YUROK FISH KNIVES: A STUDY OF WEAR PATTERNS AND ADHERING SALMON SCALES

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In the collections of the Lowie Museum of Anthropology (University of California at Berkeley) are five hafted stone knives from the northwestern California coast. Four of these specimens (Fig. 2, a-d) were obtained from the Yurok by A. L. Kroeber in 1901. The other example (Fig. 2, e) was collected by Phillip Mills Jones from the Yurok village of Weitchpec in 1902. The Yurok people occupied a territory which lay near and along the lower Klamath River in Del Norte and Humboldt Counties, California (Kroeber 1925: see Fig. 1).

All of these specimens have been previously published and illustrated (Goddard 1903: Pl. 3; Kroeber 1925: Pl. 16; Kroeber and Barrett 1960: Pl. 20). However, there are no detailed descriptions of these unusual pieces, and more importantly in view of the recent interest in wear pattern research, none have been microscopically examined for evidence of use-wear.

We believe that it is worthwhile for archaeologists to accumulate wear pattern information for tools whose precise function has been ethnographically documented. There have been numerous studies in the past five years devoted to the analysis of microwear on chipped stone tools (see Hester and Heizer 1973 for a bibliography of relevant publications in this field; see also Keeley 1974; Odell 1975). Most of these investigations have focused on prehistoric stone implements whose function was not known. By combining the data gathered from microscopic wear pattern research with information obtained through the measurement of tool edge angles and experimental replication, archaeologists have been able to make inferences regarding the actual use of certain prehistoric stone tools. A fourth avenue of inquiry, ethnographic comparison, has not been adequately exploited. Notable exceptions are the studies, based on research among Australian aborigines, of Gould, Koster and Sontz (1971) and Gould and Quilter (1972), and the work of Wilmsen (1968) and Nissen and Dittemore (1974) with ethnographically-collected stone tools. There are numerous examples of ethnographic stone tools in museum collections, and in many cases, the precise function of these tools is known. These constitute an important resource in future microwear research.

YUROK USE OF THE HAFTED KNIVES

As noted above, four of the hafted knives were collected from the Yurok by Kroeber in 1901. Goddard (1903) subsequently illustrated two of the specimens and attributed them to the Hupa, neighbors of the Yurok. In discussing the hafted flint knives, Goddard (1903: 26) reported that they were used in cutting fish and (ibid.: 22) skinning deer. In a more recent publication, Kroeber and Barrett (1960: 92) unequivocally state that the knives were obtained from the Yurok; they illustrate six specimens, five of which are shown in Fig. 2 (one cannot be located). The catalog of the Lowie Museum clearly links the artifacts to the Yurok, and we must assume this to be the correct provenience.

Kroeber (1925) and Kroeber and Barrett (1960) have provided very specific

comments regarding the function of these knives:

> "Both salmon and lampreys were split for drying, the former with a wooden-handled knife ... of 'whale-colored' flint, as the Yurok called it; the latter with a bone awl" (Kroeber 1925: 85).

> "A special type of knife for descaling salmon, and for splitting and cutting up salmon and presumably sturgeon, is made of a nicely chipped flint blade, hafted to a wooden handle, wrapped and pitched for firmness. These blades are usually of a greenish stone, which the Yurok call hekwsa 'whale (color)'." (Kroeber and Barrett 1960: 92).

We should also point out here that these stone knives had ceremonial, as well as utilitarian, importance among the Indian groups of the northwest California coast. For example, both the Karok and the Hupa used unhafted "flint knives" during First Salmon Ceremonies (Kroeber and Gifford 1949: 38). One of these unhafted specimens is illustrated by Kroeber and Gifford (ibid.: Fig. 3) and is identical in form to specimens we have shown in Fig. 6, a-c.

Hafted flint salmon knives are also recorded in the cultural inventory of other Northwest Coast peoples, particularly the Klikitat, Shuswap, Lower Thompson, Lower Carrier, and the Kutenai (Ray 1942). Mason (1889: Pl. 18; see also Wilson 1895: 131) illustrates hafted stone knives from the Hupa, and these are practically identical to the specimens described here; however, he makes no comment on their function. He does record (ibid.: 222) that chipped stone bifaces, similar to those set in the hafts, are found in graves in the Hupa area.

ANALYSIS OF THE HAFTED KNIVES

The hafted stone knives collected by Kroeber and Jones are illustrated in Figs. 2-4. Although some brief descriptive notes were offered by Kroeber (1925) and Kroeber and Barrett (1960), additional details are given here. Also provided are observations on wear patterns recognized through microscopic study. A binocular microscope, with magnification powers up to 75X, was used for the study; techniques follow those outlined in Hester, Gilbow and Albee (1973). The data on color are based on the standards provided by the Munsell and Gley charts. Dimensions, weights and tool edge angles are summarized in Table 1.

In the descriptions that follow, there are several terms which require definition. "Protrusions" are projections or points along the lateral edges of the stone blades; in most cases these represent remnants of striking platforms created during the bifacial reduction process. Both "crushed" and "blunted" protrusions were noted on the knives. Viewing a "crushed" protrusion from the side, under magnification, one observes a layered or splintered effect (see Fig. 5, b). "Blunting", on the other hand,

refers to a rounding-off or smoothing of the protrusion; this may or may not be accompanied by dulling of the concavities along the edge. We follow Hester, Gilbow and Albee (1973: 93) in defining "light dulling" as a "narrow attrited band confined to the tool edge", and "heavy dulling" as a "broad band of wear generally obliterating portions of flake scars adjacent to the edge and removing all protrusions."

