FIELDIANA · ANTHROPOLOGY

Published by
CHICAGO NATURAL HISTORY MUSEUM

Volume 36 | August 29, 1963 | No. 12

INDIAN SITES AND CHIPPED STONE MATERIALS IN THE NORTHERN LAKE MICHIGAN AREA

Lewis R. Binford
Assistant Professor of Anthropology
The University of Chicago

and

George I. Quimby
Curator of North American Archaeology and Ethnology
Chicago Natural History Museum

INTRODUCTION

Stone materials collected by Quimby from 1959 to 1962 during Chicago Natural History Museum's archaeological survey of the northern Lake Michigan area were recognized in 1962 by Binford as manifesting a particular flint knapping technique, which, insofar as we can determine, has not been reported previously from the New World. This technique is a very distinctive type characterized by the production of small nuclei that have a ridge of percussion produced by the placing of small pebbles on an anvil and directing a blow parallel to the vertical axis of the pebble. It is a crude and poorly controlled method of working stone. Whether or not this bi-polar flint knapping technique simply represents a way of utilizing small tabular pebbles within a more diverse and elaborate stone working tradition is not known to us at the present time.

In chipped stone assemblages there are two major categories of artifacts: tools and the by-products of tool production. Since tool production is a process, the techniques and motor habits of which vary stylistically and according to their relative efficiency, it should follow that variations in processes of tool manufacture are as important to our understanding of extinct cultural systems as the variations in the tools themselves. In addition to the patterned or normative factors which may be isolated through the analysis of chipped stone materials, we may discover that some of the steps in the manufacturing process were undertaken at different locations.

Library of Congress Catalog Card Number: 63–21954

Understanding of the manner in which manufacturing sequences were broken up and executed by different social units at different places is of prime importance if we are to understand the operation of extinct cultural systems. For these reasons it is argued that as much analytical attention should be given to the artifacts that are the by-products of tool production as to the tools themselves. Experience has shown that there are certain general steps or phases in the production of chipped stone tools, the characteristics for the recognition of which are fairly well known.

Raw material which breaks with a conchoidal fracture normally occurs in two primary forms and a variety of secondary forms. Primary forms are those *in situ* raw materials which can be obtained from the deposits where they were structurally formed. In general, primary sources yield either nodular or vein materials. Secondary forms of raw material are normally either spherical or tabular chunks of eroded and redeposited primary raw material such as cobbles in glacial till and stream-eroded pebbles. The form and size as well as the ease of procurement and abundance of raw materials are important factors for consideration in understanding the techniques and motor habits characteristic of different manufacturing procedures. In the case of primary forms of raw material and certain situations of occurrence of secondary forms, some quarrying may be needed in order to obtain the material. When such is the case there are apt to be sites which exhibit a quality in their flint assemblage resulting from the forms of the raw material and the quarrying techniques used. Such sites may also vary with regard to the number of steps or phases in the manufacturing sequence that were executed there. In cases where the raw material can be easily gathered without quarrying, we would expect all formal characteristics of quarrying activity to be absent; there may be "collecting stations" or places where the raw material was accumulated and then processed through various stages prior to being removed from the locality where it was collected. Flint assemblages which represent quarrying activities will vary with the nature of the raw material but in general will exhibit evidence of very heavy work such as on-anvil or block techniques resulting in flakes with developed bulbs of percussion and striking angles of around 120 degrees. In addition to the quarry techniques there is normally a large quantity of massive "shatter" (cubical and irregularly shaped chunks that frequently lack any well-defined bulbs of percussion or systematic alignment of cleavage scars on the various faces). It is the result of both heavy

percussion techniques and the cleavage of raw material along old fracture planes such as frost cracks and the like. Shatter is particularly frequent in frost areas and in places where the raw material must be "tested" for its fractural qualities before it is selected for further processing.

In the initial phase of processing raw materials there are only two possible procedures: (1) production of tools by the detaching of spalls so as to alter the original form of the raw material, or (2) production of *nuclei* from which spalls are detached and then modified into tools. The debris from either process is likely to include large quantities of shatter. However, shatter from this phase of processing is apt to be smaller and show less scarring than shatter from quarry activities. In addition to the shatter there will be trim flakes from the preparation of the nuclei, particularly in the area of the striking platform, and quantities of decortication flakes; that is to say, flakes exhibiting the weathered surface of the original raw material on one or more faces.

Assemblages which are typified by the production of tools from derived elements or spalls detached from nuclei, may vary in the types of derived elements selected for further processing into tools as well as with respect to the number of steps in the modification sequence executed at any given location. The elements selected for further modification into tools are termed *blanks*. A *flake blank* is any selected spall which was systematically derived from a nucleus. Chips that were selected for further modification are termed *chip blanks*. Chip blanks are those that have been derived through the modification of a blank of more primary form. A *phase blank* is any artifact which has been processed beyond the point of recognition of the form of the original blank, but is unfinished and was not utilized as a tool. Frequently tools will be "roughed out" at one location and transported to another where further processing is carried out, in which case the end product of the former manufacturing location would be a phase blank. A *tool blank* is an artifact that served as a tool in its original form but has been remodified into another tool type. The debris associated with blank modification is normally composed of large quantities of chips with little or no shatter present. These chips usually exhibit: (1) a tendency to a concavo-convex longitudinal section; (2) a faceted striking platform; (3) a reticulate scar pattern on the external face; (4) a very acute angle formed between the striking platform and the external face; (5) flat or actual negative bulbs of percussion. These attri-

butes arise when chips are removed in the formal modification of blanks ordinarily accomplished by bifacial flaking along the edges. The faceted striking platform is present because in most cases the striking area is the edge of the blank which has already been modified on the opposite face in such a way that the edge is scarred. The reticulate scar pattern is frequent because chips are removed to modify the blank into a desired shape; hence the chips are usually removed at varying angles. The degree of "reticulateness" will be greater when small round objects are produced and less as the length and size increase. This is ordinarily true also for the amount of concavo-convexity that is present.

The degree to which these generalizations hold will normally be a function of the particular phase of processing represented and the degree to which the blank form was modified. Experience in analyzing flint assemblages generally enables one to separate quite reliably chips from spalls derived from other phases of processing. Shatter associated with this phase is normally derived from the breakage of spalls and is frequently found in the form of unattached hinge fractures and small slivers of stone derived from irregular breakage along the cleavage faces.

Ideally the archaeologist analyzing a flint assemblage should be able to determine the type and method of production for the core forms present, identify the flake blank forms selected for the production of various tool types, and be able to identify every scrap of stone debris in relation to the phase of processing during which it was produced. In addition, given a good knowledge of the physics of conchoidal fracture, he should be able to reconstruct the motor habits and general classes of tools utilized in the manufacturing process.

It should be stressed that this report could not have been written unless the by-products of stone tool production as well as the tools themselves had been collected in the field. There were times when Quimby was concerned about the amount of stone "junk" he was bringing back to the museum, but, as can be seen subsequently, it was worth the extra effort.

THE ARCHAEOLOGICAL SITES

The stone materials analyzed in this report were collected from four sites in the Upper Peninsula of Michigan. The first of these sites to be considered here is located in Section 10 (T. 37 N., R. 19 W.),

Fairbanks Township in southeastern Delta County. It was discovered by Quimby and James R. Getz in early October of 1962 and named the Point Detour Bay site because it was situated at the head of an unnamed bay just west of Point Detour and about two and a half miles east of the village of Fairport (fig. 125).

The cultural remains consisted of a layer of flint debris that extended over an area about 3 feet wide and perhaps 5 feet long beneath some 6 inches of wind-blown sand on top of a sand beach. At the southwestern edge of this deposit there were some large patches of charcoal that appeared to manifest a former hearth. The charcoal and flint materials were about 18 feet (measured by hand level) above Lake Michigan. A small trench was dug by trowel across the western edge of the flint deposit and about a thousand fragments of flint were obtained and brought back to Chicago Natural History Museum.

