

Research Article

Roman Vávra*

Fish and Chaps: Some Ethnoarchaeological Thoughts on Fish Skin Use in European Prehistory

<https://doi.org/10.1515/opar-2020-0115>

received December 31, 2019; accepted August 18, 2020.

Abstract: The following study summarizes the available ethnographical, historical, and archaeological data about the use of fish skin as a material. Fish skin and the methods of its processing are described. The fish skin utilisation accounts from around the world are collected in an organized matter. Afterwards the various factors affecting the use of this material are discussed and some concluding remarks about the further research possibilities are proposed. The use of fish skin does not appear to be based purely on climate, subsistence strategies, or the availability of fish, but also on cultural norms and traditions. Careful hypotheses can be made by using relational analogies, but ultimately a re-examination of museum collections or new archaeological discoveries are fundamental in furthering this field of research.

Keywords: ethnoarchaeology, zooarchaeology, fish leather, prehistory, perishable materials

1 Introduction

Fish as a source of animal protein and fat has been exploited by humans for a considerable period of time. Fishing is well attested since the Palaeolithic, however its prominence in the subsistence systems of human cultures has waxed and waned during the ages. The role of fishing was also determined by the availability of fish. Some cultures have therefore evolved greater dependency on fish compared to others that merely supplemented their food with fish and other aquatic resources.

Meat and fat are not the only resources fish can provide. Bones, bladder, skin and even scales have had their uses. I will not go into describing each of those, as others have done so already (cf. Hurcombe, 2014; Irving, 1992; Rahme & Hartman, 2012, p. 66). In this paper, I will concentrate on fish skin and the various uses people around the world have had for it. By collecting the mainly ethnographic data I aimed to find and set down a summary of cultural and environmental traits leading to fish skin use. These findings can be then applied to the prehistoric populations in general, although Europe is my main area of interest. I have not included shark or ray shagreen (cf. Guth, 2015), though both shark and ray skin are mentioned several times in a slightly different context.

I believe that by collecting the available data and extracting the core traits, i.e. finding out what the factors leading to fish skin use are, we can make assumptions about past usage of this material. In this sense I lean closer to the “processualistic” approach. The results of such analysis are not universal and definitely not binding, as even with careful relational analogies they remain assumptions. I also recognize the uniqueness of some of the fish skin artefact occurrences, and the necessity to adopt a more “contextual” point of view.

This study is by no means the final result of my study of fish skin use in the past, but rather a starting point for both my own research and that of fellow researchers, who would draw on the subject. Whether it’s their own analysis of the available ethnographical and historical data, or the evaluation of new discoveries, this paper should provide a solid foundation for their work.

*Corresponding author: Roman Vávra, Slovak Archaeological and Historical Institute, Vajnorská 8/A, 83104 Bratislava, Slovakia, E-mail: vavra.roman@gmail.com

2 Method

Data collection was the most time-consuming part of the research. Depending on the point of view, there is either precious little literature or a myriad of sources on the subject. Many of the sources are sadly available only in the form of blog posts or articles on heritage-themed websites. Most of the ethnographic data available comes from the single most valuable paper on fish skin use by G. Berg (1984). The author collected information from a wide variety of sources mainly from Western and Northern Europe. He also mentions examples from Siberia. When possible, I verified his references, but otherwise I worked with what he presented. Another important source of knowledge was the book on fish leather by L. Rahme (Rahme & Hartman, 2012). Inside are several accounts of fish skin use worldwide and since Rahme is a leatherworking professional, the book contains many technological insights as well. Last but not least the works of L. Hurcombe (Hurcombe & Williams, 2002; Hurcombe, 2014) considered many important topics concerning possible fish skin use in prehistory (cf. Hurcombe, 2014, pp. 88–90). The author makes general statements on the properties and usage of fish skin, without analysing the cultural or environmental preconditions. I try to discuss this issue in the paper before you.

Other than the above-mentioned essential sources various others also provided the necessary “dots on the map”, as well as information about the ways fish skins have been used. While usually one would rather have complex data about fewer “dots” than lots of locations, in this case and under these terms (sparse data) each “dot” is valuable. The geographic locations enable us to make assumptions about the relation between climate and fish skin use, for example. An overview map is provided as Fig. 1. The precise ranges of fish skin use are obviously not possible to chart and the map is to be taken as an interpretation of the source (mostly ethnographical) data. Apart from the uses for eel-skin collected in Table 1, no other tables seemed appropriate as they would not make the many uses of different fish species any clearer than it is in the text. Eel-skin uses would clutter the text and bring no new information than the source material, so I added them to the table for clarity.

In the course of my occupation with the topic of fish skin use I tried to process fish skins into leather, so I could better understand the effort and knowledge needed. Using the methods described by L. Rahme (2012, pp. 39–41, 45–47) I tried tanning the skins with the three main methods – oil, vegetable and urine. The results were not meant to be a part of this paper, so I won't go into detail, the processes are however quite viable and the results usable (Fig. 2). It would certainly work better for people working with fish and/or leatherworks on a daily basis, providing an income of leather with every fish they processed.

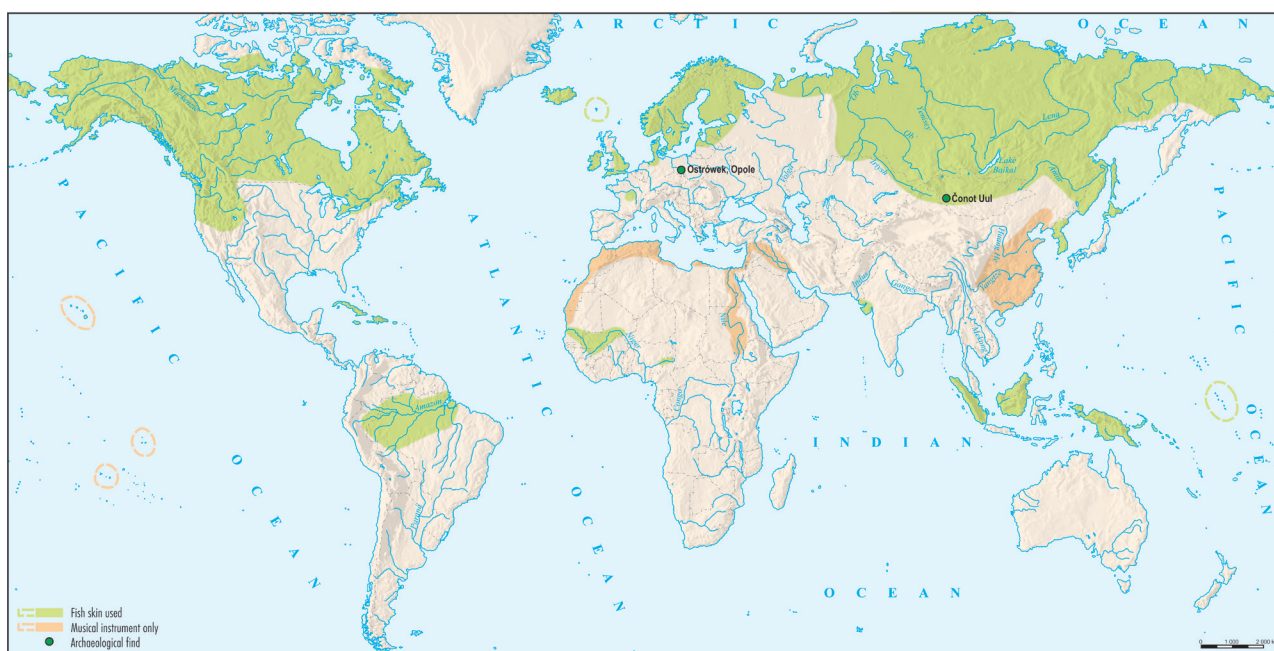


Figure 1: Overview map of documented fish skin use in the past. © Daniel Gurňák.

Table 1: Uses of eel-skin. Location accuracy according to the source.

