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ARTICLE

Fiber Artifacts from the Paisley Caves: 14,000 Years of Plant Selection in the Northern Great Basin

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Abstract

Paleoethnobotanical remains from basketry and cordage from the Paisley Caves offer an opportunity to explore how people engaged with plant communities over time. Fiber identification of textiles, together with radiocarbon dating, contributes new information about landscape use within the Summer Lake Basin. Expanded marshlands during the terminal Pleistocene / Early Holocene created suitable plant communities ideal for fiber technology, specifically wetland monocots and herbaceous dicots—including dogbane and stinging nettle—by 11,000 years ago. This technology is key to subsistence activities and craft production throughout the Holocene. Despite climatic events during the Middle Holocene, in which people transitioned from caves to sites centered on lakeshores and wetlands, the suite of fiber plants and their technological application remains constant. During the Late Holocene, bast fiber material diversified with the addition of flax and milkweed. The presence of flax in particular, a high-elevation plant, may reflect the increased use of upland root collection areas as populations increased. This research provides long-term data on culturally significant native plants used in the manufacture of fiber-based textiles over the last 14,000 years.

Resumen

Restos paleoetnobotánicas de cestería y cordaje de las Cuevas Paisley ofrecen una oportunidad a explorar cómo la gente interactuaron con comunidades vegetales con el tiempo. Identificación de fibras textiles, junto con datación por radiocarbono, contribuye nueva información sobre el uso del paisaje dentro de la Cuenca del Lago de Verano. Pantanos expandidos durante el Tarde Pleistoceno / Temprano Holoceno crearon comunidades vegetales adecuadas ideales para tecnología de fibra, específicamente monocotiledóneas de humedales y dicotiledóneas herbáceas incluyendo dogbane y ortiga hace 12.000 cal aP Esta tecnología es clave para las actividades de subsistencia y la producción artesanal durante todo el Holoceno. A pesar de los acontecimientos climáticos durante el Holoceno Medio, en los que la gente hizo la transición de cuevas a sitios centrados alrededor de lagos y humedales, el conjunto de plantas de fibra y su aplicación tecnológica se mantienen constantes. Durante el Holoceno Tardío, el material de fibra de líber se diversificó con la adición de lino y algodoncillo. La presencia de lino en particular, una planta de gran altitud, puede reflejar el aumento del uso de las zonas de recolección de raíces de las tierras altas a medida que aumentaban las poblaciones. Esta investigación proporciona datos a largo plazo sobre plantas nativas culturalmente significativas utilizadas en la fabricación de textiles a base de fibra durante los últimos 14.000 años.

Keywords: paleoethnobotany; textiles; landscape use; polarized light microscopy

Palabras clave: paleoetnobotánica; textiles; uso del paisaje; microscopía de luz polarizad

The extraordinary antiquity of the fiber artifact assemblage from the Paisley Caves (Figure 1) offers a unique opportunity to document what plants were used for technological applications (principally basketry and cordage) by First Americans and later cave occupants. In this study, microscopic fiber identification, together with radiocarbon dating, serves as an effective means to understanding

Figure 1. Map of sites discussed in the text: 1. Paisley Caves; 2. Fort Rock Cave; 3. Connley Caves; 4. Cougar Mountain Cave; 5. Roaring Springs; 6. Dirty Shame Rockshelter; 7. Paulina Lake Site; 8. Chewaucan Cave; 9. Buffalo Flats; 10. Boulder Village; 11. Bergen Site; 12. Catlow Cave; 13. LSP-1 Rockshelter; 14. Bergen Site; 15. DJ Ranch; 16. Big M Village.

landscape use and plant selection for fiber-based technologies. Preservation of fiber artifacts in cave sites throughout this region has driven decades of research in Great Basin basketry, focusing on population movements, subsistence and mobility, and cultural attributes (style and structure), with an ongoing radiocarbon dating program that continues to advance regional chronologies (Adovasio 1986; Adovasio and Pedler 1994; Camp 2018; Connolly 1994, 2013, 2022; Connolly and Barker 2004, 2008; Connolly et al. 2016; Fowler and Hattori 2011; Ollivier et al. 2017; Smith et al. 2016).

Despite the substantial body of work that has contributed to basketry studies, less attention has been given to which plants were used in textile manufacture. Textiles are often documented only by artifact type; specific plant materials are generally not identified, or assumptions are made based on macroscopic observations, and fine cordage is most often described as "bast" or "hemp" fiber. Exceptions to this include analysis of Basketmaker II Yucca and *Apocynum* fiber cordage from Boomerang Rockshelter in Southeast Utah (Haas 2006); identification of bast, bark, and monocot fiber cordage and raw materials from Four Siblings Rockshelter in Nevada (Coe 2012); and fiber analysis of cordage from Bonneville Estates Rockshelter, Hogup Cave, and Danger Cave in Utah (Coe 2021; Lawlor 2020).

Extensive fiber assemblages from Roaring Springs Cave, Catlow Cave, and Dirty Shame Rockshelter have served as iconic collections on which Northern Great Basin (NGB) typologies are based (Andrews et al. 1986; Connolly et al. 1998; Cressman 1942), but systematic identification of plant taxa has yet to be conducted beyond cursory macroscopic analysis. By contrast, archaeobotanical research using seed, phytolith, and pollen datasets has flourished in recent years in the NGB, offering new insights on human health, diet, landscape use, and the paleoenvironment (Beck et al. 2018; Blong et al. 2020; Kennedy 2018; Kennedy and Smith 2015; McDonough 2019; McDonough et al. 2022; Taylor et al. 2020), particularly at sites such as LSP-1 Rockshelter, Connley Caves, Cougar Mountain Cave, and

Paisley Caves. This focus on paleobotanic microscopy and lack of taxa identification for textile technologies has prompted a systematic approach to fiber identification of the Paisley Caves archaeological textiles using direct and polarized light microscopy and scanning electron microscopy (SEM) with energy-dispersive X-ray spectroscopy (EDS).

This study addresses the following research questions:

(1) What plant taxa are represented in Paisley Caves archaeological textiles;
(2) Is there change in plant selection for textiles over time; and
(3) What can this tell us about landscape use in relation to changing climatic conditions?

To address these research questions, I systematically examined and identified more than 300 fiber artifacts using microscopy, considered the ecology of the represented taxa (e.g., wetland, dryland), and refined the chronology through radiocarbon dating of selected artifacts. Results offer a more nuanced look at seasonality and settlement-subsistence models within the Summer Lake Basin throughout the Holocene, and they suggest continuity of plant selection for technology—in particular, the use of stinging nettle and dogbane in the construction of fine cord by 11,000 years ago.

Textile Plants of the Northern Great Basin

For millennia, people have collected fiber from a wide range of plant communities within the NGB. Sagebrush (*Artemisia* spp.), bitterbrush (*Purshia tridentata*), cliffrose (*Purshia mexicana*), sumac (*Rhus* spp.), and milkweed (*Asclepias* spp.) were collected from dry steppe shrub zones and juniper (*Juniperus occidentalis*) and blue flax (*Linum lewisii*) from mid- to high-elevation open forests. Monocots from wetlands include Juncus rush (*Juncus effusus*), tule (*Schoenoplectus acutus*), cattail (*Typha latifolia* and *T. angustifolia*), sedge (*Carex* spp.), and reed or cane (*Phragmites communis*). Riparian corridors and lowlands included black and white cottonwood (*Populus* spp.), willow (*Salix* spp.), stinging nettle (*Urtica dioica)*, and dogbane (*Apocynum* spp.). Hard-stem bulrush is commonly used in anthropological literature (Fowler 1992) to refer to tule (*Schoenoplectus acutus*, formerly *Scirpus acutus*)—a large sedge with rounded, hard stems.

