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The Museum has extensive exhibits of stone implements, obtained for the most part from the Massachusetts area. They are arranged in culture periods identified in the Northeast and cover a time extension of some 10,000 years.
When we dig an archaeological site, all we actually find are oddly shaped objects and soils of different colors and textures. It is necessary to analyze, compare, and interpret these findings before we can understand what they tell us about past societies. The articles in this issue of the Bulletin all center around the process of analysis in archaeology and the methods, both old and new, we use to learn about the past.

Several of the articles involve analysis of stone artifacts, reflecting a recent upsurge of interest in lithics shown also by the theme of the recent Spring Meeting of the Massachusetts Archaeological Society. Part of this renewed interest has focused on quarries, and the first article in this issue is one of the earliest to deal with the question of where Massachusetts Indians obtained stone for their tools. The Bulletin has a long tradition of reprinting ethnohistorical accounts and other records that are difficult to obtain at most libraries, and it is therefore appropriate that this important but relatively inaccessible article be reprinted here.

If stone is the most common material on our prehistoric sites, then the flake is surely the most common kind of stone artifact. Flakes were once regarded as nearly useless to archaeologists, but the study of flakes, or debitage analysis, is now coming into its own as a method for obtaining increased information from our assemblages. This is due in large part to replication studies, such as Shea's, which allow us to study directly the material results of various stoneworking procedures.

At the other extreme are very rare and unusual artifacts such as those described by Largy and Mansfield. Such objects must have been highly personal, and are especially fascinating to us because they bring us very close to the people who made and used them. Careful examination can give us clues as to how they were manufactured, but only information on similar finds will help us define their true significance.

Johnson and Mahlstedt's article demonstrates that analysis need not be complex or technical, and that even simple descriptions of assemblages can lead to insights into prehistory. The Massachusetts Historical Commission's survey of collections is building up an impressive body of assemblage descriptions from many parts of the Commonwealth. Comparisons between these assemblages demonstrate both similarities and differences between regions, and suggest many topics for future research.

Marie Eteson's note presents the first thermoluminescence date for a Massachusetts potsherd. While this date is difficult to interpret in the absence of any other similar analyses using this method, it still represents an interesting foray into the application of "high tech" to archaeology.

Similarly, Kerber's article argues that collaboration between archaeologists and other scientists will lead to benefits for both. Though interdisciplinary cooperation has a long history in archaeology, most of us would probably agree that we have barely scratched the surface of what we could and should be gaining from such studies.

Finally, Strauss reminds us that analysis must begin in the field, when we collect our crucial data on artifact and feature contexts. An awareness of the many factors that may have disturbed artifacts after they were deposited is essential to a correct interpretation of our findings.
Taken together, these articles remind us of the diversity of activities archaeologists do, and of the many techniques available for squeezing as much information as possible from our findings. They should also stand as a reminder that new analytical methods are being invented all the time. The current emphasis on preservation of sites and proper curation of existing assemblages is intended to ensure that archaeologists of the future will be able to obtain the samples they will need for their analyses.

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LOCALITIES OF QUARRIES WORKED BY THE INDIANS FOR MATERIAL FOR THEIR STONE IMPLEMENTS

Henry W. Haynes

For some time past I have occasionally found in different Indian shell-heaps and village-sites along the north shore of Massachusetts Bay, implements and flakes made of a compact, unicolored felsite, of a light green color. It has been a matter of some interest to me to discover, if possible, the locality from which this handsome material was obtained. No specimens of it are to be found in our own mineralogical collection, and there are none at Cambridge; and our local mineralogists could not give me any clue to it. Last summer, however, I succeeded in finding a spot where it occurs in large quantities, and where manifest traces appear of its having been extensively worked in former times. The soil in the immediate vicinity is filled with chips and broken fragments, many of which, by their disintegrated condition and weathering, show marks of great antiquity. The locality is a hill in Melrose, about a quarter of a mile northeast of Wyoming Cemetery. I have brought specimens of the mineral and flakes made of it, together with several implements fashioned out of it, which I have found in different places.

Another substance much employed by the Indians, and found both in the shape of implements and of flakes in similar situations along the north shore, is the so-called "Saugus Jasper." This is not a true jasper, but a compact, non-porphyritic petrosilex, of a light red color. It occurs only in a small outcropping on the south side of the Saugus River, a short distance to the northeast of the railroad station at Saugus Centre. For many rods around the ground is filled with fragments, and there can be no reasonable doubt that the quarry was worked for a very long period. This locality is about two miles distant in a northeasterly direction from the place where the green felsite occurs. I have brought specimens of it here for your inspection, as well as implements made of it from various sites.

The most common material, however, used by the Indians of this vicinity for the manufacture of their stone implements, is the porphyritic felsite, which occurs abundantly in Lynn, Saugus and Wakefield. It is of a dark brown or chocolate color, speckled with grains of white quartz. I have here implements made of it, selected out of a much larger number, which I have found in many places quite widely separated from each other. All the implements exhibited here are marked with the names of the localities where they were found. The spot, where the outcroppings of this material seem to have been most worked by the Indians, so far as my information goes, judging from the number of implements that have been found in the immediate vicinity, and the fragments with which the hillsides above

are covered, is in the extreme southeasterly corner of Wakefield, in Greenwood. This is the same locality where Mr. David Dodge discovered those "rude implements of a palaeolithic form," which were exhibited at the meeting of this society on January 5, 1881.  

Upon a former occasion I referred to investigations made by me in certain Indian shell-heaps on the shores of Frenchman's Bay, in the island of Mt. Desert, Maine. The stone implements found in them are generally fashioned out of a compact, green felsite, speckled with grains of milky or transparent quartz. Boulders of the same material are common upon the neighboring beaches. A year ago, on a visit to Mt. Kineo, Moosehead Lake, in Maine, I found that the mountain is entirely made of the same kind of rock. Evidently it was well known to the Indians as a source of supply of the material for their implements, as was manifest from the abundance of the refuse pieces to be found there. In the fields at the foot of the mountain and near the hotel I found numerous examples of their manufactured articles, which show by the thick patina of their surface that a very long time has elapsed, since they were fabricated. Some of these I have brought here for your inspection.

Another interesting locality, from which the Indians procured material of a similar character, is the so-called "Jasper Cave," in Berlin, New Hampshire. This spot also I visited a year ago, and I have brought here specimens of the mineral broken from the roof of the cavern. This, also, is not a true jasper, but a petrissilex, striped and mottled with brownish-red and yellow. It is of a handsome appearance, breaking readily with the conchoidal fracture, and is excellently adapted for making arrowheads and other fine work. The "cave" was discovered only so recently as 1861, and is situated on a rocky ridge about a mile and a half west of the village. It is found in a vein of metamorphic, silicious rock, which cuts through a mass of micaceous hornblende schist. The entrance to it is just large enough to crawl through, and conducts by a narrow passage seven or eight feet long into an excavation about thirty feet in length, by from six to eight feet high and wide. The material here obtained was carried by the Indians about seven miles up the Androscoggin River to a site in Milan Corner. There, traces of their village can be found upon a broad terrace, about thirty rods from the west bank of the river, on a farm of Mr. Sumner Chandler. Innumerable flakes of the "ribboned Berlin Jasper" fill the soil, and many implements made of it have been found there. Several of these flakes I have brought here, which show great changes in texture and color, occasioned by long-continued atmospheric influences.

But of all the localities in the United States from which the Indians procured the material for their stone implements, by far the most celebrated is the so-called "Flint Ridge," situated in Licking and Muskingum Counties, Ohio. This has been recently described with great minuteness by Mr. Charles M. Smith in an article published in the Smithsonian Report for 1884, part I, p. 851, to which I refer you for complete information in regard to it. I have, however, brought here specimens of the material and implements manufactured from it, thinking it may be of interest to you to compare them with the materials used for similar purposes by our New England Indians.

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EXPERIMENTS IN DEBITAGE ANALYSIS: SOME TESTABLE HYPOTHESES

John J. Shea

The most common artifacts at any prehistoric site are flakes, or debitage, the waste products of stone tool manufacture. Traditionally these artifacts receive little attention in archaeological reports. This may be in part because very few of the archaeologists who excavated them have a clear notion of the behavior affecting their production and formal variability.

Most typologies of stone implements from the Northeast (Fowler 1963; Johnson et al. 1984; Ritchie 1961) treat lithic debitage, if at all, as uninformative waste. While descriptions of bifaces and other finished tools are elaborate, little guidance is given to one faced with the analysis of a more typical assemblage: two or three bifaces and several thousand flakes. A variety of recent lithics studies (Callahan 1979; Crabtree 1972; Katz 1976; Phagan 1976) have indicated that experiments replicating the products of prehistoric stone industries may be effective guides to the interpretation of archaeological materials.

