Bob Lawrence
Dept. of Anthropology
Washington State University
Pullman, Washington

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An Analysis of Wear Patterns on Utilized Flakes

This analysis is growing out of a unique experience that I had the opportunity to participate in this past summer. This was the 1974 summer Living Archeology Field School held by Virginia Commonwealth University with Errett Callahan as instructor. The purpose of the field school was to replicate the material culture of the Middle Woodland Indians and to carry out field experiments that may shed light on the technology of these primitive peoples. The accuracy of experimental replication was stressed (Callahan, 1974 a), and flakes being the simplest, were the tools which I could best replicate. Also my interest is in prehistoric technology in general rather than any particular time and place, and the stone flake as a tool is much the same over a great span of time and space. But the simple stone flake as a tool has received little attention, until recently, from archeologists, who have generally concentrated on the more complicated tools such as projectile points and knives. This lack of concern is obvious from the term that has often been applied to these stone flakes: the term-'waste flake'. One of the significant things that grew out of discussions during the Living Archeology Field School was the inapplicability of this term. In the classification system being used for the field school, the symbol A1a8 is used to represent this tool. Each element of the symbol represents a particular concept: A=Tool; 1=Stone; a=flaked stone; 8=waste flake. The contradiction between the terms A=tool and 8=waste flake soon became apparent to all members of the field school. In a paper written following the field school the instructor (Callahan, 1974c) makes this point quite clear:

> Aside from hafted knives and celts, our most useful lithic tool was the oft-degraded and so-called "waste" flake. At Pamunkey, we used biface thinning flakes for stripping bark for our packs and gathering baskets, for processing cordage for fishlines, for cutting meat and wild vegetal foods to size, for skinning and butchering small game, for scraping deer hides, for processing bark strip cordage for our shelter and raft, for carving our bone harpoons and fish hooks, for arrow shaft and foreshaft modification for bow stave planing and scraping, and for gathering virtually all the sweet flag thatching for our shelter. For these jobs, such flakes were in most cases the only tools used. That is to say, unmodified or slightly modified biface thinning flakes were of primary priority in our camp. One of our principal objectives at the Pamunky Site this year was to classify all of our 122 different kinds of implements according to a priority scale from 1 to 5. Flakes received a P-1 rating, the top priority.

I prefer to call these tools utilized flakes (Leonhardy, 1970:82), but the term utilized flake is difficult to define exactly. According to Webster's Seventh New Collegiate Dictionary, a flake is a small loose mass or bit: chip, and utilization is the action of utilizing: the state of being utilized, and utilized is to make use of: convert to use. According to Allchin(1966:195) the term flake "covers all humanly struck flakes which do not fall into any more specific category. They may be further qualified as being with or without a prepared striking platform: struck from a prepared core, or not..., and so on, if these observations appear to be significant." Pond(1938:280-337) lists 134 types and classes of artifacts from Northern Africa some 30 ofwhich can be considered flakes in one form or another-blades being long flakes. Number 10 of his list is Flakes showing use: "These are flakes like the foregoing but with a section of some edge appearing dulled as if it had been used for scraping or cutting and so lost the keenness of the edge of a flake freshly struck from the nucleus." This is a general enough description of utilized flakes to start with, but it is not specific enough to be useful in a problem solving type of analysis. The problem phrase is 'appearing as if.' There need to be more concrete means to determine or distinguish the loss of keenness of edge which resultedfrom utilization from that which may have resulted from other means, such as manufacture or natural causes. Bucy (1971:5-8) addresses this problem:

> Marginal retouch, polishing, and grinding are often cited as evidence of utilization or wear, but the same actions and terms are used to describe manufacturing processes. The origin and meaning of these traces, however, must be judged in conjunction withotherattributes displayed by the specimen...In order to distinguish traces left by utilization from those resulting from manufacture it becomes necessary to consider certain basic principles relating force to lithic materials.

Paragraph ?- But my analysis is limited to wear patterns resulting from use alone. Utilized flakes are a good subject for this analysis as can be seen in discussions by Wilmsen (1974:92-93):

> There should be sets of implements with distinctive characteristics that correspond to these different functional requirements. Flakes that have been selected for use but that have not been purposely modified to change their shapes form a distinctivecategory because the only variation they

should display, in addition to technological variation, should be directly caused by use.

Take the following examples: (1) If a flake is detached from a core and subsequently left untouched, its entire form will be determined by technological factors. (2) If, instead of being left to lie on the ground, the flake is used to perform some task, it will have a functional as well as a technological component of variation. (3) If, further, the flake is converted by chipping into a tool to make one or more edges regular, those modified edges might contain some stylistic variation. (4) Finally, if the flake is substantially altered so that little of its original form remains, it may have a relatively large stylistic component.

What value can the study of stone flakes be to the archeologist? After digging up quantities of these stone flakes, the archeologist's most obvious questions are how did they get there, were they used for anything, and if so what were they used for and how. My analysis is limited to the last of these questions: what they were used for and how. The results of this analysis is also limited to the particular data being analyzed. According to Sheets (1973:10-11), "the data represent the solutions and it is the job of the archeologists to determine the problem, or the tasks for which the implement was used," and "the most direct evidence is the kind of wear deriving from use which is recorded on the implements." For the archeologist the data are the flakes and the wear patterns on them which were produced by their being used by prehistoric peoples. The problem is to determine what kinds of wear patterns are associated with what dinds of use. I have the advantage of a unique approach to this problem through my participation in Living Archeology 1974. The people involved in this experiment lived in as close an approcimation as possible to what we considered to be the living conditions of the prehistoric peoples we were studying. The overall objectives of the experience were as follows (Callahan 1974 b): - also Ahler p 17

1. Replicate a Middle Woodland Indian material culture in so far as is known and supplement this with speculated necessities needed for subsistence.
2. Utilize replicas of the known and speculated culture in order to create a Middle Woodland Indian-like campsite complex, live off the land at a hunting/fishing/gathering subsistence level, in so far as practical, and perform relevant, structured experiments.
3. Document and analyse the replication and utilization of replicas of the material culture.
4. Determine the possible priority of any given implement in the total tool inventory and way of life.

5. To analyze the overall project in order to elucidate the archeological record, to shed light on conducting future experiments in Living Archeology, and to obtain insights into solutions for contemporary world problems.

Working within this framework, I have the advantage of knowing which flakes were used and what they were used for, because the flakes were produced, used, and documented during Living Archeology 1974. The utilized flakes were then stored is separate plastic bags to prevent further damage. Also, for compatative purposes and future tests, I collected a number of flakes which were produced at the same time but never used. Through analysis of wear patterns on flakes that I know the uses of, I hope to shed light on the uses of flakes by prehistoric peoples.

Having chosen experimental replication as my method for approaching the problem of determining the uses of utilized flakes from the wear patterns, I should discuss the limitations and assumptions behind this method. The most basic assumption is the results of the experiments resemble the results of prehistoric activities so that the experimental comparative specimens will be useful in an analysis of prehistoric specimens. This idea was expressed by Ahler(1971:4881)

> In an attempt to go a step futherr and suggest with more assurance what the various functions and uses of these artifacts might have been, a series of experimental activities were performed with the aid of recently manufactured stone tools. It was hoped that distinctive wear patterns would be pro-duced by the controlled experiments, providing comparati tive data that would shed some light on the activities for which the artifacts were used.
>
> It was hoped that the activities performed would be gene erally similar to activities carried out during the occupation of prehistoric peoples, and consequently that wear patterns produced by these activities would shed l some light on the functions of some prehistoric tools.

This assumption can be considered a special case of ethnographic analogy which id often used in archeology. In experimental archeology, the archeologist attempts to create a situation analogous to the one he is studying. Binford (1967) discusses the use of analogy in archeology in some detail. Asher (1961) states some general propositions of experimental archeology:

> Cultural behavior is patterned.
>
> Cultural behavior can be inferred from its material results.

> Artifacts produced from the s me scheme, or used accordi-ing to the same scheme, exhibit similarities which permit their division into gro ps which reflect those s schemes. Imitative experimenters work with cl sses developed on the basis of this proposition even if they do not always develop those classes themselves. This proposition, therefore, constitut s an implicit theoretical and methodological base for the execution of imitative experiments.

> Each imitative experiment is an attempt to test a belief about cultural behavior, relying implicitly on the first proposition: all cultural beh vior is patterned. The st tement of the hypothesis describing a particular pattern involves artifact classes and has implicit within it the second proposition: artifacts produced fr from the same scheme, or used according to the scheme, exhibit similarities which permit their division into groups which reflect those schemes. Taken together, the two propositions form th implicit broad working hyp hypothesis of the imitative experiment.

A more specific working hypothesis which is the basic hypothesis of this analysis is that wear patterns are consistent and distinct in relation to use. Binford (p164) quotes Wilmsen in stressing the importance of testing hypotheses :

> The most important feature about a hypotheses is that it is a mere trial idea...(and) until it has been tested it should not be confused with a law...The difficulty of testing hypotheses in the social sciences has led to an abbreviation of the scientific method in which this step is simply omitted. Plausible hypotheses are merely set down as facts without further ado

Ascher (1961) also is explicit about formulating hypotheses in a testable form, and he states this in a summary of the processes involved in performing an imitative experiment:

1) Converting the limited working hypothesis into a verifiable form.
2) Selecting the experimental materials.
3) Operating with the objective and effective materials
4) Observing the results of the experiment.
5) Interpreting the results of an experiment in an inference.

It is this first step that deserves more attention here. I propose to put my hypothesis into a verifiable form by limiting it to a very specific set of circumst nces. The hypothesis will be restricted to a limited sample-unmodified flakes of a single type of stone. The type of stone in this case is silicified slate which was quarried by the members of the Living Archeology Field School from a roadcut near Morrow Mountain, North Carolina. Also, the analysis will be limited to attributes of the utilized flakes which are considered to be directly related to tool use. Of necessity only a limited number of attributes will be considered. I went to the literature for direction in selecting the criteria for analysis. Gould (1971:154) dealing with broadly similar tools suggests that "the primary aim is to perform a task involving either cutting or scraping, with little interest being shown in the shape of the tool-exdept for the angle of the working edge relative to the particular task involved." Wilmsen (1974:5) states that "Edge angles are necessary components in a study of ecological variation and functional application of tools." Many others discuss the importance of edge angles in relation totool use(Callahan, Knudson, Leonhardy, Muto-to name a few that I am familiar with). But Adovasio et al (1974:87-9)suggest that caution be used in applying edge angles as a criteria for determining function because a variety of edges can be used for most purposes-

> No amount of numerical manipulation can produce the understanding of tool use which comes with the direct experience with manufacturing, handling, and close examination of replicas. Knowledge of optimum edge angles as they relate to function can be helpful, but the application of ranges of edge angles as diagnostic of function is, at best, risky.

Again using Gould (1971 as a reference point, I am restricting the criteria of mode of use to simply cutting and scraping. But the major attention of this analysis is on the wear patterns produced by using the experimental flakes. Semenov(1964:6) makes a strong statement about the importance of thiscriteria.

> Thus study of traces of work allows us to speak about ancient tools and their functions not conditionally and approximately, as we do with the typological method, but makes it possible to explain the actual and concrete purpose of each tool, as it was when in use.

Anotherimportant criteria is the material the tools are used on.

I chose these criteria specificallyfor the purpose of testing the hypothesis under consideration. These criteria are the data used to test the hypothesis. Wilmsen (1974: 58,59) discusses the nature of data.

