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UTAH JUNIPER (*JUNIPERUS OSTEOSPERMA*) CONES AND SEEDS FROM SALMON RUIN, NEW MEXICO

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ABSTRACT.—Morphometric comparisons with modern species reveal that ancient juniper seeds and cones discovered at Salmon Ruin, New Mexico, are *Juniperus osteosperma* (Utah juniper). Ethnographic sources for Southwestern Native Americans indicate that juniper cones are used for food, medicine, and other purposes. Evidence is presented for a similar utilization pattern of juniper cones by the prehistoric Anasazi inhabitants of the ruin. Cones and seeds have been found in a variety of archaeological contexts, including stratigraphic units from the Tower Kiva, burials, storage or processing areas, and trash deposits.

INTRODUCTION

During extensive archaeological excavations at Salmon Ruin, New Mexico, more than 1600 juniper cones and seeds were unearthed. These abundant plant remains provide evidence concerning the use of juniper cones by the prehistoric inhabitants of Salmon Ruin. A greater understanding of this archaeobotanical evidence is brought into focus through the integration of information on juniper taxonomy, regional topography, plant ecology, and ethnographic accounts of traditional Southwestern Native American plant-use practices.

Salmon Ruin is a prehistoric Puebloan site located 16 km east of Farmington in the northwest corner of New Mexico. The site is on the eastern side of the Colorado Plateau and is just north of the San Juan River flood plain. Elevations in the area range from 1900 m by the river to 2200 m on the higher escarpments above the site.

The dwelling, a multicomponent site, was built in the late 11th century A.D. and was first inhabited (primary occupation) by Anasazi groups associated with the Chaco Canyon cultural manifestation (Irwin-Williams 1977). The E-shaped, pueblo-style edifice (Fig. 1) was later inhabited in the 13th century and partially modified by another group, the Mesa Verde Anasazi (secondary occupation). The occupations were identified by pottery styles associated with early and late stratigraphic levels.

PLANT ECOLOGY

Above the flood plain to the north and south of the San Juan River Valley are ancient terraces that have been carved out of the plateau by the westward flowing river. The principal plant community of the terraces has been variously described as pigmy forest (Woodbury 1947), pinyon-juniper woodland (Howell 1941; Randles 1949; Zarn 1977), and juniper-pinyon savanna (Daubenmire 1943). Visual dominants of the community are, as some of the names suggest, pinyon (*Pinus edulis* Engelm.) and junipers (*Juniperus* spp.), the latter being much more numerous. *J. osteosperma* (Torr.) Little, Utah juniper, was the only representative of its genus found within 10 km of Salmon Ruin. A small stand of *J. monosperma* (Engelm.) Sarg., one-seed juniper, was located 15 km to the southeast of the site, but other juniper species that might have been expected in the region, i.e., the alligator juniper (*J. deppeana* Steud.) and Rocky Mountain

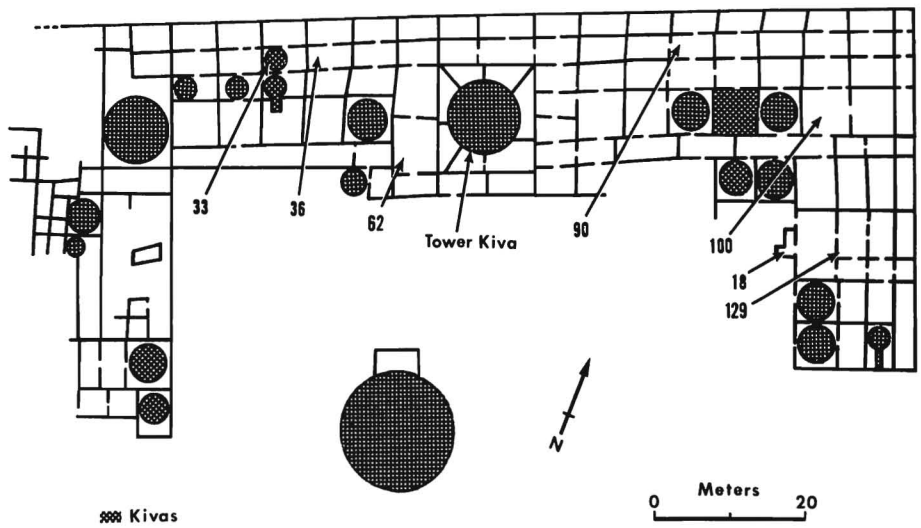

FIG. 1.—Floor plan of Salmon Ruin showing selected rooms containing juniper seed macrofossils. Room numbers are referred to in the text.

juniper (*J. scopulorum* Sarg.) were not observed despite intensive botanical surveys. Within 10 km of Salmon Ruin there are approximately 156 km (50% of the land area) covered with pinyon-juniper woodland, or what might more accurately be called Utah juniper woodland with a few small stands of pinyon mixed in.