Sagebrush and tule-twined basketry (e.g., containers, mats, bags, footwear, infant carriers) characterize much of NGB textiles (Figure 2), a region that is well-known for the Fort Rock–style sagebrush sandals (rarely tule) dating to approximately 9400 cal BP (based on an average of 58 dates). The introduction of Multiple Warp and Spiral Weft tule sandals around 9400 cal BP, continuing to the Late Holocene, were accompanied by the regionally diagnostic Catlow Twined tule basketry (Connolly et al. 2016), described as plain twined basketry with Z-twist tule wefts and Z-twist, s-spun tule cordage warps (Figures 2 and 3).

Klamath and Modoc tule caps, bowls, and trays were often made with nettle or dogbane cordage starts; decorative elements include peeled and split reed or cane, white bear grass, feather quill, porcupine quill dyed yellow with wolf lichen, and mud-dyed tule stem or root (Margaret Mathewson, personal communication 2018). Tule mats were also made with nettle or flax cordage warps (Spier 1930). In early summer, sedge was peeled and split for making mats (Coville 1897). Round Juncus rush (common name) stem is stiffer but is also used in mats.

Whereas twined tule basketry is associated with Klamath and Modoc peoples, coiled willow basketry is associated with Northern Paiute and Shoshone. Late Holocene Lovelock Cave wickerware in western Nevada is also peeled willow rod and peeled and split willow (Tuohy and Hattori 1996). Willow sticks were also used in open twined seed beaters, burden baskets, and fish traps, and in making snowshoe frames (Barrett 1910; Coville 1897).

Coarse cordage (twine and rope) was often made from shredded sagebrush bark, juniper, antelope bitterbrush, or cliffrose, as well as willow, juncus rush, cottonwood, sumac, and grasses (Poaceae). Like bitterbrush and juniper, sagebrush bark was peeled and shredded before being twisted into cord. The Nez Perce in the Columbia Basin and Northern Paiute and Klamath peoples used bitterbush and cliffrose in cordage and basketry. Woody stems were split and could be used as warp or weft elements in basketry (Chamberlain 1911; Cummings 2004; Kelly 1932; Rhode 2002).

Figure 2. A representative sample of Paisley Caves textiles. (Color online)

Strong and pliable fine cordage made from the inner fibers of herbaceous dicots was needed for sewing thread, nets, fishing line, snares, hairnets, bowstrings, and warp elements in twined basketry and matting, and it was needed in lashing and tying (Barrett 1910; Coville 1897; Downs 1966; Fowler 1992; Fowler and Dawson 1986; Rhode 2002; Spier 1930; Stewart 1939; Wheat 1967). Historically, Klamath, Modoc, and Northern Paiute peoples used long, linear nets to catch rabbits, fish, and waterfowl (Coville 1897; Oetting 1994; Spier 1930). In the NGB, the most common bast fibers used historically were dogbane and stinging nettle, although blue flax and milkweed were also used (Barrett 1910; Coville 1897; Downs 1966; Fowler and Fowler 1970; Rhode 2002; Spier 1930; Stewart 1939; Wheat 1967).

The Paisley Caves

The Paisley Caves are located within the ancestral homelands of the Klamath, Modoc, and Northern Paiute peoples, and they geologically consist of eight wave-cut rockshelters that were at one time located along the shoreline of pluvial Chewaucan Lake in eastern Oregon, now overlooking the mostly dry Summer Lake. Fieldwork by the University of Oregon (UO) Field School between 2002 and 2011 provides evidence of pre-Clovis human occupations, based on DNA and biomarkers from a coprolite around an ash feature in Cave 5 dating to 14,200 cal BP and a tule basketry weft element (Gilbert et al. 2008; Jenkins et al. 2012, 2013, 2016; Shillito et al. 2020). Early occupation periods of the caves are interpreted as brief, temporary visits during fall and spring for upland seed collecting (Kennedy 2018). Caves 2 and 5 were the most prolific for the Paisley period occupation (15,700–12,800 years ago), including cordage, bone tools, botanical remains, obsidian and chert flakes, Pleistocene animal bone, and stemmed points (Beck and Jones 2010; Jenkins et al. 2012; Wriston and Smith 2017). The Paisley period is therefore defined as 15,700 to 12,800 years ago, the Connley period as 12,800–11,500 years ago, and the Fort Rock period as 11,500–9000 years ago, based on dates acquired from Paisley, Connley, and Fort Rock sites (Aikens et al. 2011; Jenkins et al. 2004).

A Younger Dryas botanical lens rich in organic material in Cave 2 offers a unique glimpse into the lives of early occupants. The lens is a matrix of sagebrush matting with hairs, coprolites, and rat and bat feces located between two mud lenses with dates of 11,960 and 12,930 cal BP (Hockett et al 2017; Jenkins et al. 2016). The lens also contains butchered pronghorn and cut hair, jackrabbit cut bone, fish bone, insects, obsidian flakes, and two unlined hearth features (Hockett et al. 2017). Evidence of fiber industries includes sagebrush braided rope and strips of sagebrush bark—likely material for textiles or fuel. A bone needle or awl may relate to the production of sagebrush artifacts such as sandals, clothing, and matting, or sewing activities with sinew or bast fiber (Gahr 2006; Puseman and Cummings 2003).

Artifact assemblages spanning the Fort Rock period (11,500–9000 years ago) and Lunette Lake period (9,000–6,000 years ago) include an abundance of fine cordage for netting and sewing, coarser rope, and tule basketry. However, brief occupations characterize the Lunette Lake period, evident by hearths with limited faunal bone and lithic scatters. Textiles become more diverse and prolific during the later Bergen period (6,000–3,000 years ago) and Boulder Village period (3,000 years ago to the postcontact era).

Paisley Caves Textile Assemblage

The fiber artifact assemblage generated from the 2002–2011 UO field school excavations total 453 specimens (Table 2). The Museum of Natural and Cultural History's (MNCH) legacy collections and private donations (an additional 125 fiber artifacts) are excluded from the current study. Most twined structures were recovered during the 1930s and 1940s by MNCH curator Luther Cressman and other amateur collectors, possibly due to the higher number of Late Holocene basketry in higher strata or to periodic looting of the caves. This includes all of the sandals, which are Multiple Warp style dating to the Late Holocene. The field school collections include just 13 additional Catlow twined basketry fragments, one decorated with overlay and feather quill false embroidery (7560–7420 cal BP; Connolly et al. 1998) and three fragments of Z-twist open-twined matting.

Fine cordage makes up 33% of the collection, although this number may be inflated due to fragmented segments from the same structure (Figures 2, 5, and 6). Fine cordage (string-like) is defined as 8–14 twists per cm, ranging in diameter from 0.6 to 3.3 mm; is most often z-spun, S-twist, with some exceptions; and is almost exclusively made from bast plant fiber (Connolly et al. 2016; Emery 1966). Of the 135 fine cord fragments, 49 have at least one weaver's knot; only 12 have two or more knots (interpreted as a net fragment) in which a mesh gauge measurement was recorded. One possible looped cordage may be from a knotless net or other structure (Figure 6a).

Coarse cordage and braids include both the wider rope-like cords (greater than 7 mm in diameter) primarily made from sagebrush bark and the medium-sized cords (mean diameter of 2.6 mm) that are often made from tule or other monocots. Medium-sized cordage fragments made from monocot stems are likely basketry warp trimmings (Connolly et al. 2016; Figures 2 and 7). Three-strand braids from Paisley Caves are all temporally unique to the Late Pleistocene / Early Holocene (EH) and are also contemporaneously present at Cougar Mountain Cave (Rosencrance et al. 2019). The average date of braids from both sites ($n = 23$) is 11,985 cal BP, though braids from other sites, such as Roaring Springs Cave, also date much younger.

Other modified fibers ($n = 92$) include twisted and bent fiber, coils, and overhand knots. Most notable are two coils, a fiber-wrapped quill, four bent elements that are likely basketry elements, a hide strip wrapped with fiber at one end (Figures 2 and 8), and five fragments of plaited cotton fabric (Figure 9), two of which were radiocarbon dated to the Late Holocene (Jenkins et al. 2013; Table 1).

