other evidence of human consumption and digestion, whereas remains of entrapped small vertebrates will not.

The boiling of small vertebrates, as indicated by Van der Donk (Newcomb 1956:16), may be difficult to identify through the study of archaeological bone. Had small vertebrates been boiled to make a broth, and the solid remains deposited in pits, all skeletal parts would be represented and perhaps show no evidence of modification produced by the boiling. This points to the need for experimentation

in the boiling of small vertebrates and the analysis of boiled small animal bones.

CHAPTER III

EXPERIMENTATION

Purpose

In order to identify the processes which formed the archaeological record we must, by experiment, attempt to replicate those processes, observe the static physical and contextual results of those processes, and compare the results to the archaeological record (Binford 1981). The natural accumulation of small animals by entrapment in pits is a replicable process. The uniformitarian assumption that terrestrial snails and small vertebrates behave the same and occur in the same kinds of environments today as they did in recent prehistory is warranted. However, the replication of pits that may have trapped and contained animals must consider a range of possibilities regarding pit shape, dimension, content, and surrounding soil and surface conditions.

While the cultural deposition of small animal remains in pits by humans may also be a replicable process, the potential events preceding deposition, such as dismemberment, evisceration, cooking, pulverization, consumption, and defecation, responsible for determining the physical characteristics of skeletons, bones, or shells deposited, would require a number of different and potentially difficult to control experiments that cover a range of possibilities determined by culturally variable behavior.

An experimental program was designed to replicate the process of natural entrapment of small animals in pits. This experiment is considered exploratory in that it was not designed to test particular hypotheses, but to permit observations that can be used to construct plausible hypotheses concerning the formation of the archaeological record of pit features. More specifically, it was designed to permit four kinds of observations concerning small animal entrapment in pits. These include observations on (1) the kinds of vertebrate and land snail species which may become trapped in pits, (2) the ways in which particular species enter and become trapped in pits, (3) climatic and seasonal variability in species entrapment and entrapment frequency, and (4) the interaction of species entrapment and human refuse disposal in pits.

Knowing what kinds of animals may become trapped in pits is a first step toward distinguishing remains of entrapped animals from those of human refuse. Many zoological studies employing pitfall traps in eastern North America (Beacham and Krebs 1980; Boonstra and Krebs 1978; Gibbons 1970; Gibbons and Bennett 1974; Gibbons and Semlitsch 1982; Howard and Brock 1961; Hudson and Solf 1959; Semlitsch and Pechmann 1985) already hint to the kinds of animals that we may expect to find represented in archaeological pit features. For example, during the course of one year, 25 species of amphibians, 35 species of reptiles, and 15 species of mammals were trapped in pits on the Savannah River Plant in South Carolina in an attempt to monitor species presence, abundance, and activity (Gibbons and Semlitsch 1982). This

pitfall trapping program indicated that many small animals will simply blunder into unbaited pitfall traps. Shields (1985), however, suggests that amphibians will deliberately enter pitfall traps containing water in seeking shelter or thermal stasis. It is also well-known that many small mammals can be caught more readily in baited traps (Fitch 1954), indicating that the contents of archaeological pit features may at times have actually served to attract small animals into them. Knowing why particular species get into and become trapped in experimental pits may be useful in reconstructing the former contents, morphologies, and settings of archaeological pit features, and, therefore, provide potential clues to their functions. Such reconstructions would provide a stronger base for analyzing archaeological household spatial organization and other aspects of community structure (Schroedl 1986).

Recognizing climatic and seasonal variability in species entrapment may provide a means of assessing the seasons during which some pits were open on archaeological sites and when the sites were presumably in use. Humidity, rainfall, cloud cover, and temperature have variable affects on the activities of different species of animals (Briese and Smith 1974; Gentry and Odum 1957; Henderson 1945; Henne 1963; Mossman 1955; Shields 1985) and will therefore affect the rate and seasonality of entrapment of small animals in pits occurring within their ranges or migration routes. Identifying the season(s) during which a pit was open to trap small animals and receive refuse deposits may contribute to an understanding of pit function and of the seasonality of consumption of food animals represented in cultural

deposits associated with the small animal remains. While most faunal seasonality studies identify the seasons of faunal resource exploitation (Claassan 1986; Manzano 1985; Monks 1981; Morey 1983), they do not necessarily identify seasons of resource consumption or refuse deposition.

The interaction of species entrapment and human refuse disposal in pits has relevance to analyses of the periodicity and rates of pit filling and of the seasonal relationship of refuse deposits and accumulations of remains of entrapped small animal remains. Furthermore, examination of this interaction in an experimental setting is crucial to making the distinction between remains of entrapped small animals and those potentially representing human refuse.

In summary, the entrapment experiment was designed to permit observation of the interaction of natural and cultural events contributing to the formation of the archaeological record of pit features. By documenting and understanding this interaction, questions concerning seasonality (of feature use, artifact and food resource use, and site occupation), site environmental conditions, and refuse disposal behavior may be answered.

Site Setting

The experiment was conducted in an old agricultural field between a man-made pond and the Tennessee River on the University of Tennessee Holston Farm near Knoxville (Figure 1). The regional setting of the site is the Ridge and Valley province of eastern Tennessee where

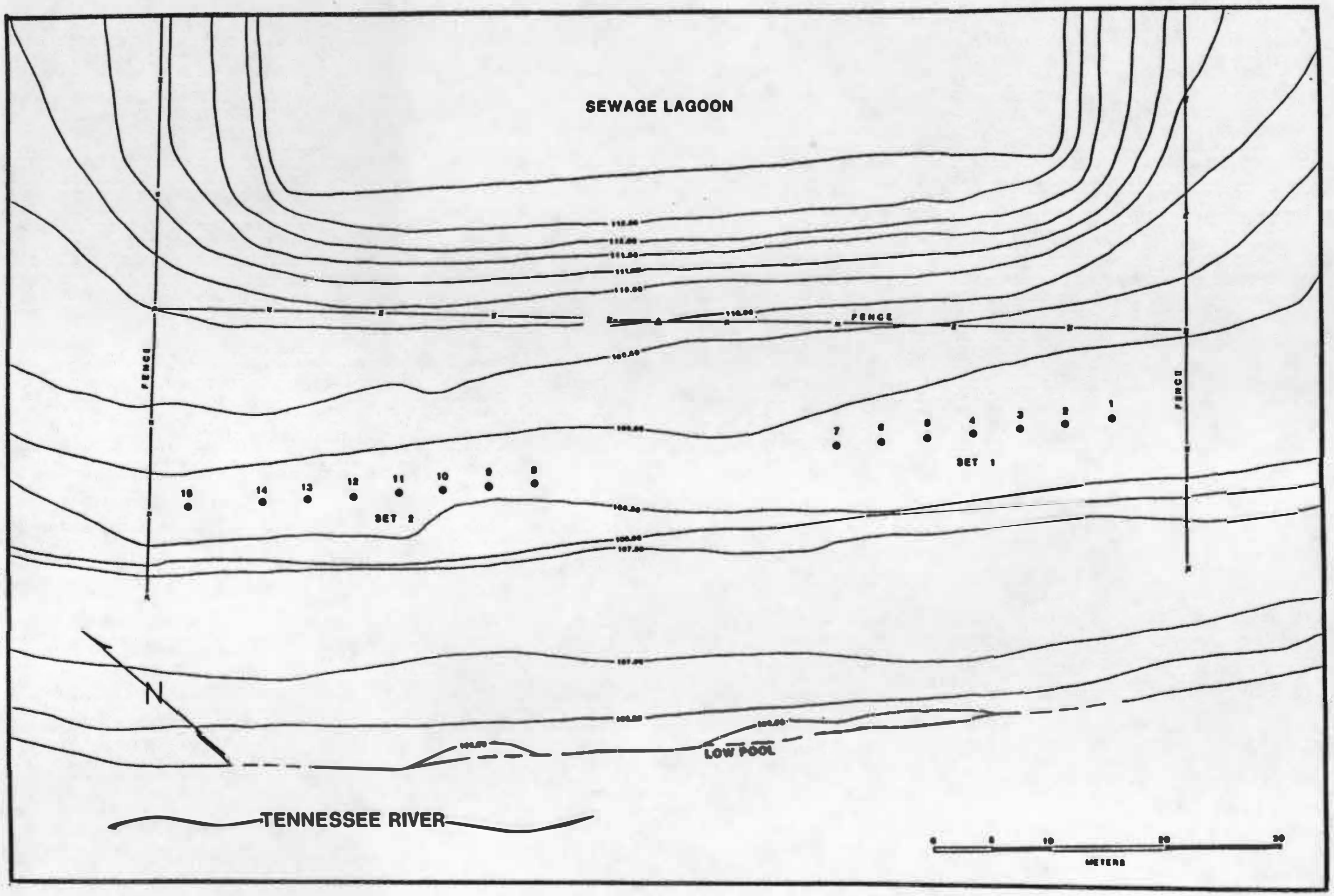

Figure 1. Map of the Holston Farm experimental site showing the configuration of experimental pits.

mean annual precipitation is 121 cm and mean temperatures range from 4^{o} C in January to 25^{o} C in July (Ruffner and Bair 1981). The site lies on an east bank first terrace of the Tennessee River approximately 1 km downstream from the confluence of the Holston and French Broad rivers. The Tennessee River at this point is impounded within Fort Loudoun Reservoir, but being only a short distance from where the river enters the lake, has a noticeable current. The annual winter drawdown of the reservoir lowers the water level approximately 1.5 m at this point and creates a ca. 20 m wide beach below the terrace face.

The pond immediately northeast and uphill of the site is a sewage lagoon of the Knoxville Community Service Center. This pond supports populations of many species of amphibians and reptiles. During the course of the experiment painted turtles and snapping turtles were seen moving between this pond and the Tennessee River, and many frogs were heard calling from the pond.

The experimental site is bordered on the northwest by a large cornfield and on the southeast by a large hay field which was mowed twice during the course of the experimental program. Each field is separated from the site by a barbed wire fence, while the pond to the northeast is separated from the site by a chain link fence (Figure 1). There is no fence between the river and the site; however the river bank is fairly steep and roughly 1 m in height. In some places, particularly where large tree stumps occur, the bank is undercut and contains mink and muskrat burrows.

A soil profile of the site terrace revealed a ca. 40 cm loamy plowzone (Ap_1) containing many fine roots of the overlying grasses and weeds. This is underlain by a ca. 16 cm thick horizon (Ap_2) of loamy fine sand containing few fine roots. A third horizon (B_1) extends to an undetermined depth and consists of a loamy fine sand lacking organic matter.

During the construction of the experimental pits, historic and prehistoric period artifacts were recovered from the Ap_1 and Ap_2 horizons, and prehistoric period artifacts were recovered from the B_1 horizon. The latter include chert flakes, burned rocks, and Middle Woodland period pottery sherds, indicating late Holocene Epoch deposition of the upper strata of the terrace.

The site had lain fallow for four years prior to the experiment. The surface vegetation at the time of the experiment was predominantly grasses and weeds, with a few small trees occurring along the terrace edge between the site and the river. Ground cover consisted mainly of ground ivy (*Glechoma hederacea*) and Johnson grass (*Sorghum halapense*). Other herbaceous plants common on the site included daisy fleabane (*Erigeron strigosus*), red clover (*Trifolium pratense*), and muhly (*Muhlenbergia schrebery*). Arboreal species along the terrace edge included silver maple (*Acer saccharinum*), box elder (*A. negundo*), white ash (*Fraxinus americana*), American sycamore (*Platanus occidentalis*), and black willow (*Salix nigra*).

The setting of the site was suitable for the entrapment experiment for three reasons: (1) it was somewhat isolated and

protected from potential disturbance by humans and large animals; (2) having lain fallow for approximately four years and being bordered by water, it was an ideal habitat for many species of land snails and small vertebrates; and (3) it was similar to the settings of many late prehistoric and historic period archaeological sites containing pit features. The site was not, however, intended to mimic or represent an idealized form of human habitation. Only the experimental pits themselves, as discussed below, were intended as representations of actual situations; the requirements of the experimental site setting were primarily concerned with features of access and small animal presence.

Pit Descriptions

Pitfall traps consisting of sunken cans (Hudson and Solf 1959) and buckets (Gibbons and Semlitsch 1982) have proven effective as means of trapping and containing amphibians, reptiles, and small mammals. Their success is in part due to the inability of many animals to climb the smooth, vertical sides of metal or plastic containers. Sunken buckets used in Savannah River Plant ecology experiments were only 35-40 cm deep (20 liter plastic buckets), yet were able to contain many species of amphibians, reptiles, and mammals, the latter including rats and young rabbits (Gibbons and Semlitsch 1982). Apparently small animals having jumping capabilities (frogs, toads, mice, and rats) are sometimes unable to free themselves from depths of only 40 cm by jumping.

Aboriginal pits typical of many late prehistoric and early historic period village sites in eastern North America would have imposed a different set of constraints on small vertebrates entering or falling into them. Aboriginal pit features would have had earthen sides or sides lined with bark, matting, or the like. Lined pits, had the linings been left in the pits when they were abandoned, would have provided a means of escape for species able to climb (e.g., small rodents). The loose, naturally-occurring soils of unlined pits, however, may have been difficult or impossible for even the most adept climbers to negotiate, given fairly steep or insloping sidewalls.

Pit features in archaeological sites in eastern North America are quite variable in shape, size, depth, and presumably, in function (Schroedl 1986; Stewart 1977). Those containing small animal remains are no less variable, ranging in depth from only a few centimeters to nearly 2 m and varying in shape from shallow basins to deep cylinders or bells (Klippel 1973; Styles 1981; Ward 1986; Whyte 1986).

It was decided that straight-walled experimental pits (cylinders) measuring 75 cm in diameter by 75 cm deep would be well within the size and shape ranges of eastern North American archaeological pit features and would be sufficient to entrap and contain anurans (toads and frogs), turtles, shrews, mice, and perhaps larger mammals.

Fifteen pits were excavated in a line 5 m from the terrace edge and roughly parallel to it (Figure 1). The 15 pits were divided into two sets of seven with one isolated from the rest. The latter (Pit 15)

was kept uncovered and empty and differed from the other 14 by having a vegetation-free surface area extending for 1 m beyond its margin (Figure 2). The pits grouped into two identical sets of seven had dense circumjacent surface vegetation and were varied according to content and the presence of a pit covering (Table 1). Pits 1 and 8 were kept uncovered and empty. Pits 2 and 9 were kept uncovered but were gradually filled with refuse and soil as the experimental program progressed.

Pits 3 and 10 were covered by laying square pieces of plywood over them. These pits contained bowls of sunflower seeds that were replaced every two weeks. Pits 4 and 11 were kept open and contained sunflower seeds that were replaced every two weeks. Pits 5 and 12 were covered the same as Pits 3 and 10 but were kept empty. Pits 6 and 13 were kept open and contained one large filleted fish carcass each, usually of a red grouper (*Epinephelus morio*) or red snapper (*Lutjanus campechanus*), which was replaced nearly every two weeks. Pits 7 and 14, the last in each set, were covered and also contained one fish carcass each.

The pits were varied (descriptions presented in Table 1) to determine if small animals (1) inadvertently blunder into open pits (Pits 1 and 8), (2) go into covered pits because they are attracted to the shelter of a pit covering (Pits 3, 5, 7, 10, 12, and 14), (3) go into pits because they are attracted to seeds in them (Pits 3, 4, 10, and 11), (4) go into pits because they are attracted to meat refuse discarded in them or to insects feeding upon this refuse (Pits 6, 7, 13

Figure 2. Vegetation-free surface surrounding Pit 15.

Table 1. Experimental Pit Variables.

Pit No.	Pit Type	Pit Contents
1 & 8	Open	Empty
2 & 9	Open	Refuse-filled
3 & 10	Closed	Bowl of sunflower seeds, replaced every two weeks
4 & 11	Open	Strewn sunflower seeds, replaced every two weeks
5 & 12	Closed	Empty
6 & 13	Open	Large filleted fish carcass, replaced every two weeks
7 & 14	Covered	Large filleted fish carcass, replaced every two weeks
15	Open	Empty, with vegetation-free surface margin

and 14), or (5) go into pits before and between episodes of refuse deposition and become trapped beneath deposits (Pits 2 and 9).

These variables by no means cover the gamut of possible reasons for the entrapment of small animals in pits. One important possibility not tested in the experimental program, for example, is that toads and frogs may be attracted to pits which retain rainwater for protection against desiccation and for breeding (see Shields 1985). Anurans using archaeological pits containing water may have had difficulty escaping, depending upon the water level, drainage rate, and angles of the pit walls (see Appendix), or may have become trapped by refuse deposition.

Pit 15, having a cleared surface around its margin, was added to the experiment on June 24, 1985 to determine if the absence of surface vegetation would affect a pit's ability to trap animals. This pit was also allowed to erode and accumulate sediment while all other pits (except Pits 2 and 9) were constantly maintained by removing accumulations of debris, sediment, and plant growth. Furthermore, animals that died in this pit were left to decay for the purpose of investigating their archaeological recoverability and identification at the end of the experiment (June 1986).

The experimental site and arrangements of pits were not intended to replicate a human habitation site containing pit features. The many variables of pit location with respect to occupied and abandoned structures, garden areas, midden or "toft" areas (Hayden and Cannon 1983), areas of frequent human activity and areas of infrequent human activity would be very difficult to control. It is assumed that

variability in site surface vegetation and other kinds of cover would especially have determined the abundance and kinds of species of small animals occurring in the area of any given pit feature. Thus, two pits being equal in all respects except proximity to small animals living on or migrating through a site may produce quite different entrapment records.

Only one simple discrete variable of pit location--the presence or absence of surface vegetation surrounding a pit--was controlled for in the Holston Farm Experiment. Consequently, assessments of archaeological pit margin characteristics reported in Chapter V will only refer to this simple dichotomy. Otherwise, an attempt was made to equalize the experimental pits with regard to access or proximity to environmental features such as the river, terrace edge, pond, and vegetation cover (except Pit 15). Due to spatial constraints, however, pits at either end of the site (Pits 1, 2, 14, and 15) were proximal to active agricultural fields. As discussed in the next chapter, this configuration may have affected species entrapment patterns.

Experiment Duration and Observation Periodicity

The site was visited at least every Monday morning to record weekly entrapments and changes on the site. Dead vertebrates found in Pits 1 through 14 were removed from the site. Dead vertebrates found in Pit 15 were left in the pit. All live vertebrates were released from the pits to maintain the numbers of animals active on the site. Otherwise, observed entrapment frequencies by season would not be

comparable. No attempt was made to mark the animals that were released and it is likely that some individuals, especially small mammals, were captured repeatedly. Nevertheless, each occurrence of an animal in a pit was recorded as a new individual.

Terrestrial snails were counted and removed from pits every other Monday, beginning on July 7, 1985. It is likely that very small species such as pupillids often went unnoticed, biasing snail counts to favor larger species. It should be noted, however, that the larger species are the most likely to be recovered and identified from archaeological sites using standard archaeological recovery techniques.

In addition to regular Monday morning visits, numerous visits were made on other days and at other times of the day, allowing important observations of daily changes and the effects of more specific weather conditions on the pits and on species entrapment.

At the close of the entrapment experiment, June 1986, the sediment and debris which had accumulated in Pit 15 was excavated and water-screened through 1.5 mm mesh screen to recover remains of individuals that died there. At that time, also, a section of the wall of Pit 11 was excavated and similarly screened to recover remains of animals that may have burrowed into the wall at floor level and died in the burrow.

Problems and Modifications

In designing any experiment involving a complex of variables, it is difficult to foresee the many problems that may be encountered

during the course of the experiment. In this strictly exploratory experiment, variable controls were not of paramount concern. The prevention of intrusion and disturbance by humans and other large animals, however, was of concern.

On July 12, soon after the experiment was begun, it was noted that frogs were being taken from pits between observation periods (Table 2). It was also noted that refuse placed in Pits 2 and 9 was on occasion removed and drug from the pits toward the river bank. The finding of raccoon and opossum spoor and scat near the pits indicated the presence of these animals on the site and the probability that they were responsible for the missing frogs and the removal of refuse. It is well-known that raccoons eat frogs (Latham 1950; Schaaf and Garton 1970) and it is doubtful that the frogs escaped from the pits by their own efforts.

To prevent the further taking of frogs from pits, 5 cm by 10 cm mesh wire fencing was pinned to the ground over each open pit. It was hoped that these screens would still allow small animals to become trapped but prevent predation upon them by larger animals. Frogs left in pits continued to disappear, however, and on August 9, 1985, following a brief rainshower, mink spoor and scat were noted in a pit from which frogs were missing. The scat contained the bones of two small ranids, perhaps taken from a pit on an earlier occasion.

Because of their failure to prevent the entry of minks into the open pits, the screens were removed on August 26 and an alternative measure was taken to deter minks from the site. All potential mink

Table 2. List of Animals Missing from Pits and Presumed Removed by Predators.

Date	Pit	Species
6/24/85	11	Hyla chrysoscelis/H. versicolor
7/04/85	15	Rana palustris
7/11/85	4	R. palustris
7/11/85	8	R. palustris (3)
7/11/85	8	Gastrophryne carolinensis
7/11/85	11	R. palustris
7/11/85	15	R. palustris (2)
7/12/85	4	Peromyscus leucopus
7/15/85	4	P. leucopus
7/22/85	4	P. leucopus
7/22/85	9	R. palustris
8/05/85	4	R. palustris
8/05/85	4	R. clamitans (3)
8/12/85	1	R. palustris
8/12/85	11	R. palustris
8/12/85	15	R. palustris
8/16/85	4	R. palustris
9/02/85	11	R. palustris
9/02/85	11	R. clamitans
9/02/85	6	R. palustris
9/02/85	6	R. clamitans
9/07/85	4	Mus musculus
9/07/85	4	P. leucopus
3/31/85	15	Microtus pinetorum
4/07/85	15	R. palustris

dens located along the river bank near the site were repeatedly smoke-bombed for a few days with the intent of causing the minks to leave and reside elsewhere. Frogs continued to disappear, however, and it was decided that the problem would simply have to be accepted and considered in the analysis.

The presence of the screens over the open pits undoubtedly prevented the entrapment of some vertebrates. During the time that they were used, no adult turtles and a fewer number of small vertebrates in general were captured. Immediately following the removal of the screen covers, a muskrat and an adult stinkpot turtle were captured in open pits. This means that reduced entrapment rates and the absence of larger animals from open pits during late July and August 1985 cannot be attributed to seasonal or climatic variables.

The removal of refuse from Pits 2 and 9 by scavengers was not seen as a problem affecting the quality of the experimental program, but as an interesting feature of archaeological deposit formation to be observed and recorded. No attempt was made to prevent scavenging of refuse from these pits. On January 20 a dog (judging from footprints) had dug into Pit 9 and retrieved a deer hide and meat buried in the pit 21 days prior.

On four occasions, mostly in summer, fish carcasses had been scavenged from Pits 6 and 13. These were promptly replaced, and it is doubted that these incidents noticeably affected the potential entrapment of small animals.

In April 1986, some youths fishing near the site had come onto the site and removed the coverings from Pits 3, 5, 7, 10, 12, and 14. The covers were off for only two days, but during this period a bullfrog and two painted turtle hatchlings fell into the pits.

By the middle of July 1985, Pits 4 and 11 had become badly eroded by rainwater and the burrowing activities of entrapped small mammals. Consequently, holes and cracks in these pits were patched with moist clayey soil. To prevent further damage to these pits, the plywood covering from the pit to the north of each one (Pits 5 and 12) was placed over it, and sunflower seeds then placed on the floors of Pits 5 and 12. This in effect exchanged the functions of these pits in the experiment.

In Late January 1986, heavy rains and a malfunction of the sewage pond pump near the site caused flooding in the southern portion of the site. Pit 3 was filled with water for two days until a canal was built to divert the flow and the pump was repaired. Entrapments for that time of year and for Pit 3 in general were so infrequent, however, that the flooding would have had no appreciable affect on the outcome of the experiment.

The local climate during the year of the Holston Farm Experiment varied somewhat from normal. Average monthly temperatures were fairly consistent for the area, except that the months of November 1985 and April 1986 were warmer than usual (Table 3). Precipitation, however, totalling only 88.1 cm for the year, was quite short of the normal average (121.6 cm). The months of May, June, September, and December

Table 3. Comparison of Monthly Temperature and Precipitation Data for the Year of the Experiment to Monthly Averages for Knoxville, Tennessee.

Month:	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
	June 1985 Through May 1986												
$\overline{X}$ Maximum Temp. (°C):	8.3	12.2	16.6	25.0	25.5	30.0	30.5	28.8	28.3	23.3	18.9	7.2	Total
Total Precip. (cm):	3.4	10.6	5.4	4.9	7.0	5.2	10.4	15.1	1.5	7.4	14.4	5.8	88.1
	Monthly Averages from 1939 Through 1978												
$\overline{X}$ Maximum Temp. (°C):	8.7	10.6	15.3	20.9	25.6	29.4	30.8	30.3	27.7	21.7	14.6	9.5	Year $\overline{X}$
$\overline{X}$ Total Precip. (cm):	11.8	11.6	13.2	10.5	9.5	10.4	11.4	9.4	7.2	6.8	8.5	11.3	121.6

Note: Climate data for June 1985 through May 1986 taken from the U.T. Agriculture Experiment Station, Knoxville. Climate data for 1939 through 1978 taken from Ruffner and Bair (1981:695).

1985, and January, March, and April 1986 were particularly dry (Table 3). It is not known how this precipitation shortage may have affected the composition of the local microfauna or the numbers of individuals of any one species inhabiting the area. It is almost certain, however, that the activities of land snails, amphibians, reptiles, and small mammals inhabiting or moving through the site were affected in some way (see Gentry and Odum 1957; Gibbons and Bennett 1974; Henderson 1945; Hirth 1959; Orr 1959).

Despite the unusual precipitation pattern for the year of the experiment, basic seasonal patterns of activity and entrapment, and patterns of entrapment related to pit variables, should not have been affected. Only the actual numbers of individuals of a species trapped are likely to have been affected by the unusually low amount of precipitation.

CHAPTER IV

EXPERIMENT RESULTS

Through the course of the 378 day experiment, at least 267 vertebrates representing 22 species were trapped, and 811 land snails were counted in pits. Figure 3 provides a plot of vertebrate entrapment data for each pit. Figure 4 shows a frequency graph of entrapment data for all pits combined, indicating a late spring through early fall peak of vertebrate activity on the site. In this chapter, beginning with vertebrates, the entrapment data for each class are presented and discussed. Then follows a discussion of the results of excavations of Pits 2, 9, 11, and 15 at the close of the experiment. The chapter concludes with a summary of experiment results and some predictions about the archaeological record of small animal entrapment.

Amphibians

Seventy-seven individuals representing seven species of amphibians were observed in the pits (Figure 5). These include the orange-spotted newt (Notophthalmus viridescens), eastern narrow-mouthed toad (Gastrophryne carolinensis), gray treefrog (Hyla versicolor/H. chrysoscelis), pickerel frog (Rana palustris), southern leopard frog (R. utricularia), green frog (R. clamitans), and bullfrog (R. catesbeiana).