Use	Location	Source
Flail links	Sweden, Norway, Denmark, Latvia, Lower Saxony, Ireland	Berg, 1984
Sack twine	Sweden	Berg, 1984
Harness-peg straps	Sweden	Berg, 1984
Bell straps	Sweden	Berg, 1984
Sheep neck straps	Sweden	Berg, 1984
Oar ties	Sweden (Medelpad, Ångermanland)	Berg, 1984
Ski bindings	Sweden (Ångermanland, Jämtland)	Berg, 1984
Spinning top whips	Sweden (Skåne)	Berg, 1984
Ropes	Sweden (Oland), Estonia	Berg, 1984
Animal harnesses	Sweden (Småland, Skåne)	Berg, 1984
Rucksack straps	Sweden	Berg, 1984
Eel net lashes	England (Gloucestershire)	Berg, 1984
Whip-lashes	Germany (West Prussia)	Berg, 1984
Shoemaker clamps	Sweden (Hälsingland)	Berg, 1984
Hairtie	Sweden (Östergötland)	Berg, 1984
Gun cases	Sweden (Ångermanland)	Berg, 1984
Lathe belts	Sweden	Berg, 1984
Belts, thongs, etc.	Sweden (Gästrikland)	Berg, 1984
Harvest gloves	Sweden (Hälsingland)	Berg, 1984
Cramp/gout medicine	Sweden (Småland, Uppland)	Berg, 1984
Rheumatism/ague prevention	England (Cambridgeshire), Ireland, German-speaking countries	Berg, 1984
Sacks, bags	Sweden	Berg, 1984
Buckshot pouch	Sweden (Värmland)	Berg, 1984
Medicine pouch	Sweden (Småland)	Berg, 1984
Coin bags	Sweden (Småland), France (Berry)	Berg, 1984
Tobacco pouch	Sweden, Finland, Estonia	Berg, 1984
Stocking shafts	Southern Lapland	Rahme & Hartman, 2012
Wristlets	Southern Lapland	Rahme & Hartman, 2012



Figure 2: Examples of finished fish leather. Commercially available catfish leather (top), two oil tanned and one vegetable tanned salmon skins (bottom left) and two vegetable tanned rainbow trout skins (bottom right). © Roman Vávra.

3 Fish Skin, Fish Leather

Before I start describing the various uses people worldwide have had for the skins of fish, some biological and technological background is required. Fish skin consists of two parts: the cellular *epidermis* and the mostly fibrous *dermis* (also known as corium). The epidermis is mostly transparent and secretes mucus, as anyone who held a fish in their hands will know. This mucus offers the fish some protection from the environment and potential pathogens. The dermis or corium is the part which provides the structure of the skin and which interests the leatherworker. It is composed of two layers of collagen fibres: the loose *stratum laxum*, which holds the scales, and the *stratum compactum* underneath, which is made of orthogonal collagen bands. These provide the skin with its firmness and toughness (see Elliott, 2011, pp. 476–478, 484). Processing the skin effectively removes the epidermis and only the dermis remains.

3.1 Fish Skin Processing

Before the skin of a fish (or any animal) can be used, it must be processed. Several methods can be used. They are mostly the same as are used in the processing of mammal hides, although there are specifics unique for the processing of fish skins. The temperature at which deterioration starts is lower for fish skins than for mammal hides, with 20 °C usually cited as a threshold which should not be crossed. Fish skins are also more stretchable lengthwise than in the other direction. Finally, they require more softening than mammal hides, but are tougher due to the different distribution of collagen fibres (cf. Rahme & Hartman, 2012, pp. 15–16, 54; Hurcombe, 2014, p. 90).

When processing skins, one has two options – to tan or not to tan. Not tanning the skin and just drying it makes rawhide, and this was possibly the most common choice by many peoples in the past (see below). Rawhide is not leather, therefore it is better to use the term “fish skin” rather than “fish leather”. It is only after the tanning process that the skin becomes leather, and for some purists only vegetable tanned (i.e. using natural tannins from plant matter) skins are considered really “tanned”. For the sake of simplicity, I will call the other processes “tanning” as well.

Since this paper deals with Prehistory we can rule out modern tanning methods such as chrome-tanning. This leaves us with the following methods: vegetable tanning, oil tanning, mineral tanning, and aldehyde (smoke) tanning. Combinations of different tanning methods are also possible. For example, oil tanning followed by smoking is common for brain-tanned buckskin. According to Forbes (1966, pp. 19–21), tanning was known in Europe since the late Neolithic,

with oil and smoke tanning being the oldest, followed by vegetable tanning and in certain regions also mineral tanning. In the following paragraphs I will describe these methods.

Oil tanning can be done in several different ways, although the principle remains the same – water in the skin is replaced by emulsified fat molecules, which bind themselves to the collagen fibres (Rahme & Hartman, 2012, pp. 40–41; Forbes, 1966, p. 8). The oils used in this type of tanning can come from animals (e.g. brains, tallow or fish oil) and their products (egg yolks, milk, butter), or oil-bearing vegetables (palm oil, rapeseed oil, olive oil). Historically these largely depended on the availability of resources. We can safely rule out the likes of palm oil in the Prehistory of Continental Europe. The same can be said about egg yolks, as the domestication of chicken (the first fowl species to be domesticated) occurred probably in the Late Iron Age and the first chickens did not provide eggs in the same quantities as the chickens of medieval and later periods (cf. Kyselý, 2010; Benecke, 1993).

There is one more method of oil tanning that I haven't mentioned yet, often separated from the other oil-tanning methods – tanning in urine. This method also relies on oils binding to the collagen, but instead of adding oil from external sources, the skin's natural oils are used. By letting the urine decompose, ammonia is released. This ammonia in turn, transforms the natural fats in the skin into fatty acids and glycerol, which are able to penetrate the skin and replace the water, effectively tanning the skin (Rahme & Hartman, 2012, pp. 38–39). There is evidence for tanning fish skin in this way in Northern America (see below).

Vegetable tanning uses tannins contained in plant matter. Tree bark, roots and other materials like nuts or oak galls can (and have been) used. Water molecules in the skin are replaced by the tannin molecules, binding the collagen chains (Rahme & Hartman, 2012, pp. 44–45). Forbes theorises that vegetable tanning might have started as a by-product of dyeing the hides in vegetable-infused baths, or simply because of immersing the skins in tannin-rich forest pools (Forbes, 1966, pp. 6–7). This type of processing not only tans the skin, but also dyes it with shades of yellow, red or brown, depending on the tree and the part used. The differences between the tanning solutions made from different plants (caused by non-tanning materials such as sugars, acids, etc.) also determine the attributes of the finished leather (Forbes, 1966, pp. 6–7; Rahme & Hartman, 2012, pp. 44–45).

Mineral tanning uses inorganic substances as the tanning agent. Historically alum (potassium alum) has been used in parts of the world where it occurred naturally in its pure form, such as the Mediterranean or Middle East. It is possible to extract alum from shale, although the earliest evidence for this comes from the 15th century (Singer, 1948). Alum tanning, also known as “tawing”, usually produces a white leather which is not very resistant to water (Forbes 1966, p. 7).

Finally, aldehyde tanning uses formaldehyde and other aldehydes as the tanning agents. In prehistory this could be done by smoking the prepared hides over smoke pits or in smoke tents, as we see from ethnographic evidence (cf. Binford, 1967; Forbes, 1966, p. 20). Smoke-tanning was probably seldom used by itself, instead forming a part of a combination (e.g. oil and smoke, urine and smoke).

Ethnographic evidence mentions urine (Inuit) as tanning agents for fish skin (Rahme & Hartman, 2012, pp. 38–39). G. Berg describes what is essentially oil-tanning in his account of eel-skin sack manufacture (Berg, 1984, p. 96). The Alaska Native peoples supposedly use smoke-tanning, though this probably complemented washing in urine (Fienup-Riordan, 2007). Otherwise the process is not mentioned. In some cases fish skins are used as rawhide, softened mechanically by hammering the dried skins until pliable (Rahme & Hartman, 2012, p. 8).

The method chosen probably depended on the technological level of the society in question, but also on the intended use for the product. One community might have tanned their fish skins for finer products while at the same time used raw skin bindings and harnesses.

3.2 Fish Skin Properties and Reasons for Its Use

The reasons for using fish skin instead of other materials have probably been mostly practical. Depending on their subsistence strategy, a community may have access to a large amount of fish skins (otherwise eaten or discarded) and/or a lack of other sources of leather. Even if there are other options, such as mammal hides, the abundance of fish might lead to the utilisation of this supplemental source. Therefore, availability is one of the main reasons for possible fish skin use.

Fish skins are stronger and more durable than mammal hides of comparable thickness (cf. Rahme & Hartman, 2012, pp. 15–16). While for the modern person accustomed to a myriad of synthetic materials for every possible purpose this might not mean a lot, certainly for people with limited resources this widens the range of options.

Another reason for making use of fish skin is the texture of the surface. Some fish have skins that even without the scales (removed during the processing) provide good grip on mittens or traction of the soles of footwear on snow. Eel-skin ski bindings supposedly do not creak and therefore are useful when hunting (Berg, 1984, p. 92). Last, but not least, the skins of fish are waterproof when processed properly (Rahme & Hartman, 2012, p. 11). Waterproof materials were certainly in high demand in times before modern plastic, rubber, etc.