This article uses this approach to propose a debitage typology for general use by amateur and professional alike, one focused on demonstrable relationships between prehistoric stone-working behaviors and their material products. Such a typology, used to organize archaeological assemblages, allows a greater return of information about prehistoric behavior than is afforded by more traditional approaches. By virtue of its reliance on easily-visible, non-metric characteristics of clear relevance to the behavior in question, only a limited degree of familiarity with lithic technology is necessary for the use of this typology.

FLAKE ANALYSIS IN ARCHAEOLOGY

The formative years of archaeology, the late nineteenth and early twentieth centuries, were characterized by a lack of archaeological investigations of lithic debitage. Most of the few technological studies of stone tools were concerned with discriminating artifacts of human manufacture from those resulting from geological processes (Barnes 1939; Moir 1912). Indeed, debitage was not even saved from many sites.

Experimentation began in earnest in the early twentieth century, spurred by ethnographic accounts of stone tool production (Ellis 1940). Before long, there developed a group of archaeologists with superior flintknapping skills including Don Crabtree (1972), Francois Bordes (1969) and Louis Leakey (1950), each of whom used his skills to augment traditional archaeological methods.

Within the last twenty years, the focus of interest expanded to include the study of debitage, or flaking debris. Functional relationships between formal flake attributes were explored. Speth's (1972, 1974, 1975, 1981) experiments and Wilmsen's (1970) analyses of archaeological materials from several Paleoindian sites established that aspects of prehistoric tool manufacture could be understood by reference to controlled experiments.

More recently, detailed studies of prehistoric technologies have developed (Bradley 1977; Callahan 1979; Toth 1982) which propose flow-diagrammed processes of artifact manufacture. The accuracy of tool replication is easily the most striking feature of these projects. However, faithful attention to the information contained in chipping debris is perhaps a more noteworthy attribute.

Copyright 1985 by John J. Shea
The course of flintknapping studies, so well recounted by Johnson (1978), has seen a gradual refocusing of interest from the "finished" tools to the "waste" of prehistoric stone technology. Such a concern becomes even more important in the light of recent use-wear analyses (Odell 1977; Keeley 1980; Toth 1982; Lurie 1983; Shea 1984) which indicate that the majority of utilized tools in many assemblages lie not among the retouched pieces but rather with the unretouched debitage.

KNAPPING EXPERIMENTS

Flintknapping experimentation is not lightly undertaken. A great investment of time and energy is required to achieve even rudimentary flaking skills (Johnson 1976), skills which must be practiced regularly in order to maintain proficiency. I began flintknapping in earnest in 1981, making "arrowheads" from bottle glass. The 1983 field season of the Belize Archaic Archaeological Reconnaissance provided me ample time to practice and an unlimited supply of high quality lithic materials (chert and chalcedony). Later, I expanded my repertoire to include crystal quartz, basalt, rhyolite, felsite, quartzite, argillite and jasper, collected from New England sources.

A flintknapper's toolkit consists of an assortment of implements. Mine includes hammerstones, smoothed cobbles of basalt (1 kg, 1.5 kg) and limestone (1 kg) which are used in hard hammer percussion. A red deer (Cervus elaphus) antler billet and a smaller baton of the same material serve as soft-hammer percussors. A set of sharpened white-tailed deer (Odocoileus virginianus) antler tines serve as pressure flakers. Modern substitutes for these are copper (gauge 0 or 1/4 inch diameter) wire tips hafted in wooden handles. Copper is about the same hardness as antler, but wears less rapidly and is more easily replaced. Abrading stones are large flakes of sandstone, arkose, and quartzite. A small leather pad protects the hand, and a large apron of tanned deerskin preserves pants and leg from incidental lacerations. The entire kit weighs about 4-6 kg and fits into a small satchel.

Certainly there is a tendency for a flintknapper to focus on the end-product of his or her labors, the finished point, handaxe, or some other aesthetically pleasing artifact. But, as an archaeologist, one cannot help but become conscious of regularities in the material products of flintknapping activities. The very presence of several hundred kilograms of flakes in one's work area begs for study.

Fortunately there exists a rather well-defined terminology for describing the shape and technological features of flakes. The conchoidal fracture of most knapped rocks allows such descriptions to be applied to a great variety of lithic materials. The generalizations in this paper, however, were formulated from observations of a select group of lithic materials: obsidian, chert, jasper, argillite, basalt, rhyolite, felsite, and quartzite, as well as (but less reliably) quartz.

Figure 11, an idealized flake, depicts several of the principal features referred to in sections that follow. The application of force, by percussion or pressure, to the surface of the striking platform starts a fracture through the rock along a course roughly parallel to the direction of applied force. The flake separates from the parent rock, or core, along a plane with the ventral surface of the flake. The ridges on the dorsal surface of the flake are the edges of flake scars left by previous flaking episodes. The convexity of the bulb of percussion is generally greater with harder than with softer hammers. The distal extreme, or termination, of the flake may end in three ways: a sharp edge (feather termination), an abrupt truncation (step termination), or a reverse curve (hinge termination). The angle formed by the intersection of the plane of the striking platform with the flake's dorsal surface may vary but is generally an acute (less than 90 degrees) angle.
Conversely, the platform angle (Crabtree 1971:82-4) or the beta angle (Wilmsen 1970:14) formed by the intersection of the striking platform and the ventral surface is generally obtuse, but rarely greater than 180 degrees. The outline of the flake in plan view is determined chiefly by the direction of applied force and by the contour of the dorsal surface of the core.

By separating and examining debitage resulting from flintknapping operations (quarrying, edging, decortication, thinning, and edge resharpening) it is possible to establish relationships between specific manufacturing activities and discrete flake types.

PREHISTORIC KNAPPING BEHAVIOR

The manufacture of bifaces and many other retouched tools involves a series of five principal operations:

Quarrying is the collection of raw material from a source and the transport of the material to the site of tool manufacture. If the destination of the stone material is distant, the amount of weight to be transported may be reduced at the quarry by breaking the rock into small manageable blocks from which further flakes may be struck. Experimental flaking at the quarry also serves as a test of the flaking properties of the quarried material. As many lithic materials are procured from high-erosion areas such as streambeds, beaches and exposed rock faces, a weathered surface (cortex) may be present on the quarried material.

Edging is performed on a small cobble or large flake core. The creation of a stable, flakeable edge is necessary before further flaking can occur. This is usually done by striking an unretouched edge obliquely and repeatedly with a hammerstone until a sinuous bifacial edge of less than 90 degrees (ideally about 60 degrees) is present around the entire core radius.

Decortication, or primary thinning, involves the removal of any remaining cortex from the core and may be accomplished through either hard or soft hammer percussion, by driving long, wide and thick flakes halfway across the core.

Thinning, or secondary thinning, the most difficult of all knapping skills to master, is an attempt to drastically reduce the thickness of the core while maintaining the length and breadth of the core. Thinning is improved by abrading the edge, and thus strengthening
it, prior to flaking. One attempts to drive, by percussion or pressure, long, broad and thin flakes of controlled shape more than halfway (but not completely) across the core.

Resharpening, or retouching, is the creation of a sharp, straight edge on the margin of the core by either percussion, or more typically pressure flaking. This activity is frequently repeated as utilized edges become dull from use. Edge abrasion may also precede the retouching of an edge.

These five activities, known from ethnographic (Ellis 1940), archaeological (Holmes 1919) and experimental studies (Callahan 1979), have consistent effects on the properties of the resulting debitage.

DEBITAGE TYPOLOGY

There are five principal types of flakes which are closely correlated with each of the five knapping operations described above.

Blocky fragments (Figure 12a) are multi-faceted chunks of rock, possibly discarded cores, that retain none of the technological features of their manufacture (i.e. no platform, no bulb of percussion, no identifiable ventral surface). Bipolar percussion and violent hardhammer percussion may produce blocky fragments in abundance. Therefore, blocky fragments may be expected to occur in greatest numbers at or near quarries and sources of lithic materials.

Primary cortical flakes (Figure 12b) are characterized by the presence of cortex on more than 50% of their dorsal surface. The striking platform (part of the dorsal surface) may be either freshly-flaked or corticated. As these are usually percussion-spalled, primary cortical flakes have pronounced bulbs of percussion which leave deeply-concave scars on the core. While these flakes may be produced during quarrying they are chiefly the products of edging operations, which may be performed anywhere.

