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Bow Staves Harvested from Juniper Trees by Indians of Nevada

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INVESTIGATION of numerous scarred juniper (*Juniperus osteosperma*) trees in western Nevada, from which it is concluded Indians took wood for the manufacture of archery bows, necessitated a review of the literature on Great Basin bows and the materials from which they were made. The goal was to better understand the significance of these trees and the relationship of the industry represented by them to the manufacture of bows in the area as a whole. Use of horn, antler, and bone for bow stave material is discussed elsewhere (Wilke 1988). In this paper, I discuss the use of various woods for bow staves in the Great Basin and adjacent regions. I then discuss the harvesting of wood for bow staves from still-living juniper trees in western Nevada, and offer ideas about the exchange of wooden bow staves or completed bows from this region to other regions. Finally, I speculate on the relationships between bowyers and the trees from which they took their bow staves, and assess stave harvesting and tree regrowth as these phenomena relate to the concept of aboriginal resource management.

THE CONTEXT OF INQUIRY

The short sinew-backed bow was of widespread distribution among the ethnographic Northern Paiute, Western Shoshoni, Northern Shoshoni, Eastern Shoshoni, Southern Paiute, and Ute groups of the Great Basin of western North America. Examples of such *reinforced bows* are preserved in museum collections, and descriptions of them are found in historic and ethnographic accounts.

Most existing Great Basin bows, whether of wood, horn, or antler, are less than a meter in length, and when at rest (unstrung) many are strongly reflexed in the handle and recurved at the ends. The backing on all reinforced Great Basin bows is of sinew, which is the extremely strong fiber of dried, shredded tendons. Sinew fibers were applied lengthwise along the back of the bow with glue made by boiling horn, hide scrapings, fish skins or swim bladders, or other animal protein, depending on the material available. The favored material for bowstrings was sinew, although various vegetable fibers were also used.

Because sinew and native-made animal glues soften when exposed to moisture, in aboriginal contexts these bows often were carried in a slipcase of animal skin to protect the string and backing (Mason 1894; cf. Coues 1897:714). Among some northern tribes,[1] rattlesnake skins sometimes were glued over the sinew backing of bows. Decoration is the usual reason given for such coverings. But the skin also camouflaged the bow and, perhaps most important, it protected the sinew backing from moisture. Usually the grip was wrapped with buckskin or other material to protect the backing from the sweat of the palm.

Most aspects of Great Basin archery technology have been reported only in very general terms. Such information as is available tends to describe the finished weapons rather than the steps involved in their manufacture. The reasons for this are several, but they mainly involve the selective survival of traditional crafts, and the biased nature of ethnographic recording.

In aboriginal western North America, crafts and technologies associated with women persisted longer in the last-century period of intensive acculturation than did those associated with men. Women continued to practice traditional crafts such as basketry and pottery, and traditional foodways such as seed and root collecting, well into the historic period. Aspects of this culture still survive in some regions (Wheat 1967; Couture 1978; Fowler and Walter 1985; Couture et al. 1986; d'Azevedo 1986). The ethnographic films *Tule Technology* (Smithsonian Institution 1983) and *The Earth is Our Home* (Great Basin Films 1979) emphasize the retention of traditional crafts and skills by women. In contrast, the advent first of the fur trade and then of widespread mining and ranching enterprises brought employment opportunities and new technologies, including firearms, to Great Basin Indians (Hattori 1975). In many regions these factors combined to significantly reduce big-game populations. As a result, male-oriented technologies, such as flintworking and archery, and hunting as a regular subsistence pursuit, rapidly declined.

Equally significant is the fact that Great Basin ethnographers who collected information on native culture in the first half of the twentieth century were trained primarily in social anthropology. While information on traditional archery did not persist to the extent that many nonmaterial aspects of native culture did (such as language, marriage and kinship patterns, myths, etc.), ethnographers also were less able, or less likely, to elicit the vestiges of such information.

By the time ethnographers seriously concerned themselves with recording the details of traditional archery, the bowyer's art had vanished from the Great Basin. All that remained were a few museum specimens (often of questionable origin) and some reminiscences of what might have been seen long ago, or more likely what had been heard about the manufacture of archery equipment. Traditional Great Basin archery is now a lost art. The task of describing it, let alone replicating it for performance experiments, is therefore difficult.

WOODEN BOWS IN THE GREAT BASIN

Without question, the most common material for bow staves in most of the Great Basin was wood. It was more generally available and much easier to fabricate into bows than either horn or antler. Various wood species were used. Mountain mahogany (*Cercocarpus*), serviceberry (*Amelanchier*), juniper (*Juniperus*), chokecherry (*Prunus*), oak (*Quercus*), maple (*Acer*), birch (*Betula*), willow (*Salix*), mesquite (*Prosopis*), and "locust" (*Robinia*?) are all identified as bow woods.[2] While all of these woods may have been used for self (unbacked) bows, especially in expedient situations, all but possibly willow were made into sinew-backed weapons.

Availability of species largely dictated which wood was used in a given region. Juniper (*Juniperus* spp., "cedar" in historic literature [Powell 1875:128]) is identified as the favored bow wood among nearly all Northern Paiute, Western (Nevada) Shoshoni, Owens Valley Paiute, Southern Paiute, Ute, and Gosiute. The Tübatulabal and Kawaiisu of the southern Sierra Nevada also used juniper. Its popularity probably was due to its widespread occurrence and the general absence of the wood species used elsewhere (Coville 1892; Curtis 1926; Steward 1941, 1943; Stewart 1941, 1942). For most of this territory, the species used was the Utah juniper (*J. osteosperma*).[3] Julian Steward (1941:236) reported that among the Western (Nevada) Shoshoni, "the sinew-backed bow was generally of juniper (Juniperus utahensis) [*sic*], the best material in most of the territory, but sometimes of serviceberry in the northern regions where it grew." Across the area, some use may have been made of other juniper species, including the Rocky Mountain juniper (*J. scopulorum*), favored by most northern Plains tribes (Grinnell 1923,I: 173), or the one-seeded juniper (*J. monosperma*).

In the Great Basin, wooden bows always were made from a single piece, or stave, of wood, not from two shorter pieces joined in the center as is the case with most horn and antler bows. They usually were reinforced with a backing of sinew. Most ethnographic accounts indicate the length of such bows was three to four feet (91-122 cm.). Drawing on unpublished notes of Willard Park, Fowler and Liljeblad (1986:439) reported that, among the Northern Paiute, bows for large game were up to 4 or 5 ft. (122-152 cm.) long, for small game only about 3 ft. Fourteen sinew-backed wooden bows (wood not identified) of Southern Paiute and Gosiute attribution in the Powell Collection of the U.S. National Museum average only 97.5 cm. in length (Fowler and Matley 1979:62-64).[4] A sinew-backed bow of reddish-colored wood, possibly juniper heartwood, is in the collections of the Eastern California Museum in Independence. Its origin is believed to be the Owens Valley. It is now strongly reflexed and recurved and measures about 104 cm. around the curve of the belly exclusive of the nocks, which are formed of sinew. Another, apparently of juniper heartwood, is in the collections of the Lowie Museum of Anthropology (Berkeley). It is attributed to the Panamint Shoshoni (the southernmost division of the Western Shoshoni), and is 101 cm. long. The nocks are formed by a wrapping of several turns of rawhide near the ends of the limbs.

As with the manufacture of horn and antler bows, information is sketchy on the methods by which wooden bows were made. With access to published ethnographic information, but without the benefit of observations made on museum specimens and the experiences of modern bowyers who have successfully replicated traditional bows, it probably is not possible to make such a bow and have it perform well. Few details are known concerning the selection of trees for stave removal, the care given to trees that supplied bow staves, the proper characteristics of such trees, their ecological requirements, or their distribution. Neither is there much recorded information on the extraction of bow staves from trees or on their fabrication into finished weapons. Likewise, of the exchange of bow staves we know almost nothing. Interesting information on the manufacture of wooden bows among the Paviotso (Northern Paiute), although brief, was recorded by Edward S. Curtis (1926,XV:61):

> The bow was about three feet long, recurved at the ends, and made of a piece of cedar taken from the trunk, not from a branch. The better ones were strengthened with a reinforcement of sinew glued to the back.

These comments are useful for understanding how bow staves were extracted from juniper trees, as we shall see below.

NEW INFORMATION ON SOURCES AND EXTRACTION OF WOODEN BOW STAVES

Recent field investigations in western Nevada provided information on the aboriginal exploitation of Utah juniper (*Juniperus osteosperma*) trees for bow staves. These studies reveal some of the decisions involved in tree selection, wood inspection, stave preparation and seasoning, stave removal, and on the care and possible management of favored trees. Considerable field time spent searching for Utah juniper trees from which bow staves were harvested in aboriginal times makes it apparent that trees of this species suitable for stave extraction were few and far between. They do not occur everywhere the species grows.

Forty-seven juniper trees were found that clearly show the removal or isolation and growth arrestment of a total of 150 linear billets of wood for bow staves. The only other item in the native tool kit that conceivably could have been fabricated from such pieces is the digging stick, but this use is discounted for the following reasons. Digging sticks could have been made of wood lacking the specific arrangement of growth rings (tangential grain) typical of such wood; these tools could be made from various straight branches. Only persons seeking bow staves would have given such careful consideration to the quality of wood in billets removed from the trees. Consistent attention was given to length, width, thickness, absence of damaging knots, straightness of grain, lack of twist in the grain, perhaps a combination of both heartwood and sapwood,[5] and growth-rings typical of flatsawn lumber where the outer ring or rings formed a gentle arc extending across the back of the bow from one side or edge to the other.