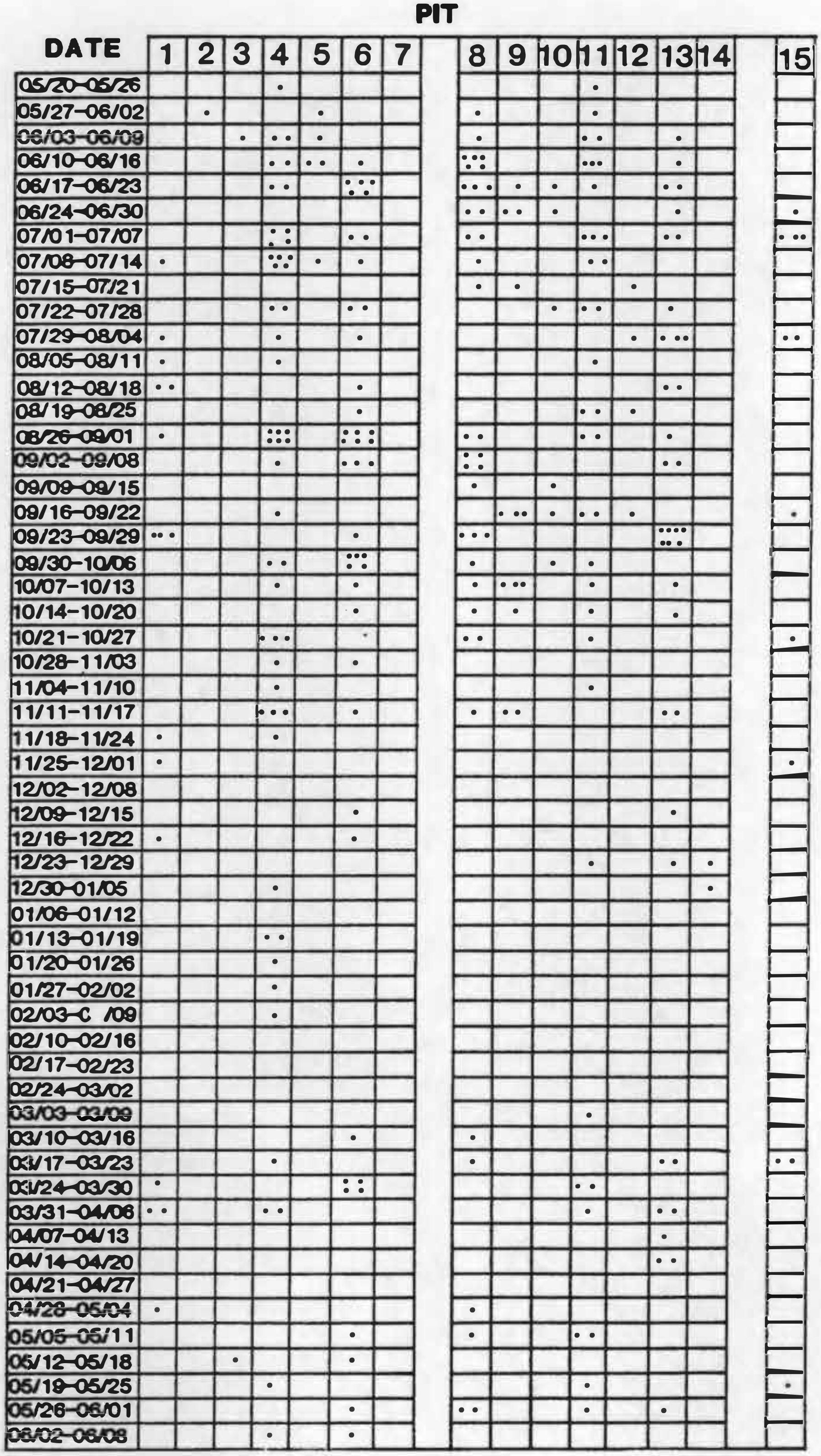

Figure 3. Vertebrate entrapment records for each week of the Holston Farm experiment.

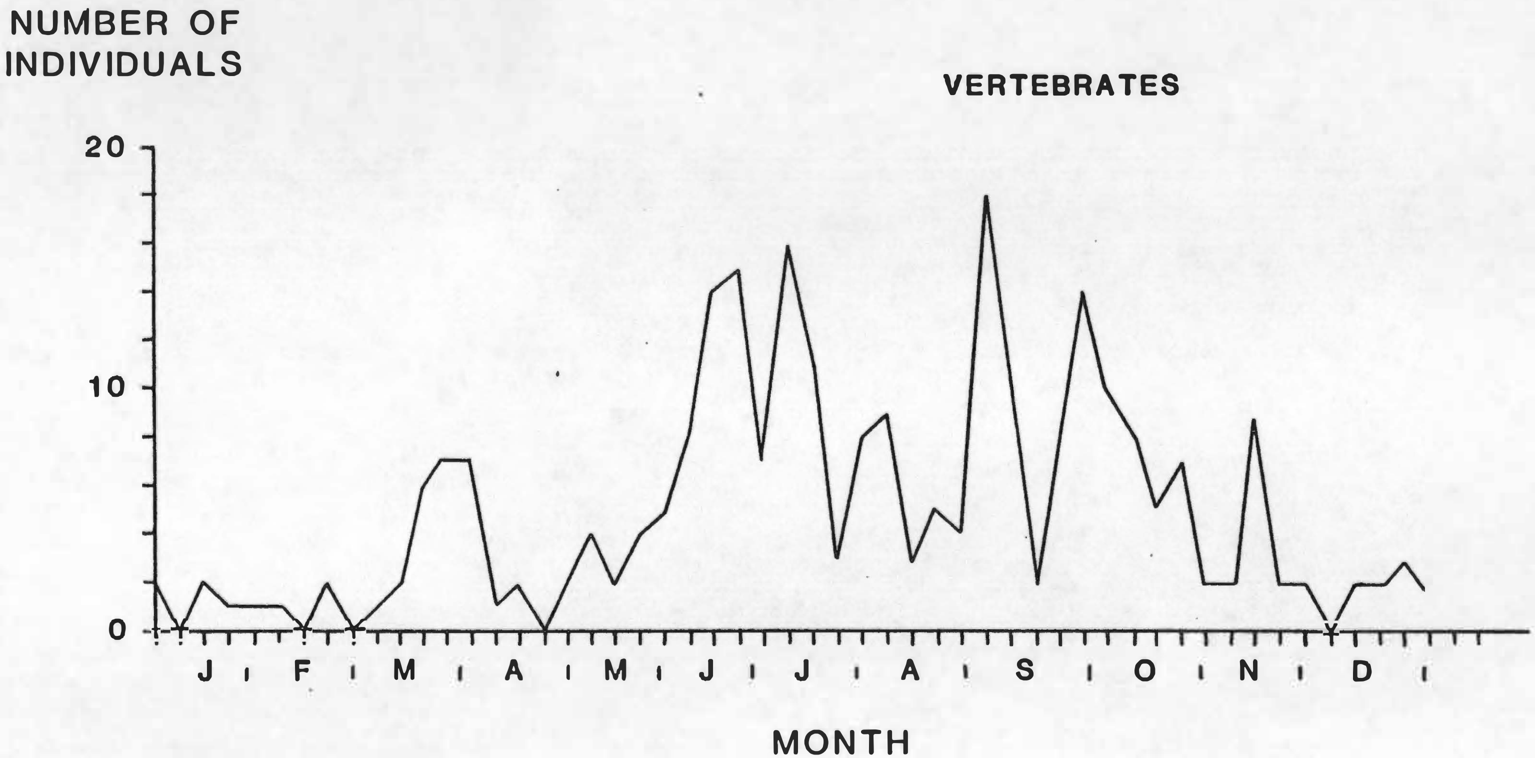

Figure 4. Graphed frequency of vertebrate entrapment by week and month.

DATE	PIT 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
05/20-05/26															
05/27-06/02											F				
06/03-06/09								F							
06/10-06/16											B				
06/17-06/23				E		EE		EEF			F				
06/24-06/30				FFF				CE					F		F
07/01-07/07						F		FF			FF		FF		FFF
07/08-07/14	E			F		F		F			EF	F			
07/15-07/21									F			F			
07/22-07/28				EE		F					FF		F		
07/29-08/04	F			E									EEF		F
08/05-08/11				F											
08/12-08/18						F							F		
08/19-08/25						E					E	F			
08/26-09/01															
09/02-09/08															
09/09-09/15															
09/16-09/22															
09/23-09/29	EF												FF		
09/30-10/06						FF									
10/07-10/13															
10/14-10/20															
10/21-10/27								F							
10/28-11/03						D									
11/04-11/10															
11/11-11/17				F									AF		
11/18-11/24															
11/25-12/01															
12/02-12/08															
12/09-12/15						D							D		
12/16-12/22															
12/23-12/29															
12/30-01/05															
01/06-01/12															
01/13-01/19															
01/20-01/26															
01/27-02/02															
02/03-02/09															
02/10-02/16															
02/17-02/23															
02/24-03/02															
03/03-03/09															
03/10-03/16								G							
03/17-03/23								G					DF		F
03/24-03/30															
03/31-04/06	G														
04/07-04/13															
04/14-04/20															
04/21-04/27															
04/28-05/04															
05/05-05/11					F						A				
05/12-05/18					F										
05/19-05/25															B
05/26-06/01								B							
06/02-06/08															

AMPHIBIANS

A Orange-spotted newt, *Notophthalmus viridescens*
B Gray treefrog, *Hyla chrysoscelis/Hyla versicolor*
C Eastern narrow-mouth toad, *Gastrophryne carolinensis*
D Bullfrog, *Rana catesbeiana*
E Green frog, *Rana clamitans*
F Pickerel frog *Rana palustris*
G Southern leopard frog, *Rana utricularia*

Figure 5. Amphibian entrapment records for each week of the Holston Farm experiment.

Pit Preference

Over 92% of the amphibians observed were of the genus Rana. These frogs, in general, showed no apparent preference for any particular pit, except that only two frogs entered a covered pit (Pits 2 and 9) (Table 4), and only then because the cover was poorly positioned over the top at the time. The fish carcasses in Pits 6 and 13 had no apparent affect on the entrapment of frogs. Frogs trapped in these pits, however, were often found dead, while those observed in other pits were usually alive. The possible relationship between the fish meat and the frog deaths is not understood.

Seven frogs were trapped in Pit 15, indicating that the clearing around the pit had no significant affect on the movement of frogs toward it. Evidently, by means of their hopping movements, frogs are generally prone to land in any open pit in their path regardless of its contents or the conditions of its surface margin. Shields (1985) suggests that frogs may seek pitfalls as refugia from predators or, if the pits contain water, as pools for maintaining body temperature and moisture. It is possible then, that some frogs intentionally entered pits on the experimental site.

Seasonal Variation

Pickerel and green frogs, comprising 83% of entrapped amphibians, were most abundant during the months of June and July (Figure 5). With the exceptions of two bullfrogs found in pits in mid-December, no amphibians were trapped between mid-November 1985 and mid-March 1986 (Figure 6). Bullfrogs occurred in pits in November,

Table 4. Species Entrapment Frequency by Pit.

Species	Pit Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Notophthalmus viridescens	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
Hyla crysoscelis/H. versicolor	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1
Gastrophryne carolinensis	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Rana catesbeiana	-	-	-	-	-	2	-	-	-	-	-	-	2	-	-
R. clamitans	2	-	-	4	-	3	-	3	-	-	2	-	2	-	-
R. palustris	2	-	-	6	-	9	-	6	1	-	7	2	10	-	6
R. utricularia	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Chelydra serpentina	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
C. serpentina (hatchling)	-	-	-	2	-	5	-	1	-	-	1	-	-	-	1
Sternotherus odoratus	-	1	-	2	-	2	-	1	4	-	1	-	2	-	-
S. odoratus (hatchling)	-	-	1	9	-	10	-	10	8	-	3	-	11	-	-
Chrysemys picta (hatchling)	3	-	-	2	-	5	-	1	-	-	3	-	3	-	-
C. scripta	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Natrix septemvittata (hatchling)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Lampropeltis getulus (hatchling)	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Aix sponsa	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Didelphis virginianus	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
Blarina brevicauda	1	-	1	1	-	-	-	2	-	-	1	1	-	2	-
Cryptotis parva	3	-	-	3	-	1	-	3	-	2	2	-	1	-	1
Sylvilagus floridanus	-	-	-	-	-	2	-	4	-	-	1	-	1	-	-
Peromyscus leucopus	1	-	-	16	4	-	-	-	-	3	-	-	-	-	-
Microtus pinetorum	-	-	-	3	1	1	-	-	-	-	4	-	1	-	1
Ondatra zibetheca	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mus musculus	1	-	1	2	-	-	-	-	-	-	2	-	-	-	1
Insectivora/Rodentia	-	-	-	-	-	-	-	1	-	-	6	1	-	-	1
Cricetidae/Muridae	1	-	-	-	-	1	-	-	-	-	-	-	1	-	-
Total	16	1	3	50	5	44	0	38	13	6	36	4	37	2	12

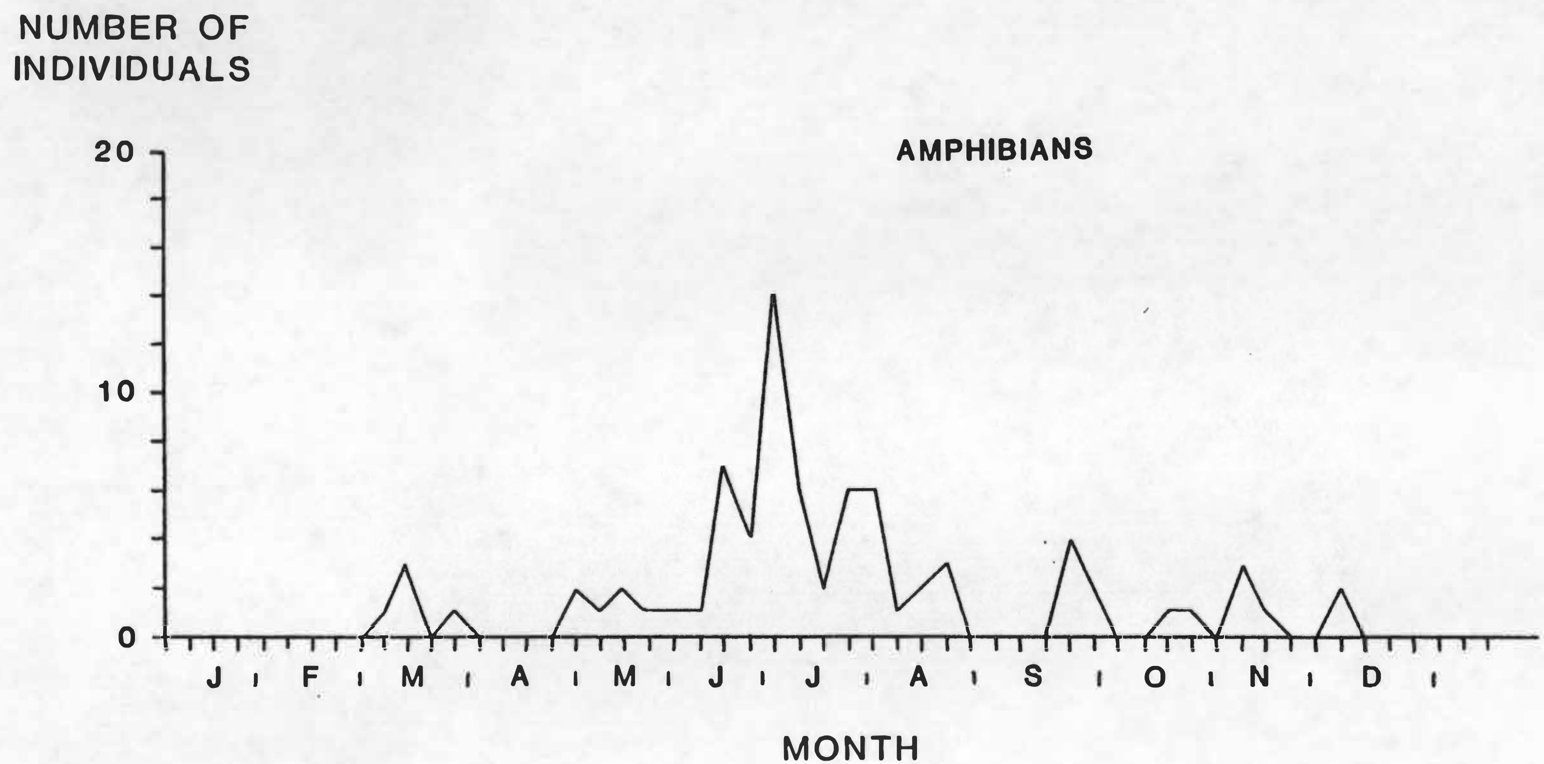

Figure 6. Graphed frequency of amphibian entrapment by week and month.

December, and March. The southern leopard frog occurred in pits only in late March and early April. The earliest spring occurrence of each species in pits is probably an indication of its earliest terrestrial activity in the region for the year of the experiment. Pitfall experiments conducted at Risher Pond and Karen's Pond on the Savannah River Plant near Aiken, South Carolina in 1968 and 1969 (Gibbons and Bennett 1974) indicated earlier peaks of anuran activity in that region. Anurans captured at Risher Pond, consisting primarily of *Rana pipiens* were most active in March and April (Gibbons and Bennett 1974). Captures at Karen's Pond, including primarily Bufonidae and Pelobatidae, were most frequent in May (Gibbons and Bennett 1974).

The implications of these data and those of the Holston Farm experiment for the entrapment of anurans in archaeological pit features are that anurans will enter pits primarily when they are most active on land, in the spring months.

Climatic Variation

It is impossible to assess the specific relationship between climate and the occurrences of amphibians in the experimental pits since dramatic variations in both temperature and rainfall may have occurred between weekly observation periods. It is well-known, however (Gibbons and Bennett 1974), that anuran activity is highly correlated with rainfall since rainfall reduces the possibility of desiccation during terrestrial travel. It has also been shown (Gibbons and Bennett 1974) that the amount of rainfall in a given area is correlated with the number of frogs moving through the area on a given day. Although

day by day records were not made on the Holston Farm site, there are evident correlations between dry spells and the lack of frogs in experimental pits. Note, for example, in comparing Figures 6 and 7, that no frogs were observed in pits during weeks of drought in September and October but they were present before and after.

The Holston Farm experiment and those of Gibbons and Bennett (1974) reveal no correlation between temperature and the terrestrial activity of anurans other than the fact that anurans are inactive during low winter temperatures. Occurrences of anurans in pits in winter months might indicate incipient breeding activity during warm days in winter (Gibbons and Bennett 1974).

Comments

Aside from the aforementioned predation of minks and perhaps other carnivores on frogs trapped in the pits, there were at least four incidents of shrews and mice eating frogs trapped in pits with them. It is well-known that shrews in particular will eat frogs in captivity and prefer certain species over others (Brodie and Formanowicz 1981; Formanowicz and Brodie 1979). It is doubtful that the frogs attracted these small predators into the pits. It is very possible, however, that frogs attracted other frogs into pits by their calling during the mating season. The predation of mice on frogs in pits probably resulted from mice attempting to avoid starvation while captive.

A final note concerning the entrapment of amphibians on the site is that no true toads (Bufonidae or Pelobatidae) were trapped. This is

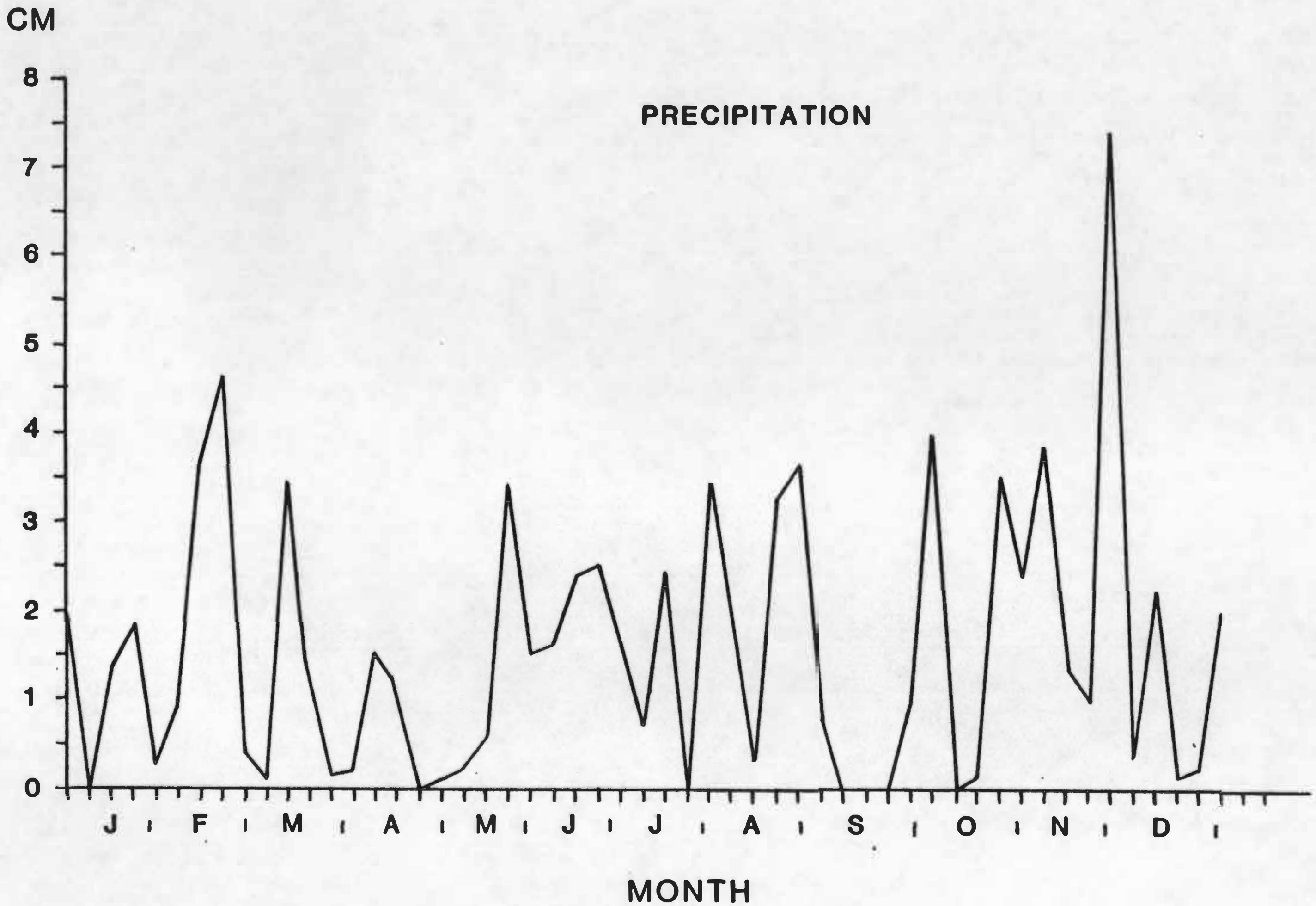

Figure 7. Experimental site precipitation data by week and month.

probably an indication that few or no toads were living on or in the vicinity of the experimental site.

Reptiles

Ninety-seven individuals representing six species of reptiles were observed in the pits (Figure 8). These include the stinkpot turtle (*Sternotherus odoratus*), painted turtle (*Chrysemys picta*), yellow-bellied turtle (*C. scripta*), snapping turtle (*Chelydra serpentina*), queen snake (*Natrix septemvittata*), and black kingsnake (*Lampropeltis getulus*). In addition, one eastern box turtle (*Terrapene carolina*) and one black racer (*Coluber constrictor*) were observed on the site. Most of the turtles and both snakes trapped were hatchlings (Figure 8). Only 13 adult stinkpot turtles, two subadult yellow-bellied turtles, and one adult snapping turtle were trapped.

Pit Preference

Reptiles showed no apparent preference for a particular kind of pit, except that only two, a hatchling stinkpot turtle and a hatchling black kingsnake, entered covered pits (Pits 3, 5, 7, 10, 12, 14) (Table 4). Only one reptile, a hatchling snapping turtle, was observed in Pit 15 whereas other open pits trapped an average of 12 hatchling turtles each. It would appear, then, that hatchling turtles avoid traversing areas of open ground.

The abundance of hatchling aquatic turtles trapped (79) is no doubt due to the proximity of the pits to a pond and a lake. Many of the turtles probably emerged from nests on the experimental site. In

PIT

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
05/20-05/26															
05/27-06/02		B						D							
06/03-06/09															
06/10-06/16													F		
06/17-06/23						B			B				D		
06/24-06/30									BB						
07/01-07/07															
07/08-07/14															
07/15-07/21															
07/22-07/28															
07/29-08/04															
08/05-08/11															
08/12-08/18													F		
08/19-08/25															
08/26-09/01				ACA		AAAA AC		CA			D				
09/02-09/08						CCC		CCCG					CC		
09/09-09/15								C		H					
09/16-09/22				C					CCC		C				
09/23-09/29						C		CCC					CCCC		
09/30-10/06				CB		CCC									
10/07-10/13			E			C		C	CDC				C		
10/14-10/20									C		A		C		
10/21-10/27				CC							C				A
10/28-11/03															
11/04-11/10				C							C				
11/11-11/17				CC		C		C	CC						
11/18-11/24				C											
11/25-12/01															
12/02-12/08															
12/09-12/15															
12/16-12/22															
12/23-12/29													C		
12/30-01/05															
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03/24-03/30	E					EEEE					E				
03/31-04/06	E			EE							E		CC		
04/07-04/13													D		
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04/21-04/27															
04/28-05/04	E							E							
05/05-05/11								B			E				
05/12-05/18															
05/19-05/25															
05/26-06/01													E		
06/02-06/08				B		B									

REPTILES

- A Snapping turtle, *Chelydra serpentina* (hatchling)
- B Snapping turtle, *C. serpentina* (adult)
- C Stinkpot turtle, *Sternotherus odoratus* (hatchling)
- D Stinkpot turtle, *S. odoratus* (adult)
- E Painted turtle, *Chrysemys picta* (hatchling)
- F Yellow-bellied turtle, *C. scripta*
- G Queen snake, *Natrix septemvitta* (hatchling)
- H Kingsnake, *Lampropeltis getulus* (hatchling)

Figure 8. Reptile entrapment records for each week of the Holston Farm experiment.

May, while the pits were being dug for the experiment, a painted turtle was seen digging a nest next to Pit 5 but did not complete the process. Turtles undoubtedly fell into pits by accident. Gibbons (1970) suggests that aquatic turtles are not terrestrially adapted to avoid pitfalls whereas terrestrial species perhaps are.

Seasonal Variation

With one exception, a hatchling stinkpot turtle observed in a pit on December 30, no reptiles were captured between late November and mid-March (Figures 8, 9, and 10). Adult turtles were prevalent from May through September (Figure 10), probably crossing the site to lay eggs or in movement between bodies of water (see Gibbons 1970). The failure to trap adult turtles in late July and early August was undoubtedly due to the wire fencing placed over the open pits to prevent predators from consuming entrapped frogs.