> Data are abstracted from observations: that is, they arise from the proposition that there is some connection between a particular set of observed phenomena and a conceived reason for their existence. Data are thus conceptually organized phenomena.
>
> In other words, those observations relevant to the propositions...are isolated from the total possible information contained in the assemblage. This is a crucial step but one that is often overlooked. Observable traits to be compared are usually chosen because they are readily distinguished from others; they are seldon construed as interlocking components of a system. That is, "diagnostic" traits are segregated from other observable phenomena

In this type of analysis there is an exchange between hypotheses and data and observations. A particular hypothesis influences which observations are considered to be important, and analysis of particular data can cause the observer to reformulate an hypothesis to be more relevant to the observations. Binford(175-176) discusses this at some length:

> At each juncture of explaining observations from the arc archaeological record, we must question anew to what variables operative in the past our observations refer. any explanatory proposition must be reasoned in terms of relevance to the operation of the cultural system under study. These arguments of relevance frequently result in the modification of our analytical units and the generation of further analytical categories. This procedure insures the expansion of our knowledge of the past, since it facilitates the testing of propositions. With the acceptance of a hypothetico-deductive method for archaeology and the use of a multiple-stage scientific procedure--observation and generalization, formulation of explanatory propositions, testing these against the archaeological data--it becomes evident that the analytical units employed in the initial stage may not be very useful during the final stages of testing. The sets of phenomena selected for observation, from the infinite number of possible observations, are not most profitably determined by the formal structure of the archaeological record itself. On the contrary, they are data which we must justify as relevant to the particular propositions advanced and as useful for hypothesis testing

This analysis of wear patterns on utilized flakes is still in its initial exploratory stages. There are almost certainly more data relevant to utilizational analysis than those initially specified. The initial working hypothesis, that wear patterns are consistent and distinct in relation to use, has been stated in testable form by limiting it to a specific set of circumstances. Tests were carried out under the field conditions of the 1974 summer Living Archeology Field School. The specimens were collected and labeled for later analysis. Information was recorded according to a predetermined format(Callahan, 1974 :#7:10). The specimens were studied initially with a 10X hand magnifier and are undergoing microscopic analysis. For the purpose of communication, specimens have been photographed in a variety of ways including photomicrography.

The recognisable wear took the form of polish and small flake scars on the edge of the utilized flakes. Dunnell gives definitions of kinds of wear that are some what consistent with my observations(

> Kind of wear. Wear is considerid to be any alteration of the surface of an artifact as a result of friction during use. Five kinds of wear were considered
> (a) Chipped: small concoidal fragments have been broken from the edge of the stone, leaving series of sharp ridges and rounded hollows along the tool's edge.
> (b) Crushed: small irregular fragments have broken out of the stone, leaving a pitted surface.
> (c) Abraded: Striations are visible on the surface of the stone, which is simewhat smoothed.
> (d) Polished: any very shiny, smoothed area on the edge or surface of the stone.
> (e) None: no macroscopic wear is visible.

Ahler gives a more complex description of wear which he relates to his experimental activities(1971:37-39, 82-87). Knudson(1973:105) lists a series of expected flaked lithic implement modifications after utilization in an appendix to her work. These last two sources of information are more general in nature than the present analysis because they are not restricted to unmodified edges or to the same tool type.

I recognised all the kinds of wear defined by Dunnell and possibly an additional one although it is similar to his chipped variety; the dissertation in preparation

distinction being that the fracture is not concoidal but the result of fracture in bending. (Muto ?) Photographs are not yet available which show crushed, abraided, or polished kinds of wear. In fact no examples of the crushed variety were available in the original sample, although many examples are available on basalt which was used in scraping a bow in preparation for the field school. But in keeping with the ongoing nature of this analysis, I used two of the unused specimens for scraping on hard bone with examples of this kind of wear resulting.

Appendix A is a group of photographs of some of the specimens. The first one is an unused specimen. The dark lines were drawn on the flakes so they would show up when the flakes were recorded on a xerox machine; these copies are shown in appendix B. This method is a simple way of recording the gross morphology of the flakes. The second page of appendix A is a flake that was used to process vegetable fiber for making string. The photo's at the top of the page were taken before the flake was used, the center picture is a vertical view of the utilized edge; the flake isheld vertically by leaning against other flakes. the most distinctive indication of use for this flake is the residue of vegetal matter adhearing to its surface. This observationshould suggest the possibility that archeologists are loosing data if they indescriminantly wash their artifacts. This possibility has been noted by Semenov(1964:24) and Sonnefeld (1962:63). The third page is photo's of the flakes represedted on the next two pages before they were used. The first of these was used to process bark for making a basket: the recognisable wear being of the chipping type of fracture in bending. The other was used to separate flesh from the skin of a deer hide. The edge of this flake polished, but it is not recognisable from this photograph. There is also a small amount of chipping resulting from fracture in bending. The rest of the photo's were taken through a 35mm lense with the entire picture covering one centimeter; the first of these showing part of a scale. The first of these (the sixth page) was used for trimming small branches off saplings. This flake exhibits both the concoidal and bending types of chipping. The center photo for the rest of these is a vertical view of the edge.

The next two pages (seventh and eighth) are photo's of a flake used to cut through a board. The wear is the chipping type resulting from bending. The next two were used for processing bark, and the wear patterns are the chipping type resulting from bending. The last photograph is of a flake that was used to cut grass (sweet flag) for the thatching for our shelter. The wear patterns on this flake are complicated by the rays or marginal fissures which result in an edge with varied thickness and thus varied resistance to fracture. The wear patterns seem to be the same chipping as the result of bending.

This analysis calls for testing the hypothesis, that wear patterns are consistent and distinct in relation to use, against a body of data. The critical factors to be involved in this analysis were the wear patterns resulting from use, the mode of use-either cutting or scraping, the material the tools were used on, and the angle of the working edge. I found that within the limits of this analysis there are consistent relationships between factors which suggest that the hypothesis can in general be tentatively accepted. But under other circumstances other factors might give different results, and even the present experimental situation might lead to different conclusions were other factors to be considered.

The relationships which I observed were between the type of use and the type and the type of flake scars produced on the edge of the tools. This is the least consistent of the relationships, possibly due to the lack of observations. This relationship is also dependent upon other factors. For instance scraping on soft material such as wet deer hide often does not result in flake scars at all on flakes with steep edge angles, but does result in flake scars on flakes with low edge angles. This can also be true for cutting. But given a limited set of circumstances, scraping results in the crushing type of wear pattern which can also be described as step flake scars. These can be distinguished other flake scars in that they originate near the edge of the tool and carry down the edge only a short distance and terminate at about 90 degrees to the face of the flake and not in a smooth feather termination. Also the termination of these flake scars is squared off rather that rounded. Another characteristic associated with scraping is that all the flake scars are on the same side of the edge of the tool if the scraping was done in the same direction. The flake scars are on the side which is trailing during the scraping motion.

The type of flake scars characteristic of the cutting motion are quite different from those resulting from using a scraping motion. They generally occur on both sides of the edge and originate far below the edge and originate relatively far below the edge of the flake on one side and carry over to the other side to a termination not far below the level where it originated. This seems to be the result of fracture in bending where the edge of the flake tool is embedded in the material being cut and snaps off when the flake is twisted. An interesting characteristic that develops on some flakes used for cutting is that they develop a sawlike edge during use. When two or more use-wear-flakes are removed next to each other sharp peaks are left between the flake scars. This serves the function of re-sharpening the edge during use up to a point where the edge becomes stable and dull.

There is a relation between the type of wear patterns and the hardness of the material the tool is being used on. This can be seen when comparing utilized flakes that were used on hides to those used on bone or antler. I saw no polish on tools with large or small edge angles when used on bone or antler-again there is only a limited amount of data available in this sample for work on bone or antler. Polish is characteristic of use on softer materials because it occurs on utilized flakes with both large and small edge angles, and for both cutting and scraping.

There is also a relation between the amount of wear and the angle of the utilized edge. This is obvious when the relation between edge angle and strength is considered: a weak edge will break more often and thus display more wear. This indicates that wear patterns in the form of flake scars on the tool's edge can be as much a function of that edge as the material the tool was used on or the way it was used. This is an important consideration when attempting to determine the use of an implement from the wear exhibited on its edge. There may be basic diagnostic relationships between tool use and wear patterns which can be obscured by such interveening factors.

It is not known to what extent variables not considered here influenced the results of this analysis. It is also not known to what extent the interaction among the factors being considered influenced the results. To make these results more conclusive it will be necessary devise tests to explore the deficiencies of the present analysis. It is hoped that each successive testing will point to new ideas about the relationship between tool utilization and wear patterns.

The present discussion is based on incomplete data, and incomplete analysis of the data that is available. In a word it is incomplete. But it is hoped that the questions raised if not the tentative results will be of benefit to experimental analysis of tool utilization.

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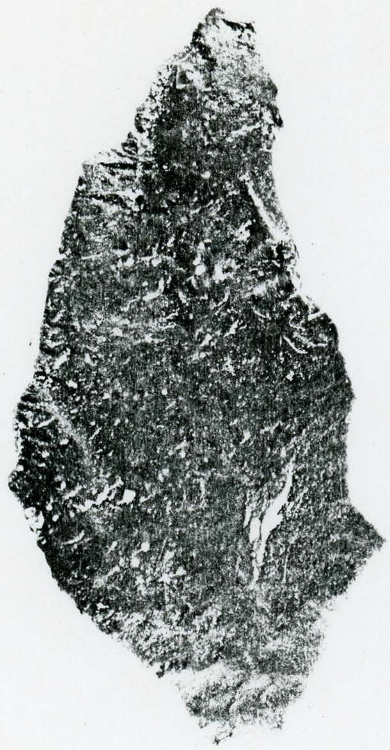