Discovery of these trees came about while searching for timber to be used in replicating the short sinew-backed juniper bow of the Great Basin. Frederick Coville (1892: 360) described the use of dead, seasoned juniper wood for the manufacture of bows by the Panamint Shoshoni:

> The bows are made from the desert juniper, *Juniperus californica utahensis* [= *J. osteosperma*]. The Indian prefers a piece of wood from the trunk or a large limb of a tree that has died and seasoned while standing.

In all cases where such wood was examined in the field, it proved to be weather-checked and cracked, and unsuitable for bow manufacture. George Frison kindly pointed out that the wood was cut from living timber, and described stave-removal scars he had seen on juniper trees in Wyoming. That description led to the discovery of the trees reported here.

The trees are all in Mineral County at elevations between 1,890 and 2,135 m. (6,200 to 7,006 ft.). The ones found represent the result of about 15 person-days searching for and recording information on such trees. Their actual distribution and abundance in the Great Basin is unknown, although several days' effort to find them in central Nevada, and elsewhere in Nevada, Idaho, and eastern California yielded negative results. The work reported here represents an expansion of investigations on aboriginal big-game wing traps, and all of the specimens found are within 2 km. of these features or camps associated with them.

Thirty-three trees occur in the Excelsior Mountains east of Little Whisky Flat in an area about 2 km. across (Fig. 1). Here they grow in Pinyon-Juniper Woodland (sites 26Mn738, 26Mn739) near a large wing-trap built to capture pronghorn (*Antilocapra americana*) and in and near a similar structure apparently constructed for capturing deer (*Odocoileus hemionus*) (site 26Mn685).[6]

Fourteen trees occur about 18 km. to the south, in an area of unnamed uplands partially timbered with open Pinyon-Juniper Woodland south of Huntoon Valley, east and south of Huntoon Spring. Again, all were found in an area less than 2 km. across. The trees occur near several aboriginal camps (sites 26Mn737, 26Mn740, 26Mn741) and near another large wing-trap (site 26Mn589) built by Indians for capturing pronghorn.[7] These trees show the growth arrestment or removal of one to several bow staves each, and one tree (Huntoon-1) bears the visible scars of at least 16 bow stave removals (Fig. 2).

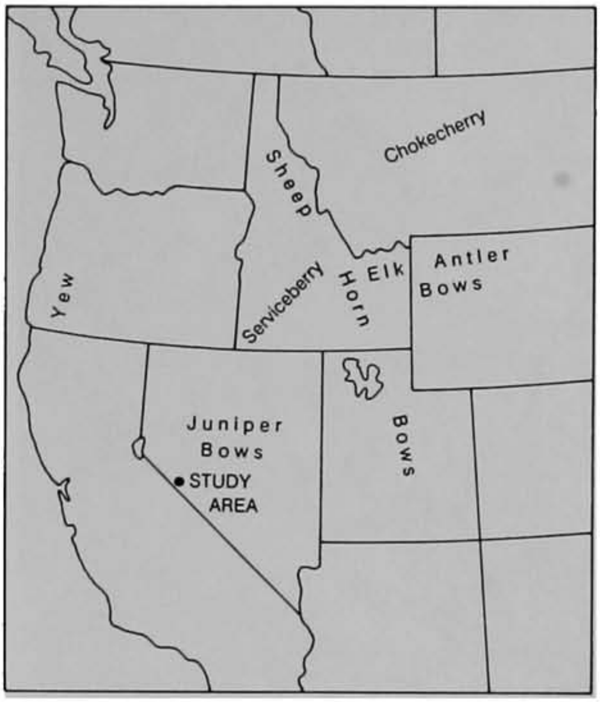

Fig. 1. Location of the study area in western Nevada.

The typical scar from bow stave extraction is a rough, trough-shaped groove split out and following the grain of the wood, somewhat over a meter long, about 6 cm. wide, and 2.5-3 cm. deep. The ends of the scar are marked by transverse V-shaped cuts made by the bowyer to isolate the stave, arrest its growth, and split it from the tree. The scars occur alone, or they flank one another in a series. In some cases they occur on opposite sides of a trunk, separated by branches or knots. In one case (Huntoon-1; Fig. 2) a series of seven adjacent stave-removal scars girdles the base of the trunk approximately one-half the way around. The same tree has a second series of stave-removal scars on the main trunk high in the crown.

Among all the trees, observed scars from stave removal vary from 89 to 187 cm. long. While the longer ones may indicate construction of longer bows, as suggested for the Northern Paiute by Fowler and Liljeblad (1986:439), it appears more likely that maximum stave length was sought to enable selection and use of the best portion thereof. The lengths of many staves cannot be determined because they split out longer than was intended or needed, or in some cases because the end of the branch or trunk from which they were removed is no longer present. In 77 cases where stave lengths can be determined, the median value is 113 cm. This is a slightly conservative figure since it does not include "greater than" measurements of stave length; some stave removal scars extend down into the duff and others are of indeterminate length for other reasons. Table 1 lists the 47 trees and provides information on each.

In the course of recording field data, each tree was marked with a small metal tag nailed to the trunk or branch. Identifying numbers, the date of recording, and the name and institutional affiliation of the investigator were embossed thereon. Measurements were made of the length of the staves isolated or removed, and notes were recorded on all aspects of cultural modification visible on a given tree.

INFERENCES ABOUT EXTRACTION OF BOW STAVES FROM JUNIPER TREES

The sequence of decisions and actions involved in stave removal can in part be inferred from examination of the cuts and scars on the 47 trees. It probably involved selecting the proper tree, assessing the quality of the wood, arresting stave growth, seasoning the stave on the tree, and removing the stave from the tree.

Selecting the Proper Tree

Tree selection involved locating a suitable tree that reliably could be located again at a later date. The trees thus seem to cluster around places where people camped or worked on a fairly regular basis. They have

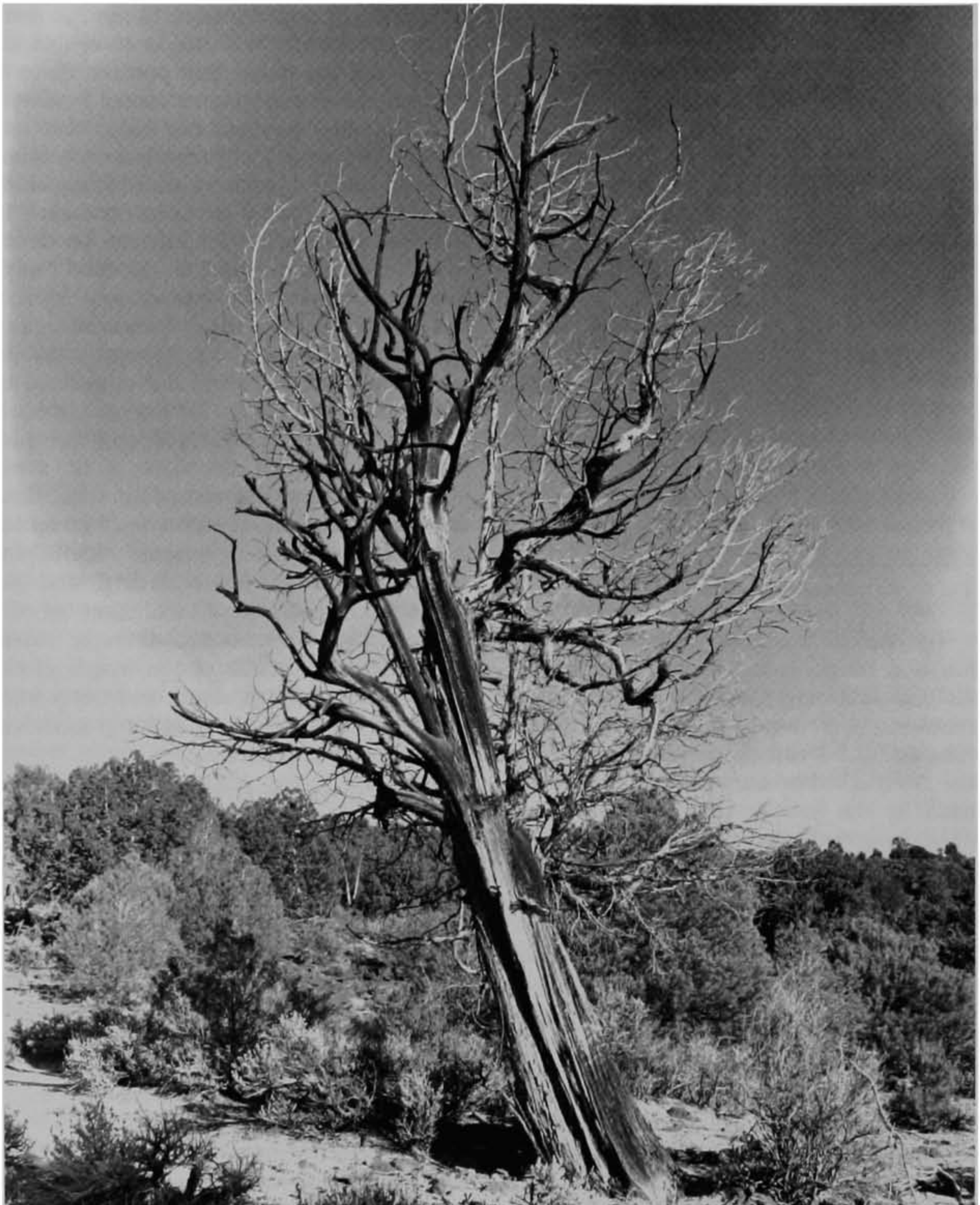

Fig. 2. Utah juniper (Huntoon-1) with 16 stave-removal scars in two tiers. The lower series girdles the tree more than half-way around. Recently killed by lightning.

