Tebiwa, Vol. 12, No. 2, 1969

THE CORBIAC BLADE TECHNIQUE AND OTHER EXPERIMENTS

By Francois Bordes and Don Crabtree

In September, 1967, F. Bordes and Don Crabtree spent two weeks experimenting with several flaking techniques, replicating various artifacts, and analysing and comparing their work to aboriginal tools. The prime concern during this work session was the replicating of Upper Perigordian blades and cores, as found, for instance, at Corbiac (Dordogne). Bordes thought that Corbiac blades were made by indirect percussion with the core being placed on a rest. Attention has also been given to blademaking without a rest and to thinning of bifaces by direct, and indirect percussion without a rest. The results of blademaking by indirect percussion without rest have been compared with Clovis blades and cores. Since this was the first opportunity for the authors to work together uninterruptedly we felt we should publish our findings.

Because this paper is primarily concerned with blademaking, it may be well to consider here what a blade is. For the Lower and Middle Palaeolithic, Bordes defines a blade as "any flake which is twice or more as long as it is wide." But for more evolved lithic assemblages, he agrees that a more elaborate definition is necessary. We tentatively propose the following one, evolved by Don Crabtree: A specialized elongated flake with parallel to sub-parallel lateral edges; its length equal to at least twice its width. Cross or transverse section may be either plano-convex, triangular, subtriangular, rectangular, often trapezoidal, and on the dorsal face, one or more longitudinal crests or ridges. **On the dorsal side of the blade there should be two or more scars of previously removed blades with force lines and compression rings indicating that force was applied in the same direction as blade detachment.**

For those not familiar with flaking stone, it seems fitting to mention here a few points regarding blade scars which may help in analysis and reconstruction. It is not impossible to reconstruct the core or artifact by reassembling flakes and blades to determine the sequence of their removal. Two features indicate the direction of force: (1) the undulations or waves radiating from the point of force across the plane of fracture (Fig. 1a). By orienting the direction of force, broken blades and flakes may be fitted together and then related to the core or artifact which has corresponding characteristics, (2) flake and blade margins have fissures which indicate the direction of force and aid in showing the sequence of flake and blade removal. The striations found on the lateral margins on the ventral sides of the flakes and blades (Fig. 7) have opposite or negative duplications on the lateral margins of the core or artifact (Fig. 1a). **The fissuring is not always apparent on both margins and is generally more difficult to detect on coarse granular material.** On vitreous stone, these fissures are more obvious. These striations, or minute fissures, are due to the compression of the material as it is removed from the core or artifact. Marginal striations are tangent and oblique to the edge and slant up toward the proximal end of the flake or blade, some sweeping in a graceful curve to the point of applied force.

From 1962 to 1967, F. Bordes excavated at Corbiac in the Dordogne Valley near Bergerac, an open air Upper Perigordian site. The upper layer yielded a vast quantity of blades, cores (more than 1000) in all stages of fabrication, tens of thousands of flakes, and about 10,000 tools. There are an estimated 100,000 blades and fragments of blades, many with very small platforms (or butts), denoting the intensive use of punch technique. These blades are usually not very curved, and in fact are remarkably often straight. Bordes carefully examined the vast quantity of both finished tools and the ones which were exhausted by use. He analyzed the flake debitage, including the discards rejected by Palaeolithic man because of flaws in the stone, miscalculations, or an error in fabrication. Any one or all three of these factors may be involved with any single piece, for there is no exact repetition of conditions when one is shaping a tool out of a lump of flint. This is one of the reasons why unfinished or broken tools and debitage are important for understanding material culture. They must be collected and studied because they provide us with an insight into the normal stages of development of the tools. This will prevent errors in interpretation such as confusing the preparation of the edge of the core platform with traces of use as a pushplane.

Bordes eliminated both pressure and direct percussion as the main blademaking technique at Corbiac, and defined the manufacturing method as indirect percussion with rest. He then did a number of experiments, eliminating various other manufacturing methods to resolve the blade and core technique used at Corbiac and by the Perigordians and other Upper Palaeolithic people. This took much time and work, for each experiment had to include the many individual stages of manufacture. Ultimately he was successful in consistently reproducing the cores and blades of this type.

Unlike other artifacts which have definite shape, outline, and functional purpose, cores are quite variable. Their forms, styles, and types are many, and the technological patterns vary, each retaining multiple diagnostic traits. Because the core demands frequent reshaping for blade detachment, it is reduced in size and even changed in form and character from the first to the last blade removed. Then the exhausted or malformed core is either abandoned, or further modified into another artifact. The core may be simply reduced to usable flakes with sharp cutting edges. End products such as these would hardly be recognizable as former cores. A large population of either malformed or otherwise abandoned cores usually indicates an abundance of raw material.

At Corbiac the numerous cores can be roughly divided into five categories (other kinds of cores do not concern us here) which are: unidirectional, bidirectional, globular, mousteroid, unclassifiable, and fragments (this fragmentation is the consequence either of breakage during work, or more often, frost action in the ground. The unidirectional cores (Fig. 1a and c) have a single striking platform; the bidirectional two, usually opposed. Among the unidirectional cores, the pyramidal or conical type (flaked all around, see Fig. 1c) seems conspicuously absent. The cores always show either cortex or preparation scars on one side. The bidirectional cores present several subtypes.

Preparation of prehistoric cores at Corbiac:

The Corbiac core was usually shaped out of ellipsoidal nodules of banded flint, which abound in the immediate neighborhood, and may be as large as a foot or two across. Usually smaller nodules were used, but these big nodules were also broken into fragments or flaked into huge flakes and cores made out of these large flakes. A bifacial ridge was then flaked along one edge to guide the first blade. Occassionally two or three ridges were produced to guide the first blade. The striking platform was made sometimes before, sometimes after, this ridge preparation and almost always at an acute angle with the side of the core. These are sometimes huge cores, up to 23 centimeters long, but some must have been even bigger, since in Corbiac blades have been found up to 26 centimeters long. In the neighboring site of Rabier, J. Guichard has found foot long blades. Some broken blades from either of these two sites must have been even longer.

The unidirectional cores are more or less prismatic, although often one side is unworked or shows only the preparation scars. The bidirectional cores show interesting variations and subtypes. The first variation is very much like the unidirectional cores, except that there are two striking platforms, one at each end and blades were taken either alternately from one or the other end, or a series from first from one end, then from the other. These we call **opposed.** Sometimes the cores were shaped in such a way that they presented about at their middle an obtuse angle (Fig. 1d). In that case, the blades unable to take a sharp turn, terminated at the middle of the core and were flat. This is probably linked to the need of the Perigordians to to have straight flat blades for the Gravette projectile points. This type can be called **opposed angular.** A variation which does not play an important role is the **opposite rectangular,** in which the angle is more or less 90°. Then there is the **opposite alternate** type, in which the blades were taken on each side of the core from the two striking platforms (Fig. 1b).

Experimental work:

Our duplications of the Corbiac cores during Bordes stay in Idaho were mainly unidirectional but a few were bidirectional. The Idaho specimens were almost entirely made from either cobbles or ovoid lumps of obsidian with outside measurements of from seven to fourteen inches before preforming. After the top of the cobble was removed to provide a striking platform, the overall length averaged between six and ten inches.

The following is a description of our experiments of replicating Corbiac blades and cores by indirect percussion with rest.

Preforming the core:

Invariably the preforming of the core is the most difficult and important step in blade making, and the "Corbiac technique" is no exception. At Corbiac a number of what would appear to modern man as perfectly good preformed cores were abandoned by Palaeolithic men who knew better. If the core is not properly made there will be failures: the blades will fail to detach, they will step or hinge fracture, platforms will crush, the end of the core will be taken away by the blade, blades will vary too much in thickness or width, will terminate short, bulb of force will be accentuated, shatter lines and fissures will be present, the blades will have prominent eraillure scars, compression rings and undulations, or will break into fragments or split in the middle. We cannot emphasize too strongly the importance of core preparation (Fig. 2). It is impossible, or at least almost impossible, to remove true blades from an improperly prepared core and no amount of skill can overcome poor preparation or conquer certain strains and flaws in the material.

A suitable piece of material, relatively free of flaws, of adequate size and proper texture is selected for the experiment (Fig. 3a). The size of the rough material selected will depend on just how large a blade is desired and of course on what is available. Since our experiments were done at Crabtree's home in Idaho, we used mainly obsidian for it is plentiful here and we had very little flint. We would have preferred to use flint, as obsidian is considerably more brittle than flint and therefore more subject to breakage from end shock. However, this substitution of material was done without changing the Corbiac technique; we only slightly modified it to conform to the material. In this case we considered it to be good stoneworking practice. Always, techniques have to be adapted from flint to chert, chert to chalcedony, etc. and slightly modified to suit the nature of the material. For example: working with obsidian, we had to grind the platform to strengthen it and give a better purchase to the punch (Fig. 5b), decrease the velocity of the blow, and detach thicker blades. Bordes had to abandon his reindeer antler hammer and adopt a wapiti antler hammer, lighter and less dense (Fig. 5a and 6a).

