ETHNOBIOLOGY LETTERS

Research Communications

Precontact Use of Balsam Fir (*Abies balsamea*) in Iowa, USA

William Green[1,2*] and Kathryn E. Parker[3]

[1]Logan Museum of Anthropology, Beloit College, Beloit, USA. [2]Office of the State Archaeologist, University of Iowa, Iowa City, USA. [3]Independent Archaeobotany Consultant, Indian River, USA.
[*]greenb@beloit.edu

Abstract Excavation of a cave in eastern Iowa (USA) revealed a feature containing charred wood of balsam fir (*Abies balsamea*) dating to ca. AD 300–400. Taxon identification was based on wood anatomy and species distribution. Balsam fir, a boreal forest species, does not currently grow near the cave but is restricted in Iowa to paleorefugia at algific talus slopes. Balsam fir's widespread medicinal and ceremonial use, along with the common ritual uses of caves throughout eastern and central North America, suggest the cave might have been the locus of a sweat bath, analogous to sweat lodges used for healing and purification.

Received January 3, 2025
Accepted May 14, 2025
Published July 24, 2025

OPEN ACCESS
DOI 10.14237/ebl.16.1.2025.1935

Keywords Caves, Wood, Anthracology, Ethnobotany, Ritual

Introduction

Seeberger Cave is one of hundreds of caves and rockshelters found in the Silurian and Ordovician bedrock systems of eastern Iowa, USA. The site, designated 13JK411 by Iowa's Office of the State Archaeologist, was excavated in 1926, but no report was published until recently (Green et al. 2025). People from several Indigenous cultures used the cave from as early as 5000 BC up to around AD 1200 –1600. This article focuses on charred wood of balsam fir, *Abies balsamea*, dating to around AD 300–400, recovered from a feature located near the center of the cave. The cave's location beyond the range limit of balsam fir, the association of balsam fir with paleorefugia at other cave openings in Iowa, and Indigenous medicinal and ceremonial uses of this species suggest the cave served as a locus of ritual activity in additional to quotidian residential functions.

Site Description and Environment

Seeberger Cave is a south-facing opening in Hopkinton Formation (Silurian) dolostone. It is situated at the head of a small ravine along the Little Maquoketa River, a tributary of the Mississippi River, in Jackson County, Iowa (Figure 1). The cave entrance is 9.7 m wide and 2.5 m high. The sheltered area extends to a depth of 10.9 m, constricting in height from 2.5 m to 1.2 m toward the rear, where a fracture admits light, moisture, and sediment from the overlying ground surface. The habitable floor area totals about 106 m^2 (Figure 2). The cave's ceiling height and habitable area would have been greater in precontact times because recent accelerated sediment accumulation has raised the cave floor.

Iowa is located within the Prairie Peninsula, an eastern extension of the Central Grassland of North America. Prairie Peninsula vegetation for most of the past 5000 years consisted of a mosaic of tallgrass prairie, temperate deciduous woodland, and savannas. According to plant ecologist Roger Anderson, "The occurrence of the three community types (prairie, savanna, and forest) in the vegetation mosaic was the result of climate and fire frequency, which was strongly influenced by topographic features and distribution of waterways" (Anderson 2006:635; see also Robertson et al. 1997 and Transeau 1935). Iowa currently has a moderately warm, humid, continental climate (Shepard et al. 2024:10).

United States General Land Office (GLO) surveys and paleoenvironmental studies permit

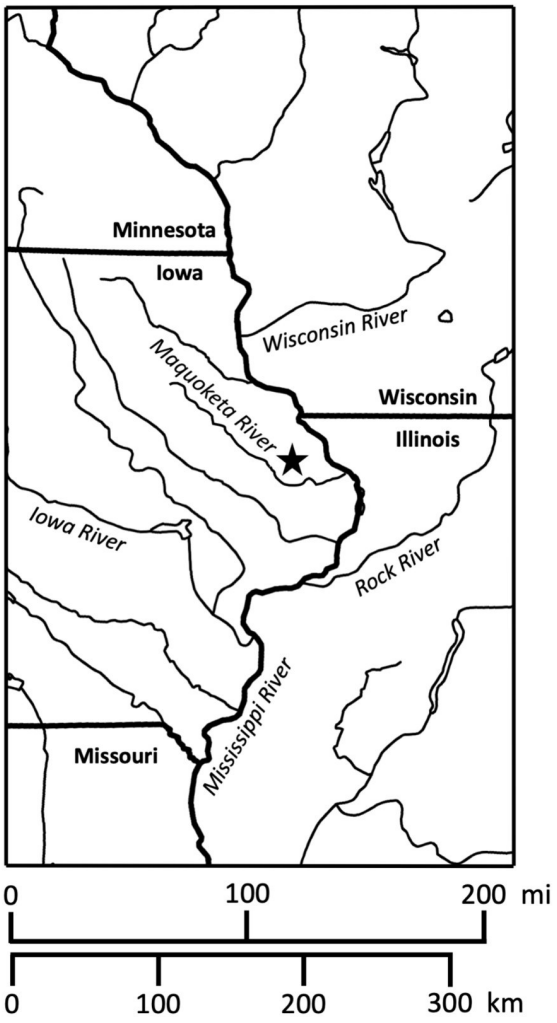

Figure 1 Location of Seeberger Cave (indicated by star) in eastern Iowa, USA.

general reconstructions of Late Holocene (ca. 2000 BC–present) regional vegetation patterns and climate. Figure 3, based on GLO survey records, illustrates the distribution of prairie and forest/savanna communities near Seeberger Cave in 1838–1839. Large stream valleys and areas of high topographic relief supported deciduous woodlands, while tallgrass prairie covered more level uplands. Because the surveys were conducted near the end of the Little Ice Age—represented in the Prairie Peninsula by a cool and moist eighteenth century—it is likely that fire frequency had declined and that forests had recently expanded at the expense of grassland (Stambaugh et al. 2011; Wood 1976).

In stark contrast to these Late Holocene patterns, regional vegetation in the Late Wisconsinan (ca. 25000 –11000 RCYBP) consisted of open tundra and mixed conifer-hardwood forests (Jans-Langel and Semken 2003; Josephs 2005; Slaughter 2001). Late Glacial and Early Holocene biomes in eastern Iowa transitioned from boreal forest to mesic deciduous woodlands beginning around 9300 RCYBP (ca. 8550 cal BC). Subsequently, prairies expanded during the warm and dry Middle Holocene. During the Late Holocene, oak savannas spread into some of the prairie loci, forming the mosaic observed in the nineteenth century.

Cave Investigation

Paul H. Nesbitt excavated portions of Seeberger Cave over a 10-week period in the summer of 1926 on behalf of Beloit College's Logan Museum. Nesbitt had just graduated from Beloit and would begin graduate school in anthropology that autumn at the University of Chicago. Having received a few days of training in field methods by Logan Museum archaeologist Alonzo Pond, Nesbitt mapped the cave, excavated a trench and two additional units, and wrote a short summary report. The recovered collection remained unstudied and mostly intact at the Logan Museum. Documentation of the excavation is sparse: No field notes have been found, nor have any excavation profiles or photographs been located[1].

Despite the paucity of associated documentation, analysis of the recovered material permitted interpretations of the site's occupational history and function, as well as comparisons to nearby caves, rockshelters, and open-air sites (Green et al. 2025). Multiple episodes of occupation, as inferred from diagnostic cultural material, occurred over a period of around 6000 years. Numbers of temporally diagnostic artifacts indicate that the most intensive uses of the cave occurred during the Late Archaic (ca. 2100–950 BC) and Late Woodland periods (ca. AD 650–1100), though utilization was not limited to those periods. White-tailed deer (*Odocoileus virginianus*) elements are the most common animal remains, and numerous other mammals, birds, turtles, and freshwater pelecypods are represented, too.