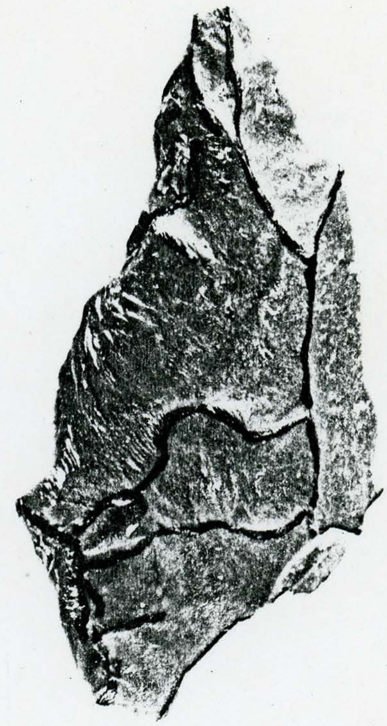

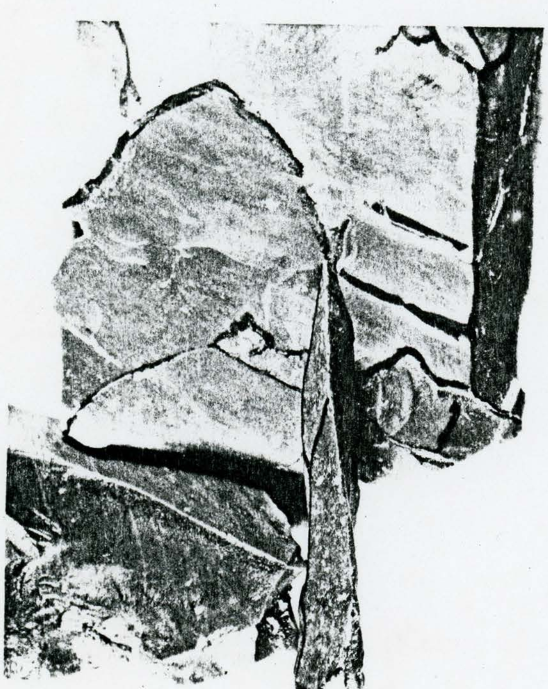

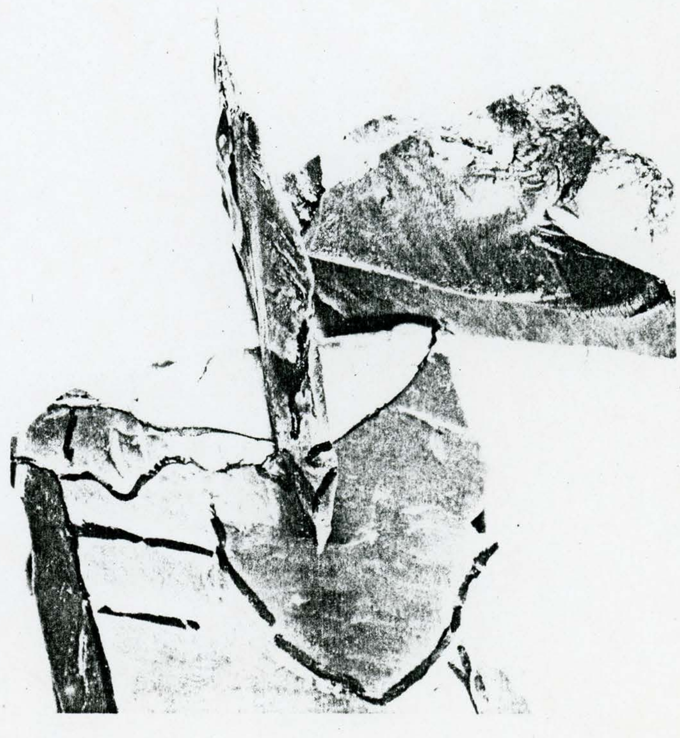

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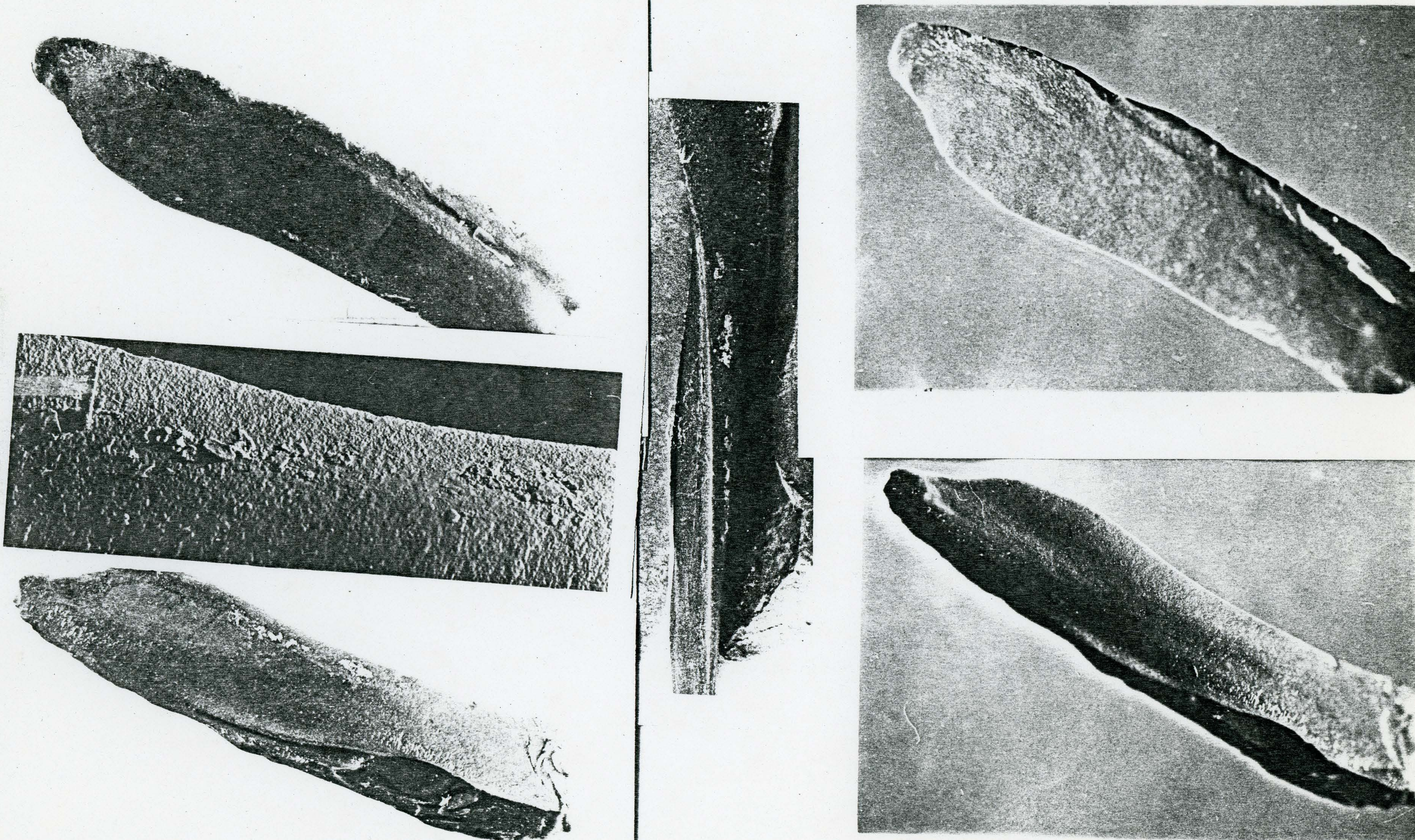

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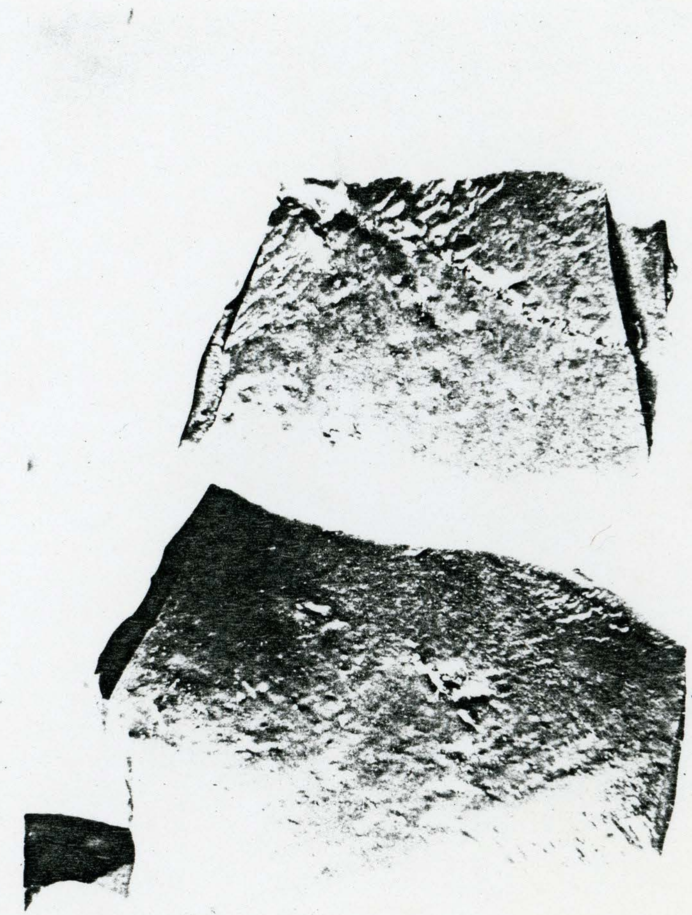

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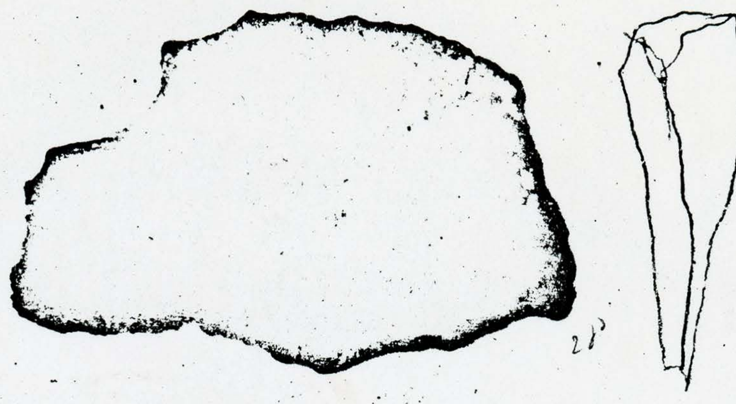

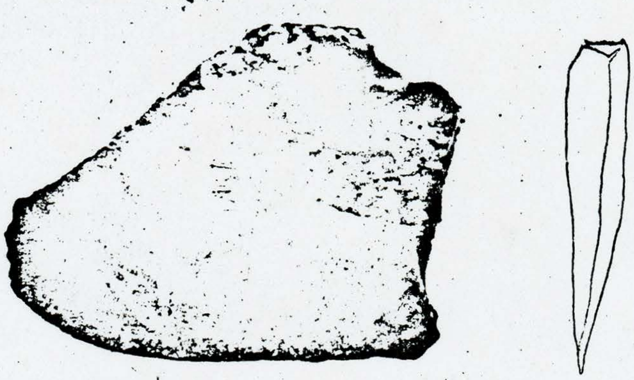

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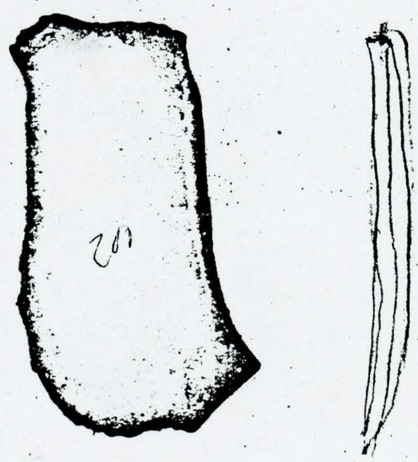