After the cobble or mass of material has been selected for blade making, the experimenter must visualize the future core within the cobble. That is, he must calculate how to remove material from the mass in order to retain as much of the material as possible, and yet properly prepare the core to the desired size. One can never immediately start removing blades from a rounded mass so that the first step of core preparation is to eliminate the rounded surface and establish a first striking platform for preparation of a ridge which is to guide the first blade. This can be done with hammerstones of variable hardness according to the material of which the core is made. An antler billet may be used if there is already a natural facet. Material which is rectangular, without rounded surfaces would be very suitable for core and blade making, but is seldom found. Angular material often has natural longitudinal ridges which may, after slight modification or unifacial trimming, suffice as a ridge to guide the first blade. If the longitudinal ridge is at the corner of a rectangular block of flintlike material, it is relatively simple to prepare the proper platform for the removal of the first blade. Sometimes, just a slight grinding, or preparation by detachinng small flakes at the corner will ready the piece for positioning the punch for blade removal.

Another favorable natural shape is the flat ovoid cobble, with almost angular edges. Once a striking platform is established by a side blow at one end, one can immediately begin taking off blades, the first of which will have its dorsal side completely covered with cortex.

However, if the cobble is rounded and has no natural facet, the worker uses a medium-sized hammerstone to establish the first facet. A hammerstone is necessary, for the antler billet would not have sufficient force to detach a flake from a rounded surface. The worker holds the hammerstone almost vertical to the rounded edge of the cobble and strikes a sharp and strong blow (Fig. 3a) to remove the first flake (Fig. 2a, b). Usually, only one flake is necessary (Fig. 3b) to eliminate the rounded surface.

Preparing the ridge:

To create the first ridge from the bottom to the top of the core (it is usually better to begin at the bottom) the worker uses an antler billet or a soft hammerstone and strikes with sufficient force on the first facet to remove a flake on the other side of the still rounded core. This blow is given in an upward direction (if you begin at the bottom) in order to detach a flake which extends toward the upper end of the core, and is situated along the edge slightly higher than the first flake (Fig. 2b). An antler billet or soft hammerstone and direct percussion is used for this flaking process to prevent the strains and shattering which would result from a harder percussor and also to avoid getting deep negative bulbs, which would make it more difficult to get a straight edge along the core. This is the first step in a series of flakes to be removed in this same manner along the margin of the cobble to establish the ridge. Each scar is used in its turn as the striking platform to remove a further flake, and the worker continues to strike alternately on the edge of the cobble from bottom to top (or the other way around) until the ridge is established (Fig. 2c, d). The edge made in this manner will be sinuous from the alternate flake scars. If the ridge is too accentuated for blade removal it may be straightened by striking off the crests between the lateral flake scars with the antler billet (Fig. 2e). Very often, in Palaeolithic times, much care was devoted to this straightening of the ridge, and so prepared cores, from which no blade has been struck are often confused with tools. The ridge will serve as a guide for removal of the first blade. This first blade removed will create two longitudinal ridges for removal of additional blades and so on around half the circumference of the core (Fig. 4e). If the removal of the first blade is not well done,for instance if the blade breaks at about half the length of the core, it is very often abandoned if the geographical location is rich in flint. If it is a two-ended core, then the second part of the first blade can be removed from the opposite direction and the core can continue to be used. This preparation and follow-through is of the utmost importance because the form and shape of the core control the type of blade detachment.

Preparation of the striking platform:

Before the first blade can be removed a striking platform has to be prepared at one or both ends of the core (Fig. 2f). It is a difficult part of the process and several methods can be used and have been used by Palaeolithic men: (1) striking the core on an anvil stone (Fig. 4b), (2) by direct percussion with a hammerstone (Fig. 3c), (3) by tangential percussion, the core being held on the outside of the thigh which seems to have been the method of the Brandon flintknappers, (4) preparing a small platform on the end of the longitudinal ridge and then severing the top by indirect percussion (Fig. 4c), and (5) preparing a platform by removal of small flakes, like the truncations on truncated blades (Fig. 4a). This method was common enough in Upper Perigordian times, but it is difficult to control and one needs a lot of training to detach the small flakes at the correct angle.

Bordes usually uses methods 2, 3, and 5, but Crabtree favors method 4.

When a core top is severed, the angle of the blow must be calculaed and delivered to create a striking area platform with an angle corresponding with the desired core type. In most Corbiac cores, this platform is oblique to the long axis of the core (Fig. 4f, 5a), but some have a platform at or near a right angle to the axis. This platform angle is the result of the angle at which the force to remove the core top is directed. An interesting feature of the Corbiac cores is that almost all of the two-ended cores (blades taken off from both ends of the core), even if these blades have been flaked off from only one longitudinal side of the core, present on the other longitudinal side a prepared ridge. The one-ended cores, on the other hand, usually present only the natural surface or cortex on the side opposite the ridge (Fig. 2f). This preparation of the second side facilitates the holding of the core between the feet, and in some cases seems to be a kind of precaution against bad handling of the first side. In that case the angle of the striking platform is "reversed," and blades are taken off the second side. Many of the prepared Corbiac cores prior to blade removal, must have looked like thick bifacial implements. Magnificent samples of this preparation have been recently found by M. Duport in a late Magdalenian "cache" in Charente (la e Magdalenian technique is almost identical with Upper Perigordian technique). But usually the Corbiac core had blades detached from only one side (one sided), often from the two ends. As blades were removed from this face they created new ridges, this face assumed a polyhedral appearance with long longitudinal facets, and the working edge of the striking platform becomes semi-circular or lunate. In our experiments, we were sometimes successful in detaching as many as thirty usable blades from a core (Fig. 3d). Later when Bordes was giving a demonstration at Washington State University, he successfully detached fifty-three blades from a single core. The first blades are sometimes irregular (Fig. 7d) and it is usually after he fifth or sixth blade that they become really "good" (Fig. 6b). Our cores were abandoned when the platform surface was exhausted and they were left with little or not platform surface. The core was by this time elongated and half-cylindrical, showing blade scars on the rounded side and cortex on the other.

Angle of the core top:

At Corbiac very often the top of the core is designed to slant at less than a 45 degree angle away from the apex (working edge) (Fig. 4f, 5a). This provides a bearing surface for seating the punch and prevents the tip of the punch from slipping when the blow is delivered. Because of the obliquity of the surface on which the punch has to be held, it would be impossible to remove a flake or blade if the platform surface slanted toward the working edge.

Other core types, which usually do not have the top at this angle, overcome the slippage of the punch either by grinding or by removing on the striking platform near the edge, small flakes which leave small depressions (bulbar scars) in which to seat the punch. Rough natural surfaces may also be used. These characteristics are sometimes but not often found on the Corbiac type cores.

Platform preparation:

A small hammerstone is used to prepare the zone on which the tip of the punch will rest. The idea is to isolate a small promontory (Fig. 4a) on which the punch will rest, and which will become the butt of the blade. Isolation is accomplished by holding the hammerstone in the right hand, the core in the left hand (Fig. 5b) and pressing and thrusting the hammerstone downward and outward along the edge of the core, above the preestablished ridge. This action will remove small flakes and shape the promontory without causing hinge or step fractures as would be the case by striking even light blows. This operation is continued until the center of the promontory is above the ridge and in line with the axis of the future blade. This preparation isolates a small but strong striking platform and removes any overhang. Sometimes it is also necessary to complete the preparation by removing small flakes from the top of the core on each side of the promontory (Fig. 4a). (Note: these flakes are removed from the top of the core rather than the leading edge.) For additional strength (mainly when working with obsidian, but this also occurs with flint cores) the platform is then abraded on its top by rubbing with a granular stone (Fig. 5b). This abrasion will round the edges and give a roughly polished appearance to the platform (Fig. 5a).

If the striking platforms are on both ends of the core and blades are removed from both ends, the bi-directional core which results will be sometimes mistakenly called bi-polar. True bi-polarism would be the result of force being delivered simultaneously from both ends of the core.

Seating the core on rest:

When the core has been completely and carefully prepared for the first blade removal (the one which will remove the ridge (Fig. 4d, e), giving a "lame a crete"), it is then placed between the feet on a resiliant support to eliminate shhock at the distal end and also to prevent it from slipping. For our experiments, we used a pine board approximately 2 x 2 x 14 (Fig. 6a).

The blademaker assumes a seated position very slightly elevated above the core; places the core on the rest and holds it tightly between both feet (Fig. 5a). The core is positioned on the rest with the side to be flaked pointed away from the worker with its distal end supported by, but overhanging, the edge of the wooden rest when the core is held vertically. This allows the blades to clear the plank and thereby eliminates breakage. The core is held by the feet in different positions following the type of the core and/or the various problems posed by the detachment of each blade, and also following the preference of the worker.