Hatchling stinkpot turtles began to accumulate in open pits in late August and continued to be trapped regularly until mid-November (Figure 9). One late-comer was observed in Pit 13 on December 30. In the following spring (April 7), two additional hatchling stinkpot turtles appeared in Pit 13, adding another record of spring emergence for this species (see Gibbons 1970).

Hatchling snapping turtles were found in pits in late August and then again in mid-October (Figure 9). None was observed in the following spring as were individuals of other species. One adult snapping turtle weighing an estimated 10 kg fell into Pit 8 in early May.

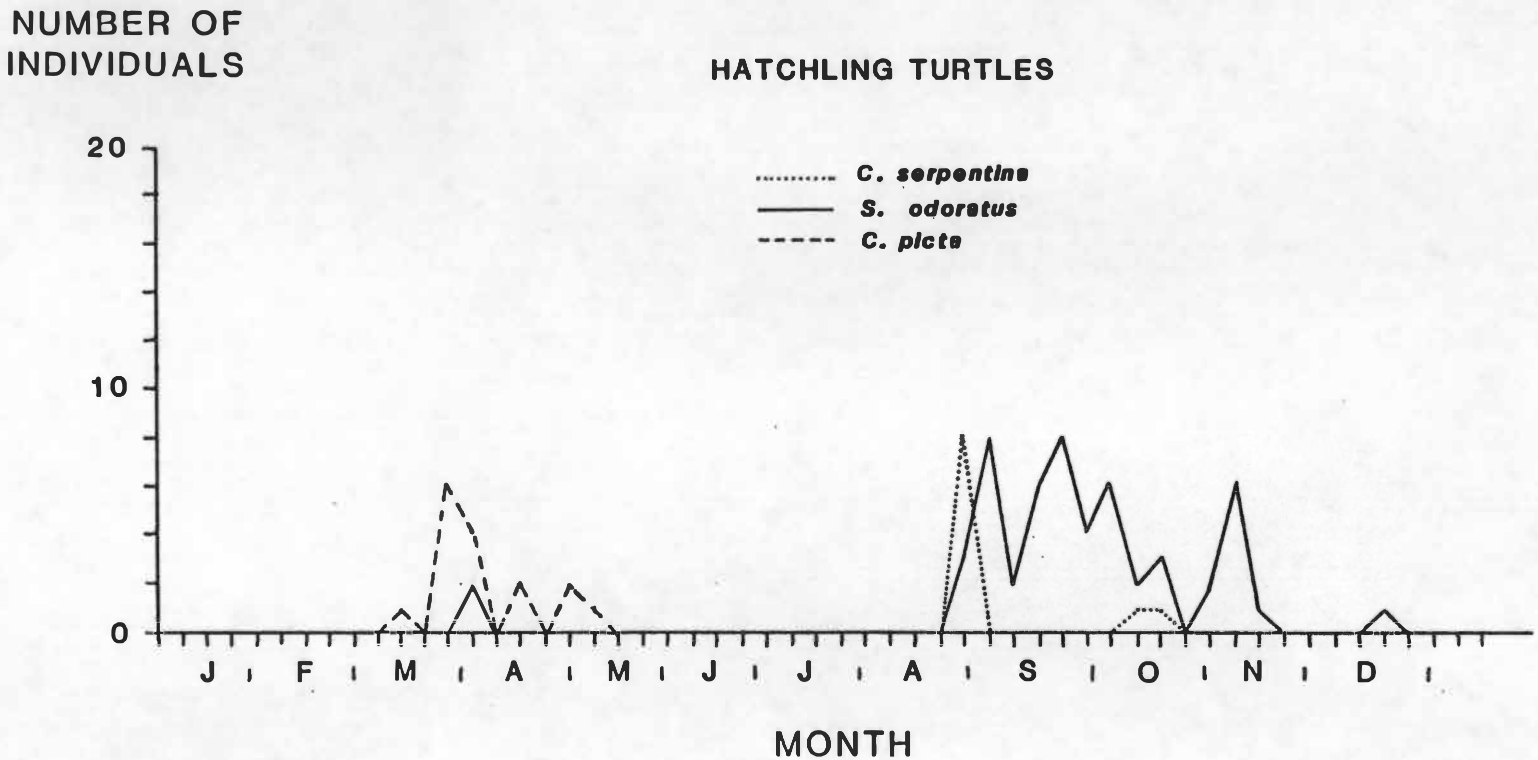

Figure 9. Graphed frequency of hatchling turtle entrapment by week and month.

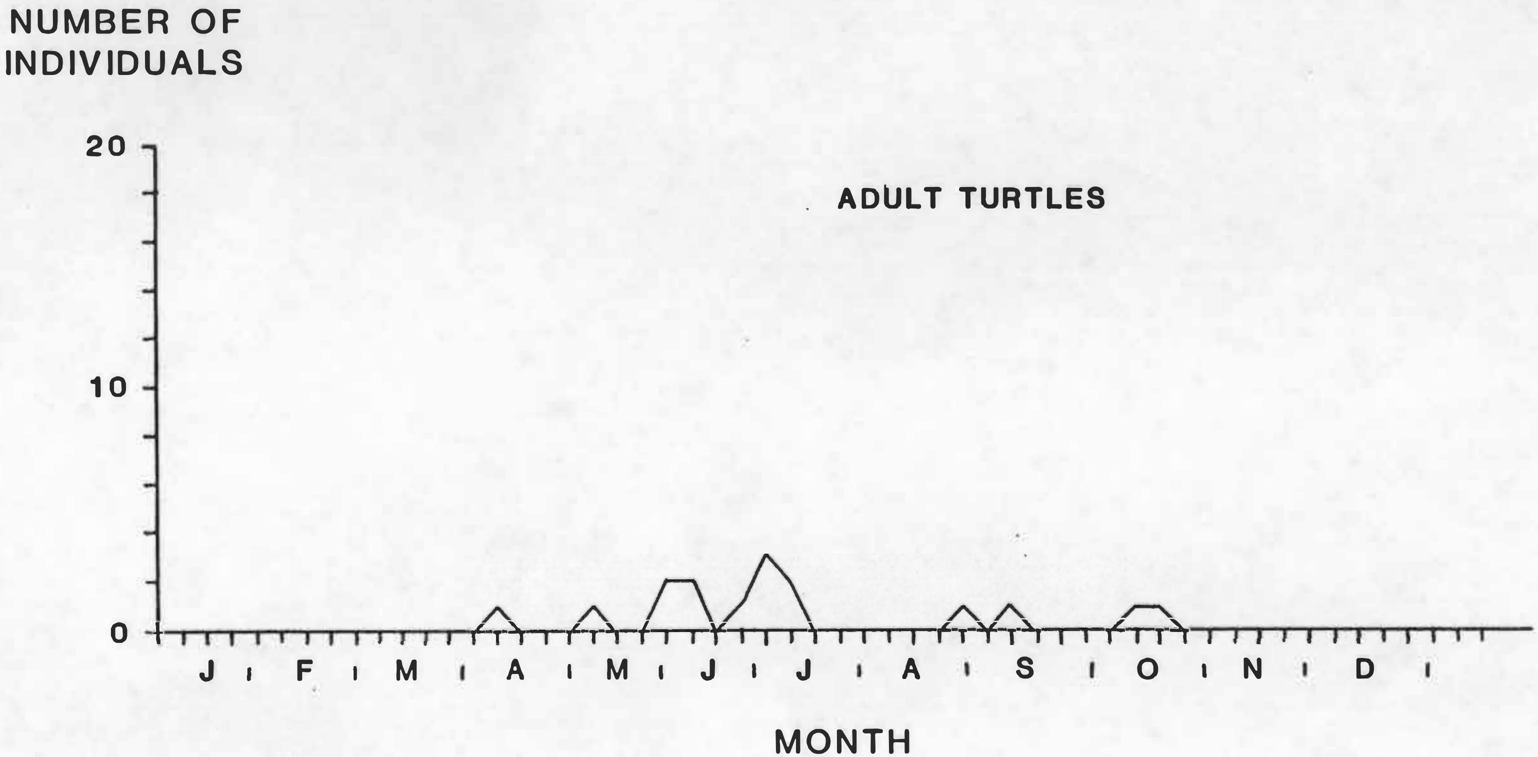

Figure 10. Graphed frequency of adult turtle entrapment by week and month.

Between mid-March and late April, 17 hatchling painted turtles fell into open pits (Figure 9). Spring emergence for this species is common (Gibbons 1970); the Holston Farm experiment, in fact, provided no evidence of summer or fall emergence for this species.

Climatic Variation

The results of the experiment indicate no definitive correlation between reptile entrapment frequency and climatic variables other than gross seasonal patterns. The work of Gibbons (1970) at the Savannah River Plant near Aiken, South Carolina, indicated increased terrestrial activity of adult turtles following heavy rains in spring, and a high correlation between rainfall and movement in fall months. Gibbons and Nelson (1978) recognized no relationship between rainfall and turtle hatchling emergence, but suggest that delayed emergence from the nest is cued by temperature change. Carr (1952), however, suggests that the emergence of painted turtle hatchlings in spring is timed with heavy spring rains that soften the ground and facilitate their egress from the nest. The entrapment (and spring emergence) of stinkpot and painted turtle hatchlings in the Holston Farm experiment was high in mid- to late April when rainfall was fairly heavy, giving some support to Carr's (1952) statement.

Comments

No eastern box turtles (*Terrapene carolina*), a common species in the area, were trapped during the experiment, although one was later observed on the site. Gibbons and Semlitsch (1982) observe that this

species is probably terrestrially adapted to avoid pitfall traps, and thus, that pitfall traps are an inadequate means of assessing their abundance and activity in an area.

Birds

Quite unexpectedly, an infant wood duck (Aix sponsa) was trapped by Pit 11 during the first week of the experiment in late May. The previous week, a hen and her chicks were seen on the river next to the site. Presumably, she once led her chicks onto the site and too close to the pit.

Following a light snow in January, small bird tracks were observed in the snow on the floor of Pit 4. Perhaps birds were enjoying the sunflower seeds baiting Pits 4 and 11. This brings to mind the possibility that raptors or crows were in part responsible for the occasional disappearance of some small vertebrates from the pits.

Mammals

Ninety-one individuals representing eight species of mammals were observed in pits (Figure 11). These include the opossum (Didelphis virginianus), short-tailed shrew (Blarina brevicauda), least shrew (Cryptotis parva), house mouse (Mus musculus), white-footed mouse (Peromyscus leucopus), pine vole (Microtus pinetorum), muskrat (Ondatra zibethica), and eastern cottontail rabbit (Sylvilagus floridanus). In addition, the footprints of dog and mink were noted on pit floors on one occasion each.

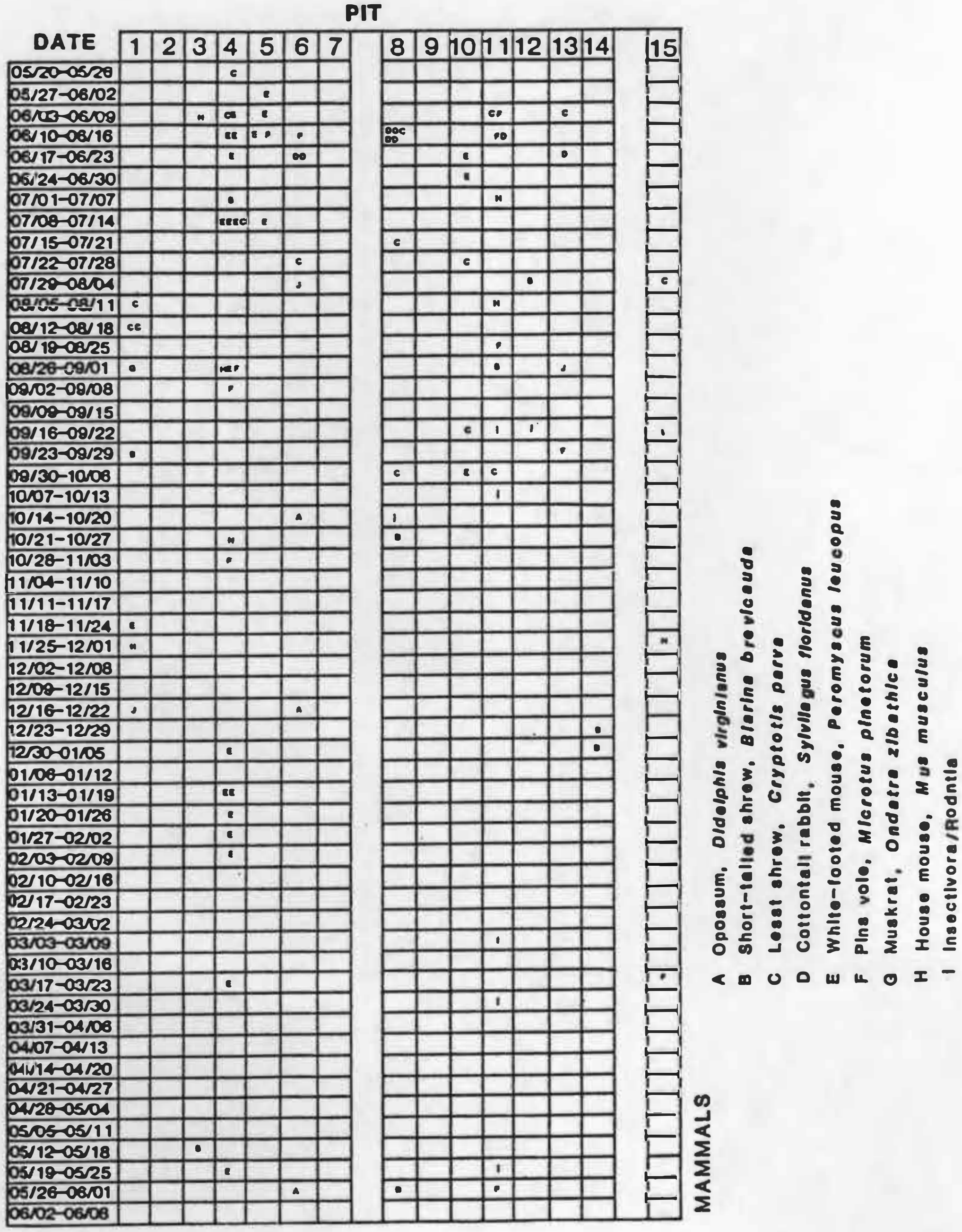

Figure 11. Mammal entrapment records for each week of the Holston Farm experiment.

Pit preference

Mammals were observed in all pit types (Table 4) except for Pits 2 and 9 which were gradually filled with refuse. The refuse occasionally deposited in these pits raised the pit floors and may have allowed small mammals which entered them to escape. Mammals rarely entered pits containing fish carcasses (Pits 6, 7, 13, 14) (Table 4). Three of those that did were the three opossums which were probably attracted to the carcasses for food. The short-tailed shrew was the only species to enter a covered pit containing a fish carcass. Mice and juvenile rabbits were observed in open pits containing fish carcasses only after the carcasses had become desiccated and less malodorous just prior to their regular replacement with fresh ones. During the colder weeks of winter when fish carcasses remained "fresh," mice were not found in these pits.

No mammals appear to have been particularly attracted to open empty pits (Pits 1 and 8) (Table 4). Their occasional entrapment in them may have been fortuitous. Covered pits, regardless of content, likewise trapped only an occasional shrew or mouse in late spring or early summer, indicating no apparent attraction of small mammals to covered pits. It was noted, however, that some small mammals had constructed runways under the plywood coverings next to pit margins.

Open pits containing sunflower seeds (Pits 4, 5, 11, 12) were unquestionably attractive to mice (Table 4). Of the 35 mice observed in open pits, 28 (80%) were in open pits with seeds, indicating that mice, for the most part, entered pits intentionally to obtain the

seeds. Experiments by Drickamer (1970) have shown that Peromyscus spp. prefer sunflower seeds over many other foods. The low incidence of mouse entrapment in covered pits containing seeds may indicate the inability of mice to detect seeds in the dark. King and Vestal (1974), however, suggest that mice are better able to detect food by smell than by sight. Howard and Cole (1967) discovered a positive olfactory detection of buried pine seeds by Peromyscus.

The demonstrated olfactory attraction of Peromyscus individuals to others of the opposite sex (Mazdzer et al. 1976) may have relevance to the present study. On several occasions two or three individuals of Peromyscus were observed in a pit, indicating that some individuals may have attracted others into pits. No attempt was made to determine the sex of individuals trapped; however Briese and Smith (1974) report frequent trappings of heterosexual pairs on the Savannah River Plant.

Only four mammals were observed in Pit 15, whereas other open empty pits (1 and 8) trapped eight and 10 individuals respectively (Table 4). Although these samples are small, there is a possibility that the clearing around Pit 15 hindered entrapment either by making the pit more visible and thus avoidable, or by making small animals vulnerable to watchful predators.

Shrews showed no particular attraction to any type of open pit, suggesting that they blindly blunder into open pits in their paths. There is a marginal possibility, however, that shrews were attracted through olfaction to mice (see Eadie 1952), frogs (see Formanowicz and

Brodie 1979), snails (see Ingham 1942,1944), insects, fish carcasses or other shrews.

Seasonal Variation

Mammals in general were observed in pits primarily during the warm months of the year (Figures 11 and 12). During the cold winter months, mice (*Peromyscus leucopus*) were the most regularly captured and only in open pits containing sunflower seeds. These seeds were undoubtedly an attractive winter source of food for mice living on the site.

In the Savannah River Plant experiments, Briese and Smith (1974) reported fairly continuous entrapment of *Microtus pinetorum* and *Peromyscus gossypinus* with peaks of activity in August. They reported that *Blarina brevicauda* and *Cryptotis parva* showed peaks of activity in spring and fall with few entrapments in summer and winter months.

Climatic Variation

No relationship between mammal entrapment and climatic variables can be seen in the weekly observation data obtained in this experiment. Other research, however, has shown strong correlations between small mammal activity and climatic variables. Gentry and Odum (1957), for example, trapped more mice (*Peromyscus*) when weather conditions changed from clear and cool to warm and cloudy and following light rains. Hirth (1959) reports trapping more *Peromyscus* on cloudy nights and few on rainy nights. Orr (1959) also found *Peromyscus* to be more active at times of high humidity and especially when temperatures are

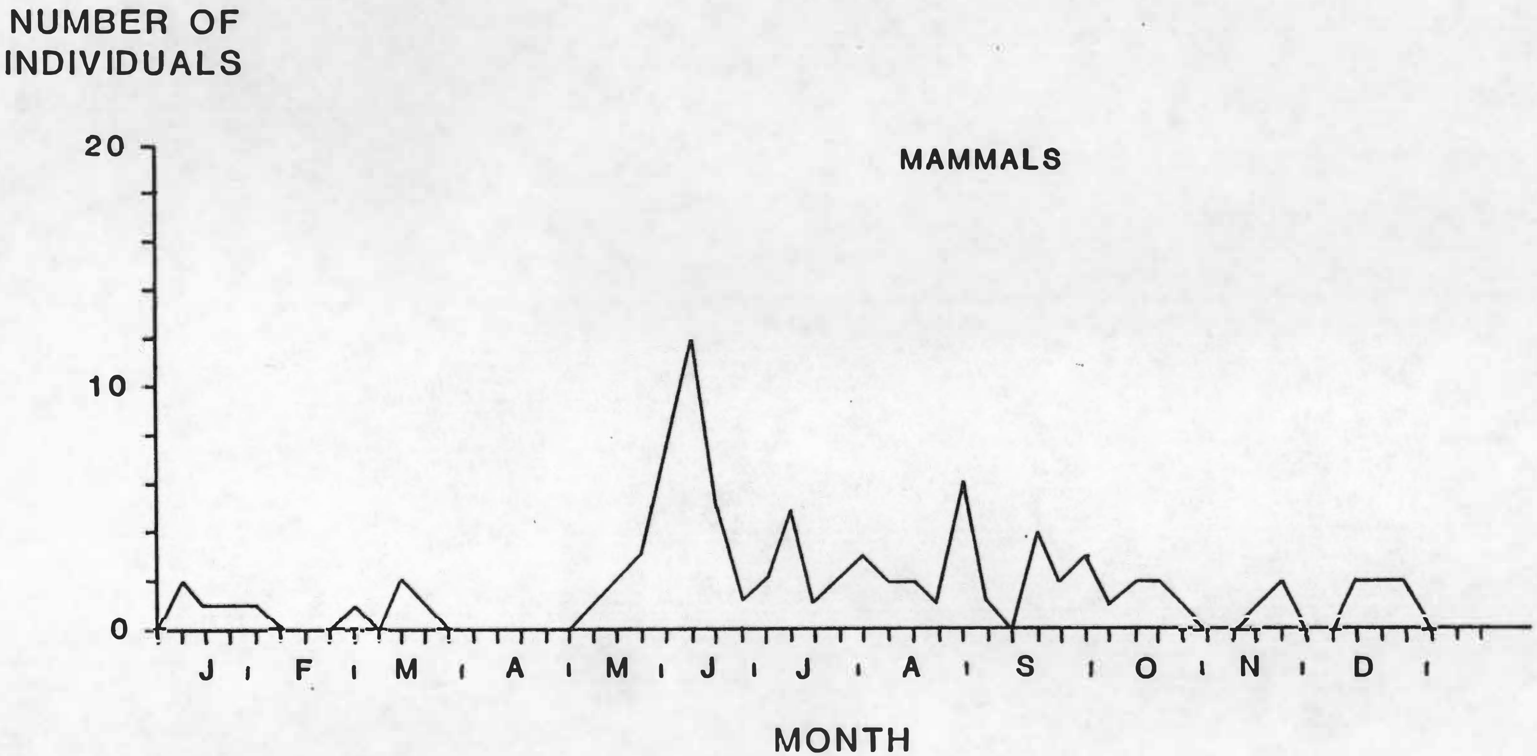

Figure 12. Graphed frequency of mammal entrapment by week and month.

between 5^{o} C and 10^{o} C. Hirth (1959) suggests that reduced activity on clear nights may be an adaptation to avoid predation by owls relying on moonlight for prey detection.

Comments

Although the pits used in this experiment were 75 cm deep and obviously able to trap and contain many animals, there is reason to believe that some mice escaped from pits prior to detection. One white-footed mouse was observed scaling the wall of a pit to within 15 cm of the top. Furthermore, entrapped mice left in pits for observation were sometimes missing on the following day (Table 2). It is not known whether they had escaped or if they had been removed by a predator. A further difficulty of observation was the fact that small mammals often burrowed into pit walls at the level of the floor and could not be observed for species identification. Consequently, some individuals are listed in Figure 11 and Table 4 as Insectivora/Rodentia or Cricetidae/Muridae.

A further observation is the predation of mice and shrews on other animals entrapped in pits with them. The floors of pits containing live shrews were generally clean of insects and worms in comparison to other pits, indicating that the invertebrates had been consumed by the insectivores. Gnawed land snail shells were also noted in these pits. In addition, shrews and mice were occasionally observed eating frogs, hatchling turtles, or other small mammals. In some cases the bones became damaged, although no distinctive gnaw marks were noted.

Terrestrial Snails

The idea of recording terrestrial snails occurring in pits came to mind shortly after the experiment was initiated. Beginning on July 1, 1985, all observable (with the naked eye) land snails and shells in pits, with the exceptions of Pits 2 and 9, were removed, identified, counted and disposed of on a biweekly basis (Table 5). No attempt was made to identify the species of each individual, but a few samples were identified to determine the species most commonly represented. *Ventridens acerra/demissus* and *Retinella indentata* appeared to be the most abundant large species on the site, followed by *Mesodon downieanus*, *M. inflectus*, and *Mesomphix rugelli*. Adults of all of these species exceed 5 mm in maximum dimension. Undoubtedly, small snails such as representatives of the Pupillidae may have been present and perhaps abundant in pits at times, but went unnoticed.

Pit Preference

Snails were much more abundant in open pits than in covered ones, sometimes numbering more than 40 individuals in one pit (Table 5). Among the open pits, no preference according to content was evident. Pit 15 generally contained fewer snails than other open pits, perhaps indicating an avoidance of the cleared ground surrounding the pit.

Only five snails were noted in covered pits containing fish carcasses, whereas 145 were observed in covered empty pits (Table 5). This disparity may indicate an avoidance of fish carcasses by snails,

Table 5. Biweekly Terrestrial Snail Counts by Pit.

Date	Pit Number 1	3	4	5	6	7	8	10	11	12	13	14	15	Total
7/1/85	12	2	8	0	0	0	34	0	27	7	7	0	12	109
7/15/85	7	1	1	0	5	0	12	10	24	7	14	0	3	84
7/29/85	3	0	7	0	2	0	12	5	5	2	3	0	19	58
8/12/85	0	1	48	0	0	0	18	10	12	1	5	0	6	101
8/26/85	2	1	3	0	7	2	16	4	24	1	22	0	4	86
9/9/85	1	0	2	0	0	1	18	1	10	3	2	0	2	40
9/23/85	1	0	2	0	1	0	1	1	0	0	1	0	0	7
10/7/85	1	0	4	0	4	0	4	1	1	1	12	0	0	28
10/21/85	0	2	11	2	1	2	3	0	2	1	18	0	1	44
11/4/85	0	0	3	0	0	0	0	0	2	1	1	0	0	7
11/18/85	0	0	0	0	0	0	0	1	0	0	0	0	0	1
12/2/85	0	0	0	0	0	0	0	5	0	0	0	0	0	5
12/16/85	0	0	0	0	2	0	0	1	0	0	0	0	0	3
12/30/85	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/13/86	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/86	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/10/86	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/24/86	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/10/86	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/24/86	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/7/86	0	0	3	0	0	0	8	1	1	0	1	0	1	15
4/21/86	0	0	1	0	0	0	16	0	0	0	1	0	0	18
5/5/86	0	.1	1	1	0	0	0	2	0	2	1	0	0	8
5/19/86	3	0	2	0	10	0	6	0	2	0	7	0	0	30
6/2/86	14	1	11	0	2	0	41	15	26	12	40	0	5	167
Total	45	9	107	3	34	5	189	57	136	38	135	0	53	811

which is in agreement with the findings of Elwell and Ulmer (1971) that some land snails avoid fresh or rotting meat detected through olfaction.

It is perhaps noteworthy that the few individuals of *Mesodon inflectus* observed were found only in covered pits. This typically woodland species may prefer darker places than the other more cosmopolitan species common in open pits (Pilsbry 1948).

Seasonal Variation

Snails were abundant between early May and mid-October, and were absent between mid-December and early April (Figure 13). Although snails were removed from pits on a biweekly basis, it was evident that they preferred not to hibernate in the pits during the winter. Had the pits contained sufficient amounts of debris for cover, however, some snails may have wintered in the pits.

Climatic Variation

Fluctuations in snail numbers during spring, summer, and fall were correlated with ground moisture. It was obvious that when pits were very dry, snail counts were low. It was noted that between rains, when the site began to dry, snails would gather on the shady pit floors where moisture would linger for a few days. When pits became very dry after a period of no rainfall, snails would disappear from the pits.

