Adaptive Radiations in Prehistoric Panama

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Report Number 16

Lithic Assemblages from the Aguacate Peninsula

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INTRODUCTION

In 1969 and 1970, excavations were conducted at several archaeological localities on the Aguacate Peninsula in the Atlantic province of Bocas del Toro, Panama (section 5.0 and report no. 6). Four of these shell-midden localities (a,b,c, and d) appeared to belong to a single dispersed hamlet designated as the Cerro Brujo (CA-3) site. A fifth spot, CA-2, belonged to a different hamlet 4½ kilometers away. The CA-3 localities are approximately one kilometer from the coast and occupy hilltops and ridges. The four midden localities which constitute CA-2 are found in similar topographic positions. Excavations were most extensive at locality CA-3a, where 118 square meters of deposits were removed. Additional excavations were undertaken at CA-3b (18 square meters), CA-3c (4 square meters), CA-3d (6 square meters) and CA-2a (12 square meters). The depth of the archaeological deposits varied from nearly 100 centimeters in the deeper middens to less than 20 centimeters in nonmidden habitation areas.

All the localities investigated are quite small, the largest (CA-3a) measuring 22 by 36 meters. All consist of "shell middens" or kitchen dumps and open spaces where, presumably, houses and outside activity areas were located. The major occupation of the sites — phase 2 or the Bocas phase — has been dated to the tenth century A.D., based on five radiocarbon dates from the Cerro Brujo site (section 7.7). An earlier occupation — phase 1 or the Aguacate phase — occurs at three of the four Cerro Brujo localities and has been dated to ca. A.D. 600. Faunal and floral remains suggest that these hamlets were populated by tropical forest agriculturalists who also hunted terrestrial fauna and, at least during the last occupation, made rather extensive use of marine resources.

Excavations at the Aguacate Peninsula sites produced 273 pieces of stone which had been modified by man (table 1). A number of other stone specimens, while showing no evidence of modification, were of materials foreign to the sites and were, therefore, carried in by the occupants. Of the modified stone specimens, 150 can be considered tools. The rest are either waste flakes from manufacturing processes or use flakes accidently removed from tools.

The stone artifacts from the Aguacate Peninsula were preliminarily analyzed and described after the 1970 field season by Rosenthal (1970). They were reexamined in 1975 and compared with the collections from La Pitahaya and Volcan by Rosenthal and Shelton Einhaus. Finally, the collections were reanalyzed by Ranere in 1978. In presenting the tool descriptions

TABLE 1 THE DISTRIBUTION OF STONE TOOLS AND FLAKES FROM THE AGUACATE PENINSULA SITES

	Bifacial cores	*Bidirectional cores*	*Tanged blades*	*Miscellaneous blades*	*Flake blades*	*Used flakes*	*Stemmed unifacial points*	*Axes*	*Type A celts*	*Type B celts*	*Type C celts*	*Celt butts*	*Chisels*	*Adzes*	*Hammerstones*	*Pestles*	*Handstones*	*Miscellaneous*	*Totals (tools)*	*Flakes*
CA-3a (I)									2	3			1						6	9
CA-3a (II)	2		12	6	5	2	1	1	11	34	2	4	8	3	3	2		3	99	65
CA-3b (I)																			0	1
CA-3b (II)			1	2	1				4	6		1	1				1		17	7
CA-3c																			0	
CA-3d										1									1	4
CA-2	1	2	2	1		2			1	6		1	1	3	2		1	5	28	31
Total	3	2	15	9	6	4	1	1	18	50	2	6	11	6	5	2	2	8	151	117

we have utilized a typology that is essentially descriptive. The typology was established in collaboration with Shelton Einhaus and Sheets in an attempt to keep the type definitions constant over the range of sites described in this volume. Thus, Type A celts from CA-3, IS-3, and BU-17 all have the same characteristics and the same type descriptions.

Primary tool categories were based on the final method of manufacture (cf. Einhaus 1976; this volume, section 8.0). Size, shape, and evidence of use served to subdivide further the primary categories. Those tools that were not manufactured, but were simply rocks used as found, were classified according to use modification and inferred function. A complicating factor in the classification was the fact that many of the stone tools served more than one purpose, or more frequently, served several purposes sequentially in their respective histories. Thus, for example, a tool originally manufactured as a celt almost inevitably was used as a hammer after its useful life as a celt was over. It might then (or instead) be used as a core for detachment of flakes. These flakes could subsequently be retouched or used as cutting, scraping, or piercing tools. In our classification, a tool is considered a celt regardless of whether it had also been used as a hammer or core, since the final method of *manufacture* was grinding and polishing. A flake tool was classified as such regardless of whether it was struck from an unmodified core, or from a core which had once been a celt, since the tool was *manufactured* by flaking. In both cases, the final manufacturing process (polishing for the celt, flaking for the flake tool) determined the primary category for the tool. Each specimen appears only once in the artifact descriptions. Where multiple use was present, it is indicated in the type descriptions.

THE CHIPPED STONE INDUSTRY

Two quite distinctive flaking patterns are represented in the Aguacate Peninsula assemblages. One is similar to what Sheets (1975) has called a household or cottage industry. Flakes were removed in a rather irregular fashion so that neither the flakes nor the cores display much patterning. In the Aguacate Peninsula assemblages, these flakes were removed by hammerstones without any preparation of the core platform surface. Usually the blow was struck well back from the platform edge.

In contrast, a number of chipped stone artifacts were made on skillfully manufactured blades. No blade cores were recovered in any of the Aguacate Peninsula sites (a point of some significance) but the manufacturing techniques can be reconstructed by examining the blades themselves. The regularity of the blades requires that they were made from prepared cores (perhaps polyhedral). Each blade usually has one or two dorsal ridges running its length, indicating successful removal of at least two or three blades prior to its own removal. The blades have little curvature, suggesting that an anvil or support was used for the core during blade detachment. The platforms have been minimally prepared prior to blade detachment by removal of the platform overhang. The point of impact occurs well back from the platform edge. The absence of crushing at the point of impact, the diffuse bulb of force, and the lack of *éraillure* flakes are consistent with either the use of a soft hammerstone or a punch. At any rate, the blades were clearly not made by pressure or by a hard hammer. These blades were the product of a skilled craftsman — a specialist — unlike the irregular flakes discussed previously, which could have been removed by anyone.