Detaching blades:

The indirect percussion is done with a "punch." This punch is a cut section of antler (reindeer, red deer, moose, etc.) about six inches long with one end flat and the other shaped to a blunt point (Fig. 6a). It is possible to use a stone punch when working flint, and in Palaeolithic layers elongated pebbles bruised at both ends have been found. This is not satisfactory to use on more brittle material such as obsidian. The punch is held in the left hand (for right-handed persons) and its tip placed and held on the platform at a low angle. This angle varies following the type of core, the angle of the platform of the core to the axis, or the nature of the striking platform: rough natural surface, ground surface, preparation by detaching small flakes, etc.

Using a heavy section of antler about fourteen inches long for the percussor (Fig. 5a, 6a), the right hand delivers a blow of sufficient force to the proximal end of the punch to detach the blade. When working flint, the hammer may be stone instead of antler. The antler punch as well as the antler percussor acts as a shock absorber and causes the force to be delivered more gently to the platform of the proposed blade. Wooden punches may also be used, made of some hard wood, like box wood or oak, and if they are placed at the correct angle on the striking platform, this wooden punch can be used time and again without showing much crushing at its tip. This tip can be hardened by fire.

At present, there is no means of measuring the amount of force necessary to remove a blade from a core, for much depends on the type and size of the material and the blade lengths or thicknesses desired. Since the blade is first detached at the proximal end of the core and then literally peeled down its face, the amount of force is reduced if the butt of the blade is isolated from the core by the "promontory technique" prior to blade detachment. A quick "rule of the thumb" method to determine the necessary amount of force is to calculate the area of the ventral side of the proposed blade and then formulate the amount of force necessary for detachment.

When making blades, to get the best possible results, the same material should consistently be used. One becomes accustomed to controlling the blow on a given material and it may take several days to correlate the amount and kind of force necessary when another material too different in texture and elasticity is used. Some materials are worked best with a sharp blow given at high velocity with no follow through; while others are best worked by using a slow blow with a heavy percussor and a follow through. Blades often leave the core at considerable velocity and must be recovered on some type of soft yielding material (such as grass, moss, sand, etc.) to prevent fracture. In some cases when the force of the blow is perfectly controlled, it happens that the blade just "falls" out of the core.

In our experiments, generally the widths and lengths of the blades were variable and were controlled by the form of the working face of the core. The more attenuated the ridge and the narrower the core, the narrower the blade. The thickness of the blade is also controlled by the position of the punch and the design of the platform in relation to the core. The nearer the punch is placed to the leading edge of the core, the thinner will be the transverse section of the blade. A blade that is triangulate will have the platform oriented in line with the single ridge on the core and the blade that is trapezoidal in transverse section is one that has had the platform oriented between two longitudinal ridges.

Marginal striations on the ventral sides were not noted on flint blades but were quite obvious on blades of obsidian. Any deviations of straightness of the ridge or ridges caused the blades to follow the irregularities and a malformed blade resulted. If differential resistance within the material caused the previous blade scars on the core to be malformed then very often subsequent blades would also be malformed. In some cases the ridge can be straightened by detaching a thick blade which does not follow the irregularities. Another way is sometimes to detach a blade from the other end of the core, and so get rid of the irregularities. If the ridge is prominent enough, it can also be perfected by detaching a series of flakes by lateral blows. This explains why some good blades, taken off the core after many blades have been detached, present on part of their back a "ridge" similar to the "first blade" detached from a core (Fig. 4e). Some imperfections cannot be overcome and then the core must be abandoned or transformed into a flake core.

Should a blade terminate in a step or hinge fracture, at half its intended length for instance, then the core must be either abandoned or corrected if possible. This can be done by detaching a blade from the other end, at reduced velocity, in such a way that this blade terminates at the step or hinge fracture. If the fracture was such that it could be taken as a striking platform, one can place the punch on it and so rectify the core. Each error, miscalculation, or imperfection in the material must be considered individually because each presents a different set of problems to the worker. No amount of skill can overcome some of the problems encountered and the core has to be discarded.

For two different knappers the general method can be the same, however different the realization. Bordes makes the Corbiac blades in a seated position with the core held between the feet on a rest, placing the punch at a low angle and striking away, or obliquely, from the body. After he had demonstrated this technique, Crabtree found that he could replicate these blades with this position, but it was more comfortable for him to reverse the striking pattern. He placed the core on the rest between the feet, but with the working surface facing him. He seated the punch on the platform above the ridge at the same angle as Bordes, but with the tip of the punch pointing toward him, instead of away from him, as Bordes does. This was easier and more accurate for him because it did not require leaning so far forward, and also because Crabtree had been doing a similar but different blade technique for the last six months and had become accustomed to this way of working. This position is more dangerous as the blades detach toward the worker, but it has the advantage of permitting the worker to see what is actually happening. Crabtree finds that this variation permitted him to align the punch on the guiding ridge with much greater accuracy and also to actually view the blade detachment. Since the angle of seating the core, striking pattern, punch, and rest are the same in both ways, the characteristics of the blades are also the same. A variant is used by Bordes; the blade is detached laterally, inside the arch of the foot. If the blow is delivered in just the right way, the blade just separates from the core, but rests on the scar.

Characteristics of Upper Perigordian blades:

At Corbiac, and other Upper Perigordian sites, the blades have usually a very small butt (the butt being the part of the core striking platform which is taken away by the blade): it can be either a small circular or semi-circular surface, or a more elongated one (Fig. 7b, c). However, when the butt is wide enough it is often facetted in the "Mousterian way." This facetting is the trace of the striking platform preparation by detachment of small flakes, usually when a thick blade is desired. The size of the butt depends in part on whether the punch has been put on the edge of the striking platform or more inside. Most of the blades with very small platforms have been made by the promontory technique, but it sometimes happens that such a blade is detached without this special preparation of the edge, and one should not conclude, from the presence of some of these blades in an assemblage, that this technique was known to this culture. The presence of this technique is more certain when deduced from the examination of cores.

The angle of the butt on the ventral side of the blade (Fig. 7a, b) depends for the most part on the angle of the striking platform of the core. Here too there are freaks. There is a general if not complete absence of eraillure flakes on the bulb and no fissures radiate from the point of force in the bulbar part. The dorsal part of the blades shows one, two or sometimes more longitudinal ridges. There are very seldom undulations on the ventral side. Most of the time these blades are straight or only a little curved. Crabtree attributes the straightness of the blades to using a rest, for it prevents movement of the core as the blades are detached and simultaneously causes force to be exerted at the base of the core when the blow is delivered on the upper end. Cores not supported by a rest will produce strongly curved blades. This is certainly an important factor, but it seems to Bordes that the shaping of the core also plays a role. Blades from unidirectional cores are more often curved than blades from bidirectional cores, and in some cases Palaeolithic people made special cores to get perfectly straight blades (Fig. 1d).

These blades are further characterized by the frequent absence of undulations and waves of compression, features which are characteristics of those detached from the core by direct percussion with a hard hammerstone. Another distinct feature of the Corbiac blades is their distal end termination (Fig. 6b). The end feathers out without removing any part of the distal end of the core in most cases. This is due in part to the rest, or anvil, and can be controlled to a degree by the angle at which the punch is held.

At Corbiac, where the flint supply was plentiful and the natural nodule huge, blades are often of large dimensions. Blades over 20 centimeters (eight inches) are very common, and most of them have more than 10 centimeters (four inches) in length. But the same technique applies also to small cores, giving two inch blades, or smaller.

Indirect percussion without rest:

Crabtree experimented also with a different and less tiring position of the body. He sat on a little taller stool, placed the core on a pad of folded layers of buffalo hide and held it between his knees for both the preforming of the core and detaching blades (Fig. 8a). This position was more comfortable for him and he was able to make blades with less effort than in the seated position with the core between the feet. However, the blades had then an entirely different character than those made with the other technique, for this method lacked the solid support, or rest, for the core.

Even though the angle of applied force, the type of blow, and the platform preparation were the same, the lack of support on the base of the core allowed the core to be slightly displaced by the blow, and the curvature of the blade was more accentuated (Fig. 7b). Also, the blades did not feather out and they often terminated by taking off a part of the distal end of the core ("lames outrepasses" in French). This knee-holding experiment did show however, that fewer blades were broken because the leather pad acted as a cushion for the dorsal side of the blades, dampening the shock. However it is probable that this method could not produce Corbiac blades with any regularity.

Bordes' observation of this technique led him to a slight modification of his own experiments. He tried wrapping the core in a cloth, or any soft material (like fur) to lessen the shock and prevent the violent propulsion of blades far from the core. This, which did reduce blade breakage, was an adaptation of an experiment he had done in France, coating the external part of the core with clay which gave the same results but was messier. The ideal way, as already pointed out, is to be able to regulate the amount of force of the blow in such a way to detach but not project the blades. This calls for practice and repeated experiments with the same material.

