APPENDIX L

EXCAVATION OF A WOODCHUCK DEN

EXCAVATION OF A WOODCHUCK DEN

By

Robert M. Jacoby

THE LOUIS BERGER GROUP, INC.
2300 N Street, NW
Washington, D.C. 20037

Submitted To

U.S. DEPARTMENT OF TRANSPORTATION
Federal Highway Administration

and

DELAWARE DEPARTMENT OF STATE
Division of Historical and Cultural Affairs
Bureau of Archaeology and Historic Preservation

Prepared For

DELAWARE DEPARTMENT OF TRANSPORTATION
Division of Highways
Location and Environmental Studies Office

✦

Eugene E. Abbott
Director of Planning

2004

TABLE OF CONTENTS

SECTION PAGE

I. INTRODUCTION L-1

II. BEHAVIOR L-1

III. EXCAVATION DESCRIPTION L-2

IV. SOIL CHEMISTRY L-5

V. DISCUSSION L-7

REFERENCES CITED L-8

LIST OF FIGURES

FIGURE PAGE

L-1 *Marmota monax* L-1

L-2 Marmota Den Distribution L-3

L-3 Plan View of Excavated Marmota Den L-4

L-4 Cross Section of Excavated Marmota Den L-6

LIST OF TABLES

TABLE PAGE

L-1 Soil Chemistry Test Results L-5

I. INTRODUCTION

The identification of archaeologically encountered subsurface features is often complicated by activities associated with animal behavior, such as burrowing and wallowing. Animal activities resulting in the modification of soil horizons transform the morphology, contents, and contexts of culturally generated features, and can produce sediments that mimic the appearance of cultural features (Butzer 1982; Schiffer 1983). If interpretations of feature functions and origins are to be meaningful, then a clearer understanding of burrowing behaviors must be sought.

A controlled excavation of a woodchuck (*Marmota monax*) den was undertaken in Locus 2 at the Puncheon Run Site as a method of obtaining data on burrow construction and dimensions. Soil samples were taken from several locations within the den that might reveal specific chemical signatures of animal occupation. Comparative data of this sort should be useful in evaluating features encountered during archaeological investigations, and possibly lead to an enhancement of the feature identification process.

II. BEHAVIOR

Woodchucks, ground hogs, or "whistle pigs," as they are variously named, are heavy-bodied, short-legged mammals of the squirrel family (Figure L-1), with a wide geographical range from central Alaska southeastward to the central Plains and eastward to most of eastern North America. The elimination of wolves, bobcats, cougars, and coyotes as predators in many areas has benefitted the woodchuck, increasing its numbers and prevalence in rural and suburban locales. Abandonment of agricultural fields and the construction of recreational spaces such as golf courses and ball fields have promoted the expansion of woodchuck communities into residential suburbs. Its vegetarian and burrowing behaviors have caused it to be labeled a serious agricultural pest, yet burrows become homes for a range of different animals, including opossums, rabbits, skunks, raccoons, foxes, and game birds. Burrowing activities also contribute to soil aeration and mixing, a factor in continued soil productivity.

