35. THE MANUFACTURE OF PECKED AND GROUND STONE ARTIFACTS: A CONTROLLED STUDY

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Not infrequently the professional archaeologist along with the interested layman have had cause to speculate on the refined finish or delicate form displayed by some artifact of native manufacture. That stone is a "hard" substance and primitive man's methods were rude has perhaps encouraged the idea that patience and time were the principal tools of creation. Too few ethnographic accounts dwell in detail on the production of stone implements -- with an apparent growing necessity for a more accurate recognition of artifacts in the early cultural horizons of North America, any additional data on the subject is a welcome one.

Chipped stone, being more spectacular and of more common occurrence, has been studied almost to the complete exclusion of pecked and ground stone. This rarity is evidenced in a recent comprehensive study by R.J. Squier (1953) where in addition to Californian examples, other accounts of working stone in North America are cited.

The stone specimens dealt with in this paper are by California terminology called "charmstones" (Elsasser, 1954). The forms illustrated, though not manufactured by Californian Indians are virtual duplicates of actual specimens recovered from various aboriginal Indian village sites in the San Francisco Bay area. The purpose of this study was not simply to demonstrate that it is possible to recreate forms, but to experiment with various stone materials and tools known to have been utilized by Indians in the manufacture of pecked and ground stone objects. It was desired to know how various rock materials responded to different shaping tools, to understand perfection and latitude in the use of tools, the time factor involved in various stages of manufacture, and the casualty rate in production.

For some years Mr. Leonard Valdivia has concerned himself with the study of primitive technology as applied to the manufacture of both chipped and ground stone artifacts. His present abilities are comparable to those which would be evidenced by the "average" or even skilled aborigine. It will be shown here that Mr. Valdivia has in every respect attempted to maintain the spirit of an aboriginal setting. His work falls short of completion only in that some of the more resistant rocks out of which occasional charmstones were made by Indians could not be obtained, but this in no way detracts from the value of the present study.

Tools Used In the Manufacture of Charmstones[1]

Since no specific data exist on the exact type of tools used in the production of pecked and ground stone objects, some element of personal judgment had to be exercised as to their identification. Actual grinding and battering stones found in local archaeological sites when correlated with artifacts representing various stages of completion in their manufacture provided the basis for choosing the heavy duty tools. The more refined tools for cutting, scraping, and drilling were all manufactured by Mr. Valdivia and represent in themselves no mean expression of virtuosity in the art of flaking stone.

Obsidian saws (Pl. 3a) Thin obsidian blade used to block out primary shape of charmstone from large piece of steatite. (Pl. 3b) Obsidian saw used to cut in grooves and notches as noted in steatite Specimen 10 (Pl. 2d; Pl. 1g).

Obsidian scraper (Pl. 3c) A thick obsidian blade used as a scraper to reduce size and rough spots on steatite specimens.

Chalcedony reamer (Pl. 3d) Used to ream out holes following drilling.

Chert drill (Pl. 3e) Used for making bi-conical perforations in steatite specimens. Mounted on wooden shaft and rotated with a bow drill.

Bow The bow used in conjunction with the drill was made from a simple willow branch and a flat leather thong. This arrangement is similar to that of a typical Eskimo bow drill.[2]

Sharpening stone (Pl. 4a) This pecking stone was used to sharpen the core tools which became blunt from continued use.

Sandstone abraders (Pl. 4b) A partially completed charmstone rejected by Mr. Valdivia and used as a finishing smoother. (Pl. 4d) A micaceous sandstone stream pebble used for rubbing against body of charmstone. A still larger specimen, one about 12 inches long, was used when the charmstone was held in the hand and rubbed against the abrasive surface.

Core tools (Pl. 4c and f) Illustrated are well-used specimens just prior to resharpening. (Pl. 4c) A jasper specimen made by Mr. Valdivia but never used. In the course of manufacturing the charmstones discussed here numerous core tools were rejected as gradually they wore down to such a degree that resharpening was no longer practical.