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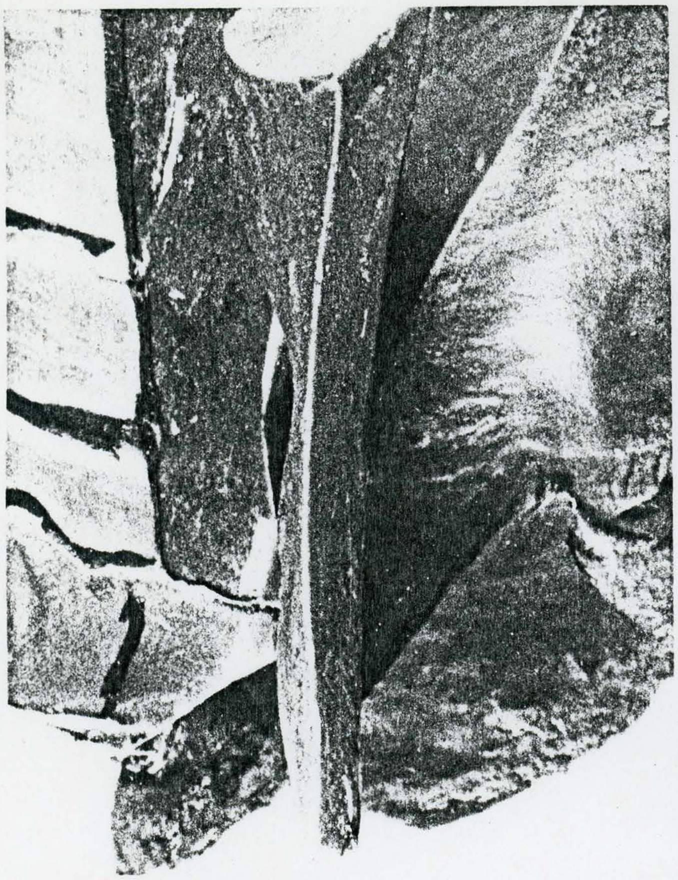
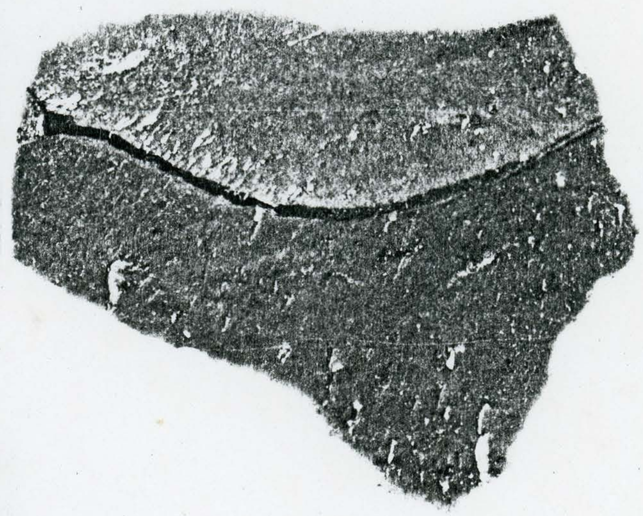
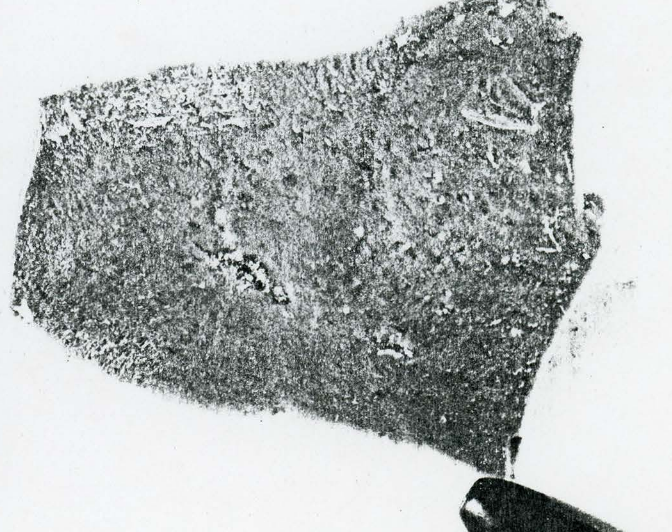
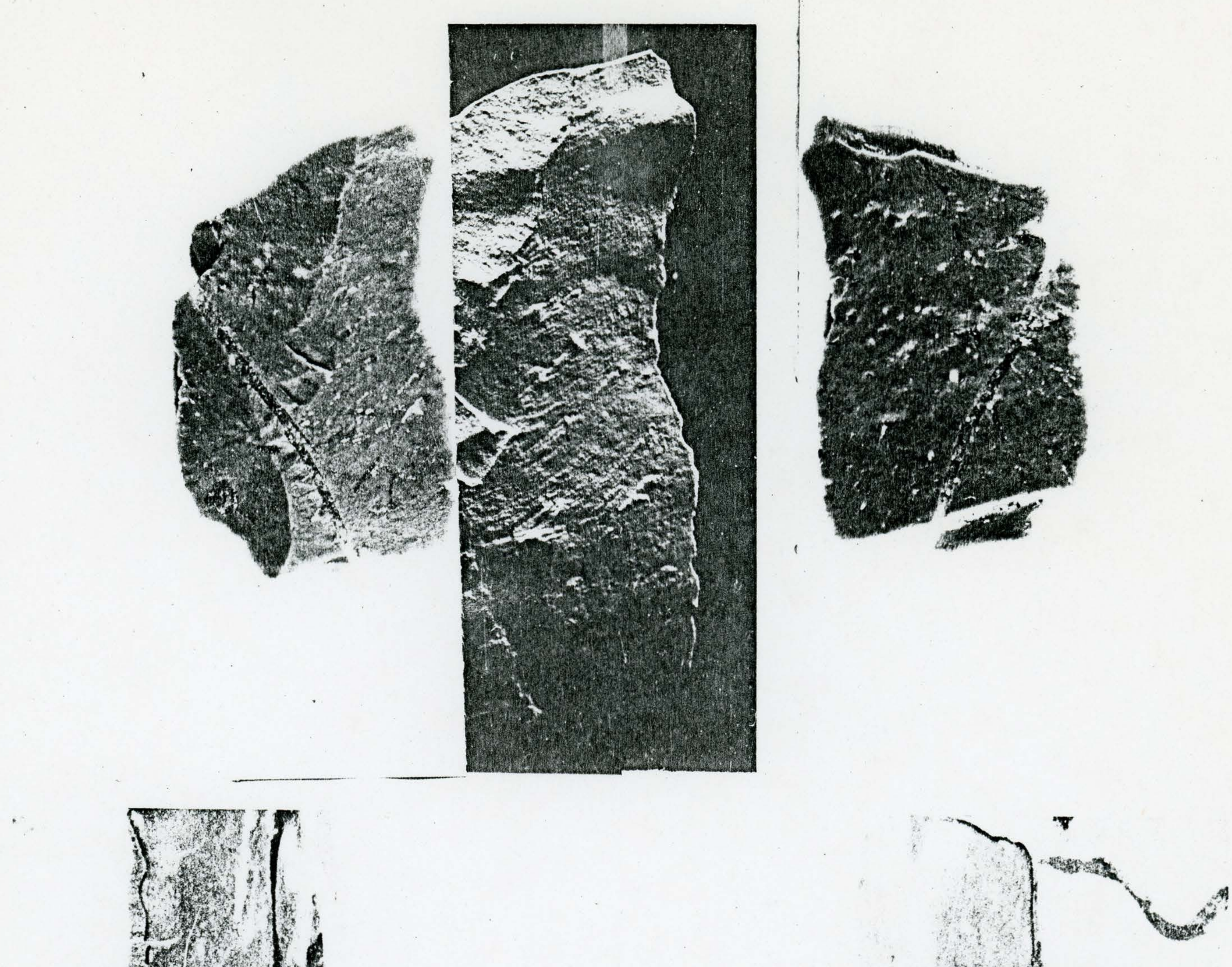