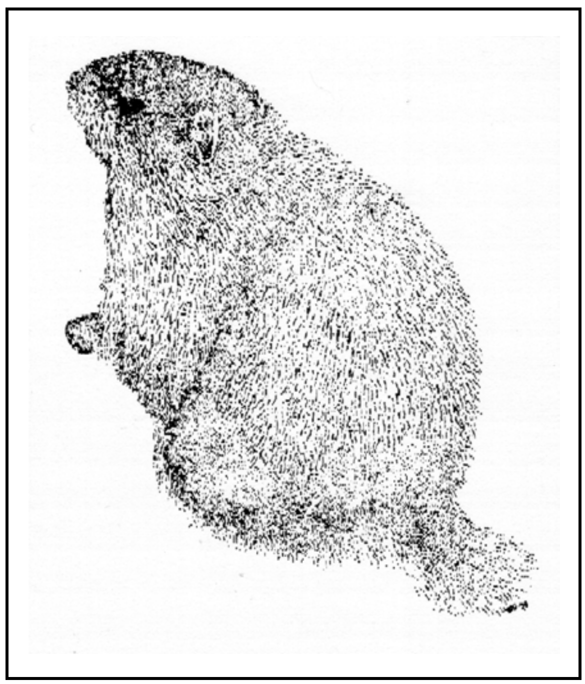

FIGURE L-1: ***Marmota monax***

ARTIST: Matt Doherty

Woodchucks are not only highly territorial creatures but also the most solitary of the marmots, resulting in low population densities of perhaps one or two adults per acre (Purdue University 1997; University of Michigan 1997). The breeding season in early spring brings together mating pairs for brief periods, but dens are usually occupied by single adults and are well defended against other woodchucks. Woodchucks enter hibernation in mid-October and emerge in late winter, mating soon afterward. Females are monestrous, meaning they have one birth cycle per year. Gestation takes one month and the average litter size is between three to five young. At about six weeks the young are fully active and are forced out of the birthing den to establish their own territory.

Woodchucks are vegetarian, subsisting primarily on the stalks and roots of grasses, forbs, and sedges (Purdue University 1997; University of Michigan 1997). An adult will typically consume between ½ kilogram (kg) and ⅔ kg of food per day. Crop plants such as corn, soybean, and milo can form a big part of its diet, which is a chief reason farmers label the woodchuck a pest. After emerging from hibernation, woodchucks will resort to eating the bark and buds of flowering trees if young green vegetation is sparse.

Woodchucks are generally diurnal, searching for food during daylight, though some nocturnal activity has been noted, particularly if food is scarce. Much of the woodchuck's time is spent sleeping underground, but it can sometimes be seen preening in the sun by its main den entrance, although always alert to danger. As anyone who has approached a woodchuck can attest, while not especially swift, they are very wary animals. In the wild the average woodchuck's lifespan is between four and six years.

Two types of burrows are established by woodchucks, summer dens and winter dens. Woodchucks usually locate their summer dens in open areas, such as farm fields and golf courses, reserving better concealed sites for their winter dens (Purdue University 1997). Built essentially as hibernation chambers, winter dens are generally located in dense brush and have only a single entrance. Though somewhat more vulnerable to prey because of the lack of a secondary escape hole, these dens are better insulated for overwintering. Open summer dens are close to foraging resources but are dangerously exposed to predators, such as foxes, hawks, and dogs. Typically, summer dens have one to five openings, although only one will serve as the main entrance. The larger openings are excavated from the outside, while the escape or "plunge" holes are dug from below. One advantage of the main entrance is the backdirt pile, from which woodchucks typically stand to gain extra height when surveying their surroundings.

Observations of woodchuck dens indicate they may be reutilized for several generations. The regular collapse of chambers and tunnels within the den is thought to produce a cycle of burrowing activity that may, over time, create a dense maze of translocated soil simulating a feature of cultural origin. Research has revealed the extraordinary ability of woodchucks and other burrowing animals to move soil. Estimates range from a low of three cubic meters per hectare per year (Bocek 1986:590) to a high of 120 cubic meters per hectare per year (Golley et al. 1975:237). Using a conservative estimate of two adult woodchucks per hectare, a complete reworking of the soils at Locus 2 of the Puncheon Run Site could be achieved in a time frame ranging from half a century to almost 1,700 years. Woodchuck activity is therefore capable of eliminating or obscuring much evidence of prehistoric cultural features, certainly those attributable to Archaic and Early Woodland periods.

III. EXCAVATION DESCRIPTION

The open fallow field located in Locus 2 and Locus 3 of the Puncheon Run Site is an ideal place to investigate woodchuck denning behavior. Situated equidistant between the Puncheon Run to the south and the St. Jones River to the north, the 3½-hectare field contained 22 separate woodchuck dens, with an average spacing of one den per 40 meters (Figure L-2). The dens identified at the Puncheon Run Site ranged from one hole to four holes ($\bar{x}$=2.45), with one-third containing three holes.

Located near the center of the field, den No. 8 (see Figure L-2) was selected for a controlled excavation to identify and map specific features related to woodchuck behavior. A large entrance hole was identified along with its telltale mound of soil amid a large clump of Johnson grass (*Sorghum halapense*). Forming an equilateral triangle, two plunge holes were located about 5 meters from the main entrance (Figure L-3). Since these smaller holes are dug from below ground, they do not have mounded soil deposited alongside. This appears to be a behavioral adaptation on the part of the woodchuck to mask these plunge holes from potential predators. The number of plunge holes per den is not dependent on the number of resident animals but rather on the age and cyclical reuse of the den.