Nesbitt reported finding three "fireplaces" in his excavation. Two, found at depths of 31–41 cm below the surface, were "very small." The third, and the only one from which he collected charred wood, was, in his words (Green et al. 2025:386),

> quite large covering an area 18 inches [46 cm] long and 12 inches [31 cm] wide, and at a depth of 2 ft. 3 inches

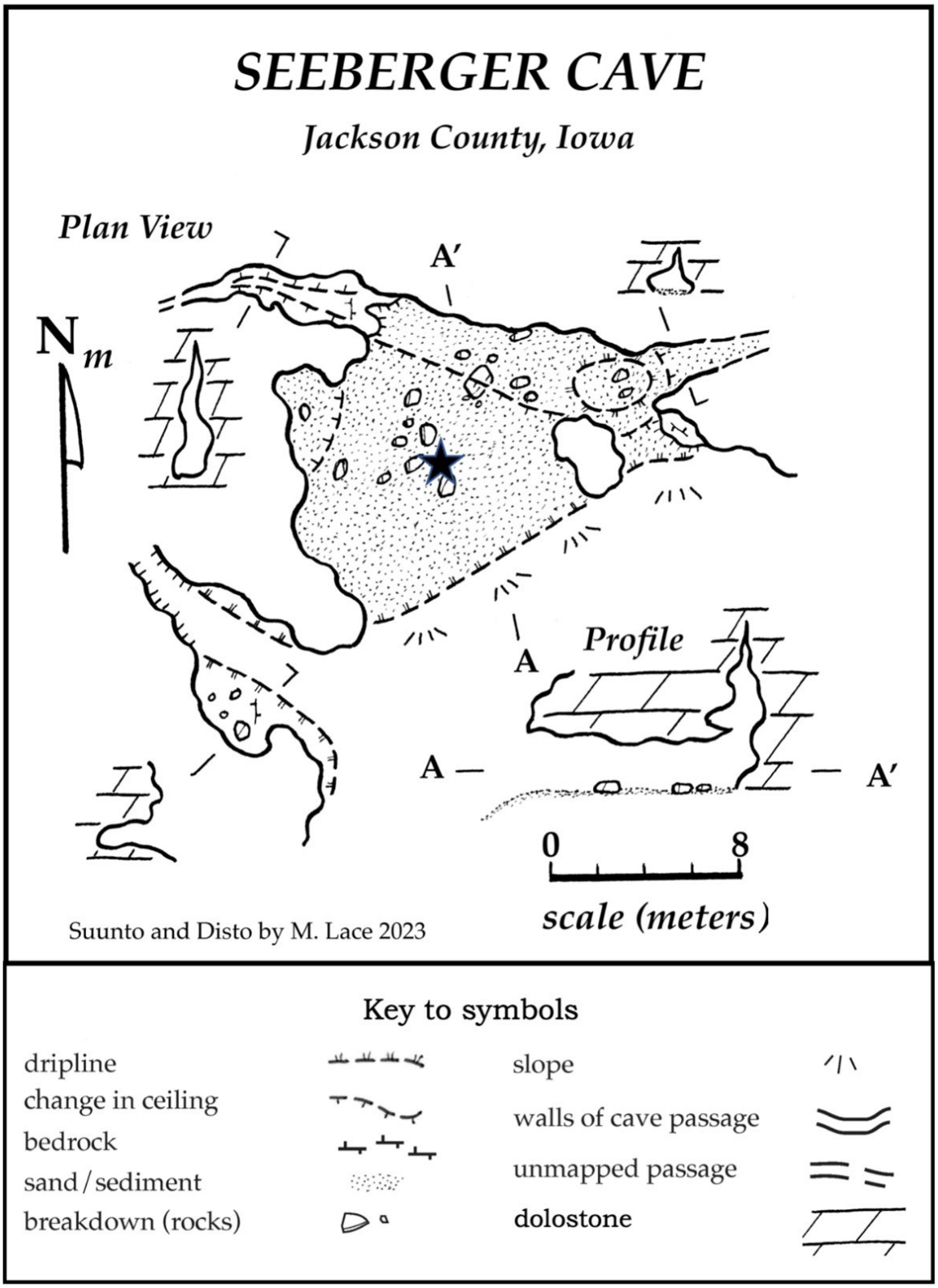

Figure 2 Map of Seeberger Cave with plan view and four profiles. Star indicates approximate location of balsam fir feature. Drafted by Michael Lace, November, 2023. Used with permission.

Figure 3 Historic vegetation of the Seeberger Cave vicinity from General Land Office surveys. Source: Iowa State University Extension and Outreach, https://naturalresources.extension.iastate.edu/Iowas-Nature/educational-graphics. Accessed on January 6, 2024.

> [69 cm], just above the clay. There was a 3 inch [7.6 cm] layer of charcoal, and the whole fire place was so situated that it occurred in the very middle of the cave. Nothing was found in the ashes but just above them was found a few small burnt bones[2], and small chips of flint. Around the ashes and below them was found a number of burnt rocks, used in building the fireplace.

Consistent with his statement that this feature was situated "in the very middle of the cave," Nesbitt reported that it was located 15 feet (4.6 m) north of the cave entrance. Figure 2 shows the feature's approximate location within the cave. According to Nesbitt, organically enriched deposits full of artifacts overlay a light-colored clay with little or no cultural material. The interface between the two main layers appeared at depths of around 69–86 cm. The presence of the large "fireplace" at a depth of 69 cm and Nesbitt's mention that it was "just above the clay" indicates that it appeared near the base of the principal cultural deposit. It is possible that the feature constituted the basal portion of a pit that originated higher in the deposit. The "few small burnt bones" and small flint chips found above the feature are common inclusions throughout the deposit and were not necessarily associated with the feature.

Wood Identification and Dating

Charcoal from the large "fireplace" was stored at the Logan Museum of Anthropology in a sealed glass test tube. Examination of the entire sample at 6.3–40x magnification determined that it consisted entirely of charred wood fragments. All of the specimens were narrow fragments, such as from small branches. Size-grading resulted in an assemblage of 110 fragments >2 mm, plus innumerable smaller pieces. The >2 mm subsample weighed 1.92 g.

All of the >2 mm specimens were apparently the same wood taxon. Ten fragments were selected for anthracological analysis and identification. All were found to be conifer wood featuring distinct growth ring boundaries, an abrupt transition between earlywood and latewood, and the absence of resin canals in the transverse section (Figure 4a), with taxodioid cross-field pitting exhibited in the radial section (Figure 4b). Homocellular uniseriate rays are visible in tangential view (Figure 4c). These characteristics indicate wood of the *Abies* (fir) genus. Although ray cell height in *Abies* species typically ranges from 1 to 25 and in some cases over 30 cells (Panshin and De Zeeuw 1980:471), the Seeberger Cave sample exhibits low ray height, which may be associated with juvenile wood as in other gymnosperms (Meng et al. 2021). For *Abies* wood anatomy, see García Esteban et al. (2009), Hoadley (1990:158), NC State University Libraries (2025), Panshin and de Zeeuw (1980:469–471), and Strelis and Kennedy (1967).

