A STONEWORKER'S APPROACH TO ANALYZING AND REPLICATING THE LINDENMEIER FOLSOM

By Don E. Crabtree

Folsom! This projectile point is one of the most remarkable forms of the many types of stoneworking art which depict the highly specialized techniques of the New World lithic industries. It has become a Stone Age enigma with the only remotely parallel techniques of the Old World being those evident on the Dorset Point and the Nuclei from Gran Pressigny. Its anomolous technique has placed it in a class by itself, but has caused it to be both controversial and misunderstood. My analysis and explanation of the Folsom will attempt to describe the skill required in its fabrication, the many phases of its construction, and the unique techniques demonstrated in its manufacture.

Prior to 1927, the mention of man's antiquity in America could not extend beyond a few thousands of years. It was the finding of such points in association with extinct bison at Folsom, New Mexico which changed man's perspective on New World prehistory. Since then the geographic and temporal position of Folsom points has become better known, but interest and inquiry continues. What attracts man to Folsom points is the extinct skill with which they were made and the beauty which such tools possess. This point, then should be made familiar to anyone with an interest in man's development in the New World.

Most flintknappers, including the writer, consider this to be one of the most beautiful, practical, highly specialized, and, admittedly, one of the most difficult points to replicate. My experiments in flintknapping have led me to conclude that the making of this point probably took more time, patience and skill than any other projectile point of comparable size. For example: a common Rocky Mountain side notched point of some length made on a flake can be done in five to ten minutes, whereas it may take several hours to complete the painstaking preparation of its many stages of manufacture before the Folsom point is finally fluted and finished.

All my Folsom experiments have been an effort to reproduce the Lindenmeier type and, therefore, this paper will deal only with the "classic" point from that site and is not to be confused with the Clovis, Folsom-like, basally thinned, or other fluted point traditions. When I use the word "classic" to describe the Folsom, I mean to infer that this particular artifact reflects the very ultimate in working skill and control. "Classic" indicates that the worker produced an artifact of exceptional workmanship; being as thin and perfectly shaped as the technique would allow; showing ultimate control in the skill of duplicating and replicating the flaking techninques; and, further, that the finished product is as near perfect an example, as possible, of the workers preconceived idea. The classic speciman should not be confused with the type speciman which may or may not have all the attributes of the Folsom herein described. Folsom points encompass numerous aberrant forms and a few varied techniques such as shape, base character, unfluted examples, etc. that haven't been explained or described in this text.

For the benefit of those who are not too familiar with the "classic" Lindenmeier Folsom, an analysis is inserted here to indicate the many problems involved in its working technique. Description covers cast of Point B22/83 of the Denver Museum of Natural History. This represents a classic speciman from the Lindenmeier site and is available at the Museum in plastic cast suitable for examination and comparison with my description.

Folsom point B22/83 is 1-7/8 inches long and 7/8 inches wide. However, some Lindenmeier points may be as much as 2½ inches long and can average ¾ inches in width. The shape of the point resembles the outline of a rowboat in form but is slightly constricted at the base and, unlike most projectile points, the tip (or distal end) terminates abruptly.

Although some publications describe the tip of this projectile as being "snub-nosed" (Mewhinney 1957), it actually has a very thin, sharp edge, which is the result of a carefully controlled pressure retouch. Such a tip has strength and has piercing and penetrating qualities not found in a fragile, acuminated tip. The proximal end resembles the shape of a broad U, ordinarily with a slight convexity at the base of the U. This convexity is usually a remnant of the platform left after the second channel flake has been removed. The base is characterized by two diagonal pressure flake scars on both sides of the bulbar scar. This represents a very definite Folsom characteristic. When the second channel flake was removed, it left a negative scar with heavy ridges. This projecting material was r e m o v e d by the application of pressure and the detachment of the two diagonal flakes. These diagonal flakes served to flatten the base, probably to facilitate hafting. The same technique was applied after the detachment of the first channel flake, but, in some cases, was obliterated when the platform was prepared for the second flute. Examination with a twelve power hand lense reveals a total of 152 retouch flake scars on the perimeter and this number does not include the retouch on the base. The minute space available on each scar indicates that the pressure tool had a very small tip, not exceeding one millimeter in thickness. These minute retouch flakes have parallel sides and the length of these tiny flake scars is about four or five times their width. The terminal ends of the flake scars were, in most cases, removed by the fluting flake, therefore, their total lengths are unknown. For the first series of flakes, the micro retouch flaking was worked from the tip to the base. Then the preform was turned over and the same technique was used on the other side. The opposite side was then retouched from the base to the tip, then turned over and the other side retouched from the base to the tip. The spacing interval was kept constant by placing the pressure tool directly opposite the ridge left by the removal of the flake on the opposite side. Close inspection of the edge, discloses a sinuous or undulating edge resembling a microsawblade with denticulate edges. Because of the extreme accuracy in placement of the pressure tool and the attainment of maximum control of the downward and outward pressure, the flakes removed left an uncrushed, razor-sharp edge. Such meticulous care with placement and control of the pressure tool resulted in the removal of the micro-flakes and their adhering platforms from the edges of the Folsom. Such an edge has much strength and sharpness in spite of its obtuse angle. On one edge, there remains a small area indicating the primary retouching between the channel flake and the secondary retouch. Because nearly all the primary flake scars have been erased by the secondary edge retouch, there is no way to determine the techniques used for the primary pressure flaking. However, before the fluting was done, the surface of the preform must have been made very smooth and regular. Any irregularity on the surface of the point would cause the channel flake scar to be erratic, misshapen or aberrant from the normal channel flake. The platform of the first channel flake was placed slightly above the now existing tangs on the base. The first channel flake was then removed from the base to the tip with a slight curvature of the flake, terminating in a feather edge. The two ridges on either side of the bulb of pressure (channel) were then removed by two well controlled diagonal flakes preparatory to the construction of a platform for the removal of the second channel flake on the opposite side. In the preparation of the second platform, small flakes were removed by pressure from the area between the tangs to isolate the platform and position it midway on the base, directly in line with the tip. There is a small loss of platform material after removal of the first flute, so, when preparing the second platform, one must lower it between the two tangs. This deviation in platform preparation is necessary to the technique in order to obtain sufficient material to prepare a large enough and strong enough platform to withstand the amount of force necessary to remove the channel flake. The second platform must be positioned in such a manner that when it is removed, the bulb of force will intersect, or nearly so, the bulbar scar left by the first channel flake. If all techniques are followed carefully, the base will be knife-e d g e d, or approximately knife-edged. The removal of the second flake produces a wide longitudinal c h a n n e l corresponding to the one on the opposite face. The second channel flake is also slightly curved, resulting in a double convex longitudional section. There are two ridges outlining the channel flake scar and parallel to the edges of the point, g i v i n g the artifact the desired additional strength. The mid-section between the two fluting flake scars measures 5/64 inches in thickness, thus weakening the artifact. However, this weakness is compensated for by the two ridges. The worker must exercise the ultimate amount of control in order to start the detachment of the fluting flakes at the base and t e r m i n a t e them at the tip, thus creating an arc on both flakes to leave such a small amount of material in the midsection.

The Folsom point is often misunderstood perhaps due to the lack of understanding of the difficult mechanical problems involved in its fabrication and the misconception that it was made by the free-hand percussion method. Detachment of a channel flake by free-hand percussion can be accomplished, (Fig. 21a-c) but the finished point will be larger, thicker, have different character, and will look more like a Clovis than a Lindenmeier Folsom. Using the pressure with rest, and the indirect percussion with rest methods produces the true Folsom character and these techniques afford greater accuracy and control even though they are more time-consuming.

Artifacts produced by the free-hand percussion method, and those produced by the pressure and indirect percussion techniques may sometimes be mislabeled due to a lack of workshop material (including the removed flakes) from other fluted point sites. Such workshop debris would permit comparison and analysis of technology and identify the distinct difference between Folsom and other fluted traditions.

At present, the name Clovis encompasses such a wide array of artifacts of various sizes, forms, types of basal thinning and fluting, as well as many techniques of workmanship that only a few may be compared to the Folsom. The Lindenmeier Folsom has some definite hallmarks that set it apart from other fluted or semi-fluted points. The basal portion between the tangs is generally knife-edge thin after the removal of the second channel flake. This negative flake scar then makes a slight curve from the base to the tip of the point, often feathering out to an infinitesimal margin. The negative bulb of force left by the last channel flake is purposely designed to be deep in order to thin the base. This leaves surplus material projecting on both sides of the negative bulb. The suprlus material is then removed by pressing off two diagonal flakes which leave the narrow diagonal flake scars just below each tang. This is done after the fluting to leave the projectile point with a flatter and more uniform base.

The retouching on the margins of the Lindenmeier Folsom is equal in skill to the channel flaking, but it cannot be compared since the retouch technique is very different from that necessary to remove the fluting flake. These parallel marginal retouch flakes are as close as one twenty-sixth of an inch in width. Their length must be estimated and evaluated for they have been intersected by the channel flake and we cannot be sure of their original length or termination before fluting. Infinite skill is required to remove each of these diminutive micro-flakes, for each flake removal requires the same platform preparation, the same spacing, the same downward and outward pressure and the force must be applied each time at exactly the same angle.

A section of the length and a cross-section of the width of the Folsom is one of the attributes useful for distinguishing between Folsom and other fluted points. After fluting, it is thinner with the channel scar extending almost the width of the artifact. The section of the length is also thinner and doubly convex, with the channel scar starting and terminating to an infinitesimal margin All of these things are pertinent to the manufacture of Folsom. It would appear logical, therefore, that there is a great need to separate the Folsom from the other fluted point traditions by a more careful examination of the technology involved and a comparison of the techniques characteristic to each. The unfluted Folsom has, no doubt, equally diagnostic flake scars, but I have never had a chance to examine such material.

At times we tend to overrate this point because we sometimes lose sight of the fact that it represents only a single example of the many fine types of art which are evident on other types of stone tools. There is international interest in Folsom because of the technique involved in the removal of its two channel flakes and this concern has resulted in many theories regarding its manufacture and function. Yet the distribution or geographical range of this classic type is not great and its appearance in prehistory covers only a relatively short period of time. If and when a similar interest is shown in the technology of other artifacts which incorporate the removal of hundreds of flakes from one single tool, these too, will be just as distinctive. Consider the parallel flaking such as that found on Eden points. A different technique was used, almost as difficult as Folsom, but requiring an equal amount of control.

Admittedly, the Folsom technique is classic, but there are many other techniques of equally exacting and difficult workmanship, such as the Egyptian knives and bracelets; the Danish Daggers; the reversally fluted Dorset points from the Artic; the Mayan eccentrics; the polyhedral cores from Mesoamerica; the flakes spheres of Algeria; the very thin bifacial Soluterean types of the Old and New Worlds; and last, but not least, the magnificent pressure retouch done on some of the Early New World points.

The faceted spheres from Algeria are fantastic creations, but they cannot be compared to the fluting flakes of the Folsom because the working techniques are not comparable. However, the technique used for the making of the reversally fluted Dorset points can be compared favorably to the fluting of the Folsom. The Dorset pointmaker had problems confronting him that were quite different, but equally as difficult as those of the Folsom toolmaker. According to Jorgen Meldgaard (1962): "After careful chipping on both sides, two long blades were pressed off from the pointed end on the same side, each removing approximately one-half of the chipped surface, and resulting in a keeled appearance of this side of the blade. This process is parallel to the fluting of the Folsom blades, but the purpose was primarily to obtain sharp edges, secondarily to make the blade thinner." Consider the mechanics involved: the very fragile tip of the Dorset had to serve as the platform for removal of the two parallel flakes. This required the craftsman to use exceptional skill in the application of pressure in order to prevent crushing or breaking this point. After these two parallel flakes had been removed, they left a ridge down the median line and a razor edge on both sides. When one considers the problems of mechanics of fracture in relation to the amount of platform material on the fragile tip, then he realizes that this is indeed a remarkable accomplishment. The techniques of Folsom and Dorset appear to be parallel, but there is little doubt that these techniques were different.

The blades removed from the Gran Pressigny cores are a remarkable achievement and may be compared favorably to the dimunitive channel flake of the Folsom. However, these large blades were detached from a thick stable core and from only one side, whereas the blades removed from both sides of the Folsom were only slightly thicker than the point itself. The polyhedral cores from Mesoamerica also display much skill, as a single error or miscalculation would have ruined such a core. Here, too, there is a massive core from which to remove long narrow blades, which makes this manufacturing job less difficult than Folsom.

Fine Egyptian knives reveal a series of flake removal comparable to the fluting of the Folsom. Such knives demonstrate the maker's ability to repeat and duplicate flake removal, but the flakes are removed from a greater mass of stone.

I first became aware of the Folsom point sometime around 1928 when a tourist from Colorado, knowing of my interest in flintknapping, told me about this peculiar projectile point. He described it as having on both the dorsal and ventral sides "blood grooves" to permit the animal to bleed after the weapon had been inserted, and he further believed that the grooves had been ground out. From this description, it was difficult to make a mental picture of this point which, at that time, had no name. However, several years later I came into possession of one of these mysterious artifacts. Then, for the next ten years, I made numerous futile attempts to successfully replicate the Lindenmeier Folsom. I had little success, but I did gain much experience in what **not** to do and filled my files with broken and misshapen projectiles.

In 1941, I met Dr. E. B. Renaud at a Museum Congress in Columbus where I was working with Dr. H. C. Shetrone on lithic experiments, where I was able to study some of the Ohio fluted points. Dr. Renaud was working on typology and it was during a discussion of tool analysis that I obtained my first accurate information about Folsom points. When I had completed my work at the Ohio State Museum, I went to Washington, D. C. to talk with Dr. Frank H. Roberts, Jr. and was then able to view a collection of Folsom points and their channel flakes from the Lindenmeier site. My study of this collection was brief, but it gave me immeasurable assistance in understanding the technology of the Folsom point.

In 1963, Dr. H. M. Wormington of the Denver Museum of Natural History allowed me to examine some of their Folsom material and, after studying these artifacts, I revised my thinking about possible techniques of manufacture. The collection included some partly finished artifacts which gave me my first opportunity to analyze the actual steps of preparation for removal of the fluting flake. Principally, I noticed that the distal end of the preform was polished and left with excess stone, making the tip end of the preform thicker in relation to the design of the finished artifact. This technique was employed, no doubt, to provide better support and to lessen the shock received by the preform from the force necessary to remove the channel flake. This observation further strengthened my belief that either the pressure method with clamp and anvil, or the indirect percussion method with clamp and anvil, was used as the means of fluting. Logically, the excess material could be of no conceivable help when one employed either the free-hand percussion or free-hand pressure technique. In fact, this excess material might be detrimental. Further, the polished tip would serve no purpose. I reasoned that the polish on the tip was to strengthen the stone and the excess material was purposely left there to permit the artifact to withstand the great amount of force applied during the manufacturing stage whether by pressure or percussion. I did some experimenting with this technique of point support and tried a new method of placing the artifact in a holding device. Previously, I had felt the tip of the artifact should not be touching solid material, for I felt this would cause crushing or compression of the channel flake. The excess material left on the tips of the Denver Museum collection indicated that the aboriginal rested the tip of his preform directly on a support. Thereafter, my artifact was placed in a holding device in such a position that it rested on the leading edge of an anvil and in such a way that the leading edge of the tip of the preform was supported by the antler block (anvil). Therefore, when force was applied on the platform and the fluting flake was being detached, it would clear the antler support and still flute the projectile point to the tip without the customary end snipping. The use of this method resulted in better replicas and I did not snip off the tips as often as without the support. I also found when using this method that fluting flakes removed in this fashion had the same characteristics as those removed by Folsom Man. To extend the test of my thinking, I described my theory to Gene Titmus, a competent Idaho flintknapper. Titmus also obtained similar, improved results. My experiments with this technique, whether using pressure with rest or indirect percussion with rest, have been quite successful and have produced points with the character of the Lindenmeier Folsom.