Some sources attribute medicinal properties to skins of certain fish. G. Berg (1984, p. 94) mentions several of these (see below). Recently, burns of the skin have been successfully treated with tilapia skins (Whitaker & Garcia, 2017, May 25; Bruillard, 2018, January 26). The process uses sterilised tilapia skins and was used on both human and animal patients. It is questionable whether using unsterilized fish skins in the past would provide more harm than benefit to the patients, and certainly there are no accounts of fish skin being used this way before.

I would rather not delve too much into matters of tradition and religion, as this is better suited for another paper. However, in the next part of this study I do mention these cultural or spiritual reasons for fish skin use, when appropriate.

4 Geographical Distribution of Fish Skin Use

The distribution of fish skin utilisation around the globe is far from uniform. There are regions where fish skins have been used for a long time and are still in use today, if only as a part of heritage preservation efforts. We can count in Alaska, parts of China and Russia, and the Western Asia/Northern Africa (WANA) region. In other parts of the world fish skins are no longer in use except as novelty leather in the last few decades. This entails the majority of countries where ethnographic evidence about past fish skin use is available. Then there are countries and regions immediately adjacent to those which are known for using fish skins, but they offer no information on this matter. For example, there are accounts from the fens of England, but not from Wales or Scotland – quite possibly fish skins could have been used in a similar manner even in the neighbouring countries, we just lack the evidence.

This chapter presents the findings in a digestible manner, thus sacrificing some information found in the raw data. Regions with documented fish skin use are shown on the map in Fig. 1. The two categories shown let us see the regions where fish skins were used only as musical instrument parts (mostly drum membranes), and those where people used the fish skins in various ways, musical instruments included. While certainly not definitive, I believe the map provides the necessary overview; for more accurate work specialised maps should be made.

4.1 Europe

In Europe the largest amount of recorded uses comes from the Nordic countries, with Sweden being the most prominent. Most of these are from the already mentioned work of G. Berg (1984), who collected many ethnographical accounts by various scholars, including Carl Linné (Linné, 1751, p. 30) and Olaus Magnus (Magnus, 2010, p. 1006). In the Nordic countries, fish skins have been used for all kinds of straps, belts, and pouches, occasionally even for clothing and footwear. The fish used for these purposes were mainly burbot, salmon, wolffish, and most importantly eel. The spectrum of eel-skin uses is so large it can rival that of mammal leather (see Table 1). What is both interesting and important to note is that apparently eel-skins were traded in certain parts of Sweden. In Härjedalen, the skins were transported from Västergötland, and in Dalarna skins from Hälsingland could be found (Berg, 1984, pp. 97–98). This shows that in these regions people valued eel-skins highly enough to trade them over some distance. I will come back to this fact later.

Apart from the Nordic countries, eel-skins have been used to make flail links in Latvia, Lower Saxony and Ireland (Berg, 1984, p. 92). In Cambridgeshire, Ireland and some German-speaking countries, eel-skins have been used as prevention against rheumatism and ague (Berg, 1984, p. 94). Strips of eel-skin were used to tie eel nets in Gloucestershire

(Berg, 1984, p. 93). From the literature we can presume that in the Berry region of France, purses were made of eel-skin (Sand, 1857, p. 288). Tobacco pouches were made of this material in Estonia, as well as ropes (Berg, 1984, pp. 93, 98).

Burbot skin, while not as universal as eel-skin, was also quite widely used. Many of the uses were similar to that of eel-skins, such as flail-links, bags or purses. More specific uses of burbot skin include the mending of cracks on glass window-panes or covering of cracked bottles with the skin flayed in one piece. Salmon skin caps are reported from the Sami people in eastern Finnmark. Catfish and porbeagle skins were used to make footwear in the Faroe Islands (porbeagle), Norway and Iceland (catfish), though the shoes didn't last long (Berg, 1984, pp. 98–100). Some examples of Icelandic catfish shoes can be found in the SARPUR online database (<http://sarpur.is>). Rahme adds wolfish, lumpfish and also sharks to the list of skins used for shoemaking. Plaice was used recently (during World War II) in Denmark and cod, wolffish, flounder and salmon in Norway to make shoes as well (Rahme & Hartman, 2012, pp. 10–11, 20, 22, 27, 38). Skins of a “large fish” were used as window-panes in the Lofoten Islands (Berg, 1984, p. 99).

In Central Europe supposedly the skin of sturgeon, mainly beluga sturgeon, has been used. Primary historical or ethnographical sources are not easy to obtain. It is often stated in works on sturgeon conservation (cf. Reinartz, 2002, p. 21; Gessner et al., 2010). From my experience, sturgeon leather is quite tough and thick, difficult to soften. The scutes limit the usable surface of the leather for many products where larger plain surface is needed. Large sturgeons would seem to be preferable, because they would have larger scute-free skin surfaces. However, for some applications even parts of the skin with scutes are usable, as can be seen on modern novelty leather products such as shoes and handbags.

A singular archaeological find comes from the site Ostrówek in Opole, Poland. There a strip of eel skin has been discovered in an Early Medieval (9th century) context. Several finds of archaeological leather are known from this site, many of which are the remains of footwear. The author of the eel skin analysis states that the fragment probably wasn't treated in any way and there are no signs of sewing (Radek, 1981). Since it was supposedly well preserved and the conditions in Opole were neither dry nor salty, we can presume it was actually preserved in some way. Otherwise, it would hydrolyse in waterlogged conditions, and simply rot away in others (see below). I believe we can also rule out the possibility that this skin was just kitchen refuse. It might have been stored for further use in crafting, whether for making footwear or some other purpose.

4.2 Asia

While in Europe the use of fish skins waned during the 20th century, with a brief revival during World War II (see Rahme & Hartman, 2012, pp. 20, 38), in parts of Asia the production of fish skin items continues until today. The Nanai/Hezhe people of the Amur basin (eastern Russia and north-eastern parts of China) still make their traditional summer clothing from fish skins (Fig. 3). Rahme states that only fish of 50 kg or more are used for this, and I will return to this statement later. Another interesting fact is that the skins are merely scaled, dried and then beaten with a wooden mallet; no tanning is used. Another use for fish skins among the Hezhe is the making of paper (Rahme & Hartman, 2012, p. 8).

G. Berg describes (Berg, 1984, p. 101) various uses for burbot, salmon, sturgeon and pike among the peoples of Siberia: Khanty, Ket, Yakut, Nganasan, Yukaghir, Siberian Yupik and Oroquen. The range of fish skin products includes bags for storing dried geese or fish fat (Nganasan), dried fish (Khanty), and various foodstuffs (Ket). Child-carrying bags were also made by the Nganasan people, and the Khanty are reported to have used burbot skin as window-panes. In the British Museum collection, a sieve made by the Khanty using fish skin is found (British Museum Collection Database, “As1898,0702.39”).

The Nivkh were another fish skin using people of Siberia. VanStone mentions (1985, pp. 4–7, 10) garments, tobacco pouches and even tents made of fish skin in his anthropological study of the Northern Sakhalin. There are also items in the British Museum collections made by Nivkhs from fish skin (British Museum Collection Database, “As1896,-583”, “As1896,-580”, “As1975,Q.2”). More Nivkh fish skin items can be found in the Musée du quai Branly – Jacques Chirac (Figs. 4, 5).

The Ainu of Japan and Russia used fish skin for footwear and other products as well. A pair of shoes made of salmon skin can be found in the British Museum collection (British Museum Collection Database, “As1885,1219.34.a-b”). They also made coats similar to the Nanai/Hezhe ones (cf. Hokkaido Museum, p. 8, Fig. 3).

A peculiar artefact from Edo period Japan, more specifically the early 18th century, is in the collection of the British Museum. It is a netsuke representing a dried fish (salmon), made of wood, lacquer, nacre and fish skin (British Museum



Figure 3: Hezhe (Nanai) fish skin jacket and pants from the collection of Shanghai Museum. © Rolf Mueller/Wikimedia Commons, CC BY-SA (<https://creativecommons.org/licenses/by-sa/3.0>).



Figure 4: Nivkh-Nanai fish skin boots from the collection of Musée du quai Branly – Jacques Chirac. © Marie-Lan Nguyen / Wikimedia Commons, CC BY 4.0 (<https://creativecommons.org/licenses/by/4.0>).



