The Obtuse Angle as a Functional Edge

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The interpretation of the diverse functional uses of stone tools has, to date, been based principally on a theoretical analysis of their wear patterns. (Bordes 1968, Semenov 1957). This has been our most reliable archaeological guide, but actual functional experiments will give more substance to the theory. Questions must be posed and answered such as: What materials was prehistoric man forming, altering or modifying with his stone tools, and at what angle did he hold the working tool? Were the stone tools held only in the hand when performing these tasks or were they affixed to a handle or holding device by fitting and wedging? Were they adhered to other materials with vegetable resin, or were they lashed to stocks and shafts? Many stone artifacts have been placed in typological categories which imply function. Some are correctly typed because of actual observation and ethnographic accounts. Others are functionally typed based on theory of on the industries of a particular site which place similar implements bearing certain technological characteristics into useful typological categories. However, this tends to associate various shapes with specific functions when, in reality, they could have been multi-purpose tools. As a result, artifacts not conforming to these categories are said to be non-diagnostic and are often discarded as debitage, lithic debris, flakes, exhausted cores, or general manufacturing by-products. The most reliable source of implied function is a careful analysis of the wear pattern on the edges or ridges of lithic implements.

The use of obtuse angled edges or ridges of artifacts as working edges has generally been overlooked or ignored in the past, whereas recent evidence reveals functional scars and wear patterns on these angles. The results of functional experiments indicate that these obtuse angles provide additional diagnostic traits. The obtuse edge of a tool will often show polish when it is used continually on homogeneous materials. Striations or scratches on the obtuse edge are the result of abrasive contamination, while occasional minute step fractures are due to improper holding, too much pressure, or the non-homogeneous nature of the material being worked.

We know from experiments and from archaeological evidence that the acute angle or a flake or blade is an excellent cutting edge for yielding materials, but we have failed to consider the functional value of the obtuse angle of more than 90° and less than 130°(Fig. 1). (The obtuse angle of more than 130° has proven so far to be too flat to have functional value.) Experiments in function reveal that the obtuse angle on stone tools can perform tasks which are impossible to complete with stone tools having acute angle edges of 90° or less. The use of the obtuse angle as a cutting edge has been a revealing experience and has opened the door to further experiments to determine the diverse uses of this angle as a functional edge.

Experimental results show that the obtuse angle on stone tools made of material even as fragile as obsidian can be used to remove spiral shavings from dry bone with accuracy and control, and the tool will still retain its cutting edge. For example, the use of the obtuse angle of a stone tool provides a clue to the elaborate carving of lintels of extremely hard wood (sapodilla) used in temple construction by the Maya in Yucatan. Using the obtuse angle of a stone tool may also explain the modification of other resistant materials such as bone, horn, antler, and ivory. When the acute angle edge is used to work this type of resistant material, the tool will either break or the edge will dull before the task is completed.

I made replicas of obtuse angle tools and then used them in many ways -- cutting at different angles, holding in different positions, and cutting and working a variety of materials. Both the cutting tool and the material being worked were compared with archaeological specimens in order to evaluate the striations, polish and functional flake scars. In each experiment, both the tool and the material being cut or formed were the same as those employed in prehistoric specimens. It is essential that the worker use the same materials for modification as those which were available aboriginally--whether they are being gouged, planed or chopped--in order to verify the manner of holding and function. Some implements having acute angle edges, such as the obsidian blade, require light force for cutting soft materials. The thumb and index finger furnish sufficient force for these light cutting tasks; but when the obtuse angles of tools are used for cutting, more force is required--much the same principle as our modern lathe. The acute angle can be used to work softer material while an obtuse angle is used to work more resistant material. The angle of the tool edge must correspond to the resistance of the material being worked. During the functional experiment, the worker must keep in mind the brittle nature of the stone tool and he must be familiar with the tool's strong and weak areas. These tools cannot be twisted or used in a levering way, and must be kept in correct alignment with the opposing resistance of the material being worked. Skill in using any hand tool requires practice and reasoning, which necessitate continued experimentation. Even when experiments yield good results, they may not compare to the work of a skilled aboriginal workman.

One source of an obtuse angle cutting edge is a blade scar ridge on a polyhedral core (Fig. 2a). The parallel blade scars are slightly concave between the ridges, making the ridges satisfactory obtuse angle working edges. The core is used as one would use a draw plane--holding the proximal and distal ends of the core with the right and left hands. The modern draw plane or draw knife can only be pulled toward the user, but the obtuse angle edge on a polyhedral core can be pushed or pulled. The polyhedral core is drawn at a slight angle rather than at right angles as one would use a modern plane. When used in this fashion, the depth of the cut may be accurately adjusted by a slight change of angle of the bearing surface. The obtuse angle of the cutting edge is far stronger than an edge of 90° or less. When soaked antler is worked, shavings three inches long may be removed with a single pass of the core. I know of no single edged metal tool which will remove material with the speed of the obsidian core too. The cuts are very clean and smooth and show no bruising of the surface being planed. When the core planer is used on very hard wood, the finish is excellent and the core can be used to produce flat surfaces. It is surprising how durable the obtuse angle edge can be. Use flake scars along the edge generally result from holding the tool at the wrong angle, or lack of homogeneity from contamination of the material being planed rather than from function. When the obtuse angle of the core is used repeatedly on resinous wood, resin will build up and impair the cutting action. The resin then must be scraped off or removed with solvent, or a new blade must be detached from the core to expose two new sharp cutting edges or the entire polyhedral core can be rejuvenated by removing a series of blades around the perimeter to expose new obtuse angle cutting edges.