There seems to be an erroneous opinion that the Folsom was made for beauty and its flutes for decoration, or due to the desire of the worker to reserve for posterity a record of his knapping skill. I do not believe the aboriginal had beauty in mind, or art for art's sake, but, rather, was desiging a practical and functional tool of high quality. As a stoneworker, I consider this point to be structurally and mechanically the best designed for its purpose of any weapon produced in this period of time. I think this projectile was designed to permit easy withdrawal from a mammal and to provide for repeated stabbings to insure the kill. The shaft of the spear must also have been of sufficient strength and diameter to penetrate between the ribs and deep into the body cavity and permit the hunter to make repeated thrusts through the thick, tough hide of a prehistoric mammal. The Folsom point met these needs. The shape of this projectile was designed for strength, having a tip that was razor-sharp because of the minute delicate, denticulate retouch; yet it was not the fragile constricted tip of some of the points of later periods. The toolmaker, I surmise, designed the point with a broad tip so it would be less likely to break if it struck bone. Its design makes it one of the strongest of all projectile points for, when properly hafted, the cutting edge was about all that was exposed. I do not believe that the Folsom was simply lashed on the end of a split stick, for its design would indicate that it was fitted to a shaft with care and precision. Logically, it would seem that the shaft was designed to fit the fluted channel in such a manner that only the cutting edge of the projectile would be exposed. Possibly, the serving included the use of gums, resins, or other dopping cements to insure stability after the final lashing to the projectile. The basal portion of this point is slightly constricted, or tapered, perhaps to provide clearance for a serving to the shaft. This allows the shaft to be tied in such a manner that it will cover the constriction and make the sides of the flint point slightly wider than, but parallel to, the shaft. The base of the artifact should be the same width as the diameter of the shaft, otherwise there would have been no need for the toolmaker to constrict the basal portion of the point. The tangs and the convex portion of the base (remnant of the platform) between the tangs served as a holding device to more firmly secure the point and make it immobile when it was finally secured to the shaft. The finished product would then allow for repeated insertions in a large mammal (Fig. 12). It is reasonable to think, therefore, that Folsom hafted in this manner, would have no stemmed points made of comparable weight or size that would have had equal resistance to breakage.

In the future, it would be a most interesting project to study and compare the points that were broken on the hunt, those broken in the process of manufacture and, upon rare occasions, those that were, perhaps, taken as playthings by curious children and subsequently lost. It would seem unlikely that a finished point was discarded casually.

In other traditions, we sometimes find repeated manufacture of tools with exact duplication of size and shape of flakes even to an extent that we wonder if the same knapper did not make all the tools. Not so with Folsom. We find the toolmaker at one time removing a beautiful channel flake that spreads across almost the entire surface of the point and terminates without margin at the distal end. Then again, we find the fluting scar narrow and hinged off before it intersected the tip. Some specimens were broken in manufacture because the tip adhered to the channel flake, while others break in two pieces, and some show multiple fractures. My experiments lead me to believe that such breaks are generally due to improper control of downward and outward force and from improper support of the distal end of the preform. We find the stubby type Folsom, which appears to be the result of reclaiming a broken specimen and retouching the tip, evidently the rejuvenation of a point that was broken by snipping off the distal end during the fluting process. These show the same character of working techniques, but the variance of size and length of the channel flake seem to indicate that even Folsom man was having problems fluting his projectile point.

The number of completed points cannot be estimated from the amount of debitage and channel flakes found in an occupation zone. Many of these flakes were broken as they were removed from the point, while others were utilized as cutting implements. Therefore, the amount of channel flakes broken during manufacture gives no clue to the number of points that were actually finished. Also, points broken on the hunt and then returned to the camp for replacement will give no clue to the percentage that were finished and lost at the hunting ground. It would seem that all points broken in the manufacturing stage would remain where they were fabricated. A full assemblage of the discarded, broken and resharpened points must be examined in order to learn how a point was broken. A study of the relationship of the flakes to the artifacts should help resolve whether they were removed by percussion or pressure, the order in which they were detached, the rhythms and muscular behavior patterns of the worker, and what type of preparation was provided for the removal of the flakes. When one has an understanding of the working techniques that produce flakes, then he can make other comparisons with other flakes and flake scars. Certain mechanical conditions produce a definite scar on the breaks thereby making it possible to determine whether the point was broken in manufacture or was shattered when the shot made impact with mammal bone. The character of the break is similar if the conditions that caused the break remain the same. The same is true of breaks that occur during flake removal; for example, the removal of a channel flake leaves features which are diagnostic for Folsom but are not found in Clovis points. Such differences are described more fully under percussion and pressure experiments.

Before a flintknapper can attempt to replicate a technique, he must analyze the artifact and his analysis must include an examination of the flake scars and a mental reconstruction of the processes and techniques involved to produce a flake that would fit each particular scar. If he has only the flake for this reconstruction process, he must then make a mental picture of the negative flake scar left on the artifact and calculate at what stage of fabrication it was removed and further decide what part it played in the completion of the tool. When examining an artifact, the student of flintknapping studies the edges for remnants of platforms which may reveal diagnostic traits pertinent to certain types of platform preparation. He attempts to compute the angles at which force was applied and determine whether the pressure or percussion method of force was used. He tries to determine why certain artifacts have flake scar conformation and regularity while others show irregular and disordered flaking. He studies the edges, the hinge or step fractures, the feathering of the flakes and the width of the flake scars in relation to their length. Also important is the size and form of the artifact relative to the type of flake scars. The general eye-appeal of the form may have little bearing on the amount of skill necessary to produce this certain tool. A lenticular cross-section would, by necessity, have curved flakes, whereas the diamond-shaped cross-section will result from the removal of flat flakes.

Appraisal of artifacts should include comparison of the different degrees of the toolmaker's skill and the multiple techniques required to produce these stone tools. Each must be evaluated according to the individual's ability to produce a flake of the desired dimensions under certain set conditions and must be related to the quality of material. To be considered are the isotropic and homogeneous qualitities of the material, whether the stone had been altered by heat treatment, and whether undetected flaws or inclusions caused a higher frequency of breakage in partly completed points. These are a few check points to be remembered. It is unfortunate that only the final stages of the flaking are represented by the flake scars left on the completed artifact. There were, no doubt, several retouchinges done before the final one, but without a *complete assemblage* of the flakes there is no means of being certain whether pressure or percussion techniques were used. When such assemblages are available for interpretation of all stages of production, from the rough to the finished tool, then we may discover some of the more elusive points of their manufacture.

To my knowledge, no present-day flintknapper has ever really mastered the Folsom techniques, but my experiments have helped eliminate, for me, some of the methods purportedly used. Many of these methods I abandoned because the character of the flakes does not replicate the Folsom techniques. However, they will be listed here and explained for purposes of elimination. Before one can reasonably accept any suggested technique, the channel flake removed in the experiment must result in duplication of all features of the flake scars of the aboriginal point.

It is not enough just to successfully accomplish removal. I have tried every conceivable method of producing this fluted artifact and have, finally, accepted two methods and find that a third technique has merit but needs further experimentation. Accepted methods are (1) Fluting by direct pressure with rest; (2) fluting by indirect percussion with anvil and clamp; (3) combination of both. Following is a list, explanation, description and analysis of methods and techniques used in experiments to replicate the Lindenmeier Folsom. Emphasis will be placed primarily on the fluting technique because detailed preliminary work prior to fluting (preforming, surface flaking, form, size, etc.) is similar up to this stage of manufacture regardless of the method of flute removal.

List of experiments on Folsom techniques:

I. Direct free-hand percussion using a hand-held hammerstone, billets, or rods made of bone, antler or wood. Hafted stone, antler, or bone hammer may be used.

II. Direct percussion by securing preform in holding device and striking on anvil.

III. Direct percussion with preform placed on anvil.

IV. Indirect percussion, free-hand without rest.

V. Indirect percussion with rest.

VI. Pressure, free-hand with flaking tool either unhafted or hafted to a short handle.

VII. Pressure, free-hand with flaking tool hafted to a long handle.

VIII. Pressure, free-hand with short shoulder crutch and rest.

IX. Pressure with chest crutch and clamp.

X. Pressure with chest crutch, clamp and anvil rest.

XI. Combination of pressure and indirect percussion with clamp and anvil.

For each of the last three experiments it is essential to consider in sequence aspects of manufacture listed briefly below. One must consider: (1) Quality of material; (2) method of removing blanks from the mass without establishing stress; (3) percussion preforming; (4) first pressure retouch; (5) second pressure retouch; (6) transverse profile; (7) longitudinal profile; (8) general design of form for fluting; (9) swelling mid-section with a constricted base; (10) regular or ground edges; (11) preparation of the base; (12) very thin basal portion between the tangs; (13) preparation of the first platform; (14) angle of the platform; (15) position of the platform; (16) freeing of the platform; (17) size of the platform; (18) grinding and polishing of the platform; (19) diagonal thinning flakes at the base; (20) preparation of the tip; (21) angle of the beveled tip; (22) polishing the tip; (23) correct lateral position in the clamp; (24) correct longitudinal position in the clamp; (25) correct lateral and vertical angle of the artifact in the clamp; (26) correct side and downward pressure of the clamp; (27) correct support of the tip; (28) the amount of downward force necessary to flute; (29) the amount of outward force necessary to flute; (30) the angle at which the force is applied; (31) the correct longitudinal angle of force; (32) correct intersecting of the bulbs of force at the base; (33) correct intersection of the channel flakes at the tip; (34) removal of the second channel flake using the same preparation as the first; (35) final retouch with character distinctive to Folsom.

If we bear in mind that these factors do not apply equally to all experiments, we may consider in detail the eleven methods which I have tried.

I. **Direct free-hand percussion:** It is not impossible to flute an artifact by the use of this method, but it will not produce a true replica of Folsom. With the worker in a sitting position, flute removal is accomplished by placing the artifact in the left hand, resting on the underside of the four fingers, the long edge of the preform parallel with the inside of the little and index fingers, the platform projecting beyond the thumb and the index finger, the preform held securely in place by the thumb (Fig. 21a-g). For support, the hand holding the preform is then rested against the inside of the left thigh. The percussion tool (either a hammerstone, or a hafted or unhafted billet of horn, antler or wood) is held hammerlike in the right hand and the blow is delivered to the prepared platform at an angle perpendicular to the artifact. The amount of force necessary cannot be estimated for it must be related to the material of the preform and size of flute desired. This knowledge can only be acquired by experiment and experience. "When using **obsidian** for percussion work, use tree wood, not antler. Antler is too hard—box wood or any moderately hard and dense wood should do the trick." (Personal correspondence, Francois Bordes). The momentum of the hammer may be increased by the use of a long billet or by hafting the horn, stone or antler to a handle. "Holding the tool by its extreme end will increase the momentum and overcome the inertia problem. It is tricky, but gives the blow a better momentum that you cannot get if you hold the antler shorter." (Personal correspondence, Francois Bordes). However, the use of the longer billet or handle does multiply the margin of error. The force must be mentally calculated to control the flake and restrain or restrict it from travelling the full length of the point, otherwise the tip will be removed. Since material from the Lindenmeier site indicates the fluting flake terminated without a sharp margin, this fact would seem to eliminate direct percussion as the method used. If this method is used, the character of the channel flake will be one of many undulations due to the compression which results from the sharp impact of the hammer. The force will terminate the flute in a step or hinge fracture. This method may have been used to produce some of the Clovis points, but it does not produce the same character of flakes and scars that are found on Folsom points.

When using the hand-held percussion method for removal of the first channel flake, the platform is prepared across the base by pressing off a series of small flakes to remove sufficient material on each side of the center to leave a projection called a "nib" or "tit" (platform) which receives the impact from the striking tool. The platform is then rounded by abrasion to prevent it from shattering. If and when the first channel flake is successfully removed, the base is then reflaked to make a second nib for removal of the second channel flake. When preparing for percussion detachment, the first platform must be prepared high above the base in order to leave enough material to prepare a second platform. The second projection will be even with, or slightly higher than, the base. Platform preparation must be worked in this manner, otherwise the percussion tool would strike the corners (tangs) of the artifact before it hit the platform. Artifacts made using this method will have a flat or only slightly concave base and the base will be thick when compared to the Folsom. Further, the finished artifact will be almost devoid of tangs (Fig. 21 a-c).

Points made by hand-held percussion must necessarily be heavier than the Folsom, for the lighter point, lacking sufficient weight, will move with the impact from the striking of the hammerstone or billet. My initial fluting experiments were done using this method and I used every conceivable type of percussion tool and tried various tool-holding methods. For thinnning or making a Clovis, longitudinal flakes removed by the hand-held percussion method are not uncommon. However, this technique is not compatible with the actual fluting found on a Folsom point. When the aboriginal was rough-shaping a preform, it seemed to be a common practice for him to leave the object thick so that it would withstand the shock from the impact of striking (Fig. 22 g-j). He would then use the hand-held percussion method to remove a flake from both the dorsal and ventral sides. However, the removal of these two flakes was only to rid the preform of the surplus material before the final thinning and retouching and not to design the point for hafting. This basal thinning is ordinarily done on points of more than two inches in length and larger than most Folsom points in their completed form.

I discarded this hand-held percussion method of replicating a Lindenmeier Folsom because the space between the two barbs at the base of the artifact is so small that it prohibits striking with sufficient speed, accuracy and required force to permit removal of a flake from the base to the tip. To execute this fluting feat, the percussion tool must be large enough and have sufficient and necessary weight to remove a flake almost as large as the artifact itself. A tool of such size will not fit in the restricted area between the tangs. Further, the margin of error in this method is so great that the accuracy required would defeat man's attempt to remove a series of fluting flakes. If this method permits one to detach a fluting flake from one side, then the artifact is so weakened that it is practically impossible to repeat the operation on the opposite side without fracturing the preform. The first blow would have removed not only the flute, but also the platform and, therefore, it would be necessary to prepare a new platform for the second flute. Loss of original platform material would require preparing the second tit deep and well inside the barb. For this reason the second platform cannot be reached with the percussion tool. The force of the percussion blow also causes shock on the distal end of the artifact and the shock will tend to remove the tip.

II. **Hand-held percussion striking anvil:** When using this method, the preform is secured in a holding device and struck in such a manner that the prepared platform on the proximal end of the artifact will make contact with a hard object. The preformed artifact (with prepared platform) is inserted between two strips of flat wood that have been securely lashed together in such a manner as to provide a handle at one end, and at the same time, hold the projectile point securely at the other end. The device is held at one end in the same manner as one would hold a hammer and swung in an arc with sufficient force so that the platform of the artifact, held in the other end of the device, will strike against a partly buried cobble. The anvil is partly buried for the sake of stability. The cobble should have a ridge against which the platform of the artifact can be struck.

My experiments with this method have, to date, resulted in failure. However, the method merits further experiment. Results of my experiments have been: the shattering of the base, heavy undulations, loss of the tip and other breakage. The Levallois technique has a relationship to this method, but the tortoise core is much more massive and it lends itself well to this technique.

III. **Direct percussion with preform placed on anvil:** This is accomplished by placing the preform on an anvil and striking the prepared platform with a percussion implement. The tip of the preform is polished to avoid crushing under impact. Preform is then placed on the anvil, with the tip resting directly on the anvil and the preform held in a vertical position by the left hand. A vertical blow is then delivered on the basal platform of the artifact. The result is a bi-polar compression which is caused by one force directed against the other. These two cones of force are in opposition and, under impact, they will collapse, shattering the point. If the angle of force is changed to correspond with the angle of the cone, then the thumb and fingers of the hand holding the preform cannot provide sufficient resistance to the blow to allow a channel flake to be removed. I have had little or no success with this method. However, this technique can be used for removing a blade from a core.