SPECIMEN 1-1538 (Figs. 2, b; 4, a)

This specimen consists of a broad chert bifacial blade set into a wooden haft. The wood is probably the bark of coast redwood, Sequoia sempervirens. The blade is secured to the handle by the application of a mastic (unidentified) and wrapped with cordage made from the fibers of Iris sp. The color of the chert is "dusky red" (Munsell 2.5YR 3/3), with an area near the tip of "light greenish gray" (Gley 5GY 7/1). C. Chesterman (personal communication) believes this chert to be of the Franciscan complex; he regards the dusky red coloration as derived from iron in the ferric state, and the light greenish gray coloration as derived from iron in the ferrous state. Numerous fish scales adhere to the handle and blade. (For analysis of the scales, see below.)

SPECIMEN 1-1539 (Fig. 2, c)

The blade is quite large, with broad flake scars on the interior of both faces, but with short parallel flakes lining the edges. The nature of the flaking along the lateral edges has produced a biconvex cross section, characterized by a bulging or rounding effect. The haft is similarly massive, with the blade secured through a combination of cord-wrapping and the application of mastic. The entire haft is coated with a thick incrustation, and there are a number of fish scales visible on the surface of the haft. At the base of the haft, the incrustation has been broken away, exposing the redwood (?) handle.

The chert blade is greenish in color, but is not directly comparable to any of the Munsell classifications. However, it approximates the "dark greenish gray" in the Gley charts (5G 4/1). The notable difference is the high gloss or sheen exhibited by the chert. This vitreous aspect could be the result of the thermal alteration of the chert prior to the manufacture of the blade (heat-treating of siliceous stone was widespread among historic California Indian groups and was noted among the Yurok by Paul Schumacher in 1877; cf. Hester 1972, 1973). Alternatively, some of the gloss might be derived from use.

One edge of the biface has been beveled and has an edge angle of 55°. This beveling appears to have been intended to resharpen a dulled or heavily-worn cutting edge (Sollberger 1971). On the opposite edge, there is marginal retouch, as well as some light dulling of flake scars paralleling the edge. Under microscopic scrutiny, this edge exhibits light, discontinuous crushing and a single striation emanating at an angle of 45° from the edge. On the steeply beveled edge, protrusions are distinctly crushed and blunted (see Fig. 5, b). In addition, there is an area, 5 mm in length, of dulling near the juncture of the blade and the haft.

SPECIMEN 1-1540 (Fig. 2, a)

The large bifacial blade on this specimen has a broken distal tip. The blade is set in a wooden handle, the upper one-half to two-thirds of which is cord-wrapped and caked with an unidentified matter. Numerous fish scales are present on the haft. The proximal end of the handle (lower one-third) has the cordage and incrustation stripped away, exposing a somewhat splintered wooden handle (apparently of coast redwood).

The chert biface which serves as the knife blade is "dark greenish gray" in color (Gley 5GY 4/1) and appears to be covered with soot. An unidentified residue was noted on one edge.

On both edges of the biface, there is light dulling and polishing, increasing in intensity near the haft. Since the area near the juncture of the blade and the handle may have been the strongest part of this composite tool, one might predict that the heavier wear would occur there (cf. Hester 1970). The edges of the specimen are marred by recent chips and nicks which have apparently been incurred during more than 70 years of museum storage.

SPECIMEN 1-1541 (Fig. 2, d)

This artifact has a thin, convex-edged, bifacially-chipped blade, characterized by broad interior scars and oblique scars along the lateral edges. The blade is set in a wooden handle, with the upper one-half wrapped with cord and the exterior coated with a thin film. The color of the chert approximates the "dark greenish gray" of Gley 5GY 4/1. There are fine black lines in the material, as well as some reddish-brown splotches. The material has a glossy sheen identical to that manifested on specimen 1-1539.

The tip of this biface is very heavily dulled and polished (Fig. 4, a). The protrusions along the lateral edges are crushed and blunted and minor discontinuous retouch was also observed.

SPECIMEN 1-1326 (Fig. 2, e)

A small bifacial chert blade with parallel flake scars is hafted to a cord-wrapped wooden handle. The surface of the haft is covered with a film or incrustation about 1 mm in thickness.

The chert blade is olive-gray in color, most closely resembling Munsell 5Y 5/2. Flake scars on both faces are worn, with especially noticeable polishing and wear on the distal one-third of the blade. On one lateral edge, there is microwear in the form of light dulling and polishing, and there is scattered steep retouch (re-sharpening). On the other edge, there is nibbling or step-flaking resulting from use

and some abrupt retouch scars.

ANALYSIS OF FISH SCALES ON SPECIMEN 1-1538

The junior author has conducted an analysis of the fish scales found on specimen 1-1538 (Fig. 2; Fig. 4). Many of the scales adhere to the pitch-covered handle of the specimen. Scattered on the surface of this incrustation are about 60 fish scales, some of them partly embedded in the pitch. Near the base of the haft, where a small piece of the incrustation has fallen out, two other scales are visible at different depths in the dried pitch. All of these scales appear to be those of salmonids. They are cycloid, with prominent circuli in the anterior field, but without radii in either field (cf. Mosher 1969: 2; Casteel 1972b: 83).

Five scales (one is shown in Fig. 4, c), dislodged during microscopic examination of the haft, are recognizable as those of the king (chinook) salmon, Oncorhynchus tshawytscha (Walbaum). Little freshwater growth is apparent; only the first 8 or 10 circuli on these five scales were laid down in fresh water, presumably during the first few weeks after the fish's emergence from the gravel (Kenneth H. Mosher, personal communication). Radial striations extend across the posterior field (these are obscure on the smallest scale). Reticulations are absent. With the exception of the first 8 or 10 circuli, which are complete below the focus, the circuli generally do not invade the posterior field from their bases (cf. Mosher 1969: Figs. 2, 9-11).