The Seeberger Cave charcoal most likely represents twigs, branches, or juvenile wood of balsam fir (*A. balsamea*). Although several *Abies* species have similar wood anatomy (Eom and Kwan

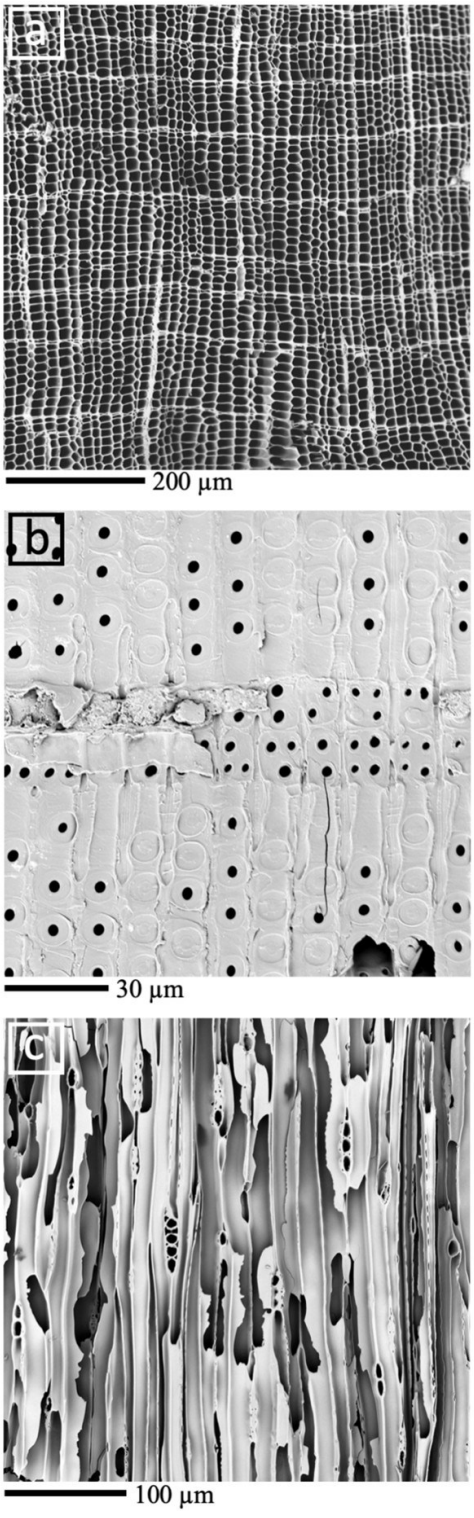

Figure 4 Scanning electron micrographs of Seeberger Cave charred wood indicating typical *Abies* anatomy: **A** transverse section (400x), **B** radial section (2000x), and **C** tangential section (700x). Note the different scales for each image. Images courtesy of Peter Kováčik.

2009; García Esteban et al. 2009; Panshin and de Zeeuw 1980:471–474; Richter et al. 2004), balsam fir is the only species that occurs in or near Iowa. The three species other than balsam fir whose ranges are closest to Iowa occur more than 1000 km from Seeberger Cave. Fraser fir (*A. fraseri*) is endemic to the high elevations of the southern Appalachian Mountains (Beck 1990), while the easternmost range limits of subalpine fir (*A. lasiocarpa*) and white fir (*A. concolor*) are 1200 km distant in the Rocky Mountains (Alexander et al. 1990; Laacke 1990). Other *Abies* species occur even farther from Iowa (Burns and Honkala 1990).

Only three conifers other than balsam fir are native to Iowa (van der Linden and Farrar 2011:267, 282), and their wood anatomy does not resemble the Seeberger sample. Eastern white pine (*Pinus strobus*) wood features resin canals, and both Eastern redcedar (*Juniperus virginiana*) and Canada yew (*Taxus canadensis*) exhibit a gradual earlywood to latewood transition. For images and descriptions of the wood anatomy of these taxa and closely related species, see Hoadley (1990:16–17, 26, 56, 145–147, 159, 163), Kukachka (1960:894–895), Panshin and de Zeeuw (1980:439–441, 490–492), and NC State University Libraries (2025).

To determine the age of balsam fir usage at Seeberger Cave, we submitted one wood fragment for AMS radiocarbon dating. The sample, weighing 57 mg, was pretreated at the DirectAMS lab in Bothell, Washington, and dated at the Center for Applied Isotope Studies (CAIS) at the University of Georgia. CAIS also conducted stable isotope assays. The resulting age of 1723±21 BP ($\delta^{13}C$ = –22.22‰; UGAMS 60959) has a mean date of 342 cal AD, with 2-sigma probabilities of dating to 252–291 cal yrs AD (30.1%) or 319–406 cal yrs AD (69.9%). This date is compatible with several artifact types from the site, principally Linn ware pottery and Steuben points, both dating to the fourth-century transition between the Middle Woodland and Late Woodland periods (Green et al. 2025).

Balsam Fir in Iowa

Seeberger Cave lies outside the modern range of balsam fir (Figure 5; Little 1971). There are no historic records of the species in Jackson County or in any of the bordering counties. As a boreal forest constituent with extremely low fire resistance (Ali et al. 2008; Starker 1934), balsam fir disappears from paleobotanical (pollen and macrofossil) records after around 9400

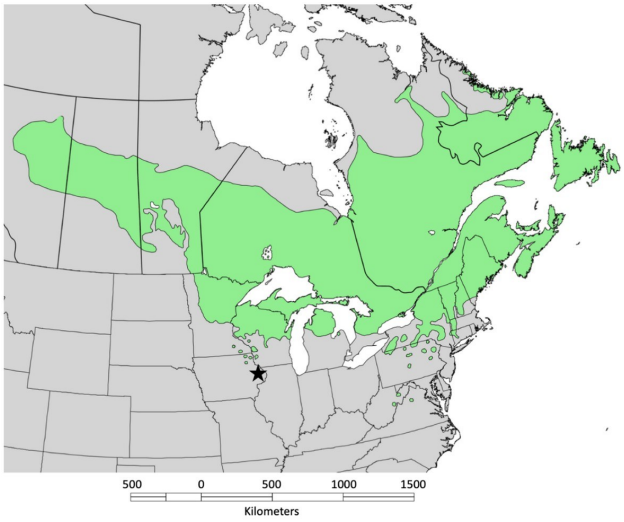

Figure 5 Modern range of balsam fir. Star indicates location of Seeberger Cave. Source: U.S. Geological Survey Geosciences and Environmental Change Science Center, Digital Representations of Tree Species Range Maps, from Little (1971). Wikimedia Commons.

RCYBP (ca. 8650 cal BC) in central Iowa and 8500 RCYBP (7550 cal BC) in northeast Iowa (Baker et al. 1990; Baker et al. 1996; Reimer et al. 2020).

In Iowa today, balsam fir occurs only as disjunct, scattered, relict populations restricted to the state's northeastern-most counties (Figure 6; Conard 1938; Eilers and Roosa 1994:38; Glenn-Lewin et al. 1984:24; van der Linden and Farrar 2011:80–81)[3]. The nearest stand is 85 km northwest of Seeberger Cave. The Bluffton Fir Stand State Preserve—the only substantial protected stand of this species in Iowa—is 193 km northwest of Seeberger Cave (Gibbs 2016; Herzberg and Pearson 2001:12–13). Balsam fir in Iowa occurs at north-facing algific talus slopes, "steep hillsides which are bathed in cold, moist air from adjacent ice caves" (Nekola 1993:iii). The cold air emanates from bedrock fissures connected to deep caves that harbor ice reservoirs. Even in the summer, soil temperatures at these locations rarely exceed 15° C (Conard 1938; Eilers and Roosa 1994:8–9; Frest 1982; Hartley 1966:17–18; Nekola 1999:2463–2464; Shea and Furnier 2002:783–784). Algific talus slopes constitute ecologically and biogeographically significant paleorefugia whose stable, cool microclimates have allowed survival of balsam fir and more than 60 other disjunct boreal forest species well south of their contiguous ranges (Nekola 1999:2463). The stands of balsam fir at these isolated locations exhibit low genetic variability, consistent with long-term habitat fragmentation (Shea and Furnier 2002).