Our experiments in blademaking revealed

technological differences which were significant when related to those of the aboriginal. For instance, we noted that blades made by this technique of knee-holding were similar to the Clovis blades illustrated and described by F. E. Green (1963).

The major difference between the Upper Perigordian (or Corbiac) blades and those produced by this technique is in the degree of curvature of the blade and, interestingly enough, is the same difference noted between the Blackwater Draw blades and blades from Upper Perigordian sites. The Blackwater Draw blades have most of the characteristics of the Upper Perigordian blades, except that they are strongly curved, and so resemble those made by indirect percussion without rest. They resemble rather the Aurignacian blades or other cultures for which the straightness of the blades was not overly important. The fact that a rest **is** or **is not** used may appear to be a minor technological trait, but in reality a pronounced curve in the blade indicates a major difference in manufacture. From our experiments, strongly curved blades are the result of leaving the core free to move when the blow is given on the punch, and flat or gently curved blades result from immobilizing the core by a support placed at the distal end, the side of the core being prepared in such a way that it is more or less straight itself. It is interesting to note that a minor change in technology can cause a major change in the type of blades, a change which can sometimes serve as an archaeological index to determine traditions and/or cultural differences in time and space.

In terms of reproducing the sequence of events in blademaking, some of the blades from Blackwater Draw represent the first stages of blade manufacture. These blades bear on the dorsal side the cortical surface of the core, and have a triangular cross section. One of them (Green 1963; Fig. 3d) seems to show on its distal part the ridge of preparation of the core for the first blade. This indicates the aboriginal flintknapper took full advantage of the additional strength provided by the single ridge on the dorsal surface. But this first blade fell short of taking with it all the ridge; part of it stayed on the core and was taken away only later. Following Green, these blades have been used intensively to cut and scrape, even the ones with cortex on one side. These naturally backed knives were already known by the Mousterians. Other blades from this cache have a trapezoidal section (Green 1963, Fig. 4b, e) and represent blades detached later from the core. This technique is to be distinguished from blades with a trapezoidal cross-section. Blades with triangular cross-section are stronger since there is a greater mass of material than occurs on blades with a trapezoidal cross-section.

If we mentally reconstruct the core from which the curved Clovis blades were detached, it would be quite conical with pronounced curved blade scars on the sides. Also, the angle of striking platforms, in relation to the longitudinal axis, would be the same on the core as is exemplified on the blades. It is a common practice to form a regular surface on the working face of a core by first removing cortex flakes and blades. Blades made during preforming to make the surface of the core regular, have a functional edge and, with the cortex used as backing, they serve as excellent knives and cutting implements. Therefore, it is not surprising that a cache of such blades was found; but it is impractical to assume that the Clovis people defined the sophisticated technique of blademaking and then ceased detachment after the first series of blade removal. It is highly possible that after removing a series of these curved blades, the Clovis people went on to a rest method and ultimately produced straighter blades. This thought is, of course, hypothetical but is certainly substantiated by the Clovis scrapers which give evidence of flatter blades, trapezoidal in cross-section.

Strongly curved blades are unsuitable blanks for projectile points for it would be very difficult to straighten them by flaking both surfaces. Further, Clovis projectile points vary in size and form, and only the smallest could be derived from blades of the dimensions of those from Blackwater Draw (Warnica 1966). The majority of Clovis projectile points were derived from preforms considerably larger than the finished artifact (Agenbroad 1967; Butler 1963; Haynes 1966; Wormington 1957). The indications are that most of the Clovis points were not derived from blades, but rather from large flakes or bifacial blanks formed directly from a nodule or a slab of flint, or chert. Therefore, at present, one can assume that in America as in Europe blademaking encompassed a group of technological traits not directly related to bifacial projectile point manufacture. However, the Clovis blades represented in the Blackwater Draw cache give an incomplete picture and until more blades and, hopefully, cores are unearthed, many technological details will remain uncertain.

Of further note in Green's report is an illustration showing one face of a core from a surface collection in Comanche County, Texas (Green 1963: Fig. 8, 161). It is almost a duplicate of some cores we produced in our experiments with the Upper Perigordian technique. It is a unidirectional core, and the blade scars indicate that the blades should have been flat, not curved, and feathering at their termination. This core seems to show on the left, the lateral flake scars showing the Corbiac type preparation. The blades probably were detached with a punch, the core being poised on a rest, and probably would show a very slight curvature, small striking platforms, and unaccentuated bulbs of force.

Conclusions:

Indirect percussion without rest resulted in typical Blackwater Draw Clovis style blades. However, Bordes points out that when he began making blades with the punch technique he did not use a rest and did not hold the core between the knees. He placed it on the ground and got curved blades with unidirectional cores. So it seems that curved blades indicate a technique in which a hard, or resilent rest is **not** used, while straight blades indicate a hard rest, and probably also a preforming of the core in a slightly different fashion. However, one should not conclude, on the base of **one** or even **a few** blades that such or such technique was used, since sometimes it happens that one gets curved blades with a hard rest, or straight blades with a soft rest, or no rest at all.

The presence of Clovis blades in the New World does not necessarily indicate a blade culture, but only an industry and the knowledge of blademaking. Blades are superb cutting implements, particularly for dismembering large game. Upon becoming dulled, they may be modified into other assorted tools with a minimum of effort. The limited finds of whole blades and cores would seem to indicate a shortage of suitable raw material for making blades. Blademaking is a conservation measure as well as a means of avoiding transportation of surplus material long distances from a quarry.

Blade industries are represented in many parts of the New World from the Arctic to South America. Technologically, blademaking encompasses a wide range of variations and modes of detachment, various flintknapping tools, methods of applying force such as direct percussion, indirect percussion, pressure, and any combination of the three. Numerous techniques and technological traits are represented in both forming and preparation of the surface prior to removing blades. Last but not least the relationship of techniques to the raw material is involved.

Since the discovery of the large, thin, precision flaked bifacial implements at the Simon Site in Idaho, (Butler 1963; Butler and Fitzwater 1965), Don Crabtree has spent much time experimenting with various techniques to resolve this method of thinning. Replicating these implements presented a real challenge for they were thinned by the removal of incredibly large, rapidly expanding flakes from both faces and all margins. Their manufacturing technique was unique because:

(1) The area of fracture of the flake scars on the artifacts is many times the area of the transverse section of the artifact.

(2) The amount of force necessary to remove a flake of this dimension in relation to the thinness of the implement would almost necessarily be too great to detach the flake without breaking the artifact.

(3) The angles of imparted force must be calculated with incredible accuracy.

(4) The intensity of the percussor must be calculated to correspond to the area to be fractured.

(5) The contact point of the percussor and the impact area of the artifact must be diminutive, yet strong enough to withstand the force necessary to remove such a large flake.

All these problems caused me to experiment with various thinning techniques. Although the following described method produces replicas of the Simon material, I cannot resolve this as the actual technique until further experiments are conducted. At the Lithic Technology Conference in Les Eyzies (Jelinek 1965; Smith 1966), Bordes and I had tentatively eliminated a direct percussion technique and also dismissed the possibility of a rest. Now, finally, we had a chance to experiment further with this type of biface thinning.

Thinning of bifaces; first by direct and then by indirect percussion:

Indirect percussion with punch technique was further tried for thinning large bifacial implements such as knives, lance and spear points, large thin discs, and flaked scrapers. This technique includes two phases or steps of fabrication by first direct, and then by indirect percussion. The artifact is first preformed from a large thick flake, or by removing most of the surplus material from a large nodule or rough mass of quarry material, by direct percussion with an antler billet or hammerstone. Then it is later refined with the indirect percussion technique (Fig. 8 a).

Preforming by direct percussion:

(1) The rough material is placed on the thigh of the left leg which is covered with a pad of several layers of buffalo hide. This padding supports the objective piece and, at the same time, dampens the shock induced by the percussor. During the preforming stage of manufacture, the objective piece is held, not on top, but rather on the **outside** of the left thigh. The support provided by the padded thigh relieves the left hand of the entire support of the objective piece and frees the hand to manipulate the piece into position to receive the blows of the percussor. The pad also protects the left hand from bruises and cuts from the flakes as they are detached from the objective piece.

When maximum thinning and forming has been accomplished by direct percussion, then the marginal edges are turned, or beveled. This is done by pressing the edges of the artifact on a basalt cobble until the correct angle is attained. The angle is variable, depending on the form of the piece being worked. Then the longitudinal edge is rubbed on the basalt cobble until the leading edge is slightly rounded (Fig. 8 b). This beveling and grinding strengthens the edges so that any part of the edge can be used as a striking platform and, therefore, individual platform preparation is eliminated during the next step of further thinning the artifact by indirect percussion.

Thinning by indirect percussion with punch:

(2) Now that the worker has reached the limitation of thinning and forming the artifact by the direct percussion technique (1), he further refines the piece by indirect percussion with punch (Fig. 8 a).