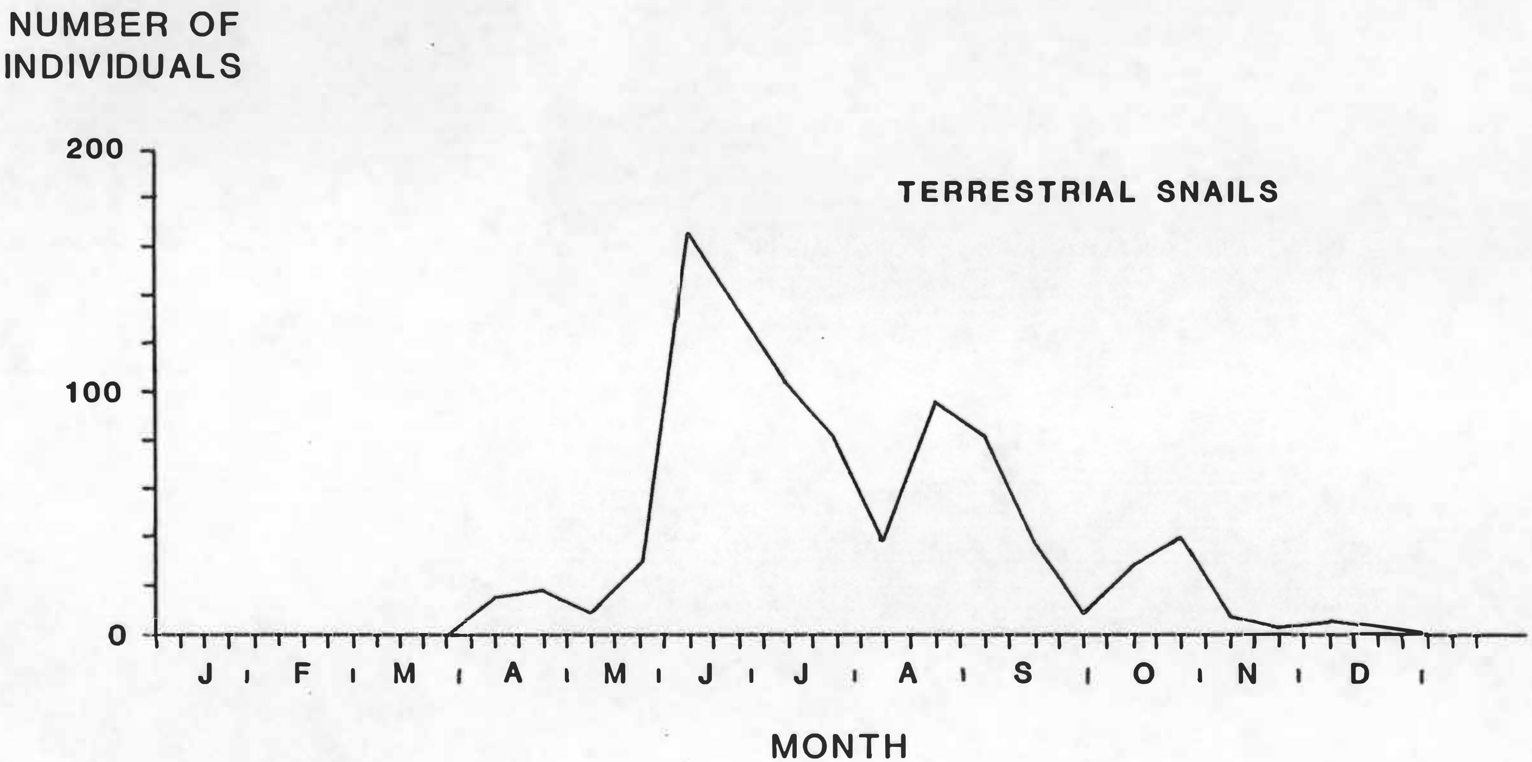

Figure 13. Graphed biweekly frequency of terrestrial snails in pits.

Entrapment in Refuse-filled Pits

The frequency of vertebrate entrapment in Pits 2 and 9, which were gradually filled with deposits of refuse and soil, was fairly low (Table 4). Only one vertebrate, an adult stinkpot turtle, was observed in Pit 2, having fallen in after refuse deposition brought the pit floor to within 62 cm of the top. However, by June 29, only one month after the experiment was begun, Pit 2 was nearly filled with refuse, thus preventing the further entrapment of individuals.

Pit 9 was filled more gradually, being only half full by late December. All vertebrates observed in Pit 9 were stinkpot turtles, with the exception of one pickerel frog entrapped when the pit contained only 27 cm of refuse (48 cm from the top).

All of the vertebrates trapped by these pits were removed when observed. Undoubtedly, had they been left in the pits or gone unobserved before depositing additional refuse, many if not all would have eventually died and become part of the depositional records of these pits. Snails were never removed from Pits 2 and 9; they became trapped by refuse deposition and were only recorded upon excavation of the pits in September and October 1986.

No evidence of vertebrates burrowing into or out of the deposits in these pits was observed at any time, with the exception of the disturbance of Pit 9 by a dog in January.

In reexcavating these pits, an attempt was made to isolate the fill from original depositional layers, using standard archaeological

excavation and recovery techniques. All fill was washed through 1.5 mm mesh window screen.

Pit 2

Ten layers of refuse had been deposited in Pit 2 (Table 6). Layers 10 and 11, both consisting of soil originally removed in creating the pit, were indistinguishable upon excavation and are thus combined in the analysis. All other layers were fairly distinguishable, yet it was impossible to prevent some mixing of materials between layers during the excavation process.

No vertebrate remains other than those deposited as refuse were recovered from Pit 2. Terrestrial snail shells, however, were abundant (Table 7). Shells of 76 individuals representing five species were recovered. These include some not identified in pits during the biweekly snail counts. Probably all of the shells recovered from Layers 10 and 11 came from the interface of these layers. After Layer 10 was deposited on June 29, the pit remained untouched until August 19. In the meantime, grasses and weeds had grown in the pit and many snails had taken refuge on the surface of Layer 10.

The many snail shells recovered from Layer 9 may have come from the interface of Layers 8 and 9, meaning that they crawled into Pit 2 between June 14, when Layer 8 was deposited, and June 29, when Layer 9 was deposited. The few shells from the excavation of Layer 8 (Table 7) also probably came from this interface or from the pit walls.

Table 6. Pit 2 Refuse Deposition Records Listing the Contents, Date, and Depth of Each Deposit.

Deposit	Date Deposited*	Surface Depth (cm)	Contents
1	5/27/85	62	filleted fish carcasses
			rabbit carcass
			chicken bones
			eggshells
			oyster shells
			crab exoskeletons
			wood ashes
			wood charcoal
			paper
			glass bottle
2	5/27/85	60	soil from pit excavation
3	6/1/85	57	fish meat
			squid meat
			eggshells
			oyster shells
			vegetable matter
			paper
			metal can
4	6/1/85	56	soil from pit excavation
5	6/6/85	54	filleted fish carcasses
6	6/6/85	51	soil from pit excavation
7	6/14/85	44	fish carcasses
			vegetable matter
			paper
			plastic
			metal can
8	6/14/85	39	soil from pit excavation
9	6/29/85	22	filleted fish carcass
			shrimp exoskeletons
			vegetable matter
			plastic
			metal can
10	6/29/85	18	soil from pit excavation
11	8/19/85	0	soil from pit excavation

*The pit was made on 5/16/85 and reexcavated on 9/1/86.

Table 7. List of Species of Terrestrial Snails Identified from the Final Excavation of Pit 2.

Deposit	Species	Quantity
1	Retinella cumberlandiana	4
2	none recovered	0
3	none recovered	0
4	none recovered	0
5	none recovered	0
6	R. cumberlandiana	6
	Ventridens acerra/V. demissus	5
7	R. cumberlandiana	4
	V. acerra/V. demissus	5
8	Hawaiia miniscula	3
	Mesodon downieanus	1
	R. cumberlandiana	6
	V. acerra/V. demissus	3
9	M. downieanus	1
	R. cumberlandiana	2
	R. indentata	1
	V. acerra/V. demissus	22
10 & 11	M. downieanus	1
	R. cumberlandiana	3
	V. acerra/V. demissus	9
	Total	76

Snail shells recovered from Layers 6 and 7 probably occurred at the interface of these layers, meaning that the snails crawled into the pit between June 6 and June 14.

No land snail shells were recovered from Layers 2, 3, 4, or 5, and only four shells of Retinella cumberlandiana were recovered from Layer 1. The latter probably occurred on the floor of the pit and were sealed by Layer 1 on May 27, two weeks after the pit was excavated.

A note of interest is that many of the Retinella cumberlandiana snails recovered from Layers 6, 7, 8, and 9 were alive. Only one other snail, an adult Ventridens acerra/demissus from Layer 9, was recovered alive. Evidently, some of the snails were able to survive burial for several months.

Pit 9

Nine layers of refuse had been deposited in Pit 9 (Table 8). Layers 5 and 6 were inseparable upon excavation; Layer 6 consisted of ashes which, when deposited on top of Layer 5, settled in and among the debris (fish skeletons) of Layer 5. These are combined in the analysis.

No vertebrate remains other than those deposited as refuse were recovered from Pit 9. As in Pit 2, land snail shells were plentiful (Table 9). Shells of a total of 491 individuals representing nine species were recovered. Most of the 354 shells associated with Layer 9 probably accumulated in the spring and summer of 1986; Layer 9 was deposited on December 30, 1985 and was dug into by a dog 21 days later, who retrieved the deer hide and meat included in Layer 8 below. The

Table 8. Pit 9 Refuse Deposition Records Listing the Contents, Date, and Depth of Each Deposit.

Deposit	Date Deposited*	Surface Depth (cm)	Contents
1	6/6/85	69	oyster shells quahog shells blue mussel shells shrimp exoskeletons lobster exoskeletons vegetable matter ceramic plate fragments aluminum can paper plastic foil
2	6/6/85	65	soil from pit excavation
3	6/12/85	57	oyster shells quahog shells blue mussel shells vegetable matter coins plastic
4	6/12/85	48	soil from pit excavation
5	6/20/85	45	fish skeletons
6	10/21/85	45	wood ashes wood charcoal nails
7	12/23/85	42	fish heads
8	12/30/85	30	deer meat and hide bird meat and feathers
9	12/30/85	21	soil from pit excavation

*The pit was made on 5/19/85 and reexcavated on 10/18/86.

Table 9. List of Species of Terrestrial Snails Identified from the Final Excavation of Pit 9.

Layer	Species	Quantity
1	*Mesodon appressus*	1
	Retinella cumberlandiana	1
	Ventridens acerra/V. demissus	13
2	*V. acerra/V. demissus*	8
3	*R. cumberlandiana*	1
	V. acerra/V. demissus	12
4	*R. cumberlandiana*	1
	V. acerra/V. demissus	17
5 & 6	*Hawaiia miniscula*	2
	R. cumberlandiana	4
	R. indentata	2
	Triodopsis sp.	1
	V. acerra/V. demissus	86
7	*Mesodon* sp.	1
	R. indentata	1
	V. acerra/V. demissus	3
8	*H. miniscula*	2
	M. downieanus	1
	R. cumberlandiana	16
	R. indentata	8
	Triodopsis sp.	1
	V. acerra/V. demissus	17
9	*Gastrocopta contracta*	1
	H. miniscula	1
	M. downieanus	1
	R. cumberlandiana	36
	R. indentata	14
	V. acerra/V. demissus	297
	Total	553

pit remained, as it had been altered by the dog, until its excavation in October 1986, allowing much time for snails to accumulate. Many of the snails from Layer 9 were alive at the time of excavation.

Snail shells associated with lower levels of the pit occurred on top of soil layers (Layers 2 and 4), among the ashes of Layer 6, on the pit floor, and against the pit wall.

Summary

Terrestrial snails, one frog, five adult stinkpot turtles, and eight hatchling stinkpot turtles were trapped by those pits gradually filling with soil and refuse. The frog and turtles were freed upon observation but the land snails were left in the pits to be sealed by depositional layers. As the pits were excavated, it was noted that land snail shells were most abundant at levels which remained exposed for longer periods. Furthermore, they occurred between depositional layers and against the pit walls and floors. Had the vertebrates gone unobserved and been left in the pits where they had fallen, their remains too would have occurred between depositional layers unless they were able to sustain themselves and burrow upward through each layer as it was deposited.

Final Excavation of Pit 15

Pit 15, as mentioned earlier, was not continually maintained (the floor cleaned of sediment and vegetation) as were other pits on the site. Furthermore, dead individuals in the pit were left there to decay, with the intent that the pit would be excavated at the close of

the experiment to investigate the archaeological recovery and identification of remains of entrapped vertebrates.

Pit 15 was excavated on June 11, 1986, nearly one year after its creation. The sediments which had accumulated on the pit floor, primarily coming from the pit sides as a result of alternate freezing and thawing through the winter, varied in thickness from 2 cm at pit center to 12 cm against the wall (Figure 14). The erosion of the pit walls gave the pit somewhat of a barrel shape and formed a ring-shaped sediment talus around the interior periphery (Figure 14). These sediments were excavated in quarters and gently washed through 1.5 mm mesh window screen.

In addition to faunal remains, historic and prehistoric period artifacts which had evidently eroded from the pit walls were recovered from the sediment (Table 10). Only two vertebrates were observed to have died and were left to decay in Pit 15--one least shrew and one pickerel frog observed on July 30, 1985 (the shrew had killed the frog and consumed most of its meat). What is interesting is that only a few bones of each was found after a careful 10X magnifier-assisted search of the recovered debris (Table 10). Undoubtedly, some smaller bones of these vertebrates (phalanges, metatarsals, metacarpals) passed through the 1.5 mm mesh screen, but the missing long bones and skull parts of each are difficult to explain. Nevertheless, these data point to biases that may affect the identification and interpretation of small vertebrate remains from archaeological contexts and the utility of

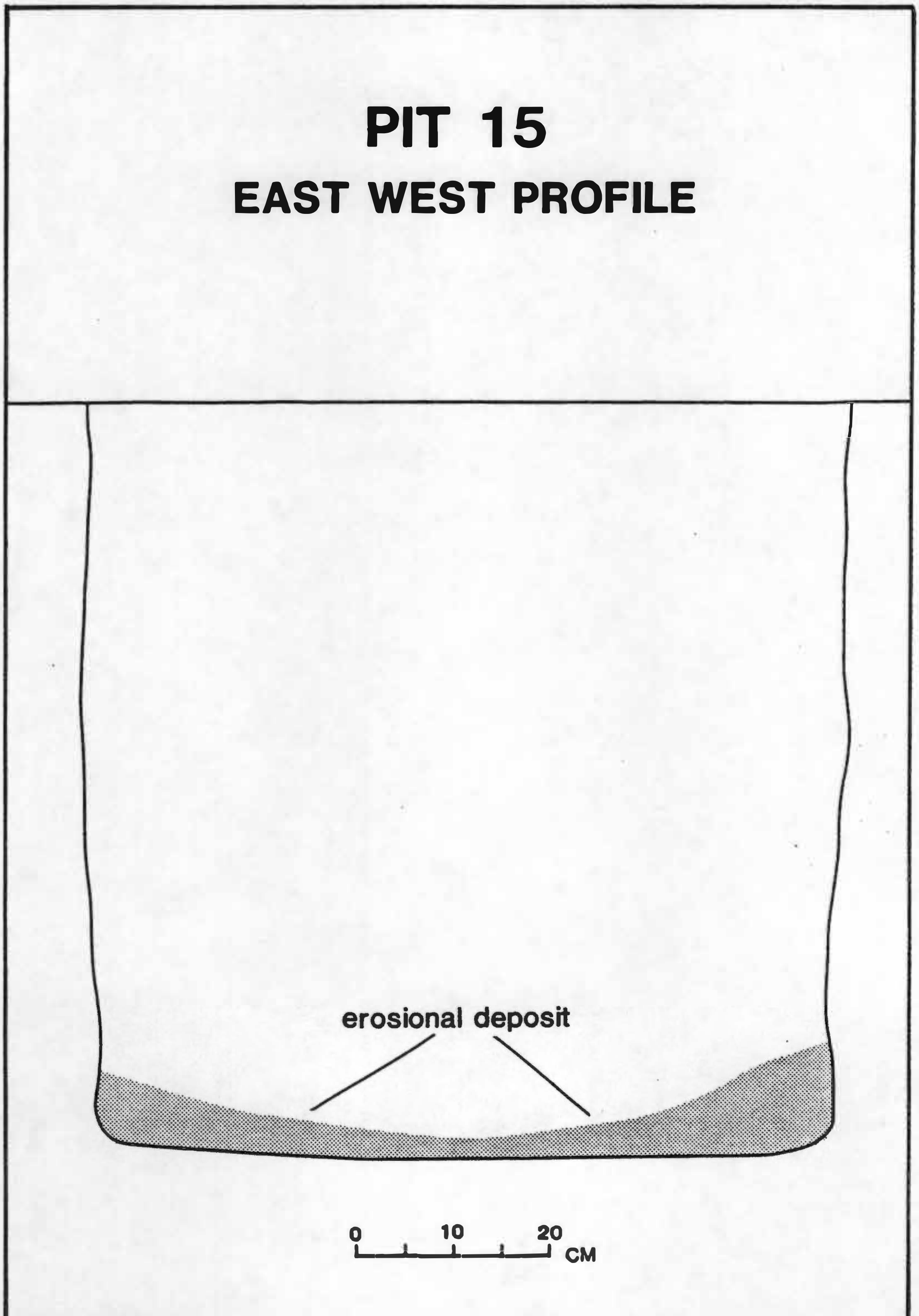

Figure 14. Pit 15 final excavation profile.

Table 10. Small Animal Remains and Artifacts Recovered from the Final Excavation of Pit 15.

Species	Element	Quantity
LAND SNAIL SHELLS:		
Ventridens acerra/*V. demissus*		25
Mesodon downieanus		1
VERTEBRATE REMAINS:		
Rana cf. *palustris*	right humerus	1
	vertebra	1
	right ilium	1
	femur	1
Cryptotis parva	left mandible	1
	right mandible	1
	right femur	1
	left ilium	1
	thoracic vertebra	1
ARTIFACTS:		
Type:		
lead birdshot		3
prehistoric pottery sherds		3
chert flakes		5
burned rocks		68

skeletal completeness indices in distinguishing distal and proximal communities (e.g., Thomas 1969).

Only 26 land snails were recovered from the sediments in Pit 15 (Table 10). Twenty-two of these (all *Ventridens acerra/demissus*) were still alive. Again, the paucity of snails in this pit is probably due to their avoidance of the cleared ground surface surrounding it.

Final Excavation of Pit 11

Many of the mammals trapped in Pits 4 and 11 had burrowed into pit walls at the level of the floor. Some of these burrows were determined to be more than 20 cm long. Recognizing the probability that some mammals had died unobserved in these burrows, a 25 cm square section of the northwest wall of Pit 11 was excavated down to the level of the pit floor to inspect the burrows occurring there and to search for small vertebrate remains (Figure 15). Two burrows were encountered. All soil from around and within these burrows was gently washed through 1.5 mm mesh window screen. During excavation, mouse bones, land snail shells, and hundreds of sunflower seeds were observed in these two burrows. After screening and sorting the recovered debris, bones of a frog (*Rana*, cf. *R. clamitans*), an immature least shrew, a pine vole, and shells of 13 land snails were identified (Table 11). Some of the bones appeared to have been gnawed by a mouse.

The burrows had probably been made by mice or shrews in attempts to escape from the pit or in seeking shelter. These burrows may then have been used by other vertebrates and snails that got into the pits.

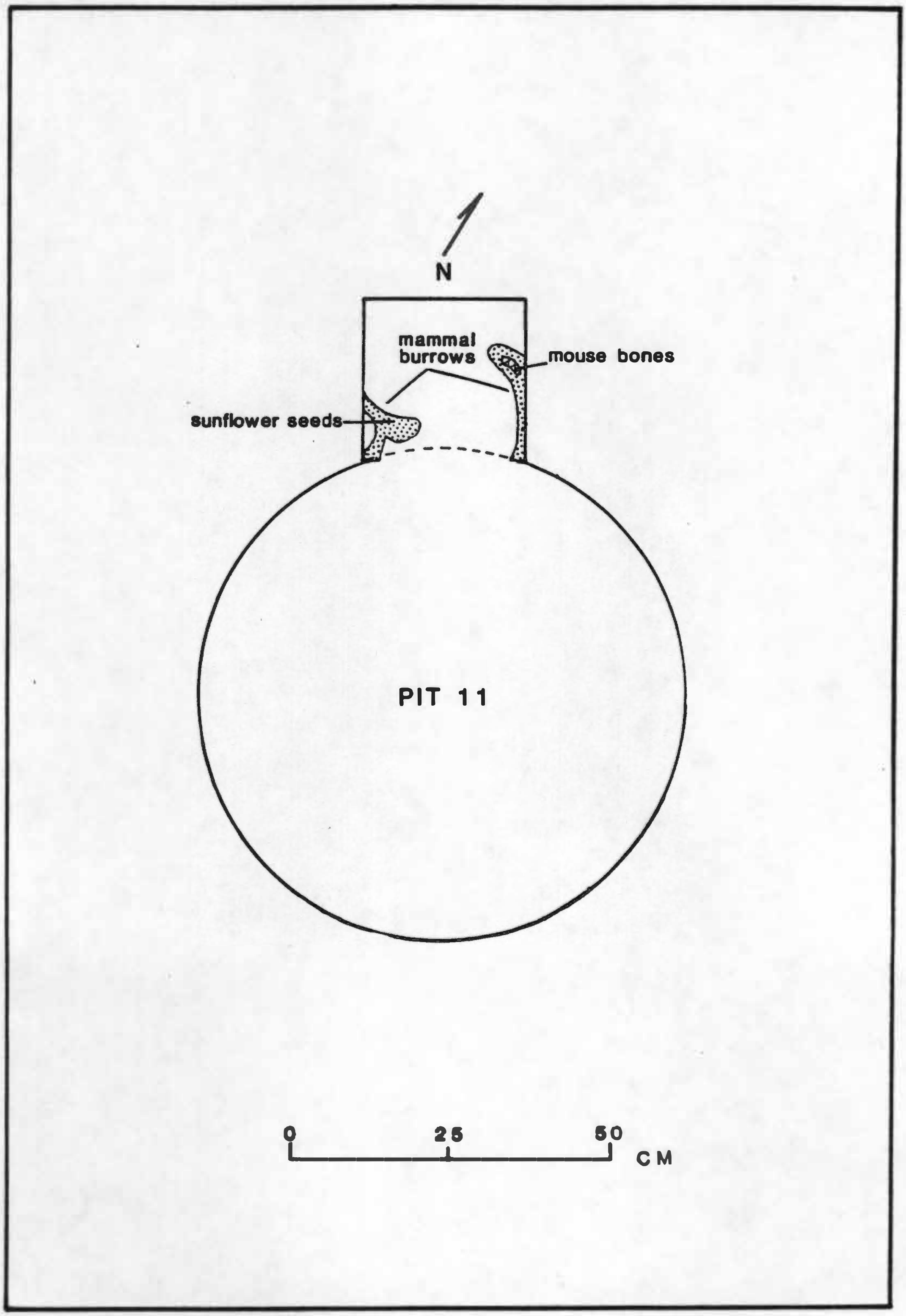

Figure 15. Pit 11 final excavation plan view.

Table 11. Small Animal Remains Recovered from Burrows in Pit 11.

Species	Element	Number
Retinella cumberlandiana	shell	1
Ventridens acerra/V. demissus	shell	12
Rana cf. clamitans	skull bone	1
	left ilium	1
	femur	1
	metacarpus	3
	long bone	3
Cryptotis parva	left mandible	1
	vertebra	2
	right humerus	1
	right femur	1
Microtus pinetorum	left parietal	1
	right mandible	1
	vertebra	5
	left clavicle	1
	right clavicle	1
	rib	1
	left humerus	1
	left radius	1
	right radius	1
	left ulna	1
	metacarpus	1
	left femur	1
	left tibia	1
	left calcaneum	1
	metatarsus	4

The bones and snail shells may have accumulated through the deaths of animals in these burrows, or some, along with sunflower seeds, may have been hoarded by mammals using the burrows. Nevertheless, the occurrence of these burrows and their contents has important implications concerning the archaeological record of small animal entrapment in pit features. Remains of trapped small animals may occur in burrows beyond pit confines as well as within a pit. Moreover, the archaeological identification of burrows in pits containing these remains is a strong indication of animal entrapment as opposed to cultural deposition of the remains. Finally, evidence of rodent gnawing on bones recovered from pits containing small rodent remains may indicate the entrapment of these animals.

Comparing the Two Sets of Pits

The purpose of having two identical sets of pits on the experimental site was, in effect, to replicate the experiment and thus produce more reliable data. The total number of vertebrates (119) trapped by pits of the first set (Pits 1 through 7) is not significantly different from that (136) of the second (Pits 8 through 14) (Table 4). One outstanding difference between the two groups, however, is that nearly 90% of all white-footed mice trapped occurred in pits of the first set, while other mammal entrapments were generally equitable between the two. This disparity may have occurred because the first set of pits was bordered by a hay field while the second was bordered by a corn field. Although the preferred habitat of the white-

footed mouse is woodlands with dense ground cover, it is also common in open grasslands but only in areas with the densest cover (Mossman 1955). It is possible that the periodic mowing of the hay field just southeast of the site caused movements of mice onto the experimental site where they first had access to the first set of pits.

Entrapment frequencies for hatchling turtles were quite variable from pit to pit and between the two sets of pits (Table 4), but were probably affected by the proximity of pits to nests from which the hatchlings had emerged. It would appear, for example, that more stinkpot turtle (Sternotherus odoratus) nests were located in the northwestern part of the site nearer the second set of pits and that more snapping turtle (Chelydra serpentina) nests were located in the southeastern part of the site nearer the first set of pits (Table 4).

The more regular entrapment of amphibians in pits in the second set (Pits 8 through 14) is difficult to explain. Untold variation in the surrounding site vegetation or of the adjacent riverbank, such as bank slope or the amount of drift debris along the bank may have affected amphibian numbers in or movements through that part of the site.

Less than one third (27%) of the terrestrial snails recorded in the two series of pits occurred in the first (Pits 1 through 7). This disparity is probably a reflection of variability in the natural distribution of snails across the site and unrelated to possible physical differences between the two sets of pits.

The importance of having two identical sets of pits in the experiment is readily apparent. Had only one series been employed, certain results and interpretations would have been quite different. Many species, for example, would not have been trapped had only one of the two series been used (Table 4). More importantly, the attraction or indifference of certain species to certain kinds of pits might not have been apparent. For example, had only the second series of pits (8 through 14) been used in the experiment, the attraction of mice into pits containing sunflower seeds would not have been indicated in the entrapment data.