Figure 5: Nivkh fish skin mittens from the collection of Musée du quai Branly – Jacques Chirac. © Marie-Lan Nguyen/Wikimedia Commons, CC BY 4.0 (<https://creativecommons.org/licenses/by/4.0>).

Collection Database, “F.1078”). The fish skin here is used purely for decorative purposes. Also from Japan, we know of the *oroshiki*, graters made from shark skin used to finely grate vegetables.

The 13th century Mongolian Khagan, Kublai Khan, supposedly ordered fish-skin slippers from Korea (then Goryeo) to help with his gout. This information seems to be regularly mentioned in almost every biography of Kublai Khan that I came upon (e.g. Bartlett, 2009, p. 214; Rossabi, 2009, p. 98; Man, 2012, p. 247). What varies is the place of manufacture – the slippers were either made in Goryeo, or only the skin of a special kind of fish from Korea was imported and presumably made into slippers by Kublai Khan’s own craftsmen. It is intriguing that the fish skin was attributed medical properties (cure for gout) in a similar manner as is the case in North-Western Europe (see above).

In China the *yugu* or “fish drum” is a type of long, cylindrical drum made of bamboo. For the head of the drum snake or fish skin is used. The instrument is one of the attributes of Zhang Guo, one of the Eight Immortals (Yetts, 1916, pp. 784–785). It is made and played in China even today.

The south of Asia also has its share of fish skin use. Shark skin shoes made on the Kathiawar peninsula of India are in the collection of the British Museum (British Museum Collection Database, “As.8964.a-b”). Whilst this is the only mention of fish skin use from the Indian Subcontinent I have found, it is significant due to its location in the tropical climate zone. Another museum piece from this zone comes from Borneo in the form of a sleeveless jacket made of barkcloth and fish skin (British Museum Collection Database, “As1895,1112.8”). From Sumatra, we know of a shield made of wicker covered by shark skin (British Museum Collection Database, “As1971,05.1”), and a tambourine with a fish skin head (Morris, 1914, p. 15). All of these finds can be dated to the 19th century.

A spectacular find from Čonot Uul in western Mongolia (Bemmann & Nomguunsüren, 2012; Törbat, Batsüch & Batbajar, 2012) provides us with the only fish leather product from an archaeological context known to me at the time of writing this study. The item in question is a small belt pouch (Fig. 6). The shape is typical for the period, only the material is unusual. It was found in a cave burial site in a grave containing the bones of two male individuals. Among the finds were a bow, a quiver with arrows, and several small artefacts made of iron or wood. Radiocarbon dates (Bemmann



Figure 6: Fish leather pouch from Čonot Uul, Mongolia and its contents. © Jürgen Vogel/LVR-LandesMuseum Bonn (<https://www.uni-bonn.de/neues/014-2012>).

& Nomguunsüren, 2012, pp. 210, 217, note 41) for the site place it into the period of the Liao Empire or Khitan state (907–1125 AD). The material of the belt pouch is fish leather, and while the species of the fish could not be determined by microscopic analysis, the authors presume it is made of a member of the snakehead family due to the size of the scale pockets and the geographic location of the find (Törbat, Batsüch & Batbajar, 2012, p. 276). Inside the pouch were two coiled leather thongs, a wooden toggle, a sheep astragalus, and another smaller pouch, containing a firesteel and tinder. The sheep astragalus could be used for ritual purposes, possibly connecting the whole pouch with shamanic or similar practices (Holeščák, personal communications, December 19, 2019).

According to A. Taşağıl (2009, p. 395) the Shiwei people of the 10th century AD used to make clothes from fish skin or leather. He mentions no source for this claim although it corresponds with the dating and very roughly with the geographic region of the abovementioned find from Čonot Uul.

In the western Asian countries, including but not limited to Iraq, Syria, Palestine, and Lebanon, the membranophones such as *riq/tār* or *tabla* can be headed with goat or calf skin, (or recently with synthetic membranes) although fish skin was supposedly used traditionally (Stottlemeyer, 2014, pp. 46, 50, 88). The skins used for this purpose are not tanned, only cleaned and stretched over the frame when wet, affixed by means of glue or string (cf. Stottlemeyer, 2014, p. 52). Sturgeon or ray skins are mostly used (Stottlemeyer, 2014, p. 50), while Rahme (Rahme & Hartman, 2012, p. 12) also mentions Nile perch.

In the Sinai Peninsula, the Asian part of Egypt, the majority of the local Bedouins supposedly used to wear fish skin sandals, at least in the first half of the 19th century (Watts, 1842, p. 206). This ought to be accepted with caution, as another explorer, E. Robinson describes sandals made of “the thick skin of a fish which is caught in the Red Sea” worn in the same area (Robinson & Smith, 1841, p. 171). He then goes on to state that the “fish” in question is *Halicora hemprichii*, which is an archaic scientific name for the *Dugong dugon* or simply dugong (Shoshani, 2005, p. 92). Whether the fish skin reported by Watts truly is from fish or from a sea mammal such as the dugong is not clear.

While there is no archaeological support for this claim, we might consider the possibility there once was a practice of making garments from fish skins in ancient Mesopotamia. Figures clad in fish-shaped capes thought to be priests or sages (*apkallu/abgal*) are found on art since the Bronze Age Kassite period (ca. 1600 BC–1155 BC) and continue well into the time of the Achaemenid Empire, possibly even during the time of the Seleucid Empire (Black & Green, 1998, pp. 82–83). While these depictions are of a mythological nature, they might have been inspired by earlier garments made

of fish skin. Or, vice versa, stories involving priests wearing fish as capes might have inspired real fish skin vestments. One particular depiction on a cylinder seal dated to the Neo-Assyrian period in the collection of the Vorderasiatisches Museum in Berlin shows the priest not only wearing the fish cape but also a tight-fitting sleeveless garment and high boots with similar texture (Vorderasiatisches Museum Sammlung Online-Datenbank, Ident.Nr. “VA 07825”). Again, it is impossible to see this as evidence for real fish garments in Mesopotamia, but the depiction might have some real basis that served as an inspiration.

4.3 Africa

In the Maghreb region (Libya, Tunisia, Algeria, Morocco, Mauritania, and Western Sahara), Egypt, and Sudan, fish skin is also used as the head of drums and similar musical instruments. As in the Near East, *tabla* and *riq/tār* are the most prominent. As for the materials and construction, it is the same as in the Near East (see above). One of the fish used for this purpose is the *bayad* (*Bagrus bajad*), a bagrid catfish native to Africa (Schaeffner, 1943, p. 148). Another drum used by the Bata people of northern Cameroon is headed by the skin of the *fahaka* pufferfish (*Tetraodon lineatus*). The body of the drum is made of a broken rim of a pot and the instrument is considered a children’s toy (Schaeffner, 1943, pp. 144–147).

Fish skin parchment has been used in the making of a 15th century Qur’an in the collection of the Mama Haidara Library in Timbuktu (Robert Goldwater Library Blog, 2009). On the other hand, the restrictions of 16th century Jewish law do not permit the use of parchment made of fish skin for writing verses from the Torah (Schulchan Aruch, Orach Chayim 32:12; cited from <http://www.sefaria.org>). If there is a need to forbid something (using fish skin parchment), it is probably quite conceivable fish skin parchment was employed for other purposes. Interestingly, there are charms in the Kabbalah that specifically call for fish skin to be used as parchment (Swart, 2013). Continuing with the parchment excursion beyond the borders of this chapter, there is supposedly a Bible written on fish skin in Iran (Membrado, 2015, November 21), although the veracity of this claim cannot be proven.

A sword from East Africa purchased by the British Museum from the Church Missionary Society has the hilt and scabbard covered in “leather and fish skin” (British Museum Collection Database, “Af1953,24.60a”, “Af1953,24.60b”). The dating is not specified, neither the estimate of the fish species used. Here the fish skin had probably a merely decorative function.

4.4 Australia and Oceania

The inhabitants of Oceania spend most of their lives close to the water and fishing is often vital to their subsistence. It is therefore unsurprising that the use of fish skin is known from Oceania as well. It is, however, mostly limited to drum heads, whether it’s the Hawaiian *pahu* and *puniu* (cf. Morris, 1914, pp. 48–49) or the drums from Raivavae, Tahiti (British Museum Collection Database, “Oc,LMS.20”, “Oc.6961”, “Oc1854,1229.139”, “Oc,TAH.21”, “Oc,LMS.82”), and Marquesas (Hooper, 2006, p. 155) in French Polynesia. Papua New Guinea has also seen this kind of fish skin use quite recently (British Museum Collection Database, “2008,2007.1”). The *gama* drum of the New Guinea Kiwai people was usually made with monitor lizard skin, although on the Goaribari island the Kiwai used pufferfish as the source of the drum head (Horniman Museum & Gardens Collection, no. 6.173).