All five scales are those of fish that spent no winter in fresh water (after hatching), but two winters in the ocean; allowing for differences in size and shape, all five could have come from the same fish; all but the smallest scale are from the area below the end of the dorsal fin and above the lateral line (Kenneth H. Mosher, personal communication).

In the king salmon, Casteel (1972a: 21, 177-190) found a positive correlation between the number of circuli on a scale from his Area C (see Fig. 8 of Casteel) and the weight of the fish (his Area C corresponds with the area below the end of the dorsal fin and above the lateral line). The largest of the five scales from the Yurok knife is 6.9 mm in length and bears about 103 circuli between the focus and the anterior margin. If Casteel's formula based on a scale from Area C is applied to a count of 103 circuli, the weight of the fish (estimated mean value) would appear to be about 17 kg (37 lb.). This would correspond to a length of about 109 cm (43 in.; see Snyder 1931: Table 2). This size, in itself, would corroborate the identification of this scale as that of a king salmon. The species whose scales are most likely to be confused with those of the king salmon is the silver salmon, Oncorhynchus kisutch (Walbaum), which is not known to exceed a weight of 22 pounds in California (Fry 1973: 70).

King salmon is the official name of Oncorhynchus tshawytscha in California, but chinook is official elsewhere in the United States and in Canada. The attributives quinnat, blackmouth, spring, and tyee have all had wide usage. For a concise discussion

giving much information about the king salmon, see Fry (1973: 74); an excellent colored plate of this species was published by Hudson (1917). The salmon of the Klamath River were discussed in considerable detail by Snyder (1931) and the extensive utilization of salmon by aboriginal peoples, including those of northwestern California, was discussed by Rostlund (1952: 15-23, 256, Map 8) and by Swezey and Heizer (in press). Archaeological sites in this region yielding remains of king salmon have been noted by Follett (1975).

Scales imbedded on other specimens in our sample were not detached for detailed analysis. However, the junior author's perusal of those scales indicated that all of them appear to be salmonid. He noted the absence of scales on 1-1326, 24 scales on 1-1439, 21 scales on 1-1540, and two on 1-1541.

RADIOGRAPHS OF THE SPECIMENS

The junior author, working with James E. Gordon (California Academy of Sciences), secured radiographs (the necessary exposures varied from one to four minutes) of all of the hafted specimens (Figs. 3, 4). These reveal that all but one of the specimens are bipointed. In general, the lower one-third of each biface was inserted into the haft. Although the radiographs are not sufficiently distinct to allow exact measurement of the depth of insertion into the haft in each example, we can offer these following approximate figures: 1-1540 (Fig. 3, a): 40 mm; 1-1539 (Fig. 3, b): 35 mm; 1-1541 (Fig. 3, c): 21 mm; 1-1326 (Fig. 3, d): 18 mm; 1-1538 (Fig. 4, b): 34 mm.

The one hafted specimen that is not bipointed (Fig. 3, d; 1-1326), appears from the radiograph to have a broken proximal end. Perhaps the specimen was originally bipointed, but was broken at an earlier period of utilization and was subsequently re-hafted. Certainly, the radiographs of the other specimens indicate that a bipointed outline was the desired form of biface to be hafted as a fish knife.

UNHAFTED BIFACES: DESCRIPTIONS AND MICROWEAR DATA

Just as certain kinds of archaeological interpretation rest heavily on ethnographic analogy, it seems reasonable that a homologous situation could exist between observable microwear on ethnographic stone tools and their prehistoric counterparts in particular regions. In order to test this specific proposition, several unhafted bifaces from the Yurok area (Fig. 6) were examined to see if the characteristic wear patterns on the hafted stone knives could be duplicated. However, since only a limited number of unhafted specimens were available in the Lowie Museum collections, the comparisons between the hafted and unhafted bifaces are not fully satisfactory. Dimensions of the study specimens are found in Table 2.

SPECIMEN 1-152067 (Fig. 6, b)

This specimen is not from the Yurok area, but was excavated at site Teh-58 (Tehama County, California). However, it was selected for analysis because of its great technological resemblance to the hafted Yurok specimens; it is, in all likelihood, a trade piece from the Yurok area. It is bipointed and has convex edges. The interior has broad flake scars, but exhibits near parallel trimming flakes along the edges. The biconvex (rounded) lateral edges noted on specimen 1-1539 are also present on this piece.

The chert is variegated in color, but is predominately reddish-yellow (Munsell 7.5 YR 6/6), with gray areas. The lower part of the specimen seems stained, perhaps from hafting (Fig. 6, b). The chert is glossy, perhaps the result of heat-treating.

The microwear observed on the edges of this biface consists of crushing and blunting, identical to that recorded for the Yurok fish knives.

SPECIMEN 1-1546 (Fig. 6, a)

This unhafted biface was collected by Kroeber in the Yurok area in 1901. It is bipointed, with convex sides, and is constricted at one end. The faces are marked by broad, shallow flake scars and the specimen is quite thin. The color of the specimen is approximately "pale brown" (Munsell 10YR 6/3), but it, too, has a glossy texture. The constricted end mentioned above retains scattered bits of residue (mastic) and it seems quite probable that this was the end inserted into a haft.

Under microscopic examination, the lateral edges reveal scattered light dulling, and more significantly, the blunted and crushed protrusions are identical to those on the hafted Yurok fish knives.