Materials and Methods

Fiber artifacts were divided into (1) phloem fibers from herbaceous dicot plant stems (used in making nearly all fine cordage); (2) bark and leaves used in making coarse rope, braids, and some knotted fibers; and (3) monocots used in making most basketry and coarse cordage. Reference collections were established based on herbarium samples and loose fibers collected from nineteenth-century basketry housed at MNCH. Specimens were first examined under low magnification to select those requiring further analysis. Approximately 328 were sampled for examination with a Leica DM polarizing light microscope; 125 were not sampled (mostly tule basketry, cordage, and sagebrush coarse rope and knots).

Bast Fiber Identification

Bast fiber identification was conducted by the author at MNCH and the Center for Advanced Materials Characterization in Oregon (CAMCOR) following previously established methods

(Bergfjord and Holst 2010; Florian et al. 1990; Haugan and Holst 2013; Jakes and Mitchell 1996; Jakes et al. 1994; and Suomela et al. 2018). Control samples for dogbane, nettle, flax, milkweed, and fireweed from herbaria were first examined using polarized light microscopy (PLM) and scanning electron microscopy (SEM) with consecutive energy dispersive X-ray spectroscopy (EDS) to establish fiber characteristics. Results from the control samples, together with previously reported characteristics, were then compared to fibers from artifacts (Kallenbach 2023). Fibers too difficult to identify using only PLM were also examined under SEM with EDS. Elemental composition provided an additional tool to aid in distinguishing between nettle, milkweed, and flax in some cases. Assistance in flax and milkweed characterization was also provided by Sandra Koch (McCrone Research Institute). All samples obtained from artifacts for plasma ashing and for SEM with EDS were less than 5 mg.

Bark Identification

Bark identification was conducted in consultation with wood scientist Suzana Radivojevic (UO, Historic Preservation Program), in which salient microscopic characteristics were established for three taxa of bark: sagebrush, bitterbrush, and juniper based on herbarium reference samples, literature, and wood anatomy databases. Longitudinal views of both unprepped bark and macerated bark fiber were examined. It was not feasible to examine bark cross sections due to the small fiber samples and because of the risk of unnecessary alteration of the artifacts. Subsets of samples were also analyzed by archaeobotanists Kathryn Puseman (Paleoscape Archaeobotanical Services Team) and Linda Scott Cummings (PaleoResearch Institute) as independent verifications of the author's identifications.

Monocot Identification

Microscopic identifying criteria were established for three monocots: tule stem, cattail leaf, and juncus, based on herbarium reference samples, literature, and online sources. Additionally, a subset of samples was analyzed by archaeobotanists Kathryn Puseman (Paleoscape Archaeobotanical Services Team) and Linda Scott Cummings (PaleoResearch Institute).

Results: Fiber Identification

The textile assemblage includes 453 artifacts. Sagebrush, tule, dogbane, and stinging nettle account for 74% of all taxa; the remainder includes milkweed, flax, cattail, grass, bitterbrush, sumac, juniper, cottonwood or willow, cotton (commercial/modern and ancient), commercial jute, animal hair, and unidentified fibers (Table 2). Unidentified taxa (about 13%) were documented as monocot, bark, bast fiber, or unidentified plant fiber. Modern jute ($n = 1$) and cotton cord ($n = 25$) were identified; these are not included in the analysis.

Woven Structures

Woven structures include twined matting and basketry constructed of tule stem (13%), sagebrush bark (2%), cattail leaf (1%), and cotton plaiting (4%; Figures 3 and 4). Some twisted and bent fibers grouped under "Other" may be basketry weft or warp elements. Catlow twined basketry is constructed of tule stem; two matting fragments are made from cattail leaf and sagebrush bark.

Fine Cordage and Netting

Fine cord and netting ($n = 182$) are constructed almost exclusively from bast fibers (Figures 5 and 6)—primarily dogbane (47%) and stinging nettle (28%), followed by flax (2.6%) and milkweed (2%). Other fibers include unidentified bast fibers (7.8%), cotton (2.6%; Figure 9), unidentified plant fiber (2.6%), tule stem (1.6%), and unidentified bark (1%). All 49 cords with at least one weaver's knot are constructed of dogbane or nettle, or a mix of these two plants. Fifteen cords include blended dogbane and nettle fibers (Table 2); based on the current study, it is unclear if mixing of these two taxa was intentional.

Very few fine cords are made from nonbast fibers but still fall within the metrics defined for fine cordage—more than eight twists per cm and less than 3.3 mm in diameter. These include tule stem ($n = 3$), unidentified bark ($n = 1$), unidentified plant fiber ($n = 4$), and cotton ($n = 5$). Of the 18 cotton cords identified, 15 are considered modern intrusions based on evenness of ply, coloration,

Figure 3. Woven structures: (a) tule matting; (b) whole tule matting selvage; (c) sagebrush weft element; (d) tule Catlow twined basketry; (e) tule weft element; (f) tule Catlow twined basketry; (g) unidentified fiber, weft element. (Color online)

Figure 4. Cattail matting, possible edge, open twined, 6660–6485 cal BP. (Color online)

and disturbed contexts, and they are likely remnants from articles of clothing or string left behind by the numerous visitors to the caves since the early twentieth century. Five cotton cords were included in the analysis based on precontact radiocarbon dates (Table 1).

Coarse Cordage and Braids

Coarse cordage and braids ($n = 128$) are constructed almost exclusively from tule stem (39.8%) and sagebrush bark (30.4%), followed by sumac stem (2.3%), bitterbrush bark (1.5%), juniper bark

Figure 5. Fine cordage: (a) polarized light microscopy; (b) dogbane cordage, 11,105–10,700 cal BP; (c) dogbane cordage, 7785–7615 cal BP; (d) stinging nettle cordage; (e) stinging nettle cordage, 11,070–10,715 cal BP; (f) stinging nettle cordage, 670–560 cal BP; (g) stinging nettle cordage, 670–560 cal BP; (h–k) milkweed cordage, 2670–2350 cal BP; (l) dogbane; (m) flax, 1825–1630 cal BP; (n) flax, 685–570 cal BP; (o) flax, 560 ± 20 BP; (p) dogbane, 3230–3070 cal BP; (q) dogbane, 8520–8360 cal BP; (r) dogbane, 11,270–11,205 cal BP; (s) quill-wrapped with dogbane cordage; (t) flax, 6295–6115 cal BP. (Color online)

(1.5%), cattail leaf (1.5%), grass (0.7%), unidentified monocot (7%), unidentified bark (3.1%), and unidentified fiber (11.7%; Figure 7). Rope-like and coarser cord is most often constructed from bark, whereas medium-sized coarse cordage is constructed from tule stem, and in some cases, these cords could be basketry elements. Sumac cord (Figure 7i, j) is constructed from whole stems. All braids are constructed from sagebrush bark.

Other

Other fiber artifacts include twisted, crimped, and bent fiber, coils, wraps, and knots, and they represent a more diverse group of fiber material. This is perhaps because of the diversity in structure types, which likely represents a wide range of artifact functions, although these are unknown (Figure 8). Sagebrush (28%) includes primarily overhand knots, a half hitch knot, folded bark, twisted fibers, and one coil. Tule (34%) includes twisted, crimped, and bent fibers (likely weft or warp elements); and one knot and coil. Bitterbrush (2.2%) includes two knots; goosefoot (2.2%) includes twisted fibers likely from a structure; cattail (1.1%) and unidentified grass (1.1%) include twisted fiber; cottonwood or willow (2.2%) includes two coils; unidentified monocots (10.1%) and unidentified plant fiber (5.6%) include bent and crimped fibers, and wrapped sticks and stems. Five fiber twists or wads were identified as animal hair; only two of these five (5.6%) are interpreted as intentionally twisted.