Secondary cortical flakes (Figure 12c) are flakes with cortex on between 50% and 25% of their dorsal surface. The bulbs of percussion are less pronounced than in primary cortical flakes.

Tertiary flakes (Figure 12d) are flakes with cortex on less than 25% of their dorsal surface. They are often produced during the final stages of debitage.

Retouch flakes (Figure 12e) are flakes with retouch on one or both edges. They are produced by retouching.
Secondary cortical flakes (Figure 12c) are wide and long in plan while thick in cross-section. Their principal attribute is the presence of cortex on less than 50% of their dorsal surface, accompanied by scars from previous flaking. Again, the striking platform may be fresh or cortical. A faceted striking platform may be the remnant of edging. Such debitage suits the objectives of decortication both by removing the cortex and by greatly reducing core thickness. The resulting decrease in core mass allows the core to be transported more easily, and thus secondary cortical flakes may be expected to be encountered frequently near lithic sources.

Tertiary flakes (Figure 12d) are principal products of secondary thinning and typically lack cortex. They are also the products of the manufacture of simple flake tools. As such, striking platforms may be either faceted or planar. These flakes may be detached either by percussion or by pressure flaking. In plan they are long and broad while very thin in cross-section. Bulbs of percussion tend to be small and diffuse. Their dorsal surfaces may contain multiple intersecting flake scars. The platform angle will be very obtuse. Flake terminations tend to be of the feather type, although this will vary with the skill of the knapper. Step and hinge terminations leave deeply-concave flake scars which are obstacles to further flaking and thinning. As thinning is the most difficult operation in flintknapping, one might reasonably expect tertiary flakes to occur in greatest numbers at the end-locality of an exchange system. Further, because of the substantial amount of time and effort needed to achieve mastery of secondary thinning, regularity in the features of tertiary flakes should be the logical focus of attempts to detect craft specialization.

Retouch flakes (Figure 12e) are the main products of resharpening and edge rejuvenation but also occur with thinning and, less often, with decortication. They are typically small, with length rarely exceeding twice the width of the flake. Remnant unifacial or bifacial edges form the striking platform/dorsal surface intersection, where use-wear or edge abrasion is often present. As retouching of an edge is the flaking operation which is least wasteful of lithic material, such flakes may be expected in greatest frequencies in assemblages formed in situations where the source of the lithic material is distant or inaccessible. Because retouch flaking resharpen a dulled edge, such flakes may be expected to predominate at sites where tools were used and maintained.

<table>
<thead>
<tr>
<th>Knapping Activity</th>
<th>Block Fragment</th>
<th>Primary Cortical</th>
<th>Secondary Cortical</th>
<th>Tertiary</th>
<th>Retouch</th>
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<tr>
<td>Quarrying</td>
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<td>Edging</td>
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<td>Decortication</td>
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<td>Thinning</td>
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<tr>
<td>Resharpening</td>
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Note: The number of asterisks in a cell reflects the relatively greater or lesser strength of association between the variables.

Some patterns emerge from the correlation of flake types with flintknapping operations (Table 4). At least with reference to biface production, both flake types and knapping operations occur in a logical order. There is a progressive increase in the
absolute number of flakes resulting from each successive knapping operation but a decrease in the average size and mass of the individual flakes resulting from each operation (Katz 1976:87). Nevertheless, the classification of flakes by mass, despite its value as a statistical discriminator of flake types, will probably be of little value in reconstructing the origin of any individual flake at a level of certainty greater than is possible by the use of the technological criteria outlined above.

As both the flake type series and the number of flakes in each category are easily converted to simple descriptive statistics, a relatively simple measure of similarity can be devised for comparing lithic assemblages from different sites by comparing the relative frequencies of different flake types. The frequencies obtained may also be correlated with properties of the archaeological context, such as features, geographic location of the site, distance to lithic sources, trade-exchange systems and the suspected presence of craft specialization.

CONCLUSIONS

Flakes are perhaps the most important source of information about prehistoric behavior. Virtually indestructible, they comprise the greater part of the sole record of human culture for more than two million years. The classification of debitage from archaeological sites can yield a detailed record of past human behavior. Combined with functional analysis based on use-wear and accurate lithic source-tracing methods, a vivid picture can be drawn of the activities represented by any particular lithic assemblage. The archaeology of New England can only benefit from such detailed reconstructions.

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PHAGAN, C.J.

RITCHIE, W.A.

SHEA, J.J.

SPETH, J.D.

TOTH, N.P.

WILMSEN, E.N.

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AN UNUSUAL NOTCHED PENDANT

Tonya Largy

The pendant described in this paper is believed to be from Wayland, Massachusetts, a town located in the Sudbury River valley. It was brought to the author's attention by an art collector from central Massachusetts. He noted that the artifact originally bore an old paper label on which the name "Wayland" was handwritten in white ink, probably by the collector who plucked it from the soil. Unfortunately, the actual site location was not written on the label and the information is lost.

Stone pendants made to be worn as body ornaments are known from the archaeological record in Massachusetts although they are uncommon. They were manufactured from a wide range of materials in many sizes and shapes. Some were perforated, others were not. Fowler has described and illustrated some of these artifacts found in Massachusetts and Rhode Island (Fowler 1966:43-45, 50-51).

C.C. Willoughby called these artifacts neck and ear pendants. He quotes William Wood's observations regarding the aboriginal use of personal ornaments: "They wore pendants in their ears as forms of birds, beasts and fishes, carved out of bone, shells, and stone" (Willoughby 1973: 180). Because of the acidic soils of New England, only the stone pendants survive to become part of the archaeological record. Several of the stone pendants illustrated by Willoughby are from the Concord and Sudbury River valleys (Willoughby 1973:180-181).

ARTIFACT DESCRIPTION

The pendant under discussion is made from a water-worn slate pebble and is plano-convex in cross-section. It measures 4.9 cm in length, 3.3 cm at its widest point and is .4 cm thick. Its weight is 9.8 grams. A groove is incised around the entire neck of the pendant. On the front, there is the suggestion of another groove beginning at the left margin and running toward the center of the pendant. A series of notches, spaced approximately 1.5 mm apart, are incised along the entire lower margin below the groove. One notch was begun above the groove, on one side, but was not completed. A small section of the margin is broken off the other side of the pendant above the groove (Figure 13).

Both the obverse and reverse sides of the pendant are lightly incised with fine lines running horizontally, vertically and diagonally in both directions. Even though the engraving is very complex, no actual design is evident. Finally, the perforation at the top of the pendant was made by drilling from both sides at a diagonal slant until the two perforations met.

MICROSCOPIC EXAMINATION

Dr. Russell Barber, Department of Anthropology, California State University at San Bernardino, was asked to examine the artifact under magnification to provide information about method of manufacture. The artifact was examined under a standard binocular microscope, using magnifications ranging from 8X to 40X. The following paragraphs are taken directly from his report.

"At low power a general spiral pattern of relief was visible on the inside of the perforation that appeared to be a result of the manufacture process, but no striations were detectable at higher magnification. There are no suggestions regarding what kind of tool might have been used.

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Within the perforation, however, were distinct and distinctive wear traces. The sharp edge, produced by the intersection of the two cones, that was formed in manufacture has been smoothed so that it appears darker and almost lustrous; this wear is present all around the hole, but is most prominent at the upper edge. The wear extends back from the sharp edge for a limited distance. This type of wear is distinctive of suspension by a cord. The greater wear at the top reflects how gravity would pull the object downward.

The deep cut that surrounds the top bit of the piece (with the perforation) shows a very sharp V-shaped gash. There also are distinct striations along this cut. This pattern would be produced by a flake or similar very sharp object being used with a considerable amount of pressure to make the cut. In some places the cut shows two deep Vs, where the gash was overcut and the second cut followed a slightly different course. The sharpness of these marks and absence of wear indicate that the cut was decorative, rather than functional, or at least that no cord was ever tied around the cut.

There are a number of shallow cuts on the faces of the object. These shallow cuts also show V-shaped cross-sections, but they are considerably less deep and less V-shaped than those for the deep cut at the top. It is most likely that these were made with the same tool as the deep cut, although it was used with less pressure for the shallow cuts. These shallow cuts do not in the least resemble wear from needle sharpening or the like.

The deep notches that surround the piece on its edges (with the exception of the area above the deep cut) are much broader than the cuts on the faces. Their cross-section is U-shaped. Nonetheless, they, too, apparently were made with the same or similar flakes as the other cuts. In a few cases, cuts have extended beyond the notch and are visible on one of the faces. These cuts are V-shaped and moderately deep. The notches may have been ground after the cuts were made to establish their basic shape, although traces of such grinding were not observable. There were no clear traces of wear on the notches or in the areas between them” (Barber 1983).

