The cultural roles of perforated fish vertebrae in prehistoric and historic Europe

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Abstract

This paper provides a new synthesis of perforated fish vertebrae in prehistoric and historic Europe, with a particular focus on Poland, within the broader context of Central and Eastern Europe. The earliest examples of such artefacts in Europe date from the Upper Palaeolithic, but compared to other 'beads' manufactured from animal bone, perforated fish vertebrae are rare. This paper examines the diachronic trends in the range of species that have been chosen for such objects, as well as their depositional contexts. Despite the wide range of freshwater and marine species exploited by people, only the vertebrae of a few species – especially pike and catfish – were selected for use as beads. There is a general shift from their deposition in funerary contexts in prehistoric European societies to their association as low-status objects

associated with Christian private devotion in the post-conversion period. However, this may not reflect continuity in the use of fish vertebrae, with a shift in their symbolism after the conversion to Christianity, given the substantial chronological gaps in the archaeological record. This synthesis nonetheless provides a solid foundation for contextualising future archaeological finds of such artefacts.

Introduction

In the last two decades, zooarchaeologists have regularly engaged with the socio-cultural significance of animals in past societies (Sykes, 2015), including the transformation of animal bodies into material culture; a theoretical perspective derived from post-processual thinking that recognises how artefacts constructed from animal bodies were shaped by, but also in turn shaped, human responses (Pluskowski, 2004; 2007; 2013). Animal bone (including antler and teeth), keratin (horn and hair) and skin from a range of species have routinely provided raw materials for manufacturing objects from the Palaeolithic through to the present day, which have both utilitarian and social significance. Whilst these largely derive from terrestrial species, the skeletal remains of aquatic mammals, fish and shellfish have also been reconstituted as material culture by various societies around the world. Aquatic animals have been, and remain, economically important in many societies, and they have also played a role in the metaphorical expression of social relations, as well as defining relationships between humans and riverine, lacustrine, and maritime environments (Pálsson, 1994: 114-115). Where their bodies have been transformed into material culture, the choice of species tends to reflect their accessibility, economic value and cultural significance; from the widespread use of shells as ornaments (e.g., Akerman, 2018), through to the comparatively infrequent and culturally specific role of shark teeth as ritual objects (e.g., Cione and Bonomo, 2003; Leavesley, 2007; Betts et al., 2012; Altamirano-Sierra and Vargas-Nalvarte, 2016), more common today as ornamental jewellery.

In prehistoric and historic Europe, the non-utilitarian uses of fish bones, and particularly fish vertebrae, have been noted in past studies, and these are objects that have been reported sporadically in zooarchaeological reports or small finds studies. Syntheses to date have been primarily based on examples from Britain (MacGregor, 1985: 109; Riddler, 2006: 176) and Poland (Makowiecki, 2003; Makowiecki and Makowiecka, 2017). This paper builds on this foundation with a new synthesis of the cultural role of fish vertebrae within past European societies, updating the dataset from the modern territory of Poland, whilst drawing on comparative examples from other European regions, as well as the North Atlantic (Figure 1). The broadest chronological range has been adopted to capture long-term trends, from the Neolithic through to the post-medieval period, whilst noting that the earliest reported examples of deliberately perforated fish vertebrae in Europe have been found in Upper Palaeolithic contexts (Wilkens, 1995). The aim of this paper is to provide an interpretative framework to inform future discoveries of similar material culture, or those hidden in existing and largely inaccessible grey literature, contributing to developing our understanding of the appropriation and transformation of aquatic animals into material culture.

The vertebrae in question have probably all been modified for the purposes of suspension, which has involved puncturing or drilling a hole through the centre of the vertebral body. Some analysts have connected these with specific tools found at the same sites. The edges of these central perforations, the circumference of the centra, as well as parts of the vertebral body,

often (but not always) display visible signs of wear which is consistent with being strung together on a cord and abrading against other beaded objects. Projecting bridges of bone, such as the neural arch, are typically removed, and the broken edges may be deliberately smoothed off or become worn over time. Attachment of beads to clothing may also result in differential wear or polishing on various facets of the bone. Rarely, are there traces of applied pigment, although this is more evident with some modern examples (Theodoropoulou, 2007: 511).