Figure 6. Netting and knotted cordage: (a) dogbane cordage with loops, suggesting unknotted net/bag, 10,279–10,212 cal BP; (b) dogbane, 10,250–10,205 cal BP; (c) dogbane net fragment in knotted bundle; (d) stinging nettle; (e–h) dogbane; (i) dogbane, 2345–2180 cal BP; (j) dogbane net with three knots; (k) dogbane net with multiple knots; (l–p) dogbane; and (q) dogbane, 625–515 cal BP. (Color online)

Radiocarbon Dates and Temporal Distributions of Plant Taxa

Table 1 lists 54 radiocarbon dates from fiber artifacts from field school assemblages, both previously reported dates and 34 new dates. The 28 dates obtained for this study were sampled in consultation with Richard Rosencrance (University of Nevada, Reno), who oversaw sample pretreatment and combustion to CO_2 at the University of Nevada, Reno, Human Paleoecology and Archaeometry Lab (HPAL), following standard protocol (McDonough et al. 2022). The HPAL then sent the CO_2 to the Penn State Radiocarbon Laboratory for graphitization and measurement. All results listed in Table 1 are rounded following the conventions of Stuiver and Polach (1977) and calibrated with OxCal v4.4 (Bronk Ramsey 2009) using the IntCal20 curve.

Previously reported early dates from the Paisley Caves include a basketry weft fragment, likely tule, dating to 14,660–14,080 cal BP (Shillito et al. 2020); unidentified Szz cordage (12,584–12,231 cal BP); twisted grass (12,390–12,655 cal BP); three-strand sagebrush braids (12,398–12,016 cal BP and 12,100–11,988 cal BP); and Middle and Late Holocene tule basketry and cotton plaiting (Jenkins et al. 2013). Dates obtained for the current study provide new evidence for the use of dogbane, stinging nettle, juniper, and sumac cordage by 11,000 years ago; and milkweed, flax, and cotton cordage by the Late Holocene.

Table 1. Paisley Caves Radiocarbon Dates.

Lab No.	Cat. No.	Description	Plant Material	Conv. ^{14}C	Calibrated Age BP (1σ error)	Publication
Beta-221344[a]	1374-PC5-2B-28-1	Cordage, modern?	*Gossypium*	FM = 139.1		
PSUAMS-11478[a]	1704-PC2-5D-13-1	Cordage, modern?	*Gossypium*	80 ± 15	255–30	
UCIAMS-79679	1374-PC5-5D-30-1b	Plaited fabric	*Gossypium*	275 ± 25	305 (362)–418	Jenkins et al. 2013
PSUAMS-10714[a]	1294-PC1-5A-4-1	Cordage	*Gossypium*	330 ± 15	460–310	
PSUAMS-10720[a]	1704-PC5/12A-6-3	Net fragments, Szz	*Apocynum*	535 ± 20	625–515	
PSUAMS-13787[a]	1896-PC1/7C-WF-1	Szz fine cordage	*Linum lewisii*	560 ± 20		
PSUAMS-11477[a]	1294-PC5-7C-D-1B	Cordage	*Gossypium*	585 ± 20	645–540	
PSUAMS-12950[a]	1294-PC2-3C-25-4	Net fragment, Szz fine cordage	*Urtica dioica*	670 ± 20	670–560	
PSUAMS-13784[a]	1294-PC2/3C-22-1	Szz fine cordage	*Urtica dioica*	665 ± 20	670–560	
PSUAMS-13783[a]	1294-PC2/3C-16-1	Szz fine cordage	cf. *Linum lewisii*	715 ± 20	685–570	
PSUAMS-11476[a]	1374-PC5-5C-3-1B	Cordage	*Gossypium*	815 ± 20	740–675	
PSUAMS-13791[a]	1704-PC-2/4D-8-1	Szz fine cordage	*Linum lewisii*	1015 ± 20	960–835	
Beta-195907	1294-PC1-4C-19-1	Plaited fabric	*Gossypium*	1060 ± 40	980–940	Jenkins et al. 2013
PSUAMS-13788[a]	1704-PC1/8C-7-1	Zss coarse cordage	*Rhus*	1195 ± 20	1180–1060	
PSUAMS-13781[a]	1704-PC5/11B-11-9	Szz fine cordage	*Asclepias*	1510 ± 20	1410–1345	
PSUAMS-13786[a]	1961-PC5/17B-CU-8	Szz fine cordage	*Linum lewisii*	1825 ± 25	1825–1630	
D-AMS1217-407 and AA-96489	1961-PC2-7A-31-6	Weft element, S-twist	*Schoenoplectus acutus*	2107 ± 26 and 2285 ± 37	2041–2121 and 2341–2206	Jenkins et al. 2013
D-AMS-035354	1896-PC2-60-58-9	Twined mat fragments	*Schoenoplectus acutus*	2170 ± 25	2290–2145	Connolly et al. 2016
PSUAMS-10715[a]	1704-PC2-4a-WF-1	Net fragment, Szz fine cordage	*Apocynum*	2270 ± 15	2345–2180	
PSUAMS-13789[a]	1830-PC2/6B-24-1	Szz robust cord with overhand knot	*Asclepias* with bark	2410 ± 20	2670–2350	
PSUAMS-10719[a]	1830-PC2-6A-22-1	Zss coarse cordage	*Artemisia*	2430 ± 20	2690–2355	

(*Continued*)

Table 1. Paisley Caves Radiocarbon Dates. (*Continued.*)

Lab No.	Cat. No.	Description	Plant Material	Conv. ^{14}C	Calibrated Age BP (1σ error)	Publication
PSUAMS-12614[a]	1961-PC2-7C-17-60a	Szz fine cordage	*Apocynum*	2985 ± 20	3230–3070	
PSUAMS-13782[a]	1829-PC2/6C-29-2	Szz fine cordage	*Linum lewisii*	5410 ± 30	6295–6115	
PSUAMS-13790[a]	1829-PC2/6C-29-1	Twined mat, possible edge, Zss twisted weft	*Typha*	5765 ± 30	6660–6485	
PSUAMS-13593[a]	1961-PC5-17a-cu-7	Zss fine cordage	*Apocynum*	6870 ± 30	7785–7615	
PSUAMS-13779[a]	1829-PC2/4A-38-1	z-spun fine cordage element	*Apocynum*	7620+35	8520–8360	
Beta-240513	1294-PC2-3A-31-1	Possible weft elements from basketry structure	*Apocynum*	7680 ± 50	8430–8530	Jenkins et al. 2013
PSUAMS-12953[a]	1896-PC2-6D-48-1a	Zss fine cordage with knot node, possible net fragment	*Apocynum*	9075 ± 40	10,250–10,205	
AA-96487	1961-PC2-7A-18-36	Zss fine cordage with loops, suggesting unknotted net/bag	*Apocynum*	9080 ± 50	10,279–10,212	Jenkins et al. 2013
PSUAMS-13780[a]	1896-PC2/4A-44-4	Zss cordage, thicker	*Urtica dioica* or *Apocynum*	9190 ± 40	10,495–10,240	
PSUAMS-12952[a]	1961-PC2-7A-17-11	Zss fine cordage	*Urtica dioica*	9535 ± 45	11,070–10,715	
PSUAMS-13594[a]	1961-PC5-17b-cu-e-1e	Zss fine cordage	*Apocynum*	9555 ± 45	11,105–10,700	
PSUAMS-11475[a]	1895-PC5-16A-22-8b	Zss fine cordage	*Apocynum*	9555 ± 30	11,080–10,715	
UCIAMS-75104	1829-PC5-11A-37-2	Cordage?	Unidentified plant	9625 ± 20	11,120–11,170	Jenkins et al. 2013
PSUAMS-12954[a]	1896-PC2-6A-52-2	Szz fine cordage	*Apocynum*	9840 ± 45	11,270–11,205	
PSUAMS-13778[a]	1896-PC2/4A-45-2	Szz fine cordage	*Apocynum*	9970 ± 40	11,690–11,255	
UCIAMS-79678	1294-PC5-6A-44-1	S-spun fiber with tight loop	Unidentified plant	10,030 ± 90	11,375–11,790	Jenkins et al. 2013
UCIAMS-87421, UCIAMS 85337, and D-AMS1217-410	1896-PC2/6B-59-13	Szz coarse cord, w/ 2nd Szz cord tied with overhand knot	*Artemisia*	10,070 ± 30, 9995 ± 25, and 9770 ± 50	11,455–11,770, 11,370–11,575, and 11,186–11,232	Jenkins et al. 2013
PSUAMS-11479[a]	1374-PC5-5B-26-1a	Szz fine cordage	*Urtica dioica*	10,130 ± 30	11,930–11,410	