At the time of its discovery this site was somewhat of a puzzle. It possessed all the geographic characteristics of a Late Woodland site—a sandy area back of a sandy landing place. Although the underwater approach to the landing was solidly paved with cobbles in clay there were no large rocks that would interfere with the landing of a canoe. Moreover, this was the only good landing place for a canoe between Fairport and some unknown area northeast of Point Detour. Quimby and Getz dug into the beach fully expecting to find a Late Woodland or Historic Period site. It was somewhat of a disappointment to find only crude flint materials which at first glance didn't even seem to be the product of human activity, yet had to be, because flint cobbles or fragments could not occur naturally in this area in either a sand beach or a foredune ridge of sand. The possibility that the flint materials belonged to a Paleo-Indian stage was considered and then rejected because the elevation of the find was well beneath the levels of the Nipissing and Algoma strand lines in this area and the sand beach upon which they rested was the most recently formed of a series of such beaches that extended inland behind the site. It was therefore concluded that the Point Detour Bay site represented some sort of aberrant flint-working station where some Indian or Indians had landed in birchbark canoes, had selected flinty cobbles from the lake shore, had moved back from the water to the top of an old beach, had built a fire there, and had engaged in some flint-working process, the by-products of which were extremely crude. It was this particular collection of flint materials that interested Professor Binford and led ultimately to the preparation of this report.

The Summer Island site (fig. 125) is slightly more than three miles south of the Point Detour Bay site on Summer Island at the northern entrance into Green Bay from Lake Michigan. The site extends over a series of sandy beaches about 21 to 26 feet (measured by hand level) above the surface of Lake Michigan near the head of an unnamed bay on the northeast side of Summer Island in Delta County, Michigan. This bay, except for the fairly level sandy area where the site is situated, has a shoreline of angular rocks, cobbles, and stone cliffs.

Through the kindness of Mr. and Mrs. Charles W. Bissell of Grand Rapids, Michigan, who provided transportation on their boat, Quimby was able to examine the Summer Island site in August of 1959. Cultural debris was abundant on the exposed surfaces of the site, which has its lakeward border about 125 feet inland from the best canoe landing area in the entire bay. Suitable surface collections were obtained and test excavations were undertaken. At the southeastern edge of the site, Quimby, assisted by Mrs. Bissell and Mrs. George W. Doolittle, excavated a test trench 3 feet wide, 15 feet long, and 2½ feet deep. This trench was trowelled in 6-inch levels and all materials saved by level. In other parts of the site two test pits 3 feet square and 4 feet deep were dug. One of these pits contained a refuse deposit and the other indicated the presence of a grave which we left intact in order to devote the available field time to stratigraphic testing.

The upper foot of the test trench contained cultural materials, particularly pottery sherds, indicative of Late Woodland and Upper Mississippi and the lower 1½ feet contained sherds suggestive of Middle Woodland occupancy. Faunal remains included sturgeon, moose, and beaver among numerous unidentified fish, mammal, and bird bones. The stone materials studied by Binford were from the surface of the site and the upper level of the test trench.

The Seul Choix site (fig. 125) is west of Seul Choix Point (Sec. 21, T. 41 N., R. 13 W.) in Mueller Township, Schoolcraft County, Michigan. It was discovered by Quimby and James R. Getz in 1962.

At first glance this seems an unlikely area in which to find a coastal site. The shore consists of sloping beds of limestone that have split and eroded into a fantastically fractured rock surface with deep cracks and pits. Near the water the few smooth surfaces are slippery with algae and lichens. With strong southerly or westerly winds heavy seas crash over the rock shore. In the midst of this coastal mishmash there is a small natural harbor that can be entered

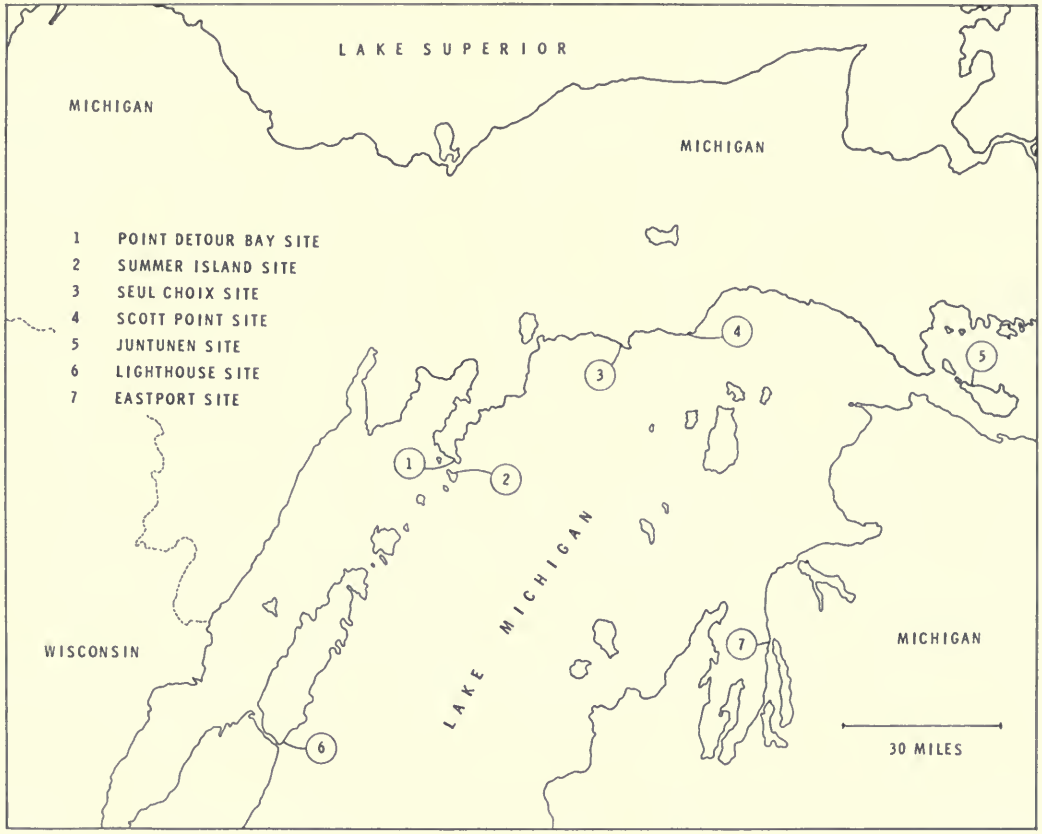

FIG. 125. Map of northern Lake Michigan area, showing locations of sites.

from the west through a pass in the offshore limestone reefs. This harbor, not on the maritime charts for northern Lake Michigan, extends less than 200 feet in width and about 200 feet in length. On its landward side there is a gently sloping sand beach ideally suited for a canoe landing. A few hundred feet back of the sand beach is a relatively level sandy area about 20 feet above water level and in this place is the Seul Choix site.

Cultural debris was spread over an extensive area, much of which was wind blown. From this area it was easy to obtain a surface collection of pottery sherds, flints, and fragments of copper artifacts. All of the pottery seems to be Late Woodland. A fragmentary copper blade of "butter knife" form also seems indicative of Late Woodland to judge from context of this type at other sites in Michigan and Ontario. The stone materials collected from the Seul Choix site will be considered subsequently in the analysis by Binford.

The Scott Point site (fig. 125), sometimes erroneously called Point Patterson site, is located (Sec. 8, T. 41 N., R. 11 W.) in Newton Township, Mackinac County, Michigan. This site was examined on a number of occasions in 1960, 1961, and 1962 by Quimby, assisted at different times by James R. Getz, Helen Z. Quimby, G. Edward Quimby, John E. Quimby, and Robert W. Quimby, all of whom rendered valuable service.

The site is situated some 300 or 400 feet from Lake Michigan in a small bay just west of Scott Point. Near the middle of this bay the sandy lake bottom is free of boulders all the way into the beach but the points of land at the extremities of the bay and the adjacent lake bottom are covered by boulders of various sizes. West of the site the shore and lake bottom are rocky for at least three and probably more miles and east of the site for a half mile or more. Thus the site itself is located behind the only suitable canoe landing place in the immediate vicinity.