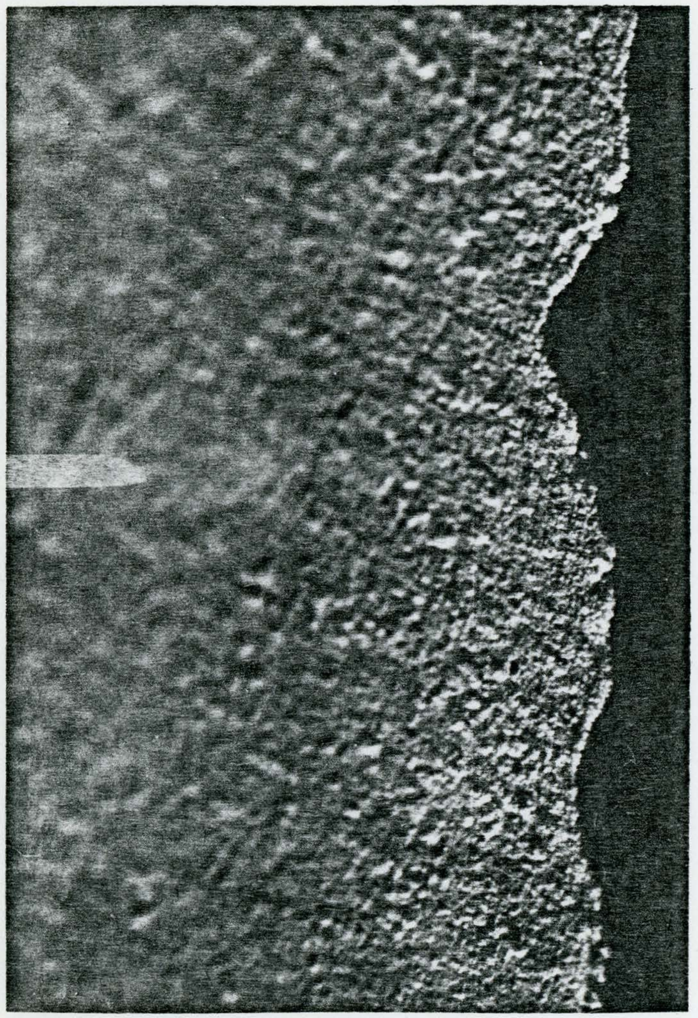


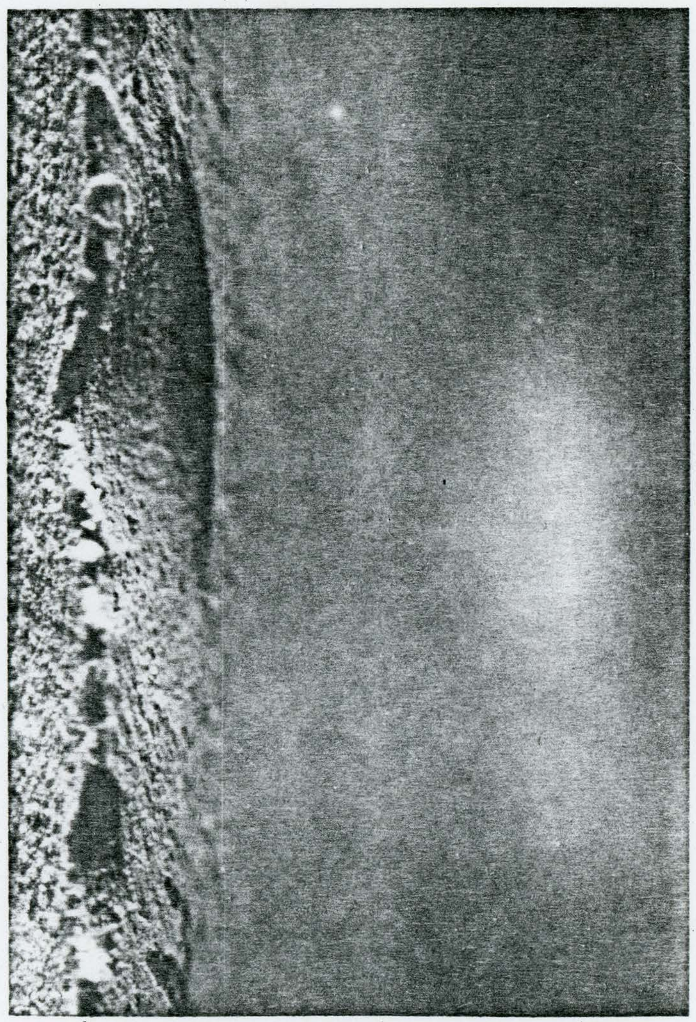


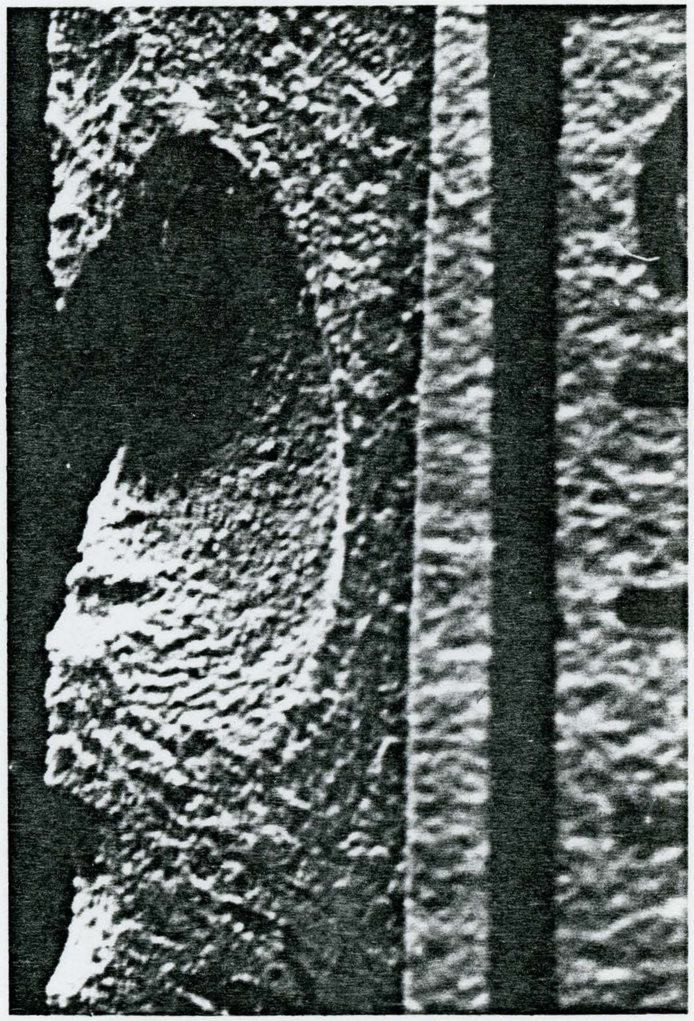


separate flesh from deer skin

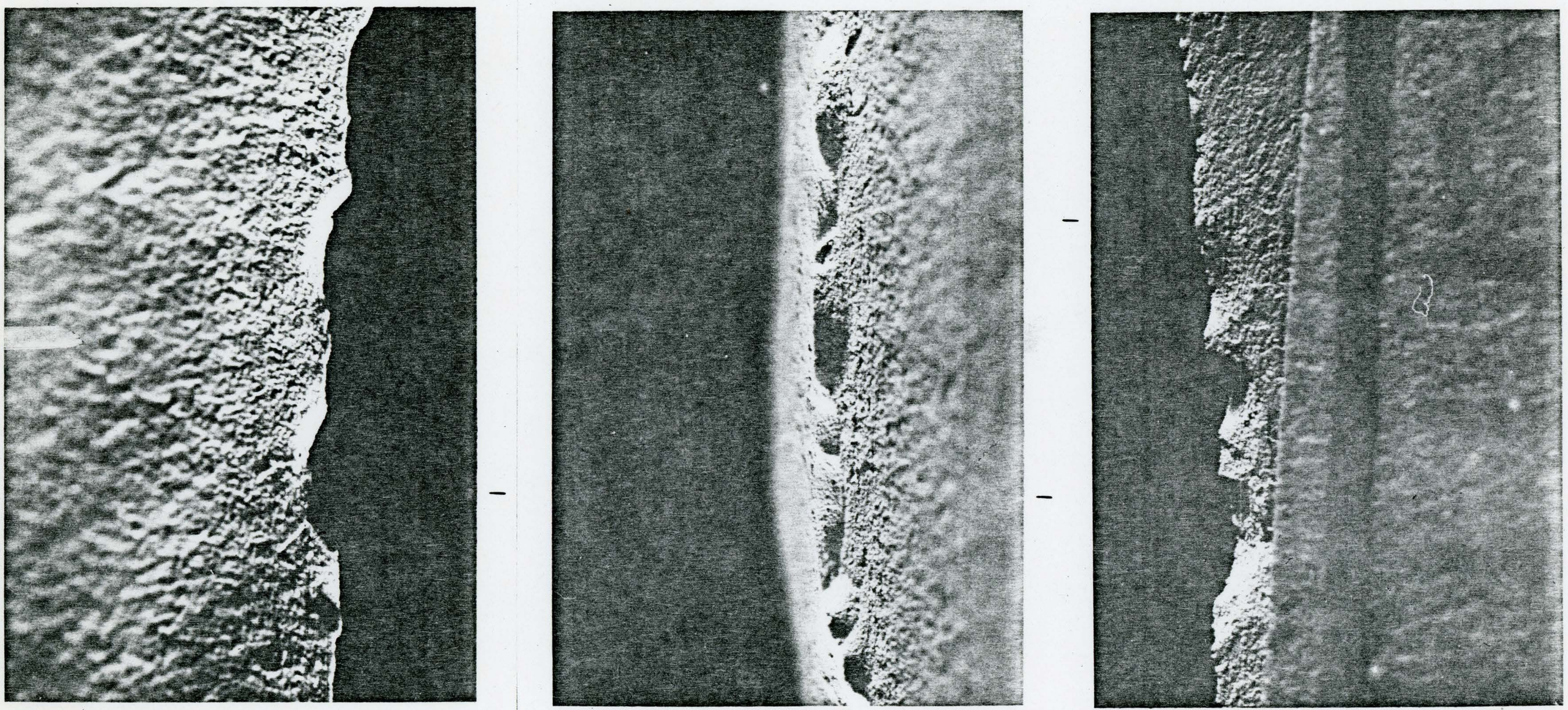
cut wood
small limbs from saplings



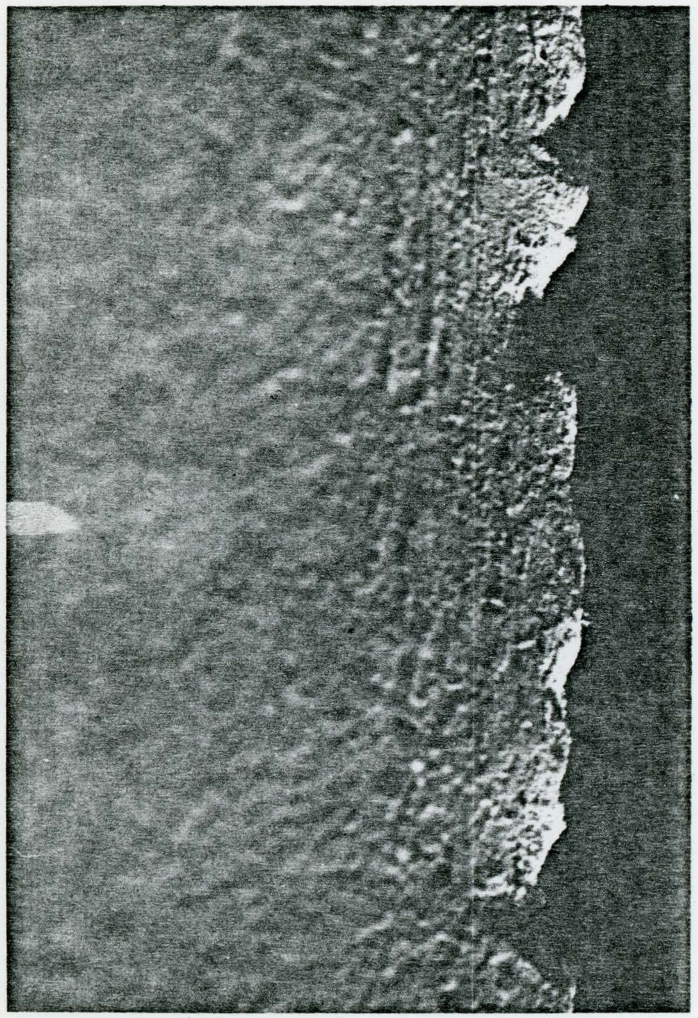


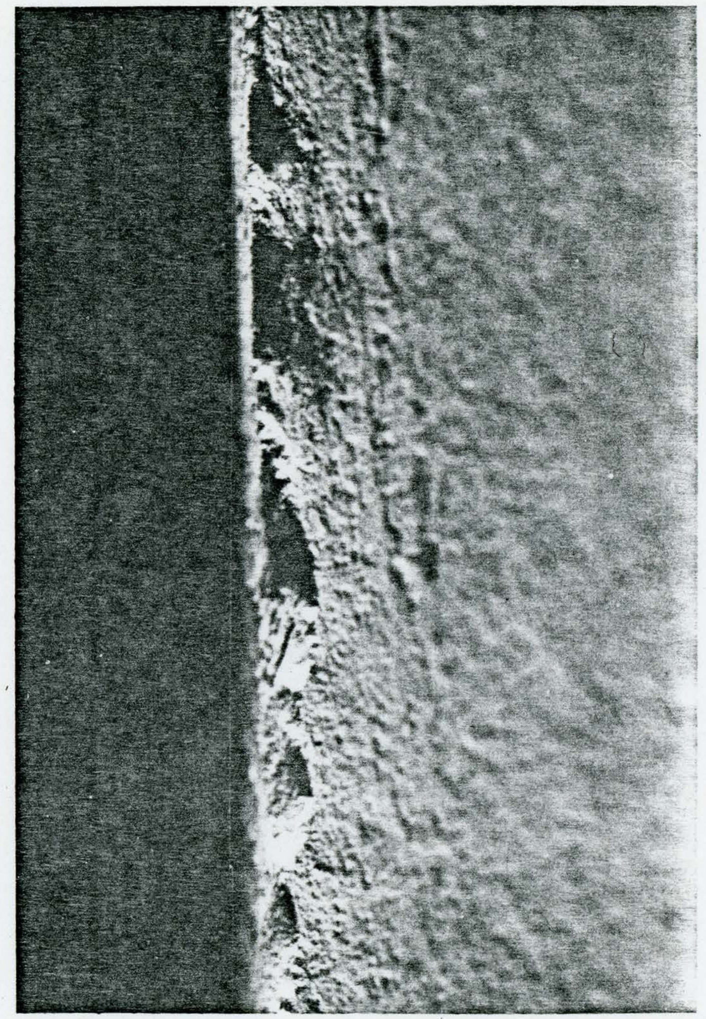


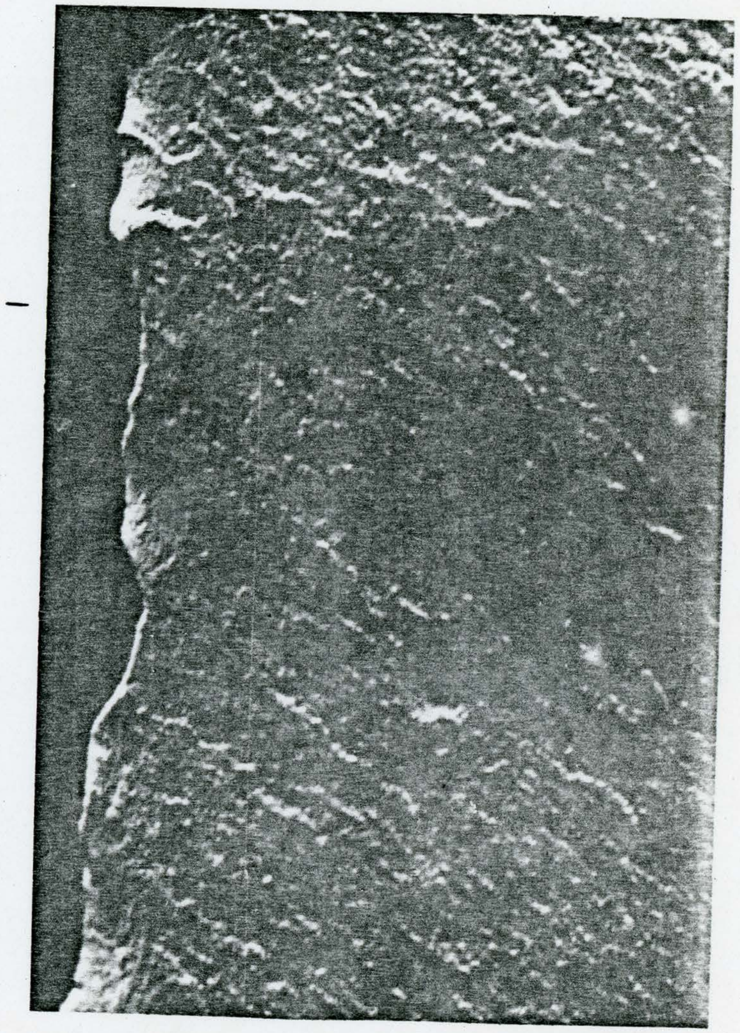