About 300 algific talus slopes have been recorded in Iowa. Some occur as far south as Jackson and adjoining counties, constituting the southernmost recorded in the Midwest USA (Nekola 1999:2464). Several of these southern algific talus slopes are located within 20 km of Seeberger Cave (Figure 7). Although no balsam fir currently grows at these southern sites, they may well have served as refugia for balsam fir for a portion of the Holocene. If this was the case, residents of Seeberger Cave could have acquired the species within just a few hours' walk. Whether balsam fir grew nearby or had retreated to its current locations in northeast Iowa by AD 300–400 is not known.

No other examples of balsam fir have been reported to date from Iowa archaeological sites. Neither the Iowa Statewide Archaeobotanical Survey (Asch and Green 1992) nor any document in the Iowa Archaeological Research Center database (2024) mentions balsam fir. However, few systematic analyses of wood charcoal fragments have been conducted for sites in eastern Iowa, so it is possible that additional research will recover evidence of balsam fir use.

Indigenous Uses of Balsam Fir

About 1700 years ago, people transported balsam fir branches or other young wood from an algific talus slope to Seeberger Cave. In the center of the cave, they built a rock-lined feature on which the wood burned. It is likely the fire was deliberate rather than accidental because this feature and two smaller ones were the only burned deposits noted in the excavation. While the wood's ultimate fate was to burn, it (and possibly other parts of the tree that did not survive) might have been used for various purposes before it ignited. The low fuel value of balsam fir wood (Wisconsin Center for Environmental Education 2020) and the occupants' access to better fuelwood in the mesic deciduous forest surrounding the cave indicate that the principal reason (s) for transporting and burning these branches or young wood did not include everyday cooking or heating needs.

Aside from the tree's aromatic qualities that are familiar to many at Christmastime, balsam fir resin and essential oils have numerous medicinal properties, including antibacterial, antitumor, and even acaricidal

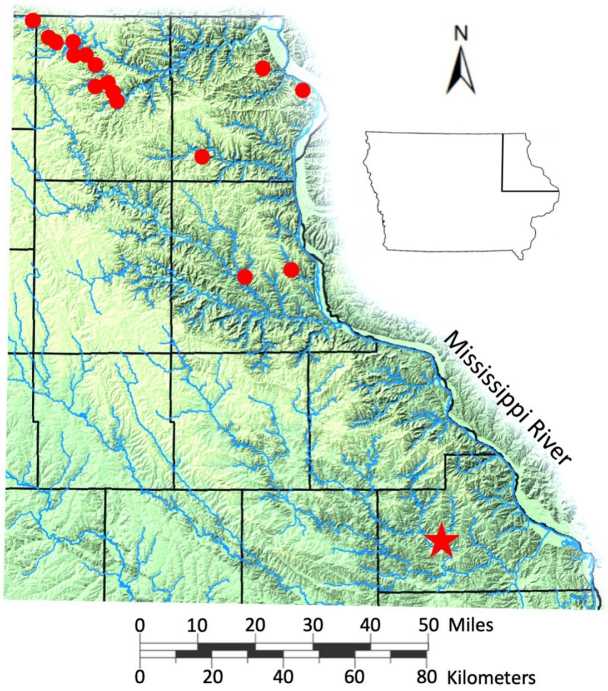

Figure 6 Present locations of balsam fir in Iowa (circles). Source: Iowa Natural Areas Inventory database, Iowa Department of Natural Resources, courtesy of John Pearson. Star indicates Seeberger Cave.

(tick-killing) (Adamo et al. 2022; Coté et al. 2016; Johnson 1999:1; Legault et al. 2003; Pichette et al. 2006; see Kaufman et al. 1999:249 on the chemical composition and properties of the plant's oleoresin). Native American medicinal uses of balsam fir employing these and other properties of the tree are well documented, though not among the Indigenous groups historically resident in eastern Iowa (Eastern Dakota, Ho-Chunk, Ioway, Meskwaki, Sauk). Ethnographic and historical sources for groups residing within the species' principal range indicate that nearly all parts of the balsam fir, from the leaves through the trunk to the roots, had medicinal as well as technological uses (Arnason et al. 1981). The Native American Ethnobotany Database (2024), which is based on information compiled and published by Daniel Moerman (1998:33–34), contains records of 87 uses of balsam fir by 12 Indigenous groups in eastern and central North America. These sources also contain numerous references for medicinal and ceremonial uses by 13 additional groups of the closely related species *Abies lasiocarpa* (subalpine fir, also occasionally termed balsam fir). More recent first-hand accounts (Clavelle 1997; M. Geniusz 2015; Geniusz 2009; Herron 2002; Kenny and Parker 2004; Roufs 2019) and compilations (Meeker et al. 1993; Uprety et al. 2012) supplement Moerman's records about Indigenous peoples' engagement with balsam fir in central North America.

Most relevant to Seeberger Cave are those uses of balsam fir that involved close exposure of the plant to heat. Anishinaabe (Ojibwe) people in northern Wisconsin and Minnesota placed balsam fir leaves, resin, and root decoctions directly on live coals or hot stones and inhaled the vapor or smoke to treat nervous ailments, rheumatism, and colds (Densmore 1928:338–339, 362–363; Smith 1932:378). Farther afield but relevant to Seeberger Cave, Absaroka (Crow) and Northern Cheyenne people burned twigs and leaves of *A. lasiocarpa* on coals during ceremonies to create smoke and "incense" for healing and spiritual purposes (Blankinship 1905:5; Grinnell 1923:169; Hart 1981:2, 5–6). Although they lived in Montana when those uses were recorded, the Cheyenne had earlier resided in or near the *A. balsamea* range in Minnesota. The live coals mentioned in these accounts could be wood or heated stones such as the burnt rocks Nesbitt found below and around the charcoal in the Seeberger Cave feature.

Anishinaabeg of northern Wisconsin also employed balsam fir along with other plants in sweat baths taken for ceremonial, cleansing, or medicinal reasons. The steam from boiling those plants persisted within small, enclosed sweat lodges (Smith 1932:378). Mohawk people also heated balsam fir branches for steam baths (Herrick 1995:113), as did Plateau groups (employing *A. lasiocarpa*) for use in purification rituals in sweathouses (Turner 2014:1:428). Where *Abies* was unavailable, other aromatic gymnosperms such as *Juniperus pinchotti* (Pinchot juniper or mountain cedar) would be placed on hot rocks in sweat lodges, as among the Plains Apache (Jordan 2008:94–97, 110–113). Seeberger Cave would be akin to a constructed sweat lodge, its central fireplace allowing steam and smoke to permeate the cave, especially if the inhabitants covered the entrance and rear crevice.