Source of Materials

To approximate aboriginal conditions closely as possible a series of authentic charmstones was first examined in order to determine the texture and hardness of different types of stone material used by the Indians. Following the assumption that the natives would also have been interested in reducing the labor of pecking and grinding, rocks which roughly approximated in shape the desired form of the charmstone were then selected. The sandstone pebbles at Moss Beach, San Mateo County, California provided an ample range of sizes and shapes, though considerable time was spent in the proper selection. Steatite from two different California sources was used. No margin of error had to be considered here, since this rock has a hardness scale of only 1 (Mohs) -- though it differs widely in appearance the physical properties remain fairly constant.

Description of Manufacture

As expressed by Mr. Valdivia, "These charmstones were manufactured by the percussion fracturing, pecking, and crumbling technique. Finishing was completed with an abrasive sandstone. Where steatite was involved, finishing was accomplished with fine sand and water." By crumbling is meant the technique whereby a hammerstone is struck against a specimen; instead of the removal of a large or small flake as in the percussion or pecking method, a granular powder results from the blow.[3] This procedure was generally applied toward the finishing stages of manufacture, just prior to grinding.

Specimens 1, 2, and 3

These were the first attempts, and the specimens broke in the process of manufacture. Two were fractured by overly heavy blows with a core tool and one, because of faulty material, was broken by a lighter, preliminary blow.

Specimen 4 (Pl. 1a)

Material: Hard compact sandstone collected at site SMa-75.

Tools: Core tools collected at site Ala-330 for percussion fracturing and crumbling. Sandstone pieces for smoothing.

Manufacture started by holding the rough stone in one hand and fracturing off excess material with the use of a hammerstone. When approximate size and shape was attained the hammerstone was replaced by a sharp core tool (fresh example shown in Pl. 4c) and repeated blows continued. The latter operation wears down the stone by the striking

off of small pieces and also by the crumbling effect, which wears the stone off in a powdery form.

Detailed shaping started on the stem and tip ends of the specimen. The stone was held with the tip pointing upward and blows were struck downward and around the stem part until the desired shape of stem was obtained. Ends reversed, the same process was used to shape the tip. The bulbous portion of the material could receive fairly hard blows, which were gradually decreased in intensity as the ends were approached. At times the stone was placed on one knee of the manufacturer; this position allowed better striking control over the stone because of the cushion effect thus achieved. Occasionally, throughout the primary pecking and crumbling process, rough spots created by gouging with a core tool were removed by the action of an abrading stone (Pl. 4b,d). Most of the grinding took place on the stem end, and especially when work on the specimen was near completion. This was to reduce the possibility of fracture through percussion blows and at the same time to attain symmetry of form. The final grinding or smoothing process consisted of rubbing the charmstone against a large abrasive stone (not illustrated) and then applying a small abrasive stone (Pl. 4b,d) to the specimen, in order to gain maximum smoothness.

Pecking time:[4] 5 hours.
Grinding and smoothing time: 20 minutes
Total time: 5 hours and 20 minutes.

Specimen 5 (Pl. 1b)

Material: A medium hard sandstone selected from numerous beach specimens at Moss Beach, San Mateo County.

Tools: Core tools collected from site Ala-330, and sandstone abrader.

Since this stone was only of medium hardness, elongated, and nearly round in cross-section from being water-worn the primary fracturing technique (above) was not necessary. Shaping was mostly done by the crumbling technique, i.e., by applying light blows with a hammerstone. Because of the medium hardness of the stone and long stem of the specimen only the lightest blows could be struck, for fear of breakage. For this reason pecking time was somewhat increased in proportion to the amount of material actually removed. The tip and stem ends were shaped as described for Specimen 4.

Pecking time: 3 hours and 30 minutes
Grinding and smoothing time: 15 minutes
Total time: 3 hours and 45 minutes.

Specimen 6 (Pl. 1c)

Material: A hard, compact, fine-grained sandstone from a village site adjacent to Moss Beach, San Mateo County, California.

Originally this specimen was an artifact classed as a bi-pitted stone.[5]

Tools: Core tools collected from Site Ala-330, and sandstone abrader.

Though hard, the fine even grain of this rock made it very amenable to the pecking and crumbling technique. The reduction consistently left a smooth surface and the core tool left no deep gouges as in the case of the other specimens. No "knee cushion" was employed due to the shorter stem. The grinding was similar to that already described for Specimen 5.

Pecking time: 3 hours and 40 minutes.
Grinding and smoothing time: 25 minutes
Total time: 4 hours and 5 minutes.