The objective piece is placed on the pad on the **inside** of the left thigh with its flat side resting on the pad and the leading edge upright for striking to detach flakes on the side resting on the left thigh. The knees are pressed together to hold the artifact in position. Only the edge of the objective piece is exposed to permit the tip of the punch to be placed on the prepared platform part. I find that the artifact being supported lengthwise on the leather pad and held firmly by the pressure of the thighs has a dampening effect which reduces the amount of breakage when detaching large thin wide flakes. The angle of the punch is approximately the same as that used in detaching blades from the core. However, unlike the detaching of blades from a core, we are not using a ridge to guide the flake removal. Consequently, the lateral edges of the flakes expand. The tip of the punch is oriented in alignment with the horizontal axis of the preform at less than a 45 degree angle while thinning the sides adjacent to the lateral edges. Thinning of the proximal and distal ends is accomplished by placing the tip of the punch at the same angle as above, but pointed toward the gravitational center of the artifact. Gradually, the angle of the punch is increased as flake removal nears the middle of the artifact. Flakes will have to terminate in the midsection of the artifact, otherwise they will remove the opposite edge.

The punch is struck a sharp, quick blow with no follow through. If a heavy blow is struck with a heavy percussor and a follow through used, the opposite edge of the artifact will be removed. For extreme thinning, a caribou antler percussor is used because caribou has a flared, flat surface and the blow can be delivered on the flat part. This gives a greater contact surface, thereby increasing the accuracy of the blow. Because the weight of the artifact is less than a core, the blow is modified. The worker strikes the punch a short blow with greater velocity which prevents undo movement of the artifact. This allows extreme thinning because it removes a thin, rapidly expanding flake which will terminate in a hinge fracture at the median line of the artifact. The curvature of the flake determines the convexity of the transverse section of the implement. Usually, one entire margin is worked in this manner and then the artifact is reversed and the same technique applied, but having the flakes intersect the previously struck flake scars.

Thinning a biface with this technique is difficult and requires much experimenting to judge the proper intensity of the blow and to dissipate the force before the flake travels across the entire surface of the artifact and removes the opposite edge. This technique produces flake scars which are very similar to those found on the Simon Site material (Butler 1963; Butler and Fitzwater 1965) and Debert bifaces (Byers 1966; MacDonald 1966).

Indirect percussion with foot-holding:

This experiment involves the further thinning of a biface which has been previously preformed with an antler billet and simple direct percussion. After this initial step, the preform is placed on the ground, or a layer of damp sand, held in place by the foot and further thinned by indirect percussion with an antler billet and an antler punch. In this instance, the percussor was a splayed section of reindeer antler.

The platform surfaces of the preform are prepared by beveling and grinding the edge to strengthen it to withstand the force to be applied during flaking. Then the artifact is placed in a horizontal position with the long edge of the beveled side flat on the ground, carefully nested until it is evenly supported by the earth or sand. Then the worker kneels on the right knee with the body bent forward. To stabilize the body, the left knee is positioned at the left side of the upper chest and the left foot is placed on top of the artifact but with the beveled edge exposed. Only slight pressure is exerted on the artifact by the left foot, as too much pressure, or an irregularity of the support, will cause the artifact to be broken when force is imparted to the punch.

The punch is grasped in the left hand by the thumb and fingers and held vertical to the long axis of the artifact, but slanted away from the operator at an obtuse angle. The exact angle is determined by the cross-section of the artifact and by experiment. To insure firm seating, the tip of the punch is placed as near as possible to the leading edge and yet not into the body of the artifact. If the punch is placed too far in from the edge, either an excessively thick flake will be removed or the objective piece will break. Also, if the tip of the punch is placed too far inward from the leading edge, the platform part of the flake will expand and a large lunate section will be removed from the lateral margin of the artifact, causing malformation.

Generally, for the first flake removal, the punch is placed on the lateral margin at the base of the artifact. This is the strongest part of the artifact and therefore permits the experimeter to be fairly bold with the first blow without danger of causing an unpredictable fracture of the object. This blow will be the criterion for further blows and one should examine the results to determine if the flake and scar have the anticipated character. If the flake is too short, then the angle of the punch may be repositioned to direct the force more inward into the body of the implement being fabricated. If the flake is too long, then the angle of the punch is held closer to the body of the worker. The amount of force is delivered in accordance with the size of flake desired. Only experiment can determine the amount of force needed.

Flakes are removed bilaterally from both margins in this same manner and the force is gradually dissipated as the flakes are proportionately reduced in size as the thinning process nears the tip of the artifact. When one margin and one face has been flaked, then the edge is reprepared for removal of the next series of flakes from this same edge but detached from the opposite side.

Our experiments with this technique were successful and we concluded that it had possibilities of having been used aboriginally. However, we felt that additional experiments were necessary before any definite conclusions could be reached.

The techniques of foot-holding and knee-holding (previously described) are the same, except for the manner in which the artifact is held. The one major disadvantage of foot-holding is that the flake is removed from the blind side of the artifact, whereas the knee-holding technique permits instant examination of both flake and flake scars.

ACKNOWLEDGMENTS

The authors wish to thank Dr. Earl H. Swanson, Jr., for editing the paper, Lloyd S. Furniss for photographs, Douglas R. Bucy for preparing the illustrations, my wife, Evelyn, for her aid and encouragement and Mrs. Joann Bopp for typing the manuscript.

BIBLIOGRAPHY

Abenbroad, Larry C.
1967 Distribution of Fluted Points in Arizona. **Kiva** 32: 4:

Butler, B. Robert
1963 An Early Man Site at Big Camas Prairie, South-Central Idaho. **Tebiwa** 6: 1: 22-33.

Butler, B. Robert and R. J. Fitzwater
1965 A Further Note on the Clovis Site at Big Camas Prairie, South-Central Idaho. **Tebiwa** 8: 1: 38-40.

Byers, D. S.
1966 The Debert Archaeological Project: the Position of Debert with Respect to the Paleo-Indian Tradition. **Quaternaria** 8: 33-47. Roma.

Green, F. E.
1963 The Clovis Blades: An Important Addition to the Llano Complex. **American Antiquity** 29: 2: 145-165. Salt Lake City.

Haynes, C. Vance, Jr.
1966 Elephant Hunting in North America. **Scientic American** 214: 6: 104-112.

Jelinek, Arthur
1965 Lithic Technology Conference, Les Eyzies, France. **American Antiquity** 31: 2: 277-279. Salt Lake City.

MacDonald, G. F.
1966 The Technology and Settlement Pattern of a Paleo-Indian Site at Debert, Nova Scotia. **Quaternaria** 8: 59-74. Roma.

Smith, Philip E. L.
1966 Conferences: Lithic Technology. **Current Anthropology** 7: 5: 592-593.

Warnica, James M.
1966 New Discoveries at the Clovis Site. **American Antiquity** 31: 3: 345-357. Salt Lake City.

Wormington, H. M.
1957 **Ancient Man in North America.** Denver Museum of Natural History, Popular Series, No. 4. Denver.