Barber suggests that such an artifact might have been used as a stamp. Middle Woodland sites in Ontario have produced notched tools, although linear in design, that are believed to have been used as stamps, especially for rocker stamping of pottery (Wright 1967:10). The suspension of such a stamp by a cord until it was needed would keep such a tool close at hand. The implications are that pendants such as this one may have had a functional as well as a decorative purpose. However, if this pendant had been used as a stamp, the notches should have shown evidence of polish, which they do not show.

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Figure 13. Perforated pendant from Wayland. Drawing by Nancy Lambert-Brown.
OTHER PENDANTS

Collections in the Broston Museum of the Massachusetts Archaeological Society, Attleboro, Massachusetts, and the Peabody Museum of Archaeology and Ethnology, Harvard University, were examined for the purpose of studying similar perforated stone pendants. In addition, information on such pendants in the literature and in private collections was sought. Surprisingly, very few pendants such as the one under discussion were present in any of the collections, which include thousands of artifacts from Massachusetts.

Thirteen perforated stone pendants were available for study at the Bronson. Almost all were made from round or oval flat pebbles and four had designs incised on the surface. Several of the Bronson Museum pendants have been illustrated by Fowler (1966:44, 50). There were no available records of provenience for 11 of the pendants.

The remaining two pendants were of special interest because they came from the Heard Pond site, in Wayland, and are similar in some ways to the pendant described above. C.C. Ferguson found these artifacts, which he called "earrings" and described as follows:

"... one oblong with notched edges, thin, with a hole near the tapering end, another nearly round, thin, the edges smooth, a hole in the center. These may have been worn from the ears or the neck or have been part of a neck­lace. Several also were found with the hole partly bored or without the hole bored." (Ferguson 1935:475)

The notched pendant from Heard Pond in the Bronson collection has been broken at the perforation, but part of the latter is still visible.

Four perforated stone pendants from Massachusetts sites were available for study from the collections in the Peabody Museum. Three of these were made on flat pebbles shaped into rectangles. One had notches on the top edge only, but no design. The second pendant, the largest in size of all pendants studied, was notched around the edges and had parallel lines incised on the obverse side. The third rectangular pendant had no notches, but incised designs were present on both sides. The design on the front consists of parallel lines and several other shapes, one a circle. The design on the back consists of a series of lines which criss-cross each other across the whole surface of the pendant.

The fourth pendant (#70-6/2498), from the town of Sudbury, is most like the pendant illustrated in Figure 13. It is made on a flat gray pebble with a compressed-ovoid shape, reminiscent of a large lima bean. The hole is drilled from both faces at the wider end so that, if suspended, the pendant would be oriented with the short axis vertical. The design, incised on the front side only, consists of oblique lines forming inverted cones with trans­verse lines incised within each cone so that the design resembles a range of three mountain peaks. There is a hint of such a design element on the reverse side of the pendant in Figure 13.

Information about one additional example of a perforated stone pendant from the Sudbury River valley known to the author was provided by Duncan Ritchie, of the Public Archaeology Laboratory, Providence, Rhode Island. The pendant was a surface find from a corn field under active cultivation on the Davis Farm site (M 23-26), Sudbury, Massachu­setts. It is made on a very thin, gray slate pebble with unnotched edges shaped by grinding. Both faces appear to have been smoothed and are marked with thin, faint incised parallel lines. The lines are short and placed in sets of two or three. The hole was drilled from both sides. The pendant's maximum length is 3.1 cm, its width is 2.5 cm, and it is .4 cm thick (Ritchie 1984).
A stone pendant with a similar design was excavated by William Ritchie from Stratum 2B of the Vincent site on Martha's Vineyard. The stratigraphic context was interpreted by Ritchie as transitional between Late Archaic and Early Woodland (Ritchie 1969:162). His description of the artifact follows:

"The unique object with serrated edges and partially grooved top, made from a flat graywacke pebble, is tentatively identified as a pendant. The surface... bears a group of parallel oblique incisions, with a few random transverse shallow cuts or grooves, suggesting possible use as a whetstone for sharpening needles or awls." (Ritchie 1969:145)

One other notched stone pendant must be discussed. In his "Review of Cape Cod Archaeology", Ross Moffett places a single notched pendant from Small's Swamp, in Truro, Massachusetts, in the Middle Woodland period (Moffett 1957:9-10). Another plainer perforated stone pendant is assigned by Moffett to the Late Woodland period (Moffett 1957:14-15).

CONCLUSION

Considering the vast number of stone artifacts from Massachusetts housed in museum collections, perforated stone pendants are a relatively rare artifact type. Perhaps prehistoric people found it easier to carve bodily ornaments from bone, wood or shell. These materials would have been lighter in weight, and therefore more comfortable if worn as earrings or neck pendants, or for some functional purpose as suggested by Barber.

There is evidence that this artifact type may have a Woodland association. The pendant from the Vincent site was excavated from a transitional level between the Late Archaic and Early Woodland periods. Middle Woodland sites in Ontario produced notched tools with rounded peripheries, believed to have been used as stamps. Finally, Moffett's pendant is believed to date from the Middle Woodland period.

More conclusive information must come from the recovery of at least one other perforated, notched stone pendant systematically excavated from a clear Woodland context.

No other references to stone pendants were found in a survey of the published literature of sites in Massachusetts. Since this type of artifact is infrequently reported, it is worth recording here. Anyone having knowledge of other stone pendants in either museum or private collections is invited to write to the author.

ACKNOWLEDGEMENTS

The author wishes to thank two gentlemen for their cheerful and kind assistance in locating artifacts in their museums. Rudy Busto of the Collections Department of the Peabody Museum, Harvard University and Thomas Lux, Director of the Bronson Museum offered valuable assistance and lots of good will. The author is also grateful to Duncan Ritchie and Russell Barber for their help in preparing this article. Lastly, the anonymous art collector deserves to be commended for bringing the artifact to the author's attention so that it might be recorded as part of Wayland's cultural history.
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WILLOUGHBY, Charles C.

WRIGHT, James V.

A MINIATURE STEATITE POT

John Alfred Mansfield

This pot was found in Watertown, Massachusetts, on a high knoll overlooking the Charles River. This was the spot where Roger Clap is said to have landed in 1630 (Robinson and Wheeler 1930). He described it as a place where the river grew narrow and shallow and the bank was very steep. Clap and his party were met by an old planter, John Oldham, who told them that 300 Indians were living nearby. The site of John Oldham's house was across the street from the knoll, and the Indians were probably camped on what is now the grounds of the Perkins School for the Blind. When traveling up the Charles, this is the first good landing area after leaving Cambridge. Above this spot it was nearly impossible to land due to the depth of the river and the thick marshes bordering it.

The bank facing the river to the south is very steep and badly eroded. The east and west sides of the knoll slope sharply to what would have been marshes in Indian days. The north side is a gentle rise to the grounds of the Perkins School. The surface of the knoll has been badly disturbed, much of it during my lifetime. An anti-aircraft gun emplacement was built on it in the early days of World War II.

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Dr. Dena Dincauze has written of this site and others in the near vicinity (Dincauze 1973, 1975). The miniature pot was found in the side of the eroding bank in close association with Vinette I pottery, Squibnocket stemmed and triangular projectile points, and Atlantic, Dudley notched, Wading River, and Orient fish-tail points. I believe the pot dates to the Late Archaic or Early Woodland period.

The pot itself is made out of a scrap piece of steatite, or soapstone. It appears to be a probable toy made by a father for his daughter. The lugs are well made and the inside appears to have been scraped out. Some form of nodule in the soapstone has fallen out, leaving the pot pitted (Figure 14). It is very crude and does not seem to be a paint pot.

I would welcome any remarks that members might have. I have not seen anything similar to it.

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ROBINSON, G. Frederick and Ruth Robinson WHEELER

THE CHARLES H. READ ARCHAEOLOGICAL COLLECTION
SEEKONK, MASSACHUSETTS

Eric S. Johnson and Thomas F. Mahlstedt

This report on the Charles Read collection represents the fourth Bulletin article dealing with the results of the statewide inventory of cultural resources which has been sponsored by the Massachusetts Historical Commission since 1979 (MHC 1981; Johnson and Mahlstedt 1984a, 1984b). The goals and methods of the statewide inventory have been outlined in the previous articles and will therefore not be repeated here.

