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Brain-Tanned Leather for Bookbinding: History, Use, and Identification

INTRODUCTION

While researching an 1805 American frontier journal at the Missouri Historical Society, one member of this research team noted the particular qualities of the leather used to form the journal's wrapper. Unlike most vegetable-tanned skin, it was pliable and soft and had a suede surface. Considering the journal's provenance and context of historical production, brain-tanned leather seemed likely.

A search for supporting evidence and other examples brought this research group of four book conservators together. All members of the group were aware of this method of skin processing but were uncertain about the prevalence of the technique in bookbinding or possible identification methods. The use of brain-tanned leather has been well documented in various contexts of material production, but its prevalence within the history of bookbinding was unclear and understudied.

Catalog descriptions of bookbindings frequently conflate the type of animal skin, the manufacturing technique, and the function of that skin in the book structure. For example, leather from deer skin has been associated with chemises on medieval bindings. These outer wrappers are frequently described as "buckskin" or "deerskin" and assumed to be manufactured through brain tanning or fat tanning. The Appendix lists several examples of books with catalog records with unclear language. One aim of this study is to interrogate the presumptions upon which bookbindings are ascribed to certain animal skins and techniques.

Through examination of examples of confirmed or suspected brain-tanned or fat-tanned animal skins used in bookbinding, this study sought to establish the historical and geographic circumstances of use, to define physical characteristics, and to establish a set of visual identification techniques.

METHODOLOGY

This study focused on visual examination techniques as a means of identifying brain-tanned skin. Because advanced analytical equipment is often unavailable in libraries and archives, this study sought to establish parameters of identification that are practical to carry out with the equipment that many library conservation departments already have on hand.

HISTORY AND USE

Rubbing animal fat into hides is thought to be the oldest method of making leather, and one of the earliest written descriptions is found in Homer:

*As when some master tanner
gives his crews the hide of a huge bull for stretching,
the beast's skin soaked in grease and the men grab hold,
bracing round in a broad circle, tugging, stretching hard
till the skin's oils go dripping out as the grease sinks in*

– *The Iliad*, Book XVII

Brains as a source of fat for tanning has a deeper prehistory, and its use has been documented in Southern Europe, Scandinavia, Japan, Mongolia, Southern Africa, and North America. Similar to other fat and oil tanning techniques, it produces soft, stretchy skins that are suitable for making clothing, shelter, and bags. Brain tanning requires minimal tools and materials, and skins can be processed in several days, rather than the weeks or months required for vegetable or alum tawing. It is, however, very labor intensive, and was never adapted to industrial production (Richards 2004, 18–25).

In Europe, the practice of brain tanning seems to have been largely supplanted by vegetable tanning and alum tawing before the Western codex was adopted (Cameron 2011, 85–87), and European bookbinding traditions were developed using vegetable-tanned skins, parchment, and alum-tawed skins. The production of durable books usually required access to at least one of these as a covering material. It remains an open question whether any medieval European

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bookbindings used brain-tanned skins. Some bookbinding elements, like chemises, thong supports, and overcovers were made from soft skins that are clearly not vegetable tanned. However, these books were made in communities with access to other techniques for producing soft leathers, such as alum tawing and oil tanning (Lévêque et al. 2021). The tanning and tawing of naturally soft skins, like deerskin and fine goatskin (including the original chamois goat), is also well documented (Reed 1972, 165–167; Kite and Thomson 2006, 15).

In contrast, brain tanning was widespread among Native American nations until the mid-19th century. Prepared skins were a common item of trade between European colonists and Native Americans. Deerskins, both processed and raw, were a major export item, usually for use in buckskin clothing (Richards 2004, 20–25).

Animal skin coverings on books prior to 1900 are almost always vegetable-tanned leather, parchment, or alum-tawed skin. But, the same characteristics of being a soft, flexible, and strong sheet material, coupled with widespread availability in certain contexts, suggests that brain-tanned skins may be found at least occasionally. Because its use is unexpected, this material is likely to be underidentified or misidentified.