The surprising and excellent results of using the obtuse angles of a core as a shaping and forming tool for antler, hardwood and bone prompted me to look for similar angles on other artifacts to use in cutting experiments. Similar experiments with both burin blades and cores resulted in only moderate success. Using the burin core in the manner of an engraving tool resulted in the core slipping and its corners breaking after a few passes. This occurred generally when the tip was lifted upward to terminate the cutting action. After a minimum amount of work on hard material, the right angle edges of the burin c ore would crush due to the formation of minute step flake scars on the margin. However, if the burin blade was removed at more or less than a 90° angle to the margin of the core, both acute and obtuse angles were formed on the core's edge. The acute angle was excellent for working soft woods, while the obtuse angle was good for working more resistant materials. Failure to correctly use an angle of 90° or more is probably due to a lack of understanding of the proper use of the many prehistoric styles of burins.

The natural facets on quartz crystals can also be used as forming tools but are neither as efficient nor as effective as the artifically made obtuse angles on cores and other tools. The natural facets on the crystal are plane surfaces, while those made by removing a blade or flake from a core leave concave surfaces between the obtuse angle ridges, giving a sharper cutting edge.

If the crystal is made into a blade core by removing blades longitudinally, the obtuse angles of the blade scars are a far more efficient cutting tool than the natural facets. However, the bruises found on the natural obtuse angles of a quartz crystal from Bandarawela, Ceylon may well be the result of function (Allchin 1966. Fig. 30).

Another functional experiment involved the use of a strangulated blade (Fig. 3a). Obsidian archaeological specimens from the El Inga site in Ecuador were brought by Carl Phagan to the 1970 Idaho State University Flintworking Field School. We made replicas of the originals from obsidian. In archaeology this strangulated blade has been classified as a spokeshave. We attempted to use it by placing the concave edge on a wooden shaft and pulling the ventral side of the blade toward the worker. This removed only a slight amount of the wood and left a very irregular cut on the shaft. If additional pressure was applied to the blade, it broke. We then noticed striations on the ventral side of the El Inga specimen between the two opposing concavities which comprised the strangulation. These striations gave us a clue to the manner in which the implement was held and used. The striations indicated that the slightly convex ventral side of the blade was placed flat on the wooden shaft after being shaped. The convex surface acted as a bearing and aided the adjustment of the depth of the cut being made. When we used the strangulated blade in this manner, it made a flat smooth cut and required little force to remove a clean shaving. Both concavities served well as cutting surfaces. The opposite concavity on the blade permitted the worker to tilt back the blade to terminate the cut. When used in this manner, the blade did not break because little force was necessary to remove shavings from the material being worked.

Further functional experiments with the strangulated blade showed that the angle of the cutting edge of the blade could be made acute for soft materials or obtuse for cutting harder materials (Fig. 3b). If the cutting edge was too acute or was used improperly, use flakes were removed from the ventral side of the blade rather than the concave portion of the strangulation. Many tools other than blades exhibit an obtuse angle, and these can be simply and rapidly made or resharpened. Often by the removal of a single flake a new working edge is exposed. It is possible to misinterpret this single sharpening flake as a tool when it is only a reconditioning or resharpening flake.

Robert Heizer showed me obsidian cores from Papalhuapa, Guatemala which were formed by blade removal but which also showed evidence of function on the obtuse angle ridges. The blade scar ridges on the cores were dulled which indicated that they could have been used as planes, wedges, reamers, drills, anvils or pointed percussors for making soft stone figures, and some could have been sectioned to be used as preforms for ear plugs. This site is important because it is near the source of raw material and should illustrate many manufacturing steps which can be related to ethnographic accounts. A preliminary report of this site has been published by John A. Graham and Robert F. Heizer (Graham and Heizer 1968). In 1970, Dr. Junius Bird, from the American Museum of Natural History, gave me a collection of six obsidian cores from Oaxaca, Mexico which all showed signs of wear on the obtuse angle ridges. Obsidian polyhedral cores from the Metro excavations in Mexico, D. F. shown to me by Jose Luis Lorenzo in 1970, showed apparent use of blade scar ridges. Included was one core which indicated that the distal end was used as a drill or reamer until the core was worn to a smooth cylindrical shape. I collected obsidian polyhedral cores from Teotihuacan, Puebla, Colima, and the coast of the State of Nayarit, all of which bear evidence of the use of blade scar ridges as cutting and forming edges. Through personal communication with Denise de Sonneville Bordes (1970), I learned that she has noted evidence of functional scars on the dorsal ridges of blades from the Upper Paleolithic of Southern France. Personal examination of a blade from the Clovis site at Murray Springs, Arizona (1966) showed intensive wear and polish on the dorsal ridge while the lateral margins were still quite sharp. This suggests that the ridge was used as a cutting implement <u>before</u> the blade was detached from the core. When the ridge became dulled, a blade was detached from the core to expose two fresh useful ridges. The core with multiple obtuse angle ridges would have been an ideal implement for rapidly shaping the shaft wrench made from the long bone of a mammoth found at Murray Springs (Haynes and Hemmings, 1967). Occasionally cores are noted which are not exhausted for further blade detachment, but their ridges bear evidence that they were used for shaping tools while the core was still of adequate size for a specific function.