Table 1
CHARACTERISTICS OF 47 UTAH JUNIPER TREES
SCARRED BY REMOVAL OR GROWTH-ARRESTMENT OF BOW STAVES

Tree Number	Number of Removals, Attempts[a]	Stave Lengths (cm.)[b]	Comments
Culturally scarred trees in the northern Excelsior Mountains; all work done with stone tools. Excelsior-1 through Excelsior-6 are associated with an aboriginal historic deer corral.			
Excelsior-1	2	129, 147	Two staves removed. Removal scars partially grown over. One stave would have had a natural reflex. Figure 11.
Excelsior-2	3	104	Aged juniper with a massive straight trunk. Two removal scars much grown over by younger wood and of indeterminate length.
Excelsior-3	1	120	Stunted little juniper with two trunks. Stave removed from regrowth partially obscuring a natural scar. Figure 3.
Excelsior-4	1	143	Aged juniper with a stave-removal scar almost obscured by regrowth. Stave apparently had two bad knots.
Excelsior-5	6		Long dead, standing juniper. At least six removals; heavily weathered and no stave lengths determinable. Worked half-way around trunk.
Excelsior-6	1	>117	Small juniper, with single removal scar almost healed over. Length of stave inferred by measurement from growth-arrestment cut down to present ground surface.
Excelsior-7	5	93, >103, 115, 123, 132	Moderate-sized juniper with removals from both sides of the main trunk. Longest stave was isolated by cuts but was an apparent failure as it split out short of its intended length. Figure 4.
Excelsior-8	1		Wedge-shaped strip of bark removed and upper cut made to arrest stave growth. Neither remaining bark nor stave removed. Figure 5.
Excelsior-9	2	113, 186	Much regrowth evident over the shorter of two staves. Substantial twist to shorter stave.
Excelsior-10	4	110, 110, 110, 149	Enormous juniper with massive trunk; removals on west side. Massive regrowth since removal makes observations a bit uncertain.
Excelsior-11	1	98	Aged juniper with one prominent trunk; straight wood begins 85 cm. above the ground. Regrowth from left side of cut has resulted in straight-grained wood suitable for removal now. Cuts 6 cm. wide, 2.5 cm. deep, northwest side. Stave detached upward from bottom cut and split out thin at the top.
Excelsior-12	2	>105, >105	Aged juniper with much regrowth. Staves removed from the east side.
Excelsior-13	3	114, 126, 145	Enormous juniper with staves removed from west side.
Excelsior-14	2	121, 121	Juniper with multiple trunks. Staves removed from the north side of the southeast trunk.
Excelsior-15	6	>104, >104, 113, >117, >123, >132	Aged juniper with several massive trunks. Staves removed from two trunks down to decayed wood at the present duff.
Excelsior-16	4	>100, 103, 113, 133	Scraggly tree with multiple trunks; much regrowth. Short slab (fireboard?) 70 cm. long also removed.
Excelsior-17	7	>94, 103, 104, 113, 128	Tall, straight, old juniper with removals from trunk and from undersides of two rather horizontal branches. Longest stave is from underside of branch and shows much regrowth at trunk end; a knot at the other end of this stave would have shortened its effective length to 114 cm.
Excelsior-18	1	113	Enormous tree with two trunks. One removal from one trunk yielded straight wood between bad knots.
Excelsior-19	4	99, 111, 112, 121	Great juniper with large branches. Much regrowth.
Excelsior-20	2	94, >127	Very old large juniper with recumbent trunks to 60 cm. diameter.

Table 1 (continued)

Tree Number	Number of Removals, Attempts[a]	Stave Lengths (cm.)[b]	Comments
Excelsior-21	1		Single cut on one branch arrested growth at upper end of a potential stave, which was never removed but would have been ca. 108 cm. long.
Excelsior-22	5	89, 98, >115, >140	Aged juniper with removals from trunk and main limb.
Excelsior-23	1	109	Removal was attempted from the bottom cut but failed (split out) two-thirds the way to the upper cut.
Excelsior-24	3	114, 172	Very old juniper now largely dead. Longest stave was removed from the underside of a limb and has a pronounced curve at one end; remainder straight. One stave of uncertain length due to regrowth, but likely ca. 114 cm. long.
Excelsior-25	3	120, 120	One stave of indeterminate length; two staves removed from the same cuts.
Excelsior-26	1	187	Very old, half-dead juniper.
Excelsior-27	2	113, 116	Scraggly, twisted juniper. Longer stave was a failure.
Excelsior-28	2	106, 108	Large juniper with removals from a very difficult area between two trunks.
Excelsior-29	2	>110, 127	Old, short juniper with several trunks.
Excelsior-30	7	110, 114, 114, 119, 124	Very old, crooked juniper with massive regrowth over stave removal scars; two additional limbs removed that may have yielded additional staves. Some staves removed from this tree would have required considerable straightening, or, more likely, the trunks from which they were removed have become curved since stave removal.
Excelsior-31	3	117, 135, >155	Large juniper with partial regrowth over 135-cm. long removal scar. Figure 4.
Excelsior-32	1		One very old, eroded, growth-arrestment cut on the upper side of a major limb of a very large tree.
Excelsior-33	5		Massive, ancient juniper growing only 2 m. from the floor of the canyon. Five removals, but lengths of none are determinable. Two staves removed from north side of a trunk ca. 90 cm. in diameter. One of these perhaps was wide enough to have yielded two bows. Three staves removed from a major limb. All of the straight-grained peripheral wood in this tree was harvested.
Bow trees in uplands south of Huntoon Valley, east and southeast of Huntoon Spring. Huntoon-3 is associated with an historic pronghorn wing-trap. Evidence of use of metal tools as noted.			
Huntoon-1	16	110, 118, >120, 123, 125, 126, 126, >130, >130, >130, >130, >130	Dead juniper with straight trunk and two tiers of stave removals, one above the other. Tree more than half girdled. Staves removed from the trunk and from a branch cut from the tree with a metal axe and now lying on the ground, but all stave removal, or at least growth-arrestment, on the tree itself appears to have been done with stone tools. Shows evidence of stave removal, regrowth of wood into the stave removal scar, and later stave removal from straight-grained regrowth. Two large basalt cleaver-like spalls (Fig. 7), apparently used to make stave-removal cuts, were found at the base of the tree. Tree recently died as a result of a lightning strike. Figure 2.
Huntoon-2	2		Very old juniper. Two staves isolated and growth-arrested by cuts. Arrestment cuts at the upper end of one stave, at the lower end of the other, made with stone tools. Neither stave removed. Figure 6.
Huntoon-3	1		One stave growth-arrested, but not removed, on the south side of the tree. Growth was arrested by a cut, made apparently with stone tools, 147 cm. above ground surface, toward which the stave would have been split out. This cut both arrested the growth of the stave and would have been used to split it from the tree. Partially obscured by regrowth. Straight trunk suggests intentional pruning while the tree was young. Figure 10.

Table 1 (continued)

Tree Number	Number of Removals, Attempts[a]	Stave Lengths (cm.)[b]	Comments
Huntoon-4	1	110	Aged juniper. One stave removed from a fairly small (ca. 15-cm. diameter) straight (now dead) trunk among massive twisted ones.
Huntoon-5	4	105, 107, 107, 123	Aged juniper with a large straight-grained limb removed with a metal axe. Limb lies on the ground and staves were removed from it, with metal tools, apparently while on the ground.
Huntoon-6	6	103, 108, 108	Aged juniper with multiple trunks. Three staves were removed by cuts made with stone tools at their lower ends and split upward; upper extent is not observable, so lengths are not determinable. Three staves were removed with a metal axe from a limb lying on ground after this limb was chopped from the tree. Shorter axe-cut slab may have been a fireboard.
Huntoon-7	2		Juniper with rosette form of about 16 trunks. Stave(s) removed with metal tools from the central side of one trunk 15 cm. in diameter. One of the smallest trunks seen to have been used on any tree. Staves were split out upward, and are of indeterminate length.
Huntoon-8	2	>104, >104	Metal axe cuts mark the upper ends of staves removed from one of several trunks. Measurements indicate length to the present ground surface, the staves having been split out downward below the present duff. Small knots were present in both staves. Figure 9.
Huntoon-9	1	104	Stave was removed from a single straight vertical branch in the middle of a tree with a rosette form. Removed with stone tools and has a pronounced twist.
Huntoon-10	2		Growth-arrestment cuts on facing trunks, both of which have massive regrowth. Neither stave removed. One stave growth-arrested at the upper end, the other at the lower end, both with stone tools.
Huntoon-11	2		Large, lightning-struck trunk shows long cut made with stone tools. Two staves of perfectly straight-grained wood, but of indeterminate length, taken out next to one another. Possibly taken from naturally seasoned wood.
Huntoon-12	12	99, 101, >106, 112, 117, 120, >160	Enormous, very old juniper with several trunks and many large branches. Staves were removed from both trunks and branches. Regrowth all but obscures very old removal scars. Clear evidence of stave removal, regrowth of straight-grained wood into the resulting scar, removal of that straight-grained regrowth wood, regrowth into that scar, removal of that wood, and continuing regrowth today (Fig. 13). All removal done with stone tools. Hammerstone apparently used for stave removal remains caught among small branches where it was placed atop a large limb.
Huntoon-13	3	103	Very large, crooked tree. Two removals of indeterminate length.
Huntoon-14	2	112	Staves removed with stone tools from central straight trunk among several massive, crooked ones. Only straight wood in the tree. One stave of indeterminate length.