Specimen 7 (Pl. 1d, Pl. 2a)

Material: Small water-worn sandstone cobble from Moss Beach, San Mateo County, California.

Tools: Core tools and sandstone abrader.

The pecking method was applied by holding the specimen in the left hand and striking blows with a core tool. The blows were struck downward but peripheral to the central core. This was done in order to form a central stem for the charmstone and at the same time not to weaken this stem, thereby reducing the chance of breakage in the final stages of manufacture. When the desired length of stem was obtained the position of the stone was reversed in the hand and the smaller bottom or tip protuberance was fashioned. On brief occasions an abrading stone was used to remove any excess rough surface. The removal of such surfaces made the pecking process easier and faster. The final form and surface smoothing was brought about by rubbing the charmstone against a large abrader and by using small sandstone and granular schist abraders (Pl. 4b, d) against the charmstone.

Pecking time: 2 hours and 10 minutes.
Grinding and smoothing time: 10 minutes
Total time: 2 hours and 20 minutes.

Specimen 8 (Pl. 1e, Pl.2b)

Material: Small water worn pebble from Moss Beach, San Mateo County, California.

Tools: Core tool and sandstone abrader.

Method is the same as described for Specimen 7.

Pecking time: 1 hour and 5 minutes
Grinding and smoothing time: 15 minutes
Total time: 1 hour and 20 minutes.

Specimen 9 (Pl. 1f; Pl. 2c)

Material: Water-worn pebble from Moss Beach, San Mateo County, California.

Tools: Core tools and sandstone abrader.

Method is the same as described for Specimen 7.

Pecking time: 3 hours and 25 minutes
Grinding and smoothing time: 15 minutes
Total time: 3 hours and 40 minutes.

Specimen 10 (Pl. 1g; Pl. 2d)

Material: Steatite broken from large piece of float found in gravel bar at Cascade Creek, near Fairfax, Marin County, California.

Tools: Chert core tool for fracturing and pecking (Pl. 4c), sandstone slab for grinding steatite (not illustrated), small slim piece of sandstone for rubbing (not illustrated), obsidian knife for sawing material (Pl. 3a), obsidian blade for cutting grooves (Pl. 3b), chert drill for making perforation (Pl. 3e) used with a small willow bow and leather thong (not illustrated), sand for finish polish, and final rubbing with hands to give final gloss.

First stages of manufacture involved the heavy end of a core tool to batter the rough stone to the size represented by dashed line 1 (Pl. 2d). Alternately a grinding and pecking technique followed. Grinding was accomplished by rubbing the steatite against a sandstone slab and pecking was done with a chert core tool until the form shown by line 2 was attained (Pl. 2d). An obsidian blade (Pl. 3b) was used to cut a permanent groove at one end, and two additional encircling grooves, one at either end. Part of one such groove is shown as line 3 (Pl. 2d). A chert core tool was then used to peck and crumble away the steatite surrounding the latter grooves so that two end knobs were formed. A small sandstone pebble (not illustrated) was used to shape the charmstone to its ultimate form, as shown by line 4 (Pl. 2d). The perforation was made with a chert drill (Pl. 3e). The finished surface was produced by rubbing the charmstone briskly between the manufacturer's hands, using fine wet sand as an abrasive. Finished gloss was obtained by wear in handling without use of any artificial polishing agent.

Pecking time: 2 hours and 2 minutes
Grinding and smoothing time: 2 minutes
Drilling time: 4 minutes
Total time: 2 hours and 8 minutes.

Specimen 11 (Pl. 1h; Pl. 2e)

Material: Steatite from Mt. Bullion, Mariposa County, California.

Tools: Core tool, sandstone slab, small, thin piece of sandstone for abrading, obsidian blade for cutting groove (Pl. 3a). Chert drill for perforation (Pl. 3e).

Rough shape was obtained by pecking with a core tool followed by abrading on a stone slab.

Pecking time: 1 hour and 37 minutes
Grinding and smoothing time: 5 minutes
Drilling time: 3 minutes
Total time: 1 hour and 45 minutes.