Overall, Indigenous people have long recognized and honored the healing and spiritual properties of *Abies*. The tree's many virtues cause it to be considered "a blessed plant" (M. Geniusz 2015:74; W. Geniusz 2015:342). Its powers and abilities include purification, protection from harm, and even reviving a dying person's spirit (Hart 1981:5–6). Indigenous people in the Plateau region know *A. lasiocarpa* as

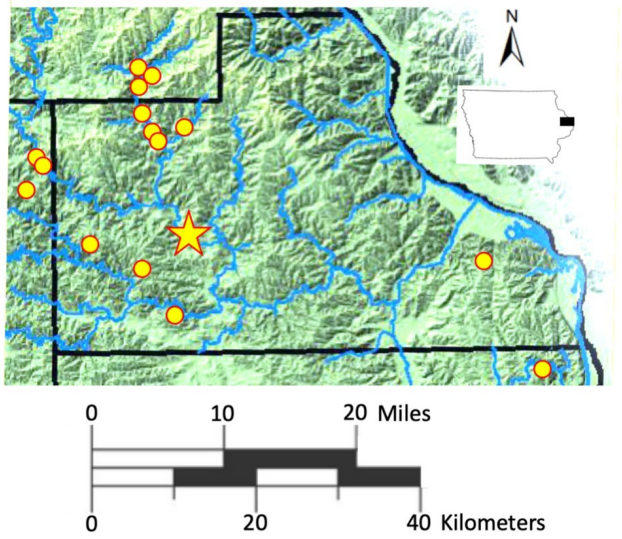

Figure 7 Jackson County and adjacent counties showing locations of Iowa's southernmost algific talus slopes (circles). Balsam fir is absent from these locations. Source: Iowa Natural Areas Inventory database, Iowa Department of Natural Resources, courtesy of John Pearson. Star indicates Seeberger Cave.

"medicine-plant" and "medicine-plant-tree" (Armstrong 2020:40; Turner 2014:1:130). Reflecting a "kincentric" worldview that considers plants as "generous relatives of humans, to be treated with care, deep appreciation, and reciprocity" (Turner et al. 2020:13), Anishinaabeg refer to balsam fir as "Elder Sister," "She Who Points Out," "She Speaks for Us," and "She Stands at Prayer for Us" (or "She makes me speak"), signifying that the tree holds "the highest concern for her family and relatives" because of her (the tree's) healing properties (GLIFWC Climate Change Team 2023:79).

Caves as Ritual and Ceremonial Settings

Seeberger Cave apparently served as a residential base camp. This conclusion is based on the diverse assemblage of domestic tools from the site—scrapers, knives, grinding stones, cooking and storage vessels—as well as indications from faunal remains of occupation during multiple seasons: fur-bearing mammals in the fall and winter; turtles in the spring through fall; newborn or full-term fetal bison in the early spring; and pelecypods in the summer and fall. Similar-sized caves and rockshelters in the region also served as base locales (Green et al. 2025).

Yet the balsam fir "fireplace" used about 1700 years ago likely reflects ritual or ceremonial use of Seeberger Cave in addition to everyday domestic purposes. It is true that the "domestic" and "ritual/ceremonial" dichotomy may well have meant little to the site's inhabitants. Globally, "ritual permeates daily practice in noncapitalist societies" (Chapman 2006:514). Nevertheless, preferences for particular fuel wood species "in both practical and ceremonial contexts" and selection "of certain species for specific purposes" reflect Indigenous traditional knowledge "based on a range of criteria and contextual considerations" (Swan and Simons 2014:325). In addition to the preference noted above for balsam fir and other aromatic species in sweat lodges, an ethnographic example of careful selection of wood for ceremonial uses is the preference for a narrow range of species for Osage ritual peyote fires (Swan and Simons 2014). For cave rituals in particular, Morehart et al. (2005) discuss archaeological and ethnographic examples of selection of pine (*Pinus*) among the Maya.

In addition to the balsam fir, other finds also suggest ritual or ceremonial activities at Seeberger Cave. The cave contained the remains of at least two bison (*Bison bison*)—one adult plus the full-term fetal or newborn calf mentioned above. The latter is represented only by a cranium. The context and age of the bison are unknown. Several nearby caves and rockshelters also contain bison elements, though none from fetal/newborn calves (Green et al. 2025). While the fetal/newborn cranium might simply reflect the fortuitous result of a spring-season hunt, bison skulls and calves play important roles in belief systems and healing rituals among many Indigenous groups of the North American prairie-plains (Brown 1953; Hall 1997; Skinner 1926; Walker 1980).

Seeberger Cave also contained the remains of at least two human individuals, one adult and one late-term fetal or newborn (repatriated and reinterred per state and federal law). Many eastern Iowa caves and rockshelters contain human remains, both as intact burials and as disarticulated elements. The common presence of human remains at these sites conforms to patterns noted throughout the Eastern Woodlands of North America (Boyd et al. 2001; Claassen 2012a, b; Crothers et al. 2002; Homsey-Messer 2015; Prufer and Prufer 2012; Sabo et al. 2012; Spurlock et al. 2006), and, indeed, worldwide (Tarlow and Nilsson Stutz 2013). Among North American prairie-plains tribes, caves are viewed as places of origin or emergence into this world, portals to spirit worlds, and sacred places

for fasting and vision quests (Foster 1999:183; Howe et al. 2011:3, 8–9). Interment in such sites, along with the accompanying ceremonies, reflected or imbued social and sacred meaning to the sites (e.g., Blakeslee 2012; Claassen 2012a, b; Homsey-Messer 2015; Turpin 1994). In Iowa, caves might have been especially appropriate sites for rituals involving balsam fir because of the species' association with ice caves at algific talus slopes. Balsam fir's healing and sacred properties as well as its restricted natural occurrence at algific cave openings would have made it an ideal medium for purification and other rituals in caves.

Discussions of ritual or ceremonial activity at caves in Iowa and the surrounding region generally focus on the rock art that is present at many sites (e.g., Baldner 2020; Paper 1997:134–138; Schrab and Boszhardt 2016). At the Gottschall site in Wisconsin, pictographs, a painted sandstone human-head sculpture, scattered human remains, and the identification of recurring strata of fired deposits and "anthroseds" (manufactured sediments) led to interpretations that the cave hosted a long-lasting "core ritual" and served as an "ancestor cult shrine" (Salzer 2005; Salzer and Rajnovich 2000). No site in the region has yet been interpreted as a locus for steam or sweat baths. But sweat baths and sweat lodges were important spaces for Indigenous societies across North America (Lopatin 1960:983–986). Seeberger Cave could constitute a natural sweat lodge, with steam and smoke emanating from balsam fir atop hot rocks in the center of the cave. What better location for a balsam fir sweat bath than a cave at the very edge (or even beyond) the range of this blessed tree, which occurs in the region only in association with caves—portals between worlds.

Conclusions

Investigations at Seeberger Cave recovered charred balsam fir wood from a stone-lined feature in the center of the cave. The wood, dating to around 1700 years ago, had been collected from an algific talus slope, a paleorefugium for boreal plants. Seeberger Cave is 85 km from the nearest extant stand of balsam fir, but algific talus slopes closer to the cave might have supported this species during the time of occupation.

Most of the cultural material found in the cave reflects domestic activities and use of the site as a residential base locale. However, records of Indigenous medicinal and ceremonial uses of balsam fir and of the spiritual importance of caves permit identification of Seeberger Cave as a locus of ritual activity as well. The types of rituals or ceremonies are uncertain because balsam fir use is absent from local and regional Native ethnobotanical records—not surprising as the site lies outside the current distribution of the species. However, Indigenous uses of balsam fir and closely related species in other regions suggest it was employed in purification or healing activities such as those associated with sweat baths.

Notes

[1]Paul Homer Nesbitt (1904–1985) received his PhD in anthropology from the University of Chicago in 1938. He served as curator of the Logan Museum at Beloit College and later as chief of the United States Air Force Arctic, Desert, and Tropic Information Center, professor of anthropology at the Air University at Maxwell Air Force Base in Alabama and founding chair of the anthropology department at the University of Alabama.