The lack of blade cores and the lack of debitage which would result from core preparation are strong indications that the blades were not manufactured at either the CA-3 or CA-2 sites. The bifacial, bidirectional, and irregular cores found at the sites and the irregular nature of nonblade flakes suggest that the blades were not made elsewhere by the Aguacate inhabitants and brought home either. Mistakes in flake removal resulting in step or hinge fractures, crushed platforms, and multiple bulbs of force attest to the rather low level of proficiency in stone knapping at the sites, and is inconsistent with the skill exhibited in the manufacturing of blades elsewhere. We should also note here that the source of raw material used for blade production lies well beyond the Aguacate Peninsula. Although some of the material might have been picked up as cobbles or pebbles along major rivers draining the central Cordillera (indeed, the two pebble cores from CA-2 are likely to have been from this source), larger blocks of raw material needed to manufacture blades were more likely to have come from farther inland, nearer the headwaters of these rivers, or perhaps from the southern side of the continental divide where extensive quarry/workshop sites are known. (We hasten to point out that very little is known about the distribution of lithic sources on the heavily forested, lightly occupied northern side of the divide.)

Most of the blades were modified for hafting by chipping a tang at one end (usually proximal). The tools were then hafted in a socket in much the same manner as we haft, or put handles on, files. These hafted blades have been used for a variety of purposes, sometimes with and sometimes without further modification. From an analysis of the microwear patterns we have inferred these tool functions as having included drilling, perforating, sawing, scraping, and slicing. These patterns, visible under a stereoscopic microscope (6x to 50x), were compared with wear patterns experimentally produced where possible (see blade descriptions for details).

The blades without tangs, and the flakes modified and/or used as tools, served many of the same functions as the hafted blades, with the exception of drilling and sawing. However, wear patterns for perforating, scraping, and slicing were visible using a stereoscopic microscope (6x to 50x).

THE GROUND AND POLISHED STONE INDUSTRY

Ground and polished stone tools dominated the Bocas assemblages. These tools, at their best, were very well made indeed. Where determining the manufacturing sequence was possible, the first step in making one of these tools was to percussion flake the block of raw material into the desired shape. Then a pecking hammer was used on the surface of the tool in order to even out the flake scar irregularities and to complete the shaping of the entire tool except for the bit. Next, the whole tool, or just the bit end, would be ground and polished with finer and finer grades of abrasives (probably sand and/or sandstones). Finally, the bit would be honed, and all or part of the tool's surface would be burnished with a hard pebble. There were deviations from this ideal sequence. Occasionally grinding would commence directly after flaking the implements; this was more likely to occur in smaller specimens — adze blades, chisels, and small celts — than in larger ones. Also, the final burnishing of the tool was often eliminated.

Clearly, the initial shaping of the tool preforms by flaking was not carried out at any of the sites examined. Only a very small number of flakes (123 in total) was recovered from the Aguacate excavations, and only 31 of those *could* have been manufacturing debris from original celt preforming, as 12 flakes were of chalcedony (a material not used for ground and polished implements) and the other 80 had polished surfaces indicating that they were struck from already completed tools. Now, in one celt-resharpening experiment that one of us (Ranere) conducted, we collected all flaking debris resulting from the reworking of the bit end of a damaged celt by hard hammer percussion flaking. Of the 48 flakes collected (with maximum diameters between 5 and 40 mm), 34 exhibited a portion of the original polished surface of the celt, while 14 of the flakes showed no evidence of having been removed from a celt. Thus, 29 percent of the flakes (14 out of 48) in the experimental situation could not be categorized as celt reshaping flakes even though they were. A similar percentage (29 percent) of nonchalcedony flakes from the Aguacate Peninsula assemblages could not be classified as celt resharpening flakes either. The experimental results thus suggest that all 31 of the excavated flakes could well have come from finished celts, from portions that did not retain the polished surface. In any event, it seems obvious that very little percussion flaking was carried out at the excavated sites, and that which was carried out was directed mainly at resharpening or reworking already manufactured (and presumably damaged) celts.

In contrast to percussion flaking, pecking must have been a major tool-shaping technique employed by the site inhabitants. Of the 69 celts recovered, 36 (and one large chisel) had been recycled as pecking hammers. These had broad, smooth hammering facets, either at both ends, or as on several specimens, completely encircling the perimeter. Other damaged celts have hammering facets on one end only. Four additional pecking hammers were recovered which were not originally celts. Thus, more than fifty tools at the sites saw moderate to very heavy use as pecking hammers.

Two alternative, though not mutually exclusive, explanations for the heavy use of pecking hammers can be suggested. First, the inhabitants could have been carrying in, or importing, flaked celt preforms for final shaping on site by pecking and grinding. Since sources of raw material for celts were at some distance from the sites, there may have been some incentive to reduce the weight of the specimens to be transported. There is abundant evidence for such "roughing out" of celt preforms at highland quarry/workshop sites on the Pacific side of the divide. On the other hand, the celts from the Aguacate Peninsula sites which were clearly reworked from damaged celts were not done with anything approaching the skill displayed in the original celt-manufacturing process. This leads us to suspect that not one of the inhabitants of the sites (or at least of CA-3, where our sample is reasonably large) was a skilled celt maker capable of shaping a roughed-out preform. Thus, the hypothetical life of a celt at one of the Aguacate sites would involve one or more major reshaping episodes accomplished by flaking and/or pecking. Major reworking would have been necessary if edge-damage was too extensive to be corrected by grinding on a whetstone. In the absence of skilled stone knappers, most of the reworking would have had to be done by pecking, thereby accounting for the large numbers of pecking hammers recovered from the excavations.

In summary, our interpretations of the lithic technology lead us to believe that most of the ground and polished stone implements were not manufactured at CA-3 or CA-2, but at quarry/workshop sites (probably) in the highlands. Furthermore, the Aguacate peoples did not go to the quarry stations either to manufacture tools, as all evidence points to their being unskilled stone knappers. It is much more likely that "outside" skilled craftsmen produced finished celts, adzes, and chisels at quarry/workshop sites and exchanged them with the Aguacate groups. These tools would then be repaired and recycled as long as possible in the hamlets of the Aguacate Peninsula where the tough, dense rocks suitable for manufacturing celts, adzes, and chisels, and for use as hammers, were unavailable. Since they require less skill than knapping, pecking and grinding were the major techniques used in the hamlets to work stone.