Laboratoire de Prehistoire
Universite de Bordeaux, France

Idaho State University

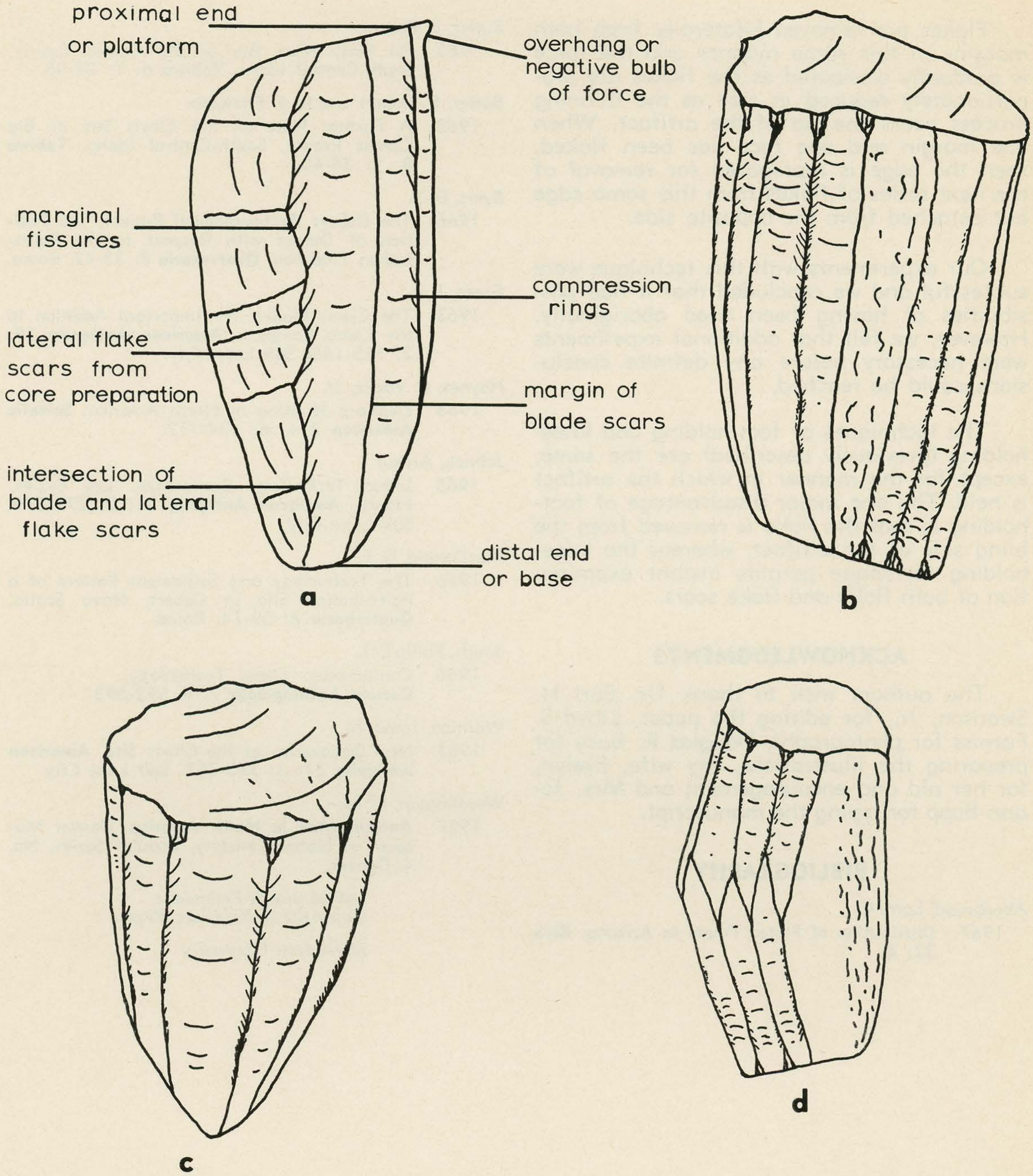


Fig. 1. **a,** unidirectional unifacial core with important features labelled; **b,** bidirectional opposite alternate core; **c,** unidirectional conical or pyramidal core; **d,** bidirectional opposed angular core.

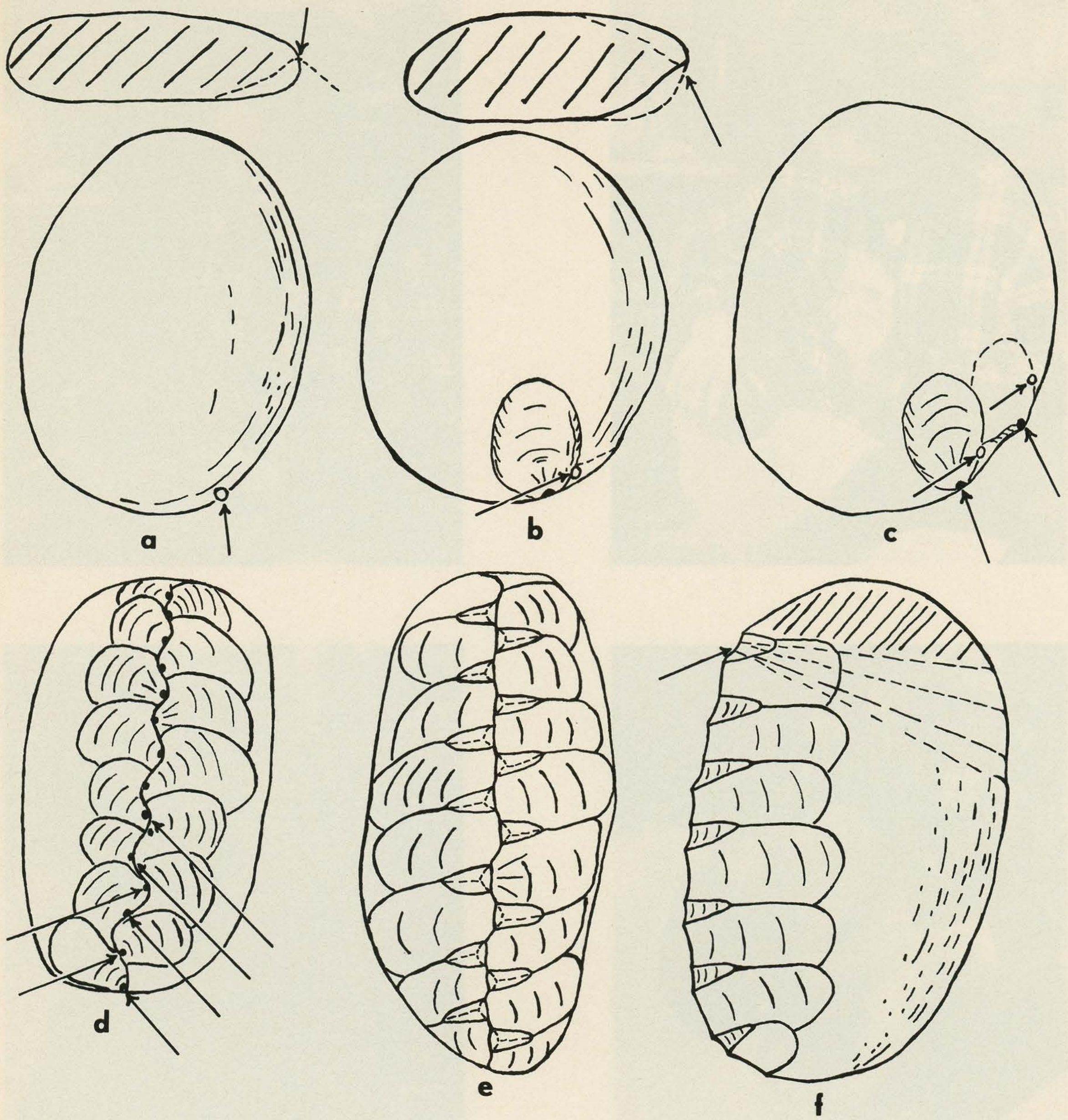


Fig. 2 Stages of preforming a blade core: **a,** removal of first flake; **b** & **c,** removal of intersecting bifacial flakes to form ridge; **d**, edge view showing bifacially flaked ridge; **e,** edge view showing straightening of ridge by removal of small flakes from margins of lateral flake scars; **f,** side view of core preform showing proposed removal of the end to form the striking platform.

Fig. 3. **a,** Bordes using a hammerstone to remove the first flake from a rounded obsidian cobble; **b,** obsidian cobble and first flake removed with the hammerstone; **c,** core preform and flake removed with a hammerstone to form the striking platform; **d,** a series of Corbiac style blades and two cores, note the straightness of the blades.