(*Continued*)

Table 1. Paisley Caves Radiocarbon Dates. (*Continued.*)

Lab No.	Cat. No.	Description	Plant Material	Conv. ^{14}C	Calibrated Age BP (1σ error)	Publication
D-AMS-035353	1830-PC5-11A-32-5	Knotted cordage (sample used up)	*Purshia*	10,155 ± 50	11,965–11,640	Connolly et al. 2016
UCIAMS-87420 and 85336	1896-PC5-16-25-5a	Szz coarse cordage, Szz, two fragments dated	unidentified bark	10,290 ± 35 and 10,250 ± 25	11,970–12,310 and 11,860–12,110	Jenkins et al. 2013
Beta-195908	1294-PC2-3C-31	Three-strand braid	*Artemisia*	10,290 ± 40	12,100–11,988	Jenkins et al. 2013
UCIAMS-79680 and D-AMS1217-411	1829-PC2-4D-48-1	Knot	*Artemisia*	10,365 ± 30 and 10,365 ± 40	12,120–12,470 and 12,101–12,466	Jenkins et al. 2013
Beta-171938	1374-PC5-5A-30 1 & 2	Five twisted fibers	Unidentified, possible grass	10,550 ± 40	12,390–12,655	Jenkins et al. 2013
AA-96490	1961-PC2-7D-18-28	Three-strand braid	*Artemisia*	10,300 ± 60	12,398–12,016	Jenkins et al. 2013
PSUAMS-12611	1961-PC2-7C-18-49	Three-strand braid, unmodified bark fiber in overhand knot at one end	*Artemisia*	10,255 ± 35	12,430–11,815	
PSUAMS-12613 and PSUAMS-12951[a]	1830-PC5-12C-22-4	Szz coarse cordage	*Juniperus*	10,265 ± 40 and 10,230 ± 50	12,440–11,815 and 11,995–11,820	
PSUAMS-11473[a]	1961-PC2-7C-16-126	Three-strand braid	*Artemisia*	10,335 ± 30	12,460–11,945	
AA-96488	1961-PC2-9B-49-12	Szz cordage	Unidentified fiber root?	10,480 ± 60	12,584–12,231	Jenkins et al. 2013
PSUAMS 12612[a]	1294-PC2-3C-29-1	Three-strand braid	*Artemisia*	10,400 ± 40	12,585–12,045	
D-AMS 035352	1294-PC5-7C-25-1	Basket element, S-twist	*Schoenoplectus acutus*	12,270 ± 60	14,660–14,080	Shillito et al. 2020

[a] Previously unpublished.

Figure 7. Coarse cordage and braids: (a) tule; (b) bitterbrush knot; (c) sagebrush three-strand braid, 12,585–12,045 cal BP; (d) sagebrush three-strand braid, 12,100–11,988 cal BP; (e) sagebrush; (f) juniper, 12,440–11,815 and 11,995–11,820 cal BP; (g) unidentified bark, 11,970–12,310 and 11,860–12,110 cal BP; (h) juniper bark; (i) sumac stem; (j) sumac stem, 1180–1060 cal BP; (k) tule possible weft with warp element. (Color online)

The oldest bast fibers include two stinging nettle cords (11,930–11,410 cal BP and 11,070–10,715 cal BP) and four dogbane cords (11,690–11,255 cal BP, 11,270–11,205 cal BP, 11,080–10,715 cal BP, and 11,105–10,700 cal BP). The combined 11 total dates for dogbane cordage and netting confirm its consistent use throughout the Holocene, with the youngest dogbane net dating to 625–515 cal BP. Similarly, the five dates for stinging nettle cordage confirm its use in the Early and Late Holocene, with the youngest stinging nettle net dating to 670–560 cal BP. All five flax fine cords were dated, and they include Late Holocene dates of 1825–1630 cal BP, 960–835 cal BP, 685–570 cal BP, and 560 ± 20 BP, and one Middle Holocene date of 6295–6115 cal BP. Two of the four milkweed cords were dated, with Late Holocene dates of 2670–2350 cal BP and 1410–1345 cal BP.

Late Pleistocene fiber other than sagebrush includes juniper bark (12,440–11,815 and 11,995–11,820 cal BP) and sumac-stem coarse cordage (11,970–12,310 and 11,860–12,110 cal BP) and one late-period sumac cord (1180–1060 cal BP). The only identified cattail fiber includes a new date for twined matting dating to 6660–6485 cal BP. Of the seven dated cotton textiles, two returned recent dates and are considered modern intrusions. Three cotton cords returned dates of 645–540 cal BP, 460–310 cal BP, and 255–30 cal BP—the latter likely historic. Two of the plaited fabrics returned dates of 305–418 cal BP and 980–940 cal BP. This is the first identification of precontact-era cotton from the Paisley Caves and the NGB.

Temporal Distributions of Plant Taxa

Textiles were grouped by artifact type, taxa, and temporal component to examine plant selection over time (Table 2). Age ranges of fibers are based on direct radiocarbon dates or associated temporal component largely based on obsidian hydration and stratigraphy (Jenkins et al. 2013). Nearly 40% of textiles are from disturbed components, which refer to krotovina disturbance and pits made by looters

Figure 8. Other fiber artifacts: (a) twisted animal hair; (b) twisted or bent animal hair; (c) multiple s-spun tule roots in loose knot; (d) sagebrush Zss cord with loop start of Zssss 4 ply; (e) s-spun split tule strand in loose knot; (f) tule wrapped stem or coil; (g.) monocot wrapped stick or coil; (h) two willow coils. (Color online)

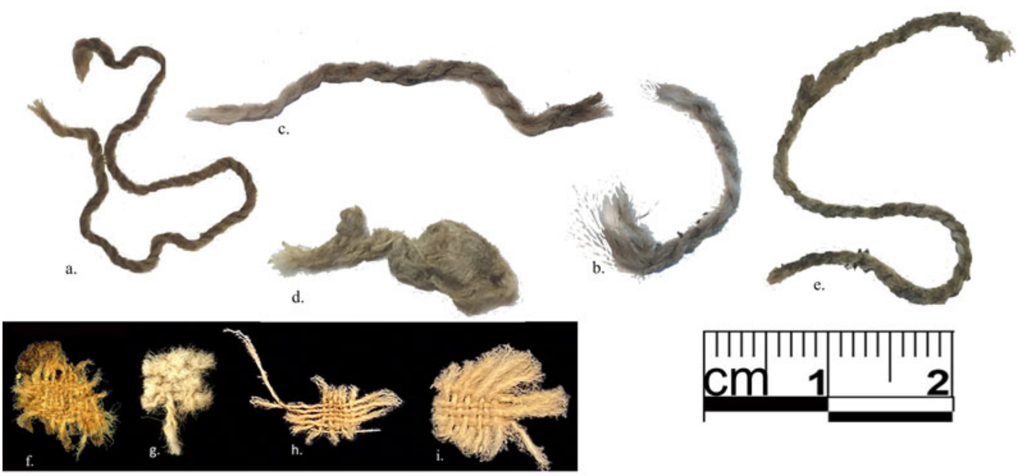

Figure 9. Cotton cordage: (a) 460–310 cal BP; (b) 645–540 cal BP; (c) 740–675 cal BP; Cotton plaiting: (f) 305–418 cal BP; (g) 980–940 cal BP; (d–e and h–i) were not dated due to size limitations. (Color online)

during the early 1900s. Overall, there is consistent use of a limited number of taxa since the Late Pleistocene. Fine cord and netting are represented by dogbane and nettle during the Late Pleistocene and throughout the Holocene, with milkweed and flax occurring much later during the Late Holocene. Coarse cordage and braids made from bark and monocot stem indicate consistent

Table 2. Artifact Type by Temporal Component and Taxa.