However, it is also important to acknowledge that holes visible in mature vertebral bodies may also represent the persistence of a notochordal canal in some species, or have resulted from natural taphonomic processes, rather than deliberate modification. This may include the action of water and sedimentary erosion on centra with canals, causing them to enlarge, or roots which may have pierced the vertebral body and gradually enlarged the holes, as well as punctures made by the teeth of small carnivores, gnawing at discarded food waste. Conversely, the absence of wear marks can also be interpreted as a tight fit on a cord, resulting in no movement and abrasion (Harland and Parks, 2008: 9). The context of the deposition, such as in a grave in association with other categories of beads, may contribute to a more robust identification of deliberate use of such vertebrae, rather than simply the discard of waste.

The examples collated in this paper have been sub-divided into freshwater, marine and migratory species, reflecting varying levels of accessibility to these contrasting aquatic environments. Some have been identified from archaeological documentation, as the artefacts in question are no longer available for re-examination, some have been documented but not previously published, whilst others have been identified by the authors (see Table 1 for details). Fish vertebrae, particularly those from smaller species, are prone to degradation, and their variable preservation, recovery – especially where sieving and flotation are not routinely used – and identification, has significantly limited the number of identifiable examples which have been reported by analysts. Given the sparsity of finds, the spatial and temporal distribution of these objects is highly varied and uneven, even within this study's focal region. Nonetheless, it is clear that a limited number of fish species have been regularly utilised for the production of bone beads, within a body of material culture that is otherwise dominated by objects crafted from the bones of domestic mammals.

This paper has three principal aims. Firstly, to map diachronic trends in the use of perforated fish vertebrae, both in terms of species and cultural context. The benefit of a long-term perspective is that it makes it possible to compare changes in the use of perforated vertebrae with major cultural transformations, in this case highlighting the significance of the adoption of Christianity. Secondly, to provide an interpretative framework for future discoveries. Thirdly, to encourage the full range of stakeholder groups likely to encounter such artefacts – excavators, zooarchaeologists, finds specialists and museum curators – to identify and report them.

Freshwater Fish Vertebrae

Perforated fish vertebrae have been identified at 31 sites within the core study area of Poland (Table 1), derived from later prehistoric, medieval, and post medieval archaeological contexts. The majority are associated with two freshwater species, which would have been readily accessible in lakes and slow-moving rivers.

Prehistoric Finds

The oldest examples have been found in Neolithic contexts. At two sites in modern Poland, Brześć Kujawski and in Krusza Zamkowa in Kuyavia, associated with the Neolithic Lengyel (Polish Lendzielski) culture, perforated pike (*Esox lucius*) vertebrae functioned as either components of necklaces or hip belts, in both cases found in high-status female burials (see Makowiecki, Makowiecka, 2017 for full references). In Brześć Kujawski Site 4, one hip belt found in Grave No. 4 consisted of more than thirty clay beads and a similar number of vertebrae arranged in an alternating sequence, in some cases augmented with perforated shells (Figure 2; Jażdżewski, 1938). Two pike vertebrae functioned as beads on the associated necklace from Krusza Zamkowa were also found in association with a female burial dating to the third phase of the late Linear Band Pottery culture (ca. 4200–3900/3800 BC), which is contemporaneous with Lengyel; along with perforated shells and belemnites. Similar perforated vertebrae were also found in the domestic spaces of related settlements.

Younger prehistoric finds of perforated fish vertebrae have been discovered in cemeteries of the Bronze Age phase of the Lusatian culture at three sites. At Bachórz-Chodorówka (ca. 1300-900 BC), a thoracic pike vertebra was found inside an urn with the cremated remains of a child, associated with the grave of a female, and another was recorded in the grave of an adult. At Laski (ca. 1300-500 BC), four cremation urns contained pike vertebrae. On the basis of the drawings of these artefacts can be interpreted as either elements of a necklace (Wrzosek and Ćwirko-Godycki, 1937), or as separate pendants. Other skeletal elements of animal origin were also discovered in these contexts, including those of brown bear (grave 1142a) and six dog or fox canines (Chmielewski, 1988: 73). At Wtórek Site 7 (the same chronology as Laski), one grave with the remains of two females (one adult, one elderly), and two children (one infant, one perinatal) included four perforated pike vertebrae.