DESCRIPTION OF ARTIFACTS

Measuring artifacts proved to be a dilemma since so many of them were broken or extensively reworked. Where dimensions of objects could be confidently estimated, they are presented in the artifact descriptions in parentheses to distinguish them from actual measurements. If no estimate was possible, a question mark was used. Thus, a celt with dimensions listed as ? x (42) x 25 mm had a known maximum thickness of 25 mm, an estimated maximum width of 42 mm, and an unknown length.

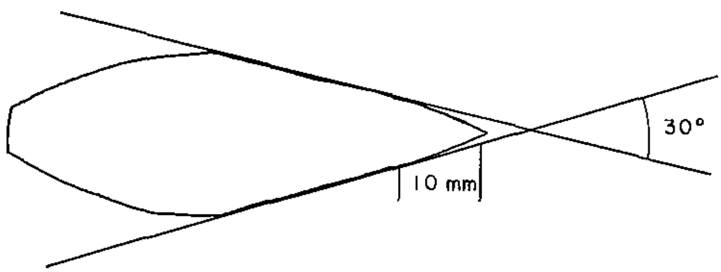

Figure 16/1: Method employed in the measurement of edge-angles for polished stone implements.

Measuring the edge angles of the bit portion of stone tools is always a difficult procedure. The Aguacate samples were particularly worrisome since very few bits were left unaltered. We measured all edge angles by arbitrarily drawing tangents to the surface of bit faces 10 mm back from the edge (see fig. 16/1) and rounding off to the nearest 5°. The measurement was taken at the center of the bit where possible.

I. *Chipped Stone*

A. *Cores*

1. Bifacial cores. Three cores have flakes removed around their entire perimeter from both faces. Two are made on celt remnants (1 basalt, 1 andesite), and the third on a chalcedony pebble (some of the weathered cortex is still present). Dimensions for the two cores made on celts and the chalcedony core are 55 x 48 x 27 mm, 48 x 32 x 17 mm, and 38 x 27 x 20 mm, respectively. The chalcedony core came from CA-3 (phase 1), the larger of the two celt cores from CA-2, and the smaller celt core from CA-3c (phase 2).

2. Bidirectional cores. Two cores from CA-2 have flakes removed from opposite ends of one face. On both, the other face retains the thick weathered cortex of the chalcedony pebbles on which the cores were made. The cores may have been flaked using a bipolar technique; that is, they may have been placed on an anvil for support while being struck with a hammerstone. Dimensions are 38 x 33 x 17 mm for one core and 39 x 28 x 18 mm for the other.

In addition to the above core types, we should note that four celts have been flaked in a manner suggesting they were being used as cores. It is possible, however, that the flaking represents an attempt to rework the celts for resharpening. All are Type B celts: three from CA-3a (phase 2) and one from CA-2 (see Type B celt descriptions).

B. *Blades*

1. Tanged blades (fig. 16/2 e-n). These tools, represented by 15 specimens, are long blades modified by steep bifacial or unifacial retouch at one end (normally the proximal or platform end) in order to form a stem or tang. Wear polish on the tangs is concentrated at the shoulder where the tang widens, presumably as a result of the friction between the tang and its socket haft.

The working ends of these tools have been modified and used in a variety of ways. On most specimens a tip or point has been formed by steep edge retouch on the dorsal face, sometimes accompanied by slight retouching of the ventral face to straighten out the tip. On two of three thick blades (the cross sections are nearly equilateral triangles) the dorsal ridge is unifacially retouched for a distance of 31 and 12 mm back from the tip (the third thick blade has the tip missing). One specimen has a concave working edge formed by unifacial retouch at the distal end. Usually, one or both lateral edges display unifacial retouch on the dorsal face. However, bifacial retouch also occurs, and some specimens display no purposeful lateral retouch at all.