[a] Number of stave removals or growth-arrestments actually visible on any given tree. Actual number removed from any given tree may be greater because older removal scars may be obscured by regrowth. If stave growth was arrested but the stave not removed, so indicated.

[b] Measurement between cuts or from such cuts down to the ground surface. In the latter cases, length is indicated as greater than the value given (>). Where stave length is indeterminate because of a broken limb or trunk, or for other reasons, it is not indicated in column three.

not been found randomly distributed on the landscape where they might have proven difficult to relocate. The importance of being able to relocate the trees is evident by the fact that the staves were removed only after they had been isolated and seasoned for some time on the tree (see below).

The selected tree contained harvestable wood with the proper grain characteristics (Figs. 3, 4). Most of the junipers in the region are crooked, twisted, and full of knots and branches. The straight-grained ones, or those that had proper grain on at least one side of a trunk or branch, were the only ones used. Overall straightness of the stave was desirable, but curves in the wood, if radially (as opposed to laterally) oriented, and if not too severe, apparently could be overcome by heating and bending. Small knots were avoided where possible, and large ones always were avoided. In most cases, this required selecting older trees on which small branches had long since dropped from the lower part of the trunk and clear wood had grown over the remaining knots. Young trees tend to have numerous small branches, and hence knots, in the surface wood. Peripheral wood on such trees or on smaller limbs also would yield staves with a more pronounced lateral curvature along what would become the back of the bow. Consequently, staves were not removed from young trees of small diameter, and when smaller limbs (10-15 cm. in diameter) were used, which was seldom, they generally had grown in shaded spots and retained few or no minor branches in the area from which the stave was taken. The available evidence shows a definite preference for peripheral wood on larger trunks or limbs.

Many trees in the region lack a primary trunk. They have instead a rosette growth form with as many as 20 or more separate trunks or major limbs of approximate equal size, none of which apparently is dominant over the others. Most such trunks are more heavily knotted and branched on the perimeter side than on the side central to the overall tree. In one case (Huntoon-7) a stave was removed from the central side (with respect to the overall tree) of one of many such trunks. Better wood can be found on the central side of any of the several trunks of such trees. Small branches in these shaded places on the lower part of the trunk tend to die while still small and drop off. The knot then becomes overgrown by straight-grained wood. Adequate work space for stave removal is lacking on most such trees, however, and they seldom were used. Without metal saws or axes, it was not practical to remove certain trunks from rosette-formed trees in order to better expose others for stave removal.

In two other cases (Excelsior-17, -24), wood was removed from the bottom sides of nearly horizontal limbs, again places where small branches generally die and drop off and the resulting knots are overgrown by straight-grained wood.

Examination of Utah juniper trees in various areas reveals that most of them have badly twisted grain. Bowyers engaged in replicating traditional archery equipment refer to this as "wind in the log (wind twist)" (Alcock 1941:5). They believe prolonged exposure to prevailing winds causes twisted grain in the trunks of trees with asymmetrical arbors. While the basic tendency to develop spiral or twisted grain is genetically controlled, it can be induced by wind, and not all trees in the same grove will manifest the phenomenon (Telewski and Jaffe 1986; Frank Telewski, personal communication 1988). Several trees (e.g., Huntoon-4) show evidence of stave extraction from an isolated, straight central trunk or limb surrounded by more massive, badly twisted ones. This suggests use of straight-grained wood grown in a sheltered environ-

Fig. 3. Small, aged juniper tree (Excelsior-3) with one stave-removal scar from straight-grained wood on the facing side of the right trunk. The right photo is a close-up of the right trunk showing the scar. The straight-grained wood from which the stave was removed had partially grown over an old natural scar. The stave was 120 cm. long.

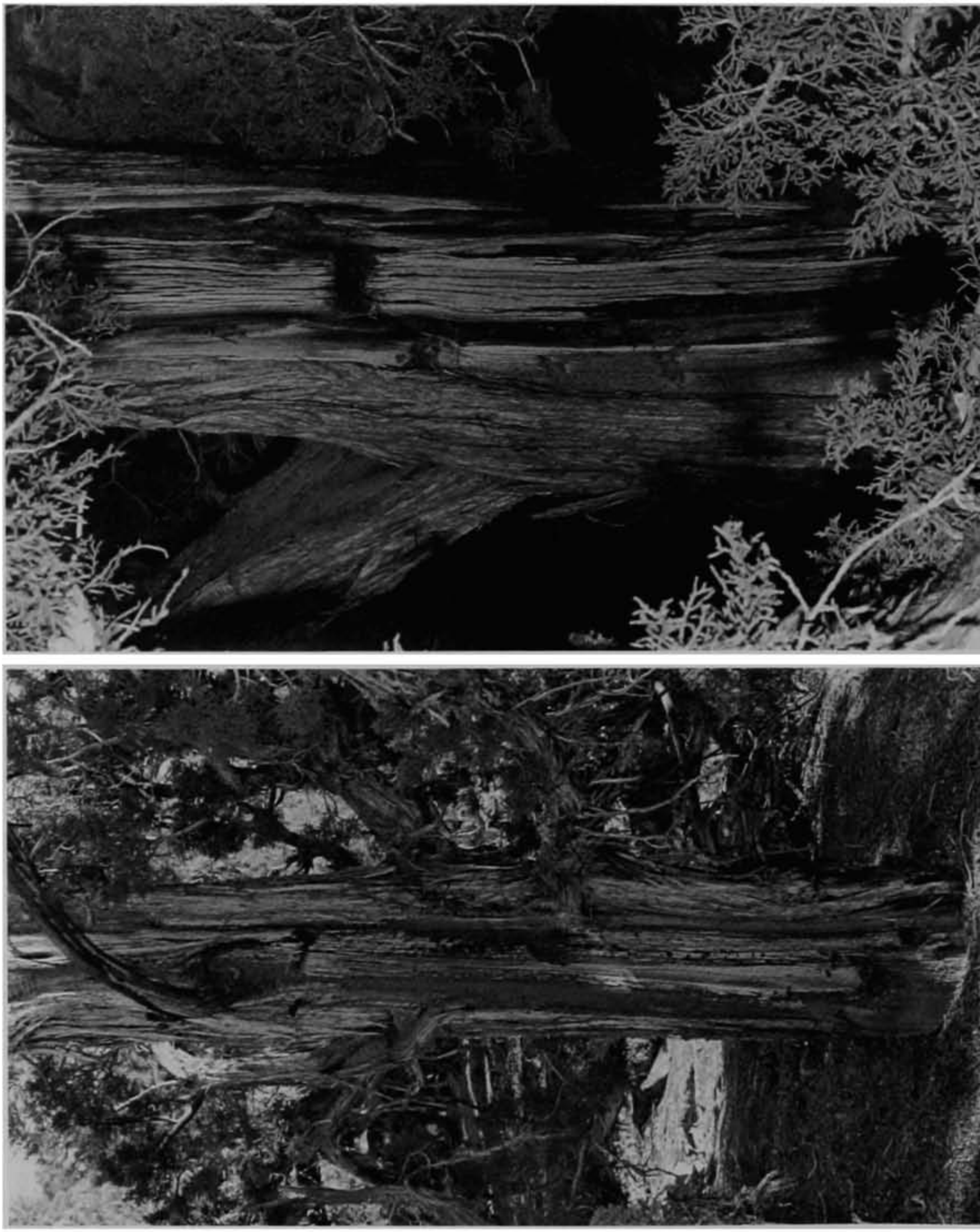

Fig. 4. Straight-grained junipers showing stave-removal scars. Left, Excelsior-7, with scars 123 and 132 cm. long on the center of the trunk (the right one was a failure, having split out short of its intended length); right, Excelsior-31, with the left scar partially obscured by regrowth.

ment in the central part of the tree. Evidence on a number of trees clearly shows that they grow in locations sheltered from the wind by other trees or, more commonly, by topographic features. Favored locations seem to be in canyons or in the lee of rimrock formations. In any event, it is apparent that some regions simply produce few or no trees suitable for bow stave extraction, all the trees present having badly twisted grain.

No preference was noted for removing wood from one side of a given tree with respect to the slope on which the tree grew. The only objective was straight-grained, knot-free wood of suitable length.