Functional polish appearing on some aboriginal artifacts presents problems of use analysis. Use polish is frequently observed on scraping and agricultural tools which usually have acute angle working edges. Scraping generally rounds or polishes the working edges, conceivably due to the abrasive nature of sandy soils on wet hides. The polish noted on agricultural tools could well be the result of continual digging and tilling, but polish and edge rounding also appear on tools which have acute and obtuse angle working surfaces. A tool with a rounded polished edge ceases to cut or plane and will only function when an excess of force and energy is applied by the worker. However, the rounded polished edge will work well as a burnisher. It is difficult to understand why prehistoric man would use an edge until it acquired a polish when a more functional edge could be established by detaching a flake to expose a new, sharp edge.

Diverse functional experiments were performed over a considerable period of time: cutting antler, bone, grass, hardwood, etc. using tools with both acute and obtuse angle edges. Yet there was never a sign of polish on the edge, and use flakes were detached only when the tool was used improperly.

Due to the durability of the stone tool and the amount of use and abuse necessary to establish functional polish or scars, criteria for determining function must be approached with caution. Many tools may have performed their task and been abandoned before they exhibited any functional scars or polish. To wit - the axe. When an axe is used, most dulling is due to misuse rather than from chopping clean wood.

Obtuse Angle Burin

The success of using the obtuse angle for forming and shaping by the planing technique prompted me to experiment with slotting implements. An obtuse angle burin appeared to be the logical tool for cutting strips from antler and bone to make harpoons, needles, awls and similar implements.

It is a simple task to make a burin by modifying a thin flat flake from a right angle to an acute angle by either percussion or pressure (Fig. 4a-c). However, establishing an obtuse angle on the burin becomes an apparently impossible task (Fig. 4d). When the worker is making an acute-angle burin, he can strike off a spall having an obtuse angle. This spall is the bulbar part, so even though the spall is obtuse it has a rounded edge which will not cut. An effort was made to produce an obtuse angle burin by detaching a flake with an edge of less than 90° (burin spall). The platform had to be tilted to receive the force; but when pressure was applied the tool would slip, and if percussion was used the percussor would ricochet. At this time it appears mechanically impossible to make an obtuse angle burin by either pressure or percussion using the established technique.

This failure caused me to mentally review aboriginal collections examined in the past which may have contained this characteristic. I recalled seeing a handful of such flakes from the Artic shown to me by Dr. Fred Johnson of the Peabody Institute which resembled broken ostrich shell and had margins with double edges of 90°. One margin of these flakes had an obtuse angle and the other margin had an acute angle. Both edges of all margins were 90° to the dorsal and ventral sides of the flakes. This seemed abnormal, since snapped flakes or blades generally have one edge of the margin with a 90° angle while the other edge of the margin is rounded due to the breaking or snapping process. This breaking or snapping process does not produce a margin with a double 90°; therefore this double 90° angle presented a question of manufacturing technique. Dr. George Agogino had also sent me a flake assemblage from the Lindenmeier site which contained a number of flakes with the same type of fracture as the Artic specimens. Ruthann Knudson also had a similar assemblage of flakes from the Claypool site in Colorado which contained a number of flakes exhibiting double 90° angle edges. These were termed pseudo-burins because the fracture force was different than the force applied to make normal burins, which are struck or pressed off longitudinally from the edge of the flake.

The shattered flakes of the Peabody collection had the appearance of the debitage of a broken window pane supported by its casing and broken by the force of a thrown rock or ball. The breakage was caused by both the support of the casing and the force of the projectile. Fractures resulting from this type of breakage commonly have double 90^{o} edges on one margin.

Using the support and projectile principle, an experiment was made to replicate this style of fracture. An indentation was made in a soft stone to resemble a "nutting stone" (Fig. 5a). The flake was then placed over this concavity and a punch of pointed stone or antler was placed on the flake and aligned with the concavity. The punch was dealt a sharp blow causing the flake to shatter. The force applied to the punch over the nutting stone concavity produced the desired double 90^{o} edges. This type of intentional fracture will produce flakes with edges at right angles to the ventral and dorsal surfaces of the original flake. It will also cause the flake to break geometrically into pieces resembling triangles with both obtuse and acute angles (Fig. 5b-c).

The use of the concavity and the punch may be only one of several ways to produce this distinctive style of fracture. The pseudo-burins must be selected from the flake shatter which is composed of both acute and obtuse angle burin-like objects. When the pseudo-burins are affixed to a handle with adhesive, (Fig. 6), the obtuse angle of the pseudo-burin will outlast and outcut burins of 90^{o} or less when used on hard materials.