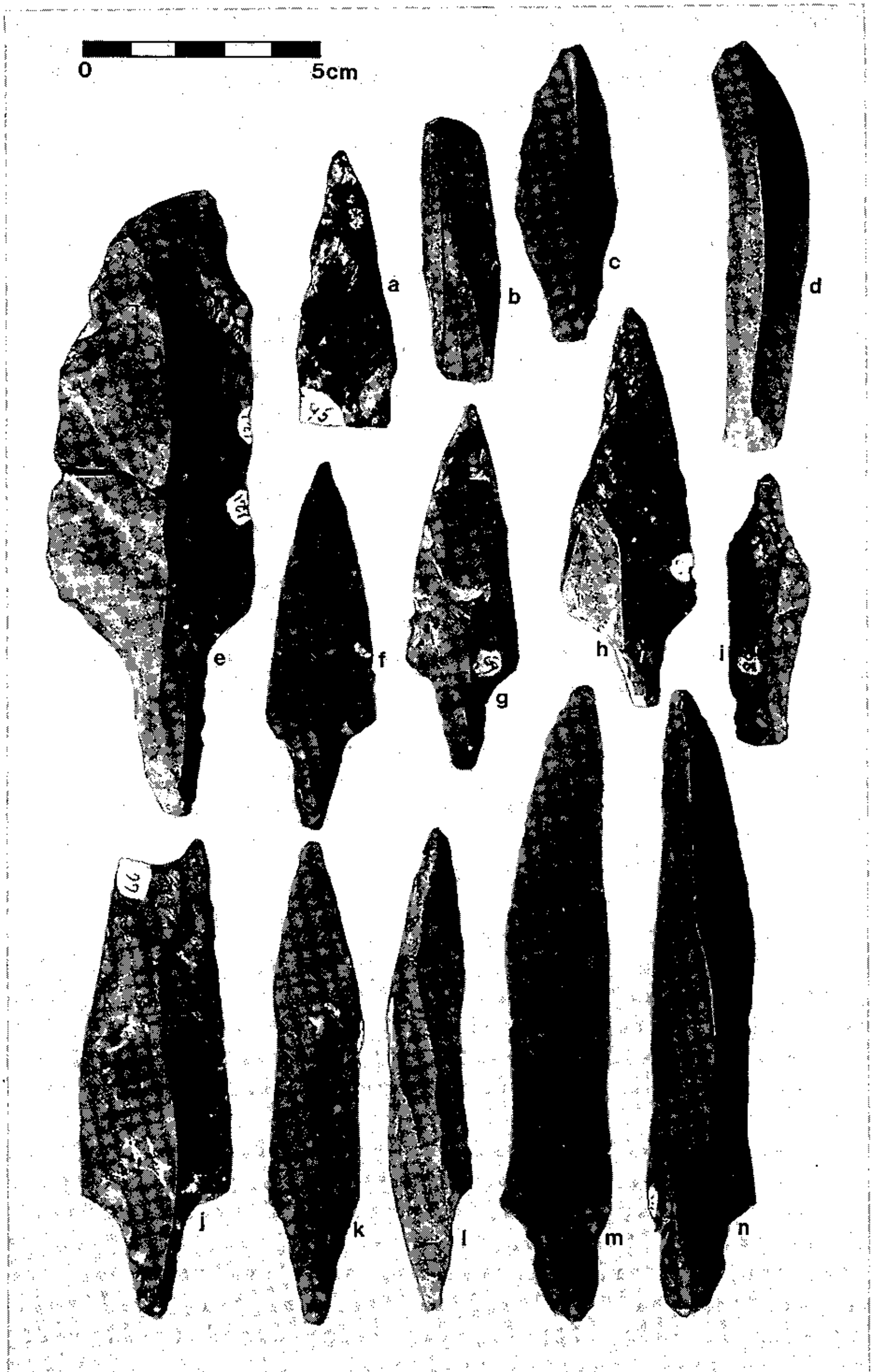

Figure 16/2: a-d. Miscellaneous blades; e-n. tanged blades.

Wear patterns are as varied as the modifications described above. The most commonly observed pattern is for use polish to show along one or both lateral edges. In one case, striations running parallel to a unifacially retouched edge, within 5 mm of it, are visible on the polished surface. These striations imply that the tool was used in a back and forth or sawing fashion. On these specimens, wear polish is often visible on high areas of the dorsal surface (e.g., along the dorsal ridges) and occasionally on the ventral surface as well. Most such tools appear to have been used for cutting or slicing soft materials (meat and/or plant foods, for example). On lateral edges with steep unifacial retouch, wear polish is restricted to the edge or extends onto the ventral surface. Use flakes and edge crushing are characteristic of these steep-angled edges. Such edges appear to have served a scraping or planing function on a hard unyielding material like wood. On the tips of the complete thick specimens, rounded wear facets occur along both lateral edges and the dorsal ridge. The curvature of the facets and the lack of wear polish on the nonprotruding surfaces near the tip indicate that these tools were used to drill a hard substance like wood or shell.

Many of the specimens were used for more than one purpose. Special note should be made here of one tool (fig. 16/2 g) showing three distinct uses. One edge of this tanged blade, which had bifacial retouch and light wear polish, was apparently used for cutting soft materials. The opposite edge was formed by steep unifacial retouch and had heavy wear polish along the edge and extending onto the ventral surface. This edge was probably used to scrape wood or some equally resistant material. Finally, a narrow chisel-like bit (now badly damaged) had been purposefully formed by grinding and polishing the tip of the blade; the manufacturing striations are clearly visible on the polished facets. The third function for this tool, then, was as a chisel for use in light woodworking tasks. We suspect that the largest of the tanged blades also had ground and polished bits, although no portion of them was found intact. The large use flakes that were "peeled" back from the tip were probably produced because the hafted tool had been subjected to heavy battering in woodworking activities. (See the description of *chisels on blades* for somewhat similar specimens.)

Dimensions of the largest complete specimen are 130 x 21 x 20 mm and of the smallest, 63 x 22 x 7 mm; the median is 77 x 31 x 9 mm. The blades are all made on fine- to medium-grained igneous rocks. Twelve specimens were found at CA-3a (phase 2), one at CA-3b (phase 2), and two at CA-2.

2. Miscellaneous blades (fig. 16/2 a-d). This category, represented by nine specimens, includes blades clearly not modified for hafting by the production of a tang, and blade fragments for which the presence or absence of a tang could not be determined. The two complete specimens show use polish on the tips. The smaller of the two shows steep unifacial retouch on the dorsal face along one edge and on the ventral face along the other edge. Retouch and use polish occur on some but not all of the remaining blade fragments. Seven of the blades are made of fine-grained igneous rock (basalt and andesite); two are chalcedony. Only four specimens have platforms intact. In all cases, the platform overhang has been removed. The

platform was struck well back from the edge (4 to 11 mm) with a soft blunt hammerstone, or alternately, a punch was set well back from the edge. These blades, as well as those which were tanged (and therefore had the platform removed or altered beyond recognition) are very regular in form. They have either one or two dorsal ridges. Most are quite straight. These blades are clearly the product of a skilled craftsman.

Dimensions for the two complete specimens are 79 x 21 x 7 mm and 67 x 15 x 5 mm. Five blades came from CA-3a (phase 2), two from CA-3b (phase 2), and one from CA-2.

C. *Flakes*

1. Flake blades are represented by six specimens. These fragments are at least twice as long as they are wide, and were detached with the direction of force paralleling the long axis (thereby satisfying a minimal definition of blade). However, they were clearly not struck from prepared cores and should probably be considered fortuitous. Three blades were manufactured by using the side of a celt as the guiding ridge for detachment. One of the blades (59 x 22 x 11 mm) has use flakes and wear polish along one edge extending from the tip to a point midway between the base and the tip. Neither of the other specimens, one complete (54 x 23 x 12 mm) and one fragmentary, showed any signs of use.

Two other flake blades (55 x 23 x 5 mm and 50 x 24 x 5 mm) had small use flakes removed along the lateral edges (primarily from the dorsal surface) and show wear polish along both edges as well. On one, the wear polish extends onto the dorsal ridges and onto the high spots along compression rings on the ventral surface.