Excavation of the den was begun by marking off a 4x5.2-meter square that encompassed the main entrance hole and most of the intervening area up to the plunge holes. The orientations and distances between the holes were measured and photographed. Excavation was undertaken in 50-centimeter levels with the use of a backhoe. Upon reaching the desired depth, final excavation and clean-up of each level was carried out by field archaeologists with shovel and trowel. The exposed den features (e.g., tunnel, chamber) were photographed and mapped for each level, providing an overall plan and cross section (Figure L-4) of the "*Marmota* Motel." Soil samples were collected in each level from subsoil and feature contexts to be used as comparative indices of chemical signatures.

The plunge holes are aptly named because of their steep descent to the underground chambers and tunnels. The main entrance descended somewhat less rapidly but was interestingly paired with a nearly vertical tunnel that branched from it just inside the entryway. This side tunnel dead-ended at a depth of 1.3 meters and is apparently a drainage feature to redirect rainwater from entering the main tunnel and chamber areas. Den No. 8 contained approximately 13.6 meters of burrowed tunnels and chambers. Three, possibly four, denning chambers were identified and are characterized by three common traits: (1) they form a "bulge" or widened section of a tunnel, (2) they are laid with matted grasses (and in at least one instance, scavenged plastic bags), and (3) they are generally located at "end-point" nodes within the tunnels, presumably for greater security and warmth.

IV. SOIL CHEMISTRY

Soil samples taken from various sections of the burrow and from subsoil horizons in each excavated level were run through a standard series of tests for soil chemistry. There were significant differences in the reported levels of organic matter, available and total phosphorus, potassium, and manganese, depending on location within the burrow and between burrow and adjacent subsoil (Table L-1). The burrow floor

Table L-1: Soil Chemistry Test Results

Sample #	Level	Depth (cm)	Context	ph	OM-WB	TTL P	P	K	MN
98/2/566.1	1	50	tunnel	5.3	2.10	642.8	44.5	105.9	14.3
98/2/566.2	1	50	tunnel	5.1	1.58	359.4	40.8	119.5	20.9
98/2/566.3	1	50	subsoil	6.0	1.34	244.0	5.9	107.2	11.1
98/2/567.1	2	100	subsoil	5.8	0.95	269.4	6.9	91.2	2.1
98/2/567.2	2	100	tunnel	5.7	1.05	204.0	3.5	78.9	10.1
98/2/567.3	2	100	tunnel	4.3	0.78	455.3	48.7	130.5	10.9
98/2/568.1	3	126	burrow floor	4.9	2.03	833.6	131.4	148.3	36.0
98/2/568.2	3	151	burrow floor	4.1	1.48	876.8	197.8	692.6	33.6
98/2/568.3	3	105	nesting den	5.5	0.79	356.8	8.7	141.7	6.8
98/2/568.4	3	105	subsoil	5.8	0.78	286.3	5.1	95.5	2.1
98/2/568.5	3	115	burrow floor beneath nesting den	4.6	1.11	1013.6	239.4	308.9	11.0

Note: Organic Matter (OM) measured by Walkley-Black (WB) method. Phosphorous (P) measured as Total (TTL P) and in parts per million. Potassium (K) and Manganese (MN) measured in parts per million.