SPECIMEN 1- 974 (Fig. 6, c)

During collecting activities in the Hupa Valley of California in 1901, Phillip Mills Jones obtained a large, convex-edged, bipointed biface. According to the artifact catalog of the Lowie Museum, Jones identified the specimen as a "woman's salmon knife." The biface has broad flake scars on the interior of both faces, with short finishing or trimming flakes along the edges. It is reddish-brown in color (Munsell 5YR 3/3), but has gray mottling and a glossy sheen. Fish scales and unidentified residue adhere to various areas of the specimen (Fig. 6, c). There is no recognizable evidence of hafting, and it is possible that the specimen was hand-held.

Microwear in the form of crushing and blunting of protrusions along the lateral edges is present, and is identical to the edge wear noted for the hafted Yurok fish knives.

SPECIMEN 1-1545 (Fig. 6, d)

This is an elongate biface with a rounded base and a broken distal tip. It was collected in the Yurok area by Kroeber in 1901. It is white in color (Munsell 10YR 8/1), and there is a polish or gloss adjacent to and along the lateral edges on both faces. The specimen is unifacially beveled on both edges at the distal end (the distal one-third of the specimen).

Wear observed on the edges of this specimen includes occasional crushing and blunting of protrusions; however, the dominant wear pattern is a broad band of dulling scattered over both lateral edges (except for the retouched distal portion, probably a resharpened area). The morphology of this specimen is different from that of the Yurok fish knives, and it may be significant that different use-wear is also apparent.

SUMMARY AND CONCLUSIONS

In this paper we have described the results of our microwear and residue analyses of a series of Yurok hafted knives. Because the function of these artifacts was fully documented by early 20th century ethnographers, it is possible to link their use to salmon processing; this conclusion is confirmed by our identification of scales of king (chinook) salmon adhering to one of the knives. As noted earlier in the paper, Goddard (1903: 22) also linked similiar knives to "deer-skinning"; any surviving evidence of this function, such as deer hair imbedded in the pitch, was not observed. The several morphological, technological and use-wear attributes that co-occur on these salmon knives can be summarized and a few generalizations put forth:

(1) Edge angles for this series of salmon knives vary from 30^{o}-55^{o} on the right cutting edge and 30^{o}-38^{o} on the left edge. The steeper edge angle on the right results from resharpening, suggesting that this edge was the one most consistently used during processing tasks.

(2) The types of wear that result from salmon processing include blunting and crushing of the cutting edges; some dulling was also noted. The most distinctive wear form is crushing (Fig. 5, b). We are not aware of detailed ethnographic descriptions of the actual manner in which a salmon knife was employed during processing, and experimental data are not available. Thus, we do not know what events during the processing cycle would lead to the formation of the observed wear patterns.

(3) Morphologically, the bifaces vary considerably in size. However, radiographs reveal them to be distinctively bipointed. A greenish-gray chert was apparently preferred for their manufacture, and there is some evidence (observed and ethnographic) that thermal alteration was used in preparing the chert for flaking. The bifaces were shaped by percussion techniques, but pressure flaking was used to finish and straighten the edges. Either technique could have been used in resharpening dulled edges.

Utilizing these data for comparative purposes, we examined the results of similar studies of the limited sample of unhafted bifaces. All of the bifaces were bipointed, except for one specimen (Fig. 6, d) which had a broken proximal end. The right edge angles of these bifaces varied from 30^{o} - 50^{o}, and the left angles, 28^{o}-47^{o}; thus, the edge angle values for the hafted specimens and the unhafted examples correlates nicely for the right edges, but less so for the left. Most significant, we believe, is the presence of blunting or crushing wear (and dulling wear in one case) on the series of unhafted bifaces. The crushing observed on three of the unhafted specimens is visually identical to that of the hafted salmon knives. This would lead us to suggest that the unhafted specimens with this type of wear could also be directly linked to salmon processing; this suggestion is reinforced by the discovery of small fish scales adhering to one of the unhafted bifaces bearing the distinctive wear pattern (Fig. 6, c).

We are aware of the rather limited applications of these data given the small size of our samples. However, if one limits the application of the data to the Yurok area, we suspect this would be valid methodology to use to ascertain if bipointed unhafted bifaces in archaeological sites in that region served salmon processing functions.

We think that the paper demonstrates the potential of ethnographically-collected specimens of known function in wear pattern studies. The applicability is obvious, but the literature suggests that this is an avenue of research that has not yet been adequately exploited.

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Spec. No.	Overall Length	Width: blade/handle	Thickness: blade/handle	Edge Angles R	L	Wt.
1-1538	175	43/37	11/24	32°	35°	80.0
1-1539	186	52/44	11.5/31	55°	38°	149.0
1-1540	169	46/40	12/24	38°	38°	95.0
1-1541	161	42/33	7/18	30°	35°	51.5
1-1326	161	28/32	7.5/20	30°	30°	44.0

Table 1. Dimensions, Edge Angles, and Weights of Ethnographic Yurok Fish Knives. All measurements are in millimeters and weights are in grams.

Spec. No.	Length	Width	Thickness	Edge Angles R	L	Wt.
1-974	132	69	11	30°	35°	113.5
1-152067	112	53	9	30°	45°	65.0
1-1546	120	47	7	30°	30°	47.5
1-1545	112	34	8	35°-50°	28°-47°	38.7

Table 2. Dimensions, Weights and Edge Angles of Unhafted Bifaces. Measurements are in millimeters, and weights in grams. For specimen 1-1545, the first edge angle value in both instances represents angle near base, and the second, the angle at beveled distal end.