JUNIPER SEED IDENTIFICATION

Reference seeds from modern junipers were collected to compare with the ancient seeds from Salmon Ruin. Since almost all the Salmon Ruin seeds were round in cross section, alligator and Rocky Mountain junipers were excluded as possible species of origin. Each of these species usually has two or more seeds per cone (Kearney and Peebles 1951; Little 1950), resulting in distinctive flattened areas, or facets, on their seeds. Utah and one-seed junipers usually have one seed per cone and are isodiametric. Morphologically, the latter two species have seeds that are quite similar, although Utah juniper seeds tend to be larger than one-seed juniper seeds.

To determine the species of the Salmon seeds, maximum length and width measurements for modern one-seed and Utah junipers were compared to those of the unbroken ancient seeds. Seed length and width were multiplied together, forming an index, to accentuate the size differences and simplify the data (Table 1). A Tukey-Kramer pairwise comparison (Sokal and Rohlf 1969) of the three populations listed in Table 1 reveals highly significant differences ($P<0.01$) among all three groups. Nevertheless, the seeds from Salmon Ruin must be from at least one of the species represented in the comparison. An inspection of the frequency polygons of the three seed populations (Fig. 2) reveals the similarities between the Utah juniper curve and the Salmon juniper seed curve, especially at the lower ends. If there were a number of one-seed juniper seeds in the Salmon seed collection, the curve of the latter would take on a bimodal configuration, the variance would be increased, and seeds would appear in the strictly one-seed juniper size range. However, this was not the case.

Although, the Salmon seed-size index mean is larger than the mean for modern Utah juniper seeds, this disparity can be explained. The modern seeds were collected during a dry year, 1977, with 33.3 mm lower than average rainfall (U.S. Department of Com-

TABLE 1.—*Size index (length in mm x width in mm) calculations for sample populations of juniper seeds.*

	Juniperus monosperma (modern collection)	*J. osteosperma* (modern collection)	Juniper seeds from Salmon Ruin
Mean	14.75	35.50	38.65
Standard Deviation	2.98	9.74	8.12
Variance	8.96	94.77	65.91
Median	14.28	36.00	38.55
Minimum Value	6.21	10.40	13.69
Maximum Value	23.37	63.00	66.00
Number of Seeds Counted	210	283	1180