Family	Genus, Species	Common Name	Paisley 15,700–12,800	Connley 12,800–11,500	Fort Rock 11,500–9000	Lunette Lake 9000–6000	Bergen 6000–3000	Boulder Vill. 3000–contact	Disturbed Comp.	Total
Fine Cordage (includes netting and cord elements)										
Apocynaceae	*Apocynum* spp.	Dogbane			8	14	13	17	31	83
Apocynaceae	*Asclepias* spp.	Milkweed						2	2	4
Urticaceae	*Urtica dioica*	Stinging Nettle		3	1	6	2	10	25	47
Linaceae	*Linum lewisii*	Blue Flax				1		4		5
Apocynaceae and Urticaceae	*Apocynum* spp. and *Urtica dioica*	Dogbane and Stinging Nettle			2	2	2	5	4	15
		Unidentified Bast Fiber (likely Nettle, Flax, or Milkweed)		1		1	1	5	5	13
		Unidentified Bast Fiber							2	2
Malvaceae	*Gossypium* spp.	Cotton					1	4		5
		Unidentified Plant Fiber		2			2			4
Cyperaceae	*Schoenoplectus acutus*	Tule (Bulrush)				2			1	3
		Unidentified Bark			1					1
		Total	0	6	12	26	21	47	70	182
Coarse Cordage, Cord Element, and Braids										
Asteraceae	*Artemisia tridentata* and other species	Sagebrush		9	4	5	9	3	9	39
Rosaceae	*Purshia* spp.	Bitterbrush		1					1	2
Cupressaceae	*Juniperus occidentalis*	Western Juniper		1		1				2

(*Continued*)

Table 2. Artifact Type by Temporal Component and Taxa. (*Continued.*)

Family	Genus, Species	Common Name	Paisley 15,700–12,800	Connley 12,800–11,500	Fort Rock 11,500–9000	Lunette Lake 9000–6000	Bergen 6000–3000	Boulder Vill. 3000–contact	Disturbed Comp.	Total
Anacardiaceae	*Rhus* spp.	Sumac, Skunkbrush			1			1	1	3
Cyperaceae	*Schoenoplectus acutus*	Tule (Bulrush)			4	9	7	5	26	51
Typhaceae	*Typha* spp.	Cattail Leaf					1		1	2
		Unidentified Monocot				2	1		6	9
		Unidentified Bark			1		1		2	4
		Unidentified Plant Fiber		1		1	4	2	7	15
Poaceae	Unknown, many types	Grass							1	1
		Total	0	12	10	18	23	11	54	128
Woven Structures (basketry, matting, plaiting)										
Asteraceae	*Artemisia tridentata* and other species	Sagebrush			1				1	2
Cyperaceae	*Schoenoplectus acutus*	Tule (Bulrush)	1		1	1	1	4	6	14
Typhaceae	*Typha* spp.	Cattail Leaf				1				1
		Cotton (plaiting)						2	2	4
		Total	1	0	2	2	1	6	9	21
Other (twisted fiber, bent fiber [possible weft or warp elements], knots, coils)										
Asteraceae	*Artemisia tridentata* and other species	Sagebrush		13		4	3		8	28
Rosaceae	*Purshia* spp.	Bitterbrush		1					1	2

(*Continued*)

Table 2. Artifact Type by Temporal Component and Taxa. (*Continued.*)

Family	Genus, Species	Common Name	Paisley 15,700–12,800	Connley 12,800–11,500	Fort Rock 11,500–9000	Lunette Lake 9000–6000	Bergen 6000–3000	Boulder Vill. 3000–contact	Disturbed Comp.	Total
Cyperaceae	*Schoenoplectus acutus*	Tule (Bulrush)		5	5	9	1	1	12	33
Typhaceae	*Typha* spp.	Cattail				1				1
Poaceae	Unknown, many types	Grass		1						1
		Unidentified Monocot		1	2	2			4	9
Salicaceae	*Populus* spp. or *Salix* spp.	Cottonwood or Willow							2	2
Chenopodioideae	unknown	Goosefoot							2	2
		Unidentified Plant Fiber			1		1	1	2	5
		Animal Hair			1	3			1	5
		Total	0	21	9	19	5	2	32	88

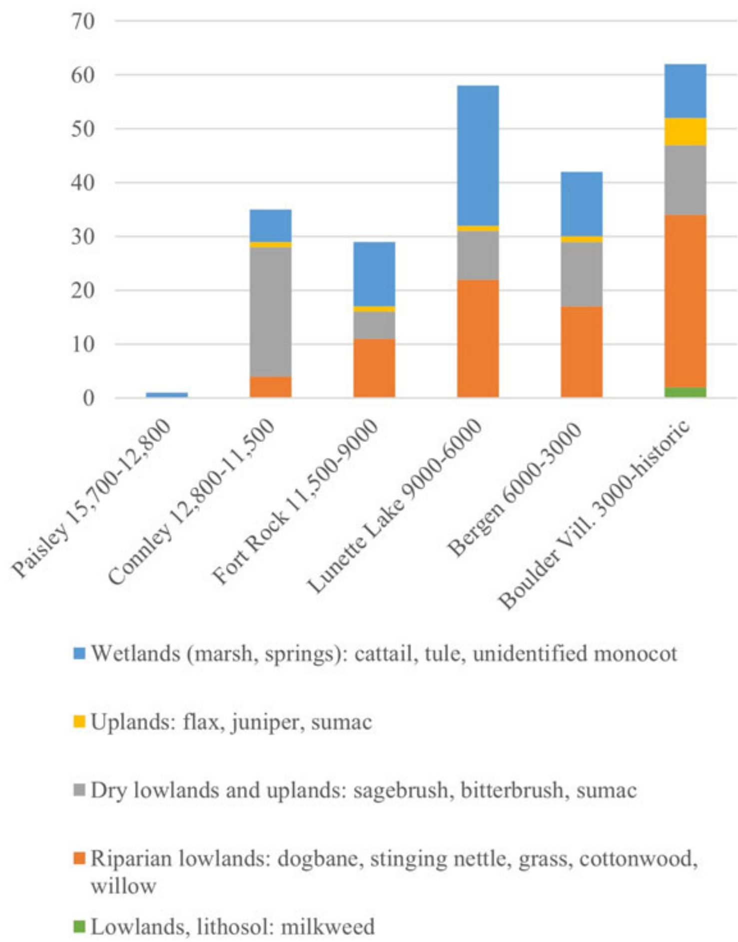

Figure 10. Taxa distribution by ecology and chronology. (Color online)

use of sagebrush since the Late Pleistocene, and although juniper, sumac, and bitterbrush represent less than 2%, they also occur during the Early Holocene. Other textiles (coils, knots, bent and twisted fiber) are dominated by sagebrush knots and tule twisted and bent fiber, which are present continuously since the Late Pleistocene; bitterbrush and grass are also present during the Late Pleistocene. Although beyond the scope of this article, it should be noted that bast cordage technology remains constant since the Early Holocene; twist direction is consistently Szz, and fine cord metrics (cord diameter and number of twists per cm) for knotted and unknotted cordage does not vary based on dogbane and nettle selection.

Plant taxa were also grouped by ecology and temporal component, excluding artifacts from disturbed components. Data are presented by number of artifacts (Figure 10); these broad ecological groupings indicate continuity overall, but with a clear pattern of increased wetland plants after 12,000 years ago. The Lunette Lake period (9,000–6,000 years ago) has the highest frequency of wetland plants, decreasing significantly during the Bergen and Boulder Village periods (after 6,000 years ago; see Discussion).