IV. **Indirect percussion, free-hand without rest:** This method can encompass the use of several techniques. Each variation can be used with some degree of success either for the preforming of a bifacial artifact or to make a tool. However, the object must have adequate size, weight, or mass to have enough inertia for a flake to be removed successfully. My experiments in using this method to remove a Folsom channel flake have resulted in little success. (a) To remove a flute, I placed the artifact between my knees which are protected by a leather pad; used a deer antler tine for a punch and an antler billet as a striking tool. Then I seat the punch at the correct angle on the prepared platform and, using the correct amount of force, strike hard with the billet. It is more difficult to strike a single blow and retain the correct angle of the punch than it is to execute a series of blows for, if the first hit is successful, the remaining flakes can be removed by just keeping the same angle and using the same amount of force. A fluting flake detached in this manner will undulate and ripple excessively and it will either hinge off short or will carry through and remove the tip. I also find that this method requires the artifact to be quite thick to permit the removal of a flake from both sides. This technique produces a projectile point that has none of the character of the classic Folsom. The percussion shock is too great to produce a thin point and the end result is generally a broken artifact. Also, there is no means of controlling the amount of downward and outward force. (b) This is similar to the first variant, but the manner of holding differs. The difference involves placright hand. This technique will invariably remove the tip or will drive the point under the foot. (c) A third method is to place the point to be fluted in the palm of the left hand, which is protected with a leather pad. The base of the preform is pointed toward the heel of the hand and the tip rests between the index and second finger. The punch is held between the fourth and the little finger of the same hand and is placed at such an angle that the tip of the punch rests on the prepared platform of the preform. The artifact is held in place by the pressure exerted between the punch and the palm of the hand. The punch is then struck hard by the billet which is held in the right hand. It is difficult to retain the proper angle of the punch for the punch cannot be held firmly enough against the platform due to insufficient rigidity of the hand holding the preform. The hand cannot keep the artifact from moving with the force delivered by the billet. Further, the left hand also takes a beating from the shock of the impact. The preformed Folsom does not have sufficient mass or weight to provide enough inertia for detachment of a flake when using this method. (d) A fourth approach and similar method is to have a second person strike the punch which is held by the first person. This eliminates the cumbersome method of trying to hold both punch and preform in the same hand and, at the same time, deliver the blow. The manner of holding the artifact is the same as above (c), but the punch is held in the right hand. The first person holds the preform in his left hand and the punch in his right hand. The second person delivers the blow. This method of using indirect percussion increases the accuracy of placing the punch and also of retaining the angle. This technique has not been fully explored by the writer because of the lack of a second person with sufficient experience in gauging the proper amount of force relative to the material and the amount necessary to remove a flake of a given dimension. This method provides no support for the tip and usually results in end-snipping.

V. **Indirect percussion with rest:** The preformed projectile is rested on an anvil or any substance that may provide the necessary support for the tip of the point. An anvil may be of medium soft stone, antler, bone, horn, wood, ivory or any material that is semi-yielding stone, and can include certain metals. The striking tool may be hafted or unhafted and be of any material as long as it can be accurately propelled with precision and control. In my experiments, I found that a billet of bone, wood or antler was preferable to an unhafted hammerstone. A hafted stone hammer or section of hafted antler will increase the needed momentum which cannot be obtained with a hand-held hammerstone. As do most techniques, indirect free-hand percussion with rest method involves many physical problems. Initially, I used this method to overcome the inaccuracy encountered in direct percussion, such as thinning a large bifacial tool. (a) The preform is placed on the underside of the middle, fourth and little fingers of the left hand while the punch rests on the index finger, held in place by the thumb. The tip of the preform (on which a proper platform has been prepared) is placed on a heavy piece of antler. The antler rests against the inside of the left thigh and is held in place by the pressure exerted between the thigh and the preform in the left hand. The punch is held in the left hand, its tip placed on the platform of the preform. A blow is delivered to the punch by an antler billet held in the right hand. It is very difficult to hold both the artifact and the punch in the left hand. Unless the left hand can exert enough pressure through the punch to the platform, a deep bulb of force will be the result, with the flake undulating excessively. Unless a second person is available to do the striking, better results will be obtained by eliminating the intermediate tool and using direct percussion. Then one can only expect to remove channel flakes which are characteristic to certain Clovis points and not to Folsom. (b) With the worker in a sitting position, the preformed, prepared but unfluted Folsom is held firmly between the heels of the worker and the polished tip is placed on an anvil which is resting on the ground between his feet. The punch is held in the left hand and its tip rests on the prepared, poilshed platform of the preform. At the moment of detachment, pressure is exerted with the left hand as the right hand delivers a blow of sufficient intensity and momentum to detach the channel flake. The amount of force necessary is relative to the material being used and the desired size of the channel flake. However, the use of the heels will suffice as a poor substitute for a of gunflints made by some African natives using this method. However, they used a metal punch to remove the flakes. This method works well for the type of product they wished to make and can be compared to this experiment, but cannot be compared to the removal of the Folsom channel flake. I have not been too successful with this technique for I am unable to sufficiently immobilize the point in order to accomplish removal of the flute. I cannot hold the punch against the platform and, at the same time, exert enough downward force on the platform of the preform to prevent the rebound which results from the billet blow. Breakage is excessive. A more limber person might explore this technique further. (c) The indirect percussion with rest technique is a method I did not explore until after I had viewed the Denver Museum collection and learned of the tip support. I conferred with Gene Titmus, flintknapper, and we spent many hours together, and separately, working on this technique. Our results were usually the same and we agreed on all phases of the manufacture. Mr. Titmus and I combined our conclusions and notes for description of Method C, and cerdit must be given here to his contribution to the writing of this method.

The most successful style of indirect freehand percussion with support is with the use of a clamp and anvil. The clamp holds the prefashioned point securely in place and also affords support for a means of pressure on the tip of the point which rests on the anvil. When preforming, in preparation for using this method, the tip of the point is beveled. This is done to allow clearance between the point and the anvil which permits the fluting to be completed without the channel flake contacting the anvil or support. The bevel is prepared on the side opposite that to be fluted. By beveling I mean the removal of a series of small pressure flakes from the tip of the preform until the desired angle is obtained. The foremost, or distal edge, of the bevel is then polished to help withstand the force applied on the basal platform. This allows the fluting flake to terminate at the base of the bevel (Fig. 22 g-j).

Let us consider this method step-by-step. A suitable piece of material (obsidian or heat-treated silica mineral free of imperfections, see Fig. 18 c-f)., is roughed out to approximate shape. Collateral parallel flaking, with each flake feathering out to slightly over half the width of the preform, is used in further shaping into the desired form. The preform should be lenticular in cross-section, as this is one control factor in getting the desired width and depth of the channel flake. A lenticular cross-section helps to spread the channel flake to the desired width. If the preform cross-section is sub-lenitcular, the channel flake may spread out to each edge until it will almost cleave the preform into two equal longitudinal pieces; or it will take off the distal end even though it is supported (Fig. 14 c-g).

Since the distal end of the preform is supported on an anvil during the fluting process, it should not be left too thin in cross-section and should be rather blunt. This strengthens the tip and helps the tip to withstand the force of the blow used to remove the channel flake. The basal end of the preform (before platform preparation) can be made slightly convex or squared. The shape of the channel flake is controlled by the outside surfaces, or faces, of the preform. Therefore, the smoother and more uniform the flaking, and the more symmetrical the cross-section of the preform, the more uniform will be the channel flake and the scar. A high spot or ridge on the preform face, in relation to the rest of the facial surface, will cause the channel flake to spread and follow this high place. A low spot will cause a narrowing of the channel flake in the vicinity of the low area (Fig. 19 c, d).

Preparation of first platform: The basal edge of the preform would normally be in the center, but the first step in platform preparation is to change or move this edge from the center (by removing short flakes from the basal edge opposite the face you wish to flute (Fig. 1a). It is moved over until it is vertically in line, or almost in line, with the face you are going to flute. These short flakes are removed until the base is nearly squared (Fig. 1b). This leaves the basal end almost flat or at right angles to the long axis of the preform. This flattening of the base will give the punch a better seat and allow the platform to be almost directly in line with the face when its preparation is completed. The next step is to segregate the striking platform from the rest of the basal edge, positioning it in the center of the base (Fig. 4a). This is done by removing flakes, starting at each extreme edge of the base, in turn, on the face you are going to flute. The flakes are removed, starting from each basal edge, toward the center. The flakes removed from the outside edges need not be too long, but as you progress toward the center they should be made longer with the longest flake immediately beside the projection (platform) (Fig. 3a, 4a). This frees the platform from the basal part of the face. This procedure also leaves the platform projecting above the rest of the basal edge. Next, on the opposite side of the face to be fluted, material must be removed to free the platform. This is accomplished by removal of a flake on each side of the platform as in Fig. 3b, arrows 1 and 2. This leaves an equi-lateral triangular shaped platform. The freeing of the platform on this side establishes where the channel flake will free itself from the preform when it is removed. Generally, the channel flake will come free immediately behind the apex of the triangular shaped portion of the platform (Fig. 4b, broken line and arrow). When the channel flake comes free immediately behind the apex of the triangular shaped platform, it leaves the small basal projection characteristic of the classic Folsom (Fig. 2). In some cases, if the platform is not freed sufficiently from the rest of the preform, the flake will free itself further behind the triangular shaped portion of the platform and leave a flake scar similar to Fig. 6 and then there will be no basal projection. The top of the platform is then polished until completely smooth. The polishing is done so that the platform will withstand the force used to remove the channel flake. If the platform were not polished, it would collapse or shatter when force was applied, resulting in a broken preform, or else in a poorly removed channel flake. In all cases, the platform must be prepared as described so that the characteristics of the classic Lindenmeier Folsom will be present when the channel flake is removed. The main purpose of the platform is to facilitate easy removal and permit better control of the removal of the channel flake. The distal end (or tip) must be beveled and polished as previously described and it must be supported on an anvil when placed in the vise (Fig. 23 a-j). The edges of the preform are also slightly polished at the base to withstand the pressure of the vise. This is to safeguard against the vice crushing the edges (Fig. 22 a-c).

Fluting: A wooden vise is employed to hold the preform during the fluting process. The preform is placed in the vise on an angle of approximately 80° with the distal end resting on a small piece of deer or elk antler anvil. Deer or elk antler is not necessarily the only substance that could be used for an anvil. Soft stone or possibly hard wood would be a suitable substitute. The vise must be capable of holding the preform firmly by its edges and also capable of exerting downward pressure sufficient to hold the distal end of the preform firmly against the anvil. This firm support of the distal end in the vise is necessary so that the channel flake will feather out when it is detached. If support of the distal end is not sufficient, the fluting action will not allow the channel flake to feather out, and the preform will break (Fig. 5). "Feathering out" (see Fig. 16 b-e) is a term used to describe the way the channel flake comes off, or frees itself from the preform face (Fig. 7), and is defined as the lessening of the thickness and the narrowing of the width of the channel flake as it is nearing the distal end of the preform. This narrowing and lessening continues until the channel flake reaches the distal end and is detached. The angle at which the force is directed into the preform determines where the channel flake will feather out. The amount of force used is also a factor involved in removal. If insufficient force is applied, the channel flake will step-fracture at the point where the amount of applied force is exhausted. After the preform is placed in the vise, the intermediate tool, which is a copper-tipped wooden-handled instrument of about one pound in weight and approximately one foot long (punch) (Fig. 8), is placed with the copper tip centered directly on the polished platform. The tip of the punch must be held firmly against the platform and the entire punch must be directly in line vertically with the preform (Fig. 9b) with he punch angled back approximately 10° as in Figs 9a and 23k, l. The punch must be directly in line vertically; that is, the punch, the platform, and the center of the distal end must all be in line. This is to insure that the channel flake will be removed from the center of the preform. If these conditions are not met and the punch is not in line vertically and is angled off slightly to one side or the other, the channel flake will come off one edge or the other, depending on which way the punch is angled off center and leave a flake scar as in Fig. 10. The next step is the striking of the blow against the punch to remove the channel flake. To strike this blow, I use an elk antler billet approximately one foot long and weighing slightly in excess of one pound. The blow must be struck directly in line with the punch. The magnitude of the blow cannot be said to be any exact amount, as the degree of force needed to remove the channel flake varies with the material and the size of the preform. But the blow must be sufficient to carry the channel flake to the distal end where it should feather out if all preparation prerequisites are fulfilled. If the channel flake is successfully removed, the preform is removed from the vise and one is now ready to start preparation of the striking platform for the second channel flake.

Second platform preparation: The second platform is prepared similarly to the first except that the basal projection left from the first flute can be used in the preparation of the second platform. First, the basal edge is moved over until it is in line with the face you are going to flute and is slightly flattened as in Figs. 1a, b. The basal projection left from the first flute should still be projecting higher than the rest of the base as it was higher at its inception. Now the platform is completed as in the first channel flake preparation, building it around the basal projection. The extreme edges of the base need not be flaked down this time and this leaves the artifact with tangs characteristic of the Folsom. Then the bevel is worked on the tip, below the flute, and the point is turned and, by using the same technique, the flute is removed from the other side. This bevel creates a shearing process between the base of the platform and the polished beveled tip and provides a medium by which the flake removal may be controlled with precision and accuracy. The bevel eliminates the compression and opposition of forces and allows the channel flake to feather out without removing the tip. It also makes the resulting channel flake much flatter and reduces, but does not eliminate, the undulations and pressure ridges on the distal end of the flake. By using this method, the proximal end of the channel flake has all of the identifying characteristics of the Folsom, yet the ripple marks, or undulations, at the distal end of the flake scar appear to be more obvious than those on a Lindenmeier Folsom. Intensive study and comparison of the two is necessary before a final appraisal can be made. Tentatively, indirect percussion must be considered one of the three possible techniques. However, in the final analysis, it would appear that we must narrow this number and, ultimately, resolve and accept only one as the true technique used by this culture. If and when one technique is recognized and accepted and these methods are seperated by either time or space, then it will be possible to separate types and sub-types (Fig. 20e-h).

VI. **Pressure freehand with tool either unhafted or hafted to a short handle:** The preformed artifact with previously prepared platform is placed on a folded leather pad in the palm of the left hand and held in place by the grip of the four fingers. The distal and proximal ends of the preform are positioned in line with the middle finger of the left hand. The proximal end of the preform rests at the base of the palm with the tangs on the base placed on either side of the concavity of the hollow of the palm. This hollow provides space for the channel flake when it is detached from the underside of the projectile point. The right hand holds the pressure tool which is a piece of bone or antler sharpened to a point and either hafted to a short handle or used unhafted. Inward pressure is first applied on the prepared platform at the base of the preform, towards the middle fingers. Then, as the inward pressure attains the necessary intensity, a downward pressure is applied to pull the channel flake loose from the artifact. These bi-directional forces must be perfectly co-ordinated. When one is attempting to replicate as thin a projectile as the Lindenmeier Folsom, the basal corners (tangs) are likely to be broken unless the downward pressure is applied very carefully. A rudimentary fluting flake to accomplish basal thinning may be removed by this method, but this is not to be confused with the Folsom technique. Some of my initial experiments and attempts to flute a projectile were done using the hand-held pressure method. It is no problem to thin the base on both sides, but to remove a channel flake that extends from the base to the tip of the artifact involves a completely new set of problems that cannot be overcome when the point is hand-held (Fig. 24b).

VII. **Pressure, free-hand with tool hafted to a long handle:** The technique of detaching the channel flake by this method is the same as that described in VI except that a long-handled hafted antler or bone tip is substituted as the pressure tool. The long handle is substituted for the shorter one, as it will allow greater pressure to be exerted. The finished, long-handled tool will be of sufficient length to reach from the tip of the middle finger to the elbow. The artifact is held in the left hand which is resting on the inside of the left knee. The right hand, holding the pressure tool, is placed so that the back of the hand is resting on the inside of the right knee with the antler tip of the pressure tool placed on the prepared platform of the artifact. The handle of the pressure tool rests on the inside of the right elbow and against the rgiht side of the body. By using this position, leverage is increased over the short tool described in VI. The long-handled tool is very satisfactory for heavy pressure flaking and does not unduly tire the wrist muscles. However, because of the difficulties encountered in holding the preform, the results are comparable to method VI (Fig. 23k-l).

VIII. **Pressure, free-hand with short shoulder crutch and rest:** (a) A preform is held on the protective leather pad in the palm of the left hand. It is resting on the hollow of the palm and held in place by the pressure of the four fingers of the same hand. The right hand is curled around the outside of the fist of the left hand in much the same manner as one would hold a ball. The horizontal portion of the crutch is placed on the shoulder in a manner similar to holding a rifle, with the sharpened antler tip of the staff placed on the platform of the preform. Pressure is then exerted by pressing with the shoulder on the horizontal portion of the crutch to the platform of the preform. The use of the shoulder crutch provides the worker with the ultimate pressure that may be exerted when hand-holding the preform. This maximum amount of pressure is obtained because it allows the hands to press the artifact against the antler or bone tip while the shoulder is simultaneously exerting pressure against the crutch through to the platform of the artifact. I am a little apprehensive about this method because of some experimental Folsom work I did for the Ohio State Museum in 1940, using this technique. In an effort to develop sufficient pressure to remove a true Folsom fluting flake, I tried this short crutch method. When the pressure was applied, the unfluted preform collapsed and I drove the antler tipped pressure tool through the palm of my left hand. No doubt this was accidental, but it does serve to illustrate some of the hazards involved. This considerably dampened any enthusiasm I might have for this method. (b) In order to overcome the possibility of injury, I developed a series of clamps and holding devices for the preform. They not only prevent injury, but provide a means of immobilizing and securing the material being worked. If a clamp is used, preforms may be held secure so that in each experiment the force can be applied in the same degree and the angles remain constant. One can repeatedly remove the same type of channel flakes if the operator's coordination and motor habits remain the same. The shoulder crutch and viselike clamp have been useful for experimental work, but they will not allow one to develop sufficient pressure to produce a normal size Folsom flute.