Ethnological Observations

Noted in Beatrice Blackwood's "The Technology of a Modern Stone Age People in New Guinea" (1950) are several observations pertinent to the present study. This excellent paper is one of the few published accounts which treats primitive technology in a detailed pictorial and descriptive way. Mr. Valdivia's methods of working stone with the pecking and grinding techniques were conceived independently without reference to this cited work. For that reason the parallels between Valdivia's procedures and those described by Blackwood are of interest.

On the manufacture of the New Guinea adze-blade: "A stone of suitable shape and size is sought for in the bed of a stream, or a small boulder is cracked with a heavy stone and such of its fragments that are suitable are picked up, one of which is chosen for immediate use and the other put away until wanted.

"The blade is first shaped roughly by being struck with a hammerstone. Any stone of convenient shape and size to hold in the hand is used for this purpose. One made of porphyritic lava (probably andesite) was apparently not a wise choice, for it soon broke. A granite pebble was then used, and remained serviceable until the completion of the blade.

"The worker sits on the ground, either cross-legged or with one or both legs extended. The hand holding the implement rests on one leg. Pieces are struck off both front and back of the blade by battering strokes, the hammerstone striking either the edge or the surface. . . .

When the blade is thought to be sufficiently shaped, it is finished by grinding. The grindstone consists of any piece of suitable stone . . . one in the Museum is made of volcanic tuff. It resembles sandstone in appearance and texture" (Blackwood, 1950, p. 15).

On the preparing of a club-head: "A roundish stone is selected from the bed of a stream . . . a man will travel a long way to find good stones . . . having selected his stone, the worker begins by piercing the hole for the haft . . . the perforation is done by pecking with a pointed stone . . . pecking is done alternately on both sides, the stone being turned so that the depth of the hole on each side is kept approximately equal" (Blackwood, 1950, p. 34).

Because the tools mentioned in Blackwood's account were worked on only sporadically, no accurate record could be noted for the time spent in manufacture. Also it should be noted that in the case of both the adze-blade and the club-head more resistant stones were involved than in the charmstones dealt with in the present paper. Any difference is probably one denoting time rather than technique.

Earlier Studies

Around the turn of the century, on sporadic occasions from about 1890 to 1916, studies were made relating to the technological capacity of primitive man. Such studies were a part of the general anthropological investigation into the nature of the evolution of culture.

Of particular interest to the present study are the experiments made in 1892 for the United States National Museum by J.D. McGuire (McGuire, 1892), where the purpose and attitude of the creator marks a striking parallel to Mr. Valdivia's. However, the material for charmstones described in the present paper represents a range of fairly soft stones, whereas McGuire experimented with rock materials higher in the hardness scale.

Pertinent are the following notes: ". . . all the tools (used) were similar to those of the North American tribes, and all the objects produced were fashioned with these tools, which were made out of raw material. The principal work which has been done is the pecking of stone with the stone hammer and the carving, polishing, rubbing, and boring of stone with the rudest appliances. The result of the experiment goes far toward proving that the time required for manufacture of stone implements by primitive man was very short" (McGuire, 1892, p. 166).

In the manufacture of an adze- or axe-blade McGuire obtained a piece of New Zealand nephrite and started work with a hammerstone at the rate of 140 blows per minute. The hammerstone was composed of quartzite and some 40 specimens, lasting no more than 10 minutes each, were rejected until a close-grained grey example was found to last 8 to 10 hours.

Gabbro and gneiss, as hammerstones, proved useless. Finally, a piece of yellow jasper from Yosemite was used for 40 hours and was still usable. The jasper crumbled at the same rate as the nephrite and the author concluded therefore that the aborigines must have worked nephrite against nephrite in order to obtain good results. Following the pecking, the blade was held in the hand and ground against a wet block of rotten granite. This was done for 5 hours and was followed by 6 hours of wet and dry polishing with a compact quartzite pebble. Rubbing with wood and buckskin produced no observable effects. Pecking time was 55 hours and 10 minutes or 460,000 estimated blows. Original stone weight was 7625 troy grams, while the finished weight was 5143 grams (loss 2482 grams). The author remarks . . . "This specimen, however, can hardly be taken as a fair standard of aboriginal work, for in selecting the material a workman would naturally choose a pebble as near the desired shape as could be produced . . ." (McGuire, 1892, p. 167).