Because of the infrequent appearance of the classic burinations of tools from Middle America, the unidentified pseudo-burin may have been used to accomplish the same function as the conventional burin.

In conclusion, limited experiment and limited examination of paleolithic implements indicate that more lithic debris should be retained and intensively examined and should not be discarded as non-diagnostic. It is entirely possible that distinct technological traits, characteristic modes of use, manners of holding or hafting, and the nature of the material being worked can possibly be defined by this lithic debris. We also may find multi-purpose implements. It has been a revelation to find that for some tasks a thin, sharp acute-angled edge will not perform as well as an obtuse-angled edge. Aboriginal tools bearing an obtuse angle working edge may not fall into the categories of well defined types. Some may be asymmetrical or without definite form, but a careful study of the wear patterns on the obtuse angles may determine the amount and type of function, and the way in which these tools were used.

My functional experiments were hampered by the lack of imperative "know how" of the aborigine in using lithic tools, and it is doubtful if today we can ever approach his functional skill with stone implements.

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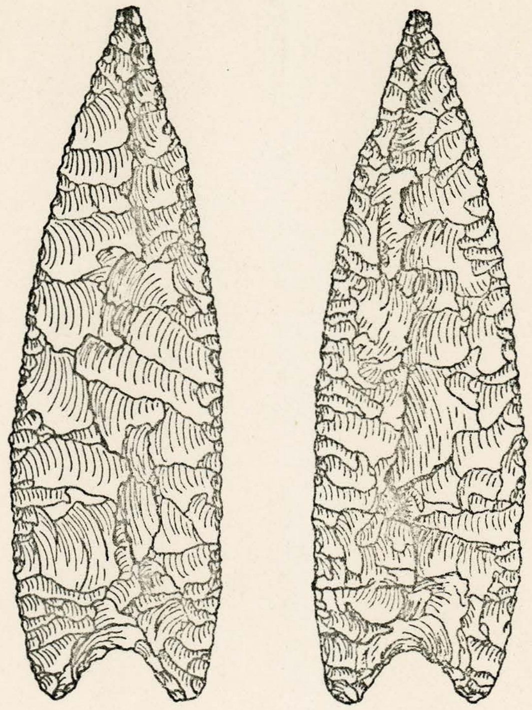
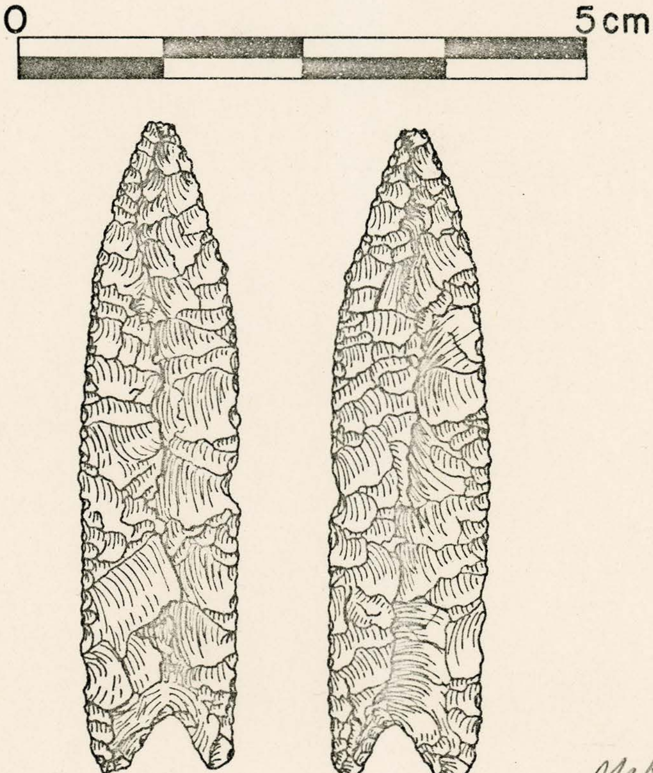
Cutlines

Figure 1a	Prismatic blades with obtuse angle ridges indicated by hatching.
1b	Obtuse angle ridges on a segment of blade.
1c	Obtuse angle edge on lip of flake.
Figure 2a	Polyhedral blade core showing obtuse angle ridges.
2b - 2e	A variety of cores exhibiting usable obtuse angle cutting edges.
Figure 3a	Strangulated blade cutting yielding material.
3b	Right angle, acute and obtuse angle cutting edges.
Figure 4a	Right angle burin
4b	Acute angle burin
4c	Acute angle burin with obtuse angle burin spall.
Figure 4d	Obtuse angle burin attempt. Force will not remove burin spall.
Figure 5a	Punch applied to flake resting over concavity in "nutting stone."
5b	Thin flake with radiating fractures.
5c	Segment of fractured flake showing acute angle and obtuse angle cutting edges and double 90° edge.
Figure 6	Obtuse angle burin mounted in wood handle with adhesive.