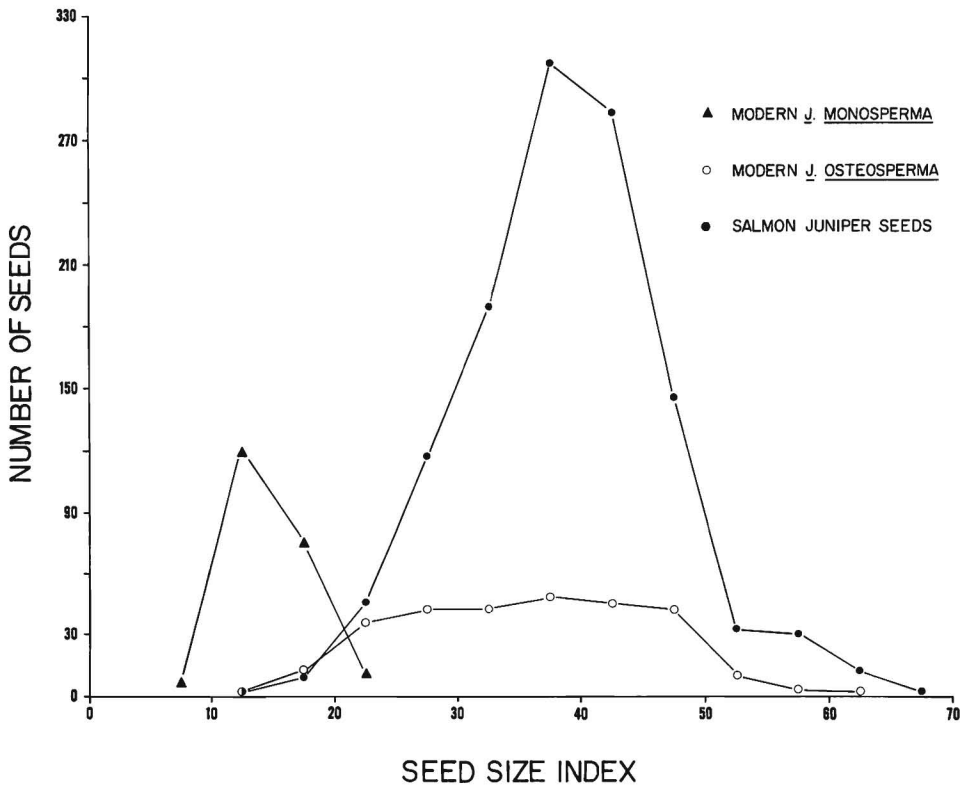

FIG. 2.—Graph showing frequency polygons for three juniper seed populations. Seed index = length in mm x width in mm.

merce 1977). The preceding year was even drier, with an 81.3 mm rainfall deficit (U.S. Department of Commerce 1976). In this arid region, even a small drop in rainfall has substantial ramifications as preciptation averages only 264 mm per year. Probably the seed size of the juniper crop was adversely affected. The modern juniper seeds were collected during a dry year and were smaller than average whereas the juniper seeds from Salmon were collected over many years and undoubtedly reflected a closer approximation to the true population mean.

ETHNOGRAPHIC SOURCES AND ARCHAEOBOTANICAL INTERPRETATION

Most traditional Southwestern Native Americans use juniper cones for food, medicine, or ornamentation. The extensive ethnographic literature relating to juniper cone use is outlined in Table 2. Assuming that plant use practices of present day Native Americans are similar to those of the past, ethnographic information can aid in the interpretation of archaeobotanical data.

TABLE 2.—*Use of juniper cones and seeds by Southwestern Native Americans.*

Native American group	Species of *Juniperus*	Use, method of preparation or storage technique	References
Hopi	*J. osteosperma*	cones baked with piki bread, seeds used as beads for necklaces	Whiting 1939
Tanoan Pueblo (Jemez)	*J. scopulorum*	cones eaten fresh or stewed	Cook 1930
Tanoan Pueblo (San Juan)	*J. communis*, *J. monosperma*	cones eaten fresh	Ford 1968
Tanoan Pueblo (Isleta)	*J. deppeana*	cones boiled then eaten	Jones 1931; Castetter 1935
Tanoan Pueblo (Santa Clara)	*J. monosperma*	cones eaten fresh or heated in an open pan over a fire, decoction in water used as remedy for internal chills and as a diuretic	Robbins et al. 1916
Tanoan Pueblo (Santa Clara)	*J. monosperma*	cones eaten fresh	Hough 1931
Tanoan Pueblo (San Ildefonso)	*J. monosperma*	cones eaten fresh (?)	Robbins et al. 1916
Keres Pueblo (Sia)	*J. monosperma*, *J. scopulorum*	cones eaten fresh or cooked	White 1945
Keres Pueblo (Cochiti)	*J. monosperma*	cones eaten fresh or baked, tea used as a cold remedy and as a tonic after childbirth	Castetter 1935

TABLE 2.—*Use of juniper cones and seeds by Southwestern Native Americans.* (Continued)

Native American group	Species of *Juniperus*	Use, method of preparation or storage technique	References
Keres Pueblo (Acoma, Laguna)	*J. monosperma*	cones eaten fresh or mixed with chopped meat and roasted	Swank 1932; Castetter 1935
Western Apache	*Juniperus sp.*	cones an important wild food	Goodwin 1942
Western Apache	*J. osteosperma*	cones eaten fresh, stored in sealed baskets	Basso 1969
Western Apache	*J. monosperma*	cones eaten fresh, seeds spat out, beverage derived from dried cones mixed with water, cones sun dried and stored for winter	Gallagher 1977
White Mountain Apache	*J. monosperma*, *J. osteosperma*, *J. occidentalis*	cones boiled before eating	Reagan 1929
San Carlos Apache	*Juniperus* spp.	cones boiled before eating	Hrdlicka 1908
Northern and Southern Tonto	*Juniperus* spp.	cones eaten fresh	Gifford 1940
Navajo	*J. monosperma*, *J. osteosperma*	cones eaten fresh, boiled juice used as a cure for influenza, as a source of green dye; seeds used as beads for necklaces	Elmore 1944
Ramah Navajo	*J. monosperma*, *J. deppeana*	cones eaten fresh, boiled, roasted and also stored for winter use	Vestal 1952
Gosiute	*J. osteosperma*	cones eaten after boiling	Chamberlin 1911
Southern Paiute	*J. osteosperma*	trees sampled for sweetest cones; cones crushed on a metate, seeded, then eaten	Kelly 1964