In Domasław, a younger cemetery of the Early Iron Age phase of the Lusatian Culture (700-500 BC), in chamber grave 390 a pike vertebra was found with the remains of an adult male. Although the analysts argued that the perforation was artificial, its size of ca. 0.5 mm suggests that it is natural (Abłamowicz, Józefowska 2020). The vertebra was tinted with a greenish patina, indicating that it was located near a bronze artefact, perhaps an ornamental element. Amber beads and other decorative items, as well as a sword, were also found in the grave (Gediga and Józefowska 2018). Pike vertebrae were found in two cemeteries of the Pomeranian culture (ca. 650-200 BC); at Grzybno in the Chełmno Land (Figure 3a), where two vertebrae were found inside an urn with an adult female cremation, and at Smętowo Graniczne in Pomeralia, where a vertebra was found in an urn containing a cremated infant (Makowiecki 2020; Drozd-Lipińska 2020), although there is no record of the vertebra's condition.

Comparable examples are known from regions neighbouring modern Poland. At the inland freshwater shellmidden site of Rinnukalns in Latvia, dating to the early fourth millennium BC (Berziņs et al., 2014), a perforated pike vertebra has been found amidst waste in layers underneath and predating the midden by perhaps 2000 years. Eight perforated pike vertebrae had been found with the cremated remains of an adult female inside an urn (No. 39) at Gross-Teimmendorf in north Germany, interpreted as the remains of a necklace (Kühl, 1984), and one bead of pike have also been found at Riekofen near Regensburg, a settlement associated with the Corded Ware culture (ca. 2800 - 2200 BC); in these cases the vertebrae had not been cremated (Busch, 1985). One of the clearest examples of pike vertebrae use in necklaces has been found in Khrinnyky, Site 1, in the Rivne region of Ukraine. Here, finds from a dwelling dated to c. AD 230-330, associated with the Wielbark Culture, included part of a necklace

consisting of a glass bead, three pike vertebrae and two fragments of amber (Gorbanenko et al., 2018).

Whilst pike appears to be the prevalent species used for fish bone beads in Prehistoric Central Europe, sporadic examples deriving from Wels catfish (*Silurus glanis*; henceforth simply 'catfish') have also been found. This species is the largest freshwater fish in Central-Eastern Europe and shares the same aquatic habitats as pike. The earliest reported examples are from the north German Mesolithic site of Friesack 4 (Robson, 2016: 169) and the 5th millennium BC Ertebølle inland site of Trustrup on the Danish island of Zealand. In the Masurian Lake District, in north-eastern Poland, at the site of Dudka, a perforated vertebra was found in a context dated to ca. 3600-2200 BC, when the settlement was occupied by communities associated with a sequence of Neolithic cultures (Makowiecki, 2003). Perforated vertebrae from the same species were also found in Sandomierz, most likely dated to the Neolithic (Figure 3b), whilst four examples were discovered at the fortified settlement in Biskupin (750 – 400 BC) and one in a cemetery of the Przeworsk culture within a grave dating back to the younger pre-Roman period (200BC – 25 AD), in the village of Gąski in Kuyavia.

The use of this species has also been reported in prehistoric contexts in south-eastern Europe. A perforated catfish vertebra (alongside a perforated cyprinid example) is attested from the Late Neolithic site of Dimitra in Northern Greece, with the former retaining traces of reddish pigment (Theodoropoulou, 2007: 511, 514). At the Chalcolithic site of "Dâmbul Cetăţii" associated with the Cucuteni-Ariușd Culture in Romania, three perforated vertebrae, tentatively identified as catfish, showed traces of wear (Beldiman et al., 2015: 138-9), and 16 such vertebrae have been found at the Copper Age Gumelniţa tell site of Pietrele, Romania, dating to the 5th millennium BC (Hansen et al., 2014) (Figure 4). A perforated catfish vertebra was also found at the site of Slava Rusa in Dobrodja, dating to the 4th-5th centuries AD (Stanc et al., 2008: 277).