Fig. 1.



a



b

McKean Lanceolate
McKean Type Site
J.P. Green

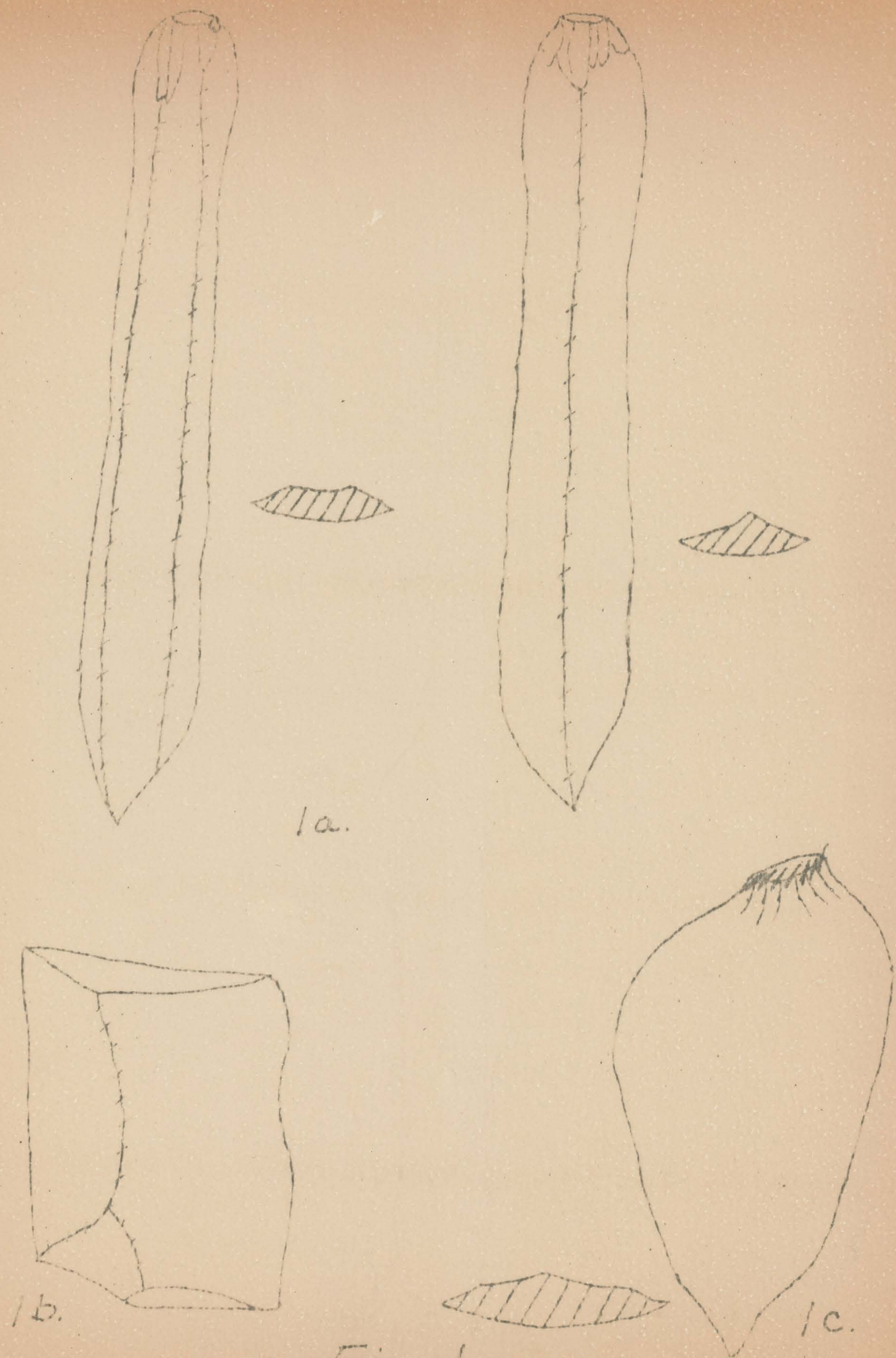


Fig. 1