A stone axe was made by pecking and polishing with quartzite in less than two hours. The axe material was kersantite, reported to be tougher than the materials commonly used for stone axes from the eastern United States.

A ceremonial object of catlinite required 16 hours to complete, but it was noted that with better selected tools it could have been done in 6 to 8 hours. In brief, the process was to peck as far as was safe. Various types of scrapers (quartzite, chalcedony, chert, jasper) were then used, held between the thumb and forefinger.

An obsidian object was made by employing both the flaking and grinding techniques, and a copy of a Mexican glyph was executed in basalt.

Miscellaneous observations by McGuire (1892) are: (1) Better results are obtained when the manufacturing tool is hafted. (2) Quartzite striations look like file marks. (3) Chert having a perfectly smooth edge left a mark that might be taken for the scraping of a steel blade. (4) After considerable scraping it was found that more progress could be made by reverting to the pecking technique even though the danger of breakage increased. (5) Final stages required grinding with coarse sandstone, a block of wood and sand, and finish was done with a fine quartzite pebble and water.

On drilling, Rau's experimental study is noted (Rau, 1869, pp. 392-400) but in addition McGuire (1892, p. 171) says "The experiments made by me, while leaving much to be learned, demonstrate conclusively that the various processes may all be explained satisfactorily . . . every indication tends to strengthen the belief that the methods employed were simple and the work easily accomplished."

In his experiments McGuire made use of the hand-, the bow-, and the pump-drill. "The first experiment in drilling was in a piece of limestone, which was performed in a few minutes with a bow drill and stone point. . . . A hole in siliceous sandstone about one and one-fourth inches in thickness required two hours to bore with jasper point and drill . . . point needed frequent resharpening" (McGuire, 1892, p. 173).

"Slate was readily sawed to a depth of an eighth of an inch with stone blades used alone, in a few minutes " (ibid., p. 175).

McGuire's earlier work (1891) on the stone hammer and its various uses is mainly a distributional study of types and functions of hammerstones. Experimental uses of the stone hammer are not treated at length.

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NOTES

1. The tools and the charmstones were donated by Mr. L. Valdivia to the Museum of Anthropology, University of California.

2. The bow drill was not aboriginal in California, so far as known.

3. The term crumbling, employed, for example by Holmes (1919, p. 330) has now fallen into almost complete disuse in American archaeology.

4. As used here, the term "pecking time" will include the total time involved in pecking, fracturing, and crumbling, unless otherwise stated.