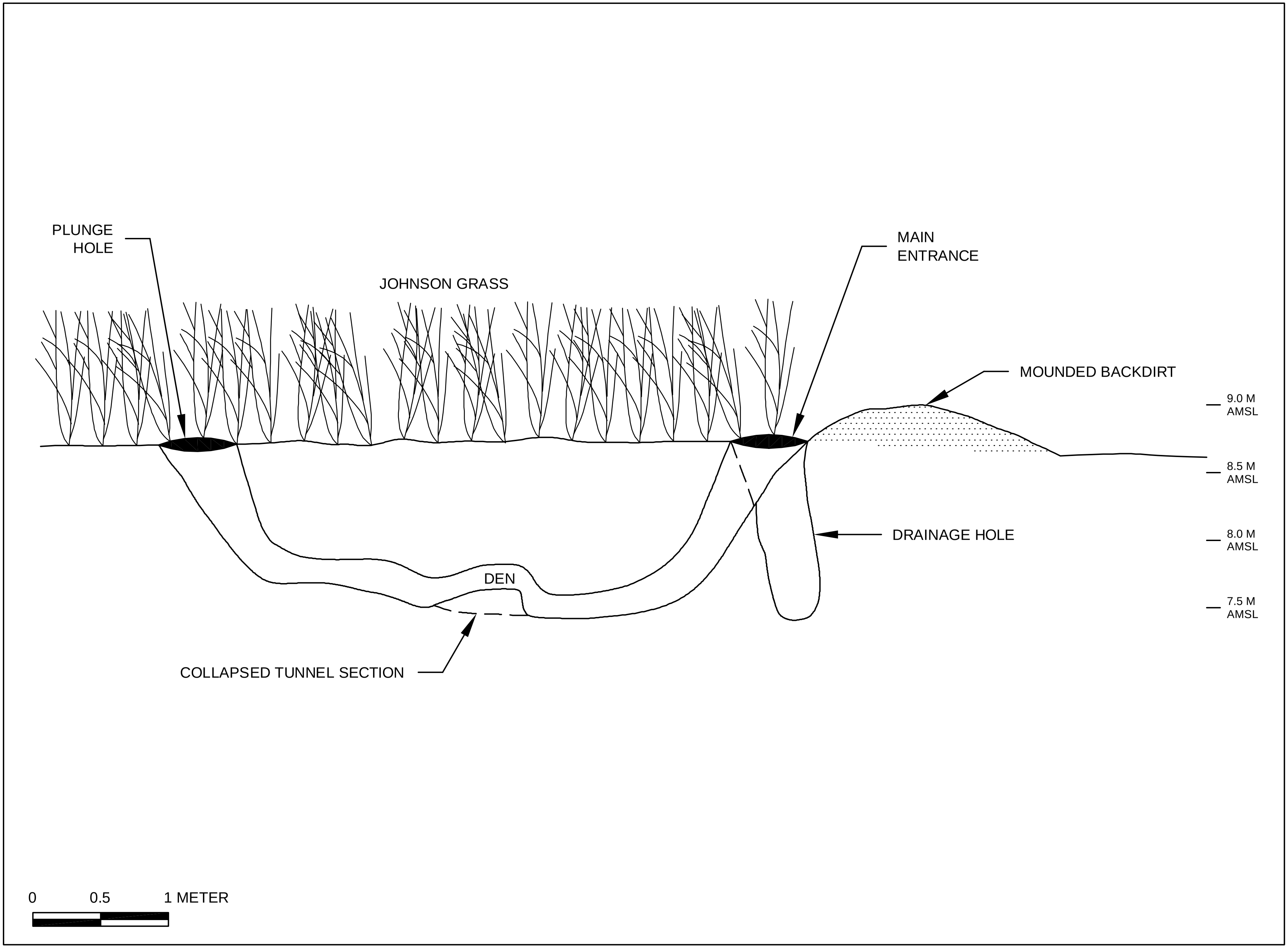

FIGURE L-4: Cross Section of Excavated Marmota Den

consistently registered the highest levels for each test, with tunnel sections less elevated, and subsoil samples the lowest. Phosphorus, potassium, and manganese are essential organic nutrients and are found in high concentrations where they have been excreted by animals. Because woodchucks spend much of their time in their burrows, organic waste can be expected to accumulate there. For the same reason, the burrow floor generally registered higher levels of soil acidity, as measured by the standard pH test, and organic matter, as measured by the Walkley-Black method, which estimates the availability of organic carbon in a sample.

An interesting exception to the very high levels of phosphorus, potassium, and manganese found within the burrow floor was from a mass of loose soil, dragged-in grasses, and strips of plastic bags that made up the nesting den. This spot was perched slightly off the burrow floor, creating a somewhat better drained location for sleeping and perhaps for rearing the young. A second nesting den was located about 60 centimeters away in a side tunnel. The low nutrient content of the nesting soil sharply contrasted with the sample taken 10 centimeters beneath it on the burrow floor, which exhibited the highest levels of phosphorus anywhere within the burrow. The loose soil of the nest apparently does not retain much of the excreta from the animal, allowing it to pool away from the woodchuck onto the denser surface of the floor, in a way similar to a diaper.