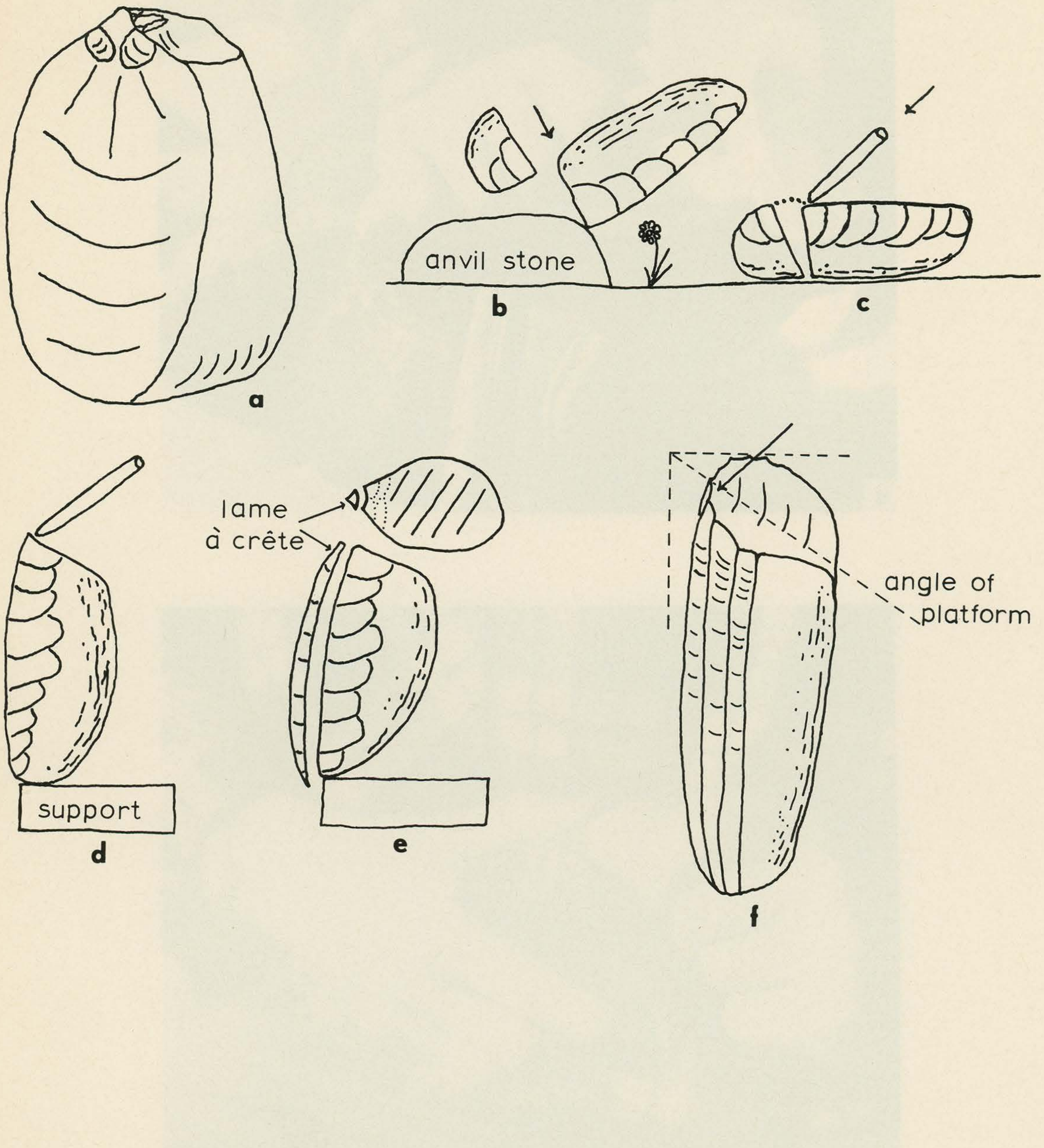


Fig. 4. **a,** end of core showing isolation of platform and removal of small flakes from top of core to provide a seat for the punch; **b,** removal of end of core preform by striking on anvil; **c,** removal of end of core preform by indirect percussion; **d** & **e,** core on rest, note angle of punch and removal of ridge giving a "lamé à crête"; **f,** unidirectional unifacial core, note angle of core platform.

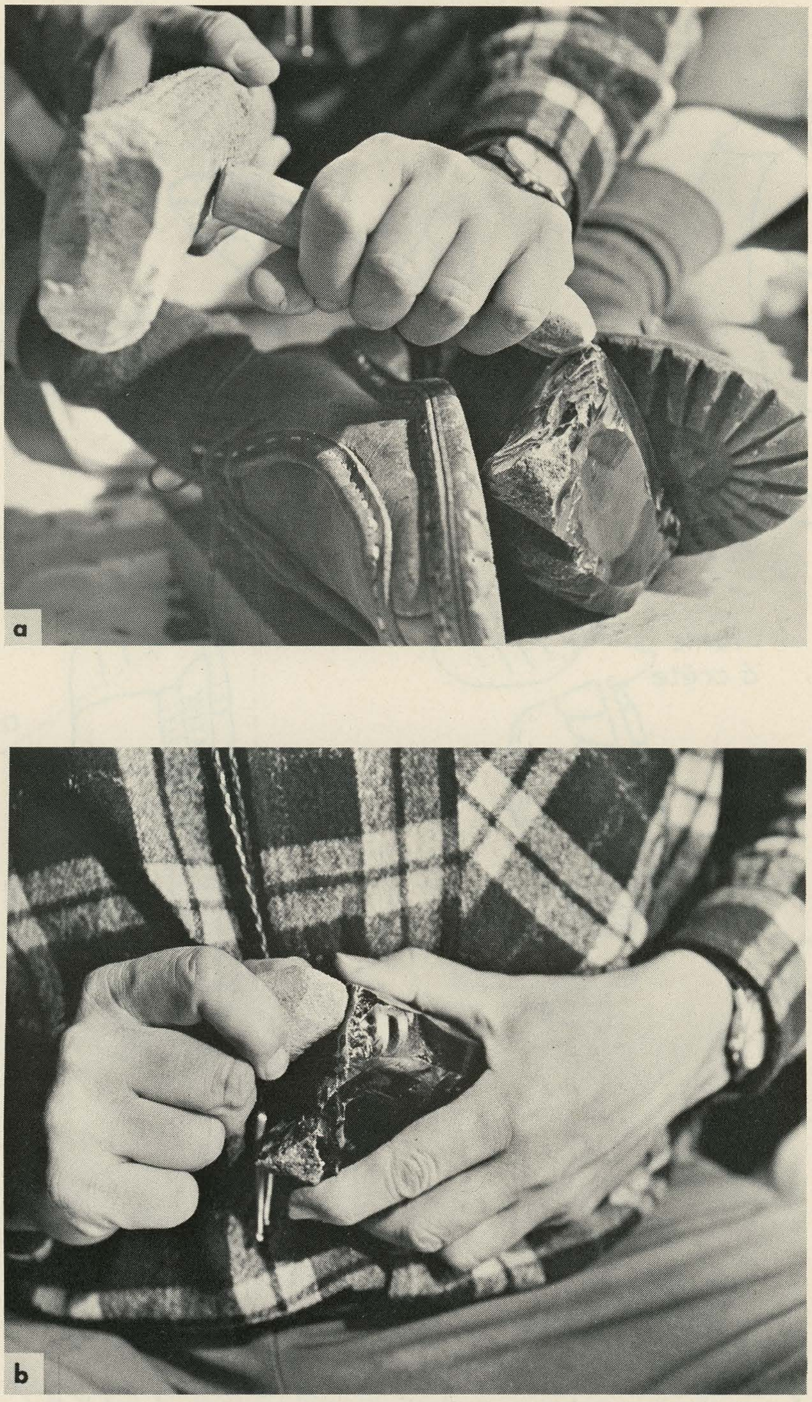


Fig. 5. **a,** core held between the feet and resting on the support with punch and billet positioned for blade removal, note the angle of the punch and of the core platform; **b,** platform preparation with a small granular abrading stone which isolates a platform and abrades the edge of the core.

a

b

Fig. 6. **a,** tools used in Corbiac technique, two antler billets, a hammerstone, a small abrading stone and two antler punches resting on the wooden anvil; **b,** core and blade produced by the Corbiac technique, note the straightness and termination of the blade.