The authors found a few references to the possibility of brain-tanned skin in bookbindings, but no cited historical examples. Perhaps least helpfully, a 1945 guide to the conservation of books mentions the possibility of encountering skins made by “primitive peoples” and blithely instructs the caretaker to humidify, apply leather dressings, and mend tears with “any good leather cement” (Lydenberg and Archer 1945, 75–76). In her study of early American bindings, Julia Miller notes that some sewing supports that are described as being alum tawed may be brain tanned, as the material and knowledge of this manufacturing technique was available to early immigrants (2013, 272). A broader claim is made in a history of St. Louis, Missouri, where the author suggests a significant trade in brain-tanned deerskins brought to France for bookbinding:

Between 1772 and 1775, St. Louisans shipped 625,000 pounds of furs to New Orleans, including 215,000 pounds of shaved and brain-tanned (dressed) deer leather and over 133,000 pounds of raw deerskins, when prices for them soared in France but soured in England. La Rochelle developed a booming market for book-binding with deer leather, and many a gentleman’s library in fashionable France featured the “works” of Osage women along the “savage” frontier of Missouri. (Fausz 2011, 150)

Robert Espinosa refers to more recent use in his 1983 article on conservation rebinding, where he mentions as a footnote his interest in using brain-tanned skins as a substitute for vegetable-tanned or alum-tawed skin. And finally, a number of book artists have created bindings using brain-tanned skin, including works by Pamela Spitzmueller and Jim Croft (Yerkes 2006, 39; GBW 2021, 21).

HOW IT WAS MADE

Information on how brain-tanned skins were made is based on modern interpretation since there is little written historical information about the process. It is likely, however, that the fundamental steps are unchanged. The process of making brain-tanned skins includes the following, summarized from Richards (2004) and Nurse (2012):

Fleshing. The first step in the process is to scrape the flesh (underside) of the skin to remove fat and membrane. This is often done with the skin draped over a pole or beam with the flesh side up. The skin is then scraped with a draw knife or similar tool to remove the membrane.

Alkalizing (also referred to as bucking). The scraped skin is alkalized. Traditionally this was likely done by soaking the skin in a wood ash and water solution. This step further removes organic matter like mucus that would inhibit the penetration of the tanning oils found in the brain mixture.

Graining. Graining is one of the more distinctive steps in brain tanning. The epidermis and grain of the skin is removed by scraping, which allows for better penetration by the tanning agents. Since vegetable-tanned leathers do not require this step, the removal of the grain layer is one possible indicator of a brain-tanned skin.

Rinsing. After graining, rinsing removes the alkaline agents introduced earlier. Traditionally this step probably would have been done in running water, such as a stream. Modern approaches in still water are often facilitated with the introduction of weak acids, such as vinegar. Weak acids may also be introduced at this stage to impart a softer finish to the skin.

Membraning. This step is a second scrape of the flesh side to remove any last remainders of the membrane.

Wringing. Excess moisture is removed from the skin by twisting and squeezing.

Dressing. The dressing is the introduction of the brain matter. The brain is mixed with water until a soupy consistency is achieved, then additional water is added until there is sufficient quantity to allow the skin to soak. After wringing out, the steps are often repeated to ensure proper saturation with the fats.

Softening. Softening is achieved through physical manipulation of the skin.

Smoking. Smoking introduces aldehydes and ensures that the skin can be wetted out and dried repeatedly. It also

imparts the tan, yellow, or brown color often associated with “buckskin” leathers.

Skin preservation techniques are messy, both in process and categorization. The precise steps in brain tanning vary by community and tanner, and similar results can be achieved by substituting soap or other fats for brains. The same step can also be used in different tanning techniques, and vegetable-tanned and alum-tawed skins are also “dressed” to lubricate and soften the skin. Almost any available fat has been used for this step, including brains, livers, egg yolks, tallow, butter, and milk.

FINDING IT IN OUR COLLECTIONS

Brain-tanned skin is likely to be unidentified or misidentified in descriptions of bookbindings. When seeking potential examples in library catalogs, contextual clues and related search terms from the following categories may be helpful:

- Soft, flexible skins: tawed, alum tawed, chemise, reversed leather, reversed skin, suede, limp.
- Related preservation processes: oil tanned, chamois, fat tanned, smoke tanned, buckskin, organ tanned.
- Species-related terms: deerskin, buckskin, doeskin, elk skin, bison, buffalo.

While this project did identify examples of books that incorporate brain-tanned elements, these are more likely to be singular exceptions than part of any “book binding tradition.” Brain-tanned elements are most likely to be found outside of mainstream European bookbinding practice. These books might be found in circumstances analogous to the North American examples discussed below, i.e. books bound in communities that produced brain-tanned skins, or by people in a close trading relationship with those communities.

The authors encourage conservators and curators to more fully describe these materials to aid in their identification and to work towards a clear and consistent terminology. As conservators and curators bring the use of brain-tanned skins in bookbinding to light and find better ways to describe them in catalogs, they may also be in a position to improve how Native American nations, places, and relationships are described. This can include correcting inaccurate or harmful descriptions in catalog records or can include bringing to light connections that were ignored or marginalized. Some resources that the authors have found useful include the Native Governance Center (nativegov.org) and the National Museum of the American Indian (americanindian.si.edu).