The Charles H. Read archaeological collection, located at the Seekonk Public Library, represents the result of twenty five years of surface collecting by Charles Read on his ancestral farm in southern Seekonk. Between 1915 and 1940 an impressive array of artifacts representing over 9,000 years of human activity was collected from a number of discrete loci within the boundaries of the Read Farm.

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The Read Farm property, as it existed when Mr. Read was assembling his collection, occupied approximately 110 acres (44.5 ha) of land. This consisted primarily of level terraces overlooking extensive salt marshes to the south and east, near the confluence of the Runnins River and the Barrington River estuary, which empties into Narragansett Bay. Within the limits of his farm Mr. Read discovered a number of sites. Unfortunately no written records were kept, so the exact locations from which specific specimens were collected cannot be determined.

Mr. Read's principal and most productive collecting area was located near the family house on School Street. Here, an eroding sandy bank continuously yielded prehistoric artifacts after heavy rains and under the footfall of dairy cattle that traversed the steep slope. Adjacent to the slope is a flat area which was excavated between 1969 and 1974 by members of the Massachusetts Archaeological Society, archaeology students from Rhode Island College and Providence College, and local residents. This small area proved to be remarkably complex with a maze of features lying superimposed on one another. Although complete results of these excavations have not yet been published, a preliminary paper indicates that over 20 features were encountered in the 1974 season alone (Barnes n.d.). Two radiocarbon dates secured at that time indicated that at least some of the activity at this location could be attributed to the end of the Late Archaic Period. Copies of the site records, field notes, maps, and photographs were being assembled and photographed at the Bronson Museum at the time of writing (T. Lux: personal communication).

The exposed bank and excavated area represent but a small portion of a larger site or series of sites which extended along the edge of the terrace overlooking the confluence of the Runnins and Barrington rivers. Read collected from these sites and from other locations on his family's property. His collection, therefore, represents a mixture of several assemblages from a number of prehistoric sites which were once located within the Read property. Although the sites occupy essentially the same environment, and some are likely to be related to one another in time as well as in space, we cannot fully appreciate the relationships at this time. The nature of the occupations at several of these sites will, in fact, never be known, owing to extensive recent subsurface disturbances.

**COLLECTION ANALYSIS**

The Charles Read archaeological collection contains a total of 756 artifacts. The assemblage is comprised of six different classes of lithic artifacts, including projectile points, perforators, bifacial implement blades, cores, chipping waste, and pestles (Table 5).

Projective points are the most numerous class of artifact in the collection. Over 95% (721 specimens) of the collection is made up of projectile points and projectile point fragments. Four hundred forty-one of these are diagnostic or "typable" and can be used to determine the range of cultural and temporal occupation at the Read Farm. The high proportion of typable points in relation to "untypable" (441:144) enhances the significance of the collection.

While projectile points do provide a means for determining the approximate dates of a site, the preponderance of this form of artifact illustrates a major bias of the collection. The Read collection is obviously not a representative sample of artifacts from these sites and it cannot accurately reflect the full range or nature of the prehistoric activities that occurred at the various loci. Owing to these limitations, the remainder of the report will briefly focus on certain cultural/temporal periods that are represented in the collection by specific projectile point forms, and patterns of lithic resource utilization shown by these points.
TABLE 5
CHARLES READ COLLECTION: GENERAL ARTIFACT CATEGORIES

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>% Total Collection</th>
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<tr>
<td>Projectile Points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typed</td>
<td>441</td>
<td>95.4</td>
</tr>
<tr>
<td>Untyped</td>
<td>144</td>
<td></td>
</tr>
<tr>
<td>Point Tips</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>Point Midsections</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>721</td>
<td>95.4</td>
</tr>
<tr>
<td>Other Chipped Stone Tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bifacial Implement Blades</td>
<td>11</td>
<td>4.4</td>
</tr>
<tr>
<td>Perforators</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Chipping Waste</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Cores</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>4.4</td>
</tr>
<tr>
<td>Ground Stone Tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pestles</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Total Artifacts</td>
<td>756</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The 441 typed points inventoried in the Read collection document nearly the entire chronological range of human occupation in New England, spanning over 9,000 years. The only period not represented in the collection is the Paleoindian Period (ca. 12,000-9,000 B.P.), during which the first hunter-gatherers entered New England shortly after the glacial retreat.

Bifurcate base projectile points, considered diagnostic of the Early Archaic Period (ca. 9,000-8,000 B.P.) constitute the earliest evidence of human activity at the Read Farm. Points of this type have been reported from a number of other sites in Eastern Massachusetts; however, they are rarely found in numbers. To date, the largest concentration of Bifurcate base points in the region has been reported from the upper Taunton River in the vicinity of the Titicut site (Taylor 1976).

The Read collection contains eight Bifurcate base projectile points, a relatively large sample from an area the size of the Read Farm. The majority, if not all of these points were manufactured from lithic materials that were probably regionally available either at outcrops or in glacial drift. Six specimens were made from varieties of felsite, including a red felsite similar to "Attleboro" felsite, which is believed to outcrop in southeastern Massachusetts. A maroon felsite similar to that which occurs in the Lynn Volcanics outcrop at Marblehead was also used. Black argillite and milky quartz were also utilized; generally these two materials were rarely used for Bifurcate base points in Eastern Massachusetts.

During the Early Archaic period sea levels were considerably lower than today because of the quantities of water still locked up in the retreating ice mass. During this time the Read Farm site would have been much farther inland, the adjacent marshes would have been fresh water and the head of Narragansett Bay would have been several miles further south. It is likely that many Early Archaic sites were located in areas that have since been inun-
dated by rising sea levels. An inability to investigate a significant number of Early Archaic sites is one reason why, at present, our knowledge of Early Archaic settlement patterns, subsistence and social organization remains poor. Early Archaic components are rarely encountered and very few have been excavated. However, it is possible that intact Early Archaic components may yet remain at the Read Farm site. For this reason, the Read Farm site may hold much potential for future research into the Early Archaic Period.

Later prehistoric activity is also indicated in the Read collection. The Middle Archaic Period (ca. 8,000-6,000 B.P.) is represented by 54 points, including Neville-like, Neville-variant, Archaic Stemmed and Stark-like varieties (Table 6). Patterns of lithic raw material utilization among Middle Archaic point types conform to the general patterns observed in previous collections analyses. Stark-like points were made exclusively of green and blue gray argillites. Neville-variant materials include argillite as well as hornfels, Attleboro felsite and a felsite similar in color and texture to material from the Blue Hill River Quarry site in Braintree. Four specimens were made of a tan quartzite. Tan quartzite was also used for eight Neville-like points. Four Neville-like points were made from the Attleboro red felsite.

### TABLE 6

CHARLES READ COLLECTION: PROJECTILE POINTS

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<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>% Total Collection</th>
</tr>
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<tbody>
<tr>
<td>Bifurcate base</td>
<td>8</td>
<td>1.8</td>
</tr>
<tr>
<td>Archaic stemmed</td>
<td>19</td>
<td>4.3</td>
</tr>
<tr>
<td>Neville-like</td>
<td>13</td>
<td>2.9</td>
</tr>
<tr>
<td>Neville-variant</td>
<td>11</td>
<td>2.5</td>
</tr>
<tr>
<td>Stark-like</td>
<td>11</td>
<td>2.5</td>
</tr>
<tr>
<td>Archaic notched</td>
<td>17</td>
<td>3.9</td>
</tr>
<tr>
<td>Broad eared</td>
<td>6</td>
<td>1.4</td>
</tr>
<tr>
<td>Small stemmed</td>
<td>144</td>
<td>32.7</td>
</tr>
<tr>
<td>Small triangle</td>
<td>142</td>
<td>32.2</td>
</tr>
<tr>
<td>Atlantic-like</td>
<td>9</td>
<td>2.0</td>
</tr>
<tr>
<td>Susquehanna broad-like</td>
<td>5</td>
<td>1.1</td>
</tr>
<tr>
<td>Wayland notched-like</td>
<td>3</td>
<td>0.7</td>
</tr>
<tr>
<td>Orient fishtail</td>
<td>5</td>
<td>1.1</td>
</tr>
<tr>
<td>Small pentagonal</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>Meadowood</td>
<td>4</td>
<td>0.9</td>
</tr>
<tr>
<td>Rossville</td>
<td>3</td>
<td>0.7</td>
</tr>
<tr>
<td>Woodland stemmed</td>
<td>6</td>
<td>1.4</td>
</tr>
<tr>
<td>Woodland lanceolate</td>
<td>5</td>
<td>1.1</td>
</tr>
<tr>
<td>Large triangle</td>
<td>34</td>
<td>7.7</td>
</tr>
<tr>
<td><strong>Total Typed</strong></td>
<td>441</td>
<td>100.0</td>
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<tr>
<td><strong>Untyped</strong></td>
<td>144</td>
<td></td>
</tr>
<tr>
<td><strong>Point Tips</strong></td>
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<td><strong>Point Midsections</strong></td>
<td>47</td>
<td></td>
</tr>
<tr>
<td><strong>Total Projectile Points</strong></td>
<td>721</td>
<td></td>
</tr>
</tbody>
</table>
A total of 325 Late Archaic (ca. 6,000-3,000 B.P.) points were inventoried, including examples of each of the three traditions attributed to the Late Archaic (Table 6). The Laurentian Tradition is represented by eleven Archaic notched and six Broad Eared points. The Small Stemmed Tradition, which may include both Late Archaic and Woodland period components, is represented by 142 Small triangles and 144 Small stemmed points. The Susquehanna Tradition is evidenced by three Wayland notched-like, five Susquehanna Broadlike and nine Atlantic-like points. In addition, five Orient fishtails, associated with the Terminal Archaic, are contained in the collection. Virtually every type of useful local stone was used by the various traditions of the Late Archaic. Argillites, hornfels, quartzites and a wide variety of felsites are present in various quantities. Eighty-four percent of the Small stemmed points and 81% of the Small triangles were manufactured on quartz, indicating a strong preference for this locally or regionally available material, a trend also recognized in other collections.