Much of the Scott Point site has been exposed in large sand blows covering an area 200 feet by 300 feet or more. Numerous clusters of fire-cracked rocks indicate the locations of former dwellings and/or hearths. Pottery sherds, flint materials, and hammerstones lie on the surface in great abundance. Various kinds of flint scrapers and small triangular arrowheads found here were probably made at the site because from time to time the wind blows away the sand, exposing clusters of small chips of the kind that would have been removed from a flake to make a point or from a core to make a scraper.

Bone tools include awls, flat matting needles, and unilaterally barbed harpoons or points for fish spears. Faunal remains include deer, moose, beaver, and considerable quantities of fish, among which are sturgeon. There are large piles of fish remains two and three feet deep in various parts of the site. These fish bone middens might represent the remains of sturgeon only, for the bony plates of sturgeon are present in all the heaps. Of some thousand or more sherds collected from the Scott Point site about five are shell-tempered, thin, Upper Mississippi types. The bulk of the pottery is a grit-tempered ware that is Late Woodland in style (judged by rim sherds).

The Late Woodland sites described above and some others not included here but nonetheless situated along the northern shore of Lake Michigan have in common a single principle of locality: a site is found only behind a good landing place for canoes; there is never a site behind a bad or dangerous landing place.

Since drinking water can easily be obtained from Lake Michigan the presence of a spring or stream is not a factor influencing choice of site as it is with interior locations occupied in non-winter months. Although availability of food such as sturgeon may have been a deciding factor it seems more likely that food was equally available throughout the area and that the deciding factors were distance from one settlement to another and presence of a good beach upon which to land a canoe. It should be noted here that there are more places unsuited for Late Woodland Indian occupancy along the northern Lake Michigan shore than there are suitable locations.

Although there is no direct evidence that Late Woodland Indians had the birchbark canoe, their settlement pattern indicates that they did. Moreover, such would be expected from the widespread use of the birchbark canoe in early historic times. A wooden dugout canoe of the kind known archaeologically in the middle west would have been unsuitable in this context for many reasons.

The Late Woodland Indians with whom we are here concerned occupied the northern Lake Michigan area from about A.D. 1000 to about 1600, and they spent the summer months in settlements along the northern shore of the lake. They traveled by canoe to these villages, which were always located adjacent to a good landing place for canoes. In the manufacture of some or possibly all of their stone tools they used an unusual flint knapping procedure which will be described and analyzed by Binford in the following pages.

ANALYSIS OF THE SITE SAMPLES

The method of presentation has been to describe the classes of items in the inferred sequence of their production. Each described category of material is a distinct formal class definable in terms of a demonstrable clustering of attributes and as such is a valid taxonomic unit regardless of the validity of its inferred meaning in the reconstructed flint knapping procedure. The described formal classes will then be utilized in the comparative quantitative analysis of the site samples.

Raw Material

The raw material occurs as small tabular and angular eroded and rolled pebbles having their origin in the glacial deposits and beaches of the Great Lakes region. These deposits ordinarily contain a rather wide variety of pebble sizes, yet the raw material selected for use at the four described sites is uniformly of small size, usually not exceeding five centimeters in thickness or eight centimeters in length. The material is uniformly a waxy chert of relatively good quality ranging from a gun-metal blue to steel gray or light brown to cream color. It often has small fossil inclusions and usually has the appearance of having formed around and between irregular zones of a tannish sandstone-like material. The latter substance frequently forms the cortex of two or more surfaces, the other surfaces merely being eroded and deteriorated faces of the chert. In my experience (Binford) this waxy chert occurs in the glacial deposits only in small tabular pebbles while the larger cobbles are normally chert of a lower quality such as Eastport Chert (see Binford and Papworth, 1963). In view of the latter observation the preference may have been for the waxy chert rather than small pebble size.

Remains of Stages in Processing the Raw Material

PRIMARY SHATTER

Relatively large fragments of shatter exhibiting major cortical surfaces and internal cleavage faces of an unsystematic angular and cubical nature are rather common. The internal cleavage planes frequently follow along inclusions or old "frost cracks," and lack bulbs of percussion. Specimens lacking major cortical surfaces but exhibiting the angular and irregular cleavage planes are also believed to represent shatter from the initial phase of working the raw

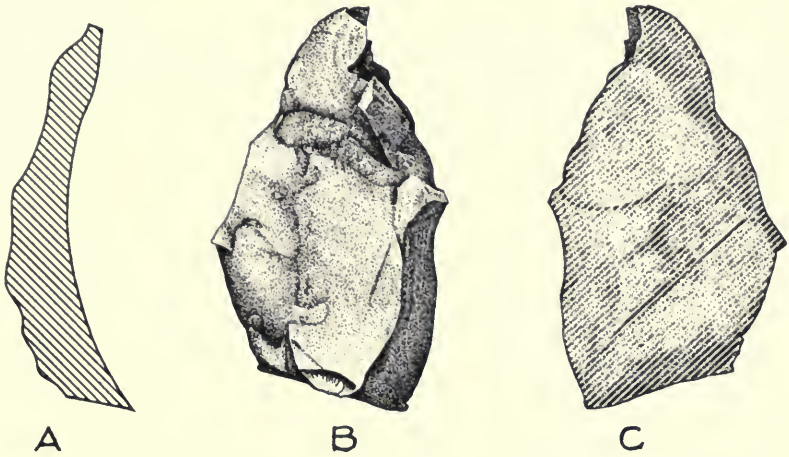

FIG. 126. Decortication flake: A, longitudinal section; B, internal face; C, external face.

material. These specimens more often show cleavage along the lines of inclusions. All material classed as *primary shatter* is believed to have been produced by the initial percussion blows delivered to the raw material, some pebbles breaking up so that further processing would be impossible. In other cases, after the initial shattering, some larger chunks may have been selected for further processing.

DECORTICATION FLAKES. FIGURE 126.

Flakes of this type have the following attributes: (1) the external face of the flake is the unmodified cortex of the original raw material (fig. 126, C); (2) the internal face shows scarring from heavy percussion (fig. 126, B). Specimens most commonly exhibit strong *negative* bulbs of percussion and extreme concavo-convex longitudinal sections (fig. 126, A). Some specimens, particularly when they represent angular corners of the cortical surface, may have essentially a triangular longitudinal section with the characteristic negative bulbs of percussion. Some few specimens may exhibit strong positive bulbs of percussion, in which case they are invariably derived from the relatively flat sides of a tabular pebble. Longitudinal sections of the latter flake form tend to be plano-convex.

Both the type of shatter described above and the decortication flakes were apparently produced in a single operation. A tabular pebble was placed on an anvil and struck with a heavy blow so that

the axis of percussion was approximately parallel to the vertical axis of the pebble when resting on the anvil (fig. 127). The point of impact on the upper striking surface was localized, thus producing a single cone of percussion, whereas the irregular surface of the pebble

FIG. 127. Reconstruction of "on anvil" work.

base resting on the anvil produced multiple cones from the basal area. However, because of the diffuse nature of the impact zones on the base it sometimes happened that no fractures originated there. Cleavage was of two types: (1) internal shatter, resulting from the presence in the pebble of old fracture planes compounded by the complex stresses associated with the simultaneous production of opposing cones of percussion at the anvil and the upper zone of impact; and (2) external cleavage, resulting from the production of opposing cones of percussion. Flakes fell away from the cones; therefore they exhibit pronounced negative bulbs of percussion. When external cleavage occurred, a roughly fusiform nucleus was produced from the pebble if the points of impact on both anvil and upper striking surface were localized, or a cone-shaped nucleus was produced if the points of impact at the base were diffuse as a result of an irregular surface. The form of the shatter and the form of the decortication flakes do not lend themselves to alternative interpretations. This model is further supported by an examination of the residual nuclei or cores represented in the sample.