PHYSICAL AND VISUAL CHARACTERISTICS

The appearance of a skin is influenced by many factors, including the species of animal, its age, added color, how it

was used, and its degradation over time. Some of these aspects correlate with the method of tannage and can be used in the identification of brain-tanned skins. For example, there are many objects that incorporate brain-tanned bison, deer, and elk skin, but not so many that use brain-tanned calf, sheep, or goat skin.

As noted above, the initial preparation of skins for brain tanning usually (but not always) includes removing the grain layer to allow the oils to fully penetrate the skin. Brain-tanned skins are initially quite stretchy and easily deformed. Cut edges do not maintain 90 degree angles, and slits can be pulled into soft, round holes (Emmerich Kamper 2020, 203–206).

Although both vegetable-tanned and brain-tanned skins can be dyed or painted to be a variety of colors, most vegetable tannins impart a medium brown, dark brown, or reddish color. Brain tanning initially produces skins that are off-white. Subsequent smoking can impart a variety of yellow, cream, gray, or light brown colors. Therefore, a dark brown, grain-on calfskin with crisp cut edges is unlikely to have been brain tanned, while a light brown skin with grain missing, soft edges, and stretched out areas from use, might be brain tanned (fig. 1).

Further examination under UV illumination can support the identification of brain tanning. Raw skins naturally fluoresce under UV illumination, and most preservation methods do not eliminate that fluorescence. Accordingly, rawhide, parchment, alum-tawed, urine-tanned, and brain-tanned skins all fluoresce. Vegetable tannins, however, strongly



Fig. 1. Samples of brain-tanned, alum-tawed, chrome-tanned, and vegetable-tanned skins under normal illumination. Note the suede surface texture and lack of grain layer in the brain-tanned samples.

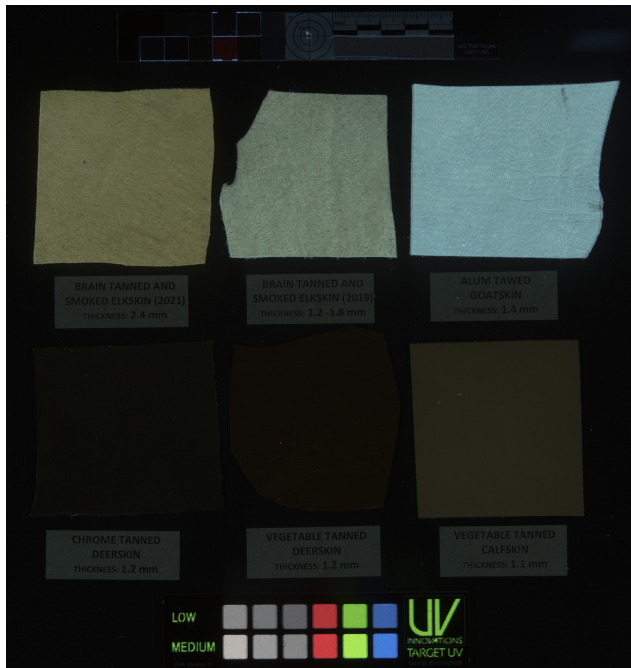


Fig. 2. The same samples as figure 1. Under UV illumination, brain-tanned and alum-tawed skins fluoresce, while chrome- and vegetable-tanned skins do not.

quench fluorescence, so a vegetable-tanned skin will appear almost black under UV illumination (fig. 2). Skins that have been dyed or painted with tannin-based colors will also appear black on the surface, though some fluorescence may be visible in cross section or abraded areas. Chrome tannage also quenches fluorescence (Reed 1972, 252–256), and the authors have observed that some modern leather dyes have a similar quenching effect.

In limp bindings, transmitted light can also help with identification. In strong transmitted light, rawhide, parchment, alum-tawed, urine-tanned, and brain-tanned skins show skin translucency. Vegetable-tanned skins do not. This difference is apparent even on very thick and very thin skins (Emmerich Kamper 2020, 106). The authors did not fully investigate chrome-tanned leather, but in the few examples they examined, no translucency was observed (fig. 3). For on-site inspection of books, the authors used a handheld ultraviolet lamp with 365nm 6 watt bulbs and a 350 lumen LED headlamp for transmitted light. For photographing the samples in figures 2 and 3, they used a 365 nm ultraviolet studio lamp and a transmitted light box with a 250 W bulb.

These physical and visual characteristics can suggest or support the identification of brain-tanned skins but do not provide conclusive identification. This evidence can suggest candidates for further analysis or eliminate possibilities from further evaluation. They can also be used to improve catalog records by more accurately describing notable features of a book. For example, a book described as being bound in



Fig. 3. The same samples as figure 1. Brain-tanned and alum-tawed skins allow transmitted light to pass, while chrome- and vegetable-tanned skins do not.

leather might be more helpfully described as being sewn into a soft animal skin wrapper, possibly buckskin.