Summary

Many vertebrates and terrestrial snails representing a considerable array of species were trapped or observed in the 15 pits over the course of the year of the experiment. Undoubtedly, since live animals were released from pits to maintain their numbers on the site, several individuals were captured more than once. However, many animals died in pits, indicating that the site's populations were depleted somewhat. The deaths of animals moving through the site (primarily frogs and turtles) would have had little affect on seasonal variation in entrapment frequency. The deaths of mammals (at least 15 shrews and 28 mice) inhabiting the site may have biased the seasonal variation in entrapment of these animals. This might explain the entrapment of fewer mice and shrews in the weeks of late May and early June 1986 than were trapped during the same weeks of the prior year

(Figure 11). Note, especially (Figure 11), that no least shrews were captured after October 6. It is partly because of these potential biases that data provided by other studies of seasonal activity of small animals in the southeastern United States (e.g., Gibbons 1970; Gibbons and Bennett 1974; Briese and Smith 1974) are referenced throughout this study.

The abundance of small animals trapped in this and other pitfall experiments indicates the strong likelihood that many, if not most, small animal remains recovered from archaeological pit features in this region represent entrapped fauna. Interestingly, these experiments also indicate the ease with which larger species, known to have been used or consumed regularly by humans (adult turtles, muskrats, opossums), can become trapped in open pits.

Recognizing Entrapment in the Archaeological Record

The occurrence of small animal remains in archaeological pit features in eastern North America is not alone sufficient evidence of entrapment; small animals were at times eaten by some Indians of the region. Most historically documented hunter-gatherers whose diets included small vertebrates lived in arid environments where larger protein sources were scarce for much of the year. In most cases these small vertebrates were cooked and consumed whole or pulverized and made into a soup (Dansie 1984; Stahl 1982), and often, bones were ground into a powder for consumption (Hudson 1976:288; Michelsen 1967). This suggests that the archaeological record of small animal consumption by humans would usually be scant. However, had small animals been

consumed prehistorically by humans in eastern North America, it is conceivable that they were often simply boiled whole (see Swanton 1979:368-369) and the resulting "dregs," consisting of whole, apparently unmodified bones, dumped in pits and elsewhere as refuse. This means that the degree of skeletal and bone completeness and the lack of evidence of butchering, burning, or digestion on bones of small vertebrates represented in archaeological pit features may not serve as reliable indicators of entrapment.

On the other hand, the Holston Farm experiment revealed that remains of entrapped fauna may become depleted or misrepresented as a result of differential preservation, recovery, and subsequent identification biases. Consequently, there is no basis for expecting skeletons of entrapped small vertebrates to be more completely articulated or represented than those of small animals consumed by humans in this region.

Observations made during the course of the experiment, and especially in the excavation of the refuse-filled pits (2 and 9), indicate that the stratigraphic placement of small animal remains within pits is of key importance to identifying natural entrapment. It was noted that small mammals and anurans might readily escape from depths of ca. 40 cm unless the pits contained enough water to prevent jumping or unless the side walls were moist enough to prevent climbing (Appendix). This means that remains of small vertebrates trapped in archaeological pits will generally occur on the floors of pits and between depositional layers in the lower portions of pits, at depths

from which the animals were unable to climb or jump out (Figure 16). This pattern is expected to hold true independently of time and space. That is, wherever entrapment of small vertebrates in archaeological pit features has occurred, remains of these animals will show this general pattern.

Although less likely, the same pattern may at times have been produced by other natural and cultural processes. For example, had small animals been boiled whole and their bones deposited in the bottoms of deep pit features, a similar pattern would result. It is doubtful, however, that such a pattern attributable to cultural deposition would be repeated throughout a region and across time, given the diversity of dietary, culinary, and refuse disposal behavior which must have existed. More likely, small vertebrate remains representing cultural refuse would be generally distributed among other kinds of refuse in pits, showing no particular pattern of stratigraphic placement.

A second consideration is that taphonomic processes may bias bone and shell preservation in favor of materials in deeper levels of pits. It has been proposed that smaller, less-dense animal bones will decay at a faster rate than larger, denser ones under the same conditions (Von Endt and Ortner 1984), and it is possible that faunal remains nearer the surface within a pit feature are subjected to faster decay because of higher microbial activity. The fact that whole well-preserved bones of small animals do occur in shallow features and in surficial midden deposits on sites in eastern North America (Holm 1987;

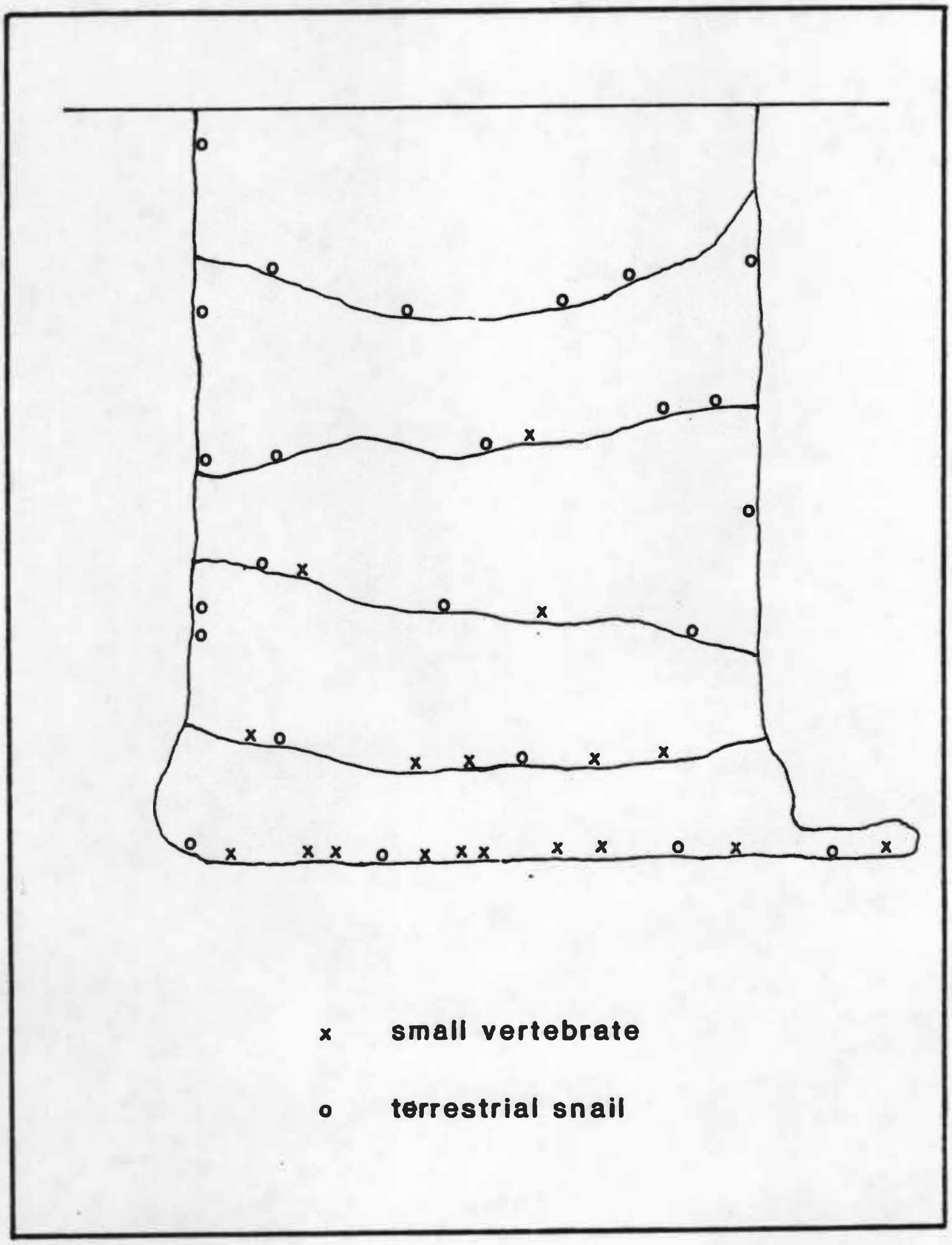

Figure 16. Hypothetical pit profile showing anticipated locations of remains of entrapped terrestrial snails and small vertebrates.

Parmalee and Klippel 1983; Styles 1981; Whyte 1986), however, is not in favor of this possibility.

It must be concluded, then, that if no positive correlation exists between the stratigraphic placement of small vertebrate remains and remains of larger species (e.g., white-tailed deer) presumed to have been eaten, and small animal remains are more abundant in deeper portions of pit features, then most of the small animal remains probably represent naturally entrapped fauna.

Additional clues to natural entrapment of vertebrates may be found in the conditions of pits containing their remains. Small mammals trapped in Holston Farm site pits typically burrowed into pit walls at floor level and often pawed at the walls in trying to escape. This digging resulted in either burrows, isolated concavities (Figure 17), or in undercutting of the entire circumference of a pit (Figure 18). Recognizing these disturbances in archaeological pits containing mouse or shrew remains would be a strong indication of entrapment.

The entrapment data indicate that shells of land snails naturally accumulating in archaeological pit features will occur along pit walls and immediately beneath depositional layers which trapped them (Figure 16). Had land snails been eaten by humans and their shells discarded in pits, larger individuals of larger species would more likely be represented and the shells would not necessarily line pit walls and depositional layers.

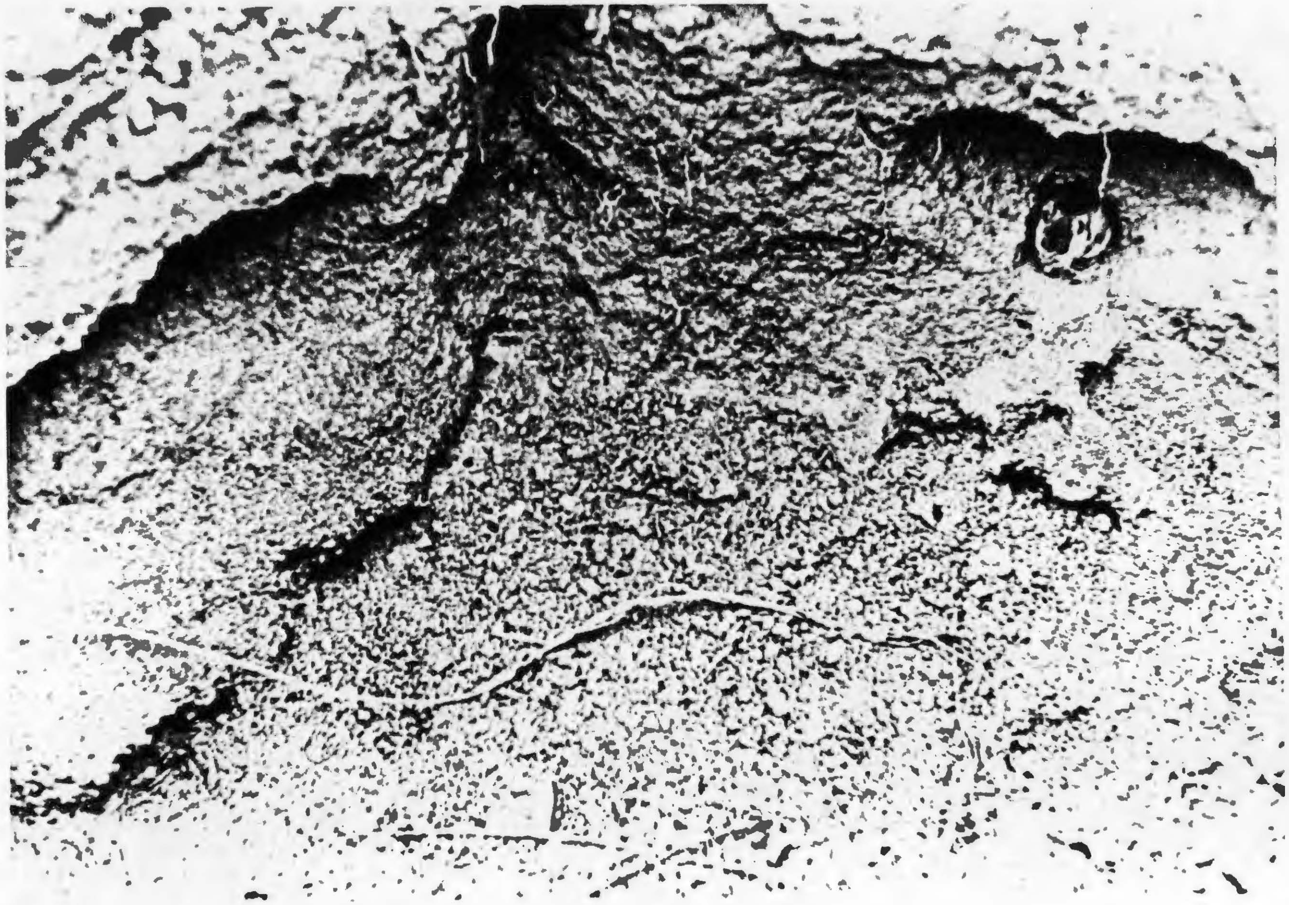

Figure 17. *Peromyscus leucopus* excavations in the wall of Pit 4.

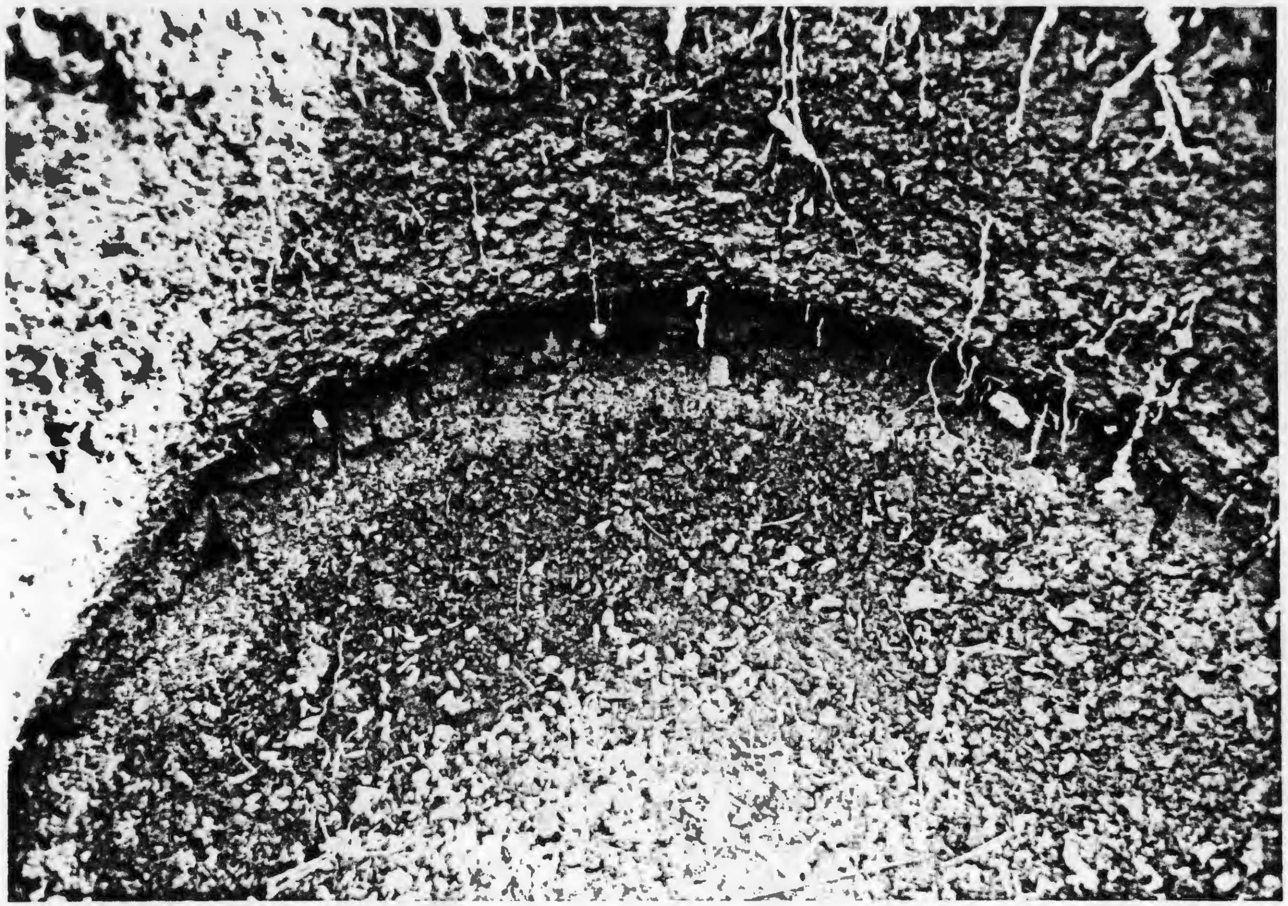

Figure 18. Small mammal burrows and excavations in Pit 11.

<u>Considerations of Pit Form and Content</u>

The extent of entrapment of small animals in a pit feature depends upon pit depth, the angle formed by the pit wall and floor, pit wall soil texture and hardness, pit contents, and whether or not the pit is open. The Holston Farm experiment employed simple plywood covers to test the affects of a pit covering on natural entrapment. No implication of the use of any particular kind of pit covering by Indians of eastern North America, however, is intended. Indications from the ethnohistorical record, in fact, are that pits housing food stores were covered with soil (Ferris 1910:363; Lescarbot 1914:249-250; Marsh 1900:140; Morgan 1901:311; Vaughan 1977:113; Waugh 1916:42-43), while storage pits in disuse were left open (DeLand 1908). The covering of some pits in the Holston Farm experiment simply considered the possibility that pits on archaeological sites may have been protected by a covering of some fashion during periods of disuse to preserve them for future needs, or that some pits may have been used for regular short-term storage and covered loosely to allow regular access to pit contents.

The experiment indicated that pit coverings generally prevented entrapment of individuals of species (anurans, turtles, shrews) which normally blunder into pits regardless of their contents, and deterred individuals of species (mice) which would enter baited pits intentionally. Snails avoided covered pits probably because the pit walls remained too dry for their existence. The presence of remains of entrapped small animals in archaeological pit features, therefore, is

an indication that the pits were left open for a period of time sufficient for their natural accumulation. The number of individuals and the number of species represented in a particular layer of a pit may even be a general indication of the length of time involved in the accumulation.

Pit contents, whether consisting of refuse, stores, or other entrapped small animals, may have attracted small animals into pits or deterred them from entering. Mice are certainly attracted to certain kinds of vegetable materials and will enter open pits to obtain them. Anurans will enter open pits containing rainwater for shelter or for breeding (Shields 1985). Shrews may enter open pits to feed on insects, snails, or refuse, but the Holston Farm experiment revealed no correlations between pit content and shrew entrapment. Many animals responding to the scents or calls of trapped individuals of the same species may enter pits intentionally (Briese and Smith 1974).

Terrestrial snails, probably responding to changes in ground moisture, will move into and out of open pits. It has been proposed (Parmalee et al. 1972) that land snails may occur in archaeological pits containing mollusk shell refuse because they were attracted to the calcium carbonate necessary to the development and maintenance of their own shells. While this remains to be tested, the Holston Farm experiment indicates that snails will enter pits containing no shell.

The occurrence of remains of many individuals of a species of small animal in a pit, based on information from the Holston Farm experiment and other ethological studies, should raise questions about

the possible former contents of pits. This is especially so for mice, which apparently have a better ability to avoid pitfalls. The recovery of the remains of many mice from the lower depths of an archaeological pit feature, for example, may indicate that spilled vegetable stores (corn, nuts, seeds) or other attractive refuse occurred in that pit at the time of entrapment.

Animals which enter or fall into open pits are only trapped if they are unable to escape. Terrestrial snails are generally able to come and go freely unless they become buried by deposits dumped upon them. Anurans can escape by jumping unless a pit is too deep and has steep walls or the pit has steep walls and contains water. Frogs can leap considerable distances (Rand 1952) but cannot achieve great height in a constricted space.

Aquatic turtles are quite helpless in even shallow pits with fairly steep walls. They are poor climbers and could only escape steep-sided pits having rims within the height of their reach.

Shrews can jump and climb but showed an inability when pursued to escape from pits on the Holston Farm site. Any steep-walled pit of 20 or more centimeters deep would easily contain a shrew. Attempts to escape by burrowing would fail because they consistently burrow laterally or downward.

Mice are adept climbers and jumpers. Mice trapped in the experimental pits, when pursued, could run up pit walls to heights of ca. 40 cm. As mentioned earlier, mice were sometimes able to scale pit walls when the soil of the walls was dry. Briese and Smith (1974)

employed metal buckets measuring 41 cm deep as pitfall traps, effectively trapping mice and rats. As noted in a pilot experiment (see Appendix), mice were unable to escape from steep-sided pits containing enough rainwater to prevent them from jumping and having moist walls to prevent them from climbing.

Table 12 summarizes propositions of pit feature characteristics and species entrapment, indicating which kinds of archaeological pit features are likely to contain remains of particular groups of small animals, given the occurrence of entrapment and adequate faunal preservation. It is proposed that terrestrial snails can occur in any open pit where they become trapped by soil and refuse deposition. Turtles and shrews may become trapped in fairly shallow pits as long as pit walls are rather steep or outsloping (bell-shaped in profile). Although no toads were captured in the experimental pits, they do not jump particularly well and would probably also become trapped in fairly shallow pits (see Gibbons and Semlitsch 1982). Similar pits containing several centimeters of rainwater would also effectively trap mice were they to fall in. Otherwise, only deeper pits of 40 cm or more and having straight or outsloping walls would effectively trap mice.

A final point regarding pit characteristics and small animal entrapment concerns pit linings. Abundant ethnohistorical (Lescarbot 1914:249-250; Morgan 1901:311; Vaughan 1977:113; Waugh 1916:42-43) and archaeological sources (Dickens 1976:63; Lucy and McCracken 1985:7; Mason et al. 1944:380-385; Ritchie and Funk 1973:232-233) attest to the use of linings, especially bark, in storage pits in eastern North

Table 12. Summary of Propositions Relating Pit Characteristics and Small Animal Entrapment.

Pit Type	Taxa
Any open pit	land snails
Shallow (20 to 40 cm) open pits with vertical or outsloping walls	land snails turtles toads shrews
Shallow (20 to 40 cm) open pits with vertical or outsloping walls and containing more than 10 cm of water (see Appendix)	land snails turtles toads frogs shrews mice
*Deep (> 40 cm) open pits with vertical or outsloping walls	land snails turtles toads frogs shrews mice

*Very deep pits might also trap slightly larger mammals.

America. Bark linings left in abandoned storage pits may have been attractive cover for land snails and would have facilitated the ingress and egress of mice exploring pits for food.

Seasonal and Climatic Inferences

It can safely be said that species of small vertebrates and terrestrial snails in eastern North America respond to changes in temperature and moisture. Seasonal peaks of activity were evident for all major animal groups (land snails, frogs, turtles, mammals) observed in the Holston Farm experiment, although seasonal data for resident mammal species may have been biased somewhat by trap deaths. Daily entrapment records for anurans, turtles, and small mammals from the Savannah River Plant experiments (Briese and Smith 1974; Gibbons 1970; Gibbons and Bennett 1974; Gibbons and Nelson 1978; Gibbons and Semlitsch 1982) provide additional and more sensitive data on relationships between climatic variables and species activity.

It is almost certain that individuals of a particular species and, to a large extent, of the same genus in different regions in eastern North America respond similarly to climatic change barring minor variations with latitude and altitude. In other words, pickerel frogs in South Carolina will generally respond to temperature and moisture changes in the same way as pickerel frogs in Pennsylvania. It is argued, therefore, that data generated by these experiments are generally applicable to the study of small animal entrapment in pits on late prehistoric and early historic period archaeological sites in the same general region of eastern North America.

A plethora of recent studies indicates the importance of determining seasons of food resource exploitation by aboriginal human societies (Claassen 1986; Manzano 1985; Monks 1981; Morey 1983). Most of these studies identify the season of death of food animals utilized by aboriginal peoples by examining annular growth of animal bones or mollusk shells. Identifying seasons of food resource procurement is crucial for reconstructing human subsistence and settlement systems and understanding former human ecological systems. Often, however, the archaeological remains or modern control specimens needed for such studies are unavailable and the archaeologist must infer seasons of resource use based upon a knowledge of seasonal variation in resource availability for a region. This approach works when migratory species such as birds and marine fishes are the resources concerned (e.g., Whyte 1986), but is obviously dubious when studying the remains of more non-migratory fauna.

One shortcoming of most seasonality studies is that, while they can identify seasons of food resource exploitation, they do not necessarily establish seasons of resource consumption and deposition or site occupation. The reasons for this are obvious: foods can be and often were stored by humans for later consumption. Furthermore, parts of animals (shells, bones, teeth, antlers) used for tools or ornamentation may have been deposited on sites far from the time and place of their original derivation.

A benefit of the present study of small animal entrapment in pit features is its application to assessing seasonality of refuse

deposition and, therefore, of site habitation. There are, however, several conditions which must prevail in order to make confident judgements. For example, it must be realized that small animals may accumulate in pits during times when pits are open but when the site is not being used. Subsequent use of the site and refuse deposition in the pits, then, may occur in seasons different from those indicated by small animal entrapment. However, if remains of entrapped small animals occur between refuse deposits in pits, a stronger association between the seasonality of entrapment and refuse deposition may be argued. This requires the assumption or demonstration that pits were filled within a reasonable time (less than one year) of their abandonment.

Research by Hayden and Cannon (1983) and Schroedl (1983; 1986) indicates that the rate and processes of pit filling will vary with distance from domicile areas and with pit size or degree of hindrance. The rate or regularity of cultural deposition in a pit should be indicated by the character of pit fill stratigraphy. Pits left open for more than one year before or between times of refuse deposition should contain fairly obvious zones represented by erosional deposition, while pits filled over a period of a few months or less should show little or no natural accumulation of sediment between refuse deposits. The rate of erosion, however, will vary with climate, soil type, and surface vegetation. In essence then, attempting to assess the seasonality of consecutive deposits in an archaeological pit feature based on microfaunal remains in one of those deposits requires

the demonstration that the lapse of time between deposition was less than one season.

Based on the observations made in the Holston Farm experiment, this may not be an easy task. One year's accumulation of erosional sediments in Pit 15 only measured 10 to 12 cm in maximum thickness. Pit 9 remained untouched for up to two months between refuse depositions, yet no archaeological evidence of erosional deposition between the refuse deposits was observable when the pit was excavated the following year. Evidently, the deliberate filling of a pit could take place gradually over the course of a year or two with little or no archaeologically detectable evidence of the time lapses between deliberate depositions. Small animal remains from various levels in such a pit might have accumulated in different seasons or in the same season of different years, thus encouraging a misinterpretation of refuse deposit and site occupation seasonality.

Of the groups typically caught in pits in eastern North America, only poikilothermic (cold-blooded) animals are basically inactive during winter months, but an occasional frog or turtle may find its way into a pit during warm spells in December or January. The occurrence of remains of several individuals of poikilothermic species (terrestrial snails, frogs, toads) at one level in a pit would indicate a warm season accumulation. Furthermore, the identification of remains of many individuals of species especially active on land during a restricted breeding season (e.g., frogs) may help to further refine estimates of entrapment seasonality.