Assessing the Quality of the Wood

Wood quality sometimes was assessed by removing a strip of bark over the area where the prospective stave was sought (Fig. 5). In some cases (e.g., Huntoon-3), it is evident that a strip of bark the full length of the prospective stave was removed, because the growth-arrested stave was fully exposed but never was removed from the tree. In another case (Excelsior-8), only a triangular strip of bark was removed in the course of making the growth-arrestment cut at the upper end of a prospective stave. Perhaps a small area was cleared of bark and the growth-arrestment cut made, and the remaining bark over the prospective stave stripped off only after the wood had partly seasoned on the tree. Whether or not the bark was completely removed over the area of the intended stave may have depended on the season in which the growth-arrestment cut was made. Complete removal of bark over a prospective stave without risk of weather-checking may have been possible during colder months when growth was restricted.

Removal of the bark allowed visual inspection of the wood for straightness of grain, absence of twisted grain (not always evident under the rough and shaggy bark), and absence of potentially damaging knots. Many trees that lack bark in a strip on one side, but otherwise appear natural, may show the effects of such bark removal by bowyers prospecting for quality staves. Most trees exposed to such treatment will simply heal and, with the passage of time, escape detection.

Fig. 5. Bark partially removed and growth-arrestment cut completed (Excelsior-8). No further work ever was done on this potential bow stave, and the scar has partially been obscured by regrowth.

Arresting Stave Growth

Growth arrestment was accomplished by cutting into the wood at the upper or lower end of the stave, or at both of these points.

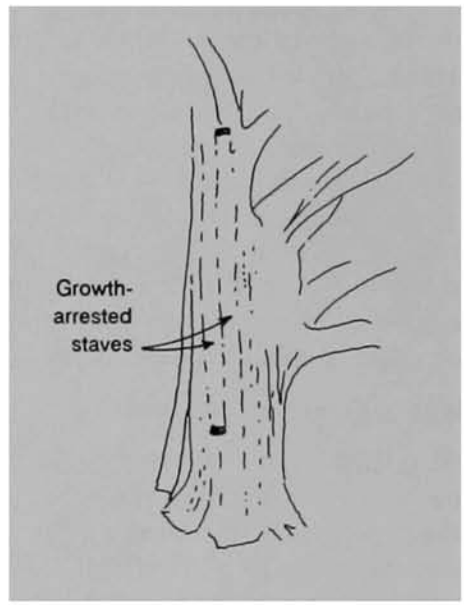

Fig. 6. Small, aged juniper (Huntoon-2) with two growth-arrestment cuts. The cuts isolated two staves, the left one at the lower end and the right one at the upper end, but neither was removed. All the bark is now gone from this side of the tree.

This cut took the form of a chiseled-out V-shaped notch averaging about 6-8 cm. wide and 3 cm. deep (Fig. 6). In most cases the cut is quite clean and apparently was chiseled out by pounding large, sharp tools of fire-spalled local basalt into the wood. Two such tools (Fig. 7), each markedly step-fractured near the working edge, were found lying on the ground at the base of Huntoon-1. A basalt cobble (maximum dimension, 15 cm.), apparently a hammerstone (Fig. 8), was found where it had been set between branches on the upper side of a limb of Huntoon-12. These items, together with observations on the nature of the cuts themselves, suggest the means by which staves were isolated and their growth arrested. The precision of the cuts suggests these large stone chisels were carefully positioned and driven with hammerstones, rather than wielded in the manner of an axe. One might conclude the opposite from the comments of Edward Curtis (1926,XV:60) concerning manufacture of wooden bows by the Paviotso (Northern Paiute): "Their axes for cutting cedar to make into bows were made of serpentine."

It is recognized that serpentine is not widely distributed in Northern Paiute territory, and may not have been widely used for axes. The fact that the tools in question are identified as having been used for cutting bow staves suggests some degree of functional specialization, more so than one would expect for such a generic tool as an axe. The tools may, in fact, have been of a

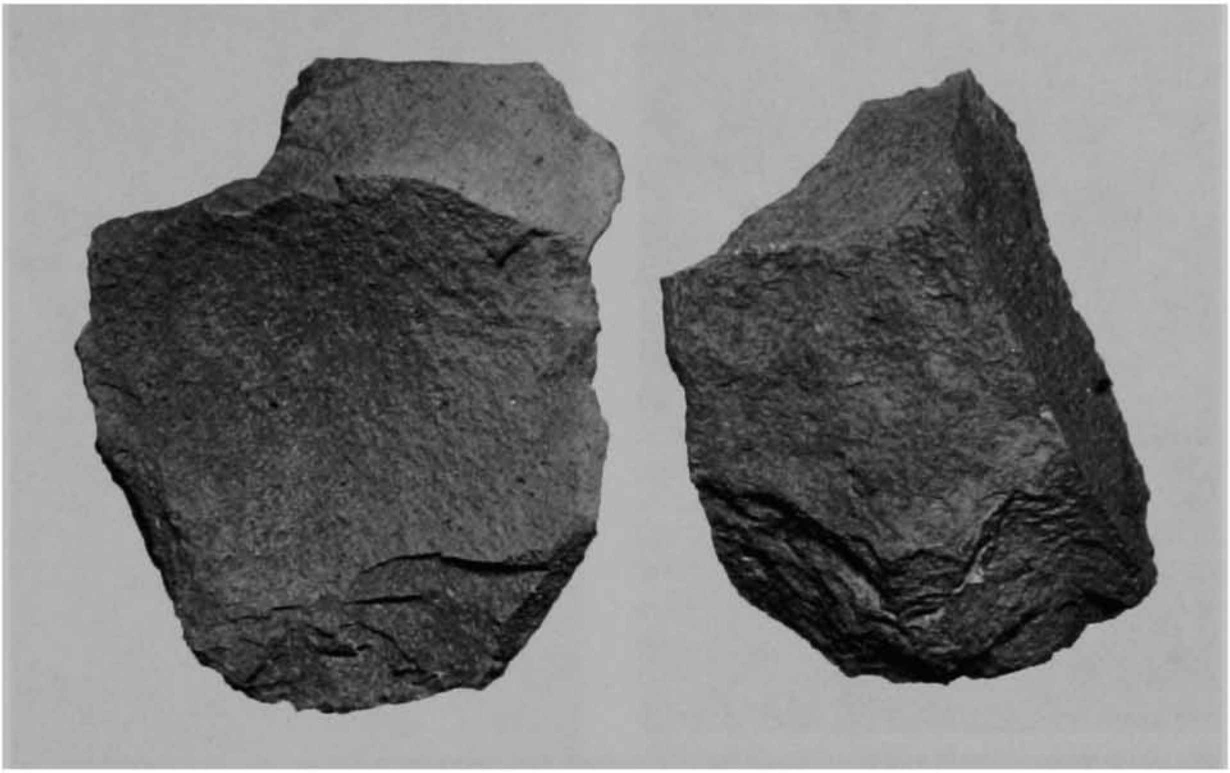

Fig. 7. Stone tools found under Huntoon-1. They are simple thermal-spalled pieces of local basalt with pronounced step fractures at what was once a sharp edge (shown here at the bottom). They probably were used as large chisels, driven with hammerstones, to make the growth-arrestment and stave-removal cuts. Both are fractured at the end opposite the cutting edge. Length of left specimen, 16 cm.

more specialized nature, such as that suggested by the chisel-like tools of fire-spalled basalt discussed above. Where steel axes were available, as they obviously were in some cases in the Huntoon group (Table 1, Fig. 9), the cut usually is more erratic and ragged, and a stray blow or two usually is evident where the point of strike missed the point of aim.

Seasoning the Stave on the Tree

Isolating the potential stave by a cut into the tree at one or both ends severed the conductive tissue and caused the wood between the cuts to cease growth and season naturally on the tree, presumably with a minimum of splitting and twisting.

It is apparent from the evidence in a number of cases that prospective bow staves usually were growth-arrested and seasoned on living trees. Seasoning the wood might have taken several years, and only replicative experiments will provide information on this point. Whether or not green wood ever was removed from the trees for use as bow staves cannot now be determined. It is apparent from the junipers studied that stave removal frequently was accomplished only after the wood had been growth-arrested and seasoned for some time on the tree.