Quimby was originally of the opinion that the cores had been utilized as tools. Alan McPherron of the University of Michigan, currently working on a similar assemblage from the Juntunen Site (fig. 125), has observed that in many cases the flakes drawn from the cores do not show evidence of utilization. McPherron states: ". . . none shows signs of reworking or use of any kind. It would

in fact appear that they were drawn not for primary use as blanks but as wastage in the preparation of cores for use as artifacts. A good proportion of spent cores show a peculiar nibbling or resolved flaking on the flattest or concave surface of flattish cores or core fragments. This causes the core 'ridge' to resemble a steel wood-gouge. The resolved flaking is consistently absent from the back of these cores. The nibbling may certainly in many cases have been produced by the bi-polar process; in other cases, it appears to have been achieved through utilization of the core as a tool." (McPherron, personal communication, 1963.) Binford is in agreement with Quimby and McPherron that some cores have been incidentally utilized and they may even represent "core tools" or the end product of the knapping process. At present the solution of this problem is not at hand and we shall treat them simply as cores. However, it should be kept in mind that they may be core tools, in which case we are describing their mode of manufacture.

CORES

Three major forms of percussion surface are exhibited in various combinations on the recognized cores. The most common is a *ridge of percussion,* which is defined by the line of convergence of the two opposite cleavage faces. It is normally straight and considerably bruised with many small short hinge fracture scars on the cleavage faces directly below the ridge. In most cases the flake scars on the opposing cleavage faces exhibit negative bulbs of percussion, suggesting that the ridge is the result of the progressive removal of flakes from both cleavage faces, such flakes having originated at a true striking platform. The ridge is the result of the exhaustion of the striking platform and the production of what amounts to a series of lineally arranged overlapping cones of percussion from which no further flakes could be removed without changing the striking angle. Another common form of remnant striking platform, a *point of percussion,* is formed by the convergence of three or more cleavage faces resulting in a pyramidal form, the apex of which is the point of percussion. This is actually the apex of a cone of percussion from which no further flakes can be derived unless the striking angle is altered. An *area of percussion* is relatively flat, generally the cortical surface of the tabular pebble, from which flakes have been detached along the edges.

All of the cores in this assemblage are bi-polar forms of six major varieties. "Bi-polar" refers to the fact that on each core there are

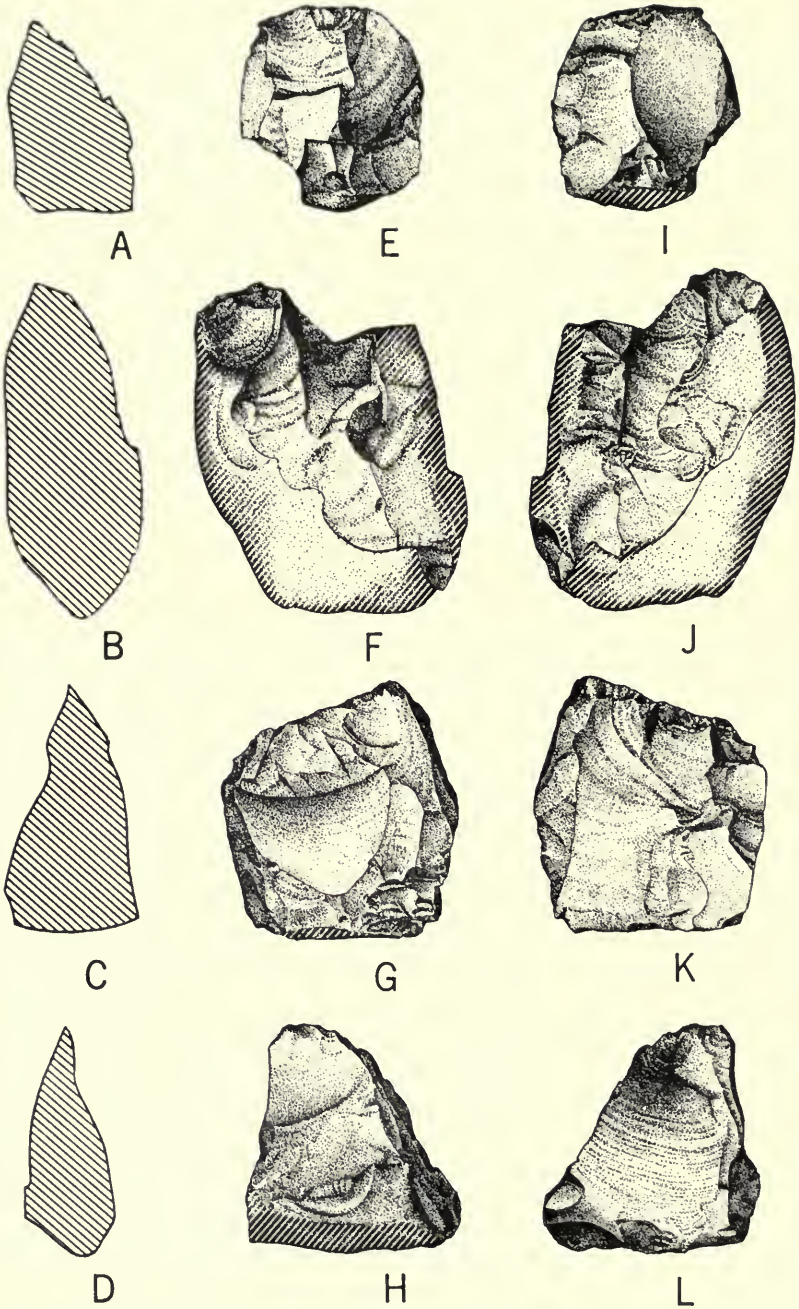

FIG. 128. Ridge-area cores: A–D, longitudinal sections; E–L, opposite faces.

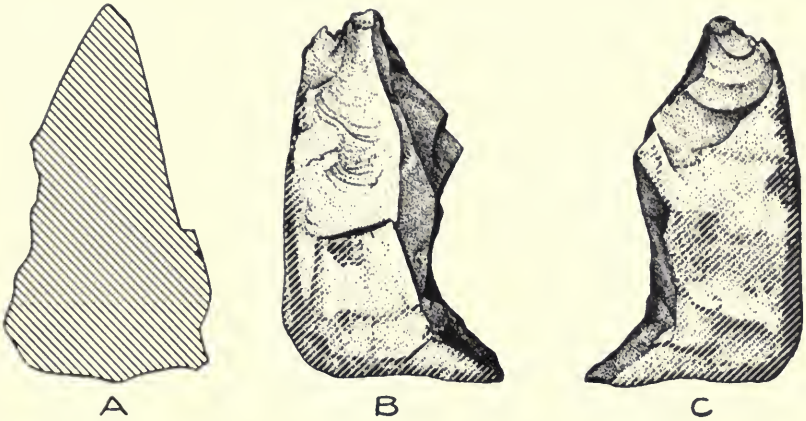

FIG. 129. Point-area core: A, longitudinal section; B, C, opposite faces.

two opposed striking platforms or zones of percussion. These two zones are directly opposite each other, with the cleavage faces on both sides of the core converging on both zones of percussion. In most cases one zone of percussion can be recognized as the base or the zone resting on the anvil by the following: (1) a large percentage of flake scars originating there end in abrupt hinge fractures and are very short (fig. 128, G); (2) the zone is bruised and irregularly altered by percussion; and (3) the dominating flake scars on the cleavage faces do not originate from the basal zone. The upper zone of percussion, the actual striking platform, exhibits less bruising, the flake scars originating there dominate the face of the core, and the small shatter flakes detached from this area tend to have fewer hinge fractures and are more conchoidal in shape.

The scar pattern on the cleavage faces is of two major types, bi-polar cleavage and uni-polar cleavage. The former is characterized by a continuous flake scar with bulbs of percussion at both ends of the core. In this case the flake removed would have had a marked concavo-convex longitudinal section and developed bulbs of percussion at both ends. The latter form, uni-polar cleavage, is the more normal type with the flake scar exhibiting a single negative bulb of percussion and either terminating at the basal zone or at some point along the cleavage face.

Six varieties of core are represented in the sample, differences between them apparently being the result of minor modification in the production process largely stimulated by the "accidental" factors of breakage and differential cleavage properties of the raw material.