Discussion

Late Pleistocene–Early Holocene Transition

Late Pleistocene and Early Holocene fiber artifacts at Paisley Caves are limited in number but already suggest knowledge of a variety of textile fiber resources represented by sagebrush rope and three-stand braids, tule basketry weft elements, bitterbrush knotted bark, and twisted grass threads. Dogbane and stinging nettle fine cordage, along with sumac stem and juniper bark coarse cordage, are present between 12,000 and 10,000 cal BP. All three-strand braids are made from sagebrush bark (Figures 4, 5, 6). These plants continue to dominate the NGB textile record throughout the Holocene and into the nineteenth century.

During the Bolling/Allerod (>14.7–12.9 ka), deep-bodied lakes filled lowland basins, and Lake Chewaucan was at its highest levels as the Earth warmed at the end of Last Glacial Maximum. Lake-level high stands during the Paisley period were followed by lake contraction during the Younger Dryas cold snap between approximately 12,900 and 11,600 years ago when the Earth's climate returned temporarily to a glacial state (Goebel et al. 2011; Hudson et al. 2021). During the Late Pleistocene / Early Holocene transition, expanded wetlands, spring fed lakes, and seasonal ponds overall may have improved conditions considerably for animal and plant resources (Hockett et al. 2017), including fiber plants. Riparian and wetland textile fiber well suited for basketry and cordage—such as tule, cattail, rushes, dogbane, and stinging nettle—likely thrived in these new landscapes. This dramatic period in ecological change coincides with the earliest evidence of humans populating the NGB by 14,500 years ago (Goebel et al. 2008; Hockett et al. 2017; Jenkins et al. 2012; Shillito et al. 2020) and the Columbia Plateau by approximately 16,000 cal BP (Davis et al. 2022).

Earliest dates for stinging nettle and dogbane fine cordage are 11,900–11,200 years ago, with an increase in the presence of tule and other monocot artifacts after 12,000 years ago. This coincides with expanded wetlands and lowland riparian areas—ideal habitats for these plants. The decline in Lake Chewaucan lake levels (to the immediate southeast of Paisley Caves) during the Younger Dryas likely resulted in expanded wetlands (in place of deep-water lakes) to the north and south as well as around Lake Abert, with steppe shrub habitat moving upland. Although an increase in the presence of wetland and riparian plant fiber artifacts could be due to preservation issues, it may also reflect an increase in or introduction of tule basketry and fine cordage manufacture. Whether this represents cultural innovations or changes in fiber-based technology due to environmental adaptations, or both, is unknown.

Research at Paisley Caves and Connley Caves suggests that a broad-spectrum diet was already established by the Younger Dryas (Hockett and Jenkins 2013; Kennedy 2018; McDonough et al. 2022), including bison, pronghorn, grouse, rabbit, fish, insects, and a range of plants. The botanical lens in Paisley Cave 2 includes pronghorn and jackrabbit cut bone, and possible fishbone and insects also deposited by humans (Hockett et al. 2017). At Paisley Cave 2, human coprolites with dates of 9,620 ± 30 and 10,833 ± 59 BP include edible taxa of the sunflower family (Asteraceae), the mustard family (Brassicaceae), carrot (Apiaceae), Great Basin wild rye (*Leymus cinereus*), wild buckwheat (*Eriogonum* sp.), and the evening primrose family (Onagraceae; Taylor et al. 2020). Uncharred stinging nettle seeds were present in the hearth features and Cave 5 earth oven (Kennedy 2018); this plant resource was used for nettle cordage during the Younger Dryas. This diverse diet was likely established in tandem with textile technology, including netting suited for rabbit hunting and fishing.

Younger Dryas macrofloral remains from a Paisley Cave 1 hearth suggest a diet of *Chenopodium*, bunch grass (Poaceae), needlegrass (*Achnatherum), Sesuvium,* borage (Boraginaceae), and saltbush (Kennedy 2018). These upland charred seed taxa reflect the seasonal use of the caves during early spring and fall when these plants were most abundant (Jenkins et al. 2016; Kennedy 2018). It is noteworthy that raw bast material is not present in the unmodified macrobotanical remains (sticks, bark, grass), as is seen at Bonneville Estates Rockshelter (Coe 2021), which includes unmodified milkweed, dogbane, and flax phloem fibers. The absence of raw bast fiber material at Paisley Caves may suggest a lack of cord-making activity at the site, which supports the interpretation that the caves were used during the spring and summer months for short periods, with requisite tools being brought to the site rather than being made on site.

Foothill shrub zones and upland areas also provided resources for coarse cordage technology, including sagebrush, bitterbrush, sumac, and juniper. The presence of five cords of juniper, sumac, and bitterbrush during the Younger Dryas—although few in number—illustrate that sagebrush was not the only dryland shrub or upland resource for fiber (Figure 7). Younger Dryas pollen studies of Paisley Cave 2 coprolites include juniper, the sagebrush family (Asteraceae), bitterbrush, alder

(*Alnus*), pine (*Pinus*), fir (*Abies*), poplar (*Populus*), hemlock (*Tsuga*), and willow (Beck et al. 2018; Blong et al. 2020; Taylor et al. 2020)—evidence that these taxa were available for technological use.

Early Holocene and Seasonal Fiber Collection

During the Fort Rock and early pre-Mazama period (11,000–7,600 years ago), populations increased, people were highly mobile, and they traveled long distances based on obsidian sourcing (Connolly 1999). People also accessed a diverse range of habitats, including marshlands, dryland, step shrub zones, and high-elevation forests to maintain a broad-spectrum diet. Textile fiber collection and processing was likely an important component of travel to different ecological zones for seasonal foraging and hunting activities. Winters were spent primarily at lakesides and marshes where fish and waterfowl were available year round. Tule stem, one of the most common monocot basketry and cordage fibers in the Paisley assemblage, is gathered from marshes in the fall when the stems turn brown; stands of tule in standing water could be accessed from dugout canoes. Other wetland fiber plants such as cattail, sedge, willow, and juncus would have been collected in late summer through early fall (Downs 1966; Fowler and Fowler 1970; Stewart 1939; Wheat 1967). Travel to high elevations in summers for large game hunting of ungulates (antelope, mountain sheep, deer, and bison) included foraging for seeds, roots, and berries, and this may have been an opportunity to collect juniper bark and sumac. The abundance of sagebrush and bitterbrush lowland and upland shrub zones were ideal for collecting wood fuel and bark fiber for textiles.

Dogbane and stinging nettle were well established as the primary bast fiber resources for fine cordage and netting by 11,000 years ago (Figures 5 and 6), and they continued to be used throughout the Holocene and into the contact era. Fine cordage netting was likely used in fowling and fishing year round, and possibly in fall rabbit drives as early as the Late Pleistocene. In addition to Late Pleistocene rabbit bone and carcasses in the Paisley botanical lens (Hockett et al. 2017), the Early Holocene site Buffalo Flats in the Fort Rock Basin is known for pit features with a sizeable number of jackrabbit and cottontail bone. These features are interpreted as processing areas following repeated hunts in which rabbits were driven into pits (Oetting 1994). Long linear nets made from dogbane and nettle, ethnographically known to be anywhere from 6 to 121 m (20 to 400 ft.) long, were used in communal hunts to catch rabbits as they were driven from brush (Connolly et al. 2017; Kelly 1932; Wheat 1967).

Based on the continuity and quantity of dogbane and nettle cordage and netting from Paisley Caves, summer and fall activities likely included the essential task of gathering these bast fibers as part of larger foraging activities. Both of these plants grow adjacent to wetlands and in riparian habitats; *Apocynum cannabinum*, the wetland species of dogbane (Franklin and Dyrness 1988; Gilkey and Dennis 2001; Rhode 2002), was likely targeted over *A. androsaemifolium* (spreading dogbane) and *A. pumilum* (low dogbane). The tall stems of *A. cannabinum* are ideal for extracting long strands of phloem fiber, especially if stands are cut down each fall. Dogbane cordage manufacture would have required repeated visits to wetland stands in the late fall when stems die and turn brown; they could then be cut back to the ground. Their rhizome root structure allows for seasonal return to the same patches. Historically, Northern Paiute peoples collected long, dried dogbane stalks and scraped bark away or crushed and then peeled or scraped away bark. After stalks are hammered or retted, they are split open, and the inner pith is removed (Rhode 2002; Wheat 1967). Stinging nettle can be collected throughout the summer around the periphery of wetlands, near shady spring-fed creeks in the foothills above the basin floor, and as an understory within the Fremont National Forest and Owyhee Mountains (Gilkey and Dennis 2001; OregonFlora 2021).