Pufferfish was the fish of choice for making the *tebarantauti*, a helmet from the Kiribati. The pufferfish is killed while inflated and buried in sand to dry out (O’Riordan, 2013). Other sources claim the skin of the pufferfish is dried in the sun (Clark, undated). The helmet was worn alongside other pieces of armour – the coconut fibre cuirass *te tana*, sometimes reinforced with ray skin (British Museum Collection Database, “Oc1904,0621.29”), and a belt of ray skin *tekatibana* (O’Riordan, 2013; Clark, undated). Complemented with weaponry utilising shark teeth, the whole panoply must have looked terrifying and probably had a symbolic meaning of obtaining the power of the animal used in its manufacture (O’Riordan, 2013).

Fish skin rasps were used by some peoples in Oceania as well. There are several examples from Papua New Guinea (British Museum Collection Database, “Oc1878,1110.24”, “Oc1878,1110.25”) and another from the Santa Cruz Islands (British Museum Collection Database, “Oc1944,02.1203”) in the British Museum. The fish in question are various species of ray and sharks.

4.5 Northern America

Fish skins have been used in parts of Northern America by the First Nations, the Inuit and other indigenous peoples. The Alaska Native people utilised fish skins for various crafts, as several ethnographers report (Jackson, 1888, p. 491; Nelson, 1983, p. 31; Osgood, 1940, pp. 155, 248; de Laguna, 1972, p. 426; Berg, 1984, p. 101; Hickman, 1988, Fienup-Riordan, 2007, p. 194). Nadia Jackinsky-Sethi published an article about fish skin use in Alaska recently (Jackinsky-Sethi, 2014), in which she sums the historical accounts and complements them with interviews with contemporary Alaska Native artists. Many fish species were used (including lamprey eel, halibut, burbot, grayling and Arctic char), but the most prominent of these are the different salmon species – the Chinook or king salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), chum (*O. keta*), sockeye (*O. nerka*) and pink salmon (*O. gorbuscha*). Various articles of clothing and other items such as diapers, window covers or quivers were made from this material (Jackinsky-Sethi, 2014, pp. 40–41; Lantis, 1947–51).

For the Alaska Native peoples fish have not only had an economical role, but also a cultural and deeply spiritual one. For example, when the catch is used well, the fish would return to the people and sustain them again. It is also a part of the peoples' identity, as their lives are bound to the fish nutritionally and culturally throughout the history. Wearing fish skin clothing reinforces this cultural identity (Jackinsky-Sethi, 2014, p. 42). The Yup'ik people have made parkas out of fish skin, which they believed to protect the wearer not only from the elements, but also from harmful spirits (Williams, 2003, Plate 6). The Ingalik used to make cradles out of salmon skin to protect the children of parents who already lost a child (Osgood, 1940, p. 100; Hickman, 1988, p. 12).

A more modern example of fish skin use, although it might have a deeper history, is shown on the archival photographs of a Cree man from Saskatchewan making a fish skin rattle (Dalby, 1976). Burbot or pike skin was used for this purpose.

Fish skins were in use also further to the south. In the Stockholm Museum of Ethnography there is a salmon skin bag made by the Bannock people. The Bannock tribe, a Northern Paiute tribe located in southern Idaho, western Wyoming and parts of Oregon and Nevada, fished for salmon on the Snake River and used their skins to make carrying bags (cf. Pritzker, 1998, p. 333). The Plateau Indian peoples of the Columbia Plateau used bags made of cattail leaves lined with salmon skin to store dried salmon meat, a staple of their diet and also an important trade article (Hunn, 1990, p. 192; Pritzker, 1998, p. 353). The Shasta tribe of California and Oregon used salmon skin as backing for their bows (Curtis, 1924, p. 115).

In the Caribbean Islands the native Taíno people supposedly used to grate cassava on *lebisa* (other forms *libúça*, *libusa*, *lebisa*, *labusa* or *labuza*), a strip of dried skin of *Dasybetus torrei* (or possibly also *Himantura schmardae*), a kind of ray (Las Casas, 1561, p. 312; Friederici, 1960, p. 345). This is similar to the Japanese *oroshiki* used for grating vegetables.

4.6 Central and Southern America

I have so far found no evidence for fish skin use from Central America. The evidence is slightly better for Southern America. All of it comes from Brazil, from the Amazon River basin. The only specific item I found is a staff, possibly used by a shaman or a person of similar status. The entry in the museum database states that a part of it is made of fish skin with a question mark (British Museum Collection Database, "Am.5768"). Whether the skin really is from a fish is questionable. Further research will be needed to find more such items from the area. Also, from an encyclopaedia compiled by Alexander Aitchison, there is a passage stating that the peoples of the Amazon used shields ("targets") made of "cane, or fish skin" (Aitchison, 1807, p. 543).

The only other mentions of fish skin as a material are recent, where the fish skins are used as a base for novelty leather. One source specifically states that the people of northern Brazil used to discard the skins of the pirarucu fish, which is now being used in the leather industry (Hitti, 2018).

5 Observations

From what I have learned and tried to summarise in the previous parts of this study, I have come to several observations about fish skin use through time and space. I will present these here in a manner of responses to imaginary questions in a discussion.

5.1 Climate Restrictions

It might be tempting to think that fish skin use is restricted to the colder climates of the Northern Hemisphere, as many of the most prominent examples are located there (Alaska, Northeast Asia, Northern Europe). The many examples outside the polar and subpolar zone, often right in the subtropical or tropical zone, prove that fish skin as a material is by no means restricted to colder areas of the world. Granted, the uses differ between the climate zones, with colder zones featuring a more diverse array of uses, but we can even find fish skin clothing in areas like Borneo and Kiribati (see above).

However, climate might have been a factor in the processing of the skins. As I already mentioned, fish skin is sensitive to temperature while unprocessed, and it should not be exposed to temperatures higher than 20 °C. Again, we can see that this obstacle was readily beaten by people around the globe, but it might have influenced the volume of fish skins processed. A valid point is that while one can freeze large quantities of skins waiting to be processed in the colder zones, it is impossible to freeze anything in warmer climates. This may have been remedied by the salting of the skins for storage.

5.2 Distance to Water Features

Another prerequisite for the use of fish skin is, of course, the presence of fish. In areas with no suitable water features with fish there would be no fishing and therefore, no primary source of fish skins. Trade, transhumance and nomadic lifestyles should not be underestimated, and it is true in this case as well. From Sweden we have accounts of distance trade in fish skins (Berg, 1984, pp. 97–98) and the presence of a fish leather pouch in the nomadic environment of Medieval Mongolia (see Bemann & Nomguunsüren, 2012) provides an answer to this problem. Where there is no fishing, either preserved fish skins or ready-made fish skin products can be obtained from other regions. In some cases, the fish skin products even enabled the trade of other commodities such as dried fish meat or geese in Northern America or Siberia (see above).

5.3 Fishing-based Economies Only

Similar to the previous, this hypothesis would prevent many communities from using fish skin. In the case of communities where fishing is not the primary source of sustenance, but is practiced nevertheless, it is quite possible that this supplementary income of protein also provides other resources: fish oil, bones, or skin. Even with communities that don't fish at all, the skins can be traded for other commodities. Such behaviour could mean that the members of the community regard fish skin products as essential or desirable items, thereby warranting the effort to have them delivered from elsewhere.

5.4 Lack of Other Resources

While this claim might be true for some parts of the world (the smaller Islands of Oceania come to mind), usually there are other resources that could be substituted for the fish skin. Drums could be headed with goat skin, clothing made from plant or mammal fibres or furs, and almost every single use of the multipurpose eel-skin can be replaced by mammal leather. If someone chose fish skin, I would argue it's almost always either because of its unique properties

(mentioned at the start of this article), or because of cultural norms and traditions. It is also worth noting that while a cow provides much more leather than a salmon or eel, you can probably gather much more of the fish skins before you slaughter the cow and get its hide. Also, the fish skins are probably available on a regular basis, especially if you or your community fishes them on its own.