The three flake blades made on celts are medium-grained igneous rocks. The other three specimens are fine-grained igneous rocks.

2. Used flakes are represented by four specimens. One chalcedony flake (44 x 28 x 14 mm) from CA-3a (phase 2) shows retouch flakes and slight wear polish along one edge. A second chalcedony flake (25 x 23 x 8 mm) from CA-3a (phase 2) shows unifacial retouch flakes along one edge, but no traces of wear polish. An andesite flake (24 x 24 x 5 mm) from CA-2 had uniform use flakes removed from a concave working edge. A second chalcedony flake from CA-2, removed from a small pebble (the dorsal surface still retains the original cortex), has a tip formed by steep retouch primarily on the dorsal surface. The very tip has been damaged by the removal of a small (2 mm) use flake. Wear polish is visible behind this flake scar, along both edges, for a distance of 5 mm. The small flake (34 x 25 x 10 mm) appears to have been used as a graver or perforator.

3. Waste flakes. A total of 123 flakes was recovered from CA-2 and CA-3 localities which show no modification by design or by use after detachment. Eighty of these flakes retain a ground and/or polished surface on their dorsal face, indicating that they were removed (either purposefully or accidentally) from celts or from other ground and polished tools. An additional 31 flakes are made of the same material — igneous rocks of various descriptions — and can be reasonably considered celt flakes as well, even

though they do not retain any portion of a polished surface. We are left with only 12 flakes of chalcedony that are clearly not the product of breaking down celts. Of the flakes which retain portions of the celts' surfaces, 11 are from the bit, 23 are from some section other than the bit, and 46 cannot be categorized beyond saying that they came from celts.

The flakes were distributed as follows: 65 from CA-3a (phase 2), nine from CA-3a (phase 1), seven from CA-3b (phase 2), one from CA-3b (phase 2), four from CA-3d, 31 from CA-2, and six with no provenience.

D. A Stemmed Unifacial Point

This artifact was manufactured by trimming a flat andesite flake using steep unifacial retouch. The tool was probably *not* used as a projectile point since it is asymmetrical and has very blunted edges left by the steep retouch. The very tip (2–3 mm) of the tool has been snapped off, and wear polish is present on the edges to a point 10 mm back from the broken tip. This suggests that the tool was used as a graver or perforator. Dimensions of the specimen are 39 x 22 x 5 mm. It was recovered from CA-3a (phase 2).

II. Ground and Polished Stone

A. An Axe (fig. 16/3 e)

A single specimen was recovered from phase 2 contexts at CA-3a. A constriction (it cannot really be called a groove) just in front of the butt end distinguishes this ground and polished tool from all the others. The axe is 99 mm in length, 57 mm at the maximum width just behind the bit, 39 mm wide at the constriction, and 36 mm wide at the butt end. Maximum thickness on either side of the constriction is 29 mm, while the constriction itself is 27 mm thick. The bit is no longer intact, but an edge angle of ca. 55° can be reconstructed. The surface of the axe has been badly pitted, as if pecking of the tool was done in an attempt to resharpen it. The tool has remnants of a polished surface immediately in front of the constriction. Shaping of the constriction and the butt was by pecking. The butt end is heavily battered.

B. Celts

1. Type A (fig. 16/3 a-d) consisted of 18 celts or celt fragments complete enough to be placed in this category. The bit edge of these celts continues back along the side of the celt in a smooth curve so that the cutting edge forms a semicircle and extends from one side of the celt to the other. Behind the bit, the celts narrow to a butt which is round to oval in cross section. Type A celts are also called pear-shaped celts. The butts of these celts are shaped by flaking and usually not altered further, although some specimens are pecked. Above the butt end, the surface of the celt is completely polished except for the occasional deep flake scar which is not completely obliterated. On a few specimens it seems clear that the celts were initially flaked and then ground and polished without any pecking. The bits are all biconvex in cross section.

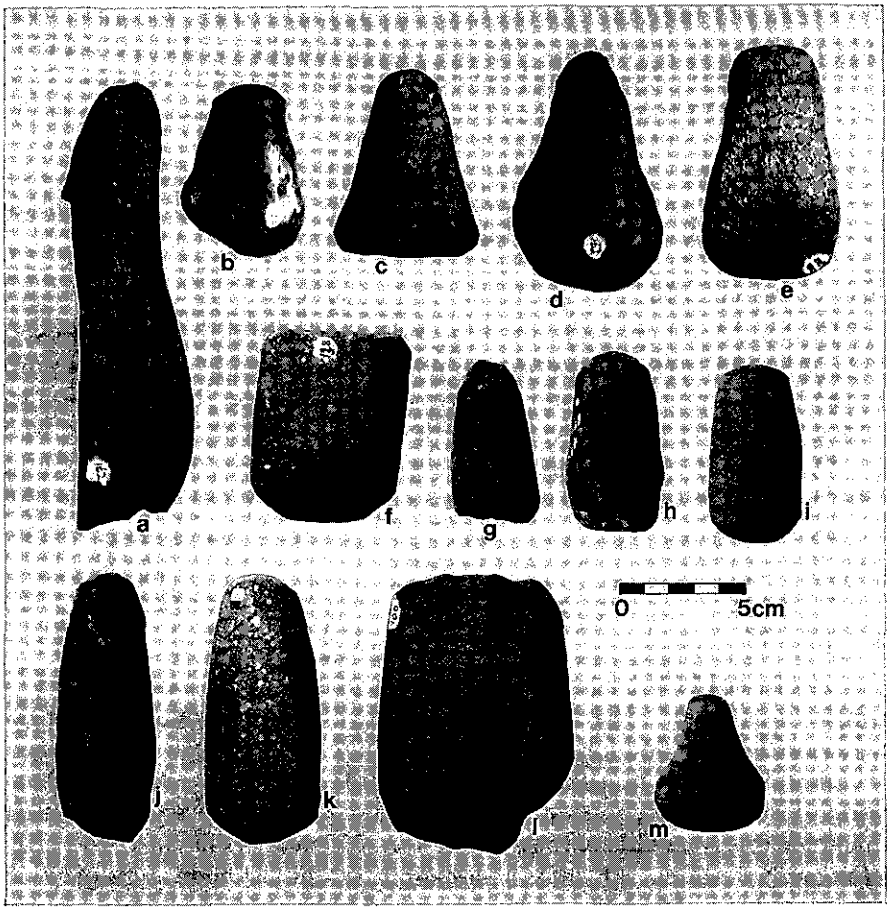

Figure 16/3: a-d. Celt Type A; e. axe; f-l. celt Type B; m. celt Type C.