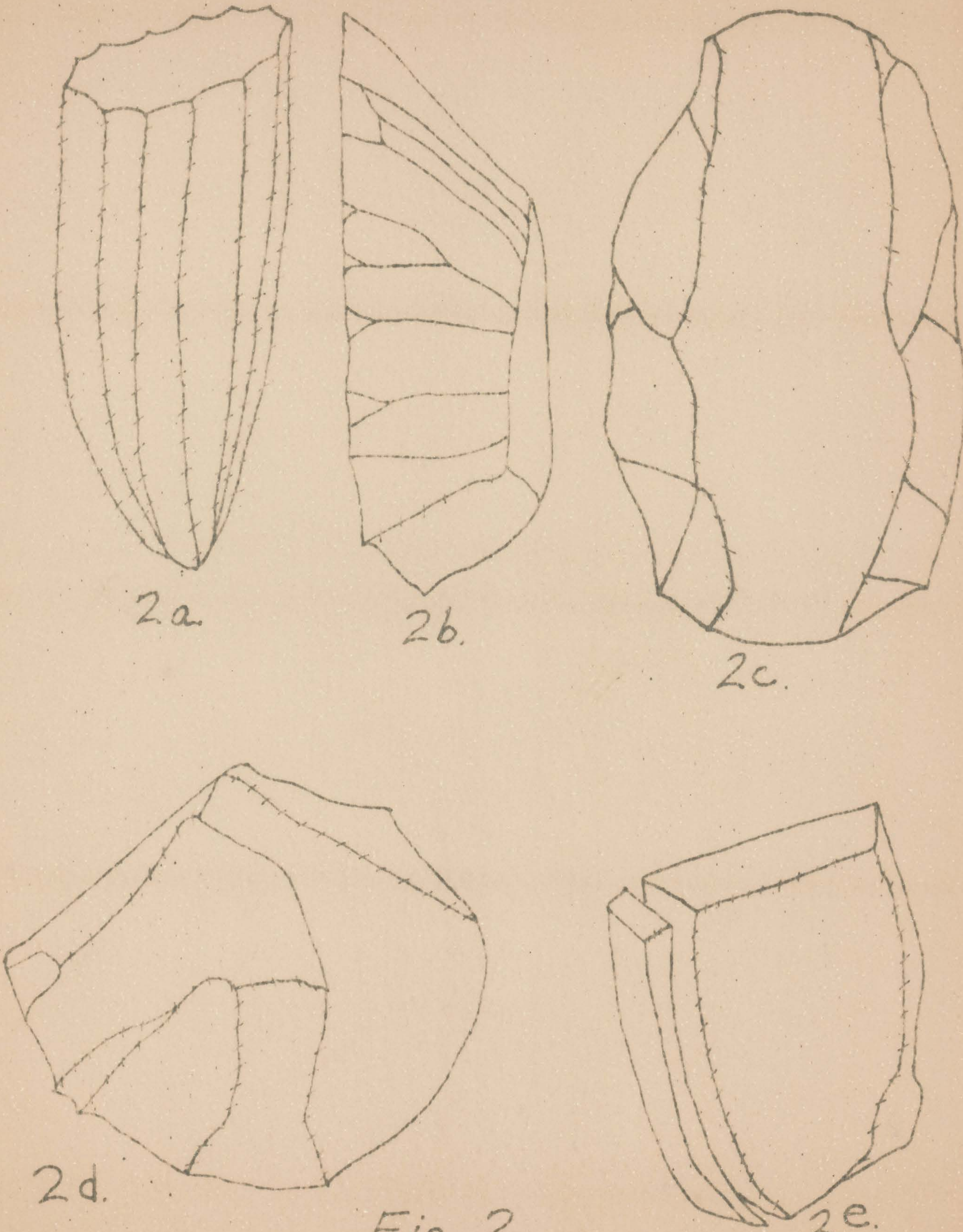
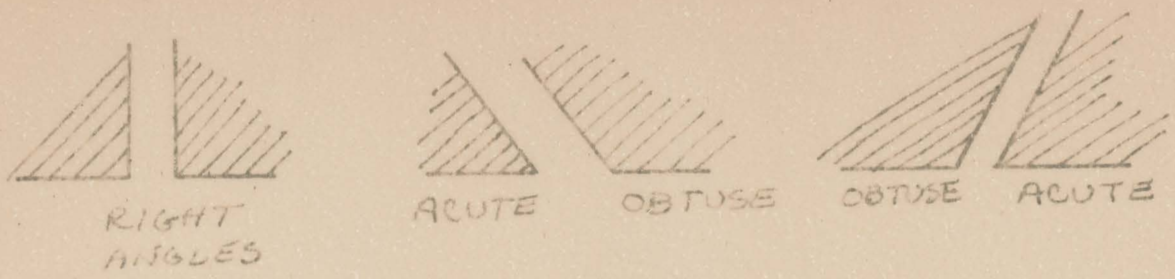
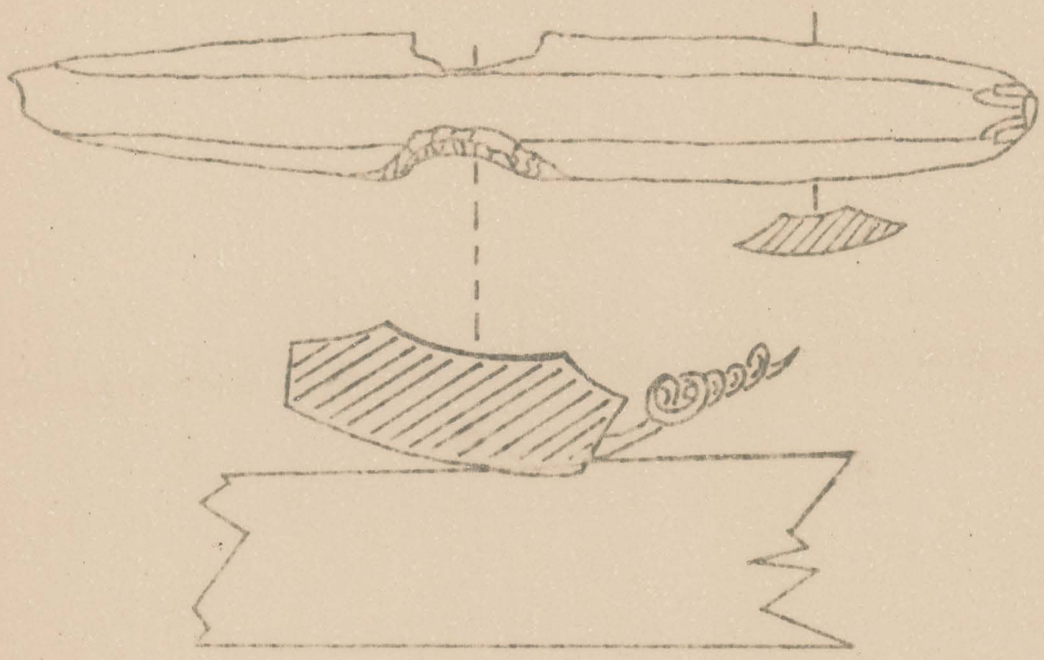