V. DISCUSSION

A small section of the central tunnel showed signs of infilling and subsequent detour. Evidence of collapse and tunnel renewal were expected to be highly visible and widespread because the sandy loam site soils exhibit a relatively low compaction value. The pre-excavation working model held that frequent tunnel collapse and renewal would create a dense network of old and newer tunnels, many of them filled with soil. It was anticipated that the intensive reworking of subsoils caused by woodchuck burrowing might generate a soil horizon that could be mistaken for a cultural feature, or perhaps a cultural feature that had been modified by animal activity.

Many features encountered archaeologically along the coastal plain, particularly in Delaware, are amorphous in shape, and therefore difficult to interpret functionally. Debate has ensued for some time about the cultural versus natural origins of a specific class of feature termed the *Delaware pit house* (LeeDecker et al. 1998; Mueller and Cavallo 1995). It was hoped that the excavation of the marmota den would help bring this question into focus with observational data obtained from animal behaviors. Little in the way of tunnel collapse was evident, however, and there was nothing to suggest the likeness of a human feature within the exposed excavation. Apparently, the sandy loam of the coastal upland on which Locus 2 sits is sufficiently stable to be continuously reused by woodchucks with little fear of den collapse. It was interesting that the somewhat sandier soils of Locus 3 displayed little evidence of woodchuck burrowing, suggesting either that the animals intuitively “know” what soils are appropriate for den sites, or that when burrows are dug into the less compactable soils, they readily collapse, leaving little surface evidence of the tunnels or of the unfortunate woodchuck.

It is interesting to ask at this point if Native Americans in Delaware hunted and ate woodchuck. Although faunal remains are absent from the Puncheon Run assemblage, presumably because of high soil acidity, woodchuck is one of a number of medium-size mammals that were indigenous to Delaware. Funk claims that woodchuck was an important prey species for the hunter-gatherers of the Susquehanna River Valley, with woodchuck remains present in the archaeofauna of excavated sites spanning the Late Archaic to Late Woodland periods (Funk 1993:48, 266-270). A different picture is described for the Saginaw Valley in Michigan: “Animals such as woodchuck, chipmunk, various mice, and voles . . . are typically not regarded as food species and are extremely costly to exploit” (Keene 1981:112). The Saginaw and Susquehanna valleys are environmentally similar temperate hardwood forests, so the environmental factor alone does not adequately explain the contrasting views of woodchuck use. Elsewhere, Scarry and Scarry (1997) note that woodchuck remains have been recovered at Piedmont and mountain sites in North Carolina dating from the Middle Woodland period to European contact, while an early historic observation by John G. E. Heckewelder was that the Lenape did not eat woodchuck (1819:251-252, cited in Kraft 1986:158). In archaeofauna lists from sites in the American Bottom of the Mississippi Valley, woodchuck remains are conspicuously absent (Julie Zimmerman Holt, personal communication 1999), although rabbits and squirrels were consumed (Holt 1996:100). Thomas reports that woodchuck is uncommon at sites along the Champlain Valley in western Vermont (Peter Thomas, personal communication 1999).

How can these disparate accounts of woodchuck use and avoidance be reconciled? Cultural preferences are sure to play a role in the types of foods exploited or eschewed by a group, not only in the sense of what tastes good and provides sufficient nutrition but also in the way a group relates to certain animals or animal classes. Ritual and symbolic depiction of animals extends back at least to the Upper Paleolithic (circa 30,000 years before present [BP]), and images of animals have been common in Native American crafts up to the present. Often these portrayals represented animals that were economically important to the group, such as deer, fish, or ducks, or were of creatures that possessed special physical or spiritual powers, such as bears, eagles, snakes, and foxes. Some animals were thought to inhabit the Underworld, a classification that separated them from the world of people. Insects, frogs, and rodents are frequently listed in this category (Holt 1996:92). The human-animal relationships created by these various characteristics sometimes developed into sacred associations that tied kin groups to specific animals as totemic representations of the group. It is possible that the differential use of woodchuck across the Eastern Woodlands can be explained by this symbolic idiom.