IX. **Pressure with chest crutch and clamp:** I have been experimenting with this method for many years, but have had little success with this technique. Rate of breakage is entirely too high in relation to the number of successfully completed points. Results are: an inability to feather out the channel flake at the distal end and generally, the fluting will break off the tip of the point. When I learned to use an anvil to prevent this end-snipping, I abandoned this method. This method is not covered in detail, for it is the same as in Method X, except than an anvil is included for tip support in X.

Results of my past experiments with the fluting technique of the Lindenmeier Folsom have resulted in certain, definite conclusions:

1. This very thin projectile must be immobilized and supported, but it must be gripped by something other than the hands or feet, for these do not allow the necessary amount of rigidity (Fig. 22g-j).

2. One worker can complete all the stages of manufacture.

3. The degree of accuracy in placing the pressure or percussion tool on the platform between the tangs is critical, if an accurate replica of the fluting channel is to be produced (Fig. 20d).

4. The angle of the long vertical axis from the base to the tip of the point must be computed with extreme accuracy when the preform is placed in the vise. This is essential if the fluting flake is to terminate at the distal tip of the projectile (Fig 16b, c).

5. When the point is placed in the vise in preparation for fluting, the short, or lateral, axis must be estimated with the same degree of accuracy to insure that the channel flake follows the median line of the preform.

6. The worker must consider and compensate for the fragility of the thin preform when applying the fluting force.

The difficulty of fluting a Folsom may

be compared to a nearly exhausted core, worked down to such a small size that it will allow for only the removal of two remaining blades. A larger core, having more mass and weight, is more receptive to the hand-held percussion removal of blades, but the smaller, reduced core, lacking weight and, therefore, stability, embraces a whole new set of mechanical problems that can only be overcome by the use of a clamp which will provide the rigidity and firmness that is inherent in the larger core. Some may raise an eyebrow when the use of a vise, clamp or holding device is mentioned. Why? Any aboriginal who was able to master the complex mechanics of the fluting technique of the Folsom projectile was certainly able to devise and design something as simple as a method of holding his preform. A vise made of a few strips of hide, thongs or cordage, and two pieces of wood long enough to provide adequate leverage would most certainly suffice. My experiments have resulted in the conclusion that this clamp is an integral part of the fluting technique and could have been contemporaneous with the development of this particular artifact.

X. **Pressure, free-hand using a chest crutch with a clamp and anvil:** This method is covered in greater detail for it is one of my accepted techniques which will replicate a Lindenmeier Folsom. Following is a list of factors that are pertinent to obtaining satisfactory results:

1. **Lithic material:** Since there is evidence at the Lindenmeier site that Folsom man altered the natural material by application of heat, let us consider here, briefly, the merit of alteration relative to Folsom manufacture. One selects material having the qualities adaptable for the manufacturing technique of Folsom. Preferably one of the cryptocrystalline varieties of silica minerals, such as chalcedony or jasper, with a greasy or vitreous lustre similar to glass or obsidian. The material must be homogeneous and free of strains, flaws, and inclusions. When it is necessary to use stone lacking these qualities, thermal treatment will make the stone more receptive to fluting. Heat treatment gives to the silica minerals the vitreous quality necessary for fine pressure flaking and channel flake removal (Fig. 20e-h). Further, treated material loses much of its tenacity, cohesiveness and toughness, but still retains its hardness. Alteration also enhances the elasticity of the stone and, therefore, allows the flake to bend and increases the worker's control for pressure retouch and in guiding the fluting flake. Heat treatment also reduces the chance of a hinge fracture. Folsom can be made of naturally vitreous materials, but supplies of such material are limited and the heating increases the amount of usable material. If the silica mineral is to be heat-treated, I use percussion to remove large flakes, or blades called blanks from a core. After the blades are detached, they are then given thermal treatment. This is my method, but I have found that some prehistoric flakes reveal that the toolmaker first altered his core and then detached the flakes from the core. Ancient man apparently used both methods, tempering the stone before the flakes were removed and tempering the flakes after they were removed from the core. I find that there is less waste from heat fracture if the blanks are removed from the core first. The larger the mass, the more difficult it is to control the expansion and contraction of the core in order to prevent heat fractures. The larger the mass, the more slowly it must be heated and cooled. The aborigines who used this technique apparently understood the nature of these materials and were able to overcome the variables in composition, water content and impurities. A full understanding of the heat-treating of these materials is still to be explored, and we still have much to learn about what changes take place in the minerals. For experimental purposes, glass is a good substitute. Glass is homogenous, has the same fracture, the physical characteristics, and mechanical properties of suitable silica minerals. However, glass is fragile and this weakness must be compensated for accordingly (Fig. 15g,h-19e,f).

2. **Blanks and Preforms:** Initial steps in replicating a Folsom are: Start with a block of stone of sufficient size to permit removal of large flakes, or blades, from the mass, which will be called the core. This is done for the sake of economy and to provide one with a supply of flakes for preforming. A series of flakes may be removed from the perimeter of the core until it is exhausted. These blades, or flakes, will be referred to as blanks (Fig. 15 a-e). They are then worked into preforms and, ultimately, into artifacts. Blanks are removed from the core by the direct free-hand percussion method, using a medium soft hammerstone to eliminate end shock and avoid inherent stresses and strains that result from the use of a hard hammerstone. This is called the blade and core technique. The blanks must be thicker, longer and wider than the

finished preform. Another method is to use the core as the blank, a technique common where there is a shortage of material of the size necessary to use the core and blade method. When the core method is used, the surplus material is removed by using a hammerstone and free-hand percussion until it is sufficiently reduced in size for percussion retouching. The blank made by the core method is then further reduced by free-hand percussion with an antler billet until the proper conformation is reached—including the general form, thickness, and absence of irregularities. The antler tool allows the worker to remove flatter flakes, permits greater accuracy and subjects the preform to a minimum of shock and bruising. The core tool preform is now ready for pressure retouch.

We shall now return to the blanks that have been struck from the core. Most blades have a slight curve extending from the proximal to the distal end and this curve must be removed in order to straighten the flake. The curve, or slight arc, is straightened by percussion striking with an antler billet to remove the bulb of percussion and the underside of the distal end of the flake, until the long axis is straight. Then the worker continues the percussion retouch until the flake is preformed in the same fashion as the preform made from the core. At this stage of manufacture, one cannot identify which of the two percussion techniques was used for preforming—the core method or the blade technique. The percussion preforms are now ready for pressure flaking (Fig. 15f).

Tools consist of a thick leather pad to protect the palm of the left hand which will hold the unfinished point and the tine from the antler of a mule deer, which has been sharpened to a blunt point. This may be used as is, or hafted. For experimental purposes, I substitute a wooden handle with a copper tip in place of the antler. It is a time-saver for it retains its tip form longer than the antler tool. The preform is placed in the palm of the left hand held tight by the four fingers of the same hand. The thumb is not used. The base, or the tip, depending on whether one starts retouch at the base or tip, rests on or near the heel of the hand (or the big muscle of the thumb) in such a manner that one side and one edge of the preform are exposed to the knapper. The four fingers exert enough pressure on the preform to hold it securely, but not too much or the preform will break when it is being flaked by the pressure tool. The pressure tool is gripped in the right hand with the four fingers around the handle and the thumb free. The handle is held in line with the knuckles so that the point of the pressure tool projects just beyond the knuckle of the first finger. This manner of holding the pressure tool allows the worker to increase the leverage and aids in control. The wrist is held immobile. The left hand holding the point to be pressure flaked is normally rested on the thigh of the left leg near the knee. The edges of the preform are then trimmed by applying the side of the pressure tool vertically on the edge in a wiping motion called "shearing". Shearing provides a regular, uniform edge and, at the same time, creates a platform on which to seat the pressure tool. The first pressure flaking is not an attempt to produce uniformity, but is merely to remove any irregularities or step-fractures left by the percussion work. The preform must then be retouched again to make regular, uniform flakes over the entire surface of the artifact. This provides the smoothness and regularity necessary for removal of the channel flake. The most suitable type of flaking is either diagonal or collateral parallel flaking. The flakes extend from the edge to beyond the median line, feathering out with no step-fracture (Fig. 14 a, b). The pressure flake scars should be shallow and the bulbs of pressure diffused. There are many kinds of pressure retouching, depending on how the hand is held, the support of the preform, the position of the pressure tool, and the types of platform preparation. Each technique will produce a different surface character, and may represent different cultural groups. There appears to be a difference in the technique of preparing and fluting of points from the Lindenmeier site, the fluted points from Texas, and some from the Eastern United States. A further study of the different fluted point traditions will, no doubt, reveal the use of many different techniques of preparation and fluting (Fig. 14 e-g).

The contours of the surface on both sides of the preform are of prime importance for satisfactory fluting flake removal (Fig. 19 a, b) The lateral cross-section should be doubly convex (lenticular) or it can be diamond-shaped (Fig. 14 c). The degree of convexity, or the steepness or flatness of the diamond-shape, is the governing factor in controlling the width and the depth of the channel flake. When the convexity is increased, the fluting flake will be narrow (Fig. 16 f, g), and the finished point will be thick. When the ridge of the diamond-shaped cross section is steep, the fluting flake will also be narrow. These problems may be partly overcome by placing the platform closer to the center of the base, but this increases the amount of necessary force since the flake scar area has been increased. When the cross-section of the preform has only a slight convexity, the flake will spread to the edge and the point will be severed in spite of the use of an anvil. This results because the amount of material at the center of the artifact is insufficient to contain the force, and the force radiates, resulting in a broad conchoidal fracture which destroys the point. The surface, as well as the contour of the point, regulates the shape and design of the fluting flake. Any irregularities on the surface will cause the channel flake to undulate, constrict, or expand, and have different degrees of thickness. A surplus of material on the face will cause the flake to expand and a depression on the surface will cause the flake to constrict or fracture before the channel is completed (Fig. 19 c, d).

Using a tool with a very fine point, the edges are then pressure retouched by removal of a series of narrow, minute, parallel flakes. This results in an edge that is thick but very sharp, which serves a dual purpose. First, it will withstand the pressure of a holding device; and second, it gives strength to the projectile when it is finally completed. The edge at the basal portion of the artifact is ground smooth for additional strength (Fig. 16 a). Grinding prevents breakage from the pressure of the clamp, and later keeps the edge from cutting the lashings when it is secured to the shaft. The distal end of the artifact should be left rather blunt and almost as thick as the mid-section to provide for the beveling and polishing of the tip and still have enough strength to support the force of removing the fluting flake. It is this part of the point that will rest on the antler anvil during the fluting process and it must withstand the force necessary to remove the flute.

3. **First channel flake platform preparation:** The next stage in flute removal is the preparation of the first platform, which is sometimes called the spur, tit, or projection. The base of the preform has been left either square or with a convexity and the worker must now isolate the platform from the tangs. It is most important that the platform be prepared in a definite manner to provide the necessary clearance for the fluting flake to be separated from the artifact without breaking the point. The first step is to flatten the base by the use of pressure. Pressure is applied from the same side of the proposed first channel flake (Fig. 14 c, d). Repeated small flakes are then removed along the base until the leading edge is in line with the face of the point. The angle of the base is now slightly less than that of a right angle to the long axis. The base now has an appearance similar to that of the edge of a backed blade. The center portion of the base will be used for seating the pressure tool when the platform is completed. The platform must now be freed by applying the pressure tool on the opposite side of the base to remove, by a series of graduating pressure flakes, the material between the lateral edges and the area on which the fluting tool will rest (platform). A series of graduating flakes is removed by pressure from the side to be fluted, starting from the proposed tangs with the last, and longest, flake terminating at the median line to form a spine directly in line with the tip. The same procedure is repeated on the opposite side. The platform should then be left projecting slightly less than a quarter of an inch above the two concavities between the tangs and the platform. The projection must be freed on the side opposit the face to be fluted. This is done by removing a series of small flakes on each side of the projecting platform to form a sharp ridge or "V" on the backside of the platform which will part easier than a flat surface. The top of the platform is then polished to prevent crushing from the application of force. The top of the completed platform should be about an eighth of an inch in width and should have the surface shape of a diminutive "U". The position of the platform will govern the final appearance of the base of the completed artifact. If one of the two platforms—that is, platform for first flute removal and platform for second flute removal—is accidentally broken or crushed, it can sometimes be re-established. But, because the second preparation removes more material, the platform would, by necessity, be lowered, resulting in long projecting tangs. The variety of basal forms is the result of a lack of uniform orientation of the platforms. The base type changes could also be due to preference of the individual or for the purpose of identifying his particular point.

When the platform is prepared, it is extended away from the body of the artifact. This is done to segregate a miniature cone of force and allow for more direct downward force to remove the flute without the channel flake removing a deep bulb from the apex of the base. If the platform is not sufficiently freed, it will be crushed, the tangs broken, or the artifact will shatter.

4. **Method of holding:** The methods of holding are many and various and may be left to the discretion of the worker. For this experiment, I use a clamp made of two strips of white pine wood about two inches wide and one inch thick with the length to suit. A wedge is placed at the back end with the fulcrum (lashings, a bolt, or any securing device) as close to the projectile point as is necessary to get the correct amount of pressure to immobilize the artifact. The preform is then clamped at the front end between the two strips of wood and is positioned about 10 degrees from vertical, in such a manner that the platform on the side to be fluted will be vertical to the long axis in order to intersect the basal portion of the beveled tip. The distal end of the polished, beveled tip will rest on the leading edge of the anvil. The anvil may be of any resilient material, but one must not use any unyielding substance. For the anvil. I have used bone, ivory, hard wood, or softer grades of stone. The polished distal end of the artifact must be held firmly against the anvil by means of the downward pressure from the tightened vise or clamp. If the point is not held firmly on the anvil, the fluting force will cause a rebound. In turn, this will cause space to develop between the pressure tool and the platform, or allow space between the tip and the anvil. The artifact will be severed by a hinge fracture or the entire tip will be removed.

The length of the channel flake is controlled and determined by the combination of the downward and outward fluting pressure. When excessive outward pressure is used, the fluting flake will feather out rapidly, leaving an embryonic short flake with no hinge or step-fracture (Fig. 20 b). If no outward pressure is used, the platform will collapse or the projectile will disintegrate or be crushed (Fig. 22 d-f). If insufficient downward pressure with enough outward pressure to free the platform is used, a step fracture with a right angle break will be the result (Fig. 17 a, b). If insufficient downward pressure and too much outward pressure are exerted, the channel flake will terminate in a hinge fracture with a rounded end. The worker must calculate the proper amount of downward and outward pressure relative to the material used and size of the preform. This knowledge of necessary amount of force can only be gained by practice and experience. In the future, I hope to resolve the ratio of downward and outward pressure by proper calculations under controlled laboratory experiments.

The preform with prepared platform is now secured in the clamp, ready for removal of the first channel flake. The pressure tool used is made from a piece of hard wood thick enough to be fairly inflexible, yet not be cumbersome. A pointed piece of antler, or a rod of copper, is affixed at the end of the staff, secured by a ferrule, or serving, to hold it tight. This immobilizes the tip of the pressure tool and also prevents the shaft from splitting. The other end of the shaft is fitted with a short flat piece of wood, shaped to the size and comfort of the worker, to be placed against the chest. The length of the shaft is determined by measuring the distance between the tip of the index finger and the chest. Place the shaft on the chest, bend over and place the tip of the shaft on the platform of the artifact, and the distance between the chest and the tip of the index finger will give the correct length. It is important that the crutch be no longer, as the index finger must place and guide the point of the pressure tool to the tip of the platform (Fig. 13).