[2]These were animal bones. None of the human remains excavated by Nesbitt were burned.

[3]Although it includes little about the disjunct distribution of balsam fir in Iowa, the most comprehensive treatment of the biology, geography, ecology, reproduction, growth, and modern utilization of the species is the 445-page monograph by E. V. Bakuzis and H. L. Hansen (1965). Robert Frank (1990) also supplied an informative discussion of the species.

Acknowledgments

Thanks to Seeberger Cave property owner Stephanie Weeks for her interest and assistance with our studies, to Mike Lace for mapping the site, and to Chad Heinzel, Chérie Haury-Artz, Nicolette Meister, and John Pearson for their important contributions to this research. Thanks also to Dirk Marcucci for helpful insights about local algific talus slopes. Many thanks to the EBL editors and reviewers for their thoughtful and constructive suggestions that improved this article. Special thanks to Peter Kováčik for scanning electron microscope imaging and valuable assistance regarding wood anatomy and identification. We also thank Joel Sparks and the Department of Earth and Environment at Boston University for use of its SEM facilities. None of the above-named individuals are responsible for any errors or misuse of their assistance. The Seeberger Cave collection is housed at

the Logan Museum of Anthropology, Beloit College, Beloit, WI, USA.

Declarations

Permissions: None declared.

Sources of funding: Logan Museum of Anthropology, Beloit College.

Conflicts of Interest: None declared.

References Cited

Adamo, S., A. El Nabbout, L. V. Ferguson, J. S. Zbarsky, and N. Faraone. 2022. Balsam Fir (*Abies balsamea*) Needles and Their Essential Oil Kill Overwintering Ticks (*Ixodes scapularis*) at Cold Temperatures. *Scientific Reports* 12:12999. DOI:10.1038/s41598-022-15164-z.

Alexander, R. R., R. C. Shearer, and W. D. Shepperd. 1990. *Abies lasiocarpa* (Hook.) Nutt. Subalpine Fir. In *Silvics of North America. Volume 1, Conifers*, coordinated by R. M. Burns and B. H. Honkala, pp. 60–70. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.

Ali, A. A., H. Asselin, A. C. Larouche, Y. Bergeron, C. Carcaillet, and P. J. H. Richard. 2008. Changes in Fire Regime Explain the Holocene Rise and Fall of *Abies balsamea* in the Coniferous Forests of Western Québec. *The Holocene* 18:693–703.

Anderson, R. C. 2006. Evolution and Origin of the Central Grassland of North America: Climate, Fire, and Mammalian Grazers. *Journal of the Torrey Botanical Society* 133:626–647.

Armstrong, J. 2020. Living from the Land: Food Security and Food Sovereignty Today and into the Future. In *Plants, People, and Places: The Roles of Ethnobotany and Ethnoecology in Indigenous Peoples' Land Rights in Canada and Beyond*, edited by N. J. Turner, pp. 36–50. McGill-Queen's University Press, Montreal.

Arnason, T., R. J. Hebda, and T. Johns. 1981. Use of Plants for Food and Medicine by Native Peoples of Eastern Canada. *Canadian Journal of Botany* 59:2189–2325.

Asch, D., and W. Green. 1992. *Crops of Ancient Iowa: Native Plant Use and Farming Systems*. Report prepared for the Leopold Center for Sustainable Agriculture, Iowa State University, Ames. Office of the State Archaeologist, University of Iowa, Iowa City.

Baker, R. G., E. A. Bettis III, D. P. Schwert, D. G. Horton, C. A. Chumbley, L. A. Gonzalez, and M. K. Reagan. 1996. Holocene Paleoenvironments of Northeast Iowa. *Ecological Monographs* 66:203–234.

Baker, R. G., C. A. Chumbley, P. M. Witinok, and H. K. Kim. 1990. Holocene Vegetation Changes in Eastern Iowa. *Journal of the Iowa Academy of Science* 97:167–177.

Bakuzis, E. V., and H. L. Hansen. 1965. *Balsam Fir*, Abies Balsamea *(Linnaeus) Miller: A Monographic Review*. University of Minnesota Press, Minneapolis.

Baldner, R. P. 2020. Indigenous Equations: Exploring Iconography and Meaning in Rock Art of Northeast Iowa. *Journal of the Iowa Archeological Society* 67:36–67.

Beck, D. E. 1990. *Abies fraseri* (Pursh) Poir. Fraser Fir. In *Silvics of North America. Volume 1, Conifers*, coordinated by R. M. Burns and B. H. Honkala, pp. 47–51. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.

Blakeslee, D. J. 2012. Caves and Related Sites in the Great Plains of North America. In *Sacred Darkness: A Global Perspective on the Ritual Use of Caves*, edited by H. Moyes, pp. 353–362. University Press of Colorado, Boulder.

Blankinship, J.W. 1905. *The Native Economic Plants of Montana*. Bulletin No. 56. Montana Agricultural College Experiment Station, Bozeman.

Boyd, Jr., C., D. C. Boyd, M. B. Barber, and D. A. Hubbard, Jr. 2001. Southwest Virginia's Burial Caves: Skeletal Biology, Mortuary Behavior, and Legal Issues. *Midcontinental Journal of Archaeology* 26:219–231.

Brown, J. E., ed. 1953. *The Sacred Pipe: Black Elk's Account of the Seven Rites of the Oglala Sioux*. University of Oklahoma Press, Norman.

Burns, R. M., and B. H. Honkala, coordinators. 1990. *Silvics of North America. Volume 1, Conifers*. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.

Chapman, R. 2006. Middle Woodland/Hopewell: A View from beyond the Periphery. In *Recreating Hopewell*, edited by D. K. Charles and J. E. Buikstra, pp. 510–528. University Press of Florida, Gainesville.

Claassen, C. 2012a. Cave Rituals and Ritual Caves in the Eastern United States. In *Enduring Motives: The Archaeology of Tradition and Religion in Native America*,

edited by L. Sundstrom and W. DeBoer, pp. 253–263. University of Alabama Press, Tuscaloosa.

Claassen, C. 2012b. Reevaluating Cave Records: The Case for Ritual Caves in the Eastern United States. In *Sacred Darkness: A Global Perspective on the Ritual Use of Caves*, edited by H. Moyes, pp. 211–224. University Press of Colorado, Boulder.

Clavelle, C. M. 1997. Ethnobotany of Two Cree Communities in the Southern Boreal Forest of Saskatchewan. Master's thesis, Department of Anthropology and Archaeology, University of Saskatchewan, Saskatoon.

Conard, H. S. 1938. The Fir Forests of Iowa. *Proceedings of the Iowa Academy of Science* 45:69–72.

Coté, H., M. Boucher, A. Pichette, B. Roger, and J. Legault. 2016. New Antibacterial Hydrophobic Assay Reveals *Abies balsamea* Oleoresin Activity Against *Staphylococcus aureus* and MRSA. *Journal of Ethnopharmacology* 194:684–689.

Crothers, G. M., C. H. Faulkner, J. F. Simek, P. J. Watson, and P. Willey. 2002. Woodland Cave Archaeology in Eastern North America. In *The Woodland Southeast*, edited by D. G. Anderson and R. C. Mainfort, Jr., pp. 502–524. University of Alabama Press, Tuscaloosa.

Densmore, F. 1928. Uses of Plants by the Chippewa Indians. In *Forty-fourth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1926–1927*, pp. 275–397. Government Printing Office, Washington, DC.

Eilers, L. J., and D. M. Roosa. 1994. *The Vascular Plants of Iowa*. University of Iowa Press, Iowa City.