CHAPTER V

ARCHAEOLOGICAL APPLICATION OF EXPERIMENTAL ENTRAPMENT DATA

Introduction

Archaeological data from five sites in eastern North America were selected for this study on the bases of several criteria. Most fundamentally, it was necessary that each site contain pit features that were excavated using 1.5 mm mesh window screen and which yielded remains of small animals. Secondly, it was necessary that comparable attempts were made to identify all faunal remains recovered from pits to the highest taxonomic division. It was also desired that prehistoric and historic period Native American sites from various locations in eastern North America be included in the study. The inclusion of historic period sites would provide a chance to evaluate entrapment data in light of known or demonstrable seasonal and environmental settings.

These criteria considerably narrowed the sample of reported sites qualifying for the study. Many sites having pit features that contained small animal remains were rejected because of inconsistencies in excavation or analysis, or because faunal or feature data were inaccessible. The sites chosen for this study include one in central Illinois, one in western North Carolina, two in central North Carolina, and one in eastern Virginia. Three are historic period sites and two are late prehistoric period sites.

These sites, discussed in detail below, meet the above criteria for the most part, except that terrestrial snail shells, while probably recovered from pits on each of the sites, were only analyzed for the Addington site (44VB9) (Whyte 1986). This is a serious limitation since terrestrial snail shells are important indicators of seasonality, environment, and rates of deposition. Furthermore, pit excavation methods and available contextual data varied from site to site and affect the degree to which the stratigraphic contexts of small animal remains in pit features can be evaluated. For example, arbitrarily defined levels were used to control the excavation of pits at the Rhoads and Addington sites, while pits on the three sites in North Carolina were excavated only by observable depositional strata.

Finally, potential discrepancies in faunal identification exist since they were conducted by different individuals having different levels of experience and using different comparative collections. It is impossible to measure or predict how identification bias may have affected the comparability of the faunal data for the five sites. The present study assumes (with caution) that they are comparable.

The possibility of natural entrapment as an explanation for the occurrence of small animal remains in pit features on each of the five sites is considered in light of experimental data and knowledge of small animal behavior and ecology. In addition, inferences of former site environment, occupation seasonality, and circumstances of pit feature abandonment and filling are posited. With regard to the latter, Dickens (1985:35) noted that:

> ...while the garbage in an archaeological pit feature may not be related _directly_ to the original function of that feature, it nevertheless may be related to circumstances surrounding abandonment of the feature and therefore _indirectly_ to its original function.

The remains of land snails and small vertebrates representing natural entrapments in pits may indeed be related to the circumstances surrounding abandonment of a feature and therefore indirectly to its original function. These circumstances would include, among others, the season(s) of entrapment and the immediate environment of a pit. For example, pits having only a seasonal function and the need for limited access (e.g., storage pits) may have been located in unkempt areas of a site containing ground vegetation and debris (potential habitats for land snails and small rodents). Hayden and Cannon (1983:126) refer to such areas as "toft" areas surrounding structures and "used for maintenance-storage activities and for the general disposal of household refuse whether in pits or scattered on the surface." Conversely, pits having more continuous functions (e.g., roasting pits) may have been located in well-maintained areas regularly cleared of vegetation and debris (poor habitats for small animals). Such possibilities will be considered in the analysis of microfaunal and pit feature data in the discussion which follows.

The Rhoads Site (11LO8)

The Rhoads site (11LO8) was a Kickapoo Indian summer village dating to A.D. 1800 ± 30 and located on a first terrace of Kickapoo Creek in central Illinois (King et al. 1975; Klippel 1972, 1973). At

the time of its occupation by the Kickapoo, the site was situated in an area of mixed forest and prairie of the Prairie Peninsula (Klippel 1973). Between October 1972 and August 1973, excavations conducted by the Illinois State Museum (Figure 19) uncovered 58 pit features containing vertebrate remains (Parmalee and Klippel 1983). These pits were generally deep, ranging from 88 to 219 cm below surface, and consisted of straight to insloping side walls.

Pit features were generally excavated in 6 inch (15 cm) arbitrary levels, and all feature fill was washed through 1/16 inch (1.5 mm) mesh window screen. All vertebrate remains recovered were examined by Paul W. Parmalee (Parmalee and Klippel 1983). Gastropod shells from the Rhoads site have not yet been studied (Walter E. Klippel, personal communication 1986). Several species of all vertebrate classes were identified. Small animals represented include frogs, toads, shrews, and mice. In addition, bones of moles, ground squirrels, bog lemmings, and young rabbits were identified by Parmalee and Klippel (1983) as representing potential entrapments.

Most of the small animal remains (excluding those of fish) occurred in the lower levels of deep pit features, suggesting to Parmalee and Klippel (1983) that many of the animals had become trapped in the pits when they were open. Parmalee's original analysis notes were reviewed to produce Table 13 and Figure 20, which provide stratigraphic information on small animal remains from pit features on the site. Note in Figure 20 that the vertical distribution of small animal remains in pits shows an almost inverse relationship with the

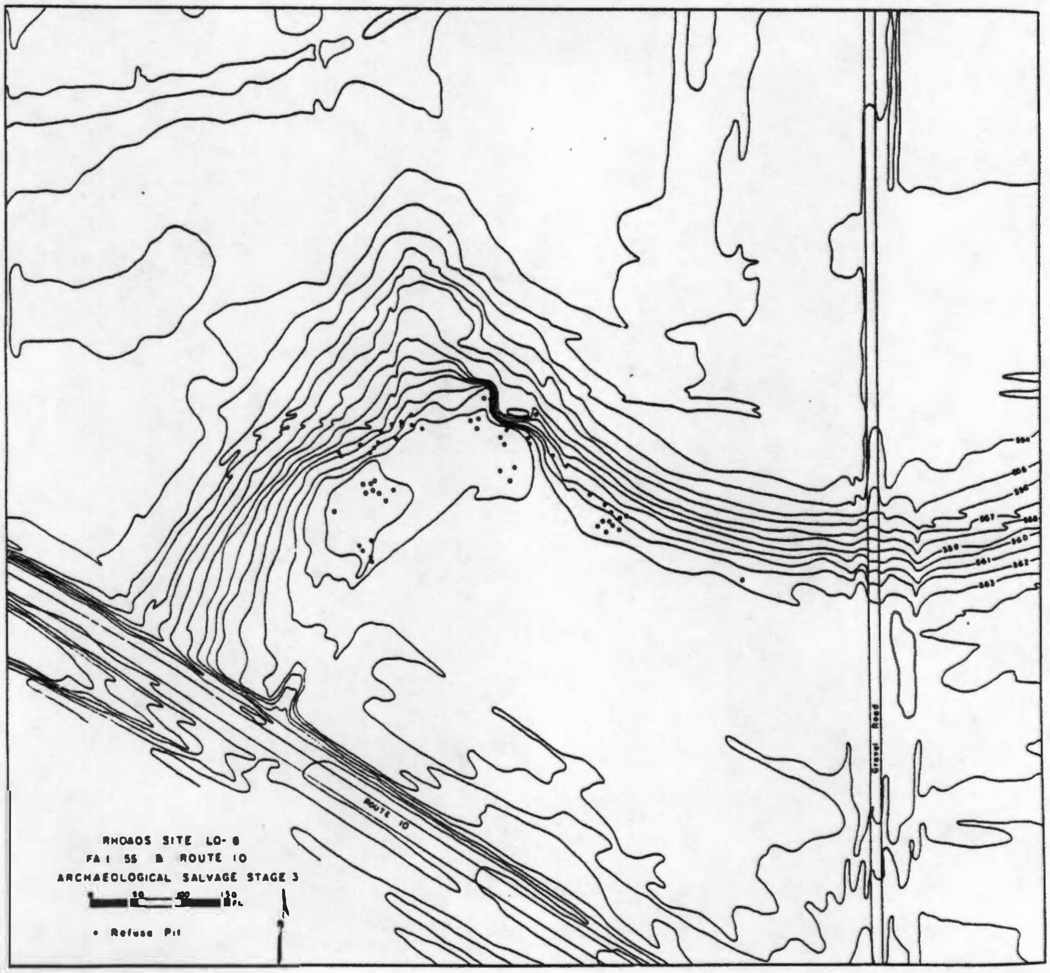

Figure 19. Map showing excavations at the Rhoads site (11L08).

Table 13. Distribution of Vertebrate Remains by 6 Inch (15 cm) Excavation Level in Pit Features from the Rhoads Site (11LO8).

	Excavation Level Number													
Feature No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
						Anuran Remains								
4	7	0	0	0	0	0	0	0	0	0	11	31	*	*
6	0	0	0	0	0	0	0	0	0	0	0	2	*	*
11	2	2	0	1	12	80	42	0	0	11	1	0	*	*
17	2	0	0	0	7	0	4	0	0	5	29	*	*	*
22	0	0	0	0	0	0	0	0	0	0	11	0	*	*
37	0	0	0	0	0	0	0	0	0	1	*	*	*	*
40	1	0	0	0	0	1	1	3	0	1	6	0	0	*
41	1	0	0	0	0	0	0	0	0	1	0	*	*	*
47	0	0	0	4	36	*	*	*	*	*	*	*	*	*
48	0	0	0	0	0	0	0	*	*	*	*	*	*	*
54	0	0	0	0	0	0	0	*	*	*	*	*	*	*
71	1	0	1	96	34	20	0	36	0	*	*	*	*	*
73	0	0	0	0	0	0	0	*	*	*	*	*	*	*
74	0	0	0	0	0	0	0	0	0	3	*	*	*	*
75	0	0	0	1	0	0	10	0	1	0	*	*	*	*
79	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	0	0	0	0	0	2	0	0	0	0	*	*	*	*
114	0	0	0	0	0	0	0	0	0	0	*	*	*	*
116	0	0	0	0	0	0	0	0	*	*	*	*	*	*
118	0	0	0	0	0	1	0	2	0	0	0	*	*	*
125	0	0	0	0	0	0	0	0	0	0	*	*	*	*
127	0	2	0	0	0	0	0	0	0	*	*	*	*	*
128	0	0	0	0	0	0	0	0	0	*	*	*	*	*
130	0	0		0	0	0	0	0	0	*	*	*	*	*
140	0	0	0	0	0	0	0	0	0	1	*	*	*	*
141	0	0	0	10	0	0	3	0	3	*	*	*	*	*
152	0	0	0	0	0	0	0	0	*	*	*	*	*	*
						Small Mammal Remains								
4	1	0	1	0	0	0	0	1	0	0	10	50	*	*
6	0	0	0	0	0	0	1	0	0	0	0	0	*	*
11	1	7	12	1	0	11	1	10	0	0	0	4	6	*
17	5	0	1	1	0	0	0	0	0	200	0	*	*	*
22	0	0	0	2	0	0	0	1	0	0	5	0	*	*
37	0	0	0	0	0	0	0	0	0	0	*	*	*	*
40	1	0	0	0	0	1	1	3	0	1	6	0	0	*
41	1	0	0	2	0	0	2	0	1	0	0	*	*	*
47	0	0	0	2	2	*	*	*	*	*	*	*	*	*

Table 13 (continued)

	Excavation Level Number													
Feature No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
(Small Mammal Remains, continued)														
48	1	0	0	0	0	0	0	*	*	*	*	*	*	*
54	1	2	0	4	1	6	4	*	*	*	*	*	*	*
71	0	0	1	8	9	0	0	39	0	*	*	*	*	*
73	0	0	5	0	0	0	2	*	*	*	*	*	*	*
74	0	0	0	0	0	0	0	0	0	0	*	*	*	*
75	0	0	7	1	0	15	31	3	76	12	*	*	*	*
79	0	0	11	6	2	0	0	0	0	0	0	0	1	0
96	2	0	0	0	0	0	0	0	0	1	*	*	*	*
114	0	0	0	0	0	0	0	0	1	0	*	*	*	*
116	0	0	0	0	0	0	0	14	*	*	*	*	*	*
118	0	5	0	0	0	1	0	7	0	3	15	*	*	*
125	1	0	0	0	1	2	0	5	8	7	*	*	*	*
127	2	1	0	0	0	0	0	0	0	*	*	*	*	*
128	0	0	0	0	1	3	1	1	2	*	*	*	*	*
130	0	0	0	0	0	0	0	0	17	*	*	*	*	*
140	2	5	0	9	0	1	0	0	0	0	*	*	*	*
141	2	1	0	7	0	1	0	0	0	*	*	*	*	*
152	0	0	1	0	1	0	1	0	*	*	*	*	*	*
Other Vertebrate Remains														
4	7	14	14	16	32	17	9	17	68	0	2	11	*	*
6	1	1	6	4	13	10	4	4	2	1	0	0	*	*
11	77	79	38	133	233	30	9	3	0	3	2	1	3	*
17	141	53	113	16	13	2	8	5	7	1	3	*	*	*
22	10	10	3	3	2	0	2	2	2	1	2	2	*	*
37	6	0	7	0	4	1	3	4	3	7	*	*	*	*
40	31	78	52	42	12	25	60	30	53	134	145	43	52	*
41	178	147	111	133	85	10	75	46	12	39	5	*	*	*
47	15	3	8	9	18	*	*	*	*	*	*	*	*	*
48	27	10	10	27	29	10	17	*	*	*	*	*	*	*
54	20	42	30	55	29	50	42	*	*	*	*	*	*	*
71	3	11	42	37	9	13	0	0	0	*	*	*	*	*
73	1	0	2	0	0	3	3	*	*	*	*	*	*	*
74	0	14	0	13	32	8	1	1	7	5	*	*	*	*
75	16	51	83	20	61	26	6	28	16	3	*	*	*	*
79	27	5	5	3	13	0	4	6	2	8	7	0	9	6
96	7	1	0	2	2	12	2	0	0	13	*	*	*	*
114	63	21	13	19	2	8	8	6	17	6	*	*	*	*
116	28	8	35	12	2	0	1	0	*	*	*	*	*	*
118	41	318	167	26	0	15	209	285	23	68	0	*	*	*

Table 13 (continued)

Feature No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
						Excavation Level Number								
					(Other Vertebrate Remains, continued)									
125	359	14	3	5	18	12	2	0	2	4	*	*	*	*
127	101	362	198	39	4	7	3	0	8	*	*	*	*	*
128	393	173	8	4	5	23	2	10	26	*	*	*	*	*
130	20	34	21	9	14	8	13	7	40	*	*	*	*	*
140	97	198	40	18	5	4	3	2	3	7	*	*	*	*
141	37	21	20	116	55	60	64	15	11	*	*	*	*	*
152	480	87	22	0	12	25	12	12	*	*	*	*	*	*

Note: A * indicates that a feature did not include that excavation level.

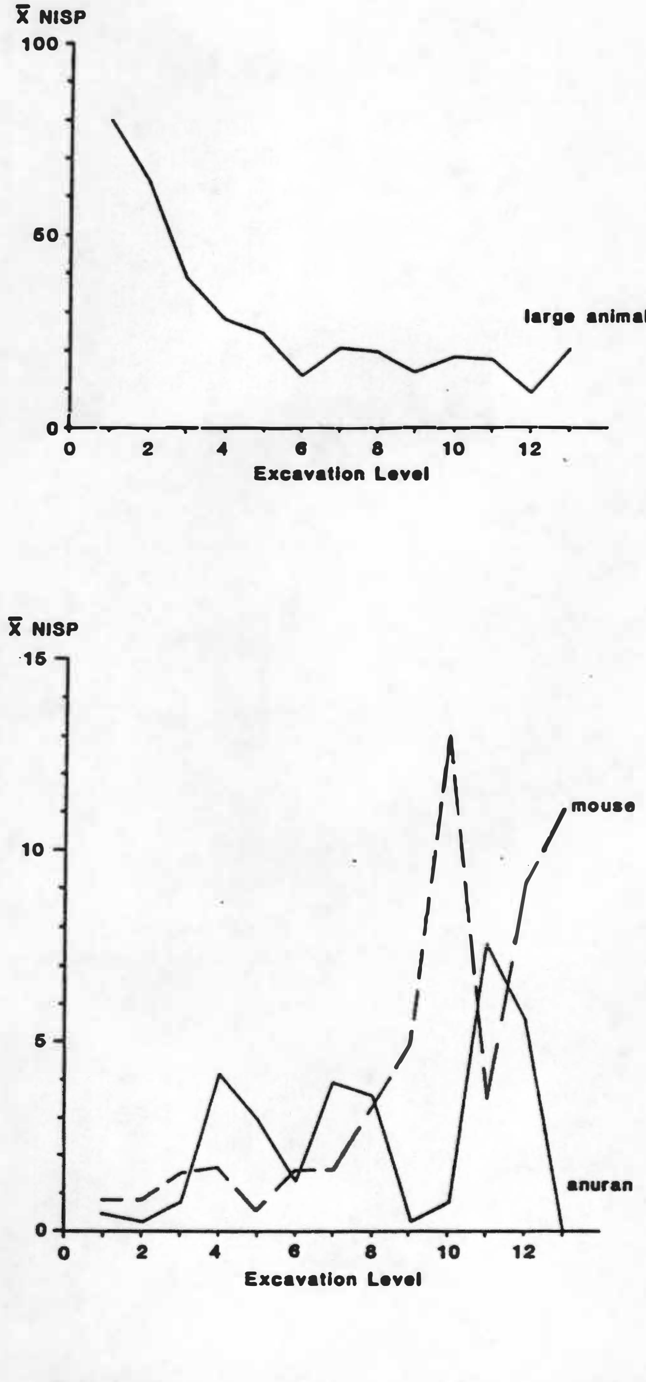

Figure 20. Graphed distribution of anuran, mouse, and other vertebrate remains by 6 inch (15 cm) excavation level in pits on the Rhoads site (11LO8).

remains of larger animals that were undoubtedly eaten or used by the site occupants. Note also that mouse and anuran (toad and frog) bones were generally recovered from lower levels of pits. This pattern strongly suggests, as proposed by Parmalee and Klippel (1983) and as detailed in the preceding chapter, that most if not all of these small animals became trapped in empty open pits.

Mice, as indicated by the Holston Farm experiment, are able to climb out of pits if pit walls become dry and consolidated. Interestingly, small mammal (mostly mouse) remains were most abundant in very deep straight-walled pits on the Rhoads site. Features 17 and 75, both cylindrical pits of 1.5 m or more in depth, contained 207 and 145 small mammal bones respectively (Table 13). The graph in Figure 20 indicates that mouse bones were abundant only below a depth of one meter in deep pits, whereas anuran bones commonly occurred within pits at depths of only 60 cm or greater.

The large cylindrical pits of the Rhoads site were undoubtedly storage pits, probably built to contain corn during winter months when the site was abandoned (King et al. 1975). Ethnohistorical accounts of the Kickapoo and related tribes in Illinois (Blair 1912; Ferris 1910; Marsh 1900) indicate that bags of corn were buried in these summer village pits for concealment and storage during winter and retrieved for consumption the following spring. Considering the experimental evidence, that mice will enter pits intentionally to obtain food, it is possible that mice deliberately went into Rhoads site pits containing

spilled corn or vegetable food refuse dumped in these pits, whereas the entrapment of other animals in these pits was perhaps more fortuitous.

Seasonality

Pollen data (King et al. 1975), faunal data (Parmalee and Klippel 1983), and a knowledge of historic Kickapoo Indian seasonal migration indicate that the Rhoads site was occupied from spring through fall. Species represented by entrapped small animals, especially the anurans, are consistent with this interpretation but do not rule out the possibility that some pits were also open in winter. Storage pits abandoned in spring when stores were used up may have accumulated refuse, erosional sediments, and small animal remains well into the subsequent year. It is likely, however, that small animal remains and refuse materials in lower zones of these pits accumulated in spring and summer soon after food stores were removed for consumption.

Environment

Federal Land Survey notes and pollen data place the Rhoads site during its occupation in the mixed forest and prairie of the Prairie Peninsula (King et al. 1975). The small animal species represented in pits are consistent with such an environment. Some species represented, such as the least shrew (*Cryptotis parva*), bog lemming (*Synaptomys* cf. *cooperi*), prairie/meadow vole (*Microtus* sp.), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), and meadow jumping mouse (*Zapus hudsonius*), prefer low meadows with tall grass

(Barbour and Davis 1974). Others, such as the toad (Bufo sp.), short-tailed shrew (Blarina brevicauda), and deer/white-footed mouse (Peromyscus sp.) prefer wooded habitats or are more cosmopolitan (Barbour and Davis 1974). The natural occurrence of remains of these species on the site suggests a site environment including at least patches of tall grass and the close proximity of some trees and woodland debris. Lacking information on terrestrial snail shells from Rhoads site pits, it would be premature to infer ground surface conditions in the immediate vicinities of pits. Mice and shrews that got into pits probably had suitable nesting places (vegetation and debris) nearby.

The Addington Site (44VB9)

The Addington site (44VB9) is a Middle and Late Woodland period (ca. A.D. 300-1500) village in Virginia Beach, Virginia, near the mouth of the Chesapeake Bay. A portion of the site was excavated in 1984 by the James Madison University Archeological Research Center (Geier, Cromwell, and McCartney 1986). Archaeological deposits on the site included several refuse-filled pit features and tree fall pits (often referred to as cradle-knolls), human burials, surface middens, and a slope midden (Figure 21). Faunal remains from a sample of the slope midden, four tree fall pits, and eight cultural pit features were analyzed by the author (Whyte 1986). These features were bisected, the first half excavated in 4 inch (10 cm) levels, and the second half by observable depositional strata. All feature fill was washed through 1/16 inch (1.5 mm) mesh screen.

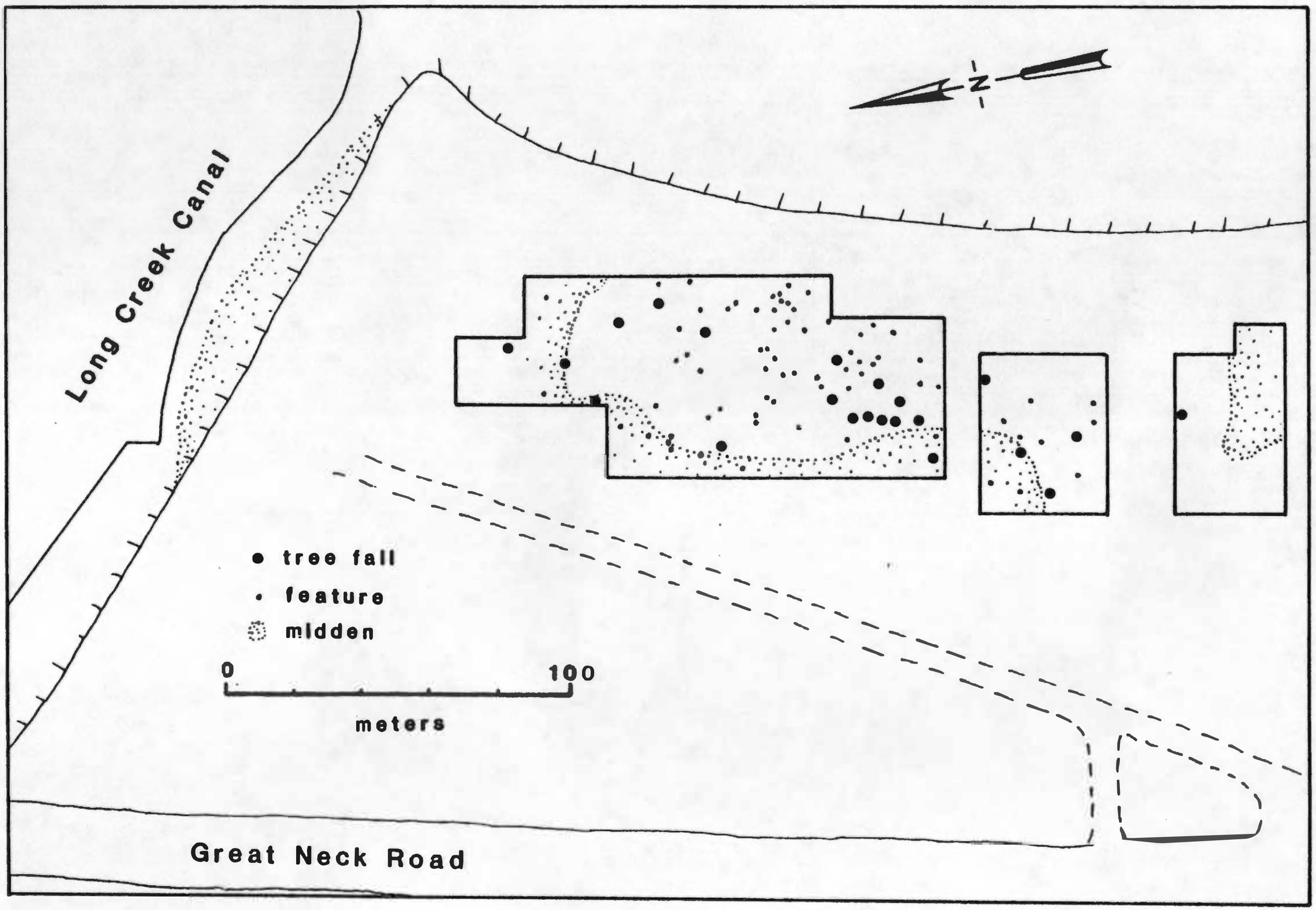

Figure 21. Map showing excavations at the Addington site (44VB9).

The pit features at the Addington site were quite variable in size and shape. Those containing faunal remains included deep cylindrical pits, a deep bell-shaped pit, and shallow basin-shaped pits (Whyte 1986).

Several species of vertebrates, crustaceans, and mollusks were identified from the samples of faunal remains (Whyte 1986). Small animals represented which are of concern in this study include land snails, frogs, toads, shrews, mice, and rats (Tables 14 and 15). Only three of the features excavated stratigraphically (Features 200N10, 200N28, and 220N5) contained many small vertebrate remains (Table 14). Each of these pit features was bisected, with one half excavated in 4 inch (10 cm) arbitrary levels, and the other half excavated by observable depositional strata. This method of excavation provides an opportunity to examine the vertical distributions of small animal remains by depth increment and by depositional zone.

The small vertebrate remains in these pits, like those at the Rhoads site, were considerably more abundant in the lower levels (Table 14), indicating the probability that most of them represent entrapped individuals. Feature 200N10 (Figure 22) contained a distinct stratigraphic sequence that can be compared to the vertical distribution of small vertebrate remains in the pit. Ninety-eight percent of the anuran remains and 90% of the small mammal (shrew and mouse) remains were recovered from the lower three excavation levels in one (north) half of the feature (Table 14). These levels correspond mostly to Zone 5 (Figure 22) which produced 97% of the anuran remains

Table 14. Distribution of Small Vertebrate Remains by Feature, Zone, and Excavation Level from the Addington Site (44VB9).