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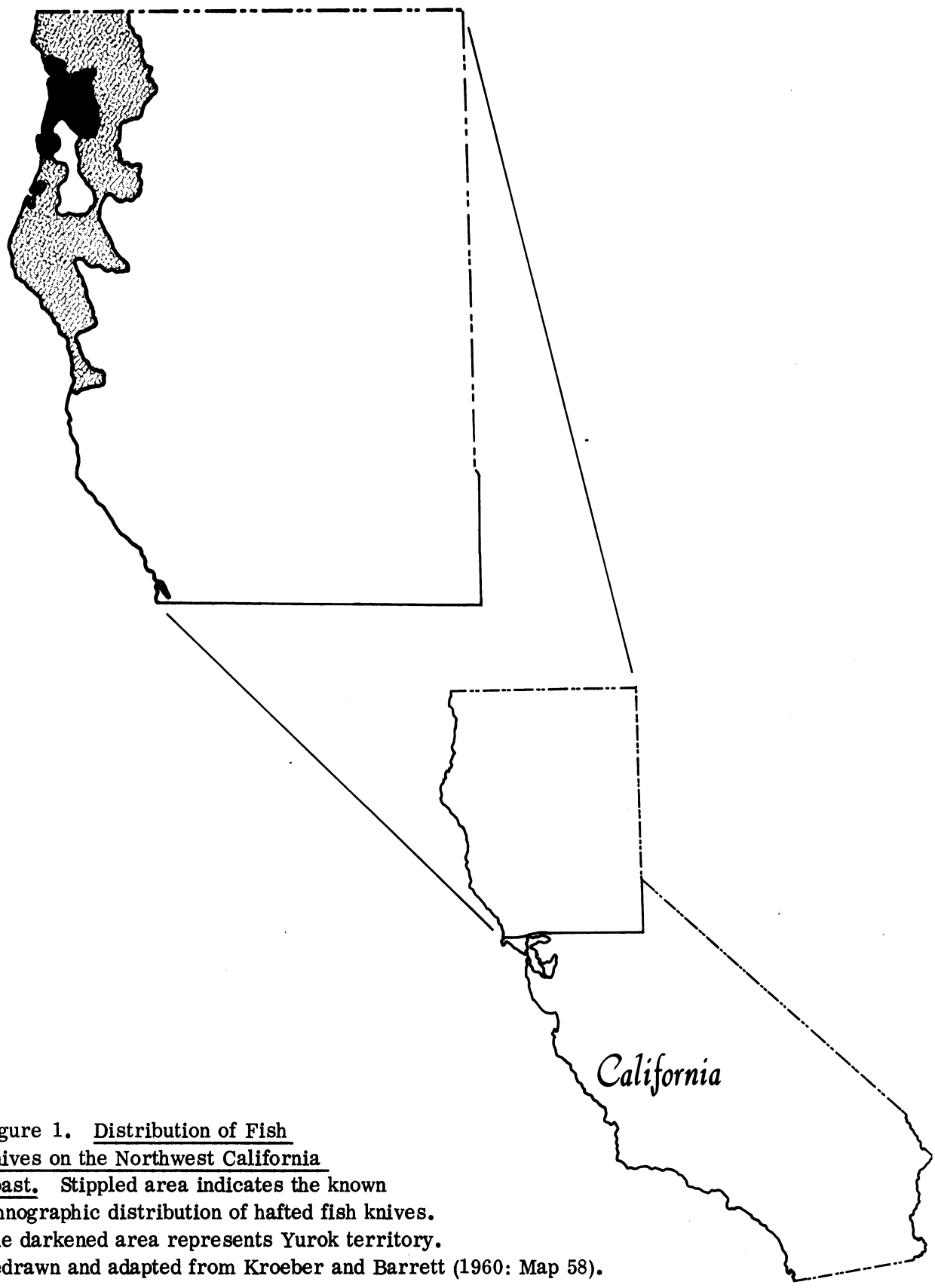


Figure 1. Distribution of Fish Knives on the Northwest California Coast. Stippled area indicates the known ethnographic distribution of hafted fish knives. The darkened area represents Yurok territory. Redrawn and adapted from Kroeber and Barrett (1960: Map 58).