Not all growth-arrested and seasoned staves actually were removed from the trees. In such cases, better staves may have been obtained. The staves not removed from the

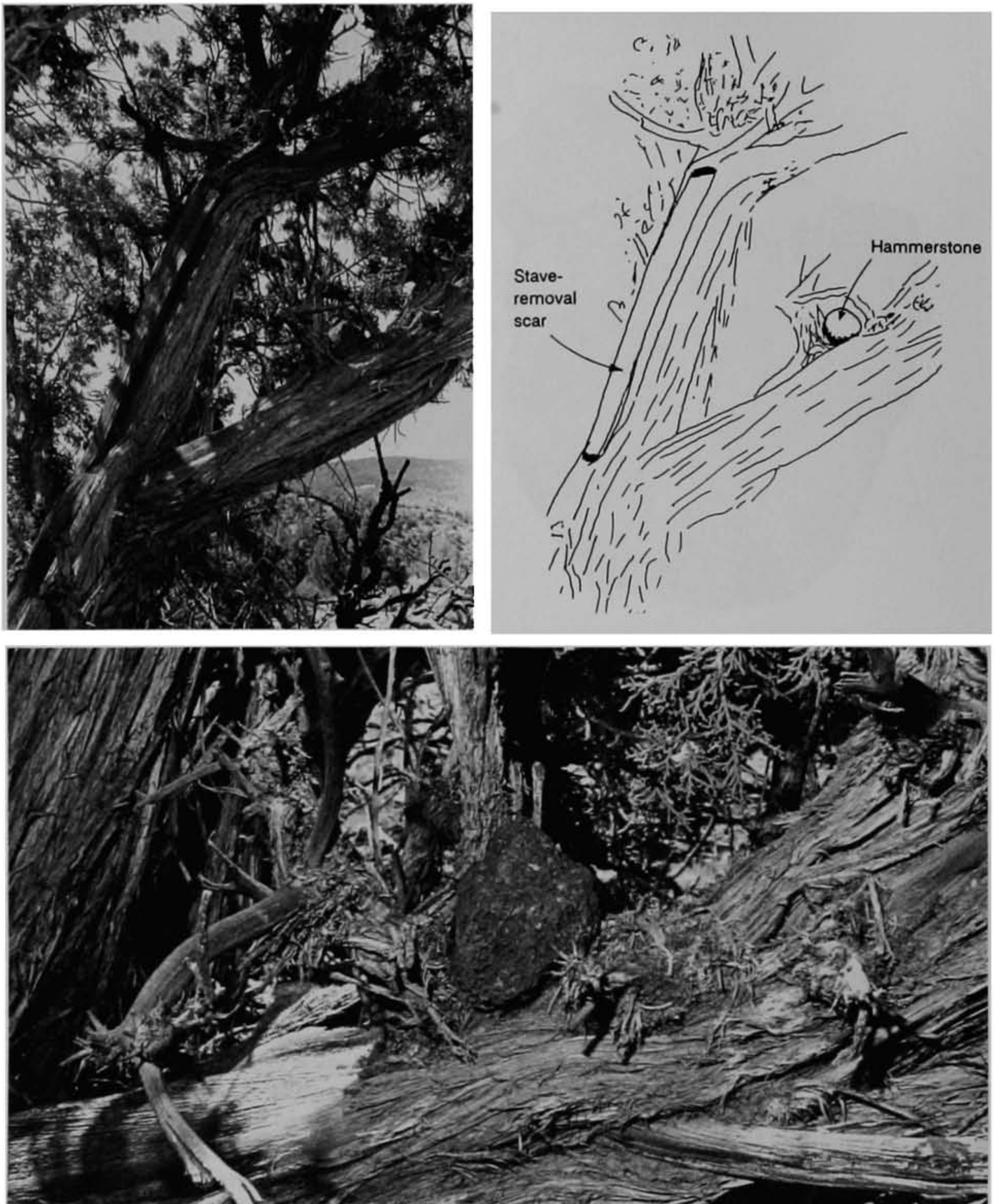

Fig. 8. Hammerstone, 12 cm. in maximum dimension, where it was left atop a limb on Huntoon-12. A stave-removal scar 101 cm. long is visible on the more vertical limb to the left of the hammerstone.

Fig. 9. Metal axe-cuts at the upper ends of two bow staves on Huntoon-8. The metal tag is 8 cm. long.

trees may be those judged inferior for reasons of configuration or grain characteristics. Perhaps they developed weather-checks or otherwise did not dry properly. Perhaps the staves not removed represent the culls from an industry that involved sale or exchange to regions lacking trees suitable for bow stave extraction. Or, perhaps most likely, they may mark the end of an industry that was replaced by firearms or that ceased with the demise of the traditional lifeway.

As noted above, one ethnographic source (Coville 1892) indicates that dead wood was used for the manufacture of sinew-backed juniper bows. The notion that bow wood was growth-arrested and seasoned on the tree is not recorded. Dead juniper trunks always have many cracks and weather-checks, and are inappropriate for bow manufacture. Perhaps Coville misunderstood or inadvertently misrepresented his informant on this point.

Removing the Stave from the Tree

Stave removal was not accomplished by the expected means of driving wedges of antler or bone under the cured wood and thus splitting it from the tree. There is no evidence in any observed cases of bruising or compression of wood fibers that would have resulted from the use of wedges. Whereas a simple *growth-arrestment* cut usually was more or less symmetrical and V-shaped, the *stave-removal cut* was V-shaped but strongly asymmetrical. The stave apparently was split from the tree by prying some sort of lever in this specially cut notch. Whether this notch was made when stave growth originally was arrested or whether it was made when the stave was removed is unknown and probably varied from case to case. The notch designed to facilitate stave removal is seen on Huntoon-3 (Fig. 10), where the stave never was removed, and on Excelsior-1 (Fig. 11), where the stave was removed. The side of the stave-removal cut that bore straight into the tree described the actual end of the bow stave. Insertion of a chisel-ended lever, such as a digging stick tipped with horn or antler, into the very apex of this asymmetrical notch apparently enabled the bowyer to engage the end of the intended stave and wrench it from the tree. Freeing the stave may have been accomplished with a tool of hardwood, stone, or antler, used as a simple lever, or the tool may have been bound to the tree with wet rawhide and the stave pried free as the binding dried and shrank.

Fig. 10. Unremoved bow stave on Huntoon-3. The growth habit of this tree is atypical for Utah junipers and apparently is not a result of browsing by animals. The tree may have been pruned while young. The detail shows that the bark was removed over the intended stave, a crack formed under it at some time, and it has been obscured partially by regrowth. Growth of the stave was arrested by a stave-removal cut made at the upper end.

Fig. 11. Detail of stave-removal cut at the upper end of a stave-removal scar now partially overgrown on Excelsior-1. Note the preciseness of the cut and its asymmetrical configuration. A second scar is fully overgrown at the left below the crotch.

Perhaps seasoning the wood on the tree resulted in formation of a crack between the main body of the trunk and the isolated stave, facilitating removal of the latter. The postulated means of stave removal is shown in Figure 12.

The stave thus removed had grain very close to that referred to in the wood industry as tangential or flatsawn grain (Hoadley 1980:5-8). In reality, the stave probably had no flat surface on what would become the back of the bow, but rather this surface merely followed the gradual curve of the outer growth-ring. The outside growth-rings of the stave became the back of the bow, the interior wood the belly. This concentric arrangement of growth-rings, a recognized aspect of the traditional bowyer's art (Pope 1925:61), distributed the stress evenly as the finished bow was drawn. Care had to be taken to ensure that the growth-rings on the back of the bow were not cut, or the finished bow might fracture at that spot.

All of the bows made from these staves would have had natural backs of sapwood over heartwood, or they would have consisted entirely of sapwood. This situation recalls a statement made by Stephen Powers (1877:373) regarding cedar (juniper) bows obtained by the Yokuts of the San Joaquin Valley of California, from the "mountaineers" (Monache or Western Mono): "The bow is taken from the white or sap wood, the outside of the tree being also the outside of the bow." The extraction of juniper wood by the Cheyenne, as reported by Grinnell (1923,I:173) was of a similar nature:

> A certain juniper tree (*Juniperus scopulorum*, Sarg.) was regarded as furnishing the best bow wood used in later times. Usually a small upright tree was chosen, or a stick was split from a larger tree if the grain of the piece was straight. The heart wood was not used.

Sinew laminated to the back of the bow would have provided additional reinforcement. Reinforcement is essential to prevent breakage in such a short bow and also would have increased its elasticity and recovery speed (and hence its cast).

REGROWTH AND RECOVERY

Most of the trees show healthy regrowth. Regrowth is indicated by a gradual laying-in of wood from the edges of the stave-removal scar, and in a number of cases ancient scars of this nature are all but obscured by more recent growth. It is possible that many trees were exploited for staves at remote points in time but only the most recent stave removals are now detectable. Cross-