Fig. 2

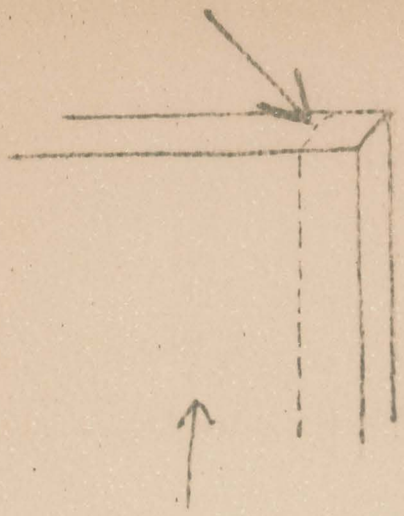


3b.

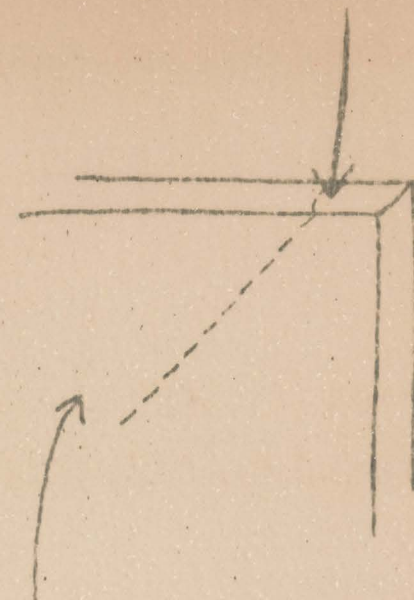


3a. STRANGULATED BLADE CUTTING WOOD

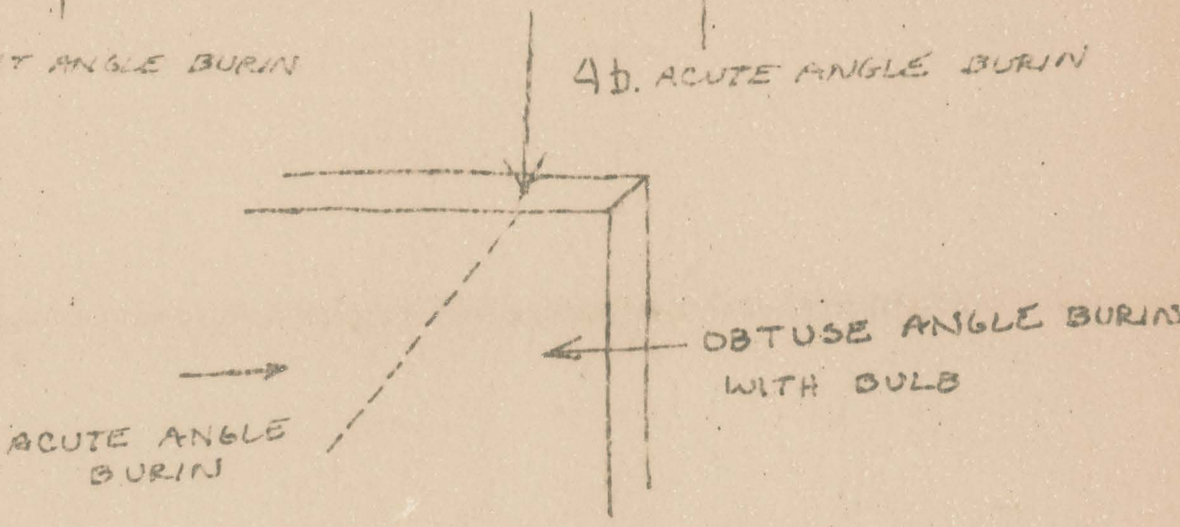
Fig. 3



4a. RIGHT ANGLE BURIN

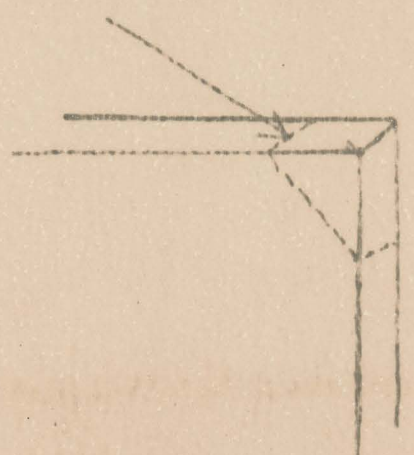


4b. ACUTE ANGLE BURIN



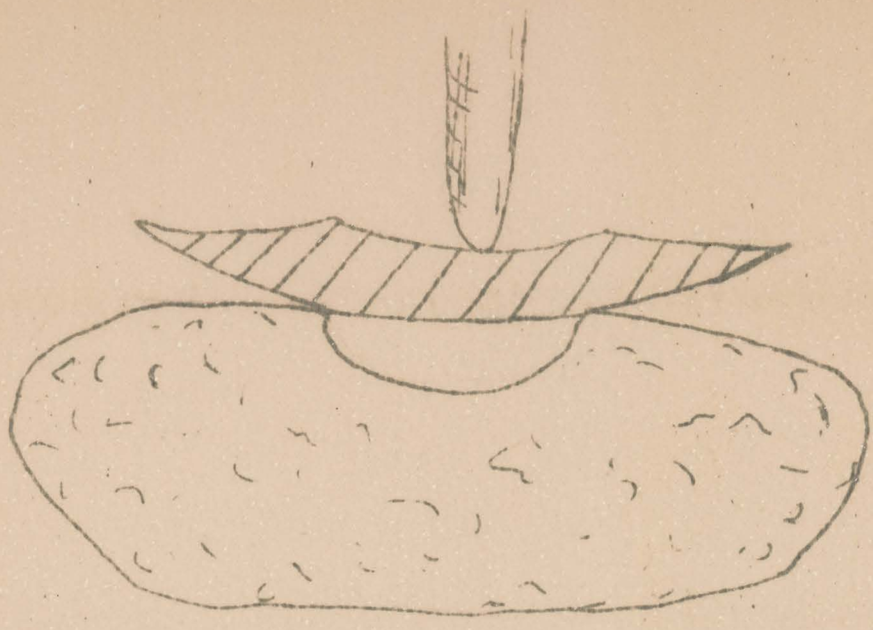
4c.

CONVENTIONAL BURIN BREAKS