Feature No.	Wall Shape	Half	Zone	Zone Depth (cm)	Level	Level Depth (cm)	Species	NISP*
60N1	Insloping	South	1	22	-	-	*Bufo* sp.	1
							Rana sp.	1
							Anura	3
							Blarina brevicauda	5
							Microtus sp.	5
200N10	Straight	North	-	-	2	20	Anura	2
							Microtus sp.	3
							Insectivora/Rodentia	2
					3	30	*Bufo* sp.	1
							Anura	1
							Scalopus aquaticus	1
							Microtus sp.	1
					4	41	*Bufo* sp.	1
							Anura	1
							Microtus sp.	1
							Insectivora/Rodentia	1
					5	51	Anura	7
							Insectivora/Rodentia	1
					6	61	*Bufo* sp.	11
							Rana sp.	1
							Anura	97
					7	71	*Bufo* sp.	48
							Rana sp.	6
							Anura	363
					8	76	*Bufo* sp.	18
							Anura	141

Table 14 (continued)

Feature No.	Wall Shape	Half	Zone	Zone Depth (cm)	Level	Level Depth (cm)	Species	NISP*
		South	1	23	-	-	*Peromyscus* sp.	1
							Insectivora/Rodentia	1
			2	43	-	-	*Microtus* sp.	1
200N10	Straight	South	3	61	-	-	*Bufo* sp.	2
							Anura	10
							B. brevicauda	6
							Peromyscus sp.	5
							Microtus sp.	1
							Insectivora/Rodentia	2
			5	76	-	-	*Bufo* sp.	32
							Rana sp.	24
							Anura	312
							B. brevicauda	34
							Microtus sp.	20
200N28	Outsloping	Both	-	-	5	86	*Rana* sp.	1
							Peromyscus sp.	6
		West	-	-	6	97	Anura	1
							Oryzomys palustris	5
							Cricetidae	24
							Insectivora/Rodentia	2
					7	107	*Bufo* sp.	15
							Rana sp.	11
							Anura	45
							Peromyscus sp.	1
							Microtus sp.	18
							O. palustris	15
							Cricetidae	13
							Insectivora/Rodentia	2

Table 14 (continued)

Feature No.	Wall Shape	Half	Zone	Zone Depth (cm)	Level	Level Depth (cm)	Species	NISP*
					8	117	*Bufo* sp.	13
							Rana sp.	33
							Anura	94
							B. brevicauda	10
							Cricetidae	1
							Insectivora/Rodentia	3
200N28	Outsloping	East	2	117	-	-	*Bufo* sp.	34
							Rana sp.	28
							Anura	106
							B. brevicauda	3
							Microtus sp.	2
							Cricetidae	3
220N5	Insloping	North	-	-	1	10	Anura	3
							Microtus sp.	1
					2	20	*Bufo* sp.	2
							Rana sp.	1
							Anura	5
					3	28	*Bufo* sp.	1
							Rana sp.	9
							Anura	10
		South	1	28	-	-	Anura	1
220N11	Straight	West	-	-	4	41	Anura	3
		East	2	41	-	-	*Rana* sp.	2
							Anura	3

Table 14 (continued)

Feature No.	Wall Shape	Half	Zone	Zone Depth (cm)	Level	Level Depth (cm)	Species	NISP*
240N3	Insloping	South		71	-	-	Bufo sp.	9
							Anura	18
							B. brevicauda	6
							S. aquaticus	9
							Microtus sp.	
							O. palustris	28
							Cricetidae	2
							Insectivora/Rodentia	4
340N2	Unknown	Both	1	Unknown	-	-	Bufo sp.	2
							Rana sp.	20
							Anura	59
							B. brevicauda	2
							Insectivora/Rodentia	3

*NISP = the number of identified specimens per taxon. Identifications for most small mammal species were based primarily on trophic elements (teeth, mandibles) and long bones. Those of Anurans were based primarily on long bones and ilia.

Table 15. List of Species of Terrestrial Snails Identified from Features on the Addington Site (44VB9).

Feature No.	Half	Zone	Level	Species	MNI*
60N1	South	1	-	Anguispira alternata	177
				Helicodiscus parallelus	6
				H. singleyanus	2
				Mesodon thyroides	5
				Retinella sp.	2
				Triodopsis albolabris	7
				Triodopsis albolabris	7
				Ventridens ligera	29
	North	-	2	A. alternata	10
				V. ligera	3
			3	A. alternata	4
				V. ligera	2
200N28	East	2	-	H. parallelus	1
				H. singleyanus	17
	West	-	4	H. singleyanus	2
				Retinella sp.	1
			6	A. alternata	1
				Haplotrema concavum	1
				Helicodiscus singleyanus	200
			7	A. alternata	2
				H. parallelus	1
				H. singleyanus	126
				Retinella sp.	1
			8	H. parallelus	2
				H. singleyanus	8
220N11	East	2	-	A. alternata	7
				Columella edentula	2
				H. parallelus	1
				H. singleyanus	8
				Mesomphix sp.	3
				Retinella sp.	2
	West	-	3	A. alternata	6
				H. parallelus	2
				H. singleyanus	3
				Mesomphix sp.	2
				Retinella sp.	7
			4	A. alternata	4

Table 15 (continued)

Feature No.	Half	Zone	Level	Species	MNI*
220N13	South	1	-	A. alternata	15
				H. parallelus	1
				H. singleyanus	3
				Mesodon sp.	2
				Retinella sp.	4
				Ventridens sp.	1
	North	1	-	A. alternata	4
				H. parallelus	5
				H. singleyanus	2
				Mesomphix sp.	1
				Retinella sp.	2
240N3	South	1	-	A. alternata	8
				H. parallelus	5
				H. singleyanus	4
				Mesomphix sp.	1
				Retinella sp.	4
				Triodopsis albolabris	1
340N2	Both	1	-	H. singleyanus	9

*MNI = the minimum number of individuals represented.

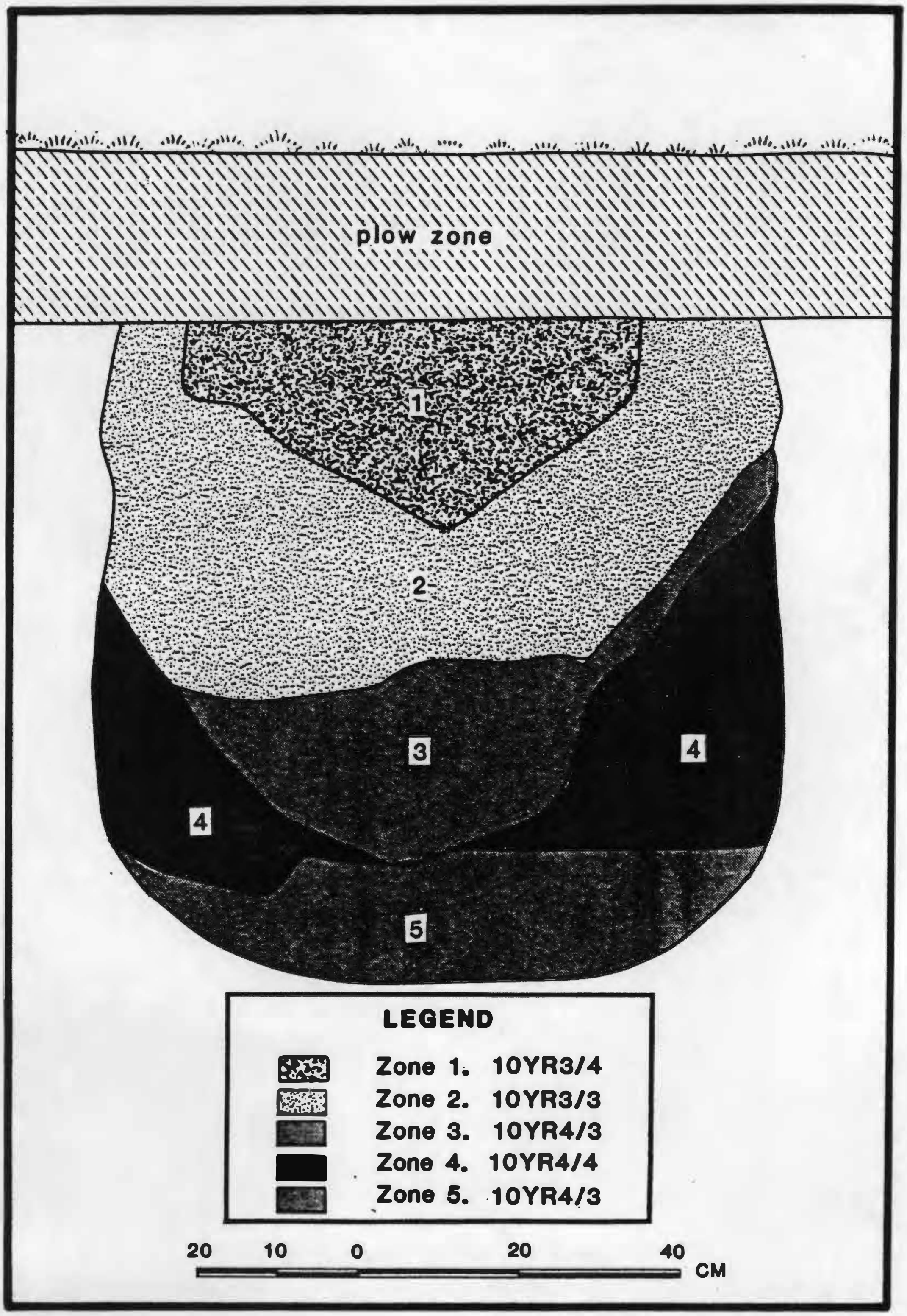

Figure 22. Profile of feature 200N10, Addington site (44VB9).

and 82% of the small mammal remains in the other (south) half of the feature (Table 14).

This abundance of small vertebrate remains in the bottom of Feature 200N10 indicates that the pit remained open for a considerable period of time for the accumulation to have taken place. A further indication of this was the occurrence of a zone (Zone 4) of clayey soil lacking artifacts and interpreted as pit wall slump or erosional talus above Zone 5 (Figure 22). Zone 4 sloped upward and outward from the pit center above Zone 5, probably the result of heavy rains and puddling while the pit remained open and dormant following the deposition of Zone 5.

No land snail shells were recovered from Features 200N10 or 220N5, probably because they had completely decalcified. Land snail shells were only recovered from pit features on the site which contained an abundance of marine mollusk shells; Features 200N10 and 220N5 contained very few marine mollusk shells. A correlation coefficient (R^2) was calculated to measure the relationship between the quantity of land snail shells and the weight of all other mollusk shell by excavation level in three features (200N28, 220N11, and 220N13) excavated stratigraphically and similarly. A strong positive correlation ($R^2 = 0.8838$) indicated that the presence, abundance, and distributions of land snail shells within pits on the site were in part determined by the abundance of other mollusk shells which would have maintained deposit calcium levels conducive to their preservation. Consequently, the relative quantities of land snail shells by stratum

within pits cannot be studied to evaluate the depositional histories of the pits since these may have been affected by differential preservation. Nevertheless, the abundance of snail shells in these pits and their occurrence in several strata of some pits (Features 200N28 and 220N11) suggest that some pits were gradually filled and that land snails were able to enter the pits between episodes of refuse and soil deposition.

Seasonality

The Addington site was probably occupied for most of the year (Geier, Smith, Andrews, and Buchanan 1986; Whyte 1986), although the existence of what are believed to be subterranean storage pits dating primarily to the Middle Woodland period (ca. A.D. 300 to 800) may indicate a short-term winter abandonment of the site (DeBoer 1984). The occurrence of land snail shells among deposits of refuse containing remains of warm season fish species (Whyte 1986) indicates that the pits were open during the warm months of the year. It is quite probable that the functions of these pits were terminated in late winter or early spring when they were then left open to receive occasional refuse, land snails, and small vertebrates. No evidence of erosional deposition prior to the accumulation of small animal remains in the bottoms of pits was observed, indicating that these pits did not remain open and exposed to weather in winter, before the springtime emergence of snails and anurans. The evidence for abandonment of these large pits in late winter or early spring suggests that they may have functioned as winter vegetable storage facilities such as those amply

documented for eastern Woodland cultures during the historic period (see DeBoer 1984).

Environment

The Addington site was not a typical "village" in the sense that it consisted of spatially organized households or a village structure. There was, evidently, no palisade wall, no plaza or central community space, and no recognizable evidence of spatial organization of features and burials. It appears more to have been a hamlet or cluster of houses and associated facilities, although no remains of actual architectural features were found (Geier, Smith, Andrews, and Buchanan 1986).

One unique aspect of the site which suggests its appearance at the time of its occupation was the occurrence of several (21) tree fall pits (sometimes referred to as "cradle-knolls"), many of which contained midden deposits and actual refuse dumps (Whyte 1986). These were interpreted by Geier (Geier, Cromwell, and Hensley 1986) as probable cultural features, but after examining several modern tree falls and recognizing identical features on other archaeological sites, it is obvious to this author that the features were probably created by large wind-thrown trees. The site probably contained standing and fallen trees during its occupation, although cleared areas for structures were undoubtedly present.

The small animal remains representing entrapped fauna in pits certainly reflect such an environment. Short-tailed shrews (Blarina brevicauda), white-footed mice (Peromyscus leucopus), pine voles

(*Microtus pinetorum*), toads (*Bufo* sp.), and all of the land snail species represented (Tables 14 and 15) generally prefer forest floor habitats.

The Fredricks Site (31OR231)

The Fredricks site (31OR231) was an Occaneechi Indian village dating to A.D. 1690 to 1710, and located along the Eno River in the Piedmont of central North Carolina (Dickens et al. 1986). The Fredricks site was visited by the Englishman, John Lawson, in 1701 when it was occupied by the Occaneechi Indians (Dickens et al. 1985). Between 1983 and 1986, excavations by the University of North Carolina Research Laboratories of Anthropology uncovered the entire palisaded village (Figure 23). The many pit features and burials in the village were excavated according to depositional strata and all feature fill except for flotation samples was washed through 1/16 inch (1.5 mm) mesh window screen.

Vertebrate remains recovered from the features were identified and analyzed by Mary Ann Holm (1987). Mollusk remains from this site have not yet been studied, though freshwater mollusk and terrestrial snail shells were recovered (Mary Ann Holm, personal communication 1988). Several species of all vertebrate classes were identified. Small animals represented include frogs, toads, shrews, mice, and rats (Table 16).

It is impossible to plot small animal remains by depth increments in pit features since pits were not excavated by arbitrary

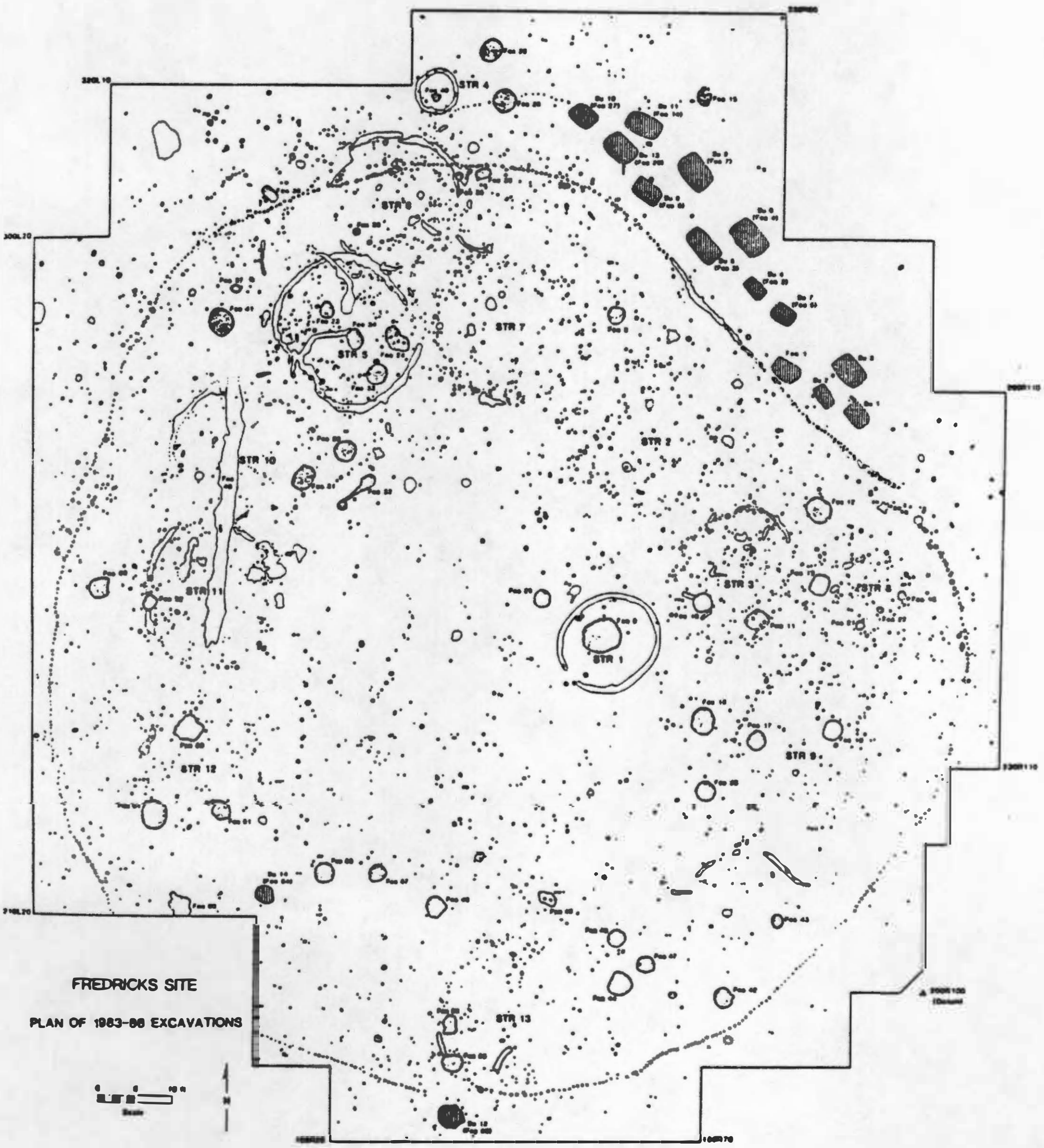

Figure 23. Map showing excavations at the Fredricks site (31OR231).

Table 16. Distribution of Small Vertebrate Remains by Feature and Zone from the Fredricks Site (31OR231).

Feature No.	Wall Shape	Zone	Zone Depth (cm)	Species	NISP*
Burial 1	Straight	1	**	Rana sp.	30
		2	**	--	--
		3	73	Rana sp.	3
				Rodentia	1
Burial 3	Straight	1	31	Rana sp.	6
				Sigmodon hispidus	3
		2	91	--	--
Burial 4	Straight	1	**	Peromyscus leucopus	6
		2	**	P. leucopus	4
		3	**	P. leucopus	1
		4	**	P. leucopus	2
		5	64	P. leucopus	1
Burial 5	Straight	1	30	Scaphiopus holbrooki	6
				Rana sp.	2
				P. leucopus	8
		2	**	Bufo sp.	1
				Rana sp.	1
		3	64	S. holbrooki	21
				Blarina brevicauda	1
				P. leucopus	2
				S. hispidus	1
Burial 8	Straight	1	30	--	--
		2	**	--	--
		3	76	P. leucopus	3
1	Straight	1	**	Rana sp.	6
				S. hispidus	1
		2	64	--	--
12	Straight	1	6	--	--
		2	43	P. leucopus	1
13	Straight	1	6	--	--
		2	45	Rana sp.	2
18	Straight	1	**	--	--
		2	27	Rodentia	1

Table 16 (continued)

Feature No.	Wall Shape	Zone	Zone Depth (cm)	Species	NISP*
20	Outsloping	1	21	--	--
		2	46	Rodentia	1
42	Straight	1	15	*P. leucopus*	5
		2	49	*Bufo americanus*	5
				Anura	47
				P. leucopus	78
				S. hispidus	45
		3	55	*S. holbrooki*	31
				Anura	15
				P. leucopus	211
				S. hispidus	19
44		1	27	--	--
		2	55	Anura	1
				P. leucopus	1
				S. hispidus	2
		3	55	--	--
		4	76	--	--
45	Straight	1	46	*P. leucopus*	20
47	Outsloping	1	18	--	--
		2	49	*P. leucopus*	1
51	Straight	1	6	--	--
		2	61	*P. leucopus*	11
56	Straight	1	38	Anura	1
				P. leucopus	26
				S. hispidus	5
		2	46	*P. leucopus*	2

*NISP = the number of identified specimens.

**depth not recorded.

levels. Note in Table 16, however, that mouse and rat remains tend to cluster in the lower depositional zones of deeper pit features. This distribution, similar to that identified at the Rhoads and Addington sites, indicates that most of these animal remains represent entrapped individuals. Anuran remains are more evenly distributed by depth (Table 16). It is probable, however, that these too represent entrapped individuals and not human food. Only one pit feature (Feature 18) containing small vertebrate remains was less than 40 cm in depth below the plow zone (Table 16). However, considering that at least 20 cm of the pit had been truncated by historic plowing (Dickens et al. 1986), it would originally have been at least 47 cm deep. As might be expected, all of the features containing remains of small vertebrates were straight-sided or had outsloping walls (bell-shaped) (Table 16). Moreover, none of the nine pits with insloping walls and none of the pits less than 40 cm deep below surface contained small vertebrate remains (Table 16), yet many of these pits contained other faunal remains.

The fact that five of the 12 human burials on the site contained small animal remains (Table 16) is intriguing. Ward (1986) believes that the animal bones and other refuse found in these burial pits represent cultural refuse following ritual feasts at the times of burial. He notes that this refuse is generally concentrated in the upper fill zone of each burial and includes pottery sherds, animal bones, and charred plant remains. In effect, Ward's interpretation considers toad, frog, shrew, mouse, and rat bones found with these

burials to be human food refuse produced by ritual feasting. It should be noted, however, that many of these remains occurred in deeper zones of the burial pits (Table 16) where they must have been "deposited" independently of refuse in the uppermost zones or to which they may have gravitated following deposition.

An alternative to Ward's interpretation is worth considering. The stratigraphy of burial pit fill on the Fredricks site is consistent with the collapsing of chamber-type graves and the subsequent fortuitous accumulation of surficial refuse in the resulting depressions. This would explain the occurrence of fairly clean clayey soil immediately above the skeletons, and the sloping upward and outward of this soil toward the pit walls (see Ward 1987). It would also explain the diversity of debris and of animal species represented in the upper zones of fill. In the upper zone of Burial 1, for example, remains of deer, opossum, gray squirrel, raccoon, turkey, passenger pigeon, bobwhite quail, woodpecker, plover, frog, box turtle, musk turtle, catfish, sucker, sunfish, and gar were identified (Holm 1987). Such diversity among the faunal remains alone is certainly more characteristic of an acretional midden than of a spontaneous feast! In fact, Holm (1986:253) notes that the faunal assemblage recovered from the surface midden along the village palisade of the nearby Wall site (31OR11) is very similar to that predominantly recovered from the burials of the Fredricks site. The remains of frogs, toads, mice, and rats occurring in the uppermost strata of burial pits may represent individuals falling into slumped chamber burials or living among the

refuse, soil, and vegetation occurring in the surface of slumped chamber burials.

Seasonality

Faunal and floral remains recovered from pits indicate that the Fredricks site was probably occupied year-round (Holm 1987; Gremillion 1987). The remains of what were probably entrapped anurans in pits on the site indicate that the pits containing these remains were open at the same level during the warmer months. Refuse deposits in direct contact with these remains, then, were probably also deposited in the warmer months. The presence of land snail shells in many of these deposits (Mary Ann Holm, personal communication 1988) further suggests a warm season deposition.

Environment

Except for human burials, all features producing small animal remains occurred within the Fredricks site palisade wall, generally among houses surrounding a central plaza area (Ward and Davis 1987). It is certain that a village site with wooden structures, facilities, and household debris would have provided suitable habitat for rats, mice, shrews, toads, and land snails. It is understandable that these animals would occasionally have encountered open pits during movements within their home ranges.

Only one feature (Feature 42), located immediately within the palisade at the southeastern extreme of the village (Figure 23), contained an appreciable number of small animal remains (Table 16).

Feature 42 was a cylindrical pit 55 cm in depth below the plow zone. Because of its proximity to the palisade wall, and its position behind houses and away from the plaza area (Figure 23), it may have been located in a weedy toft area supporting rats, mice, and toads. Only the human burials, located immediately outside of the village palisade on the northeast, contained comparable numbers of small animal remains.

The Warren Wilson Site (31BN29)

The Warren Wilson site (31BN29) is a multicomponent prehistoric Indian village site located along the Swannanoa River in Buncombe County, North Carolina (Keel 1976). The largest component of the site consisted of features and material residues of a Pisgah phase (ca. A.D. 1200-1400) village occupation investigated extensively by Roy S. Dickens, Jr. from 1966 through 1968 (Dickens 1976) (Figure 24). Dickens (1976) reported the remains of 11 houses, 12 partial palisade lines, and 33 features as belonging to the Pisgah phase occupation. Runquist (1979:305), who analyzed faunal remains from the site, stated that all feature fill was processed through window screen (1.5 mm mesh) or floated.

Remains of several species of all vertebrate classes were identified from 34 Pisgah phase features on the site (Runquist 1979). Remains of white-tailed deer, black bear, turkey, box turtle, and toad were especially abundant. Small animals represented, which are especially relevant to this study, included toads, frogs, moles, mice,

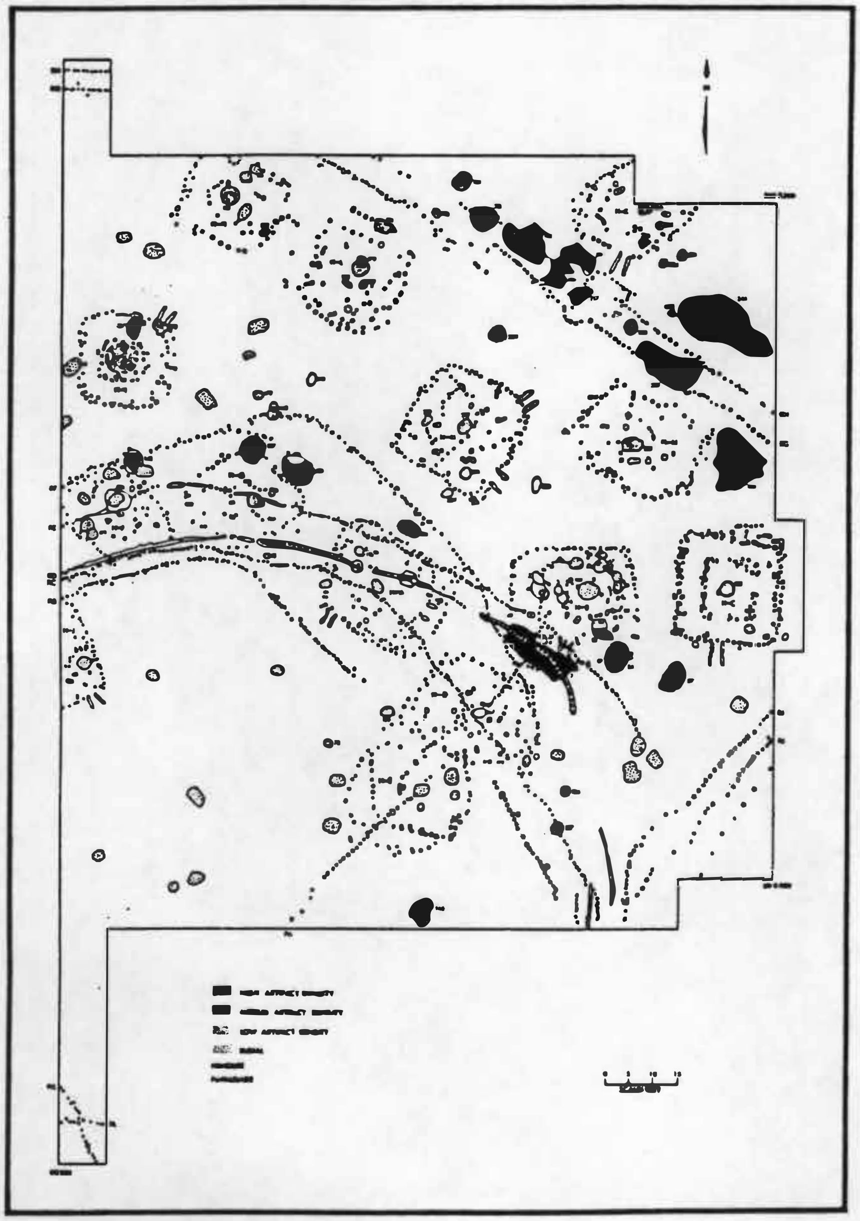

Figure 24. Map showing excavations at the Warren Wilson site (31BN29).

and rats. No terrestrial snail shells or other mollusk remains are reported to have been recovered from these excavations.