Ten of the 18 specimens have been very extensively modified and used as pecking hammers. Only one specimen is complete, the smallest of the group (53 x 43 x 15 mm), and it appears to be the reworked butt half of a once much longer celt (the estimated original length is 83 mm). The edge angle of its bit is 40°. The largest celt for which dimensions can be reconstructed measures (193) x (100) x 39 mm. The bit for this specimen was missing. The only medium-sized specimen for which the dimensions could be reconstructed measured (142) x 78 x 29 mm (the bit is too battered for an edge angle measurement). A different medium-sized celt fragment had a bit edge angle of 50°.

The celts were made from a variety of igneous rocks (e.g., basalt, andesite, and granite). They were recovered from the following contexts: two in CA-3a (phase 1), eleven in CA-3a (phase 2), four in CA-3b (phase 2), and one in CA-2.

2. Type B (fig. 16/3 f-l) consisted of 50 specimens with straight sides tapered from front to back. The bit is only gently curved, and makes a

well-defined angle with the sides of the celt (cf. description of Type A celts). The celts are ground and polished over the entire surface. Characteristically, they have three facets on each face, making them hexagonal in cross section. Not one of the 50 specimens is complete, 25 have been utilized as pecking hammers; that is, they have broad, battered facets on both ends. Most of the other celts show on one end signs of use as hammering or pounding tools. Three appear to have been used as cores since large flakes have been removed from one or two edges. On one specimen, the edges have been rounded and ground smooth, from the midpoint of the bit, back along both sides to a point half way to the butt end.

Where retained, the original surface of the celts is always ground and polished. Presumably, the celts were intially flaked, then pecked into shape before the final grinding and polishing took place. Those celts which were reworked to function as celts were fashioned by some percussion flaking and much pecking.

The largest celt for which dimensions could be reconstructed measured (155) x (70) x 31 mm. The smallest celt has a reconstructed size of (75) x 29 x 18 mm. The bit edge angle for this small celt was 35°. The three other small Type B celts had edge angles of 40° (two specimens) and 45°. The reconstructed size of a medium-sized celt is (95) x 43 x 25 mm. The only medium-sized type B celt with a bit intact had an edge angle of 50° (specimen measured ? x 52 x 25 mm). These celts were made from a variety of igneous rocks (e.g., basalt, andesite, dacite, and granite). The smaller celts are made of very fine-grained materials. Type B celts were recovered in the following contexts: 34 in CA-3a (phase 2), three in CA-3a (phase 1), six in CA-3b (phase 2), one in CA-3d (phase 2), and six in CA-2.

3. Type C (fig. 16/3 m). Two small celts from CA-3a (phase 2) have flaring bits and incurvate sides. Both have been resharpened. In fact, one may have been made from the base of a Type A celt. They appear to have been flaked into shape, then ground and polished primarily at the bit end. The two measure 67 x 47 x 20 mm (bit angle 45°) and 58 (80) x 44 x 13 mm (bit angle 40°), respectively. Both are made of fine-grained igneous rock.

4. Butt of large celt. The shape of this fragment is similar to that of Type B celt butts. However, it has only traces of polishing. Some pecking has been done, particularly along the edges, but the flake scars from the initial shaping are still visible. The fragment measures 69 x 49 x 39 mm and is made of andesite. It was recovered from CA-3a (phase 2).

C. *Adzes (fig. 16/4 a-e)*

Six small adzes were made on the ends of blades. Only the bits have been ground and polished. The specimens are plano-convex (actually plano-diamond) in cross section, the ventral surface of the blade forming the flat side of the adze. On the five specimens which retain bits, the edge angles vary between 35° and 50°.

Dimensions of the two most complete specimens are 72 x 22 x 14 mm and 55 x 24 x 10 mm. All are made of fine-grained igneous rocks. Three are from CA-3a (phase 2) and three are from CA-2.