To hold the vise stationary, the flaker must now stand on the clamp, with the chest crutch in place and the worker in a bending position. Using the index finger of the right hand, place the point of the staff on the platform of the artifact. The tip of the pressure tool must be checked and cleared of any contamination caused by previous work, as any imbedded fragments of stone may cause the platform to crush before the maximum amount of pressure can be applied. The weight of the upper portion of the body rests directly on the crutch, which is resting on the platform of the artifact. The shaft of the pressure tool must be vertical and directly in line with the median line of the artifact. The opposing axis of the crutch must then be positioned in such a manner that the pressure will intersect the forward portion of the tip of the artifact (Fig. 20 a). If this is not done, there will be an opposition of forces that will cause the point to crush. Both hands are then placed on the shaft of the crutch at a position just opposite the knees. The knees may then assist the hands in controlling the outward pressure. Outward pressure is then gradually increased by the weight of the body and pressure from the knees until the platform parts from the base and the channel flake is pressed off to the tip of the projectile point. The downward pressure must have sufficient force to prevent the pressure tool from slipping on the platform when the outward pressure is increased. If the flake is tenacious and unyielding, the operator has to slightly lift the forepart of the body and drop it and, at the same time, exert the proper amount of outward pressure by flexing the knees against the hands (Fig. 24 c). The body movement must have perfect coordination with the movement of the knees. If all conditions have been considered and coordinated, a flake will have been removed from the base to the tip. The channel flake will have a slight arc and will feather out at its distal end.

We will now assume that the first channel flake has been removed in a satisfactory manner resulting in a flake scar on the artifact having the same character as that of a Lindenmeier Folsom. The half-fluted point is then removed from the clamp and a second platform is prepared on the opposite side in the same manner as the first. This second platform will, however, be slightly lower than the first. It is the removal of this second channel flake which constitutes an identifying characteristic of the Lindenmeier Folsom, but which is not as pronounced in other fluted point traditions. The Lindenmeier point has a thin, almost knife-like, edge at the base between the tangs with, at times, a bare remnant or trace of the last platform. This very thin basal area is the result of the proper positioning of the second platform. When the second platform is properly positioned, the channel flake will, upon its removal, almost intersect the fluting flake scar left by the first fluting flake. The exact position of the second platform is determined by the worker, and a knowledge of positioning can only come from experience.

The tip is then re-beveled and polished in the same manner as the first channel flake except it is done on the opposite edge of the tip. After the second platform is prepared and the tip reconstructed and polished, the half-fluted point is then placed in the clamp for the removal of the second flake. The worker's odds have been increased by the removal of the first flake, for the first fluting removed considerable material from the opposite face of the artifact, thereby reducing the thickness and thus weakening the point.

If one examines the channel left by the removal of the second flake, he will note that the size of the flake scar is many times the area of the cross-section of the completed artifact (Fig. 16 h-j). It would appear that a law of mechanics would forbid the fluting of a Folsom projectile point. It would be much easier to explain why the Folsom cannot be fluted rather than to describe how it is made. We will assume that the second flake has been successfully removed and the point is now complete except for minor retouching by pressure flaking of the tip and the base. The final retouching on the base is distinctive because of the two narrow diagonal pressure flakes following along the line of the channel from the base. These are applied to remove the ridges left by the negative bulbs of force of both channel flakes. These particular diagonal flakes seem to be characteristic of the Lindenmeier Folsom (Fig. 17 g, h). Pressure retouching done after the fluting can usually be determined by examining the intersection of the flakes or their overlapping with the channel flake scar. Projectiles made of the finer-textured materials will show more details of the flake character than those of courser-textured materials (Fig. 19 e, f).

XI. **Combination of pressure and indirect percussion:** Method of operation and preparation of the preform is the same as in Method X except a different technique is used for fluting and the crutch is of a different design. The shaft is much the same as the chest crutch used in X except that it is made from a young sapling of hard wood. The sapling selected must have a lower branch, which will form a crotch. This lower branch is cut off to form the crotch for striking. The stub of the lower branch should be left about one and one-half inches in length, measured from the main body of the staff, and it should be about four inches from the tip or distal end of the crutch (Fig. 13).

Fluting involves the participation of two persons—one to seat the pressure tool as well as induce the downward and outward pressure, while the second person delivers a blow of the right intensity to the shaft. The downward and outward pressure must be applied by the first person and be coordinated with the blow delivered to the apex of the crotch by the second person. The blow delivered by the second person is reflected (or deflected to) in the body of the shaft and is directed towards the tip of the shaft. Intensity of the blow should be sufficient to break the cohesion between the flake and the core, or artifact. Since this paper is only concerned with the technology of the Lindenmeier Folsom and there can be only a remote possibility that this method was used, we will not cover it in complete and intricate detail. However, there is a possibility that it could be adapted to remove large fluting flakes. Experiments to date, would lead one to believe that it could be of use in making the long channel flakes on some types of Clovis points and some fluted points known as Cumberland points from Ohio and the Eastern United States. Because of the surface area of these large fluting flakes, it is not likely that they were removed by pressure alone. This method was initially attempted by H. Holmes Ellis and the writer in 1940 in an attempt to replicate some core and blade techniques. More recently, Gene Titmus and I successfully experimented with it to remove large blades from obsidian.

The combination of pressure and percussion is mentioned here only to project the need of further experiments. There are other experiments which also need to be carried out in order to eliminate the many variables encountered in making a Lindenmeier Folsom. The variable factors involved in making a Folsom are coordination of muscular behavior and the ability to control materials that have the complex qualities of wave-mechanics.

I am left with the disquieting fact that I can replicate the Lindenmeier Folsom by the use of two techniques and the nagging thought that, at this time, I cannot discard either method. Yet it is unlikely that this point was made by the use of two different techniques. My experiments indicate that this projectile point was made by either the indirect percussion with rest method, or the pressure with clamp and anvil technique. I am inclined to think that one of these two methods was the means of fabrication and it would seem that one method, with perhaps slight variations, will be deciphered and resolved when more examples from the Lindenmeier site are available for study.

The indirect percussion method leaves something to be desired or, when using this to flute, the normal results are a removed channel flake that is broken into two or more pieces. Also, the percussion blow produces flakes that are straighter, with less arc from the base to the tip than those that are removed by pressure. Indirect percussion also causes slightly more undulations on the distal ends of the channel flakes than does the pressure method.

The pressure method generally allows the recovery of the channel flake unbroken. It also produces a curved channel flake and there are fewer undulations on the distal end of the flake.

I hope that the results of my experiments will prove useful and will inspire the student of stone technology to experiment further with these techniques. The work reported in this paper is based on hundreds of experiments over a number of years and more will be needed. I shall continue to make additional experiments and refine my techniques and, if I can examine more Folsom points, I may be able to determine which technique produced the Lindenmeier Folsom. To resolve this would truly extend our knowledge of man's past.

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KEY TO ILLUSTRATIONS

Fig. 1a: Preparation of the platform for detachment of the channel flake.

Fig. 1b: Movement of platform in line with the face to be fluted.

Fig. 2: Characteristic basal projection after detachment of the first channel flake.

Fig. 3a: Lengthening of flakes toward the platform.

Fig. 3b: Freeing of the platform by flaking on the opposite face.

Fig. 4a: Positioning of the platform in the center of the base.

Fig. 4b: Place where channel flake will free itself.

Fig. 5: Break which results when the distal end of the point is not well supported.

Fig. 6: Flake scar when platform has not been sufficiently isolated.

Fig. 7: Feathering out of channel flake.

Fig. 8: Punch.

Fig. 9a: Angling back of the punch.

Fig. 9b: Lining up of punch.

Fig. 10: Flake scar which results when punch is off center.

Fig. 11: Detachment of final 2 flakes to remove swelling from the channel flake scar.

Fig. 12: Proposed hafting of Folsom point compared with hafting of blades for similar purpose.

Fig. 13: Type of crutch used to detach channel flakes in the replicating of Lindenmeier Folsom points.

Fig. 14a: Material, glass. Tabular piece with right angle edges removed from one side to permit seating of *free-hand pressure* tool. **Dimensions:** 12.9 x 4.3 x 1.0 cms.

Fig. 14b: Material, glass. First stage of pressure retouch to remove surface and make a semi-lenticular section and provide a surface more conducive to receive a more refined pressure flaking. **Dimensions:** 13.2 x 3.3 x 0.8 cms.

Fig. 14c: Material,glass. Preform retouched from both sides. Technique of applying pressure diagonally toward the worker. Base has been prepared and tip beveled. Bevels are made in opposite directions. Platform is yet to be prepared.

Fig. 14d: Edge view of Fig. 14c.

Fig. 14e: Demonstrates a type of retouch flaking which feathers out and terminates at the median line. Made by applying pressure at almost right angles to the artifact. *Transverse section is diamond shaped*, but with sufficient flatness to allow the channel flake to be contained without being excessively narrow. **Dimensions:** 9.6 x 2.2 x 0.8 cms.

Fig. 14f: Diagonal pressure retouch from only one edge. Technique is to apply the direct pressure away from the worker creating a double convex transverse section. Well suited for channel flake removal. **Dimensions:** 10.1 x 2.1 x 0.8 cms.

Fig. 14g: Feathered pressure retouch with a high median ridge from the base to the tip. Made by pressing toward the worker. This style of retouch will result in a narrow channel flake and a thick artifact. **Dimensions:** *10.6 x 1.9 x 0.8 cms.*

Fig. 15a-e: Material, White Jasper from Battle Mountain, Nevada. Showing flakes to be preformed removed from a core. **Dimensions:** 9.4 x 6.7 x 1.7 cms.

Fig. 15f: Percussion preform. **Dimensions:** 8.8 x 4.3 x 1.1 cms.

Fig. 15g: Material, Oregon pitchstone. Secondary pressure retouched preform. Pressure applied away from worker. **Dimensions:** 7.3 x 2.9 x 0.5 cms.

Fig. 15h: Material, Obsidian from Glass Butte, Oregon. Secondary pressure retouch preform flaked from both sides. **Dimensions:** 10.5 x 3.8 x 0.5 cms.

Fig. 16a: Material, Black Jasper. Final retouched edge still showing secondary pressure retouch with platform and tip prepared. **Dimensions:** 7.0 x 2.9 x 0.9 cms.

Fig. 16b-c: Material, Gran Pressigny flint. Donated by Dr. Jacques Tixier, National Museum, Paris, France. *Indirect percussion with clamp and anvil*. Showing removal of first channel flake from artifact. Illustrates feathering of channel flake and reveals lack of undulations when a good quality flint is used. **Dimensions: b:** 6.5 x 2.7 x 0.6 cms. **c:** 6.1 x 2.0 x 0.3 cms.

Fig. 16d-e: Material, Glass. Indirect percussion with clamp and anvil. Artifact showing channel flake scar and removed flake. Notice undulations. **Dimensions: d:** 5.6 x 2.1 x 0.5 cms. **e:** 5.5 x 1.6 x 0.3 cms.

Fig. 16f-g: Material, Flint from Harrison County, Indiana. Finished point and removed channel flake. Artifact and channel flake are narrow because of high ridge. **Dimensions: f:** 4.5 x 1.2 x 0.4 cms. **g:** 4.2 x 0.6 x 0.1 cms.

Fig. 16h-j: Pressure fluting with clamp and anvil. Showing both faces of the completed artifact. Fig. 16h to illustrate retouching after fluting flake was removed. **Dimensions: h:** 4.3 x 2.4 x 0.6 cms. **i:** 4.2 x 2.2 x 0.6 cms. **j:** 3.2 x 1.8 x 0.2 cms.

Fig. 17a-b: Material, Jasper. Fluted by pressure with clamp and anvil. Illustration of step-fracture. **Dimensions: a:** 6.0 x 2.2 x 0.5 cms. **b:** 2.4 x 1.5 x 0.1 cms.

Fig. 17c: Material, Glass. Types of pressure fluting with the clamp and anvil help. **Dimensions:** 8.5 x 2.7 x 0.9 cms.

Fig. 17d: Material, Obsidian. Types of pressure fluting with the clamp and anvil help. **Dimensions:** 7.8 x 2.7 x 0.9 cms.

Fig. 17e: Material, Ignumbrite. Types of pressure fluting with the clamp and anvil help. **Dimensions:** 7.7 x 2.9 x 1.8 cms.

Fig. 17f: Material, Obsidian. Types of pressure fluting with the clamp and anvil help. **Dimensions:** 8.8 x 3.1 x 0.8 cms.

Fig. 17g-h: Material, Black Jasper from West Virginia. Showing diagonal flakes at base to remove ridges left by bulbs of pressure. **Dimensions: g:** 7.3 x 2.7 x 0.8 cms. **h:** 5.4 x 1.6 x 0.3 cms.

Fig. 18a-b: Material, White Jasper from Battle Mountain, Nevada. Indirect percussion with clamp and anvil. One channel flake shows the dissipation of force. **Dimensions: a:** 4.8 x 2.5 x 0.5 cms. **b:** 4.1 x 1.3 x 0.3 cms.

Fig. 18c-d: Material, White Jasper from Battle Mountain, Nevada. Indirect percussion with clamp and anvil. Shows termination of channel flake. **Dimensions: c:** 6.6 x 3.1 x 0.8 cms. **d:** 5.7 x 1.5 x 0.4 cms.

Fig. 18e-f: Material. Fine-grained basalt. Indirect percussion with clamp and anvil. Notice lack of undulations because of the type of material. **Dimensions: e:** 6.0 x 1.7 x 1.0 cms. **f.** 5.5 x 1.4 x 0.5 cms.

Fig. 19a-b: Material, Obsidian. Pressure with clamp and anvil. Shows termination of channel flake removed from an irregular surface. **Dimensions: a:** 4.7 x 2.4 x 0.5 cms. **b:** 3.2 x 1.5 x 0.4 cms.

Fig. 19c-d: Material, Flint from Harrison County, Indiana. Pressure with clamp and anvil. Showing the constricting and expanding of channel flake due to high and low areas on the face of the preform. **Dimensions: c:** 7.2 x 2.6 x 0.9 cms. **d:** 6.7 x 1.5 x 0.3 cms.

Fig. 19e-f: Material, Quartzite from Hellgap, Wyoming. Courtesy of Dr. Cynthia-Irwin-Williams. Example of indirect percussion using clamp and anvil. ***Dimensions: e:*** 4.2 x 2.3 x 0.6 cms. **f:** 3.2 x 1.3 x 0.3 cms.

Fig. 20a: Material, Obsidian. Pressure with clamp and *anvil. Showing channel* flake not properly centered because pressure was not applied in line with the tip of the point. **Dimensions:** 6.3 x 2.7 x 1.6 cms.

Fig. 20b: Material, Obsidian. Pressure with clamp and anvil. Showing the short termination of the flake due to the application of too much outward pressure. **Dimensions:** 6.0 x 2.1 x 0.6 cms.

Fig. 20c: Material, Jasper. Pressure with clamp and anvil. Showing main flute off-center and second smaller fluting flake on the same face in order to thin the point. **Dimensions:** 4.4 x 2.6 x 0.6 cms.

Fig. 20d: Material, Obsidian. Pressure with clamp and anvil. Showing very thin point with good termination. **Dimensions:** 4.0 x 2.3 x 0.5 cms.

Fig. 20e-h: Material, Varieties of chalcedony. Indirect percussion with clamp and anvil. Good example of *replicating the Lindenmeier Folsom.* **Dimensions: e:** 3.8 x 2.0 x 0.4 cms. **f.** 3.3 x 1 x 0.2 cms. **g:** 3.8 x 2.0 x 0.5 cms. **h:** 3.4 x 1.4 x 0.3 cms.

Fig. 21a-c: Material, Obsidian. Direct free hand percussion without tip support. **Dimensions: a:** 8.5 x 2.4 x 1.1 cms. **b:** 5.7 x 1.5 x 0.5 cms. **c:** 10.1 x 4.1 x 1.2 cms.

Fig. 21d-g: Material, Flint and Obsidian. Free hand percussion with unsupported tip. Example of removal of the distal end. **Dimensions: d:** 8.5 x 3.2 x 1.1 cms. **e:** 4.0 x 3.1 x 0.7 cms. **f.** 8.3 x 1.8 x 1.0 cms. **g:** 4.1 x 2.7 x 0.7 cms.

Fig. 21h-i: Material, Glass. Direct free hand percussion with tip support. Intensity of blow was reduced to prevent end snipping. **Dimensions: h:** 6.3 x 2.5 x 0.7 cms. **i:** 2.5 x 2.3 x 0.3 cms.