5. Surface pit may still be seen on specimen's surface.

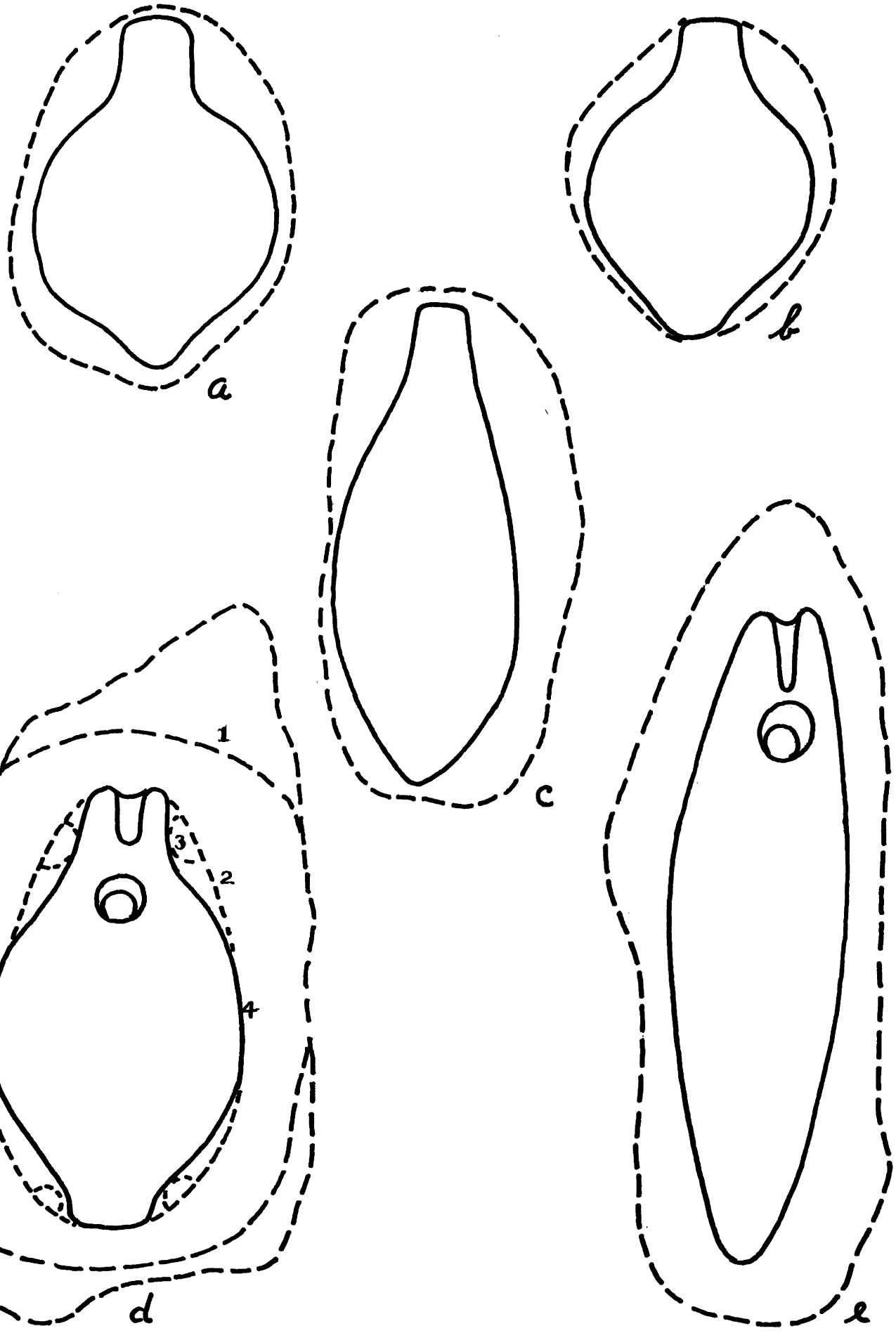
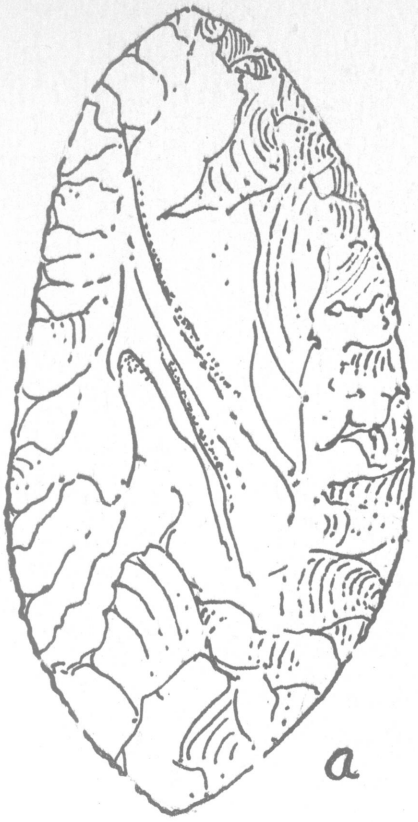


Plate 2



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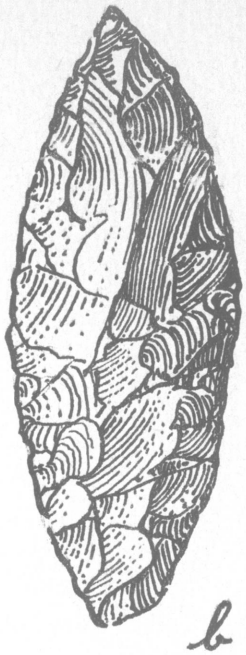

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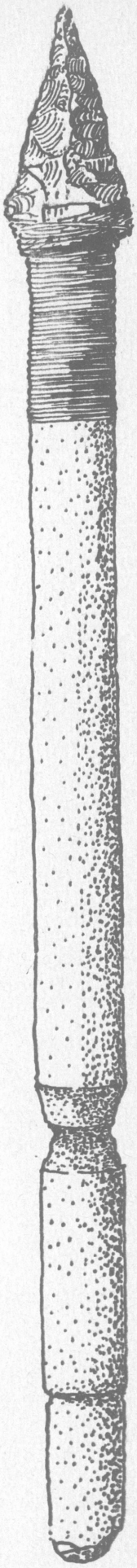