Small vertebrate remains were identified from seven pit features on the site (Table 17). Each of these features contained the bones of anurans (mostly Bufo sp.), and the deepest pit (Feature 136), having a bell-shaped profile, contained bones of at least eight mice (Peromyscus sp.) and one marsh rice rat (Oryzomys palustris) (Table 17).

Since faunal data are not available by excavation level or depositional stratum, it is not possible to evaluate the vertical distributions of small animal remains within pits on the Warren Wilson site. However, the abundance of mouse and rat bones in the deepest feature on the site (Feature 136) and their near absence from shallower pits (Table 17) suggests entrapment. The numerous toad (Bufo sp. and Scaphiopus holbrooki) and frog (Rana sp.) remains in the rather shallow pits on the site may also be explained by natural entrapment, although Runquist (1979:45-46) argues that the pits are too shallow and the remains too numerous and concentrated to represent entrapment.

These points are certainly worthy of consideration; however, two other facts which support the possibility of entrapment were not considered by Runquist. The first of these is that toads cannot easily extricate themselves from shallow pits containing just enough rainwater to prevent them from jumping from the floor (see Appendix); and the second is that excavated pits on the Warren Wilson site did retain rainwater for a long time following heavy rains (H. Trawick Ward and Mary Ann Holm, personal communication 1988). There is a strong

Table 17. Distribution of Small Vertebrate Remains by Feature from the Warren Wilson Site (31BN29).

Feature No.	Wall Shape	Feature Depth (cm)	Species	NISP*
7	Insloping	14	*Bufo* sp.	172
			Rana sp.	2
53	Insloping	34	*Bufo* sp.	13
56	Straight	21	*Bufo* sp.	28
57	Insloping	15	*Bufo* sp.	55
136	Outsloping	59	*Bufo* sp.	2
			Peromyscus sp.	42
			Oryzomys palustris	2
209	Insloping	48	*Scaphiopus holbrooki*	2
			Bufo sp.	5
			Rana sp.	8
229	Insloping	15	*S. holbrooki*	7
			Bufo sp.	447
			Rana sp.	50
			Sigmodon hispidus	6

*NISP = the number of identified specimens.

possibility that toads living on or near the site during or soon after its occupation by humans used abandoned, rainwater-filled pits as temporary breeding ponds in spring (see Bragg [1965] and Hueheey and Stupka [1967]). Toads trapped in these pits would have died as a result of drowning or starvation (J. Whitfield Gibbons, personal communication 1988). It should also be noted that Feature 229, which contained most of the identified toad remains, was apparently a soil borrow pit associated with the construction of the village palisade and occurred outside of one palisade line (Ward 1985) where toads would have had easy access. The human food refuse and artifacts found among these toad remains may have accumulated immediately before or shortly after the accumulation of the toads.

Seasonality

If the toad remains recovered from Feature 229 and other pits of the Warren Wilson site accumulated as a result of breeding aggregation, a March or April period of accumulation is implied. The species of *Bufo* (*B. americanus* and *B. woodhousei fowleri*) occurring in this region breed in March or early April (Hueheey and Stupka 1967). However, it is possible that Feature 229 remained a shallow pit for several seasons, occasionally entrapping toads throughout the warm months.

Dickens (1985) assessed the seasonality of pit feature filling on the Warren Wilson site by examining carbonized plant seed remains recovered from features. Three of the six features included in his study (Features 7, 57, and 136) contained small animal remains (Table 17). Dickens observed that these features generally contained more

late fall to early winter seeds, indicating to him that the pits were filled at that time of the year. He argues (Dickens 1985:48-50) that this is consistent with his hypothesis, that storage pits would have been inspected as potential nut or seed repositories in fall or early winter and thus abandoned at those times if deemed unsuitable. Dickens' interpretations must be rejected, however, because he did not consider three important facts. The first of these is that fall and winter seed indicators (primarily nuts and fruit pits) are much more durable, archaeologically recoverable, and recognizable than spring and summer seeds (primarily weeds, grasses, and cultigens), and will therefore tend to be overrepresented in proportion to others. Secondly, burned plant remains recovered from pit features more than likely represent incidental inclusions in hearth or midden debris dumped into pits (Wilson 1985); this secondary refuse disposal need not have taken place in the same season as the natural production of seeds represented. Finally, since plant foods (especially nuts) were often stored for later consumption, plant food refuse may have been deposited during seasons different from those of the harvest.

The small vertebrate species represented in Warren Wilson pits argue neither for nor against Dickens' hypothesis of a fall to winter season of pit filling; but if these remains represent natural entrapment, they indicate that the pits containing them were open for at least part of the warm season.

Environment

None of the small vertebrate species representing potential entrapments on this site is particularly useful in evaluating the prehistoric environment of the site. It is known that the site was a rather substantial village consisting of a group of houses surrounding a plaza area and enclosed by a palisade (Ward 1985). Forests were undoubtedly located on the nearby slopes of the foothills and along the Swannanoa River adjacent to the site. Village structures and debris would have provided suitable habitat for the small rodents represented in pit features. Frogs and toads, were they naturally trapped by pits, probably wandered through the site from their moist woodland or ripparian habitats adjacent to the site. The absence of shrew remains in the assemblage is interesting, considering the location of the site and the fact that shrews are well represented in the faunal samples from other sites included in this study. Assuming that they were absent, rather than not being recognized during the identification process, this fact might suggest that the site was kept somewhat clear of surface vegetation, thus limiting or deterring their presence.

The Coweeta Creek Site (31MA34)

The Coweeta Creek site (31MA34) is a late prehistoric and early historic period Cherokee village site along the Little Tennessee River in Macon County, North Carolina. Part of the site was excavated by the University of North Carolina Research Laboratories of anthropology from 1965 through 1971 (Egloff 1971; Runquist 1979). These excavations

exposed several features and house structures, including a platform mound which supported a townhouse (Figure 25) (Egloff 1971). Vertebrate faunal remains from 18 features on the site were analyzed by Jeannette Runquist (1979). Five of these features contained small vertebrate remains (Table 18), including those of toads (*Bufo* sp.) and frogs (*Rana* sp.). Remains of mice and rats were recovered from middens and structure floors but not from pit features (Runquist, analysis notes). Most of the amphibian remains came from Feature 65, a large shallow pit measuring at least 3.7 m in diameter and 47 cm deep. This feature contained 7106 bones of *Bufo* sp. (a minimum of 587 individuals) and 20 bones of *Rana* sp. (a minimum of 7 individuals) (Table 18). In addition, bones of fish, snake, box turtle, wild turkey, duck, opossum, squirrel, woodchuck, beaver, rabbit, deer, fox, and bear were recovered from the pit (Runquist, analysis notes).

The occurrence of the remains of 587 toads in this pit feature is especially intriguing. Considering the possibility of natural entrapment as an explanation, Runquist (1979:45-46) points out the following:

> The configuration of [this feature] was such that animals accidentally trapped probably could have extricated themselves. Although [it was] relatively deep, the walls sloped, such that toads could have hopped out with a minimum of effort.
>
> Accidental trapping might explain the greater number of toads than frogs. Frogs, with their greater hindlimb musculature can remove themselves from pits from which toads can not. Also, since toads are more independent of water than are frogs, one would expect them to occur in areas some distance from the river, i.e. a village.
>
> Although accidental trapping is a possible explanation for the presence of toads at the [site], the size and configuration of the [feature]...and the large number of remains recovered...would argue against this hypothesis.

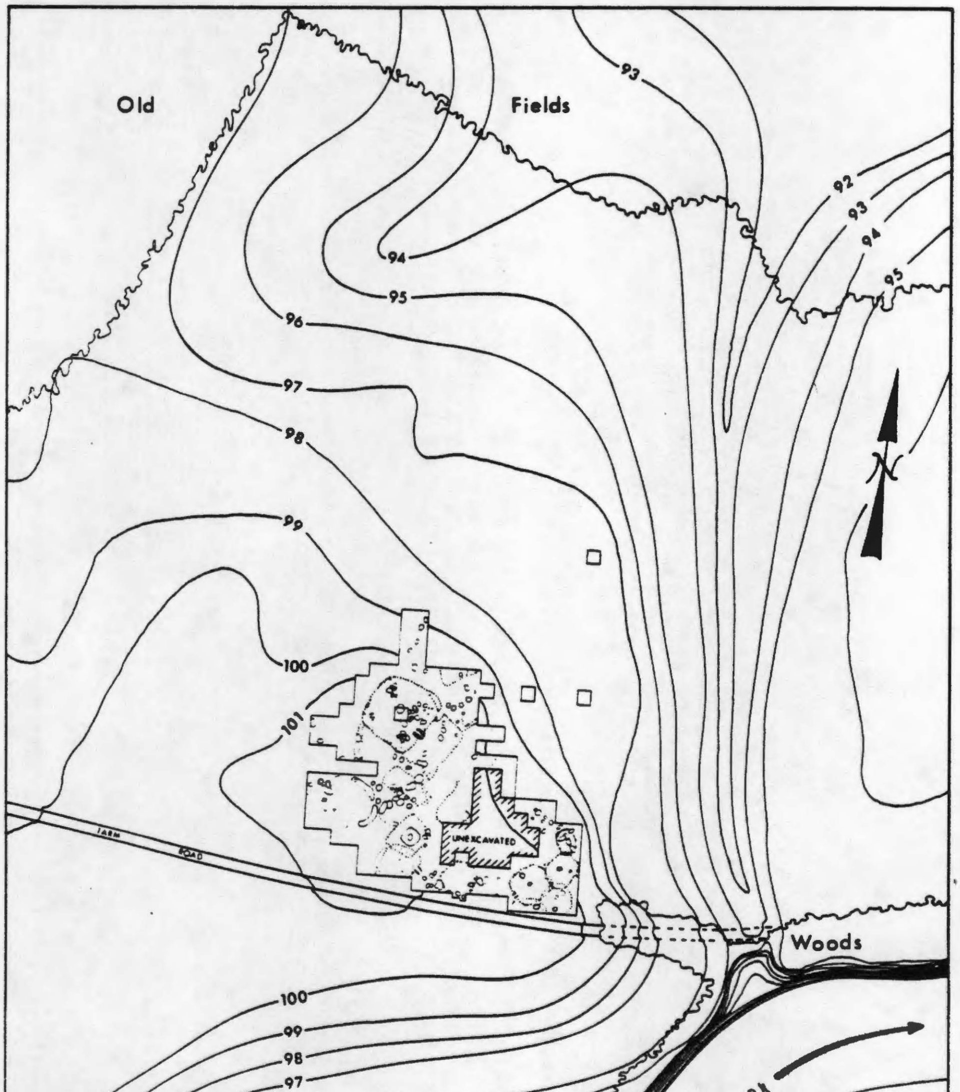

Figure 25. Map showing excavations at the Coweeta Creek site (31MA34).

Table 18. Distribution of Small Vertebrate Remains by Feature from the Coweeta Creek Site (31MA34).

Feature No.	Wall Shape	Feature Depth (cm)	Species	NISP*
15	Insloping	17	*Bufo* sp.	5
56	Insloping	72	*Bufo* sp.	3
58	Insloping	8	*Bufo* sp.	6
65	Insloping	47	*Bufo* sp.	7106
			Rana sp.	23
72	Insloping	42	*Bufo* sp.	2

*NISP = the number of identified specimens.

Certain of Runquist's points are justified; however, the possibility of this pit having filled with rainwater and served as a temporary breeding pond for toads must be considered. Excavated pits on the Coweeta Creek site, like those at the Warren Wilson site, became water-filled following heavy rainshowers (Kieth T. Egloff, personal communication 1988). Had toads repeatedly used this pit (Feature 65) as a spring breeding pond (see Hueheey and Stupka 1967), many may have become trapped because of the pit water level (see Appendix) or because the pit walls were steeper at the time the toads accumulated.

Seasonality

Runquist (1979) indicates that the faunal remains recovered from Feature 65 must have accumulated over the course of a year or more. This is based upon the presence of remains of 15- to 17- month-old deer (late summer), black bear, duck, turkey (late fall-early winter), snake, frog, toad, and fish (spring-summer). This assumes, of course, that the bones were deposited in this feature in the same seasons that the animals were killed. Had the toads whose remains were recovered from Feature 65 accumulated naturally, it is likely that the pit did indeed remain open to receive debris for more than one year. It would be difficult to imagine 587 individuals accumulating in less time. A better understanding of the seasons of refuse deposition and the sources of the deposits in this pit would have required extremely careful stratigraphic control in excavation and the mapping of the vertical relationships between toad remains and those of other fauna.

Environment

Based upon the species of small animals represented, little can be said of the early environment of the Coweeta Creek site and the nature of the site's ground surface in proximity to the pits. The setting of the site has probably changed little since its occupation by the early historic period Cherokee. Old fields and woodlands currently surround the site and the Little Tennessee River borders the site on the southeast (Egloff 1971). An abundance of toads and frogs in such a setting would be expected (Hueheey and Stupka 1967).

Summary

The five archaeological sites considered in this study represent a variety of environmental settings, periods of habitation, and human cultures. Nevertheless, each contained pit features which yielded numerous remains of small and large animals. In order to test the proposition that many, if not all, of the small animal remains recovered from pit features on sites in eastern North America resulted from the natural accumulation of live animals rather than from cultural refuse deposition in pits, formal characteristics of pit features on these sites and the contexts of small animal remains within them were examined.

In general, small animal remains were found to have been most abundant in the deeper pits and the ones that had steep side walls. On the four sites containing them, mouse remains were generally abundant in only the deepest pit features. These patterns are consistent with

those predicted based upon experimental observations of the natural entrapment of small animals in pits, but are not consistent with patterns expected for cultural refuse disposal in pits. Furthermore, the repetition of this pattern on geographically, temporally, and culturally distinct sites adds support to the hypothesis that most small animal remains found in pit features on archaeological sites in eastern North America represent natural accumulations.

Two of the pit features considered in this study (Warren Wilson site Feature 229 and Coweeta Creek site Feature 65) were large and fairly shallow, but contained unusual quantities of remains of Bufo. Considering the breeding aggregation behavior of Bufo and the fact that these pits may have retained rainwater for long periods of time, there is a strong possibility that the toad remains represent a natural accumulation.

Most of the pit features considered in this study contained remains of poikilothermic species (frogs, toads, terrestrial snails) suggesting that the pits were open to receive these animals sometime between early spring and late fall. The pits containing remains of many frogs were probably open at least between early spring and mid-summer when these animals are most active (see Gibbons and Bennett 1974). The fact that the lower levels of many pit features contained remains of numerous individuals representing several species of small vertebrates and terrestrial snails suggests that some pits remained open for a long time (perhaps weeks or months) before being backfilled.

The entrapment of small animals in pits on the five sites indicates that suitable habitats for the species represented existed nearby. Mice and shrews, well-represented in pit features at the Rhoads and Addington sites, prefer densely covered ground. It is therefore unlikely that these pits were surrounded by expanses of cleared ground. The abundance of terrestrial snail shells in pit features of the Addington site adds further support to this proposition; evidence from the Holston Farm experiment showed that snails avoid a barren ground surface.

Interestingly, the Rhoads and Addington sites were apparently seasonally occupied habitations which would not have constituted formal villages with permanent architecture, village palisades, or cleared plazas. Many of the pit features on these sites were undoubtedly storage pits which served to conceal food stores and other items during periods of site abandonment (see DeBoer 1984). This means that storage pits may have been placed in areas with dense ground cover where they would have been less conspicuous:

> Their Corne and (indeed) their copper, hatchets, howes, beades, perle and most things with them of value according to their owne estymation, they hide one from the knowledge of another in the grownd within the woods, and so keep them all the yeare, or untill they have fitt use for them...and when they take them forth they scarse make their women privie to the storehouse (Strachie 1849:115, in reference to Powhatan Indians of Virginia).

The three North Carolina sites (Fredricks, Warren Wilson, Coweeta Creek) considered in this study, on the other hand, were more formal villages contained within palisade walls and including cleared plaza areas. Although rat, mouse, toad, and frog remains were abundant

in pits on two of these sites, no shrew remains were recovered from pits located within the palisade wall. Their absence from these pits may indicate that suitable habitat for shrews (dense ground cover) did not exist within the villages. The grounds within these probably more permanent habitations may have been kept fairly clear of surface vegetation.

CHAPTER VI

CONCLUSIONS

Shells of land snails and bones of anurans, insectivores, and small rodents are commonly recovered from archaeological pit features in eastern North America. These remains, because they frequently occur among those of larger animals and cultural debris, are often assumed by archaeologists and faunal analysts to represent human food refuse. This assumption is unwarranted. The successful use of pitfall traps by biologists in studies of small animal activity and movement demonstrates the probability that some small animals were naturally trapped by pits dug by aboriginal peoples in the past. Furthermore, unequivocal ethnohistorical or archaeological evidence for the aboriginal consumption or use of land snails and small vertebrates (other than fish and birds) in eastern North America is not sufficient to account for the quantity of remains recovered from pits on archaeological sites in this region. Clearly, however, it would be equally wrong to assume without empirical justification that small animal remains recovered from pit features on a site represent natural entrapment. We must, as Binford (1981:26) warns:

> ...attempt to isolate the different agents or forces that might be expected to contribute to or "cause" a given pattern. Second, we would have to conduct studies of these agents or processes in the contemporary world so as to develop criteria of recognition. In short, we need to specify criteria for recognizing traces, "signiature patterns" apt to be preserved in the archaeological record, of the agents likely to have contributed to deposits in which hominid remains might also occur.

Recognizing the need to be able to distinguish small animal remains naturally introduced into archaeological pit features from those culturally deposited, an experimental program, reported in Chapters III and IV, was designed to develop criteria for identifying the "signiature patterns" of the natural entrapment of small animals in archaeological pit features. The specific goals of this experimental program were to determine (1) the causes of natural entrapment of small animals in pits, (2) the spatial and physical characteristics of remains of small animals trapped in pits, and (3) the seasonal and climatological variability of small animal occurrences in pits.

The experiment was conducted along the Tennessee River near Knoxville, Tennessee from May 1985 to June 1986. Fifteen cylindrical pits measuring 75 cm in diameter by 75 cm deep were excavated on the experimental site and were varied according to content, the presence or absence of a pit covering, and clearing of the pit margin. In addition, two pits were gradually filled with soil and refuse and then reexcavated at the end of the entrapment experiment to observe the relationship between refuse deposition and the natural entrapment of small animals in pits. Weekly observations of vertebrate trappings and biweekly counts of terrestrial snails in pits were made.

During the course of the 378 day experiment, at least 267 vertebrates were trapped and 811 terrestrial snails were observed in pits. Vertebrates included seven species of amphibians, six species of reptiles, one bird, and eight species of mammals. The experiment revealed that small vertebrates are easily trapped by open pits such as

many of those characteristic of late prehistoric and early historic period aboriginal habitation sites in eastern North America. Most small vertebrates appear to simply blunder into open pits regardless of their contents. It is apparent, however, that mice will deliberately enter pits containing sunflower seeds and perhaps other vegetable materials that they are attracted to.

It was also revealed that remains of entrapped small vertebrates will tend to occur in the lower levels of deep, steep-sided pits that were open, or in shallow, steep-sided pits that were open and retained rainwater during times of entrapment (see Appendix). Naturally occurring terrestrial snail shells will be found along the sides and floors and between soil/refuse deposits in pits that were open. Recognition of these criteria in the archaeological record requires careful stratigraphic excavation of deposits from pit features.

Other criteria for recognizing natural entrapment include the conditions of the walls of pits containing small vertebrate remains. Mammals trapped in dry pits will usually excavate into the walls at the level at which they are trapped. These excavations result in linear burrows or concavities that may be identified archaeologically, given careful excavation techniques, and may be found to contain remains of entrapped fauna.

In addition to solving problems of human dietary reconstruction by defining criteria for recognizing entrapment in the archaeological record, this experimental program and relevant research of small animal ecology have shown that remains of entrapped small animals from

archaeological pit features are a potential source of information for reconstructing the seasonal and environmental contexts of pit feature use and abandonment. With regard to seasonality, it was noted that terrestrial snails and vertebrate species show seasonal peaks of abundance and activity that are often experimentally monitored by entrapment (Gibbons and Semlitsch 1982). Consequently, identifying remains of entrapped small animals in archaeological pit features provides a potential source of information concerning the seasonality of archaeological deposits, site occupation, and pit feature use and abandonment.

With regard to information concerning the former environmental contexts of pit features, it was noted that small vertebrates and terrestrial snails were more common in open experimental pits surrounded by vegetation. Recognizing the remains of an abundance of entrapped small vertebrates and terrestrial snails in an archaeological pit feature, therefore, would indicate the probability that the pit was surrounded by vegetation or some form of dense ground cover during the time that the entrapments occurred. These kinds of reconstructions are basic to archaeological analyses of refuse disposal behavior, pit feature function, and site structure.

In consideration of these findings, faunal and pit feature data from five Native American archaeological sites in eastern North America were studied. The archaeological record of small animal remains on these sites showed a pattern consistent with natural entrapment. Remains of small rodents, insectivores, and anurans were more abundant

in the lowest levels of deep pit features on three of the sites studied. Terrestrial snail shells, reported for only one site, were distributed throughout pit feature deposits and included very small individuals, indicating that they too represent natural accumulations in pits. The abundance of remains of individuals of poikilothermic species occurring as natural entrapments in pits suggests that the pits were open at some time between early spring and winter. Some pit features were probably filled with refuse gradually over the course of several seasons. The occurrence of many toads in certain features on the Warren Wilson and Coweeta Creek sites is a possible indication that the pits retained rainwater and were used as breeding ponds in spring.

An abundance of shells of terrestrial snails and bones of shrews naturally occurring in pits on archaeological sites in this region indicates the probable existence of surficial vegetation or debris surrounding pits at times when they were open.

Assuming that the deep pit features containing small animal remains on these sites functioned as winter food storage facilities (see DeBoer 1984), it is likely that they were left open and abandoned to the elements and to refuse accumulation beginning in late winter or early spring when stored food supplies would have been depleted. This seasonality of abandonment would account for the common occurrence of small animal remains, especially those of frogs, in the basal levels of large pit features. Further experimentation, however, is needed to better interpret the rates at which pits became filled with sediments and refuse subsequent to abandonment.

An important question to be addressed by such experimentation is whether pits intended for further use as winter food storage facilities (assuming pits were reused) would have been left open and empty between winter use-periods when they would have been subjected to detrimental biotic and climatic processes; or if they would have been loosely backfilled to maintain their form and then reexcavated when needed.

In conclusion, the reconstruction and explication of prehistoric human subsistence patterns are recognized as paramount goals in American archaeology. At the most fundamental level of analysis, archaeologists must identify the sources of the deposits of animal and plant remains under examination and the seasonal and environmental contexts in which they were formed in order to attempt these goals. Too often, all ecofacts associated with artifacts and features on archaeological sites are accepted, without empirical basis, as being human food remains (Binford 1981). Only actualistic research such as exemplified by the present study, will allow the development of criteria for identifying and understanding the processes that create the archaeological record. Inevitably, these studies lead to unexpected methodological discoveries, and at the same time, point to further research needs.

In this study, it was recognized that a common process of archaeological deposit formation--the natural entrapment of small animals in pits--was poorly understood, and that assumptions regarding its contribution to the archaeological record have potentially obfuscated reconstructions of past human lifeways. An experimental

program was designed and conducted to provide an empirical basis for recognizing natural entrapment in the archaeological record. Beyond identifying the necessary criteria for recognizing natural entrapment, the experiment permitted observations relevant to depositional seasonality and former ground surface conditions surrounding pits on archaeological sites.

In examining pit feature and faunal data from five archaeological sites in eastern North America, it was shown that natural entrapment is observable in the archaeological record and is distinguishable from other formation processes involving the deposition of small animal remains. Given appropriate methods of excavation and observation, archaeologists no longer need to make assumptions about the origins of deposits of small animal remains in pit features. Furthermore, since entrapped small animals represent an aspect of the natural ecosystem of an archaeological site at the time of its human occupation, studies of their remains may aid in the partial reconstruction of site environment and in the identification of deposit seasonality. These reconstructions provide a context for identifying and explaining patterns of human behavior, especially with regard to subsistence and settlement systems, site spatial organization, food storage, and refuse disposal.

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APPENDIX

A PILOT EXPERIMENT TO TEST THE ABILITY OF RAINWATER-FILLED PITS TO CONTAIN ANIMALS

During the Holston Farm experiment small animals occasionally became trapped in pits holding rainwater. Mammals that did so had drowned prior to observation. Although dry pits on the site proved to be effective in trapping animals, these incidents suggested the possibility that small animals suspended in rainwater-filled pits, even rather shallow ones, may not be able to escape by jumping for lack of a firm platform from which to spring. Furthermore, the moist walls of rainwater-filled pits may prevent climbing by small mammals.

To investigate these possibilities, a toad (Bufo americanus) and a mouse (Mus musculus) were placed in a pit identical to those of the Holston Farm experiment but which contained approximately 10 cm of rainwater. Both animals were able to keep their heads above water--the toad by floating and the mouse by swimming--but neither, when pursued, was able to jump upward or gain foothold in the moist pit walls.

The animals were removed from the pit and the experiment repeated after lowering the water level in the pit to 5 cm. Each animal was able to touch the pit floor with its hind feet but was still unable to jump effectively when pursued.

Conclusions derived are that small vertebrates trapped in straight-walled water-filled pits will generally not escape unless the water level is very close to the rim of the pit. This means that small animals such as mice and toads may become permanently trapped in rather shallow pits (ca. 15 cm) partially filled with rainwater and having fairly steep sides.

VITA

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