IDENTIFICATION OF BRAIN-TANNED SKIN IN BOOKBINDINGS

Armed with the information above, the authors searched for examples in library and archival collections (see table 1). This search was frequently complicated by imprecise catalog descriptions, but examination combined with provenance revealed several clear trends.

For medieval European manuscript books, the search for brain-tanned skins centered on descriptions of the animal origin of the covers. Several dozen books with catalog descriptions related to “deerskin” or “doeskin” were examined but usually led to books with alum-tawed or vegetable-tanned deerskin covers or to books where the animal origin was unclear (or clearly not deer).

One example of a bookbinding that was evaluated is a 12th-century English manuscript in its original binding (MS G.65, Morgan Library & Museum, fig. 4). The manuscript was cataloged as bound in doeskin over wooden boards with a doeskin chemise. The chemise fluoresced under UV illumination. The fluorescence was partially masked by surface dirt and was more apparent at abraded areas and folds. A more recent vegetable-tanned leather repair on the chemise did not fluoresce. Based on the context of production

Institution	Call number or Identifier	Description in catalog leading to examination (e.g. deerskin, doeskin, or buckskin)
Library of Congress	Rosenwald 1	Deerskin
Library of Congress	Rosenwald 5	Giant Bible of Mainz, remnants of a chemise are visible
Library of Congress	Rosenwald 73	Doeskin
Library of Congress	Rosenwald 382	Doeskin
Library of Congress	Incun 1473 .V56 Thacher Coll copy 1	Deerskin
Library of Congress	Incun. 1476 .C36	Deerskin
Library of Congress	KB 90 Incun 1490.V6	Deerskin
Library of Congress	Ms. 209 Medieval and Renaissance Manuscript Coll	Buckskin
Library of Congress	BS1440 .B4 1640 Am Imp	The Bay Psalm Book in a Colonial American binding
Library of Congress	BX9070 .W7	Produced by early American printer Zadok Cramer of Pittsburgh. A number of his books are described as bound in deerskin in historical advertisements.
Library of Congress	F353 .C877	Printed by Zadok Cramer
Library of Congress	F353 .C878	Printed by Zadok Cramer
Library of Congress	F353 .C88	Printed by Zadok Cramer
Library of Congress	F353 .C89	Printed by Zadok Cramer
Library of Congress	F353 .C90	Printed by Zadok Cramer
Library of Congress	F353 .C91	Printed by Zadok Cramer
Library of Congress	F353 .C92	Printed by Zadok Cramer
Library of Congress	F353 .C922	Printed by Zadok Cramer
Library of Congress	F353 .C923	Printed by Zadok Cramer
Library of Congress	F592.5 .G2 1807	Printed by Zadok Cramer
Library of Congress	PS3157.W5 L3	Printed by Zadok Cramer
Library of Congress	Harkness Collection HC-M 2, Box 19A,19B	Sixteenth century Mexican and South American limp leather wrappers
Library of Congress	Kislak Manuscript 1015	Deerskin. Sixteenth century Central American manuscript
Library of Congress	George B. McClellan Journals	Early American journal
Library of Congress	Micajah McGehee journal (MMC-1910)	Early American journal
Library of Congress	Titian Ramsay Peale journals	Early American frontier journal
Library of Congress	Zebulon Montgomery Pike journal	Early American frontier journal
Library of Congress	George Carl Ludwig Preuss diaries (MMC-1959)	Early American frontier journal
Library of Congress	Theodore Talbot journals (MMC-2170)	Early American journal
Library of Congress	George Washington Papers, Series 1, Subseries 1B: Diary, March 11 – April 13, 1748 [New Calendar]	Suggested by curator
Library of Congress	James Wilkinson, Orderly Book, December 20, 1803	Early American frontier journal
Missouri Historical Society Archives	Clark Family Collection, v. 6. Elkskin Journal	Initially examined as part of related research project by team member
Morgan Library & Museum	MS B.28	Deerskin
Morgan Library & Museum	MS G.65	Deerskin and doeskin mentioned. Original binding with chemise
Morgan Library & Museum	MS M.105	Deerskin and doeskin mentioned
Morgan Library & Museum	MS M.123	Deerskin and doeskin mentioned
Morgan Library & Museum	MS M.326	Doeskin

(continues)