Cut gourd



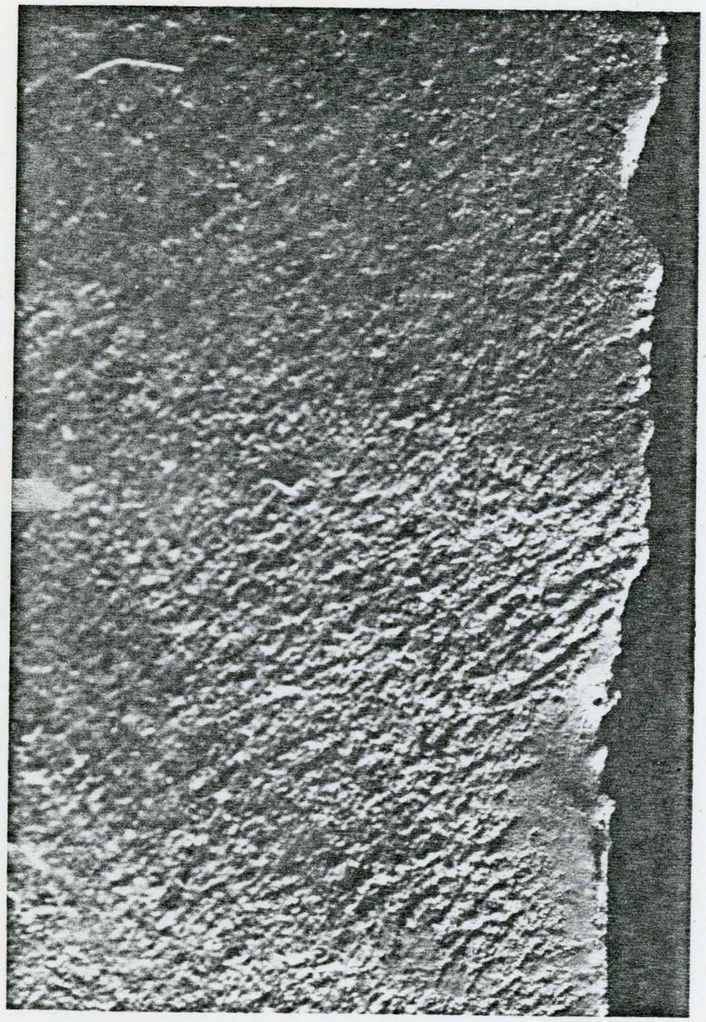
Cut Gourd

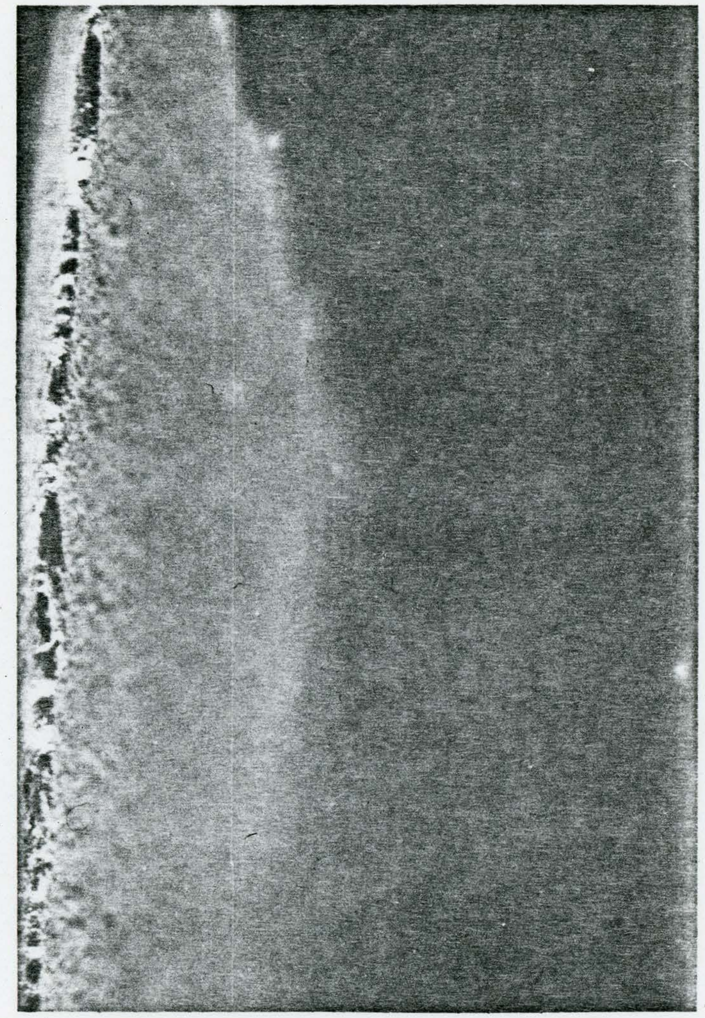


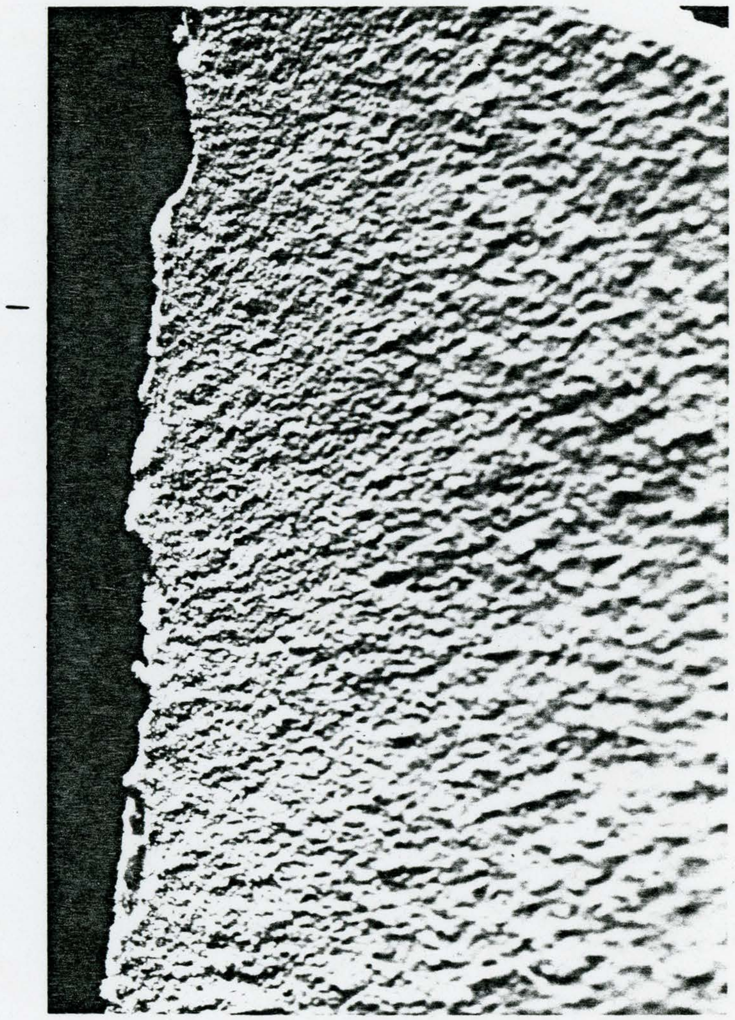




Process bath 4







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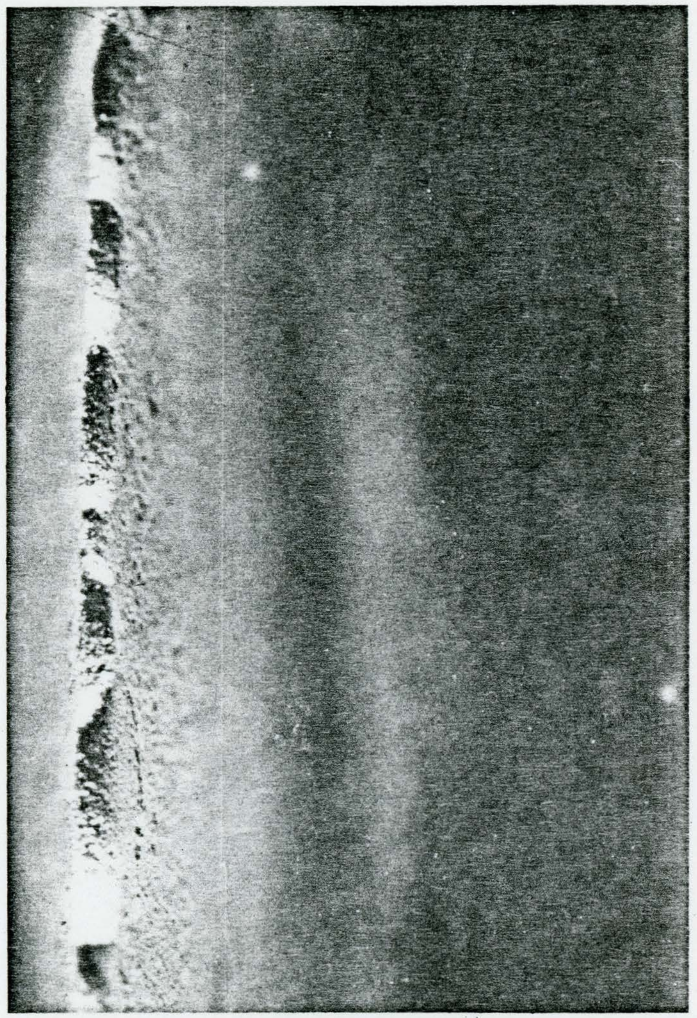
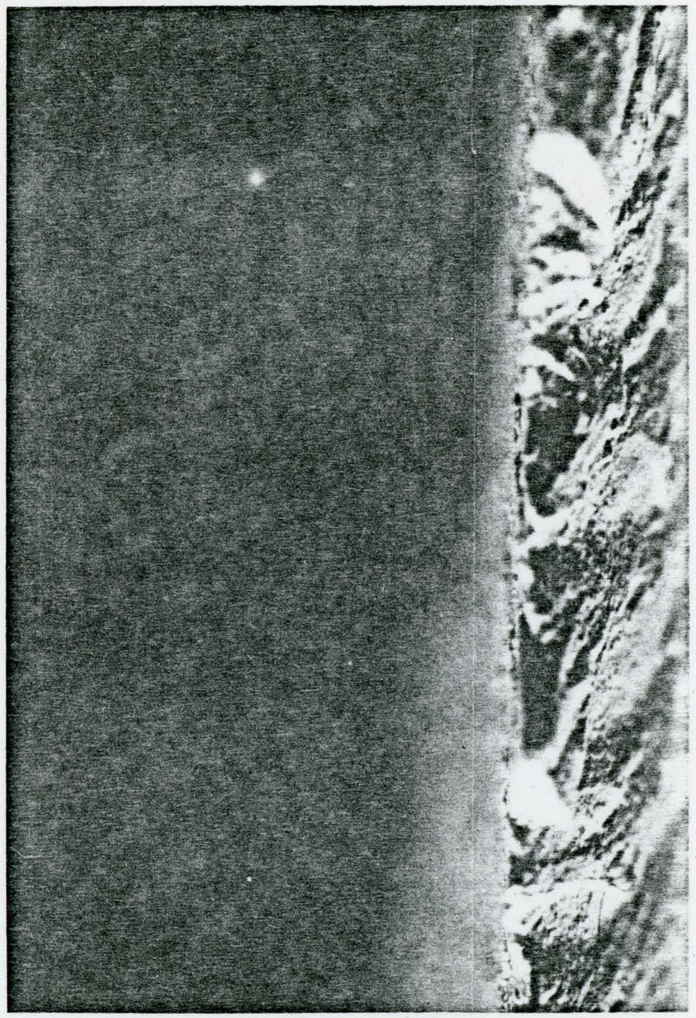
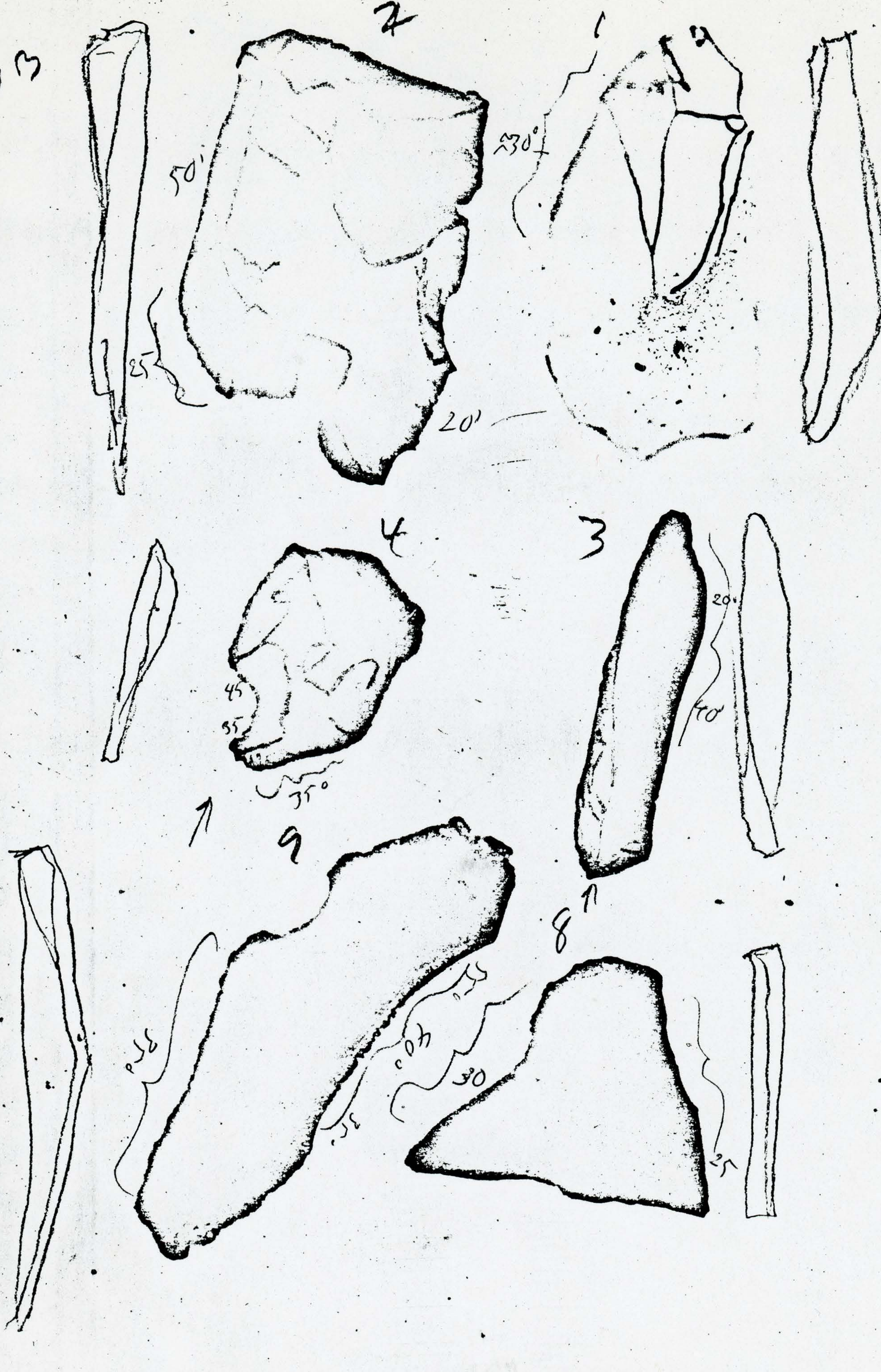
process burk