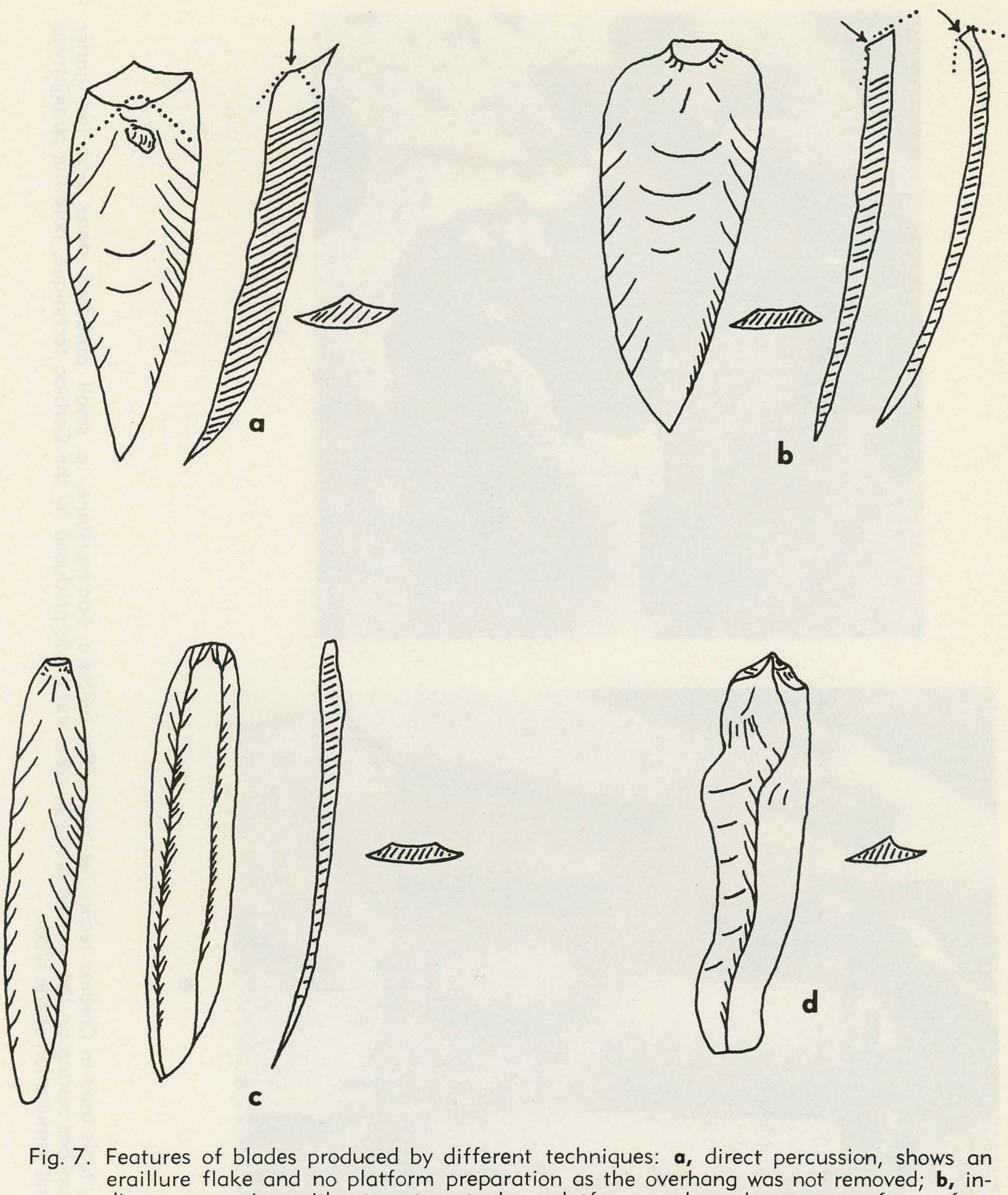
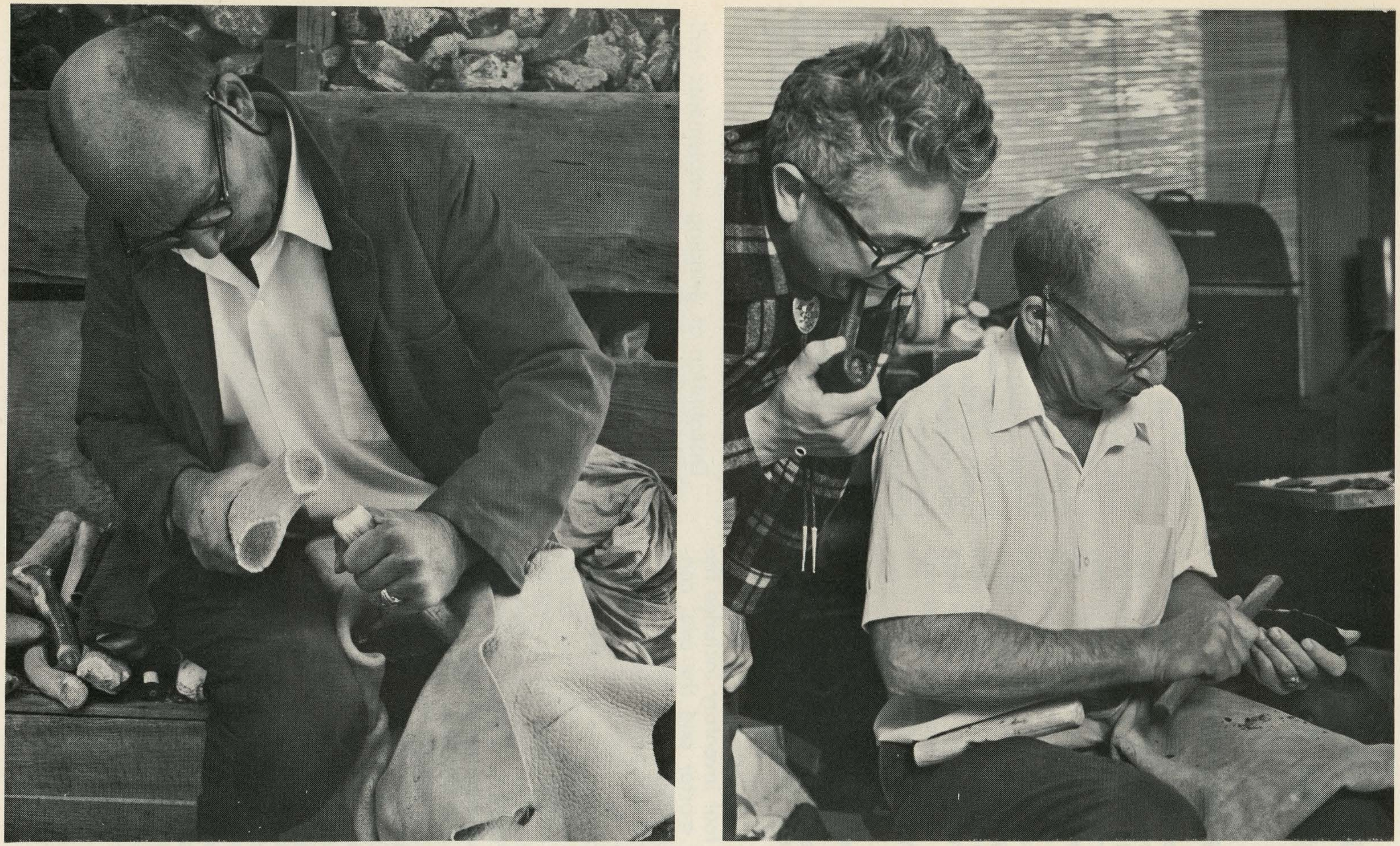


Fig. 7. Features of blades produced by different techniques: **a,** direct percussion, shows an eraillure flake and no platform preparation as the overhang was not removed; **b,** indirect percussion without rest, note how platform angle and curvature of core face affect the cone of force; **c,** indirect percussion with rest, note the small size and preparation of the platform, regularity, thinness and straightness of the blade; **d,** irregular blade, note how the form of the dorsal ridge controlled the shape of the blade.



a b

Fig. 8. **a,** Crabtree producing blades by indirect percussion without rest, this holding method is also used for biface manufacture by indirect percussion; **b,** Bordes observing while Crabtree abrades the edge of a biface to strengthen and prepare a striking platform to allow further thinning.

THE GEOGRAPHICAL AND CULTURAL CONTEXT OF THE ORIGIN OF GRINDING IMPLEMENTS IN EURASIA

By Malcolm F. Farmer

INTRODUCTION

The world wide distribution of the metate and muller and other grinding implements suggests some antiquity for such artifacts and the possibility that central southern Eurasia may have been an important center for distribution. The accumulation of data has underlined the potential of the Eurasian area as a possible hearth area of grinding implements. This paper examines the potential of Eurasia with regard to these implements with some suggested hypotheses on the ecological and cultural context of the beginnings.

Grinding Implements In The Middle East

Grinding implements are present immediately following the Zarzian phase of the cultural sequence in the hilly flanks of the Zagros Mountains of northeastern Iraq and western Iran. The tool inventory includes the deep bowl type or mortar and the oval concave to flat type, known by a variety of names including quern or saddle quern, milling stone, neither stone, or in the New World, the metate. The Zarzian phase was in transition from the terminal level of food collecting to the level of incipient cultivation and domestication of food plants. The time was between 10,500 B. C. and 9500 B. C. This great leap to the new tool inventory is recorded in such sites as Palegawra and Shanidar. The cultural context is Upper Paleolithic, particularly Mesolithic. There are various microlithic tools, backed blades, small scrapers, and items which show the early stages of a whole new series of stone implements and other objects shaped by pecking, grinding and polishing (Braidwood and Howe 1962). The origins of these grinding implements offers a problem of some interest and importance because such implements opened a new food potential and became widely associated with the development of agriculture. The oval concave to flat milling stone in particular made possible the realization of the greater potential of the new food supply, particularly small grains. These tools offered a mass production technique. Grinding was a hard task and with the flat milling stone it was possible to add more grain after the processed grain was pushed off the end of the grinding surface, with little or no break in the rhythem of the work. With the mortar the operation of pounding had to stop each time to remove the ground material from the bowl area so that new material could be placed for processing. These implements are also of interest for a better understanding of the possible movements of man and his artifacts and because of the problems of innovation and independent invention. Studies of grinding implements are hampered by inadequate reporting and in some areas lack of recognition. There is no standard terminology or nomenclature, nor has there been an adequate development of typology on a world-wide basis. Reporting will no doubt be inadequate until there has been more accomplishment along these lines.

Distribution of grinding implements indicate that such artifacts are present in many areas of the world (Farmer 1960). Such implements are usually associated with grasslands and open woodlands and the distribution includes Africa, Eurasia, Australia and the Americas. In Eurasia the greatest concentration appears to be associated with the Dry Belt from Anatolia in the west to northern China in the east. This distribution and the antiquity of these implements in the Middle East suggests the possibility that this may have been or was close to the center of origin and development.

As the transition from gathering to incipient agriculture gathered speed in the Middle East milling stones became important. Some of the best data has come from the mid-point of the Middle East distribution, sites such as Zawi Chemi, Shanidar, Jarmo, Karim Shadir, Palegawra, and others. The Middle to Upper Paleolithic sequence in the area included the Mousterian, then the Baradostian, technically of the Upper Paleolithic, followed by the Zarzian. The Baradostian dates from some 26,500 to 34,000 years ago. The Zarzian developed out of the Baradostian