Table 1. List of Objects Examined

Institution	Call number or Identifier	Description in catalog leading to examination (e.g. deerskin, doeskin, or buckskin)
Morgan Library & Museum	MS M.631	Deerskin
Morgan Library & Museum	MS M.809	Deerskin
Morgan Library & Museum	MS M.824	Deerskin
Morgan Library & Museum	MS M.891	Deerskin
Morgan Library & Museum	MS M.901	Deerskin
Morgan Library & Museum	MS M.902	Deerskin
Newberry Library	Ayer 3A 540	Book of hymns in Cree described as bound in limp elk skin
Newberry Library	Ayer MS 733	Colonial American journal, Native American connection
Newberry Library	Ayer MS 978	Journal of Joseph Whitehouse, member of Lewis and Clark expedition known for his skill as a tailor with buckskin
Newberry Library	Ayer MS 1240	18th c. Mexican manuscript
Newberry Library	Ayer MS 1480	18th c. Mexican manuscript
Newberry Library	Ayer MS 1485	16th c. Mexican manuscript
Newberry Library	Case MS 93.3	Deerskin
Newberry Library	MS 27	Limp white leather cover
Newberry Library	MS 31	Deerskin
Newberry Library	MS 38	Deerskin
Newberry Library	Ruggles 393	Buckskin. Prayer book in Mohawk language
William L. Clements Library, University of Michigan	C2 1905 My	"Edition limited to five hundred copies ... Bound in Indian smoke tanned buckskin."
William L. Clements Library, University of Michigan	J 1794 Bi	Early American scaleboard binding, thongs described as possibly deerskin

Table 1. List of Objects Examined (*Continued*)

and intact grain layer, the chemise is probably alum tawed. The doeskin over the wooden boards is also likely alum tawed.

A search for handmade, limp leather covers led to the examination of several limp leather bookbindings from the 16th and 18th centuries from Mexico and Central and South America. However, most were bound in dark brown leather

with an intact grain layer, and the leather did not fluoresce or allow transmitted light to pass.

Two handmade American journals kept by members of the Lewis and Clark Expedition (1804–1806) were examined under UV illumination and with transmitted light. Both showed fluorescence and allowed light to pass through the thickness of the skin. In combination with their

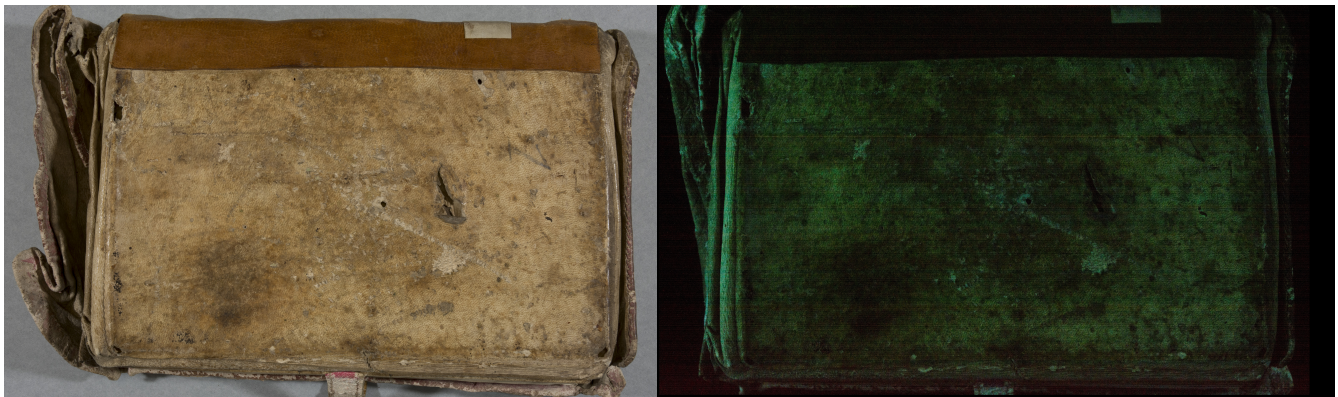


Fig. 4. *De Officiis*, England, 1150–1199. Courtesy of the Morgan Library & Museum. Normal illumination (left) and UV illumination (right). Fluorescence is partially masked by surface dirt and coloration, and more apparent at abraded areas and folds. More recent vegetable-tanned leather spine repair does not fluoresce at all. Based on context of production and intact grain layer, overcover skin is probably alum tawed.



Fig. 5. William Clark, Elkskin Journal, 1805. Courtesy of the Missouri Historical Society, St. Louis. Normal illumination (left) and detail under UV (right). Soft skin wrapper fluoresces and allows transmitted light to pass. In combination with color, tactile qualities, and a well-documented context of production, this evidence strongly indicates that the journal was bound in brain-tanned skin.

well-documented context of production, color, and tactile qualities, this provided near certainty that they were bound using brain-tanned skin (figs. 5 and 6). An 1841 hymn-book that was printed, bound, and distributed in a remote

Canadian mission was also examined. Similar visual qualities and evident interaction with the Cree Nation supported the strong possibility that it had been bound in brain-tanned skin (fig. 7).