Table 3 contains data from several Salmon Ruin stratigraphic units, illustrating the kinds of activities with which juniper cones were associated as suggested by the ethnographic literature. The units were selected on the basis of their stratigraphic integrity, favorable preservation qualities, and absence of rodent disturbance indications. By selecting strata according to these criteria, the modifying effects of post-depositional factors have been minimized.

TABLE 3.—*Selected strata from Salmon Ruin containing juniper seeds and cones.*

Room number	No. juniper remains	Stratigraphic unit	Archaeological context	Occupational component	Juniper use interpretation	Associated macrofossils
18[a]	2^{s}	L1-08	burial (juniper seeds next to the skull)	secondary	grave offering	*Yucca* leaves
33	2^{k}	L1-11.5	burial	primary	grave offering	Brush of monocotyledon leaves; prayer sticks; bow and *Phragmites* arrow shaft
36	2^{ck}	F1-15	burned store room	secondary	stored food	*Zea mays* cobs and kernels; *Phaseolus vulgaris* seed; *Cucurbita* rind; *Cycloloma* seed; *Opuntia* spp. stems and seeds; *Phragmites* stems; *Yucca* leaf bundle
62	$784^{s}\ 68^{k}\ 8^{sc}$	43 strata	trash	primary and secondary	discarded food remains	*Zea mays* cobs and kernels; *Cucurbita* seeds and rinds; *Pinus edulis* testa; *Allium* bulb scales; *Prunus* pits; *Yucca* seeds and leaves; *Xanthium* fruits; *Opuntia* spp. stems and seeds; other plant remains
64[b]	$7^{cs}\ 1^{ck}$	H1-08	burned activity surface	secondary	food, ceremonial use or medicinal use	*Zea mays* cobs; *Phaseolus* pods; *Cucurbita* rinds and seeds; *Mentzelia albicaulis* seeds; *Yucca* leaves; *Pinus edulis* testa; basketry
90	2^{s}	F2-09	burned store room	secondary	food or food refuse	*Zea mays* cobs and kernels; *Phaseolus vulgaris* seed; *Chenopodium* seed; *Xanthium* fruit

TABLE 3.—*Selected strata from Salmon Ruin containing juniper seeds and cones* (continued)

Room Number	No. juniper remains	Stratigraphic unit	Archaeological context	Occupational component	Juniper use interpretation	Associated macrofossils
100	1[ck]	N1-03	outdoor processing or storage area, burned rooftop	secondary	food	*Zea mays* cobs, kernels, tassel, peduncle, knotted leaves; *Phaseolus vulgaris* seed; *Cucurbita* rind and peduncle; *Atriplex* seed; *Opuntia* bud; *Cycloloma* seed; *Yucca* cordage
129	1[ck]	F1-08	burned store room	secondary	food	*Zea mays* kernels, cobs, and tied husks; *Phaseolus vulgaris* seed; *Cucurbita* seeds and rinds; *Xanthium* fruit; *Chenopodium* seed; *Opuntia* bud; monocotyledon leaves (quid); grass stems, evenly cut; *Yucca* stem heart, leaves, twine; matting

[a]Test Trench [b]Tower Kiva [c]Carbonized [s]Seeds [k]Seeds with cone parts attached

Modern Southwestern Native Americans often cook juniper cones by boiling or roasting them. The prehistoric Salmon Ruin inhabitants seem to have done the same. Over 200 of the juniper cones and seeds found at the site were carbonized (Fig. 3). Several trash strata in Room 62 contained carbonized and uncarbonized juniper seeds, as well as other plant macrofossils, embedded in matrices of ash. These units represent redeposited hearth refuse. Since juniper seeds are regarded as waste products according to ethnographic sources, it should not seem surprising to find the seeds in prehistoric midden deposits. Room 62 contained 53 trash strata and 43 of these included juniper seeds, suggesting the early inhabitants also discarded them. The fact that many of the juniper seeds found at Salmon Ruin are uncarbonized indicates fresh consumption of the cones by the prehistoric inhabitants similar to patterns revealed in the ethnographic literature. The durable nature of the seeds combined with the xeric conditions of the region can account for the preservation of these plant artifacts.