5.5 Size (of the Fish) Matters

Another objection one might raise is the availability of fish above a certain size (or even fish of a certain species). The Hezhe reportedly use only fish of 50 kilograms or more (Rahme & Hartman, 2012, p. 8). While it is true that large skins require less sewing if used for garments, footwear or similar purposes, and that for a drum head the skin must be larger than the diameter of the drum, this does not limit the use of smaller fish. As with mammal hides, people often went out of their way to create what they wanted – there is no difference between stitching dozens of stoat furs and dozens of skins from smaller fish. L. Rahme even shows a basket made of capelin heads (Rahme & Hartman, 2012, p. 11, Fig. 7). Capelin is a rather small species even when whole, so sewing together just the heads must have been a tiring task. Nevertheless, it was made (Rahme doesn't state the dating, so I'm presuming 20th century) and other similar items could be made in the same fashion.

5.6 Low-technology Societies

The processing of fish skin is relatively easy and fast depending on your chosen method. It probably takes less effort and time to vegetable tan a few salmon skins than the hide of one deer. It can, however, be as sophisticated as you make it and for some purposes (drum heads) no more than cleaning and drying the skin is necessary. Fish skins have been in use in Scandinavia long after the industrial revolution (cf. Rahme & Hartman, 2012). At the same time the people of Papua New Guinea used them as well. Stone tools might have been phased out by metal ones, but skin and leather remain largely the same, only the methods of their processing have become more advanced.

On the other hand, one might argue that being more delicate than mammal hides, fish skin requires a certain level of technological skill and therefore, could not be used by communities such as the Mesolithic inhabitants of Lepenski Vir or similar sites. We should not let ourselves be fooled by the wonderfully made Hezhe or Nanai clothing – fish skin products can be crude (various straps and harnesses are a good example) as well as delicate.

5.7 Cultural/Religious Significance

As I mentioned earlier in the paper, going too deep inside the intricacies of different cultural traditions and religious observances that have or might have a connection with the use of fish skin as a material, would be probably too much. I will therefore only address the possible issue of fish skin use being derived from religion and spirituality. While in some cases this definitely is one of reasons for using the skin of fish (see Northern America above), in other cases this is quite hard to imagine – the mostly Lutheran religious inhabitants of Sweden probably used their eel-skins without religious reasons, not to mention the non-religious Swedes.

6 Further Research Perspectives

So far, this article was mostly about ethnography with an occasional historical, or the even rarer archaeological, evidence. I have presented some of the issues that have been made clearer by the examination of these sources. The next logical step is to apply this knowledge to the data we have from archaeology. Without archaeological finds such as the pouch from Čonot Uul in Mongolia, or the eel skin from Ostrówek in Opole, Poland (the hard evidence), we can

never be certain, but we can infer the possibility of fish leather use in various phases of Prehistory in Europe (and other parts of the world).

From the summary of fish skin uses around the globe and their analysis it might seem that almost any society in the past could have used fish skins. It's easy to come up with arguments that make it a possibility, especially after reading this work so far. But that would bring no new knowledge whatsoever and would be poor science. It is obvious that some groups have better predispositions for making use of fish skin. Those living close to water features and practicing fishing are more likely candidates than agriculture-based ones. It might seem now that I'm contradicting what I wrote in the last chapter. However, there is no doubt a fisherman is more likely to use the skin of a fish he caught than a farmer. My point in the chapter before was that just because a society isn't focused on fishing it doesn't mean they can't desire and obtain the products of fishing, whether it's meat or skins. Therefore, when making assumptions about the use of fish skin, some connection to water and/or fishing is necessary.

Considering the various products made of fish skin that a society could have utilised, caution is in place. Theorising about using fish skins and proposing fish leather clothing are two different things, the latter a bit too specific without some evidence to support it. Evidence we sorely lack. It is perhaps best to simply allow for the possibility of using fish skin for various purposes and not go into detail. The only exception might be the medieval period in Poland, Mongolia and perhaps the other regions inhabited and influenced by the steppe peoples of that time. Since we already know of one fish leather pouch, other such items can be expected to appear with further research.

This brings us to another crucial aspect, the potential for further archaeological discoveries of fish skin and leather products. Non-tanned fish skin is essentially rawhide. It is almost impossible for rawhide to be preserved in wet conditions due to inevitable hydrolysis. Skins in which the tanning process has not been finished are also susceptible. Well-tanned leather has the best chance of survival in wet conditions. The soil pH is also vital for leather preservation – the lower the pH, the slower the decay of collagen and tanning agents. The highest pH with a chance of leather preservation is 6.4; above this level the leather will not survive. There is also the possibility of preservation in very dry or dry and salty conditions, which prevent both hydrolysis and microorganisms from destroying the material (Cronyn, 1990, pp. 267–268). This is, of course, valid for fish skin products as well – we can only hope to find tanned fish leather in most conditions. It means we probably won't find any artefacts of the same kind as Nanai clothes. Their method of processing the skins – drying and breaking – leaves the skin, which is effectively rawhide, vulnerable to all kinds of environmental hazards. The same probably applies to many of the ethnographically known uses for fish skin – only a few of these would be tanned at all and then often they would be oil-tanned rather than vegetable tanned. The Čonot Uul find was (probably vegetable) tanned and it was preserved by the dry and stable climate of the cave in which it was deposited (cf. Bemman & Nomguunsüren, 2012).

We can expect similar finds dating to this and other periods from dry cave sites nearby, and possibly in other parts of the world as well. Other likely candidates might be the various salt mines like Hallstatt and Dürrnberg in Austria (cf. Ruß-Popa, 2011, pp. 33–39; 2015, pp. 114–117), where a lot of leather artefacts have been discovered, though none from fish skin as yet. Waterlogged sites might also be an option, as sometimes organic artefacts within the bog deposits are remarkably well preserved (cf. Menotti, 2012, pp. 198–199, 240–241). A very perspective potential source of new artefacts made from (not only) fish skin and leather can be seen in the melting glaciers and permafrost (for a comprehensive list of literature see <https://secretsoftheice.com/annet/scientific-publications/>).

Lastly, we should not forget indirect evidence, or rather indirect potential evidence of skin processing. Finds of hide scraping tools or other artefacts with a connection to leatherworking and tanning provide better grounds for hypothesising about fish skin processing. It is more likely fish skin was tanned where other skins were tanned as well. Rahme shows a slate scraper (Rahme & Hartman, 2012, p. 34, Fig. 40) that could have been used for scaling the fish skins. Finds such as this one can indirectly point to the processing of fish skins. It might be worthwhile, although certainly time-consuming, to skim the archaeological databases and look for similar tools, which could have had similar functions.

7 Conclusions

Fish skin is a material seldom thought of when building narratives about the Prehistory of Europe. Yet instances of its use come up now and then in the ethnographic record, in some parts of the world even strongly enough to become (almost) general knowledge. Societies of various technological levels, organisation and subsistence strategies have found use for the skins of their fishing bounty. The many different accounts I have collected for this study show that neither climate nor lifestyle limit the utilisation of fish skin as a material; they merely affect the range of uses. Religion and cultural traits, which have not been the focus of this paper, probably had some effect on how fish skins (and other materials) were used.

The wide range of fish skin uses around the world can be summarized in several categories: clothing, footwear, musical instruments, containers and a large group of various tool parts, household items, straps, covers, etc. The presence or absence of each in a society can be influenced by the abovementioned factors such as climate or technology level, but also by the availability of certain fish species in the area, or the activities the society engages in. No ski bindings can be expected to be found on the islands of Oceania and no rifle cases can be expected to be found anywhere before the arrival of firearms to said area. Whilst fish skin clothing and footwear is known mostly from colder climates, finds from Borneo or India remind us this is not a rule, merely a tendency.

Archaeology did not yet yield many finds of fish skin products, the only two known to me at the time of writing this paper being the fish leather pouch from Čonot Uul in present Mongolia and an older find of eel skin from Opole, Poland. Supported by the textual historical sources the case to be made is not entirely weak. Were it just one unique item with no others like it, one could dismiss it and only take ethnography from the last few centuries into account. Two artifacts from the Middle Ages, and similarly dated historical texts, give us hope that more such artefacts could be found and our knowledge of fish skin use in the past could grow. Perhaps a preserved piece of fish leather from a prehistoric context might even be found. Until then, the most we can do is make assumptions. No matter how similar the prehistoric society we study is to the one we know to have used fish skin products, even the best relational analogies give us only a hypothesis, verified only by finding fish skin artefacts in an archaeological context. I believe this study I've presented will contribute to the general awareness among archaeologists. There is still a lot of work to be done with analysing the background of the relevant societies using fish skin both today and in the past. A lot of museum collections might contain artefacts from fish skin or leather that I could not have included and there might be excavations waiting to be evaluated and published that have yielded new artefacts. Perhaps someone will be able to interpret some of their finds in this new light, or someone will know what to look for and find some new evidence regarding fish skins in the past.