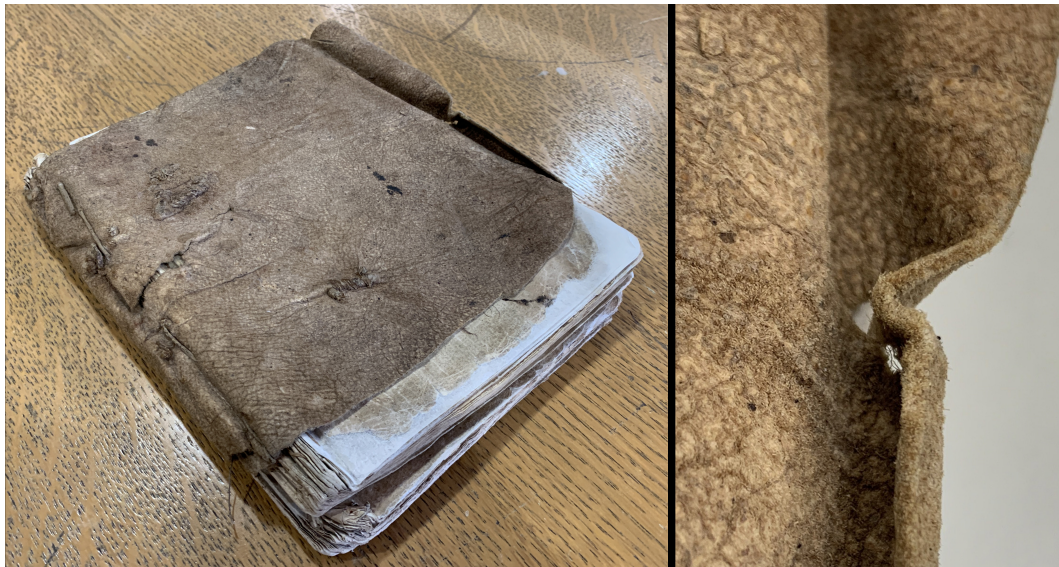


Fig. 6. Joseph Whitehouse, Journal Commencing at River Dubois, 1804–1805. Courtesy of the Newberry Library. Normal illumination (left) and detail of skin edge (right). This journal is closely related to the Elkskin Journal. The soft skin wrapper fluoresces, allows transmitted light to pass, and is likely made from brain-tanned skin.



Fig. 7. James Evans, [Hymns, Swampy Indians, their speech], 1841. Courtesy of the Newberry Library. Skin wrapper fluoresces and allows transmitted light to pass. Book was printed, bound, and distributed in a remote Canadian mission and was likely made with a brain-tanned skin wrapper.

A 1905 printed volume about frontier and pioneer life bears a note on its half-title that reads “Edition limited to five hundred copies. This is Number 285. Bound in Indian smoke tanned buckskin.” Upon examination, this binding material

appeared to have a soft surface texture without a grain layer, soft-cut edges, and an overall light brown color; it showed fluorescence under UV illumination. The subject matter and edition note suggested that the use of brain-tanned skin is likely (fig. 8).

FUTURE RESEARCH

This study demonstrated that visual and physical characteristics can support the identification of brain-tanned skins but not conclusively identify it. Further research would seek to confirm suspected examples of brain-tanned skin through analytical testing.

When sampling is possible, microchemical spot testing can usually differentiate brain tanning from visually similar techniques such as alum, smoke, or oil tanning. To identify alum-tawed skin, the sample is treated with a solution of aluminum (aurintricarboxylic acid ammonium salt); if the sample turns bright pink, the presence of aluminum is confirmed. To confirm that a skin has been brain, smoke, or oil tanned, the sample is treated with a hydroxylamine dye and heated; a bright yellow-green fluorescence confirms the presence of aldehydes, which are a marker of brain, smoke, and oil tanning. Brain-tanned skin can be differentiated from smoke or oil tanned skin by repeating the test on a positive sample.