Medieval Finds

Within the territory of modern Poland, no perforated fish vertebrae from medieval contexts are associated with burials. Most have been found within early medieval high-status urban centres in Greater Poland, including those connected with the origins of the Polish state, namely Poznań, Gniezno, Giecz, Ostrów Lednicki, Międzyrzecz, Radzim and Bydgoszcz, as well as those located beyond the core region in the Pomorze Nadwiślański in Gdańsk, in Ciepłe, Płochocinek, Chełmno (Kałdus), in Mazowsze in Błonie, in Sandomierz and in Szczecin, one of the most important centres in Western Pomerania (Figure 5a-e). These vertebrae are primarily derived from catfish, only five (one from Poznań cathedral and Płochocinek, two from Giecz, and one from Ostrów Lednicki) are identifiable as pike. Whilst the majority of these examples have been found in domestic contexts, at least three are associated with religious structures: one catfish vertebra within the early medieval palatium in Giecz, in the rotunda where a timber chapel has been identified; a pike vertebra at Ostrów Tumski in Poznań, near the cathedral, and from Kałdus in the peripheral zone of the cemetery. The few late medieval Polish examples dating from the 13th to 15th centuries, represented by two vertebrae from Poznań and a single one from Starorypino, are derived from catfish; the former was found in the vicinity of the Church of Blessed Virgin Mary (Table 1).

Elsewhere in Europe, pike vertebrae beads have also been reported from the modern area of Hungary dating to the 7th-8th centuries (Stanc, 2009; Stanc et al., 2009), and five perforated fish

vertebrae have been reported from early medieval Southampton (Hamilton Dyer, 1997), with single finds from 10th-12th century deposits in Northampton, Ipswich and York (Riddler, 2006: 176). A perforated pike vertebra is also known from Late Iron Age / early medieval contexts in Mustivere, Estonia (Luik pers comm), two examples from medieval contexts in the town hall square in Tallinn (Lõugas and Maldre 2021), and one from Riga dated to the 12th-13th century (Lõugas pers. comm).

Post Medieval Finds

A small number of perforated freshwater fish vertebrae are known from post medieval archaeological contexts in Europe, also derived from pike and catfish. Only one example has been reported from an archaeological context in Poland; in a church crypt in Kraków, a pike vertebra was identified as part of a rosary dating to the 17th/18th century (Nowak et al, 2020). A pike vertebra bead (and one game piece) has been reported in 16th century contexts in Vilnius castle (Luik 2018), and two perforated pike vertebrae were found in 16th-century kitchen waste at the Holy Transfiguration Monastery in Dubno, Ukraine (Gorobets et al., 2017: 18-19). A perforated catfish vertebra was found in a 17th century context at the Ottoman stronghold at Barcs in Hungary, described as a 'ring' with the diameter of the hole measuring 9.7 by 8.5 mm (Gál, 2016: 139). There are also examples of perforated vertebrae from freshwater fish in 20th century contexts that have been reported anecdotally. In the Polish People's Republic (1947-1989), souvenir 'folk goods' that could be purchased in Cepelia stores included necklaces made of pike vertebrae painted red (Figure 6).

Marine and Migratory Fish Vertebrae

A smaller number of excavated perforated fish vertebrae in Europe derive from species which are found in saltwater littoral and pelagic zones, or from those diadromous species which migrate from the sea into freshwater for spawning. They have been found at coastal sites or those with easy access to estuarine waters. The earliest and largest single collection has been reported in the central Mediterranean. An assemblage found in a triple burial in the coastal site of Barma Grande, north-west Italy, dating to the Upper Palaeolithic, consisted of 244 individual vertebrae, with 109 additional items arranged as a necklace. The bones were identified as trout (*Salmo trutta*) at a time when its range extended to these littoral waters, with wear and manufacturing marks visible through a microscope (Wilkins 1995). Shark teeth have been sporadically found in Mediterranean archaeological contexts, and some examples of worked vertebrae have also been identified. Sharks are cartilaginous fish, but these worked examples are made from calcified vertebrae, which are therefore more likely to be preserved in the archaeological record (Kozuch and Fitzgerald, 1989: 147). Seven intentionally perforated vertebrae from sharks and rays have been found at the Neolithic site of Lamiras in southern Portugal (Davis et al., 2018), whilst a perforated vertebra from a smooth hammerhead (*Sphyrna zygaena*) was found in household waste dating to the late Punic phase of the Roman Republican era, in the Cronicario area of Sant'Antioco, Sardinia (Carenti, 2013: 43).