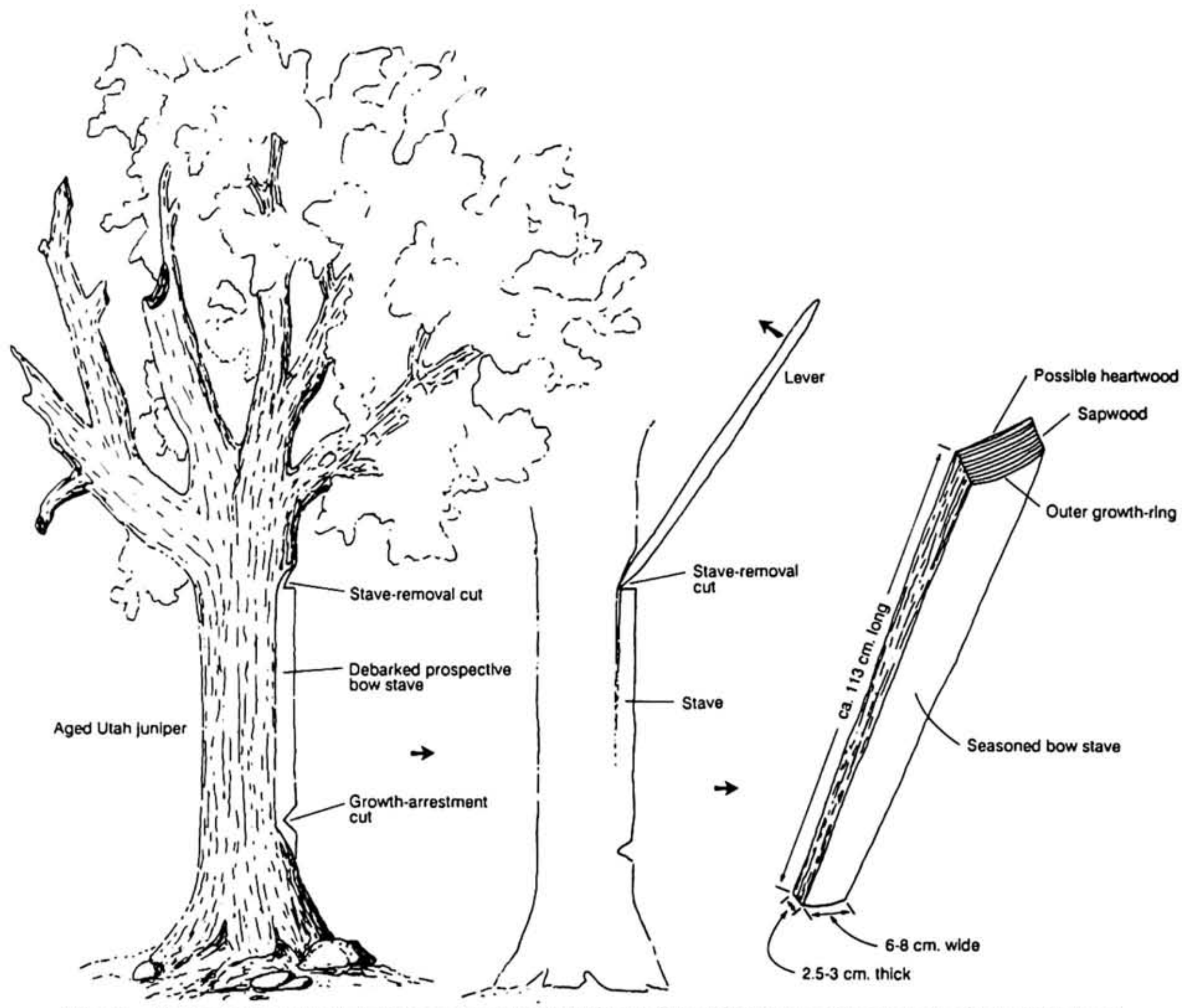

Fig. 12. Suggested method of stave removal, and grain configuration and measurements of a typical stave.

cutting the trunks of individual trees would be necessary to reveal the full history of bow stave removals in many cases.

Trees from which staves were removed had straight grain, at least in that area where the stave was removed. Healing of the scar resulted in the inlaying of new straight-grained, knot-free wood from either side of the scar. The straight scar served as a template for subsequent regrowth of straight-grained wood. If this straight-grained wood subsequently was harvested, and clearly it was in some cases (such as Huntoon-1 and -12), the continued removal of wood from a favored tree actually guaranteed the continued availability of wood with the proper grain characteristics (Fig. 13). The intervals between such removals were, however, quite long, perhaps longer than a human lifespan. Where wood of straight grain could be found around a substantial part of a trunk, it was essential that sufficient time elapsed between stave removals that the tree was able to recover and was not excessively girdled and killed.

DISCUSSION

The extraction of food substances (other

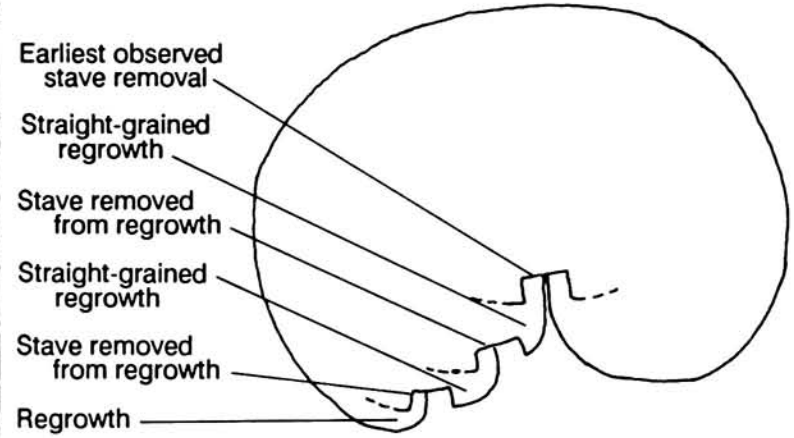

Fig. 13. Huntoon-12, with its very complex history of stave removals, the nature of which is interpreted as shown in the drawing in an idealized cross section just below the metal tag. This tree has the longest and most complex visible history of cultural modification of any found, apparently dating back several centuries. It shows evidence of stave removal, regrowth of straight-grained wood into the old scar, stave removal from that regrown wood, and subsequent stave removal, regrowth, stave removal, and regrowth. At least 12 staves were removed from the limbs and trunk of this tree. The hammerstone (Fig. 8) was found atop the large limb that rises from the base at the lower right of the photograph.

than seeds, nuts, or fruits) or raw materials from living trees is well documented. Thain White (1954) and Thomas Swetnam (1984) reported the peeling of outer bark from ponderosa pines (*Pinus ponderosa*) and other trees by native peoples of Montana and New Mexico, respectively, to obtain the "inner bark" for food. Studies of the growth-rings of such trees document the practice to nearly 200 years ago. Mary Schlick (1984) discussed the extraction of bark from western red cedar (*Thuya plicata*) and the fabrication of it into bark containers by Columbia River tribes. Hilary Stewart (1984) and Russell Hicks (1985) discussed the extraction of planks from western red cedars by various Northwest Coast tribes. In all these cases, the result was scarred trees that are still recognizable on the landscape. An argument has even been made that prehistoric pueblo peoples of the Four Corners area cultivated Douglas fir trees for construction beams (Nichols and Smith 1965). Culturally altered trees ("CATs"), or culturally modified trees ("CMTs"), are recognized as important archaeological resources in various parts of the West.

The arboreal archaeology reported here is based on data not normally recorded in the Great Basin. Archaeological survey as commonly practiced, with eyes on the ground surface, simply fails to discover evidence of this kind. Doubtless many other examples of culturally modified trees have been passed undetected at close range by careful and well-trained field archaeologists. A better understanding of the significance of these trees, the bow stave harvesting industry, and the relationship of this industry to the broader picture of Great Basin archery technology, depends on the search for similar evidence elsewhere. Only then will we understand to what extent the Excelsior-Huntoon region may have supplied bow staves or finished bows to other regions lacking straight-grained trees suitable for stave extraction.

Throughout much of the upper midwestern United States, including the Northern Plains, short wooden bows are thought (on the basis of very little actual evidence) to have been developed in protohistoric and early historic times to facilitate hunting on horseback. Favored woods included osage orange (*Maclura pomifera*, acquired by exchange from eastern Oklahoma and Texas [Record and Hess 1943:389]), serviceberry (*Amelanchier*), chokecherry (*Prunus*), perhaps hickory (*Carya*, also imported from the east-central U.S.), and other superior bow timbers. The short length of the sinew-backed juniper bow of the Great Basin, throughout most of which area the horse never had a significant impact on native culture, is due instead to the limited length of staves available. The short bows of mountain sheep horn and elk antler also reflect the length practical with those materials (Wilke 1988). Similarly, along the coastal strip, from northern California northward, bows of Pacific yew (*Taxus brevifolia*) were short, broad, and flat. Their length also probably reflects the character of the raw material. In the observed cases of bow stave removal from juniper trees, median stave length was 113 cm. When split ends were removed and the bow actually was fabricated, a length of a meter or so, as described in literature, was about the longest generally obtainable.

Why so many trees in the localities studied reveal evidence of aboriginal bow stave extraction is unknown. Perhaps few places in the region have juniper trees that produce straight-grained wood, and those areas that did have such wood exported either bow staves or completed bows to areas lacking quality wood. In any event, ethnographic records suggest that the sinew-backed Utah juniper bow commonly was used by most Western (Nevada) Shoshoni and by the Northern Paiute, with some representation among the Southern Paiute, Ute, Kawaiisu, and Tübatulabal. Serviceberry (*Amelanchier*) wood commonly was used for bows in the northern Great Basin and in the northern Rocky Mountains. The mountain sheep horn bow was more common among the Northern Shoshoni, Eastern Shoshoni, Ute, and Southern Paiute. Manufacture of elk antler bows appears to have been limited to the Northern Shoshoni and Eastern Shoshoni and to other tribes of the northern Rocky Mountains and the northern Plains. A lack of suitable wood in some regions, and the availability of horn and antler, even if more difficult to work with, may have favored or necessitated use of these materials for bow staves in regions where such bows were common. Perhaps juniper bow staves or finished bows were exchanged from the study area to neighboring regions that lacked suitable material.