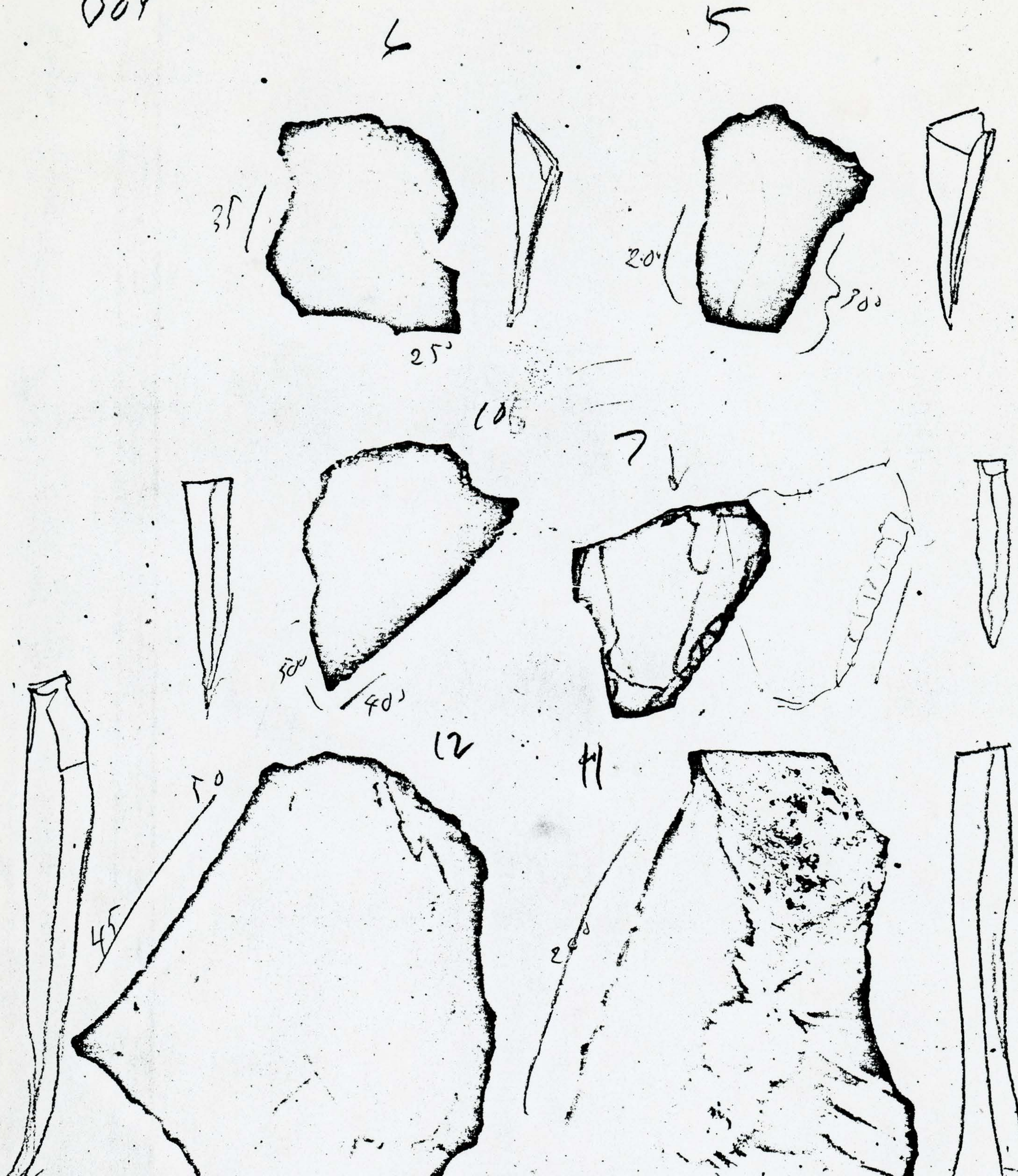
cut grass (sweet flag)