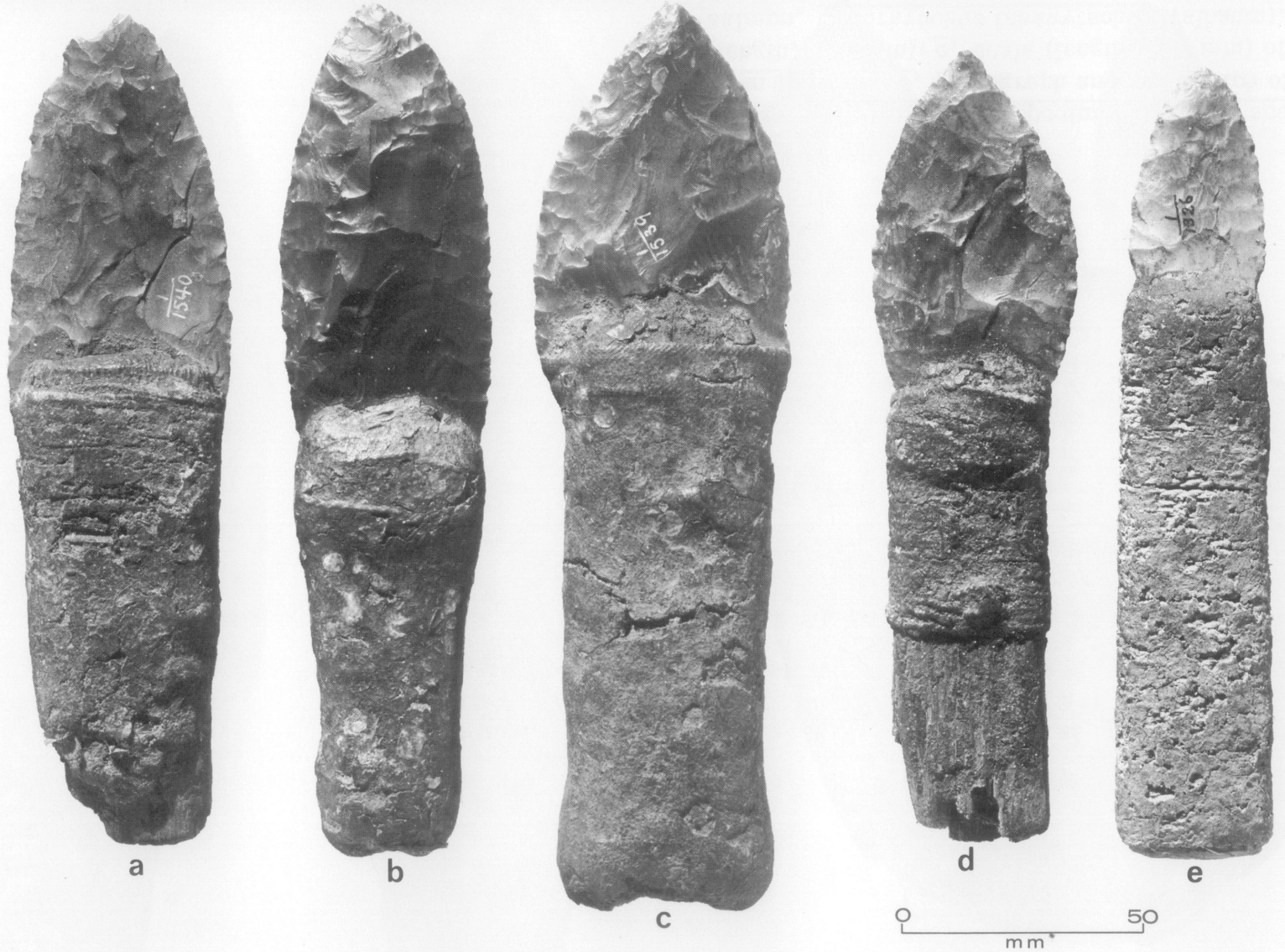


Figure 2. Hafted Bifaces from the Yurok Area. a, 1-1540; b, 1-1538; c, 1-1541; d, 1-1326. All are in the Lowie Museum of Anthropology, University of California, Berkeley.

a

b

c

Figure 4. Yurok Knife, Specimen 1-1538, and Scale from Haft. a, b, photograph and radiograph of knife (length, 175 mm); c, scale (length, 5.0 mm) of king salmon, Oncorhynchus tshawytscha (Walbaum).