Projectile points associated with the Early and Middle Woodland periods (ca. 3,000-1,300 B.P.) are not numerous in the Read collection, with the possible exception of an unknown portion of the Small stemmed component. Four Meadowood points were inventoried, three of which were manufactured on gray chert, probably from New York State. The fourth specimen was made of felsite. Three quartz Rossville-like points complete the Early Woodland component of the Read collection. Two Middle Woodland point types are present in the collection; six Woodland stemmed and five Woodland lanceolate points were inventoried. Raw materials include Attleboro red felsite, other felsites, quartzites, and argillites.

Thirty-four Large triangles (Levanna) provide evidence of Late Woodland (ca. 1,300-400 B.P.) activity at the Read Farm site. Thirty of these were manufactured on quartz; of the remaining four specimens, three were made of felsites and one of hornfels. This pattern of lithic utilization is similar to that observed for Large triangles in the Roy Athearn collection in the lower Taunton River basin (Johnson and Mahlstedt 1984a).

CONCLUSION

The Charles H. Read archaeological collection represents a valuable cultural resource for the citizens of Seekonk. Fortunately, its value has been recognized and the Seekonk Public Library has undertaken to curate the collection and to develop an informative display. In addition to their educational value, archaeological collections can be valuable sources of information to archaeologists, supplying important information for cultural resource management and providing a data base for addressing research questions. The usefulness of an archaeological collection to both the archaeological community and the general public is largely dependent on the condition of the collection and the presence or absence of contextual information. Collections such as Mr. Read's are only useful to the extent that the artifacts can be provenienced and placed in context; therefore, some minimal provenience information is essential. A catalogue listing artifact proveniences and containing maps and other notes greatly enhances the research value of even very small collections. It is equally important that collectors make arrangements to insure proper curation of their collections. During the past century, several large and well provenienced collections have been lost or separated from their notes after the collector has passed away. By retaining contextual information and arranging for future curation of their collections, amateur collectors can contribute a valuable cultural resource and educational tool to their communities.
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JOHNSON, E.S. and T.F. MAHLSTEDT

MASSACHUSETTS HISTORICAL COMMISSION

TAYLOR, W.B.

THERMOLUMINESCENT DATING ANALYSIS OF A CAPE COD POTSHerd

Marie O. Eteson

Elizabeth Couglin of the Center for Archaeological Research and Development at Harvard University has performed thermoluminescent (TL) dating analysis on a single potsherd from the Hayward's Portanimicutt Site (19-BN-324), South Orleans, Massachusetts. Her letter reports the results of her analysis as follows:

"Sample #: HC 18

TL Date: 434.7 ± 43 Years B.P. (1982) or 1547.3 ± 154 Years A.D.
The standard error for equivalent-dose/fine grain technique is 10% 
(See ± years)."

No further discussion of the analytical procedures or results was provided.

The potsherd concerned is part of Vessel F reported in Eteson (1982). It was a grit-tempered and dentate stamped sherd illustrated in Figure 6 and described in Table 7 of that article. The complete assemblage from Hayward's Portanimicutt included predominantly Late Woodland lithic artifacts, some Middle Woodland lithic types, and a large number of ceramic sherds thought to be predominantly Middle Woodland in age. The writer had hoped that the TL date might shed light on the reported provenience of most of the assemblage (18 inches down under sterile shell midden, according to Hayward, personal communication) which seemed to hint of a single occupation. If that had been the case we might have then been able to interpret the site as one where overlapping styles were co-existing.

However, the TL date would appear to confirm only the late Late Woodland occupation described in the ethnographic record for this area within a century of the date. This date for Vessel F thus suggests that smooth-bodied grit-tempered pottery, impressed by an object with regular projections, may have been used by Late Woodland people, and that cord-wrapped stick impressed decoration did not have an exclusive hold on the manufacturing efforts of the Late Woodland potter.

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INTRODUCTION

The strong ties among archaeology and the environmental and biological sciences are demonstrated by the results of the author's dissertation research (Kerber 1984) which explored the effect of estuarine development along the Potowomut River on prehistoric settlement within 500 acres (202 ha) on the southern portion of Potowomut Neck in Warwick, Rhode Island. Potowomut Neck is a peninsula along the western shore of Narragansett Bay, bordered on the south by the Potowomut River estuary which flows eastward into the Bay. An estuary may be defined as a portion of a river in which salinity fluctuates as a result of the tide.

The overall goal of this study, referred to as the Potowomut Neck Archaeological Project (PNAP), was to examine prehistoric human-land relationships in a coastal setting. Although organized through the Anthropology Department at Brown University, the project represented an interdisciplinary research effort to collect and analyze data through the expertise of several specialists in the environmental and biological sciences from across New England. The success of the PNAP was based in large part on the collaboration with these scientists and the ability to integrate the nonartifactual information with the recovered archaeological remains.

POTOWOMUT NECK ARCHAEOLOGICAL PROJECT

Fieldwork centered on obtaining archaeological and environmental data that would help to determine the degree to which the presence of human occupation in the study area corresponded with the presence of a mature estuarine ecosystem with its productive salt marshes and mudflats along the Potowomut River. It was considered likely that the first intensive use of the peninsula did not occur until after sea level rise in the surrounding area had converted the Potowomut River from freshwater into an estuary. Once matured this estuary could attract and sustain a rich food supply of shellfish, fish, waterfowl, deer and other mammals.

Since no dates for sea level rise or estuarine development were available from upper Narragansett Bay, the vicinity of the Potowomut River, local environmental testing had to be performed. Sediment borings were taken from salt marshes along the Potowomut River in order to obtain radiocarbon dates of basal peat which could be used to determine the timing of sea level rise and estuarine development. This stage of fieldwork was organized by geologists at the University of Rhode Island. A total of ten core samples containing peat were taken from two salt marshes by hammer-driving and a machine-operated vibracore.

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ENVIRONMENTAL RECONSTRUCTION AND PREHISTORIC SETTLEMENT

Peat samples were selected from two of these cores for radiocarbon dating (Chmura 1984). The uncorrected dates are 1830 ± 90 B.P. (Beta-8431) and 1200 ± 80 B.P. (Beta-8430). Chmura (1984) explained that since the section of the salt marsh from which these two cores were taken was well-established as early as 1920 B.P., one may assume that a mature estuarine ecosystem containing salt marshes and mudflats was present in this vicinity by at least 2000 years ago and possibly 1000 years earlier depending upon the accuracy of an estimated accretion rate of salt marsh peat. Thus, the rich supply of food resources of use to humans that such an environment was capable of providing was probably present by about 3000 B.P.

The results of the environmental reconstruction were used to interpret the archaeological remains excavated on Potowomut Neck. Comparison of the radiocarbon dated peat samples from the salt marsh with the radiocarbon dates of recovered shells and charcoal, as well as the diagnostic styles of projectile points on the peninsula, revealed an association between periods of prehistoric settlement and the presence of a mature estuarine ecosystem. The maximum range of dates represented from 11 of the 14 total radiocarbon samples taken from 10 excavation units across the project area is approximately 2700 B.P. to 400 B.P. or between the end of the Late Archaic to the end of the Late Woodland periods; three radiocarbon samples, possibly contaminated, yielded "Modern" dates. Similarly, the cultural periods represented by the diagnostic styles of all 69 projectile points recovered in the study area suggested occupation between the same range of periods, with the majority of typed artifacts representing a Late Woodland cultural affiliation. Hence, the well-developed estuary with its associated salt marshes and mudflats along the Potowomut River was present during all periods of human occupation on the peninsula, and none of the archaeological material proved to be older than the beginning of estuary at about 3000 B.P.