Acknowledgements: This study was supported by Slovak Research and Development Agency (SRDA/APVV) using financial support no. APVV-14-0550 and by private donors.

I would like to thank the organisers of “Beyond the Farmlands: Wild Resources in the Past of Europe” session at the 2018 EAA meeting in Barcelona for accepting my presentation which this paper is based on. My thanks also go to Dr Peter Barta for his support and helpful remarks at the very beginning, to Prof Karol Hensel for general consultations on ichthyology, to Dr Daniel Gurňák for creating the map used in this paper, and to Dr Michal Holeščák for consultations concerning the Mongolian nomads. I am above all grateful for the support I received from my parents and my wife Alexandra, who made it all possible.

References

- Aitchison, A. (1807). The New Encyclopaedia, Or, Universal Dictionary of Arts and Sciences. *Encyclopaedia Perthensis* (Vol. 1). London: Vernor, Hood & Sharpe.
- Bartlett, W. B. (2009). *The Mongols: From Genghis Khan to Tamerlane*. Chalford: Amberley.
- Bemann, J., & Nomguunsüren, G. (2012). Bestattungen in Felsspalten und Hohlräumen mongolischer Hochgebirge. In J. Bemann (Ed.), *Steppenkrieger. Reiternomaden des 7.–14. Jahrhunderts aus der Mongolei* (pp. 199–217). Bonn: LVR-LandesMuseum.
- Benecke, N. (1993). On the utilization of the domestic fowl in Central Europe from the Iron Age up to the Middle Ages. *Archaeofauna*, 2, 21–31.

- Berg, G. (1984). The use of fish skins in Northern Europe before the industrial era. In B. Gunda (Ed.), *The Fishing Cultures of the World. Studies in Ethnology, Cultural Ecology and Folklore I* (pp. 91–104). Budapest: Akadémiai Kiadó.
- Binford, L. R. (1967). Smudge Pits and Hide Smoking: The Use of Analogy in Archaeological Reasoning. *American Antiquity*, 32(1), 1–12.
- Black, J., & Green, A. (1998). *An Illustrated Dictionary of Gods, Demons and Symbols of Ancient Mesopotamia* (2nd ed.). London: British Museum Press.
- British Museum Collection Database. “As1898,0702.39” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/A_As1898-0702-39), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/A_As1898-0702-39.
- British Museum Collection Database. “As.8964.a-b” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/A_As-8964-a-b), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/A_As-8964-a-b.
- British Museum Collection Database. “As1895,1112.8” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/A_As1895-1112-8), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/A_As1895-1112-8.
- British Museum Collection Database. “Am.5768” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_Am-5768), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/E_Am-5768.
- British Museum Collection Database. “Af1953,24.60a” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_Af1953-24-60-a), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/E_Af1953-24-60-a.
- British Museum Collection Database. “Af1953,24.60b” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_Af1953-24-60-a), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/E_Af1953-24-60-a.
- British Museum Collection Database. “As1896,-583” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/A_As1896-583), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/A_As1896-583.
- British Museum Collection Database. “As1896,-580” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/A_As1896-580), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/A_As1896-580.
- British Museum Collection Database. “As1975,Q.2” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/A_As1975-Q-2), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/A_As1975-Q-2.
- British Museum Collection Database. “As1971,05.1” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/A_As1971-05-1), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/A_As1971-05-1.
- British Museum Collection Database. “F.1078” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/A_F-1078), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/A_F-1078.
- British Museum Collection Database. “Oc,LMS.20” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_Oc-LMS-20), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/E_Oc-LMS-20.
- British Museum Collection Database. “Oc.6961” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_Oc-6961-1), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/E_Oc-6961-1.
- British Museum Collection Database. “Oc1854,1229.139” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_Oc1854-1229-139), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/E_Oc1854-1229-139.
- British Museum Collection Database. “Oc1878,1110.24” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_Oc1878-1110-24), British Museum. Online. Accessed 16/06/2020 at https://www.britishmuseum.org/collection/object/E_Oc1878-1110-24.
- British Museum Collection Database. “Oc1878,1110.25” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_Oc1878-1110-25), British Museum. Online. Accessed 16/06/2020 at https://www.britishmuseum.org/collection/object/E_Oc1878-1110-25.
- British Museum Collection Database. “Oc1944,02.1203” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_Oc1944-02-1203), British Museum. Online. Accessed 16/06/2020 at https://www.britishmuseum.org/collection/object/E_Oc1944-02-1203.
- British Museum Collection Database. “Oc,TAH.21” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_Oc-TAH-21), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/E_Oc-TAH-21.
- British Museum Collection Database. “Oc,LMS.82” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_Oc-LMS-82), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/E_Oc-LMS-82.
- British Museum Collection Database. “2008,2007.1” [www.britishmuseum.org/collection](http://www.britishmuseum.org/collection/object/E_2008-2007-1), British Museum. Online. Accessed 21/12/2019 at https://www.britishmuseum.org/collection/object/E_2008-2007-1.
- Bruillard, K. (2018, January 26). Two bears were badly burned in wildfires, and fish skin helped heal them. *The Washington Post*. Retrieved on December 27, 2019 from <https://www.washingtonpost.com/news/animalia/wp/2018/01/26/two-bears-were-badly-burned-in-wildfires-and-fish-skin-helped-heal-them/>
- Clark, A. (undated). Kiribati armor. Retrieved on December 27, 2019 from <https://www.khanacademy.org/humanities/art-oceania/micronesia/a/kiribati-armor>
- Cronyn, J. M. (1990). *The Elements of Archaeological Conservation*. New York: Routledge.
- Curtis, E. S. (1924). *The Hupa, The Yurok, The Karok, The Wiyot, Tolowa and Tututni, The Shasta, The Achomawi, The Klamath*. (The North American Indian series, Vol. 13). Norwood: The Plimpton Press.
- Dalby, L. (1976). Making a Fish Skin Rattle. Northern Saskatchewan Archives. Retrieved on December 27, 2019 from <http://digital.scaa.sk.ca/ourlegacy/permalink/25640>
- Elliott, D. G. (2011). Functional Morphology of the Integumentary System in Fishes. In A. P. Farrell (Ed.), *Encyclopedia of Fish Physiology: From Genome to Environment* (Vol. 1, pp. 476–488). San Diego: Academic Press.
- Fienup-Riordan, A. (2007). *Yuungnaqpiallerput: Masterworks of Yup'ik Science and Survival*. Seattle: University of Washington Press.
- Forbes, R. J. (1966). *Studies in Ancient Technology* (2nd ed., Vol. V). Leiden: Brill.