Table 1.—Metrical Attributes of Six Varieties of Bi-Polar Cores
(Measurements in centimeters)

	Ridge Area	Point Area	Ridge Point	Right Angle	Opposing Ridge	Opposing Point
Length						
Sx	66.20	29.7	19.30	17.2	12.1	10.8
Sx^2	220.42	104.39	61.53	50.42	38.41	42.32
n	21.00	9.00	6.00	6.00	4.00	3.00
$\bar{x}$	3.15	3.30	3.21	2.87	3.02	3.60
s	.76	.88	.33	.47	.77	1.32
Maximum Width						
Sx	53.4	24.0	12.10	8.9	8.9	5.8
Sx^2	143.42	66.02	22.71	13.75	20.41	11.40
n	21.00	9.00	6.00	6.00	4.00	3.00
$\bar{x}$	2.54	2.67	2.02	1.48	2.22	1.93
s	.61	.50	.57	.34	.44	.31
Thickness						
Sx	32.20	16.4	7.40	8.4	4.6	4.10
Sx^2	51.62	31.02	9.48	11.96	5.40	5.85
n	21.00	9.00	6.00	6.00	4.00	3.00
$\bar{x}$	1.52	1.82	1.23	1.40	1.15	1.37
s	.33	.37	.26	.20	.19	.34

Sx=sum of all measurements of a given dimension.
Sx^2=sum of all squares of measurements.
n=number of specimens measured.
$\bar{x}$=mean dimension.
s=standard deviation of mean.

The metrical attributes of these varieties of cores are shown in Table 1. The most common form of core is one on which the basal zone of percussion is an area of unmodified cortex from the original tabular pebble. The impact zone is a ridge or a series of overlapping cones of percussion (fig. 128). Scars originating at the ridge of percussion are dominant on the cleavage faces, whereas scars originating at the basal area tend to be diminutive, irregular and weak. Another common variety is characterized by a third cleavage face which is essentially the end of the core from which flakes originating at the ridge detach what amounts to a cross section of the core (fig. 128, K). When removal of the latter type of flake has progressed along the length of the ridge, the core is reduced to a point of percussion at the zone of impact while the base still remains an area (fig. 129).

A third type of core is one on which the basal zone of percussion is a greatly battered and bruised point while the impact zone is a ridge of percussion (figs. 130, 132, A–C). Probably this type was produced as a result of shatter or uncontrolled breakage in the early

phases of core manufacture, resulting in the production of a cone of percussion or a point of percussion at the impact zone. When such an event occurred the core was reversed on the anvil and the point

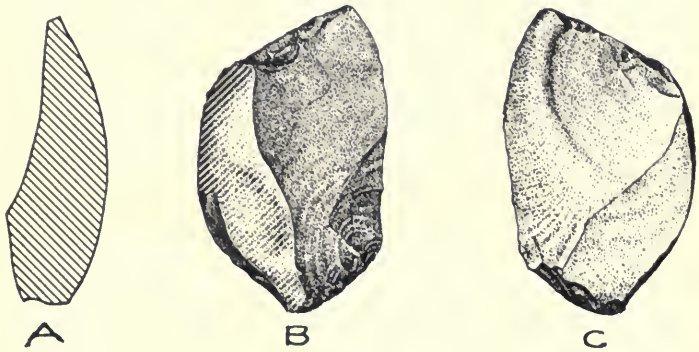

FIG. 130. Ridge-point core: A, long section; B, C, opposite faces.

assumed the functions of the base. The area which had previously served as the base was then struck in such a way as to produce a ridge of percussion. Success resulted in a core form with a point of percussion as the base, opposed by a ridge of percussion. Failure in this attempt could result in the production of the fourth variety of core, one with opposing points of percussion, a type also represented in the sample (fig. 132, D–F).

A fifth type of core in our sample is one with opposed ridges of percussion (fig. 131). With this core form it is impossible to determine which ridge served as the base and which served as the impact zone. Judging from the type of bruising and the frequency with which scars originating at the opposed ridges dominate cleavage faces, it would appear that both ridges variously served as base and zone of impact. This type of core is the result of the reduction of a small area of percussion to a true ridge, therefore obviating the possibility of further flake removal without changing the striking angle. When this occurred the core would be reversed on the anvil and the base would then be worked until it was also reduced to a ridge, at which time the core would be discarded.

The sixth and last core form represented is also characterized by opposing ridges but they are approximately at right angles to one another (fig. 132, G–L). This form was apparently produced from one originally having a ridge opposite an area. By successive removal of flakes from both ends of the core (cross sectional flakes)

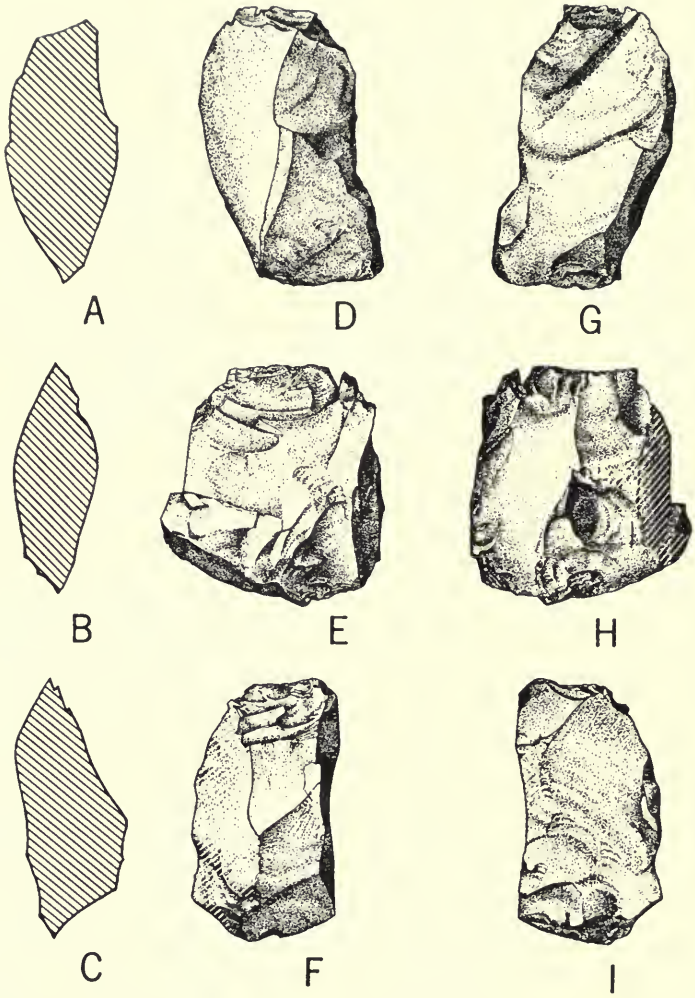

FIG. 131. Opposing ridge cores: A–C, longitudinal sections; D–I, opposite faces.

the terminal flake scars eventually converged, forming a ridge at right angles to the upper ridge of percussion.