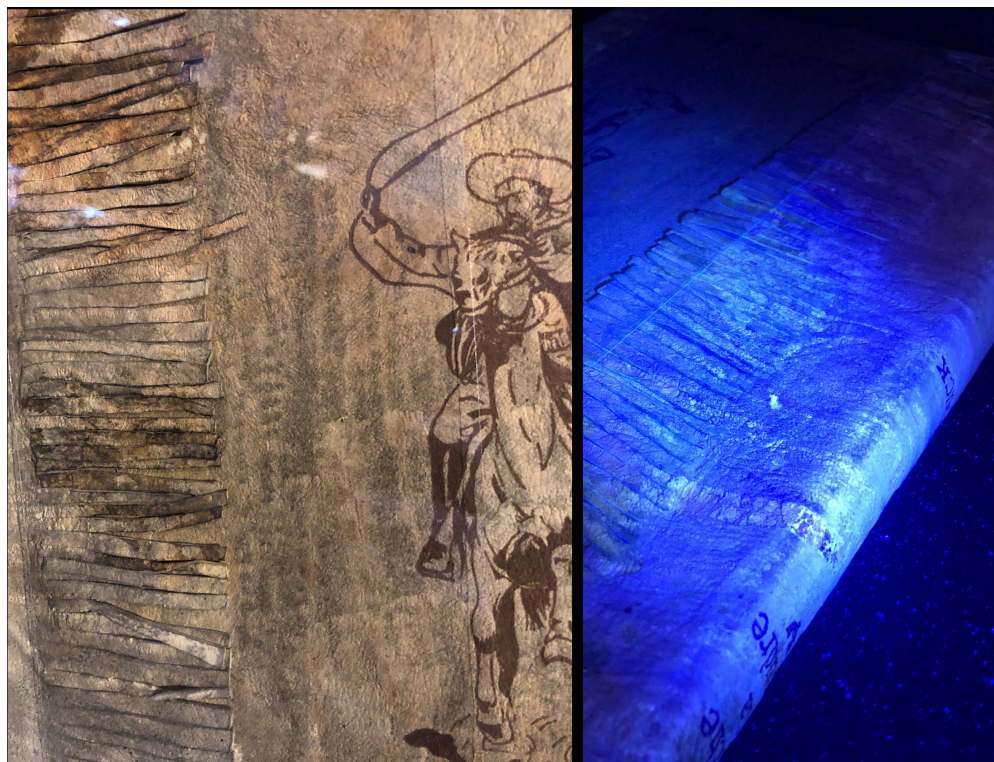


Fig. 8. Herbert Myrick, *Cache la poudre: the Romance of a Tenderfoot in the Days of Custer*, New York, 1905. Courtesy of the William L. Clements Library, University of Michigan. Limited edition advertised as being “Bound in Indian Smoke Tanned Buckskin.” Surface texture, flexibility of cut fringe, and fluorescence under UV (right) supports identification of brain-tanned skin.

If the sample still fluoresces upon the second round of testing, it is likely to have been brain tanned (Kite and Thomson 2006, 59; Pouliot and Kaplan 2012).

Biomolecular analysis may also prove useful. At present, several research groups are investigating the use of techniques like mass spectrometry and peptide mass fingerprinting to identify brain tannage and confirm the animal species of skins (Popowich 2022; Lévêque et al. 2021).

Limited analytical testing of leather samples was done at the Library of Congress in support of this research. Although preliminary, this confirmed the work of other researchers (Pouliot, Mass, and Kaplan 2015) showing that XRF was not a useful technique for distinguishing brain-tanned from alum-tawed skins. UV-induced visible fluorescence imaging indicated differences in the fluorescent emissions of an alum-tawed and a brain-tanned skin; further exploration of UV spectroscopy may reveal systematic differences in the wavelengths of the observed UV-induced fluorescence.

This study did not attempt to assess the long-term stability of brain-tanned skin or provide conservation advice. The authors suggest that conservators and curators review recent literature on conserving skins from allied conservation fields (Howatt-Krahn 1987; CCI 1992; Kite and Thomson 2006).

CONCLUSION

By combining visual examination with provenance information, this study established that brain-tanned skins were used for bookbinding within the context of North American book production with connections to Native American communities. Books described in catalogs as being bound in deerskin or even buckskin in a medieval European context were not shown to be brain tanned using the cited methodology. The classification of deerskin, doeskin, or buckskin in medieval bindings should be understood as a description of the physical qualities of a skin, rather than an indicator of skin species or method of skin preparation.

The authors hope that, by raising awareness of the use of this material in bookbindings, custodians of book collections will gain a better understanding of the context in which brain-tanned leather bookbindings were created and that the methodology discussed will assist in creating ever more accurate bookbinding descriptions in collection catalogs.