- Friederici, G. (1960). *Amerikanistisches Wörterbuch und Hilfswörterbuch für den Amerikanisten: Deutsch-Spanisch-Englisch* (2nd ed.). Hamburg: De Gruyter.
- Gessner, J., Chebanov, M., Freyhof, J., & Kottelat, M. (2010). Huso huso. *The IUCN Red List of Threatened Species*. e.T10269A3187079. Downloaded on October 17, 2019.
- Guth, Ch. (2015). Towards a Global History of Shagreen. In A. Gerritsen & G. Aiello (Eds.), *The Global Lives of Things* (pp. 62–80). London: Routledge.
- Hickman, P. (1988). *Innerskins/Outerskins: Gut and Fishskin*. San Francisco: San Francisco Craft and Folk Art Museum.
- Hitti, N. (2018, November 15). Oskar Metsavaht makes sustainable fashion garments from Amazonian fish skin. *Dezeen magazine*. Retrieved on October 23, 2019 from <https://www.dezeen.com/2018/11/15/oskar-metsavaht-pirarucu-fish-skin-sustainable-fashion>
- Hokkaido Museum (2019). Imi kiru [Clothing], *Pon Kampi-sos* (Vol. 2). Sapporo: Hokkaido Museum.
- Hooper, S. (2006). *Pacific Encounters. Art & Divinity in Polynesia 1760–1860*. London: British Museum Press.
- Horniman Museum & Gardens Collection. Hourglass Drum (object number 6.173). Retrieved on December 27, 2019 from <https://horniman.ac.uk/object/6.173>
- Hunn, E. S. (1990). *Nch'i-Wána, „The Big River“: Mid-Columbia Indians and Their Land*. Seattle: University of Washington Press.
- Hurcombe, L., & Williams, L. (2002). Fish skin as a prehistoric material. *Bulletin of Primitive Technology*, 23, 39–41.
- Hurcombe, L. (2014). *Perishable material culture in prehistory: investigating the missing majority*. New York: Routledge.
- Irving, B. G. (1992). The Pectoral Fin Spines of European Catfish *Silurus glanis*; Cultural Artifacts or Food Remains? *International Journal of Osteoarchaeology*, 2, 189–197.
- Jackinsky-Sethi, N. (2014). Fish Skin as a Textile Material in Alaska Native Cultures. *First American Art Magazine*, 5(Winter), 40–47.
- Jackson, S. (1888). A Cargo of Alaska School Teachers. *The Chautauquan*, 8(May), 490–493.
- Kyselý, R. (2010). Review of the oldest evidence of domestic fowl *Gallus gallus f. domestica* from the Czech Republic in its European context. *Acta zoologica cracoviensia*, 53A(1-2), 9–34.
- de Laguna, F. (1972). *Under Mount Saint Elias: The History and Culture of the Yakutat Tlingit*. Washington, DC: Smithsonian Institution Press.
- Lantis, M. (1947–51). Bering Sea and Arctic Coast Eskimos of Alaska. In *Encyclopedia Arctica 15-volume unpublished reference work*. (Vol 8, Anthropology and Archaeology). Retrieved on October 23, 2019 from http://collections.dartmouth.edu/arctica-beta/html/EA08-06.html#Vol_VIII-0030
- Las Casas. (1561). *Bartolomé* (Vol. 3). Historia de las Indias.
- Linné, C. (1751). *Skånska resa, på hoga Ofwerhetens befallning forrtat ar 1749. Med Ron och Amnarkningar uti oeconomien, naturalier, antiquiteter....* Stockholm.
- Magnus, O. (2010). *Historia om de nordiska folken*. Hedemora: Gidlund.
- Man, J. (2012). *Kublai Khan*. London: Random House.
- Membrado, Z. (2015, November 21). Irán retiene una de la Biblias más antiguas del mundo [Iran retains one of the oldest Bibles in the world]. *El Mundo*. Retrieved on December 27, 2019 from <https://www.elmundo.es/cultura/2015/11/21/564f3f42e2704e192e8b460f.html>
- Menotti, F. (2012). *Wetland Archaeology and Beyond: Theory and Practice*. Oxford: Oxford University Press.
- Morris, F. (1914). *Catalogue of the Crosby Brown Collection of Musical Instruments: Vol. II. Oceanica and America*. New York: The Metropolitan Museum of Art.
- Nelson, E. W. (1983). *The Eskimo about Bering Strait*. Washington, DC: Smithsonian Institution Press.
- O’Riordan, C. (2013). *An Ethnographic Analysis of a Kiribati Shark-Toothed Sword*. Retrieved on December 27, 2019 from <https://wiki.ucl.ac.uk/display/BBCollabSupport/An+Ethnographic+Analysis+of+a+Kiribati+Shark-Toothed+Sword>
- Osgood, C. (1940). *Ingalik Material Culture*. New Haven: Yale University Press.
- Pritzker, B. M. (1998). *Native Americans. An Encyclopedia of History, Culture, and Peoples* (Vol. I). Santa Barbara: ABC-CLIO.
- Radek, T. (1981). Skóra wczesnośredniowiecznego węgorza (*Anguilla anguilla*) z wykopalisk na Ostrówku w Opolu. *Roczniki Akademii Rolniczej w Poznaniu, CXXXI*, 11–18.
- Rahme, L., & Hartman, D. (2012). *Fish Leather: Tanning and Sewing with Traditional Methods*. Sigtuna: Lottas Garfveri.
- Reinartz, R. (2002). *Sturgeons in the Danube River. Biology, status, conservation. Literature study*. International Association for Danube Research (IAD), Bezirk Oberpfalz, Landesfischereiverband Bayern, e.V.
- Robert Goldwater Library Blog (2009). *Manuscripts from Timbuktu on exhibit in the Goldwater Library*. Retrieved on December 26, 2019 from <https://goldwaterlibrary.typepad.com/rgl/2009/05/on-friday-may-15-the-goldwater-library-hosted-an-exhibit-and-presentation-on-medieval-arabic-manuscripts-from-west-africa.html>
- Robinson, E., & Smith, E. (1841). *Biblical Researches in Palestine, Mount Sinai and Arabia Petraea: A Journal of Travels in the Year 1838* (Vol. I). Boston: Crocker & Brewster.
- Rossabi, M. (2009). *Khubilai Khan: His Life and Times*. Berkeley, Los Angeles, London: University of California Press.
- Ruß-Popa, G. (2011). *Die Haut-, Leder- und Fellfunde aus dem ältereisenzeitlichen Kernverwässerungswerk im Salzbergwerk von Hallstatt, OÖ – eine archäologische und gerbereitechnische Aufnahme* (Master thesis). Vienna: University of Vienna.
- Ruß-Popa, G. (2015). *Leather, Fur and Skin Technology in the Iron Age Salt Mines at Dürrnberg near Hallein, Austria and Chehrābād, Iran. Archaeological Textiles Review No. 57*. Copenhagen: University of Copenhagen.
- Sand, G. (1857). *La petite Fadette*. Collection À tous les vents, Québec: La Bibliothèque électronique du Québec. Retrieved on October 23, 2019 from <https://beq.ebooksgratuits.com/vents/sand-fadette.pdf>

- Singer, Ch. (1948). *The Earliest chemical industry: an essay in the historical relations of economics and technology illustrated from the alum trade*. London.
- Schaeffner, A. (1943). Sur deux instruments de musique des Bata (Nord Cameroun). *Journal de la Journal des Africanistes*, 13, 123–152. https://www.persee.fr/doc/jafr_0037-9166_1943_num_13_1_2545
- Stottlemeyer, N. (2014). *Āl'riq: The Arab Tambourine* (Master thesis). Lynchburg: Liberty University.
- Swart, J. G. (2013). *Fish and Hebrew Amulets*. Retrieved on December 27, 2019 from <http://kabbalahselfcreation.blogspot.com/2013/10/fish-and-hebrew-amulets.html>
- Taşağil, A. (2009). Ethno-cultural Distribution of Turkic and Mongolian Tribes between the 6th and 9th Century AD. In J. Bemmann (Ed.), *Current Archaeological Research in Mongolia. Papers from the First International Conference on "Archaeological Research in Mongolia" held in Ulaanbaatar, August 19th–23rd, 2007* (Bonn Contributions to Asian Archaeology, Vol. 4, pp. 385–400). Bonn: Vor- und Frühgeschichtliche Archäologie, Rheinische Friedrich-Wilhelms-Universität,.
- Törbat, C., Batsüch, D., & Batbajar, T. (2012). Das Felsgrab aus Čonot Uul, Bulgan sum, Chovd ajmag. In J. Bemmann (Ed.), *Steppenkrieger. Reiternomaden des 7.–14. Jahrhunderts aus der Mongolei* (pp. 267–284). Bonn: LVR-LandesMuseum.
- Vorderasiatisches Museum Sammlung Online-Datenbank, Ident.Nr. "VA 07825" <http://www.smb-digital.de/eMuseumPlus?service=ExternalInterface&module=collection&objectId=1744436&viewType=detailView>. Online. Accessed 10/08/2020.
- Watts, R. (1842). *Journal of a Tour Through Egypt, the Peninsula of Sinai and the Holy Land in 1838, 1839* (Vol. II). London: Richard Watts.
- Williams, L. F. (2003). *Guide to the North American Ethnographic Collections at the University of Pennsylvania Museum of Archaeology and Anthropology*. Philadelphia: University of Pennsylvania Museum of Archaeology and Anthropology.
- Whitaker, P., & Garcia, P. (2017, May 25). Brazilian doctors use fish skin to treat burn victims. *Thomson Reuters*. Retrieved on December 27, 2019 from <https://www.reuters.com/article/us-health-brazil-burns/brazilian-doctors-use-fish-skin-to-treat-burn-victims-idUSKBN18L1WH>
- Shoshani, J. (2005). Order Sirenia. In D. E. Wilson & D. M. Reeder (Eds.), *Mammal Species of the World: A Taxonomic and Geographic Reference* (3rd ed., Vol. 1, pp. 92–93). Baltimore: Johns Hopkins University Press.
- Yetts, W. P. (1916). The Eight Immortals. *Journal of the Royal Asiatic Society of Great Britain and Ireland* (pp. 773–806). London: Royal Asiatic Society of Great Britain and Ireland. Digitised by C. M. Weimer in 2002. Retrieved on December 21, 2019 from <https://web.archive.org/web/20111017220555/http://www.public-domain-content.com/books/journals/jras/1916-21.shtml>