Eom, T. G., and O. Kwon. 2009. Wood Anatomy and Identification of North American Firs (*Abies*). *Mokchae Konghak Journal of the Korean Wood Science and Technology* 37:451–458.

Foster, L. M. 1999. *Tanji na Che*: Recovering the Landscape of the Ioway. In *Recovering the Prairie*, edited by R. F. Sayre, pp. 178–190. University of Wisconsin Press, Madison.

Frank, R. M. 1990. *Abies balsamea* (L.) Mill., Balsam Fir. In *Silvics of North America. Volume 1, Conifers*, coordinated by R. M. Burns and B. H. Honkala, pp. 26–35. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.

Frest, T.J. 1982. Final Report, Project SE-1-4, Iowa Pleistocene Snail, January 1981-January 1982. Submitted to Iowa Conservation Commission and U.S. Bureau of Fisheries and Wildlife. Copy on file, Iowa Department of Natural Resources, Des Moines.

García Esteban, L., P. de Palacios, F. G. Fernández, and R. Moreno. 2009. Wood Anatomy of the Genus *Abies*: A Review. *IAWA Journal* 30:231–245.

Geniusz, M. S. 2015. *Plants Have So Much to Give Us, All We Have to Do Is Ask: Anishinaabe Botanical Teachings*, edited by W. M. Geniusz. University of Minnesota Press, Minneapolis.

Geniusz, W. M. 2009. *Our Knowledge Is Not Primitive: Decolonizing Botanical Anishinaabe Teachings*. Syracuse University Press, Syracuse, NY.

Geniusz, W. M. 2015. Ojibwe Plant Name Glossary. In *Plants Have So Much to Give Us, All We Have to Do Is Ask: Anishinaabe Botanical Teachings*, by M. S. Geniusz, pp. 339–355. University of Minnesota Press, Minneapolis.

Gibbs, B. 2016. Evergreen Heart: A New Year's Journey into Iowa's Northwoods. *Iowa Outdoors* 75:38–45.

Glenn-Lewin, D. C., R. H. Laushman, and P. D. Whitson. 1984. The Vegetation of the Paleozoic Plateau, Northeastern Iowa. *Proceedings of the Iowa Academy of Science* 91:22–27.

GLIFWC Climate Change Team. 2023. *Aanji-bimaadiziimagak o'ow aki: Climate Change Vulnerability Assessment Version 2*. Great Lakes Indian Fish and Wildlife Commission, Odanah, WI.

Green, W., C. Haury-Artz, R. M. Lillie, and C. Heinzel. 2025. *Seeberger Cave (13JK411), a Multicomponent Rockshelter in Eastern Iowa*. Memoir 47, *Plains Anthropologist* 68:305–399.

Grinnell, G. B. 1923. *The Cheyenne Indians: Their History and Way of Life*, vol. 2. Yale University Press, New Haven, CT.

Hall, R. L. 1997. *An Archaeology of the Soul: North American Indian Belief and Ritual*. University of Illinois Press, Urbana.

Hart, J. A. 1981. The Ethnobotany of the Northern Cheyenne Indians of Montana. *Journal of Ethnopharmacology* 4:1–55.

Hartley, T. G. 1966. *The Flora of the "Driftless Area."* University of Iowa Studies in Natural History, vol. 21, no. 1. Iowa City.

Herrick, J. W. 1995. *Iroquois Medical Botany*, edited by D. R. Snow. Syracuse University Press, Syracuse,

NY.

Herron, S. M. 2002. Ethnobotany of the Anishinaabek Northern Great Lakes Indians. Doctoral dissertation, Department of Plant Biology, Southern Illinois University, Carbondale.

Herzberg, R., and J. Pearson. 2001. *The Guide to Iowa's State Preserves*. University of Iowa Press, Iowa City.

Hoadley, R. B. 1990. *Identifying Wood: Accurate Results with Simple Tools*. Taunton Press, Newtown, CT.

Homsey-Messer, L. 2015. Revisiting the Role of Caves and Rockshelters in the Hunter-Gatherer Taskscape of the Archaic Midsouth. *American Antiquity* 80:332–352.

Howe, C., L. W. Soldier, and L. L. Lee, eds. 2011. *He Sapa Woihanble: Black Hills Dream*. Living Justice Press, St. Paul, MN.

Iowa Archaeological Research Center. 2024. Database [web page]. Available at: https://www.iowaisites.com/iArc/records.aspx. Accessed on December 21, 2024.

Jans-Langel, C. M., and H. A. Semken, Jr. 2003. Paleoecological Interpretation of Late Holocene and Late Pleistocene Microvertebrate Faunules from Duhme Cave, Eastern Iowa. In *Ice Age Cave Faunas of North America*, edited by B. W. Schubert, J. I. Mead, and R. W. Graham, pp. 119–148. Indiana University Press, Bloomington.

Johnson, T. 1999. *CRC Ethnobotany Desk Reference*. CRC Press, Boca Raton, FL.

Jordan, J. A. 2008. *Plains Apache Ethnobotany*. University of Oklahoma Press, Norman.

Josephs, R. L. 2005. A 20,000 CALYBP Caribou Mandible from a Cave Site in East-central Iowa. *Current Research in the Pleistocene* 22:73–75.

Kaufman, P. B., L. J. Cseke, S. Warber, J. A. Duke, and H. L. Brielmann. 1999. *Natural Products from Plants*. CRC Press, Boca Raton, FL.

Kenny, M. B., and W. H. Parker. 2004. Ojibway Plant Taxonomy at Lac Seul First Nation, Ontario, Canada. *Journal of Ethnobiology* 24:75–91.

Kukachka, B. F. 1960. Identification of Coniferous Woods. *Tappi* 43:887–896.

Laacke, R. J. 1990. *Abies concolor* (Gord. & Glend.) Lindl. ex. Hildebr. White Fir. In *Silvics of North America. Volume 1, Conifers*, coordinated by R. M. Burns and B. H. Honkala, pp. 36–46. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.

Legault, J., W. Dahl, E. Debiton, A. Pichette, and J. Madelmont. 2003. Antitumor Activity of Balsam Fir Oil: Production of Reactive Oxygen Species Induced by α-Humulene as Possible Mechanism of Action. *Planta Medica* 69:402–407.

Little, Jr., E. J. 1971. *Atlas of United States Trees. Volume 1. Conifers and Important Hardwoods*. Miscellaneous Publication No. 1146. U.S. Department of Agriculture, Forest Service, Washington, DC.

Lopatin, I. A. 1960. Origin of the North American Steam Bath. *American Anthropologist* 62:977–993.

Meeker, J. E., J. E. Elias, and J. A. Heim. 1993. *Plants Used by the Great Lakes Ojibwa*. Great Lakes Indian Fish and Wildlife Commission, Odanah, WI.

Meng, Q., F. Fu, J. Wang, T. He, X. Jiang, Y. Zhang, Y. Yin, N. Li, and J. Guo. 2021. Ray Traits of Juvenile Wood and Mature Wood: *Pinus massonia* and *Cunninghamia lanceolata*. *Forests* 12, 1277. DOI:10.3390/f12091277.

Moerman, D. E. 1998. *Native American Ethnobotany*. Timber Press, Portland, OR.

Morehart, C. T., D. L. Lentz, and K. M. Prufer. 2005. Wood of the Gods: The Ritual Use of Pine (*Pinus* spp.) by the Ancient Lowland Maya. *Latin American Antiquity* 16:255–274.

Native American Ethnobotany Database: *Abies balsamea* [web pages]. Available at http://naeb.brit.org/uses/search/?string=Abies%20balsamea and https://naeb.brit.org/uses/species/2/. Accessed on December 21, 2024.