In summary then, there are six core forms—ridge and basal area, point and basal area, ridge and basal point, right-angled ridges, opposing ridges, opposing points—all of which can be accounted for in terms of a single flint-working technique, which is bi-polar flaking on an anvil. The variations in the form of the cores appear to be the results of minor modifications in the way in which the zones of im-

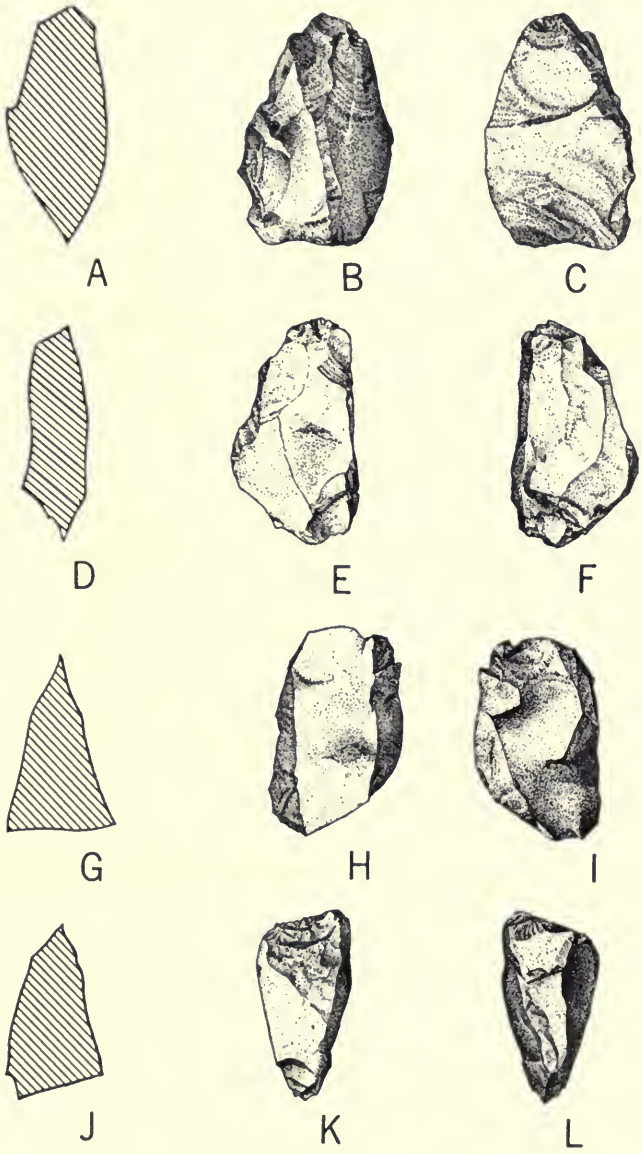

FIG. 132. A–C, ridge-point cores; D–F, opposing point cores; G–L, right-angled ridged cores.

pact and basal zones were reversed in combination, whether or not flakes were being primarily struck from the lateral faces or ends of the core. In terms of the normative concept of type, we would include all of these variations within a single type of core, the modal form of which is the variety with a ridge of percussion opposite a basal area of percussion.

FLAKES

The following presentation is the result of an attempt to determine from which zone of percussion on the core the flakes originated and from which core face they were detached.

Class I. Flakes Originating at the Basal Zone of Percussion

Flakes described under this heading are believed to have been produced incidentally during the removal of flakes having their origin at the impact zone. They were derived through contact of the core with the anvil, the percussion blow having been delivered to the upper striking surface.

Variety A.—This form of flake is believed to have been detached from the corner of one of the core forms that had a basal area of percussion. It is characterized by a large triangular area of unmodified cortical surface that forms the base of the flake. The axis of percussion and the longitudinal axis are parallel. The cross section is triangular. The external face exhibits two parallel flake scars converging to form a medial ridge. The internal face exhibits little or no development of a positive bulb of percussion. Some specimens exhibit recognizable negative bulbs of percussion. The overall shape of the flake is triangular or the lateral edges converge from the base toward the tip of the flake.

Variety B.—This form of flake is believed to have been detached from the broad lateral face of a core form having a basal area of percussion. A roughly rectangular area of unmodified cortical surface forms the base. The axis of percussion and the longitudinal axis are parallel. The cross section is roughly rectangular or occasionally triangular. The external face has multiple, parallel, longitudinally oriented flake scars. The internal face exhibits moderately developed positive bulbs of percussion. The shape is triangular or lamellar. The triangular shape would be expected if these flakes originated at the base of a core having an area opposed by a ridge or a point, since such a core would be truncated in form. The basal area having the unmodified cortex is identical to those on the recognized core forms.

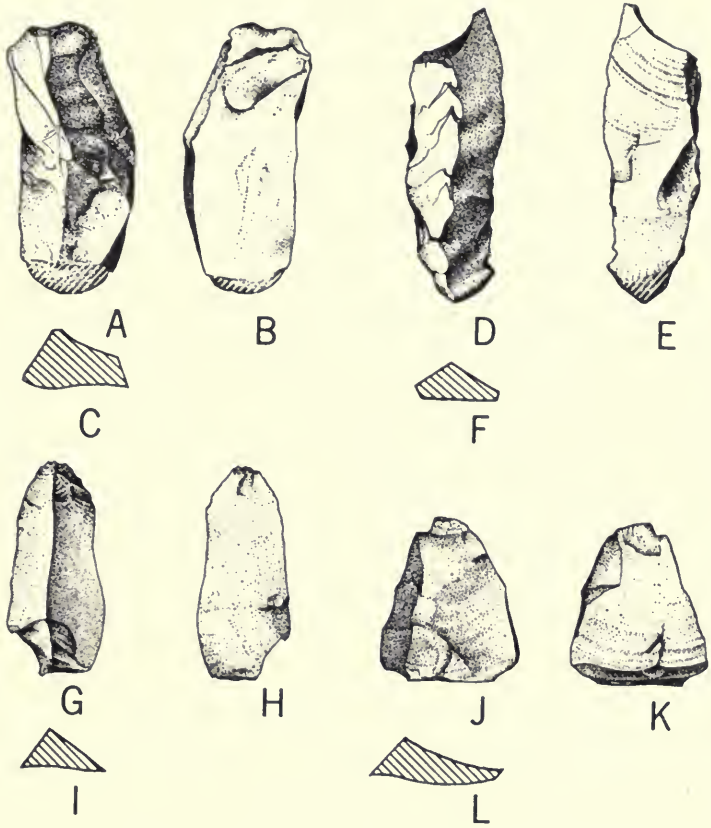

FIG. 133. A–F, end section flakes; G–I, variety C flake; J–L, variety D flake.

CLASS II. FLAKES ORIGINATING AT THE IMPACT ZONE OF PERCUSSION

Variety C (fig. 133, G–I).—This form of flake is believed to have been detached from the lateral face of the core by blows directed at the upper ridge or point of percussion. The zone of impact is very narrow or often only a point exhibiting little or no remnant of the striking platform. The axis of percussion is parallel to the longitudinal axis and the longitudinal section is generally concavo-convex, although a few specimens exhibit plano-convex longitudinal sections. Cross sections are generally asymmetrically triangular. The external face normally exhibits two parallel flake scars converging to form a ridge; occasionally there may be three parallel scars. Near the base there are generally several small hinge fracture scars extending down the face a short distance. These represent unsuccessful

attempts to detach the flake as well as shatter associated with the flake removal. The internal face has a developed positive bulb of percussion. The shape is either lamellar or excurvate.

Variety D (fig. 133, J–L).—This form of flake is believed to have been detached from the lateral face of the core by blows directed at the upper ridge or point of percussion. The basal zone of impact is very narrow or frequently only a point exhibiting little or no remnant striking platform. The axis of percussion is parallel to the longitudinal axis and the longitudinal section is bi-convex. The cross section is typically bi-convex. The external face is irregularly scarred near the base of the flake while the distal end may be scarless or only unsystematically scarred. The internal face is almost exclusively a bulb of percussion, sometimes exhibiting what amounts to a half cone of percussion. Terminal hinge fractures are common forms of the distal ends of the flake. The shape of the flake is generally conchoidal or ovate. This flake form is interpreted as having been incidentally derived from the core in attempts to detach flakes of the form of variety C. The scars on the external faces of the basal end of variety C flakes as well as those along the ridges of ridged cores are believed to be the result of the removal of this type of flake.

Variety E (fig. 133, A–F).—This form of flake we believe to have been detached from the end of the core by blows directed at the upper ridge or point of percussion. The basal zone of impact is very narrow and represents a simple segment of the ridge of percussion. The axis of percussion is parallel to the longitudinal axis of the specimen. The longitudinal section with few exceptions is concavo-convex. The cross section is rectangular (65 per cent) or triangular (35 per cent). The external face exhibits a single, longitudinally oriented flake scar, although if the flake was detached from the corner of the core, removing some of the lateral face as well as the end of the core, there may be multiple longitudinally oriented scars. The external face near the base of the flake is scarred with small hinge-terminated flake scars and is generally bruised. The internal face exhibits well-developed positive bulbs of percussion. The flake is either lamellar or expanding in form. In a few instances there are excurvate specimens representing removal from a bi-ridged or bi-pointed core.