The food remains recovered on Potowomut Neck were examined to determine the extent to which the estuary created an opportunity for an increase in prehistoric human use of the area. Relatively large quantities of estuarine resources, including shellfish, turtles, mammals and possibly waterfowl, were retrieved from several excavation units across the peninsula. Abundant fish remains, however, were notably absent; the only identifiable fragment was a vertebral process of an adult white perch (Morone americana). With the exception of fish, the abundance of the above food remains from different geographical areas and time periods suggested that indeed the presence of the productive estuary was at least one important factor for bringing about an increase in settlement in the project area.

BIOLOGICAL INFORMATION AND SEASONALITY

In addition to environmental data, biological remains were used in studying prehistoric settlement on Potowomut Neck. Biological data were examined primarily to reconstruct the season(s) when human populations inhabited the project area. This analysis was done by determining the season of death of the food consumed by these people. In particular, well preserved molluscs discovered in archaeological association are often valuable indicators of seasonality, as analysis of their growth lines may identify the season when they were harvested. Presumably, their presence at the site implies the season of occupation. Since seasonal growth bands are especially prominent on quahog (Mercenaria mercenaria) shells, 30 specimens of these molluscs were selected for analysis from various levels in three dense shellfish concentrations found on the peninsula. According to Pratt and Gleisner (1984) who conducted the analysis, the results indicate that the seasons of death for all of the specimens were between mid-summer and late fall (i.e., about June to November).
Another means of reconstructing seasonality involves determining the level of maturity of mammal, often deer, and bird remains from bone structure and/or teeth. Of the 1623 bone fragments recovered from all the excavation units and submitted for identification, only eight (all deer) could be used to suggest the season of kill. The only identifiable remains of deer (Odocoileus virginianus) were a juvenile and mandibles of a young-mid adult and young adult. Remains of a juvenile indicate a summer/early fall occupation, since in New England deer usually give birth in May or June (Cronan 1968:121; Hamilton and Whitaker 1979:320). On the whole, however, the sample of bone yielded no evidence of summer occupation according to Dr. Jim Mead who performed the analysis (1984, personal communication). Mead (1983, personal communication) claimed the season of kill for the young adult O. virginianus is "95%" fall. Sectioning of teeth from the recovered mandibles may reveal the season of kill, although serious limitations of this technique exist (James R. Purdue 1984, personal communication). Admittedly, the results from studying the deer and shellfish remains are limited due to the small sample size, but one may still infer that prehistoric settlement along the Potowomut River estuary occurred at least during the summer and fall seasons.

RELEVANCE TO THE ENVIRONMENTAL AND BIOLOGICAL SCIENCES

In conclusion, while the PNAP has relied to a large extent on information and analysis from the environmental and biological sciences, archaeological data may be of value to researchers in these two interrelated disciplines as well. For instance, Dr. Michael Arthur of the Graduate School of Oceanography at the University of Rhode Island and Dr. Douglas Jones of the University of Florida have recognized the contribution of prehistoric shellfish remains in studying the effects of pollution in Narragansett Bay. Prehistoric specimens of quahog shells excavated from Potowomut Neck are being examined by these scientists in order to obtain a "baseline" sample which predates the presence of pollution and can be compared to the properties of shellfish presently collected from the Bay. Hence, the interrelationship among archaeology and the environmental and biological sciences can be far-reaching and mutually beneficial.

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NATURE'S TRANSFORMATIONS AND OTHER PITFALLS:
TOWARD A BETTER UNDERSTANDING OF POST-OCCUPATIONAL CHANGES
IN ARCHAEOLOGICAL SITE MORPHOLOGY IN THE NORTHEAST
PART III: ANIMAL ACTIVITY AND FROST ACTION

Alan E. Strauss

As mentioned in Part I of this series of articles on post-occupational site changes, artifacts at an archaeological site are not clustered in a fossilized state (Strauss 1978:47). Artifacts move about in the soil due to the effects of several processes including tree-throw, root-action, insect-activity, animal-activity and frost-action. The effects of vegetational activity have been discussed in Strauss (1978). A discussion of the effects of invertebrate activity has also been presented in an earlier article (Strauss 1981).

This paper will therefore examine the effects of animal burrowing, tunneling and mound-building on archaeological sites. A discussion of the effects of frost heaving will also be presented, with emphasis on the quantitative measurements that have been made on frost action.

ANIMAL ACTIVITY: SMALL DIGGING ANIMALS

The effects of animal burrowing on archaeological sites have long been recognized by both amateur and professional archaeologists in the Northeast. Few data have been presented, however, on the quantitative effects and measurements of earth-moving caused by digging animals. The following section of this paper is aimed at providing some descriptive and quantitative information on the degree of site disturbance caused by both large and small rodents. It is hoped that the reader will gain a better understanding of the actual processes involved in the burrowing by various animals, as well as the degree and amount of soil moved by these troublesome creatures at archaeological sites.

Small rodents such as moles, mice, and voles move enormous amounts of soil by burrowing within the top two or three inches (five to eight cm) of the mineral soil, but they mix rather than move soil upwards. The effect of this mixing of soil layers is best described by one author who wrote, "Tunnels of small rodents can be observed in almost every square
foot of the forest floor, and the thickness and homogeneity of the A1 horizon in the Brown Podzolic soils is probably due in a large part to their tunneling, whereas the larger proportion of the fine earth material in this same horizon is the result of ant activity" (Lyford 1963:15).

In opposition to the localized digging of large animals, smaller animals may cause extensive disruption of the upper soil horizons. Due to their widespread distribution and large population density, the effect of these smaller rodents on the soil can be considerable. Take for example a mole, which is anatomically built for digging with its snout and forefeet. "Prorated as to size of the animal, in order to accomplish work equal to that of a mole digging a 60 yard tunnel in eight hours, a man would have to dig a tunnel wide enough for the passage of his body, nearly one-half-mile long in the same time" (Jackson 1961:65). Besides tunneling, moles build nests and mounds which can also move artifacts (Figure 15). Consequently, moles may disturb both cultural resources that lie just beneath the soil surface and those deeper down in the soil.

Although there are no good quantitative data on how moles affect cultural remains, their activities can be compared to that of larger animals. Moles mix cultural components just below the surface by building superficial burrows. Since these tunnels or burrows are shallow, they may not remain as evidence of mole activity for a long period of time. Weathering causes these tunnels to cave in and disintegrate, therefore not leaving any recognizable sign of mole activity for the archaeologist. The deeper burrows may, however, leave evidence in the form of burrow stains and minor changes in the normal stratigraphic sequence. Determination of the actual amount of alteration of artifact locations by moles is an exciting prospect for future research.

Although the activities of moles can severely disrupt archaeological materials, chipmunks are perhaps the most common burrowers at sites in New England. Chipmunks usually build small tunnels in one area (Figure 16). This effect may cause the nest area to look somewhat like a golf course. Burrows may go straight down into the soil for a short distance, but at some point these tunnels twist and turn. The following rather lengthy quote is presented in hopes of providing some quantitative data on the burrowing activities of chipmunks:

"The burrow (chipmunk) was about two inches in diameter, extended nearly vertically downward for about ten inches, then followed nearly horizontally into the slope for about eight feet to the upper center of the nest, or about nine feet from the entrance hall to the nest and storage chamber. The chamber, shaped like a flattened sphere was about 18 inches in diameter and 14 inches deep, the ceiling being about 33 inches below the soil surface. The entire lower half or more was filled with about 10 quarts of stored food..." (Jackson 1961:70).

The effects of chipmunk burrowing can therefore be substantial, especially in allowing upper horizon artifacts to find their way into lower soil layers, resulting in a mixing of artifacts of different time periods. Such was the case at the Seabrook Station Site, where jasper flakes were found well into the subsoil along with beer can tabs. Upon further investigation, we discovered chipmunk burrows in the same area where the metal tabs were found. Apparently the burrows made it possible for recent historic artifacts to enter into the same soil horizon that contained prehistoric items.