Certain animals may have also been avoided because of benefits obtained from the animals' natural behaviors. Despite its bad reputation among farmers, the woodchuck provides several benefits to the ecosystem from which prehistoric hunter-gatherers might have profited. By providing dens to a number of non-burrowing species (rabbits, opossums, and game birds, for instance), woodchuck burrows became attractive settings for hunters. In aerating and disturbing the soil, woodchucks inadvertently promote the growth of useful wild plants, such as goosefoot (*Chenopodium* ssp.) and jimson weed (*Datura stramonium*) (Golley et al. 1975:230). Goosefoot is an edible plant from which young greens and starchy seeds were collected. The seeds provided prehistoric hunter-gatherers with an important source of carbohydrates, which is absent from game meat and fish. Jimson weed, a highly toxic fruiting herb, thrives in disturbed soil and was widely used in North and South America as a fishing poison in sluggish streams like the St. Jones River (Heizer 1953; Quigley 1956). Jimson weed was observed vigorously growing in the disturbed soils of excavated backdirt piles across the Puncheon Run Site in late summer 1998. By practicing a strategy of avoidance with regard to the woodchuck, various groups of Native Americans may have actively promoted burrowing activities to exploit their unintended consequences.

REFERENCES CITED

Bocek, Barbara
1986 Rodent Ecology and Burrowing Behavior: Predicted Effects on Archaeological Site Formation. *American Antiquity* 51:589-603.

Butzer, K.W.
1982 *Archaeology as Human Ecology*. Cambridge University Press, Cambridge, England.

Funk, R.E.
1993 *Archeological Investigations in the Upper Susquehanna Valley, New York State.* Volume 1. Monographs in Archaeology. Persimmon Press, Buffalo, New York.

Golley, F.B., L. Ryszkowski, and J.T. Sokur
1975 The Role of Small Mammals in Temperate Forests, Grasslands and Cultivated Fields. In *Small Mammals: Their Productivity and Populations Dynamics*, edited by F.B. Golley, K. Petrusewicz, and L. Ryszkowski, pp. 223-242. Cambridge University Press, Cambridge, England.

Heizer, Robert
1953 *Aboriginal Fish Poisons*. Anthropology Papers No. 38. Bureau of American Ethnology Bulletin 151, Smithsonian Institution, Washington, D.C.

Holt, Julie Zimmermann
1996 Beyond Optimization: Alternative Ways of Examining Animal Exploitation. *World Archaeology* 28:89-109.

1999 Personal communication. Department of Anthropology, New York University. Conversation with Berger Field Supervisor Robert Jacoby.

Keene, Arthur S.
1981 *Prehistoric Foraging in a Temperate Forest: A Linear Programming Model.* Academic Press, New York.

Kraft, Herbert C.
1986 *The Lenape: Archaeology, History, and Ethnography*. New Jersey Historical Society, Newark.

LeeDecker, Charles H., Henry M.R. Holt, and John C. Bedell
1998 *Preliminary Management Report: Extended Phase II Archaeological Testing of the Puncheon Run Site (7K-C-51), Locus 3, Puncheon Run Connector, Kent County, Delaware*. Prepared by the Cultural Resource Group, Louis Berger & Associates, Inc., East Orange, New Jersey, for the Delaware Department of Transportation, Dover.

Mueller, Raymond, and John A. Cavallo
1995 Multiple Working Hypotheses: An Analysis — Pit Houses or Tree Throws. Paper presented at the Eastern States Archaeological Conference, Wilmington, Delaware.

Purdue University
1997 *Woodchucks*. Purdue University, Department of Entomology Web Site. Accessed online May 19, 1997, at <www.entm.purdue.edu>.

Quigley, Carroll
1956 Aboriginal Fish Poisons and the Diffusion Problem. *American Anthropologist* 58:508-525.

Scarry, John F., and C. Margaret Scarry
1997 Subsistence Remains from Prehistoric North Carolina Archaeological Sites. *North Carolina Archaeology Homepage*. Accessed online September 9, 1999, at <www.arch.dcr.state.nc.us/subsist/subsis.htm#Zooarchaeological>.

Schiffer, M.B.
1983 Toward the Identification of Formation Processes. *American Antiquity* 48:675-706.

Thomas, Peter
1999 Personal communication. Private archaeologist. Conversation with Berger Field Supervisor Robert Jacoby, September 16.

University of Michigan
1997 *Marmota Monax*. The University of Michigan, Museum of Zoology, Animal Diversity Web. Accessed online May 19, 1997, at <www.oit.itd.umich.edu>.