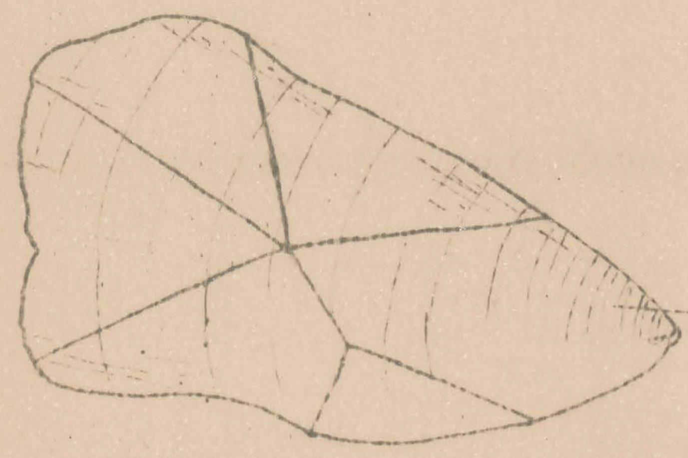


4d. OBTUSE ANGLE BURIN ATTEMPT
Force will not remove burin spall

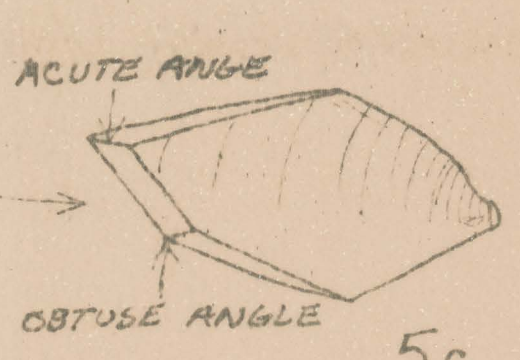
Fig. 4



5a. PUNCH APPLIED TO FLAKE RESTING OVER CONCAVITY IN "NUTTING" STONE



5b. THIN FLAKE WITH RADIATING FRACTURES



5c.

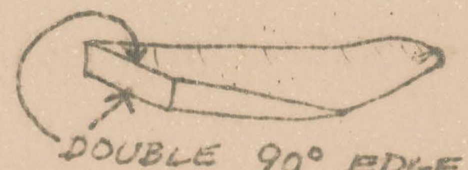


Fig. 5

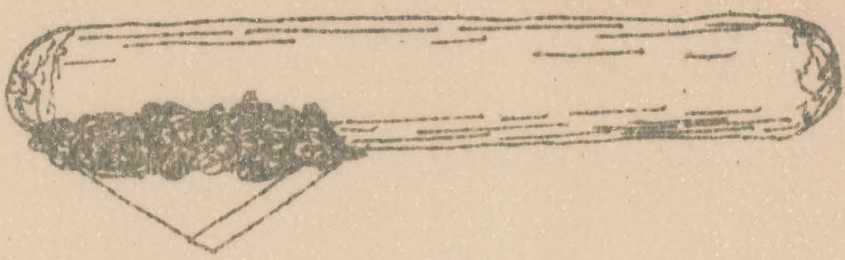


Fig. 6