Secondary Shatter: Associated with the removal of flakes from the cores was the production of some shatter which lacks any identifiable morphological characteristics. It is in the form of small slivers

of flint, broken or snapped sections of flakes, or broken off distal ends of flakes. This type of debris is generally more frequent when further modification of flake blanks has occurred at any given location.

SITE COMPARISONS

The samples from the four sites are extremely homogeneous in their range of formal variation. The forms of cores, flakes, and shatter previously described are quite distinctive and easily identified in the collections from all the sites. Formal variation in any given class of items could not be demonstrated between the specimens from the several sites, but the sites do differ considerably in the presence or absence of flint working debris not identifiable as the result of the flint processing procedure outlined in this report, as well as in the presence or absence of pottery and chips. The collection from Summer Island includes relatively massive "expanding flakes" previously identified as being characteristic of forms removed from *block core* (Binford and Papworth, 1963). These types of flakes could not have been derived from the core forms reported here; together with a single specimen of a *block core* they represent an entirely different flint knapping technology. It seems likely that the presence of this material at Summer Island is further evidence of a multiple occupancy of the location, although the use of two major processing techniques by a single group of occupants cannot be discounted completely.

Another interesting variation is that at all sites except Point Detour Bay, there is pottery of a class generally assignable to the closing phases of the prehistoric period. A comparative tabulation of class frequencies by site is presented in Table 2. The Point Detour Bay site is also distinctive in that it lacks chips derived from the bifacial modification of tools, as well as the tools themselves. This striking difference will be discussed after consideration of the variation in frequency of occurrence for the various classes of chipping debris associated with the bi-polar knapping technology.

If exactly the same flint knapping procedures were used at the several sites in the same relative proportions, there should be no variation among the samples in the frequencies of core, flake, and shatter forms except as a result of sampling error. In order to determine whether or not the flint knapping procedures are in fact differentially executed at the several sites, chi square calculations were carried out. This is a test of the hypothesis that the observable

Table 2.—Comparative Tabulation of Class Frequencies

Initial Phase of Processing	Point Detour Bay	Scott Point	Seul Choix	Summer Island
1. Primary shatter	113	19	13	8
2. Decortication flakes	41	20	7	4
Cores				
1. Complete specimens				
a. Ridge and basal area	21	21	5	4
b. Point and basal area	9	2	2	0
c. Ridge and basal point	6	2	5	0
d. Right-angled ridges	6	1	0	0
e. Opposing ridges	4	11	3	5
f. Opposing points	3	2	0	2
Total	49	39	15	11
2. Fragmentary specimens				
a. Points	12	9	1	2
b. Ridges	13	10	4	2
c. Areas	18	13	0	0
Total	43	32	5	4
Flakes				
1. Base originating				
a. Variety A	49	12	12	10
b. Variety B	33	8	6	7
2. Impact zone originating				
a. Variety C	79	64	43	31
b. Variety D	52	19	25	14
c. Variety E	58	22	12	2
Secondary Shatter	136	93	31	21
Chips	0	23	6	12
Block core flakes	0	0	0	14
Block cores	0	0	0	1
Tools (stone)	0	9	5	6
Pottery	absent	present	present	present

differences in the relative class frequencies could be accounted for on the basis of sampling error. Table 3 shows the results of these calculations for the four sites compared with regard to the frequency of decortication flakes, cores, core fragments, basally derived flakes, laterally derived flakes, and end derived flakes, the basic data for which are presented in Table 2.

It will be observed that in all cases when the conclusion is "different" the calculated value of chi square exceeds the expected value at a level of probability of .01 or greater. This means that the ob-

Table 3.—Comparison of Flint Knapping Procedures by Site

Site Combinations	Degrees of Freedom	Chi Square	Expected Chi Square Values Calculated at Probability Levels of .05	.01	.001	Conclusion
Point Detour Bay and Scott Point	... 5	19.41	11.070	*15.086*	20.517	*Different*
Seul Choix and Summer Island	... 5	0.99	11.070	15.086	20.517	*Same*
Point Detour Bay and combined Seul Choix and Summer Island	... 5	29.12	11.070	15.086	*20.517*	*Different*
Scott Point and combined Seul Choix and Summer Island	... 5	26.82	11.070	15.086	*20.517*	*Different*

served differences between the compared samples could have been produced only by sampling vagaries of less than one in a hundred cases drawn from a single population. Therefore, we may assert with a relatively high degree of confidence that there are real differences between the site combinations marked "different." On the other hand, the comparison between the Summer Island and the Seul Choix sites shows that the two samples could easily have been drawn from a single population. On the basis of these comparisons we can reasonably assert that the flint knapping activities were different at the Point Detour Bay and Scott Point sites and that both of these sites were different in flint knapping activities from the Summer Island and Seul Choix sites, where such activities were the same. It now remains for us to analyze further the qualitative nature of the expressed quantitative differences in an attempt to isolate the possible nature of the differences that we have recognized. Table 4 presents the percentage frequencies for the various classes of materials.

The most striking difference between the classes is the low frequency of broken core fragments at Seul Choix and Summer Island as compared to those at Point Detour Bay and Scott Point. Similarly, the former two sites show a high frequency of laterally derived flakes with a corresponding low frequency for this class at the latter two sites. In addition, there is a consistently lower incidence of decortication flakes at Seul Choix and Summer Island than at the other

Table 4.—Percentage Frequencies for Various Classes of Knapping Debris from the Four Sites

Artifact Class	Point Detour Bay %	Scott Point %	Seul Choix %	Summer Island %
Decortication flakes	10.15	9.25	5.50	4.44
Cores	12.13	18.05	12.00	12.22
Core fragments	10.64	14.81	4.00	4.44
Basally derived flakes	20.29	9.29	14.41	18.88
Laterally derived flakes	32.42	38.42	54.40	50.00
End derived flakes	14.36	10.18	9.60	10.00

two sites. These differences seem to form a consistent pattern. The high incidence of decortication flakes and broken core fragments, contrasted with the low incidence of laterally derived flakes, suggests that at Point Detour Bay and Scott Point raw material was being processed through the entire sequence of manufacture. The laterally derived flakes, potential blanks, either were being used up or removed from the sites. For instance, at the Point Detour Bay site 71 cores are represented, while usable flakes detached from the lateral faces of such cores are less than 80. Certainly many more flakes than are represented were struck from the cores, suggesting that such flakes were removed from the location by the flint knappers. It seems quite likely that the removed flakes were intended for use as blanks, and were further processed at some other location. This interpretation is further supported by the fact that laterally derived flakes had been used as blanks for 17 of the 20 tools represented in the samples from the four sites. The low incidence of broken cores at Seul Choix and Summer Island is interpreted to mean that only the workable cores had been introduced at these sites, whereas at the other two sites cores were being produced *in situ* and thus there was a higher incidence of core breakage. This interpretation is further supported by the differential frequencies of core types at the several locations (Table 5).

Table 5.—Comparative Frequency of Core Forms With and Without Basal Areas

	Point Detour Bay		Scott Point		Seul Choix		Summer Island	
	no.	%	no.	%	no.	%	no.	%
Ridge or point opposed by area	30	61.22	23	59.97	7	46.67	4	36.36
Ridge or point opposed by ridge or point	19	38.78	16	40.03	8	53.33	7	63.64
Total	49		39		15		11	

It will be noted that there are more cores with areas opposed by zones of impact at the Point Detour Bay and Scott Point sites than at the other two. The presence of such areas on the cores is indicative of less exhaustion of the core, whereas cores with ridges or points opposing each other have been worked until no further flakes could be derived from them. Cores were being worked to a more advanced stage of exhaustion at the Summer Island and Seul Choix sites, exactly the two sites that on the basis of other evidence are believed to represent locations where the prepared cores or nuclei and possibly laterally derived flakes produced elsewhere were being introduced. The greater exhaustion of the cores at these two sites suggests that the materials were at a greater premium there, and may have been largely introduced. However, these differences also could be interpreted as stylistic variations. The samples from Seul Choix and Summer Island may also reflect a prejudice of selection by the collector.