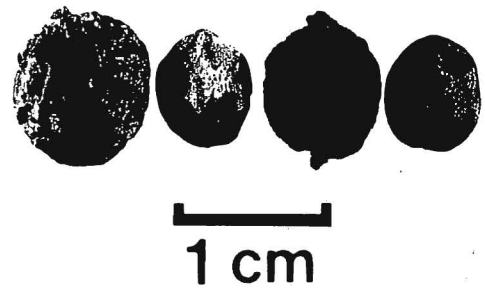

FIG. 3—Utah Juniper cones and seeds. From left to right: modern cone, modern seed, carbonized cones from Salmon Ruin, seed from Salmon Ruin.

Ethnographic sources show that juniper cones are sometimes sun dried (Gallagher 1977) and stored for winter use (Vestal 1952). One secondary rooftop (Room 100) at Salmon Ruin with juniper remains evidently served as an outdoor processing area (Bohrer 1980). Also, juniper seeds were discovered in three burned storerooms (36, 90, and 129), indicating the early inhabitants may have desired a reserve of the food item.

Juniper seeds were found on an activity surface in the Tower Kiva (Room 64), suggesting that they may have been used for ceremonial purposes. Traditionally, kivas are rooms where rituals are practiced (Vivian and Reiter 1965) and oftentimes artifacts associated with them have ceremonial significance.

Five burials containing juniper seeds and cones were unearthed at the site. All of the burials were enveloped by matting, or the remains thereof, so that these strata were discrete units. For example, stratum L1-11.5 of Room 33 showed evidence for a grave offering with two cones found adjacent to the body inside of what was left of the surrounding matting of the inhumation. In the Southwest, food offerings were often placed in proximity to the deceased (Bohrer and Adams 1977), providing nourishment for the long journey after death (Parsons 1939). The five inhumations at Salmon Ruin containing juniper remains suggest the plant's use as a funerary item.

DISCUSSION

Because of the numerous juniper remains found in a variety of archaeological contexts at Salmon Ruin, it seems apparent that the cones were a part of the prehistoric subsistence pattern of those early inhabitants. Although it seems likely that juniper cones were not a staple for the Salmon Ruin Anasazi, their supplementary role should not be disregarded. Studies comparing plant remains from the primary and secondary occupa-

tions indicate an increased reliance on wild foods, such as juniper, by the latter occupation (Doebley 1981; Lentz 1979).

Utah juniper cones have been shown to contain 7.5% reducing sugar (Yanovsky and Kingsbury 1938) and a comparable amount, 10.66%, has been shown for the bread of *J. occidentalis* Hook, with 5.69% protein and 17.87% starch (Palmer 1871). Heat of combustion tests on Utah juniper cones from the Salmon Ruin area reveal the presence of 5.3 kcal/gr in strobilus material (minus the seeds) or 6.5 kcal/cone. Combine this with the estimate of 488 mill cones produced within a 10 km radius of Salmon Ruin (Lentz 1979) during the relatively dry year of 1977, and a substantial, reliable resource appears to have been readily available.

In addition to its nutrient contents, juniper cones contain volatile oils, resins, and other chemicals with irritant properties (Claus et al. 1970). Cooking ameliorates the taste of juniper cones by driving off many of the unpleasant compounds. Another cultural adaptation for reducing the effects of irritants has been recorded for the Southern Paiute (Kelly 1964) who sample different trees until they find ones with the sweetest taste, i.e., with lower irritant contents. Similar methods would have allowed the prehistoric inhabitants of Salmon Ruin to have exploited the juniper cone crop with fewer ill-effects.

The agricultural subsistence base of the prehistoric inhabitants of Salmon Ruin probably was precarious. However, the drought-resistant juniper crop was always available, even during lean years. In addition to the ceremonial uses of juniper cones and seeds, the prehistoric inhabitants of Salmon Ruin could rely on nutrients in abundance from the surrounding juniper woodland.

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