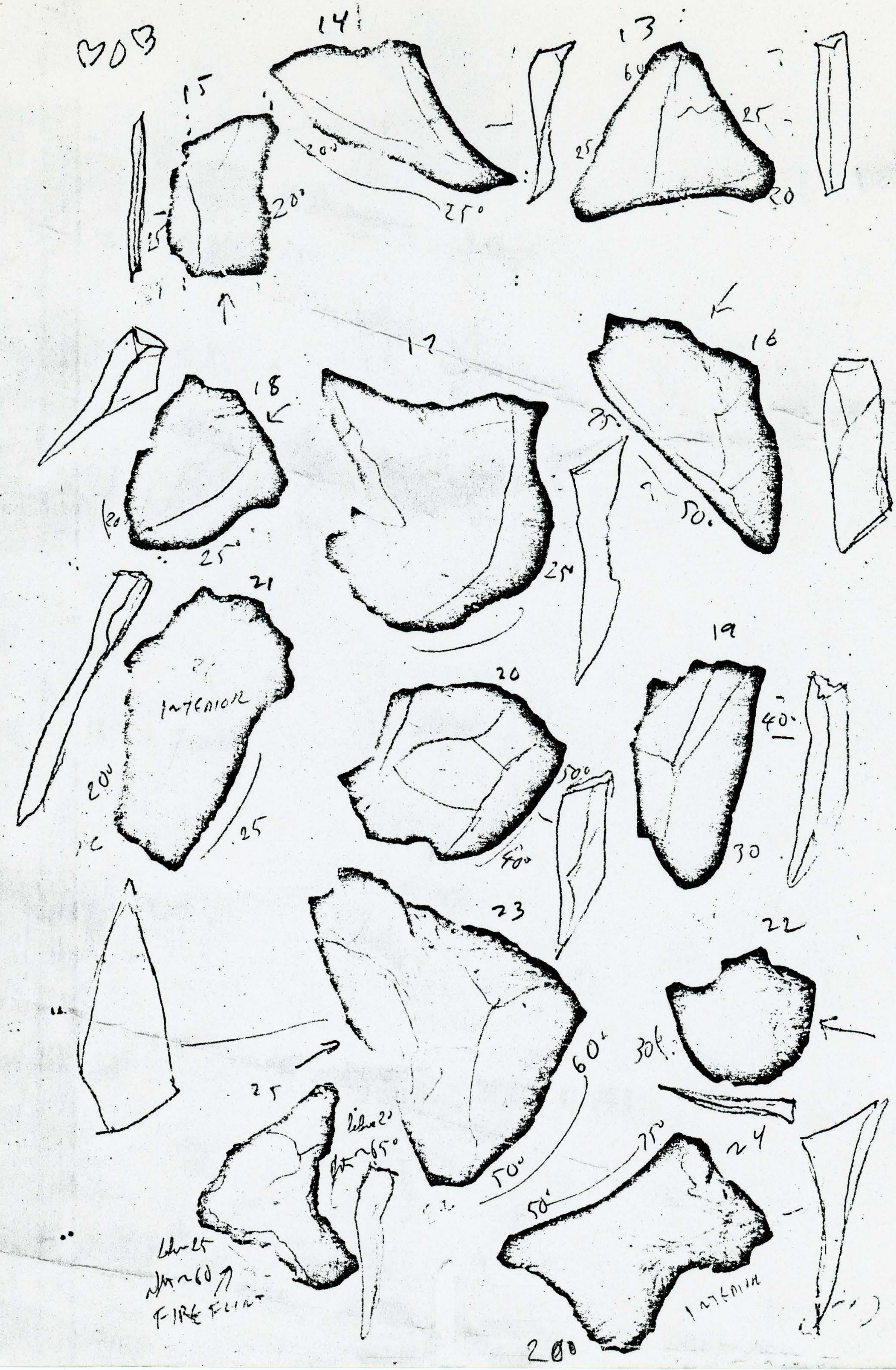


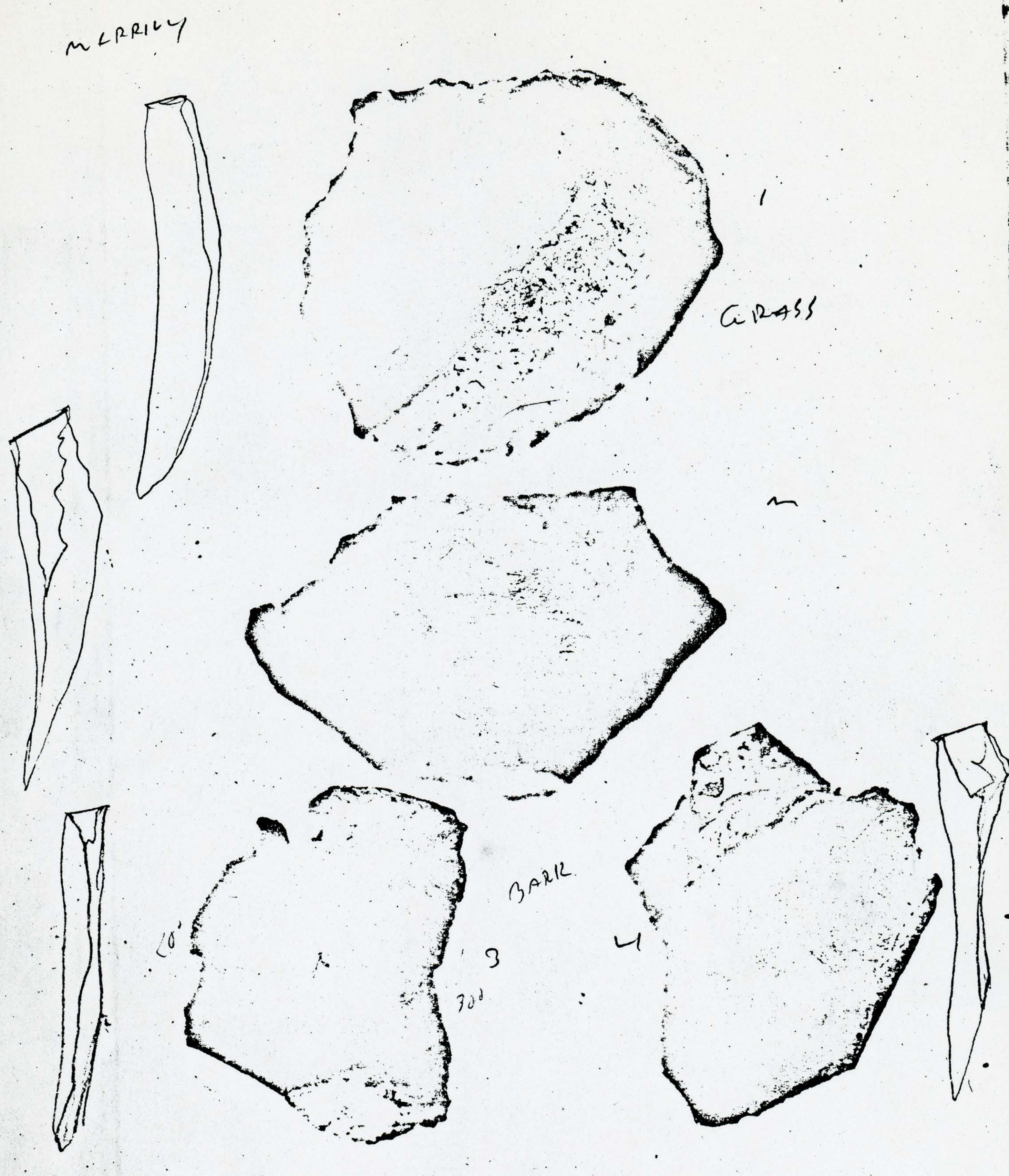
3 of 3



008

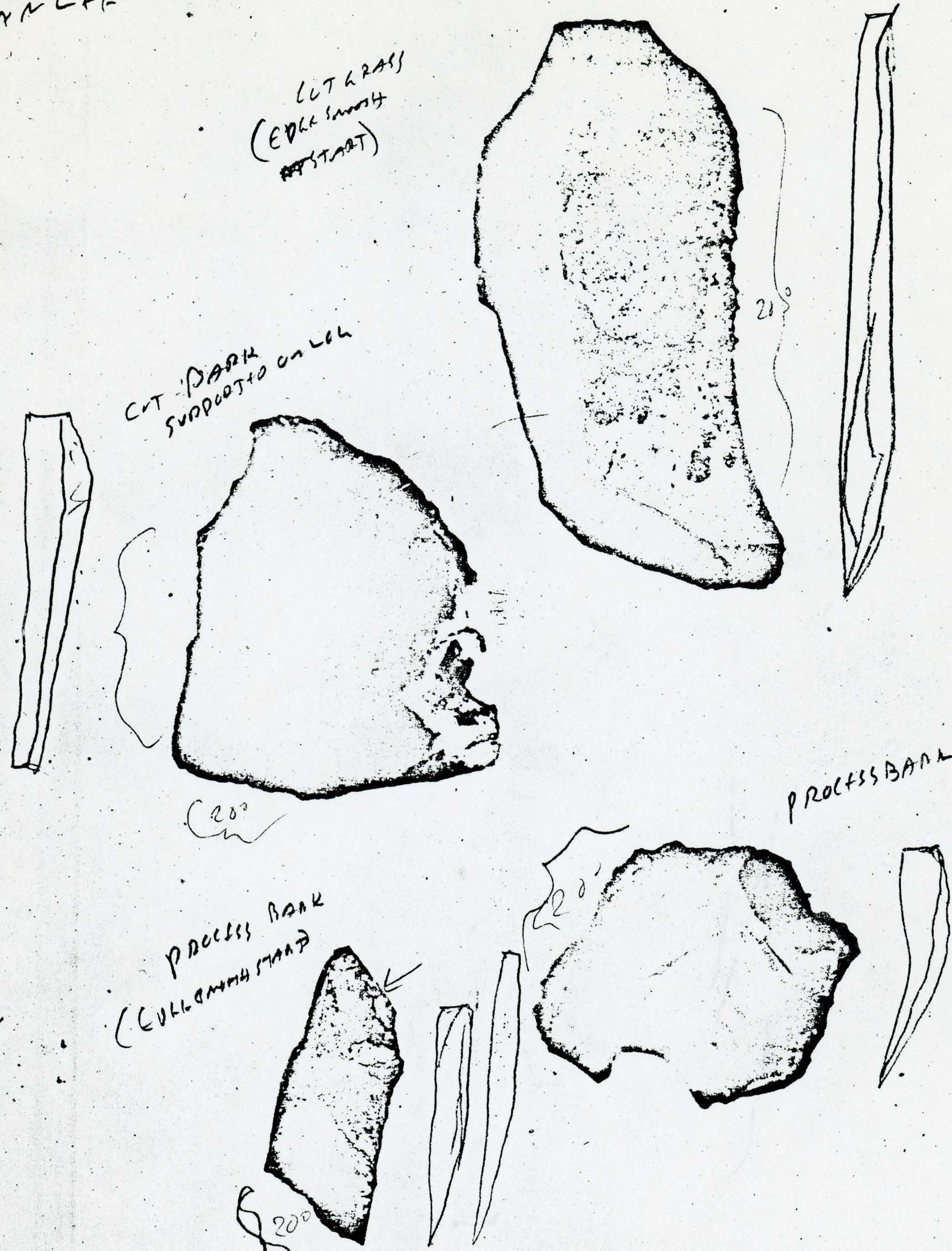



MOB
14
13
15
20°
25°
17
18
16
25
50°
21
INTERIOR
20
19
40°
30
23
22
60°
50°
24
INTERIOR
FIRE FLINT
200



MERRILY
1
GRASS
BARK
3
4

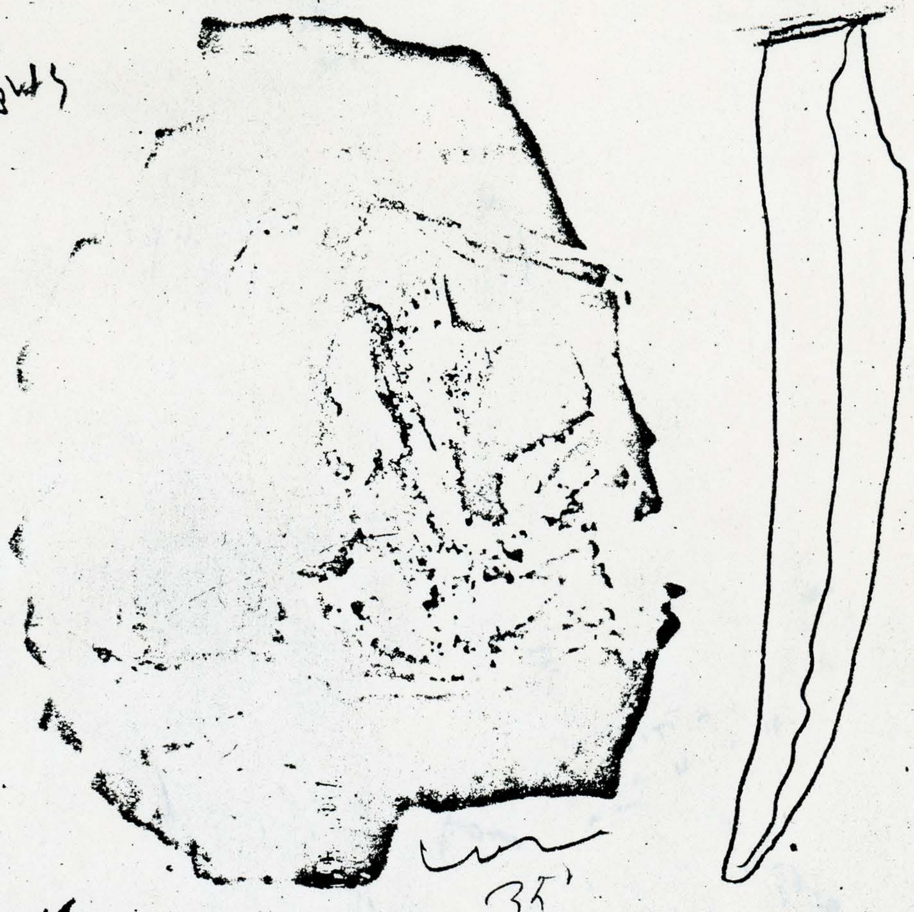
UNNLEE



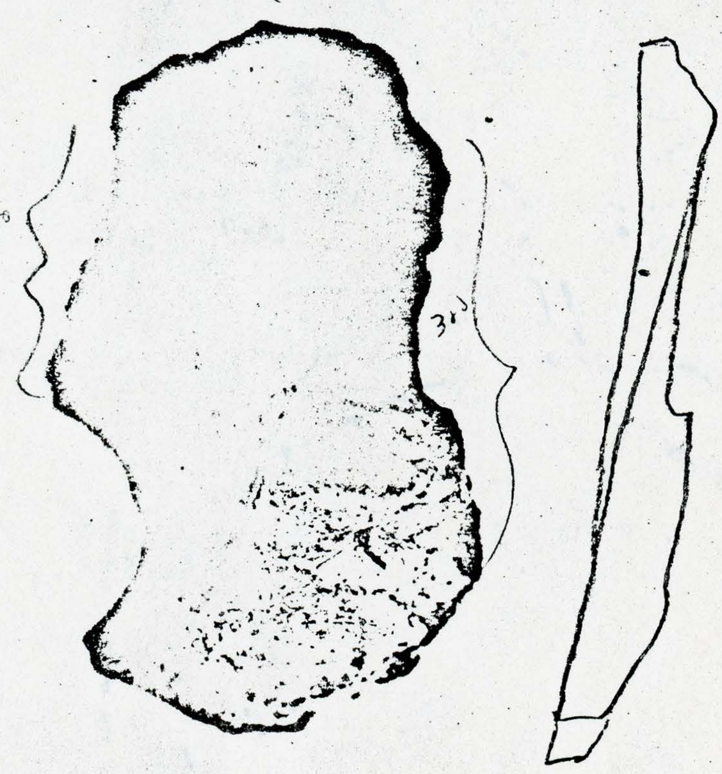
CUT GRASS
(EDGE SMOOTH AT START)
21°
CUT BARK SUPPORTED ON LEG
20°
PROCESS BARK
20°
PROCESS BARK
(EDGE ROUGH AT START)
20°

KEN

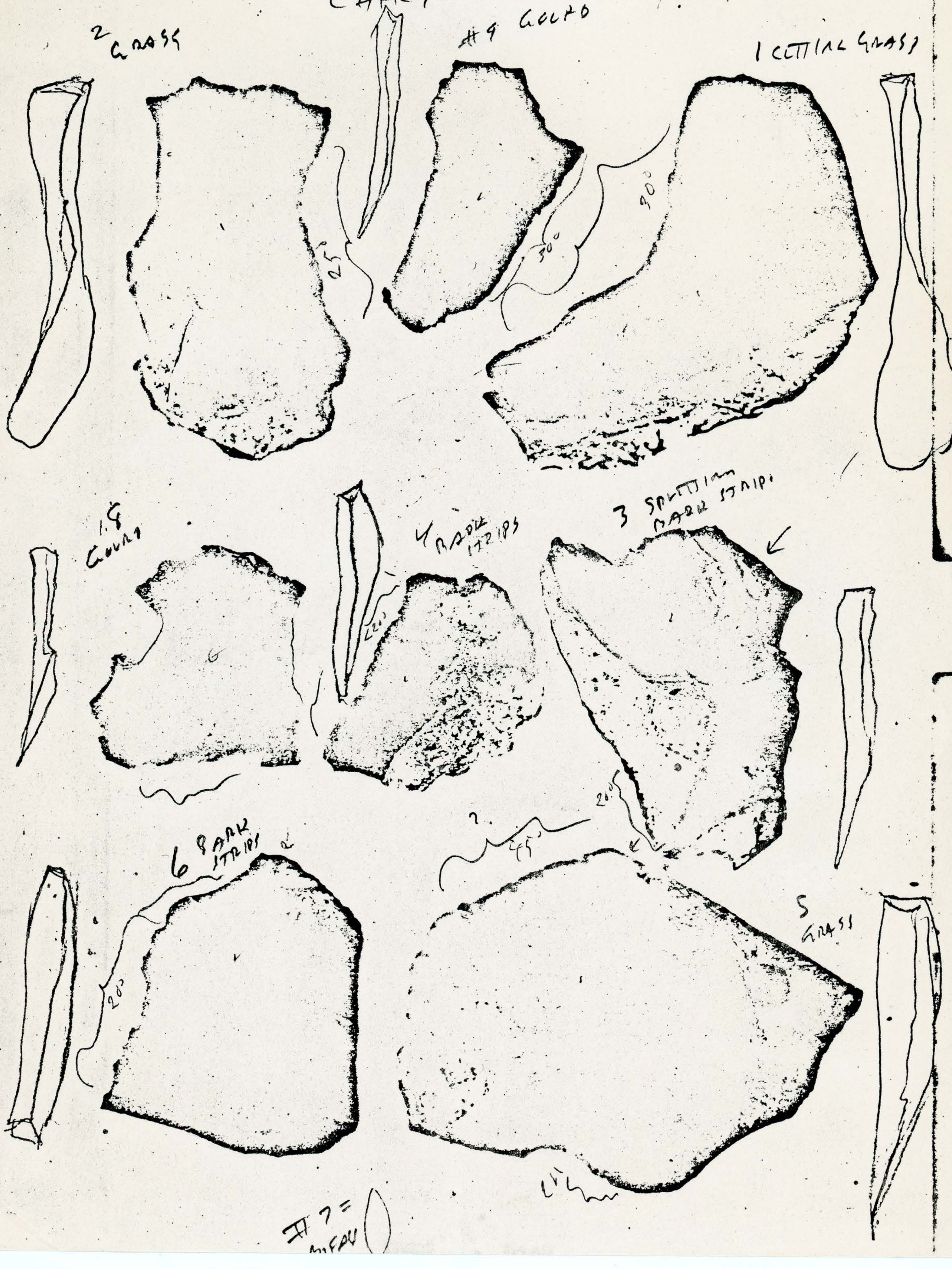
CUT ARROWS



CUT GRASS



CHERYL



2 GRASS
#4 GOURD
1 CUTTING GRASS
25°
30°
90°
GOURD
4 BARK STRIPS
3 SPLITTING BARK STRIPS
20°
6 BARK STRIPS
20°
45°
5 GRASS