Middle Holocene Climatic Change

During the Lunette Lake period, vegetation records indicate drought-like conditions, with a shift toward a drier, more arid environment, with lower lake levels and increased marshlands and spring fed basins around 8,000–6,000 years ago. Mazama ash fall likely reduced plant diversity temporarily and contributed to overall population decrease. There was a transition from cave and rockshelter habitation sites to open-air locales closer to permanent lakes (such as Paulina Lake), seasonal springs, and vernal pools, perhaps in response to this mid-Holocene climatic change (Aikens et al. 2011; Jenkins et al. 2004; Ollivier et al. 2017). Groups were highly mobile, with ephemeral use of caves sites, and temporary camps around lakeshores.

The textile assemblage from Paisley Caves offers support for this model, with an increase in wetland plants during the Lunette Lake period, including a twisted cattail leaf, tule basketry fragment, and the only identified cattail woven structure dated to 6660–6485 cal BP (Figures 4 and 10). Although this may be due to inflated numbers from fragmentary monocot (primarily tule) and bast artifacts, the increase in wetland taxa is significant. There is also continued use of upland areas, represented by one (undated) juniper cord from a Lunette Lake component, and one flax cord dated to 6295–6115 cal BP. This broader range of upland, dryland, and wetland plants may represent the more transient or temporary use of Paisley Caves during this time (Jenkins et al. 2016), in which people may have brought resources from a more diverse range of habitats.

Previous research has also used textiles as a proxy for illustrating changing land-use patterns during the Middle Holocene. At Last Supper Cave in Nevada, the sequence of dates from Fort Rock, Spiral Weft, and Multiple Warp sandals represents a hiatus during the Middle Holocene, which suggests that the gap in the sequence for these sandals may represent more short-term use of caves and rock-shelters (Ollivier et al. 2017). There is also a hiatus in Catlow Twined basketry, likely due to the more ephemeral use of dry caves rather than a reduction in production of these fiber artifacts (Camp 2018).

During the Bergen period, Lake Chewaucan shorelines rose slightly, close to historical levels at 1,290 m, as did Lake Abert after 3,900 years ago (Hudson et. al. 2021). This general trend toward a wetter and cooler climate has continued to the present (Aikens et al. 2011) with oscillating dry and wet climatic periods. At Connley Caves, plant taxa present in human coprolites dating to the Bergen period indicate seasonal use of uplands and continued reliance on wetlands, including juniper and sumac upland plants, and cattail and tule seeds (McDonough 2019). Year-round village sites—such as the Bergen Site, Big M Village, and DJ Ranch—were adjacent to wetlands, ponds, springs, and lakeshores, allowing for continued access to wetland and riparian fiber and dietary resources. Catlow Cave and Roaring Springs Cave, known for their rich and diverse textile assemblage, are also situated close to lakes and springs.

There is a significant increase in fine cordage and tule cordage and basketry in the Paisley Caves assemblage during this period. However, the slight decrease in wetland fiber plants following the Lunette Lake period may indicate that fewer marsh resources were brought out of lowlands to temporary cave sites, and more upland plants may have been brought to seasonal camps such as Paisley Caves, away from lowland settlements. No upland textile fibers are represented at Paisley during the Bergen phase; however, two sumac artifacts remain undated and from disturbed components, and upland plants overall (sumac, juniper, flax) represent less than 3% of the entire assemblage.

Late Holocene Upland Resources

Unexpected results of this study include the presence of milkweed, flax, and cotton fine cordage dating to the Late Holocene. Though limited, these fibers make up 8% of all Late Holocene fine cordage (milkweed and flax just 5%). During this period, people increasingly use upland areas for root gathering due to cyclical wet and dry periods, reduction in marshlands, and increases in population (Brashear 1994; Byram 1994; Jenkins 1994; Prouty 1994) centered around Warner Valley, Chewaucan Basin, and Klamath Basin. An expanded resource area during this period may relate to increased populations and dispersal in the NGB generally. The acquisition of cotton cordage and plaited fabric radiocarbon dated within the last 1,000 years may reflect increased interactions with exterior groups. Dietary plants are also most diverse during this time; at LSP-1 Rockshelter (Kennedy and Smith 2015), people may have been motivated by nutritional benefits, not only caloric return based on the diversity of dietary plants including *Chenopodium* sp., saltbush, and mustards, as well as marsh foods such as cattail, and upland resources including chokecherry seeds.

Flax, a high-elevation plant, was likely collected during visits to upland root-gathering areas, such as Boulder Village, the largest spring root collecting site (Byram 1994). Flax prefers drought-like conditions and mid to high elevations in association with sagebrush, bitterbrush, and pinyon-juniper habitats between 1,370 and 2,290 m (4,500 and 7,500 ft.) in elevation (Rhode 2002; OregonFlora 2021; United States Department of Agriculture 2021). Juniper bark was also used for cordage during this time, and upland sites show significant use of juniper for structural material (Stenholm 1994). Milkweed at Paisley Caves only makes up a total of four identified cords, but like dogbane, milkweed is also gathered in late summer or fall from dry open meadows and rocky slopes or in areas with moist, sandy, loamy soils (Rhode 2002).

Conclusions

This research provides long-term data on culturally significant native plants, with continuity in plant selection spanning the last 14,000 years. During the Late Pleistocene / Early Holocene transition, the archaeological record suggests a cultural "explosion" with Western-stemmed lithic technology; basketry and fine cordage; bone needles; and a broad-spectrum diet including waterfowl, rabbits, fish, artiodactyls, seeds, and roots (Hockett et al. 2017; Rosencrance et al. 2019). This cultural expansion included knowledge of several key textile plants, including tule, sagebrush, juniper, bitterbrush, stinging nettle, and dogbane. Expanded marshlands during the Late Pleistocene and Early Holocene created suitable plant communities ideal for fiber technology—specifically wetland monocots (tule, sedges) and herbaceous dicots including dogbane and stinging nettle. This technology is key to subsistence activities and craft production throughout the Holocene.

By the Early Holocene, a limited group of plants ideal for strong string fiber, rope, and basketry are well established; there is continued reliance on this select group of taxa throughout the Holocene, whereas the near absence of cattail, juncus, reed, and willow for fiber at Paisley is notable. Despite climatic events during the Lunette Lake period, in which people transitioned from caves to sites centered around lakeshores and wetlands (a trend exhibited in the increased number of wetland plants in the Paisley assemblage), the suite of fiber plants and their technological application remains constant. This overall continuity parallels what we know about dietary plants; much of the taxa present in the Late Pleistocene diet from Paisley Caves is present in the Middle Holocene diet at Connley Caves. At the Paisley Caves, dogbane, nettle, and tule fiber were used for millennia and are primary fibers in nineteenth-century Klamath baskets. During the Late Holocene, bast fiber material diversified with the addition of flax and milkweed. The presence of flax in particular—a high-elevation plant—may reflect the increased use of upland root-collection areas as populations increased.

The Great Basin is a region rich in textiles made from plant material; this study reveals new and important aspects of people's lives that have largely been unexplored archaeologically. Textile plant identification allows a more nuanced understanding of how people engaged with diverse and changing landscapes, illustrates the importance of fiber collection as part of a larger system of settlement and subsistence practice, and complements ongoing research in dietary studies. In the Northern Great Basin, ecological knowledge required for fiber technology was established by 14,000 years ago and continues today, exemplified through traditional arts and technology.

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