Fig. 21j-k: Material, Flint from Harrison County, Indiana. Direct free hand percussion with tip support. Intensity of blow was reduced to prevent end snipping. **Dimensions: j:** 5.7 x 3.5 x 0.8 cms. **k:** 3.4 x 2.7 x 0.4 cms.

Fig. 22a: Material, Glass. Pressure with clamp and anvil. Shows the type of break when the base is not properly secured in the clamp. **Dimensions:** 8.1 x 2.1 x 0.6 cms.

Fig. 22b: Material, Glass. Break caused by too much force from clamp. **Dimensions:** 7.7 x 2.3 x 0.8 cms.

Fig. 22c: Material, White Jasper from Battle Mountain,, Nevada. Break caused by insufficient downward pressure exerted by the clamp on the anvil. **Dimensions:** 5.9 x 2.4 x 0.8 cms.

Fig. 22d-f: Material, Glass and Obsidian. Breaks caused by the collapse of platform. **Dimensions: d:** 3.1 x 2.0 x 0.4 cms. **e:** 3.1 x 0.9 x 0.3 cms. **f:** 3.3 x 1.9 x 0.4 cms.

Fig. 22g-j: Material, Glass. Pressure with clamp and anvil. Breaks caused by improper support in clamp. The force lines show the force starting in the middle of the artifact and moving towards the base and tip. Observe the character of the channel flakes. **Dimensions: g:** 10.2 x 2.8 x 0.8 cms. **h:** 5.5 x 2.5 x 0.4 cms. **i:** 8.6 x 2.3 x 0.8 cms. **j:** 4.6 x 1.7 x 0.4 cms.

Fig. 23a-j: Material, Glass and Obsidian. Examples of end-snipping because of the lack of tip support. Pressure with clamp and anvil. **Dimensions: a:** 3.4 x 1.7 x 0.6 cms. **b:** 3.1 x 1.9 x 0.5 cms. **c:** 2.9 x 1.3 x 0.3 cms. **d:** 2.7 x 1.6 x 0.5 cms. **e:** 4.0 x 1.3 x 0.4 cms. **f:** 3.0 x 2.0 x 0.5 cms. **g:** 2.0 x 1.9 x 0.5 cms. **h:** 3.6 x 1.0 x 0.2 cms. **i:** 4.2 x 2.3 x 0.6 cms. **j:** 1.8 x 1.8 x 0.5 cms.

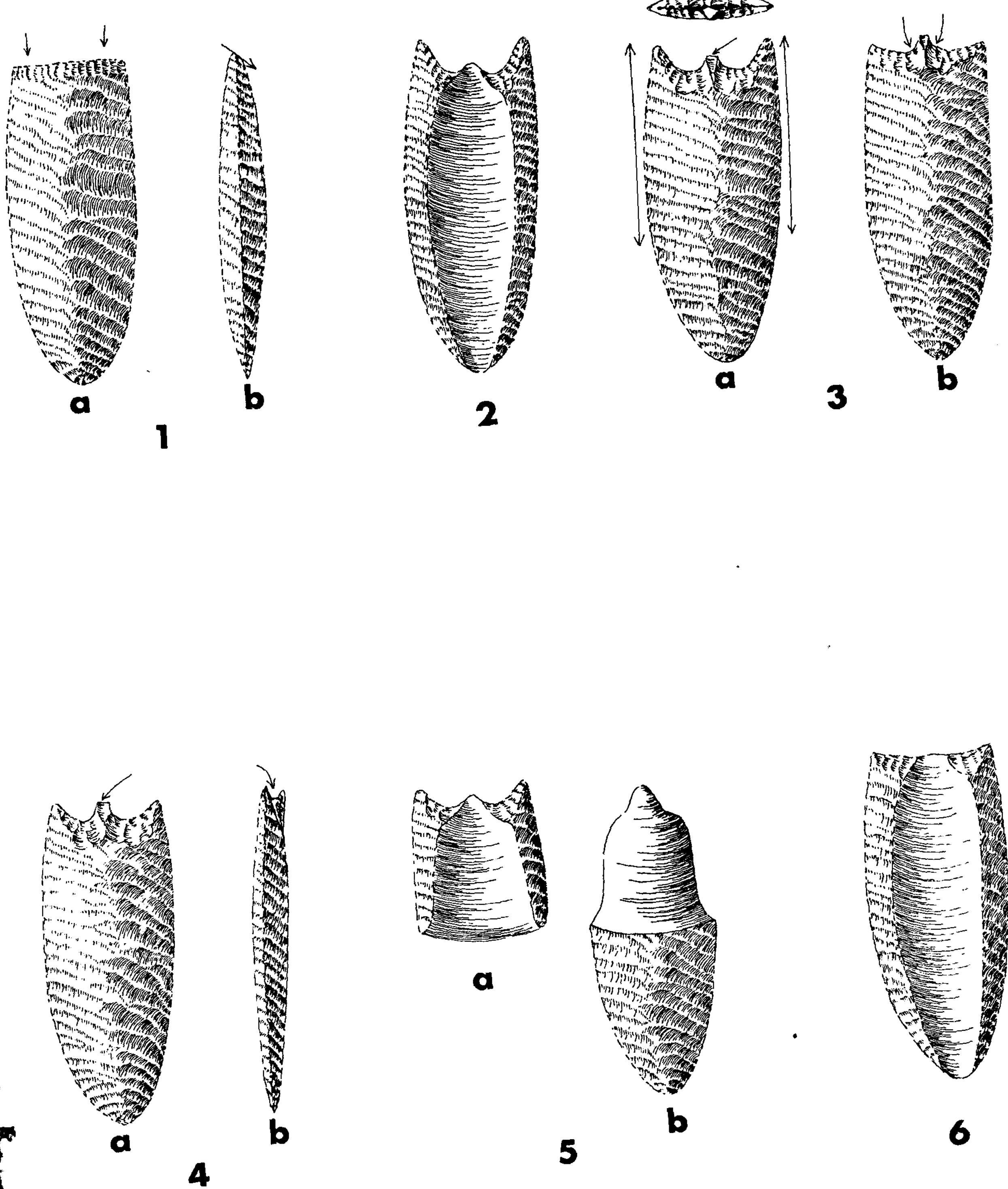
Fig. 23k-l: Material, Glass.. Indirect percussion with rest. The angle of placing the intermediate tool was not correct causing the channel flakes to be short. **Dimensions: k:** 6.0 x 2.2 x 0.7 cms.**l:** 3.0 x 1.5 x 0.4 cms.

Fig. 24a: Material, Obsidian. Hand-held pressure fluting. El Inga type of point. **Dimensions:** 5.7 x 2.8 x 0.7 cms.

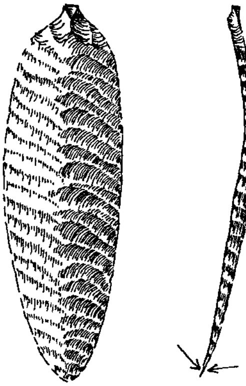
Fig. 24b: Material, Glass. Same as above to show basal thinning. **Dimensions:** 5.0 x 1.9 x 0.5 cms.

Fig. 24c: Material, Obsidian. Pressure fluting with clamp and anvil. Shows compression of flake because a thrust was used on the chest crutch in order to get sufficient pressure. **Dimensions:** 10.1 x 4.3 x 1.0 cms.

Fig. 25a-m: The complete sequence of manufacture of a Lindenmeier Folsom point.



Figs. 1-6



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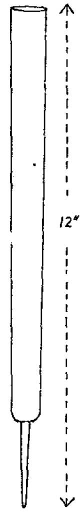

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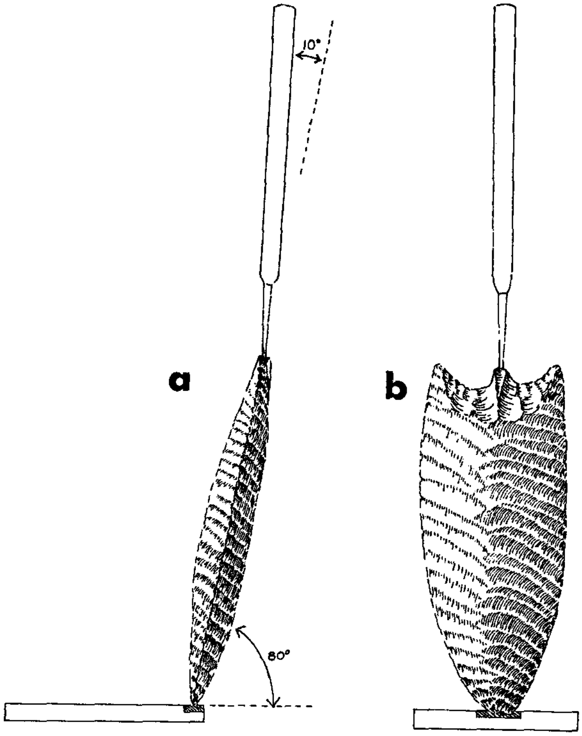

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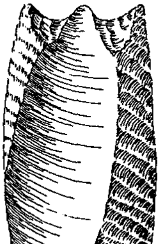

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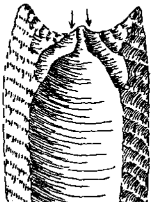
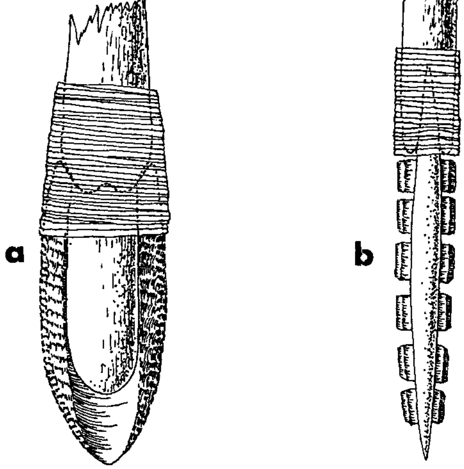


11

Figs. 7-11



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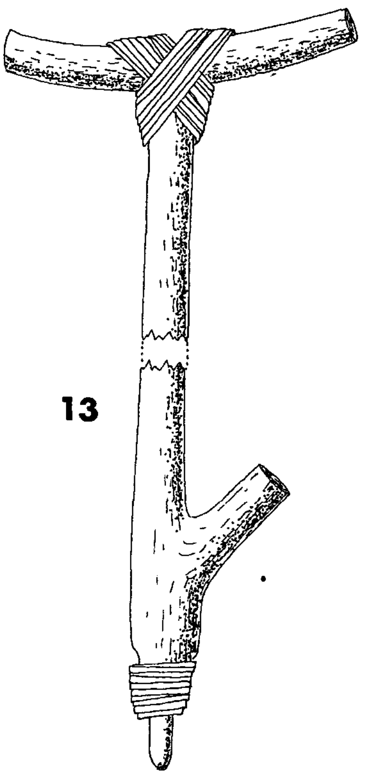