In northern Europe, the most diverse prehistoric examples have been found on Orkney, where fish vertebrae used as beads have been reported from several Neolithic sites, particularly from the anthropogenic fish deposit at the Holm of Papa Westray North, a chambered tomb, which included eleven pierced vertebrae deriving from large gadids (cod (*Gadus morhua*), ling (*Molva molva*) and potentially saithe (*Pollachius virens*)). Almost all were from the anterior part of the vertebral column, suggesting deliberate selection (Harland and Parks, 2008). At the

same time, it is important to note that the overwhelming majority of "beads" found at Orcadian Neolithic sites, such as the several thousand uncovered in Skara Brae, are made from domestic mammal bones and teeth, and in this instance whale teeth as well.

Examples from historical contexts are more scattered. In Viking Age Haithabu, a perforated vertebra was identified as deriving from halibut (*Hippoglossus hippoglossus)* (Lepiksaar and Heinrich 1977). In late medieval deposits in Kołobrzeg, Poland, single examples of a perforated cod and a salmon / sea trout (*Salmo* species) vertebra have been found, and a perforated cod vertebra has been found in medieval deposits in Tallinn (Lõugas pers. comm). A deposit of perforated ling vertebrae, in association with three perforated cattle bones, was found in a dismantled chapel in Chevington, coastal Northumberland, England, and dated to the 13th-14th centuries (Stallibrass 2002; 2005; 2007). Further west, excavations within the monastic church of Skriðuklaustur in Iceland, dating to the 15th-16th centuries, uncovered 46 porbeagle shark (*Lamna nasus*) vertebrae which had been perforated, with traces of wear suggesting they were threaded on a cord. The majority were found in the southern part of the church, most likely in close proximity to the altar (Hamilton-Dyer, 2010: 48-51). Three finds of perforated tuna vertebra have also been reported from northern Europe. One was discovered in a field near the coast at Bojendorf, on the western side of island of Fehmarn, and interpreted as early modern. Another from the village of Tarnby on the island of Amager was dated to the 16th-19th centuries, and one from excavations in Wasserstraße (Site 47), Stralsund, was dated to the 17th century. They exhibited traces of wear and most likely derived from individuals caught in the waters around Jutland and the Danish islands; tuna migrate here in the late summer, and occasionally into parts of the Baltic (Glykou, Heinrich, Enghoff 2011).

Bones derived from marine fish species are a staple of modern coastal souvenir markets around the world, with diverse examples of vertebrae strung as necklaces. This of course includes the European littoral, however, in the early 20th century, before the proliferation of mass tourism, there are examples of what may be the continuation of earlier uses of marine species amongst fishing communities. Women from the Hutsul fishing families in Czeremosz in Ukraine wore such necklaces, and in the Ashmyany region (today Belarus) in c. 1932, during Lent, a twelve-year-old shepherd carefully kept the bones of consumed herring, after which he cleaned the vertebrae, dried them, dyed them in red and blue, and drilled holes to string them together as a necklace (Moszyński, 1968: 198-9, note 1).

Diachronic Roles of Fish Vertebrae

Previous studies have interpreted perforated fish vertebrae as bodily adornments, perhaps with a spiritual function connected with the role of aquatic environments and animals in the associated cultural belief systems (Cooper, 1998; Kopaliński, 2006; Ifantidis, 2019: 146-147). This interpretation remains necessarily vague for prehistoric societies, although ethnographic studies of the cultural role of fish in other regions of the world, and their representation in material culture, indicate the potential complexity of earlier belief systems. The representation of species has often been linked to their local availability; however, it is also clear that some were deliberately and consistently selected above others. In Poland, and more broadly in Central-Eastern Europe, pike and catfish recur through time as the species of choice, both accessible from slow-moving rivers and lakes. It is striking that the vertebrae of other consistently exploited large freshwater fish in this region, such as zander (*Sander lucioperca*), do not appear to have been used in this way.