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A. Treganza

Plate 3

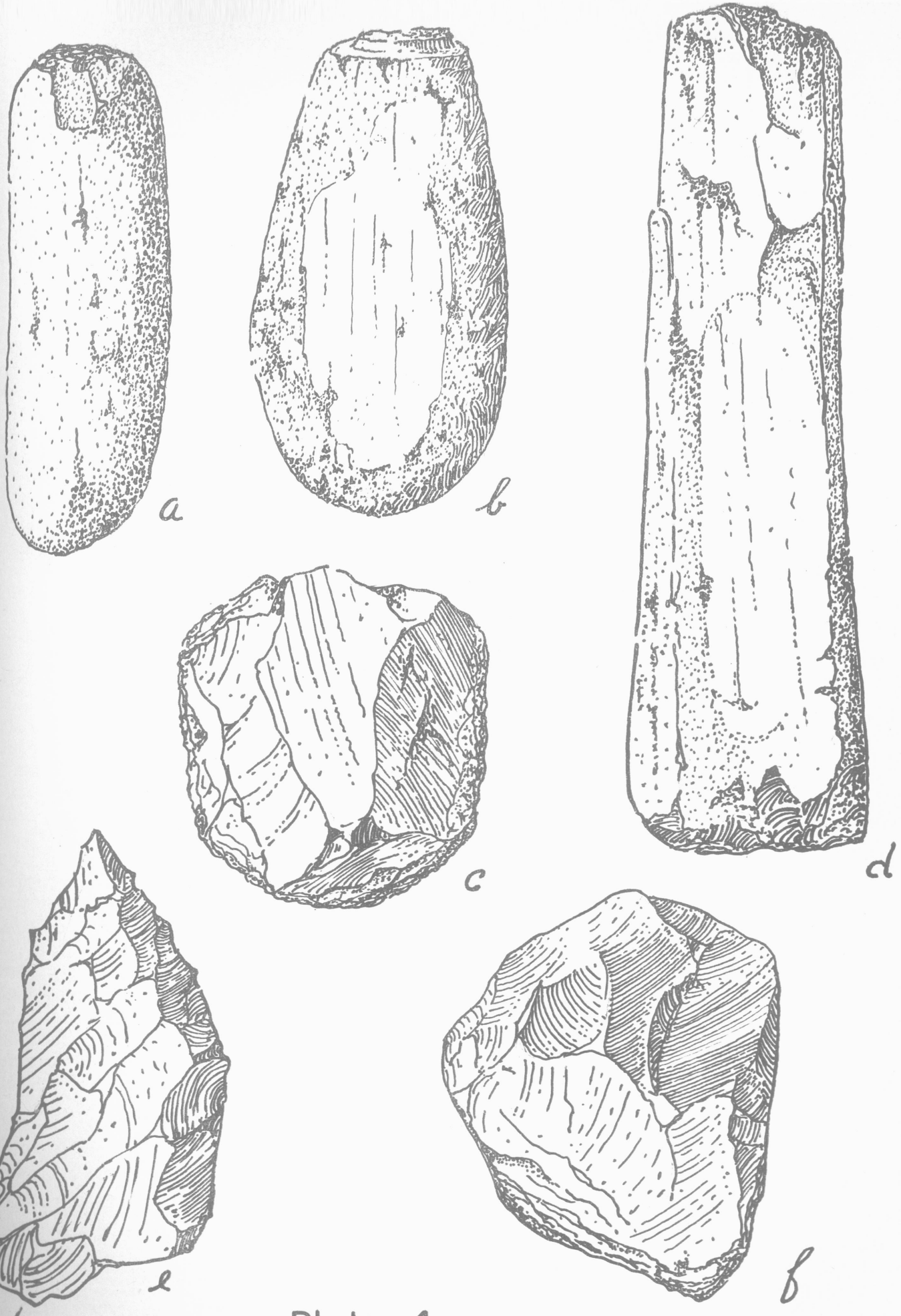

Plate 4

A. Freeanza