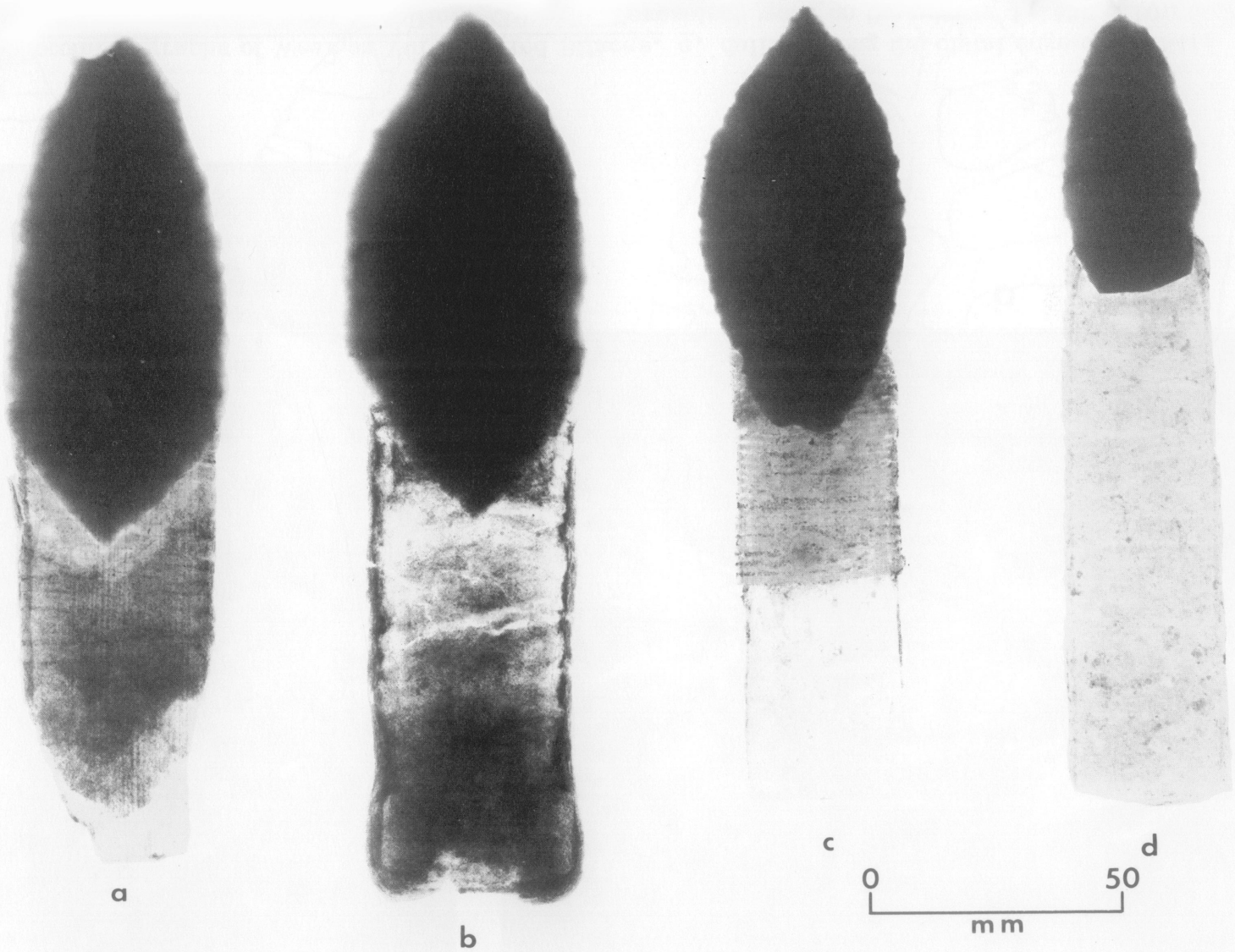
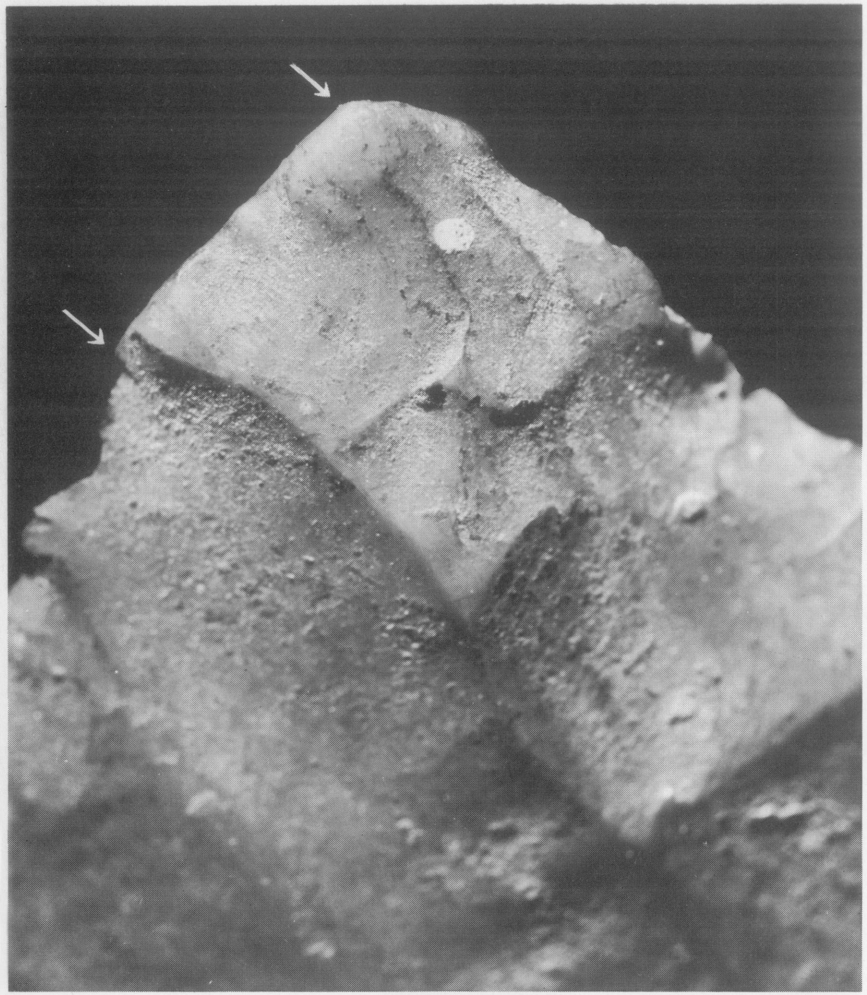
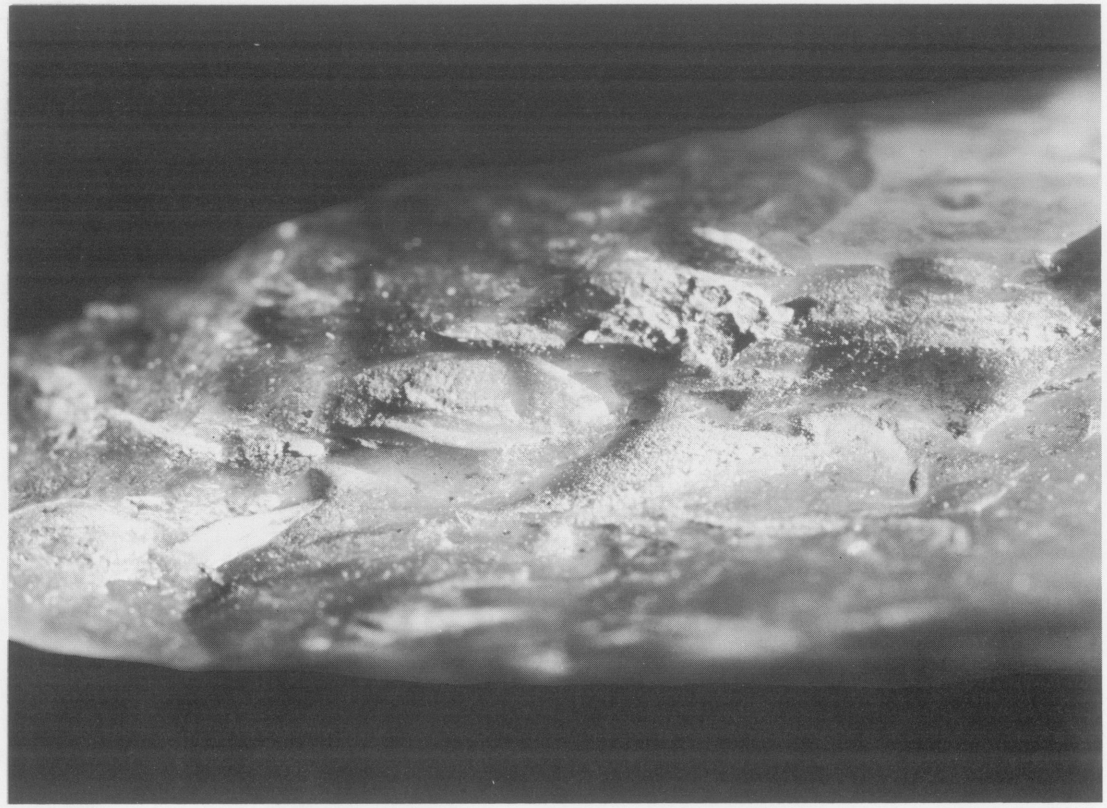