Dincauze noted mixing of the humus zone, the principal artifact-bearing stratum, at the Powissett Rock Shelter. Here, wire nails and .22 caliber cartridge cases were found together with a lead musket ball. Upon finding rodent burrows, a chipmunk jaw and burrow, and caches of acorns, the authors noted, "It is not surprising therefore, that the humus zone produced a very mixed lot of artifacts" (Dincauze and Giramly 1973:51).
Figure 15. Different Forms of Soil Movement by Moles (after Jackson 1961).

A. Burrow, mound, and nest
B. Mole transferring dirt to a deep burrow
C. Mole constructing a mound
D. Construction of a superficial burrow
Besides mixing the cultural components of a site, chipmunks cause another difficulty. Since their tunnel entrances are round and of a fairly small diameter, when they become filled with soil after abandonment they often look like post-molds. Of course these "features" can be bisected in the field and if the stains continue down into the ground or begin to twist or curve, the archaeologist will know they are burrows and not the result of human activities.

There is however, a second method for determining the difference between burrows and post-molds. The following quote provides data on the chemical analysis used to distinguish between the two types of stains:

"Chemical analysis of the soil samples from the Utz Site, Missouri, provide results which make it possible to distinguish between soil stains of human origin (postmolds) and similar stains produced by other agencies (for example rodents). Based upon the comparison of the concentrations of magnesium and phosphates in the stains with those of the immediately surrounding soil, postmolds were correctly identified with 96% accuracy in a limited sample (VanDer Merwe and Stein 1972:245).

Obviously, all of the effects of small animal burrowing should be watched for during the excavation of archaeological sites. The evidence of these activities may be as indistinct as a slight staining in the soil or as distinct as a buried cache of acorns or berry seeds. A cache of acorns was found at the Uxbridge Burial Site at a depth of four feet (1.2m) thus showing that even deeply buried sites may be affected by rodent activity. When artifacts from various chronological periods appear to be mixed within a seemingly homogeneous soil horizon, the archaeologist should carefully check for those signs mentioned above to determine if small burrowers are the culprits.

![Chipmunk Burrow Diagram](image)

Figure 16. Chipmunk Burrow and Nest (after Jackson 1961).
The nest is partially filled with food.
LARGE DIGGING ANIMALS

In opposition to small burrowers, large digging animals tend to localize their activities but may dig deeper and more extensive burrows. In general these creatures tend to cause an inversion of the soil horizons by bringing up soil from very deep below the surface (C Horizon) and piling it up on top of the A Horizon. Large diggers cause several effects on the landscape including degrading river banks, tunneling in agricultural fields, and filling ditches. Perhaps the most common large burrowing animal in New England is the common eastern woodchuck (Marmota monax refuscens Howell). The burrows of this animal can be found in woods, hillsides, meadows and transition areas between these. The burrows of woodchucks can be distinguished from those of other digging animals by the ever-present pile of fresh dirt which is mounded up by the entrance. "This mound, which is an accumulation of dirt that has been transported from the innermost recesses of the burrow, seldom passes a week without fresh material being added" (Hamilton 1934:127).

Woodchucks, as opposed to foxes, rabbits, and skunks, can move stones weighing more than two pounds (one kg) and perhaps several hundred pounds of dirt in the larger excavations. These animals build a variety of burrows as seen in Figure 17. Fortunately, quantitative data are available on the extent of woodchuck disturbance. The following quote provides an insight into the depth of soil alteration caused by these animals:

"The size of the entrance holes can vary, however, the size of the hole is directly dependent on the type of soil the woodchuck has chosen for the burrow. The depth of the burrow is likewise fixed by the texture of the soil. In sandy situations, woodchucks will dig to a depth of six feet, while in gravelly soil, composed of many large stones, the depth is rarely greater than four feet..." (Hamilton 1934:129).

Further studies of woodchuck behavior have provided data on the actual amounts of soil that they move. Each woodchuck will bring to the surface an average of 200 pounds (90 kg) of dirt and stone in a single season.

"In other words if we assume half of New York State, with its boundaries composing nearly 50,000 square miles, to harbor one woodchuck to every acre, we arrive at the astounding conclusion that over 1,600,000 tons of earth is removed to the surface each year. This is equivalent to 32,000 carloads each of 50 tons capacity" (Hamilton 1934:163).

Consequently, the activities of large burrowing animals may seriously affect the stratigraphy and vertical locations of prehistoric and historic artifacts. The general effect, again, in a homogenization of artifacts at the site.

There is hope, however, for identifying the activities of these large burrowers on archaeological sites even many years after they have disturbed the soils. Since the soil brought up by these animals comes from deep within the nest area, we should be able to identify these pockets of disturbed material. C Horizon soils may be recognized on top of A and B Horizon soils. Certain areas may be stained due to a buildup of organic matter from the nest, or there may be pockets of soil of different color or texture from the surrounding matrix.

In some cases the actual burrow may still be present within the stratigraphy. It may appear as a winding stain in the soil, or as a tunnel-shaped area with a different soil color or texture. Animals burrows of fox, skunk, and rabbit were recognized at the Debert Site and are believed to have contributed significantly to the mixing of cultural deposits. "Abandoned burrows were found in the occupation areas, and many charcoal-stained 'pipes' emanating from features can be attributed to this cause" (MacDonald 1969:19).

To summarize, both small and large burrowing animals can severely affect the vertical position of artifacts on an archaeological site. Small animals tend to mix near-surface deposits
Figure 17. Woodchuck Burrows (after Hamilton 1934).
A. Large burrow in plan view: a to b is represented in side view in lower part of drawing.
B. Side view of hibernating den of woodchuck beneath tree roots.
C. Side view of long established woodchuck burrow.
but their tunneling may be extensive. Shallow tunnels may not be recognizable within the stratigraphy of archaeological sites; however, deeper burrows, stains and caches of food-stuffs may be indicative of small rodent activity. Both physical and chemical techniques can be used to distinguish between soil stains made by people (post-molds) and rodent burrows.

Large digging animals tend to localize their work but may move hundreds of pounds of soil in one season. They affect sites by redepositing lower soil horizons on top of upper soil layers. In general these creatures homogenize artifacts, resulting in a mixing of artifacts from different time periods. The burrows of larger animals may be recognized at archaeological sites by the inversion of normal soil stratigraphy, stained burrow tunnels, pockets of differently textured or colored soil, or by increased organic matter from the nest. In all cases, as long as the archaeologist recognizes the kinds and amounts of disturbance caused by these creatures she or he can begin to deal with the common problem of mixed cultural horizons.

FROST ACTION

Throughout the Northeast, frost action has been affecting the soil for thousands of years. The most common phenomenon of frost activity is the frost heave. Frost heaving occurs when water in the soil freezes and ice crystals force the materials above them upward. This effect is well known to farmers in the Northeast who must clear their fields of cobbles every spring.

Besides raising materials to the surface, frost action may also result in the lowering of materials. In this way ventifacts, obviously formed at the surface, are sometimes found scattered at random through the soil to a depth of one or more feet (30 cm or more) (Smith 1949:1502).

The freezing and then thawing of soils may result in the sliding of materials down a slope in loose wet soil, or solifluction. Consequently, artifacts may be transported down the slope from a site, resulting in a concentration at or near the base of a knoll or hill.

Finally, frost may act to spall or break up lithics such as volcanics, resulting in "flakes" that appear to be made by humans. Although it is relatively difficult to distinguish an out-of-context true flake from a frost spall, we can factor out some of the other effects of frost action on archaeological sites.

It is important to know a few general principles about frost action before we can discuss its effect of archaeological sites. First we should remember that frost heaving is greater on clayey soils than on sandy soils. Second, ice crystals develop pressure only in the direction of growth, which, in soils, is determined chiefly by the direction of heat conduction and the availability of water. Finally, studies indicate that frost penetration can extend to 36 inches (91 cm) below the surface. Tests in western Massachusetts indicated frost penetration exceeding the two foot (.6 m) long frost gauges that were used (Willen 1971:35).

The data presented above indicate that frost action can cause several problems for archaeologists. These problems include a raising of artifacts from their original location, a lowering of artifacts from their original location, a mixing of artifacts from various soil horizons, and the sliding downslope of artifacts through solifluction. Furthermore, quantitative data indicate that frost action can affect even the deepest sites in New England.

We can, however, often identify frost activity at archaeological sites. Many times I require my field crew to determine how artifacts are oriented in the soil, that is to say whether they are lying flat, vertically or at some angle. If numerous artifacts are found
vertical or at angles in the soil, rather than lying flat, it is likely to be the result of frost action. Where artifacts are all found lying flat within the soil horizon it is likely that little frost action has occurred. The careful examination of the orientation of artifacts within the soil can therefore be used to determine if frost action has played a role in nature’s transformations of archaeological sites in New England.

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