NC State University Libraries. Inside Wood. [web page] Available at: https://insidewood.lib.ncsu.edu/. Accessed on March 28, 2025.

Nekola, J. C. 1993. Ecology and Biogeography of Isolated Habitats: Fens and Algific Talus Slopes in Northeastern Iowa. Doctoral dissertation, Curriculum in Ecology, University of North Carolina at Chapel Hill.

Nekola, J. C. 1999. Paleorefugia and Neorefugia: The Influence of Colonization History on Community Patterns and Process. *Ecology* 80:2459–2473.

Panshin, A. J., and C. de Zeeuw. 1964. *Textbook of Wood Technology. Volume I— Structure, Identification, Uses, and Properties of the Commercial Woods of the United States*. 2nd edition. McGraw-Hill, New York.

Paper, J. 1997. *Through the Earth Darkly: Female*

Spirituality in Comparative Perspective. Continuum, New York.

Pichette, A., P. Larouche, M. Lebrun, and J. Legault. 2006. Composition and Antibacterial Activity of *Abies balsamea* Essential Oil. *Phytotherapy Research* 20:371–373.

Prufer, O. H., and K. M. Prufer. 2012. Ceremonial Use of Caves and Rockshelters in Ohio. In Sacred *Darkness: A Global Perspective on the Ritual Use of Caves*, edited by H. Moyes, pp. 225–236. University Press of Colorado, Boulder.

Reimer, P. J., plus 41 authors. 2020. The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 cal kBP). *Radiocarbon* 62:725–757.

Richter, H.G., D. Grosser, I. Heinz, and P.E. Gasson, eds. 2004. IAWA List of Microscopic Features for Softwood Identification. *IAWA Journal* 25:1–70.

Robertson, K. R., R. C. Anderson, and M. W. Schwartz. 1997. The Tallgrass Prairie Mosaic. In *Conservation in Highly Fragmented Landscapes*, edited by M. W. Schwartz, pp. 55–87. Chapman & Hall, New York.

Roufs, T. G., ed. 2019. *When Everybody Called Me* Gabe -bines, "Forever-Flying Bird": *Teachings from Paul Peter Buffalo* (3 volumes). Wise Ink, Minneapolis. Text also available online: https:// www.d.umn.edu/cla/faculty/troufs/Buffalo/ pbwww.html. Accessed on December 21, 2024.

Sabo III, G., J. E. Hilliard, and J. J. Lockhart. 2012. The Ritual Use of Caves and Rockshelters in Ozark Prehistory. In *Sacred Darkness: A Global Perspective on the Ritual Use of Caves*, edited by H. Moyes, pp. 237–246. University Press of Colorado, Boulder.

Salzer, R. J. 2005. The Gottschall Site: 3,500 Years of Ideological Continuity and Change. *Ontario Archaeology* 79/80:109–114.

Salzer, R. J., and G. Rajnovich. 2000. *The Gottschall Rockshelter: An Archaeological Mystery*. Prairie Smoke Press, St. Paul, MN.

Schrab, G., and R. F. Boszhardt. 2016. *Hidden Thunder: Rock Art of the Upper Midwest*. Wisconsin Historical Society Press, Madison.

Shea, K. L., and G. R. Furnier. 2002. Genetic Variation and Population Structure in Central and Isolated Populations of Balsam Fir, *Abies balsamea* (Pinaceae). *American Journal of Botany* 89:783–791.

Shepard, R. C., P. Bitterman, J. C. Archer, and F. M. Shelley. 2024. *Atlas of Iowa*. University of Iowa Press, Iowa City.

Skinner, A. 1926. Ethnology of the Ioway Indians. *Bulletin of the Public Museum of the City of Milwaukee* 5:181–354.

Slaughter, R. W. 2001. Terminal Pleistocene and Holocene Mammal Remains from Bogus Cave, Jones County, Iowa. Doctoral dissertation, Department of Geology, University of Iowa, Iowa City.

Smith, H. H. 1932. Ethnobotany of the Ojibwe Indians. *Bulletin of the Public Museum of the City of Milwaukee* 4:327–525.

Spurlock, L. B., O. H. Prufer, and T. R. Pigott. 2006. Conclusion: Ohio Caves and Rockshelters, from Prehistory to History. In *Caves and Culture: 10,000 Years of Ohio History*, edited by L. B. Spurlock, O. H. Prufer, and T. R. Pigott, pp. 444–457. Kent State University Press, Kent, OH.

Stambaugh, M. C., R. P. Guyette, E. R. McMurry, E. R. Cook, D. M. Meko, and A. R. Lupo. 2011. Drought Duration and Frequency in the U.S. Corn Belt during the Last Millennium. *Agricultural and Forest Meteorology* 151:154–162.

Starker, T. J. 1934. Fire Resistance in the Forest. *Journal of Forestry* 32:462–467.

Strelis, I., and R.W. Kennedy. 1967. *Identification of North American Commercial Pulpwoods and Pulp Fibres*. University of Toronto Press, Toronto.

Swan, D. C., and L. M. Simons. 2014. An Ethnobotany of Firewood in Osage Big Moon Peyotism: Practical Knowledge, Ritual Participation, and Aesthetic Preference. *Ethnobotany Research & Applications* 12:325–339.

Tarlow, S., and L. N. Stutz, eds. 2013. *The Oxford Handbook of the Archaeology of Death and Burial*. Oxford University Press, Oxford, UK.

Transeau, E. N. 1935. The Prairie Peninsula. *Ecology* 16:423–427.

Turner, N. J. 2014. *Ancient Pathways, Ancestral Knowledge: Ethnobotany and Ecological Wisdom of Indigenous Peoples of Northwestern North America* (2 volumes). McGill-Queen's University Press, Montreal.

Turner, N. J., P. Spalding, and D. Deur. 2020. Introduction: Making a Place for Indigenous Botanical Knowledge and Environmental Values in Land-Use Planning and Decision Making. In *Plants,*

People, and Places: The Roles of Ethnobotany and Ethnoecology in Indigenous Peoples' Land Rights in Canada and Beyond, edited by N. J. Turner, pp. 3–32. McGill -Queen's University Press, Montreal.

Turpin, S. A. 1994. Lower Pecos Prehistory: The View from the Caves. In *The Caves and Karst of Texas*, edited by W. R. Eliot and G. Veni, pp. 69–84. National Speleological Society, Huntsville, Alabama.

Uprety, Y., H. Asselin, A. Dhakal, and N. Julien. 2012. Traditional Use of Medicinal Plants in the Boreal Forest of Canada: Review and Perspectives. *Journal of Ethnobiology and Ethnomedicine* 8:7. DOI:10.1186/1746-4269-8-7.

van der Linden, P. J., and D. R. Farrar. 2011. *Forest and Shade Trees of Iowa*. 3rd ed. University of Iowa Press, Iowa City.

Walker, J. R. 1980. *Lakota Belief and Ritual*. University of Nebraska Press, Lincoln.

Wikipedia: *Abies balsamea* [webpage]. Available at https://en.wikipedia.org/wiki/Abies_balsamea. Accessed on December 21, 2024.

Wisconsin Center for Environmental Education. 2020. Facts About Wood. College of Natural Resources, University of Wisconsin–Stevens Point. https://www.uwsp.edu/wp-content/uploads/2023/11/keep-facts-wood.pdf. Accessed on December 21, 2024.

Wood, W. R. 1976. Vegetational Reconstruction and Climatic Episodes. *American Antiquity* 41:206–208.