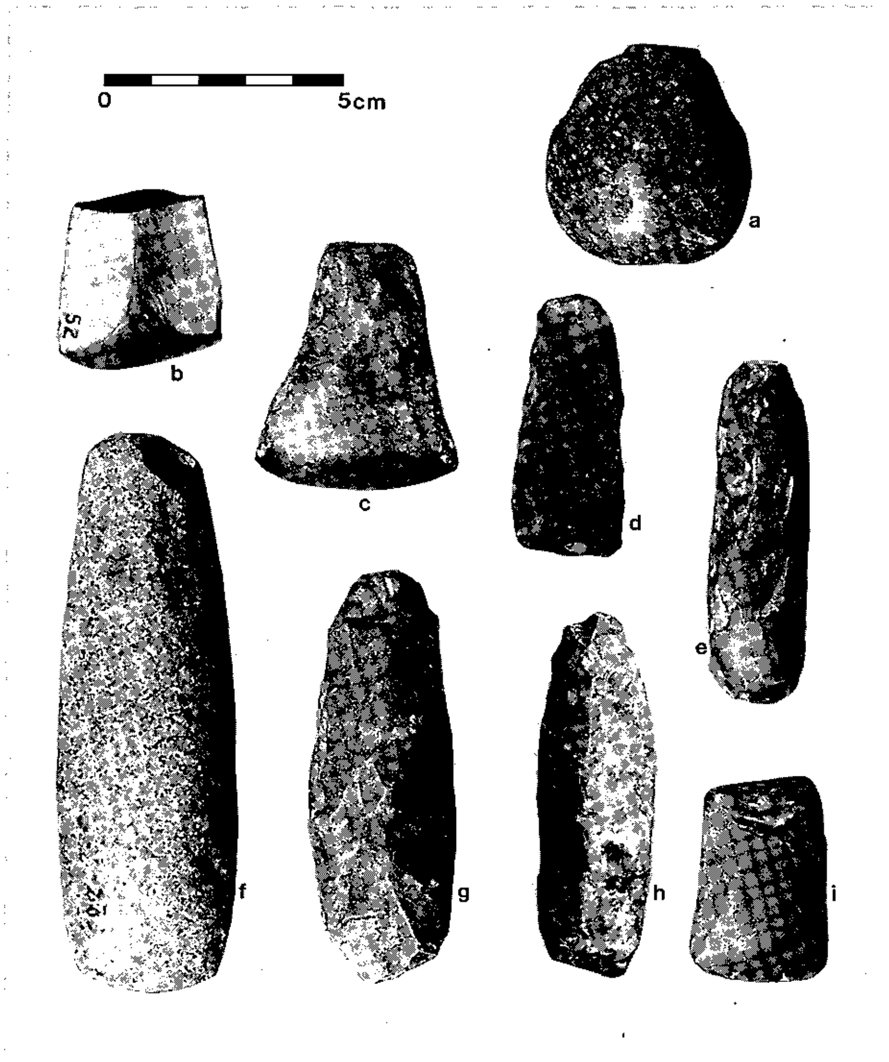

Figure 16/4: a-e. Adzes; f-i. chisels.

D. Chisels (fig. 16/4 f-i)

1. Large chisels are represented by four specimens. A large (117 x 37 x 25 mm, bit missing) ground and polished stone artifact appears to have been initially made as a chisel. The attributes closely parallel those for Type B celts except that this specimen is much narrower proportionally than any of the Type B celts, and the sides are subparallel. It has seen secondary use as a pecking hammer, so that the bit is completely destroyed. The specimen was recovered from CA-3b (phase 2) and is made of andesite. Three fragments of ground and polished tools may also be parts of chisels. One is a completely polished butt end fragment, oval in cross section and tapered to a blunt

point (? x 24 x 15 mm). It comes from CA-3a (phase 2) and it is made from a fine-grained igneous rock. The second fragment comes from a tool midsection (? x 27 x 16 mm); it is diamond-shaped in cross section and completely polished. It also comes from CA-3a (phase 2) and is made from a fine-grained igneous rock. The final chisel fragment has been heavily battered on both ends from secondary use as a pecking hammer (? x 27 x 17 mm). It is diamond-shaped in cross section, with a polished surface that does not completely obliterate the flake scars left from the initial manufacturing of the implement. It was recovered from CA-3a (phase 2) and is made from fine-grained basalt.

2. Medium chisels. Four nearly whole specimens have been flaked into form, then partially ground and polished (no pecking is in evidence). They have parallel sides, diamond-shaped cross sections, and are nearly as thick as they are wide. Only the bit and the high spots on the bit end of the chisels are polished. The dimensions of the four specimens are 109 (140) x 39 x 26 mm, 85 (110) x 30 x 19 mm, 79 (115) x 31 x 20 mm, and 75(105) x 24 x 17 mm. No bits were retained for edge angle measurements. All were made of fine-grained igneous rocks. Three came from CA-3a (phase 2) and one from CA-3b (phase 2).

3. Chisels on blades. Three blades have distal ends modified by grinding and polishing to form small chisel bits. Polishing occurs on both dorsal and ventral surfaces back 5 to 10 mm from the bit, then extends back along the dorsal ridge another 10 mm in one case, and nearly the entire length of the specimen in another. The latter specimen has retouch flakes removed along both sides, and a constricted base or tang for hafting. It measures 64 x 22 x 6 mm. Dimensions for the other chisels are 87 x 18 x 10 and 57 x 16 x 17. All are made of fine-grained igneous rocks. One specimen came from CA-3a (phase 1), one from CA-3b (phase 2), and one from CA-2. (One multipurpose tool placed in the category of tanged blade had a ground and polished chisel bit, and perhaps another did as well. See description for tanged blades.)

E. *Miscellaneous Ground and Polished Stone Implements*

1. Butt fragments. Not enough of the butt ends are present to assign these five fragments to a more specific tool category. However, they are probably fragments of either Type A celts or medium-sized chisels. All are bifacially flaked. In addition, three have been polished in small areas. All are biconvex to diamond-shaped in cross section. All are made of igneous rock. Three are from CA-3a (phase 2), one from CA-3b (phase 2), and one from CA-2.

2. Reworked celt flake. The dorsal surface of this flake retains the polished surface of the celt from which it was struck. In addition, the ventral surface and distal edge have been polished. The flake measures 40 x 27 x 5 mm and is shaped like a truncated isosceles triangle. The base of the triangle is damaged, perhaps through use as a chisel. The flake is made of granite and was recovered from CA-3a (phase 1/2).

III. *Miscellaneous Stone Tools (fig. 16/5)*

A. *Whetstones*

Two specimens were recovered from CA-2. Both are tabular and have four concave working surfaces. The larger one (51 x 43 x 18 mm) is a medium fine-grained sandstone which in cross section looks like a parallelogram. The smaller specimen (31 x 18 x 12 mm) is a very fine-grained sandstone and rectangular in cross section. Striations running parallel to the long axis of the tools are visible on all working surfaces of both tools. The curvature of these working surfaces suggests that the whetstones were used on chisels, adzes, and small celts only.

B. *Polished Pebble*

A quartz pebble from CA-2 has a highly polished surface with visible parallel striations. The wear pattern exactly duplicates that of a quartzite pebble used by one of us (Ranere) in polishing the surface and honing the bit of experimentally made celts.

C. *Battered and Polished Cobble*

A long, three-sided cobble with hammering facets on both ends and along the entire length of the three edges was recovered from CA-3a (phase 2). One of its three faces is unaltered, one is ground and lightly polished, and the third is heavily polished. The tool was presumably used in the pecking and polishing stages of celt manufacturing. It measured 92 x 31 x 28 mm and was made of andesite.

D. *Hammerstones*

Five small cobbles have been modified by hammering on one or both ends. Three specimens exhibit heavy use, the other two only light use. Three are of igneous materials, two are of quartzite. Dimensions of the tools are 93 x 52 x 23 mm, 82 x 33 x 32 mm, 75 x 49 x 33 mm, 59 x 40 x 28 mm, and 91 x 45 x 44 mm. Three are from CA-3a (phase 2) and two are from CA-2. (We should note that 10 Type A celts, 25 Type B celts, two large chisels, and one polished and battered cobble exhibited heavy use as hammers (fig. 16/6). In addition, most of the remaining celts showed some use as hammers.)