It is difficult to interpret the observable differences in the frequency of the various classes of shatter. By far the greatest amount is present in the sample from Point Detour Bay. Very little is present from the other sites. It should be pointed out that the Point Detour Bay sample was derived from excavation of a flaking station, whereas the other three sites are represented by surface collections from villages. The low frequencies of shatter from the other sites could be the result of selectivity in the gathering of the samples, shatter not being considered worth saving. No attempt will be made here to interpret the observed differences in shatter.

SUMMARY OF SITE INTERPRETATIONS

Point Detour Bay Site

The formal composition of the sample from this site is the result of a limited number of processing steps in the tool manufacturing sequence. Raw materials were gathered and collected at the site and initially modified on the spot into nuclei from which were struck flakes for future use as blanks for tool production. The residual nuclei (cores) as well as all the debris associated with the working were left at the site while the flake blanks were removed for future processing into tools. The absence of finished tools, chips, pottery, and other artifacts at this site suggests that any single occupation was of very short duration and that dwelling place activities were

not performed there. We interpret this site as a flint knapping station utilized by people practicing a single knapping task, the transformation of raw materials into desirable nuclei and blank forms.

Scott Point Site

The presence of pottery, finished tools, other artifacts, and chips at this site indicates occupancy of this location by people performing multiple tasks most of which were not directly related to tool manufacture. The presence of chips suggests the processing phases of tool manufacture that were absent from the Point Detour Bay site—modification of blanks by bifacial flaking. The configuration of differences and similarities is similar to that for Point Detour Bay when compared to those for Seul Choix and Summer Island, although the actual frequencies of various classes of items are significantly different. These differences may only represent the difference between a surface-collected sample from a wide area as opposed to an excavated sample from a restricted area, or they may be real differences representing minor variability in the incidence of execution of different manufacturing phases at the two sites.

Seul Choix Site

At this site stone chips, tools, pottery, and other artifacts were present, representing activities other than stone tool manufacture. The relatively high incidence of laterally derived flakes (blanks?), the low incidence of broken cores, and the high incidence of completely exhausted cores and the presence of chips is believed to reflect a concentration on the final phases of tool production as opposed to the earlier phases such as those dominating the activities at Point Detour Bay and present to a lesser degree at the Scott Point site. Seul Choix thus is believed to be a site at which activities other than tool manufacture were primary. The production of tools was carried out primarily by expediently utilizing partially processed nuclei and blanks brought into the site from elsewhere, perhaps from a place like Point Detour Bay.

Summer Island Site

This site differs from all of the others in the presence of flint working debris that is not characteristic of the bi-polar technique described in this report. The presence of such material is tentatively

interpreted to represent another occupation by unrelated populations presumably at an earlier time. This inference can be made alone on the basis of the Late Archaic association of the block core technique in the Great Lakes (Binford and Papworth, 1963). However, as noted earlier, Summer Island is a multiple occupancy site. In other respects Summer Island appears to be identical to the Seul Choix site as far as the technology of flint working is concerned.

KNOWN DISTRIBUTION OF THE BI-POLAR KNAPPING TECHNIQUE

The flint knapping technique described here is to our knowledge previously unreported from the New World. It is a very distinctive type characterized by the production of small nuclei having a ridge of percussion produced by the placing of small pebbles on an anvil and directing a percussion blow parallel to the vertical axis of the pebble. Technically it is a crude and poorly controlled method of stone-working. Whether or not it simply represents an adaptive alternative for utilizing small tabular pebbles within a more diverse and elaborate stone-working tradition is unknown. Our knowledge of the temporal and spatial distribution of the technique is limited. The senior author first observed material of this type at the University of Michigan in the excavated sample from the Juntunen site on Bois Blanc Island near the Straits of Mackinac. At the time he examined the latter materials, dated between A.D. 900 and 1300 (Crane and Griffin, 1961, p. 110), he was puzzled by the chipped flint and did not then recognize the assemblage as the result of the reported bi-polar technique. Without a doubt many of the Juntunen cores are identical to the forms reported here. The presence of such materials at the Juntunen site extends the distribution of the bi-polar technique eastward at least as far as the Straits of Mackinac.

Three other sites from the Lake Michigan basin are known to yield small amounts of materials representative of this technique. These are the Lighthouse site at the Lake Michigan entrance to the Sturgeon Bay Canal in Door County, Wisconsin; a site near the Stony Lake channel in Oceana County, Michigan; and the Eastport site, located between Grand Traverse Bay and Torch Lake in Antrim County, Michigan. Late Woodland cultural materials were collected from the first two sites by Quimby. The Eastport site was mainly occupied in the Late Archaic period. However, the variety of projectile point forms from this site suggests multiple occupations.

At a previous time, when Binford analyzed a large sample from the Eastport site, he reported one "truncated core" (Binford and Papworth, 1963) which we now know to have been a bi-polar core of the type with basal area opposed by a point of percussion. A single specimen of a ridge-point bi-polar core was also recently recovered from the site by Quimby. These two finds are not associated definitely with any other materials, so that their temporal and cultural relationships to the well-established Late Archaic occupation of the site are unknown.

The eight currently known sites yielding varying proportions of this material extend along the northwest, north, and northeast shores of Lake Michigan. Late Woodland sites south of this area on both the Wisconsin and Michigan shores have not revealed the presence of this technique, thus suggesting that its distribution on a north-south axis in the Michigan basin may be fairly well defined. Sites from the Huron or Superior basins have not been examined.

SUMMARY

We have defined a new and heretofore unreported bi-polar type of flint-working technique and have made the initial steps toward its spatial and temporal isolation. Four sites yielding this material have been analyzed, partly as a demonstration of what can be done with artifacts that are the by-products of tool production. The result was the recognition of a *non-ceramic* site, Point Detour Bay, as in all probability being a specific location for the processing of raw material during the initial phases of the tool-manufacturing sequence characteristic of some Late Woodland populations in the Great Lakes. The Scott Point site was identified as being a location where many different activities were carried out, including the initial and later phases of the tool-manufacturing sequence. Seul Choix was identified as a site where activities other than tool manufacture were most important; nevertheless some tool processing was accomplished by utilizing partially modified blanks and nuclei largely produced at other locations. The Summer Island site was identified as probably multi-component, having perhaps Late Archaic to Middle Woodland occupations as well as the Late Woodland remains that we analyzed. The latter assemblage was functionally identical to that at the Seul Choix site. It is believed that these insights into the activities and occupational histories of the prehistoric sites examined could not have been gained through a conventional approach that was concerned only with tools and other finished artifacts.

ACKNOWLEDGMENTS

We wish to thank Mr. James R. Getz of Lake Forest, Illinois, for his assistance, financial and otherwise, in support of Chicago Natural History Museum's archaeological investigations in the Upper Great Lakes region. We also thanked the late Mr. Harry W. Getz of Moline, Illinois, for reading the first draft of this report and making many helpful suggestions. We are grateful to the Marian and Adolph Lichtstern Fund of the Department of Anthropology of the University of Chicago for financial assistance in obtaining illustrations of the flint specimens and we are also grateful to Miss Nancy Engle, who made the drawings of these flint specimens. We are indebted to Chicago Natural History Museum for publishing our report, and last but not least we wish to thank Miss Lillian A. Ross, Associate Editor of Scientific Publications, for her editorial work in our behalf.

REFERENCES

BINFORD, LEWIS R., and PAPWORTH, MARK L.
1963. The Eastport Site, Antrim County, Michigan. University of Michigan, Anthropological Papers no. 19, pp. 71–123.

CRANE, H. R., and GRIFFIN, JAMES B.
1961. University of Michigan Radiocarbon Dates VI. American Journal of Science, Radiocarbon Supplement, vol. III, pp. 105–125.