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REFERENCES

- Cameron, Esther. 2011. "A Question of Tannage: Leather from Anglo-Saxon Contexts." In *Leather Tanneries: The Archaeological Evidence*, edited by Roy Thomson and Quita Mould, 85–92. London: Archetype Publications.
- Canadian Conservation Institute (CCI). 1992. "Care of Rawhide and Semi-Tanned Leather." CCI Notes 8/4. Ottawa, ON: Canadian Conservation Institute.
- Emmerich Kamper, Theresa. 2020. *Determining Prehistoric Skin Processing Technologies: the macro and microscopic characteristics of experimental samples*. Leiden: Sidestone Press.
- Espinosa, Robert. 1983. "Specifications for a Hard-Board Laced-In Conservation Binding." *Book and Paper Group Annual* 2: 25–49.
- Fausz, J. Frederick. 2011. *Founding St. Louis: First City of the New West*. Charleston, SC: History Press.
- Guild of Book Workers (GBW). 2021. "Wild/Life: Guild of Book Workers Triennial Traveling Exhibition 2021–2022." *Guild of Book Workers Journal* 50.
- Howatt-Krahn, Ann. 1987. "Conservation: Skin and Native-Tanned Leather." *American Indian Art Magazine* (Spring). 44–51.
- Kite, Marion, and Roy Thomson. 2006. *Conservation of Leather and Related Materials*. Elsevier: Burlington, MA.
- Lévêque, Élodie, Matthew David Teasdale, Morten Tange Olsen, Sarah Fiddymont, Maiken Hemme Bro-Jørgensen, Claire Chahine and Matthew Collins. 2021. "Biocodicology as an aid to locating the origin of materials: Investigation into the use of sealskins on manuscripts in the 12th and 13th centuries". Presented at Care and Conservation of Manuscripts 18, Copenhagen.
- Lydenberg, Harry Miller and John Archer. 1945. *The Care and Repair of Books*. New York: R. R. Bowker.
- Miller, Julia. 2013. "Not Just Another Beautiful Book: A Typology of American Scaleboard Bindings." In *Suave Mechanicals*, vol. 1, edited by Julia Miller. Ann Arbor, Michigan: Legacy Press.
- Nurse, Luba. 2012. "Investigating organic materials: wet scraping, brain tanning and smoking of deer hide with Kfir Mendel 'Two Wolves'." *Interpretation & Conservation of Material Culture*. Blog. Accessed April 9, 2022. <https://lubanurse.wordpress.com/2012/02/04/organic-materials-wet-scraping-brain-tanning-and-smoking-of-deer-hide-with-kfir-mendel-two-wolves/>.
- Popowich, Aleksandra. 2022. "A Scientific Investigation of Emulsion-Cured Leather." Presentation at Research Out Loud: Met Fellows Present on May 24, 2022.
- Pouliot, Bruno, and Lara Kaplan (comp). 2012. "Tests for tanned and semi-tanned hide/skins." Unpublished notes from Winterthur/UD Program in Art Conservation.
- Pouliot, Bruno P, Jennifer Mass, Lara Kaplan. 2015. "Using XRF for the Identification of Chrome Tanning in Leather."

Poster presented at American Institute for Conservation 43rd Annual Meeting, Miami, Florida.

Reed, R. 1972. *Ancient Skins, Parchments and Leathers*. London: Seminar Press Ltd.

Richards, Matt. 2004. *Deerskins into Buckskins: How to Tan with Brains, Soap or Eggs*. 2nd Edition. Cave Junction, Or.: Backcountry Publishing.

Waterer, John W. 1946. *Leather in Life, Art and Industry*. London: Faber and Faber Limited.

Yerkes, Lawrence. 2006. "Bill Anthony: The Lineage of a Master." *The Bonefolder* 2 (2): 36–47.

GLOSSARY

The following glossary is offered as a starting point for understanding terms used to describe the referenced materials and is compiled from Waterer (1946, 158–170) and Emmerich Kamper (2020, 231–235).

Brain Tan: a variety of fat/oil tan that uses brains as the tanning agent.

Buckskin: 1) A processed skin, usually deer, that has been fleshed and then "bucked," or soaked in an alkaline solution prior to fat/oil tanning. 2) In more modern usage: a deerskin leather prepared by oil or alum tannage and with a suede finish. Used principally for clothing, gloves and footwear.

Chamois: Originally referred to genuine chamois goat pelts that had been oil tanned (or "shamoyed"). Later the term was applied to other oil tanned skins, principally sheepskin.

Doeskin: This term can refer to the prepared skin of a female deer, or in more modern usage, to a washable gloving leather prepared from sheep or lamb skins, usually the flesh split, mostly by the oil process but sometimes by the formaldehyde method.

Fat/Oil Tan: A tanning method that uses emulsified lipids (fats and oils) to produce a soft leather. A wide variety of lipids have been used, including animal fat, brains, bone marrow, liver, milk, butter, and egg yolks.

Oil Tan: A tanning method that uses oils which oxidize at low temperature (usually marine oils like cod oil, whale oil, and seal oil) as the tanning agent.

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