13

Figs. 12-13

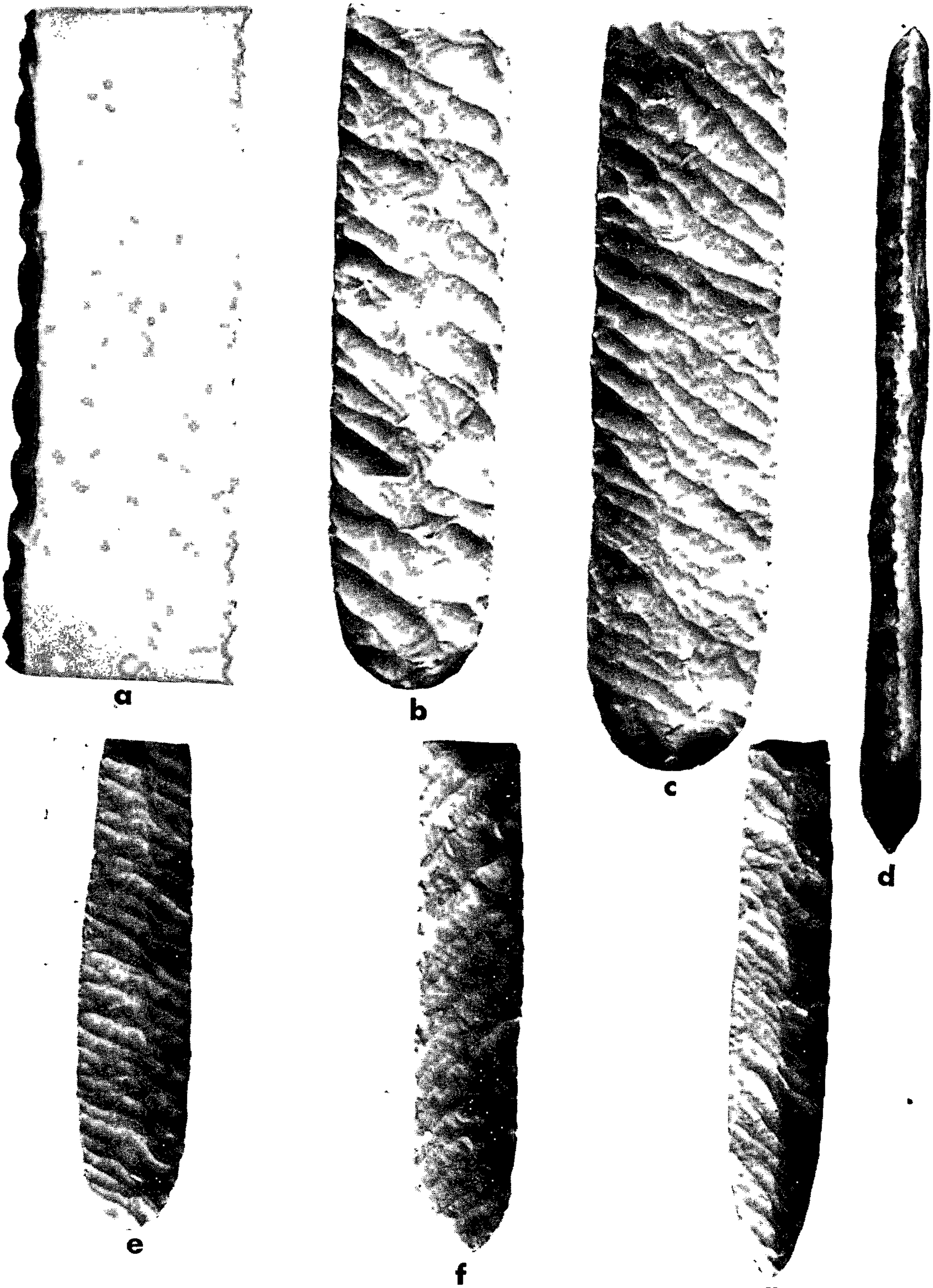

Fig. 14

Fig. 15

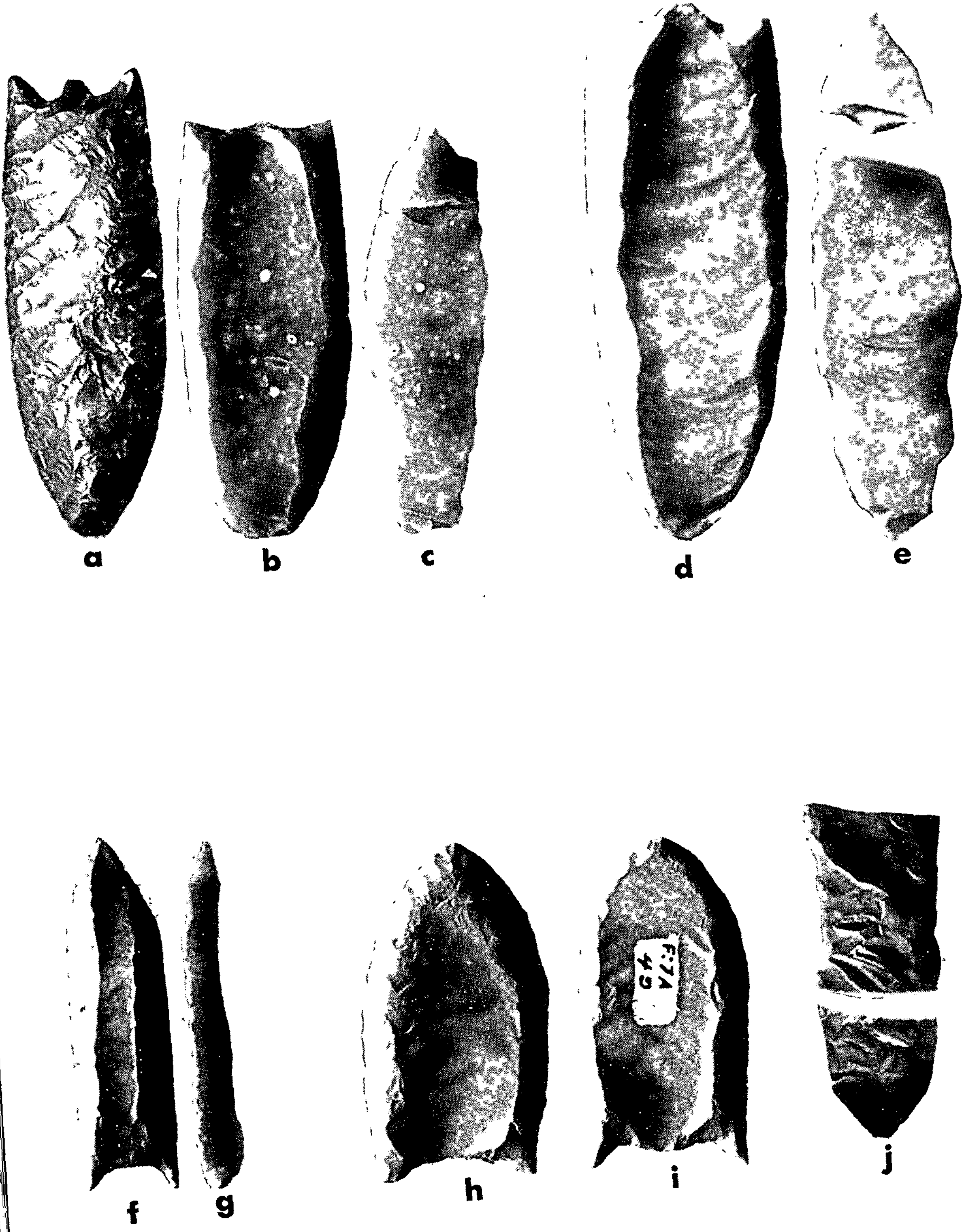

Fig. 16

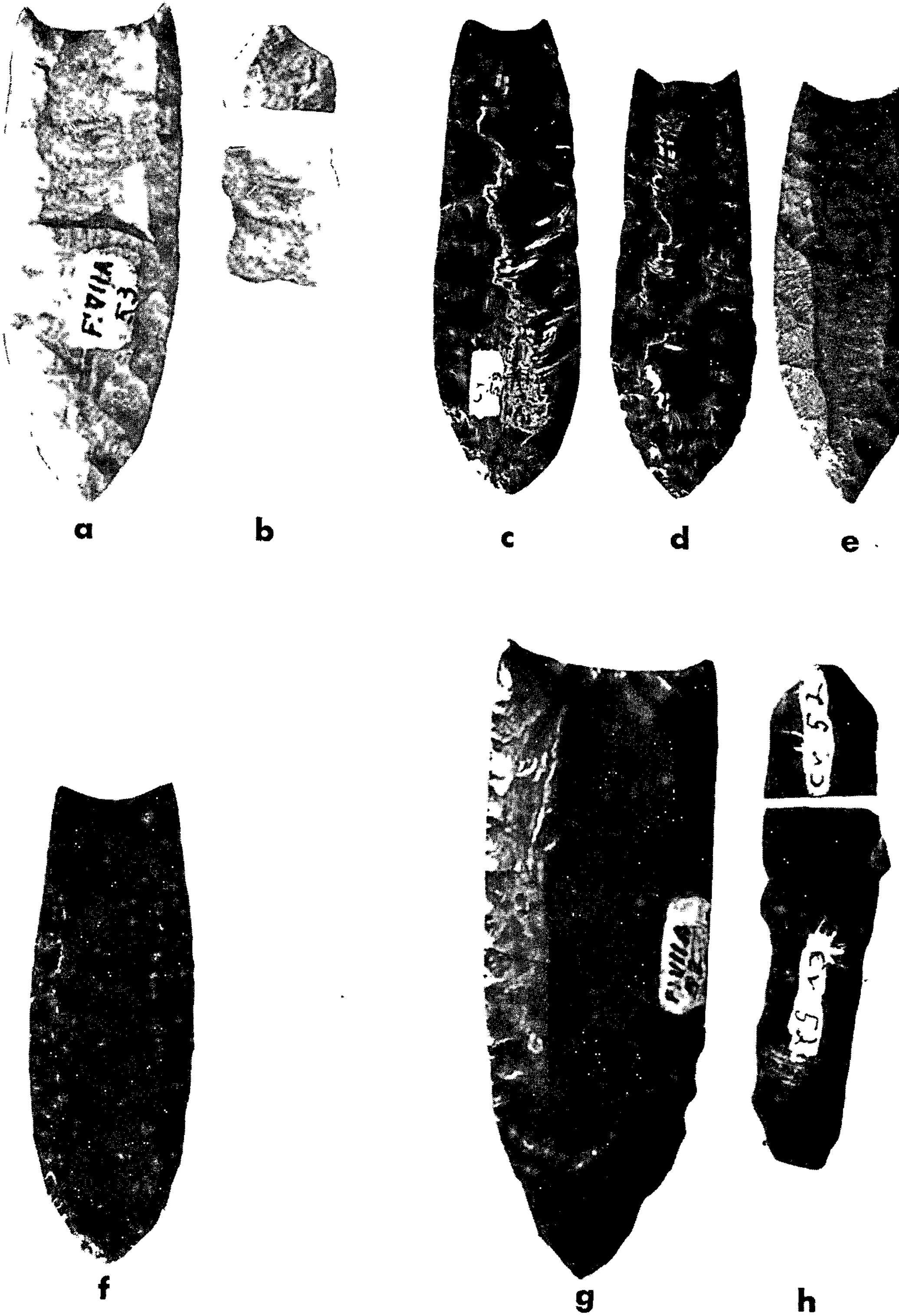

Fig. 17

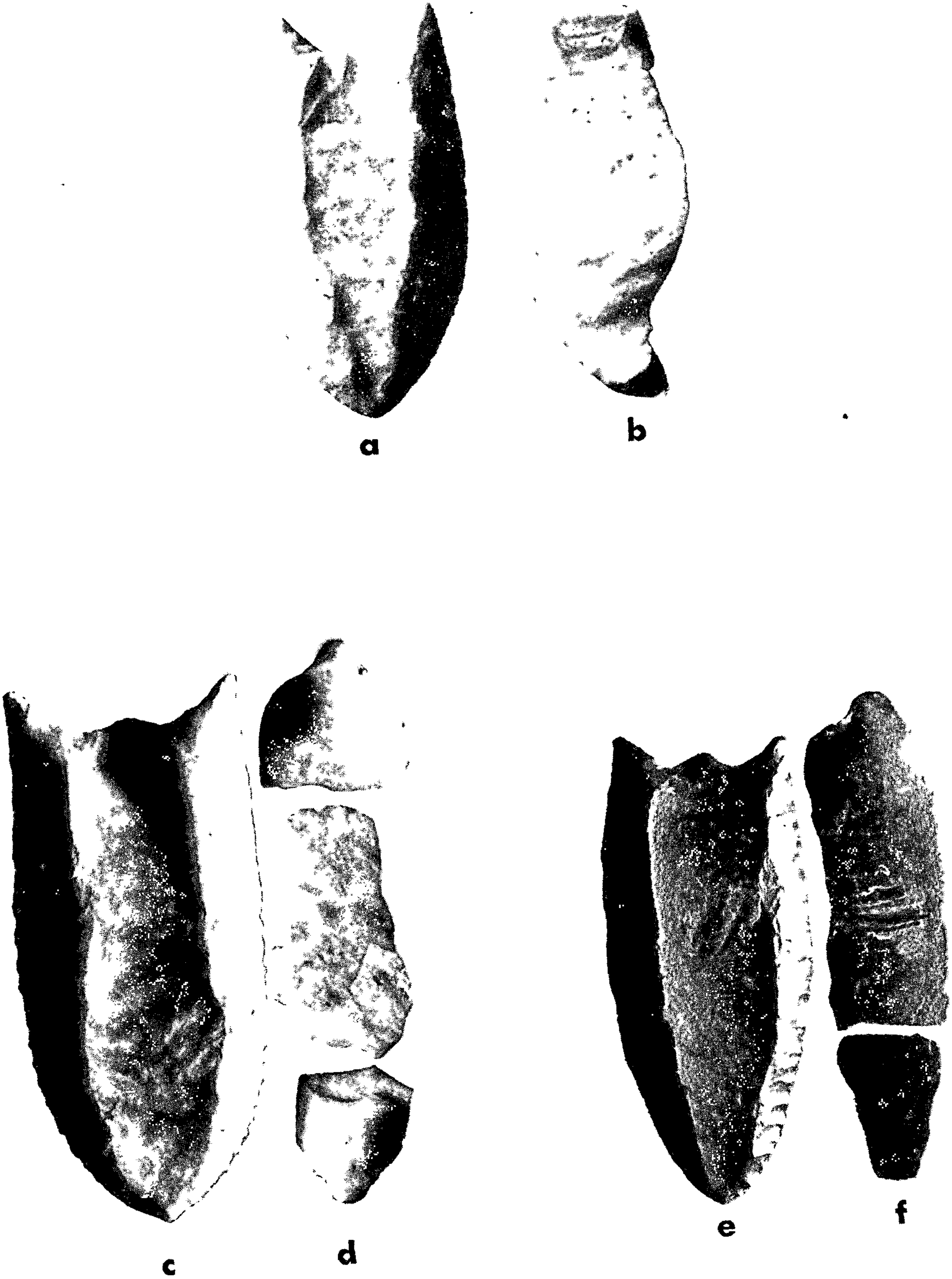

Fig. 18

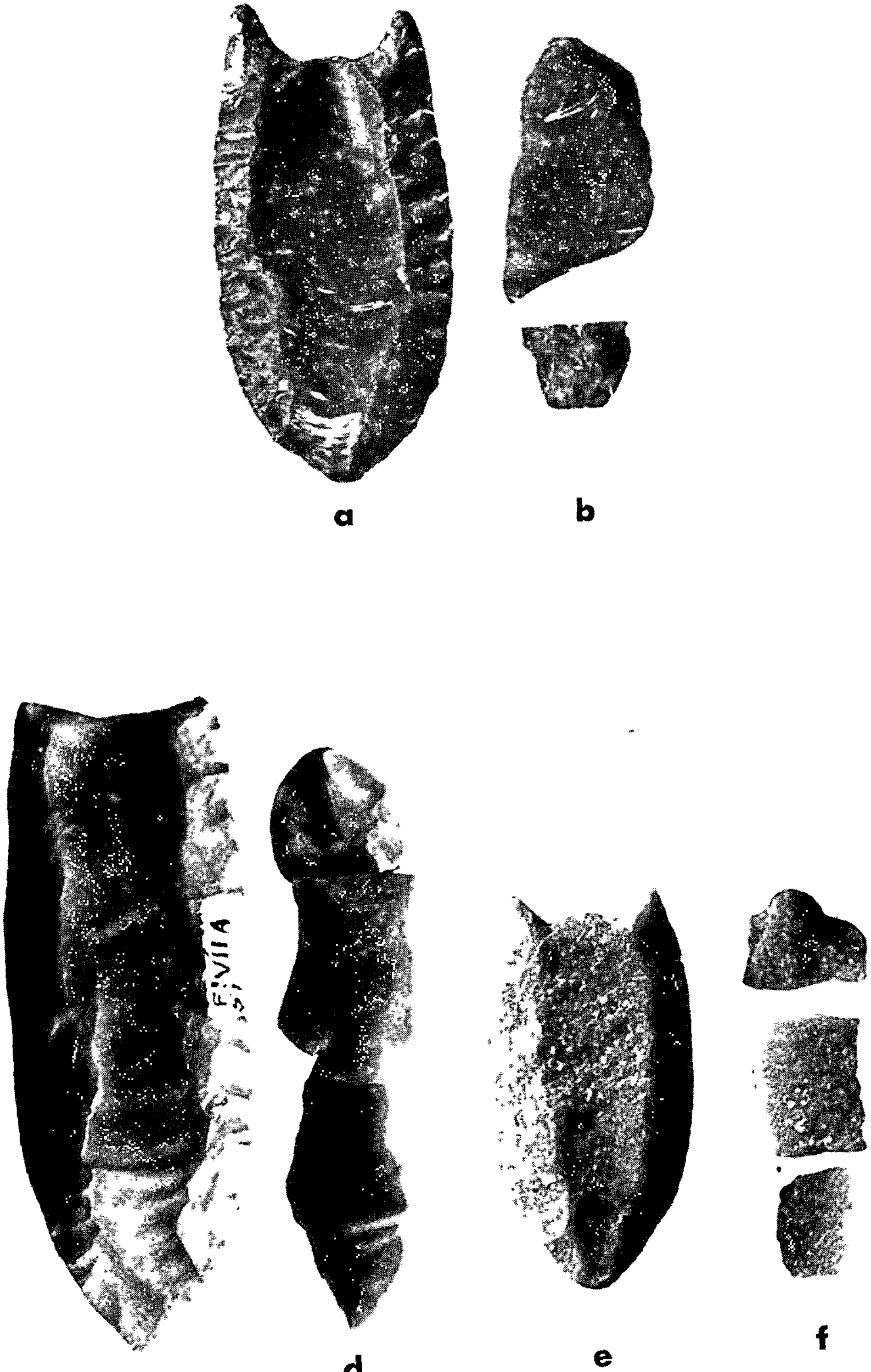