Export of juniper staves or bows across the Sierra Nevada into California is reported. Floristically, the latter region is more diverse, and suitable bow timbers may have been more readily available. However, several accounts (Powers 1877:373; Gayton 1948: 73; Latta 1977:285) indicate that Yokuts groups of the San Joaquin Valley and adjacent Sierra Nevada foothills obtained juniper bows from the Western Mono. Latta (1977: 285), speaking of the Yowlumne (= Yawelmani, a Southern Valley Yokuts tribelet [Wallace 1978]) of the lower Kern River, stated:

> The finest bows made by the Yowlumne were made of juniper. They were backed with sinew. Juniper staves were traded from the Monache and Pah-ute to the east, or were secured in Yokuts territory in the upper Coast Range of Mountains. Bows of juniper were shorter than those made of other woods. The making of them required more skill and labor to produce than those made of other woods. They were very highly valued.

The Monache (Western Mono) occupied the headwaters of the San Joaquin, Kings, and Kaweah rivers. They were bordered on the east by the Owens Valley Paiute, or Eastern Mono, and the Mono Lake Paiute. The latter in turn were located just west of the area with the scarred trees reported here. Exchange of bow staves from the study area to the Yawelmani by way of the Monache would have involved a distance of perhaps 300 km., much of it extremely difficult terrain fully impassable during six months of winter. If Latta's account is correct (and he knew the group he called Yowlumne very well), a widespread exchange network involving several linguistically distinct groups is indicated.

Based on tree-ring counts on juniper wood grown in the immediate region (up to 50 tree-rings per centimeter, or 130 per inch]), some of the trees from which bow staves were removed may be at least a thousand years old. If the last staves were removed about a century ago, the trees still seem to document an observable history of stave removals dating back perhaps as much as 400 or 500 years. Thus, the evidence suggests an ancient practice.

THE QUESTION OF RESOURCE MANAGEMENT

Current anthropological research among hunter-gatherers stresses the concept of resource management (Williams and Hunn 1982). Numerous examples around the world document the purposeful management of natural resources by aboriginal peoples. Evidence from the trees studied here indicates that individual trees were carefully exploited for bow staves over long periods of time, probably for centuries. Whether this pattern of exploitation constitutes resource management is, in my view, open to question.

By carefully removing only the desired billet of wood from a given tree, a straight template remained over which straight-grained wood would be emplaced through normal regrowth processes. Such regrown wood could then be harvested decades later. Given that long periods of time elapsed between the removal of staves from some trees, favored trees must have been well known, and tales may have been told about them and about particularly fine bows made from them. Important trees may have been named and figured prominently in local traditions.

One bow stave tree (Huntoon-3) is located along the drift fence of an enormous pronghorn wing-trap in the uplands south of Huntoon Valley. Except for this tree, which has particularly straight grain (Fig. 10), most junipers in the immediate area of the trap appear to have been eliminated in the course of obtaining timbers for construction. The form of this tree is so aberrant as to suggest that while still young it was pruned to remove branches on the lower trunk and thus ensure knotless wood for future bow stave extractions. This, however, is the only known tree whose configuration suggests intentional pruning.

While the cultural practice of stave extraction can be seen to have resulted in the continued production of straight-grained, knot-free wood, it is likely that no bowyer ever lived long enough to reap the benefits of his actions. The continued production of straight-grained wood for bow staves, as seen in greatest detail on Huntoon-12, was a natural, rather than intentional, result of normal regrowth processes following stave harvest. I do not believe the evidence warrants a strong argument for resource management or for the intentional cultivation of bow staves. The factor of consistent intent and payoff within an appreciable time is lacking.

THE FUTURE

Museum specimens of composite bows built on staves of sheep horn and elk antler stand with a few brief and scattered ethnohistoric and ethnographic accounts of their distribution and manufacture. No record of them is preserved on the landscape to provide additional information. Only replicative experiments of the kind discussed by Laubin and Laubin (1980:Chapt. 5) and Holm (1982) will broaden our understanding of the design and performance of these weapons. With reinforced juniper bows, the situation is different. Evidence of the harvesting of wood for such bows is found on still-living trees, some of which document a history of such activity that must stretch back hundreds of years. Examination of these trees has provided substantial information on aspects of archery technology never recorded in written records.

Growth-arrestment cuts have been made to isolate a series of potential staves on Utah junipers in the study area. In some cases cuts 3 cm. deep (about that seen on many of the trees studied here) encountered no heartwood at all. Bows made from such staves may have no heartwood on the belly side, and may consist entirely of sapwood with a backing of sinew (cf. Powers 1877: 373; Grinnell 1923,I:173). Further studies will concentrate on replicating the short, sinew-backed, juniper bow of the Great Basin, employing the observations and inferences presented here. The objective will be to better understand the manufacture, design, and performance of these weapons and the arrows they cast.

NOTES

1. Accounts that describe the practice of covering the sinew backing of bows with snake skin (usually specified as rattlesnake) are: Northern Shoshoni (Wyeth 1851:212; Lowie 1909: 192; Steward 1943:314, 370); Northern Paiute/

Bannock (Steward 1943:314); Gros Ventre (Kroeber 1908:161); Crow (Maximilian 1904-07,XXII:352-353); Kutenai (Turney-High 1941:83; Ray 1942:149); Okanagon (Teit 1928:241); Flathead (Teit 1928:344); Klikitat, Umatilla, Kalispel, Shuswap, Chilcotin, Flathead, and Coeur d'Alene (northern Rocky Mountains and Plateau tribes extending into British Columbia and Alberta [Ray 1942:149]; denied for the Coeur d'Alene by Teit [1928:98]); Nez Perce (Teit 1928:99); and other unspecified tribes west of the Rocky Mountains, probably the Nez Perce, Northern Shoshoni, and neighboring groups (Coues 1897:713-714; Ferris 1940:300).

2. The reference to "locust" is in Kelly's (1964) "Southern Paiute Ethnography." Probably it refers to the New Mexican locust (*Robinia neomexicana*), which occurs throughout the Southwest into Utah and southern Nevada (Elias 1980:668). For information on bow woods among various Great Basin tribes, consult Coville (1892: 360), Sapir (1910), Chamberlin (1911:346), Hooper (1920:358), Lowie (1924:245-246), Curtis (1926, XV:61), Steward (1933:259-260), Driver (1937:70), Voegelin (1938:27), Stewart (1941:384, 1942:266), Steward (1941:236, 289, 1943:313, 370), Kelly (1932:142, 1964:72), Fowler and Matley (1979:61-62), Zigmond (1981:35), and Callaway et al. (1986:350).

3. Beckwith (1855:43) commented on the "superior bows of cedar" (probably the western juniper, *J. occidentalis*) he saw among the Indians on the Pit River in northeastern California in 1854. This usually is considered Achomawi territory, although the Indians insisted they were "Pah Utahs." Their pierced nasal septa, ornamented with bars of bone or shell, suggest they were Achomawi (Steward and Wheeler-Voegelin 1974:100 [repaginated]). In the Sacramento River drainage of northern California, western juniper sometimes was used for bows. Saxton Pope (1925:14-15) described one of Ishi's bows:

> It was a short, flat piece of mountain juniper [*J. occidentalis*] backed with sinew. The length was forty-two inches [107 cm.]. . . . It was broadest at the center of each limb, approximately two inches, and half an inch thick. . . . The wood was obtained by splitting a limb from a tree and utilizing the outer layers, including the sap wood. . . . Held in shape by cords and binding to another piece of wood, he let his bow season in a dark, dry place. Here it remained from a few months to years, according to his needs. After being seasoned, he backed it with sinew.

Ishi was the last Yahi (Southern Yana) of northern California. From this description (and it must be accurate, given Pope's [1918] knowledge of Ishi's archery), it appears that the bow was roughed-out from green juniper wood, in contrast to the situation discussed in this paper. Use of juniper species is indicated, however, west of the Sierra Nevada in California. Most Indians of northwestern California, Western Oregon and Washington, and on up into British Columbia made bows of Pacific yew (*Taxus brevifolia*; Driver 1939:326; Barnett 1937:169, 1939: 245), a material Ishi used after he abandoned his traditional lifeway.

4. Excluded from this group are three wooden self bows 88.5, 95, and 144 cm. long and one Uinkarets Southern Paiute wooden bow 96.5 cm. long said to have a sinewed belly. Some old bows in museum displays, and some illustrated in literature, appear to be sinew-bellied or to have the string on the sinewed side, due to the strong reflex they have acquired with age. Only examination of the nocks might reveal that these bows have "reversed." Sinew on the belly would do nothing to protect or strengthen the bow, or to improve its cast; it would only weaken the bow and almost assure its breakage if drawn.

5. Traditional archery literature stresses the importance of combining heartwood for the belly and sapwood for the back of a bow. The compressive strength of the heartwood and the tensile strength of the sapwood complement one another for maximum strength and cast (Pope 1925:61).

6. Reports on these traps are in progress. Sites with recorded bow stave trees east of Little Whisky Flat are as follows: 26Mn685 (Excelsior-1 through -6); 26Mn738 (Excelsior-7 through -10, -15 through -30); 26Mn739 (Excelsior-11 through -14, -31 through -33).

7. This trap will be reported elsewhere by R. E. Parr. Sites with recorded bow stave trees south and east of Huntoon Spring are as follows: 26Mn740 (Huntoon-1, -2, -7, -8 through -14); 26Mn589 (Huntoon-3); 26Mn741 (Huntoon-4); 26Mn737 (Huntoon-5, -6).

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