Figure 3. Radiographs of Hafted Bifaces from the Yurok Area. a, 1-1540; b, 1-1539; c, 1-1541; d, 1-1326. Exposures varied from 1 to 4 minutes. A radiograph of 1-1538 appears in Fig. 4.



a



b

Figure 5. Photomicrographs of Wear on Yurok Hafted Bifaces. a, dulling along the distal edge of 1-1541; white arrows indicate area of dulling (X10); b, "crushing" wear on the edge of 1-1539 (X10); viewed edge-on.

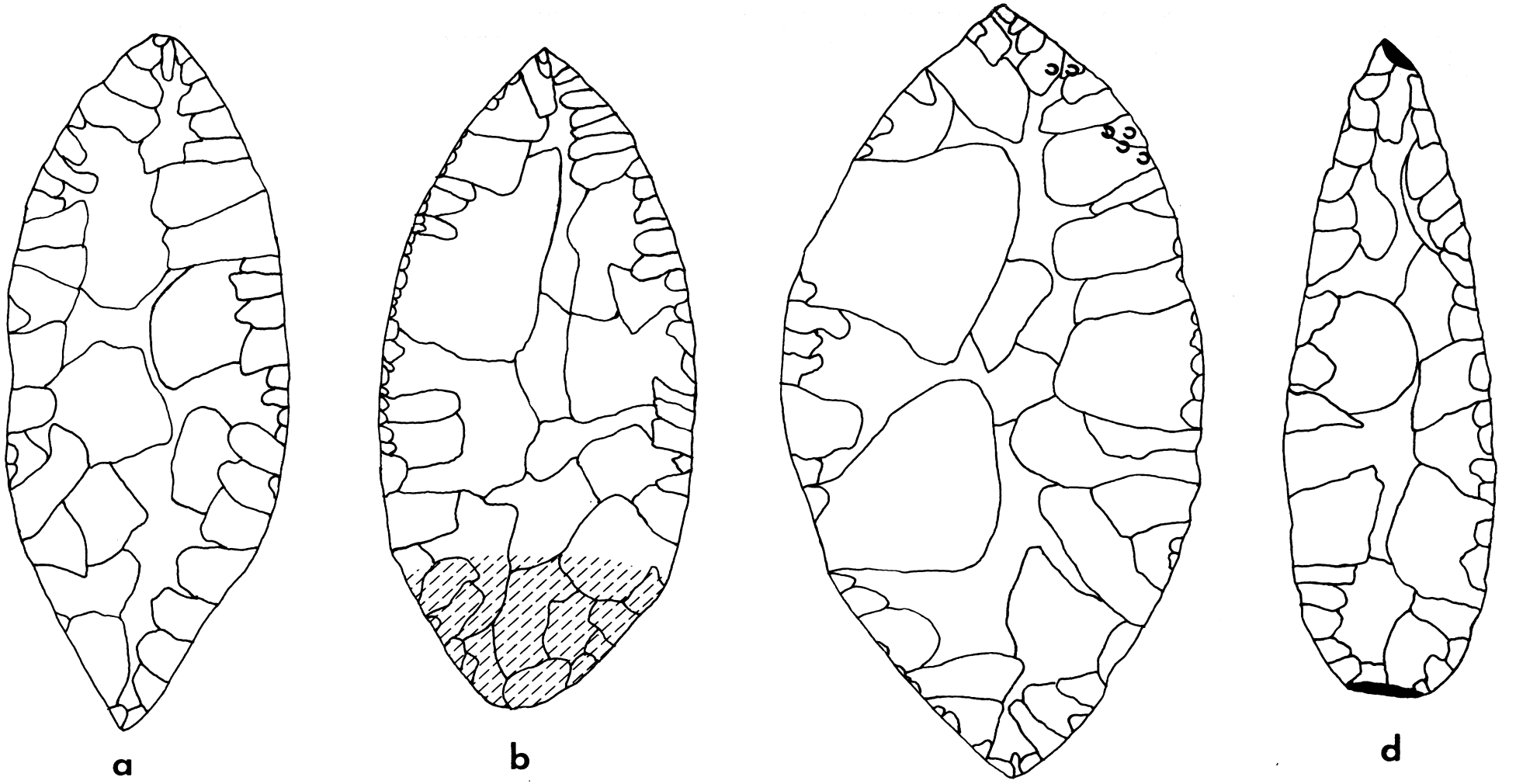


Figure 6. Unhafted Bifaces. a, 1-1546, Yurok area; b, 1-152067, Tehama-58; c, 1-974, Hupa Valley; d, 1-1545, Yurok area. Hachuring on base of b indicates a stain, presumably resulting from hafting. The presence of fish scales is illustrated near the right distal edge of c. All specimens are in the Lowie Museum of Anthropology, University of California, Berkeley.