Fig. 19

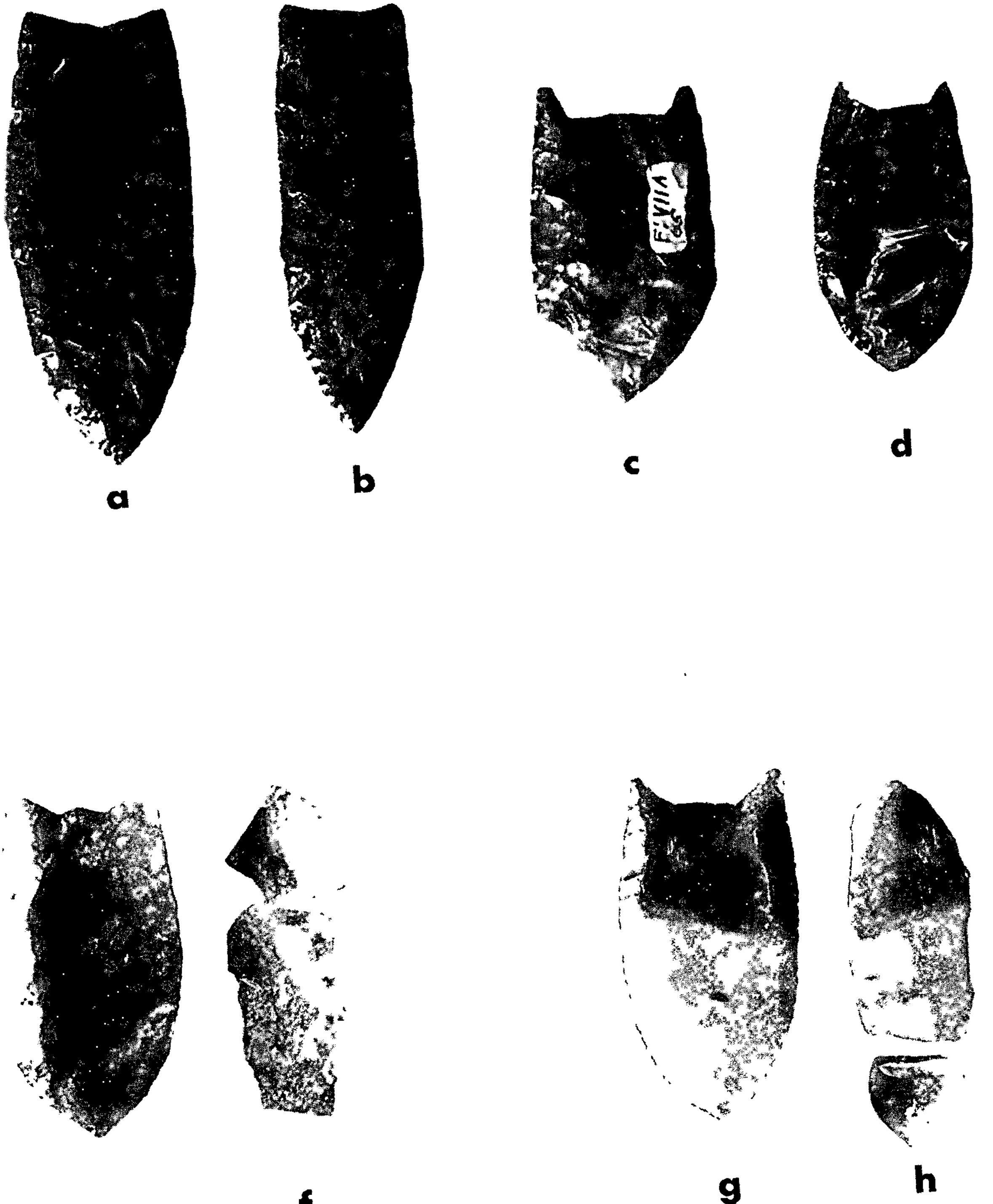

Fig. 20

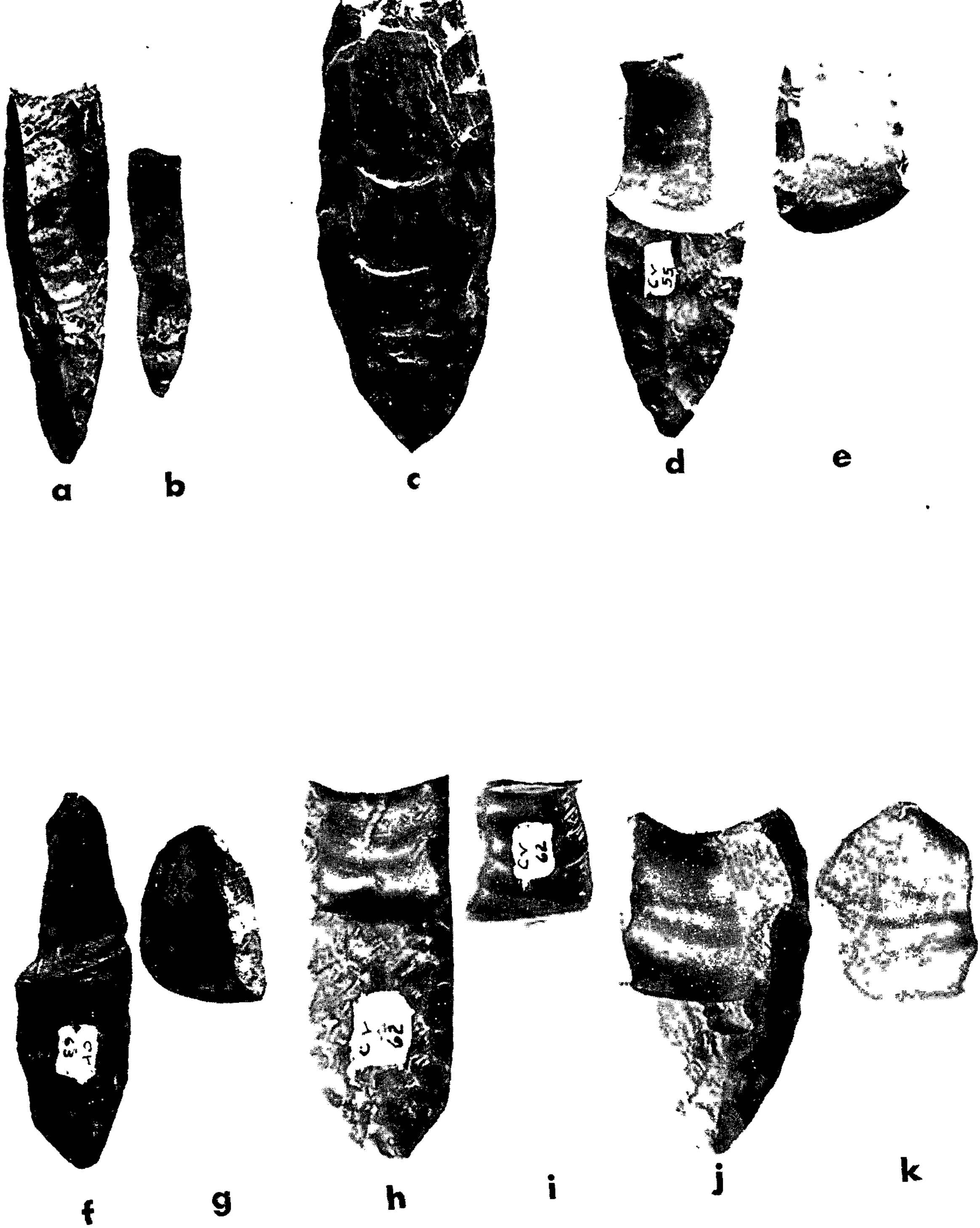

Fig. 21

Fig. 22

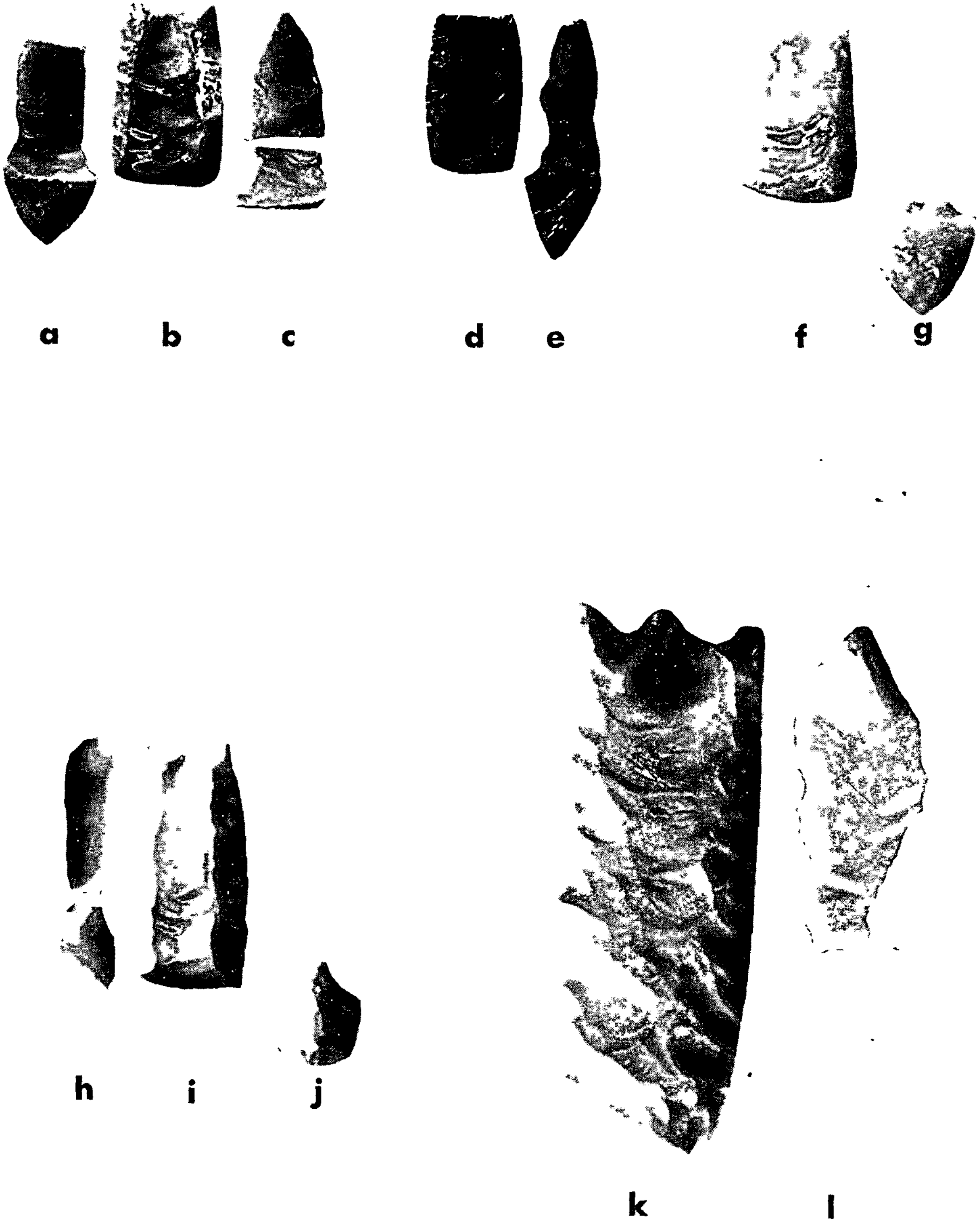

Fig. 23

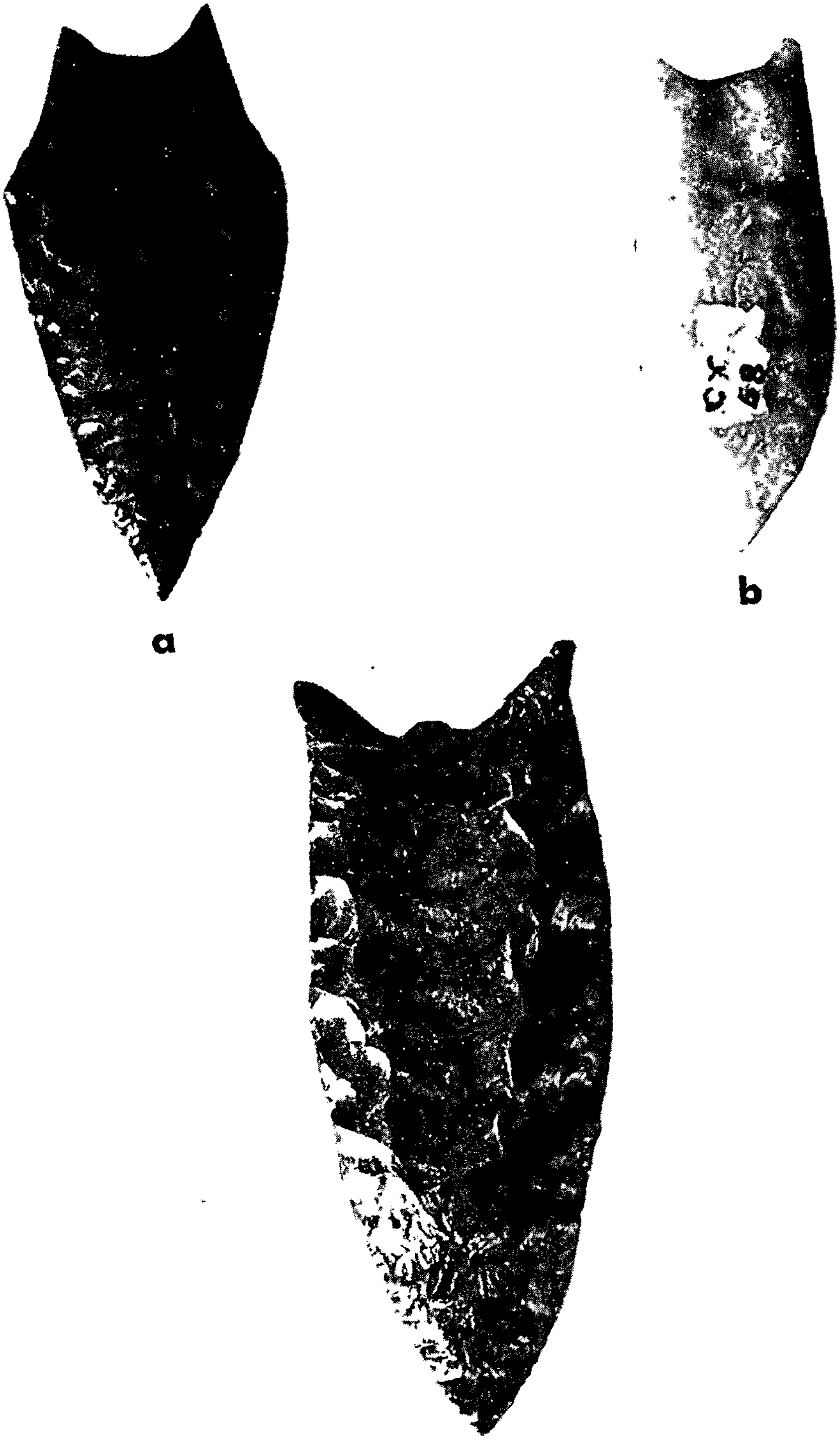

Fig. 24

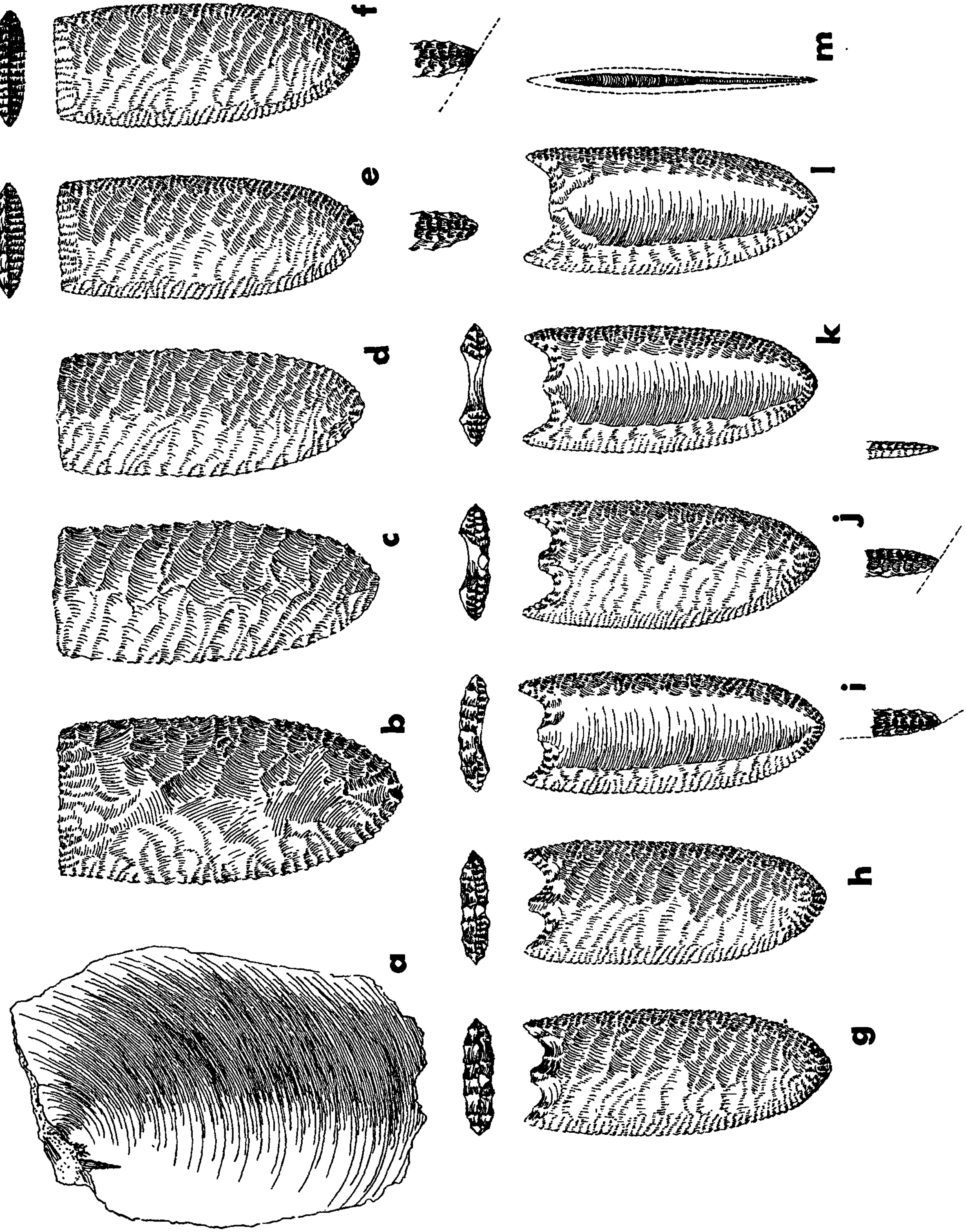

Fig. 25