E. *Anvil*

One sandstone cobble from CA-2 has a series of small depressions gouged out from one surface. It appears to have been used as an anvil in percussion flaking. Its dimensions are 91 x 55 x 42 mm.

F. *Cobble Pestles*

Two specimens, both rather large, were recovered with pounding wear facets on both ends. One elongated igneous cobble measured 151 x 83 x 72 mm; the other, a pear-shaped cobble of dacite, measured 148 x 85 x 73 mm. Both were recovered from CA-3a (phase 2).

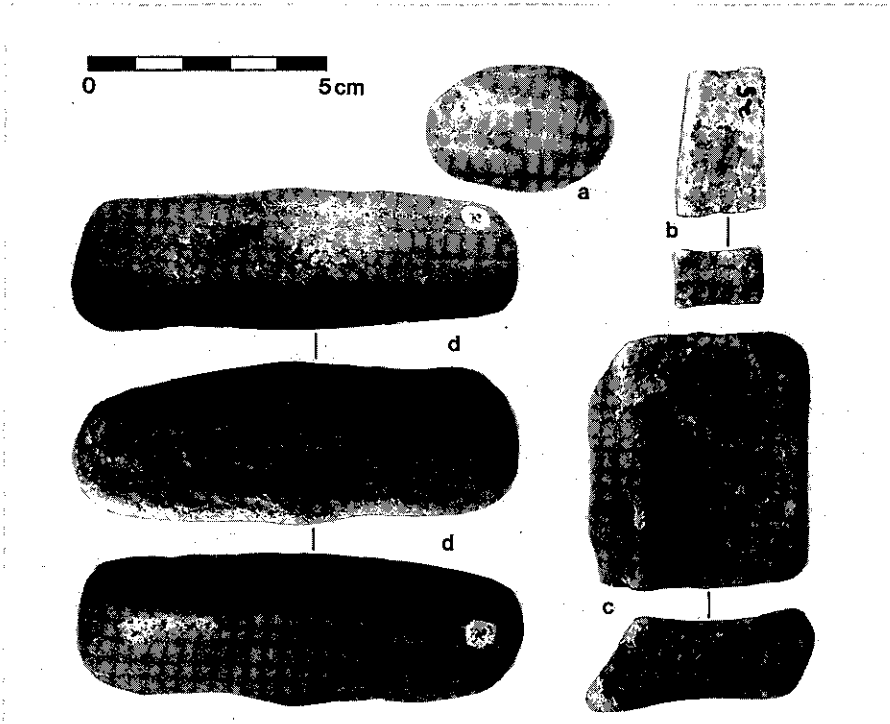

Figure 16/5: Tools presumably used in the manufacture of ground and polished stone implements: a. pebble polisher; b,c. whetstones of fine- and medium-grained sandstone, respectively; d. three-sided cobble polisher.

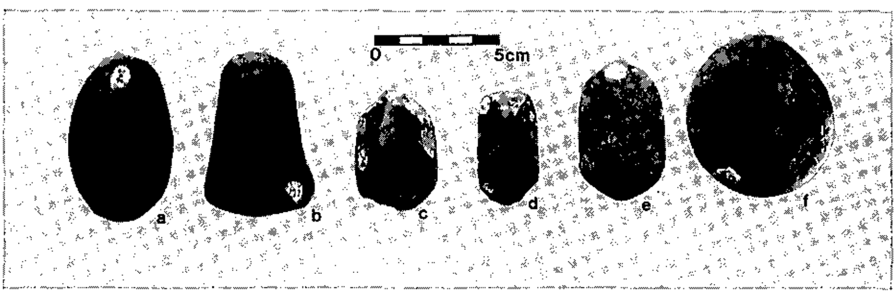

Figure 16/6: Celts reused as hammers.

G. Handstones

Two large cobbles may have been used as grinding implements. One is a flat oval cobble which appears to have ground facets on both flat sides, although heavy weathering of the limestone makes this difficult to determine. It measures 152 x 79 x 52 mm and comes from CA-3b (phase 2). The other handstone is a somewhat irregular elongated cobble of dacite (141 x 77 x 59 mm) which has a possible grinding surface. Both ends have seen light pounding, suggesting that this tool may have also served as a pestle. It came from CA-2.

H. Cylindrical Cobble

This heavily weathered dacite cobble from CA-3a (phase 2) is nearly square in cross section. Striations visible on one face parallel to the long axis of the cobble may indicate it was used as a whetstone.

A number of unmodified cobbles and pebbles were also recovered from the Aguacate localities. Although they showed no sign of use (weathering may have obscured patterns once present), they were undoubtedly brought onto the site for some purpose or another. Rounded cobbles and pebbles were not part of the natural sediments at any of the sites.

I. Notched Stone

A small oval igneous pebble from CA-2 has two notches pecked into opposite sides. It may have functioned as a net or line weight. Its dimensions are 46 x 33 x 16 mm.

Report Number 17

Sediment Analysis of a Core from Isla Palenque

G. J. WEST

INTRODUCTION

On viewing tropical Middle America one is immediately struck by the presence of large areas of open land covered with savanna type vegetation. Upon further examination one finds that in most cases these areas are by and large controlled by human activities related to agriculture (Budowski 1956, pp. 23–33). Because of this relationship an attempt was made, in conjunction with archaeological excavations, to find a pollen record of forest clearing, agriculture, and savanna development.

To obtain a pollen record, coring was done with a modified Livingston piston sampler. With this device, a series of core slugs each about a meter long can be taken to a depth of 8 to 10 meters depending on the nature of the sediments. Attempts were made to core many areas, but only a few proved successful. Cores that were recovered come mainly from coastal swamps on both the Pacific and Caribbean sides of western Panama. The sediments of one of those cores from Isla Palenque is reported below. The core is from the edge of a small estuary, some 100–150 meters away from La Pitahaya (IS-3) site (fig. 17/1).