Within prehistoric contexts, the choice of species may have communicated distinctive social identities, perhaps connected with territoriality. Their inclusion in graves may have also expressed the continuation of these identities. For example, the Orcadian preference for deep water gadid vertebrae has been connected with access to (and perhaps control over) the edges of the island's archipelago, whilst some have suggested the choices are related to totemic species (Harland and Parks 2008: 11, 14-15). Only those finds buried with individuals whose sex and age were determinable, enable fish bone beads to be connected with specific social groups. On the basis of the Polish dataset, those from the Lengyel, Lusatian and Pomeranian cultures, it could be argued that pike vertebrae beads were associated with women (in six cases) and children (in five cases). Only one example was found in a male (high-status) grave.

In the historical period, these objects are frequently interpreted as apotropaic, amuletic or talismanic; synonymous terms referring to protection against ill fortune or evil (Moszyński, 1967; Rulewicz, 1994; Makowiecki, 2003). Occasionally utilitarian uses have been proposed; the tuna vertebrae from the German and Danish coastal sites have been interpreted as fishing reel spools or an element of ship rigging (Glykou, Heinrich, Enghoff 2011: 213). More commonly, fish vertebrae in historical Europe have been interpreted as prayer beads. Such beads, for aiding the repetition of prayers, were widely used in medieval and post-medieval Catholic Europe. These were produced by specialised artisans from a diverse range of materials; luxury beads for high-status consumers were manufactured from amber, gold, precious stones, and coral, whilst more common varieties included wooden or leather discs (Zalewska, 1999; Kołyszko, 2013). Those made from bone, a cheap and easily available raw material, were produced for the least affluent consumers and for children. A rare artistic representation of the use of fish vertebrae for a rosary is visible on the polyptych of Saint Vincent by Nuno Gonçalaves, a Portuguese painter active in the mid-15th century (Stallibrass, 2002). Many examples of perforated vertebrae from medieval archaeological contexts, particularly those deposited within or near churches and chapels, are likely to have been used as prayer beads. The much larger shark vertebrae from Skriðuklaustur would have been impractical on a personal rosary, and whilst they may have been used as paternoster beads on a rosary, they were more likely to be intended for display on an altar, wall or draped over a religious statue (Hamilton Dyer, 2010: 51). However, in contrast to more commonly available fish, the shark would have represented something closer to a marvel, and like whale bones, wholly appropriate for a church's treasury (Pluskowski, 2013).

Fish vertebrae may have been chosen for manufacturing into generally low-status objects as they were easily accessible, but also significant in terms of Christian symbolism. In Poland, and more broadly Central-Eastern Europe, pre-Christian meanings associated with pike and catfish vertebrae may have been adopted within Christian society, with magical functions gradually mapping onto new religious symbolism. According to some beliefs documented in Germany, fish vertebrae could protect their bearer against the dangers of childbirth (Wilke, 1936). In Slavic symbolism, the pike, the most common predatory freshwater fish, was connected with fertility, vitality, and dominance. The catfish, rarer, but significantly larger, was connected with strength and magnificence. However, marine, and migratory species have only been found at sites in close proximity to maritime littoral waters and so it appears that accessibility is still a determining factor in the archaeological representation of fish species. The tradition of manufacturing bone rosaries has not died out completely with the advent of

plastic. In Ukraine and Russia, fish vertebrae are still used for rosaries, as well as for abacuses (Gorobets et al., 2017: 19).

Conclusion

The use of perforated fish vertebrae in Europe can be dated back to the Upper Palaeolithic. In prehistoric societies within the territory of modern Poland, the principal species whose bones were used in this way was pike, particularly in association with the burials of women and children, whilst late prehistoric communities also utilised catfish in this way. In the early medieval period, the relative representation of these two species was reversed. The preference for these two species, as well as salmonids, may reflect the presence of notochordal canals in their vertebrae centra, which would have made them easier to widen with a tool. The specific choice of vertebrae from an individual fish may also have been determined by ease of widening existing perforations. Most examples are precaudal vertebrae, perhaps because the lack of processes made them easier to prepare. In pike, processes on later vertebrae could be easily removed after boiling, whilst in catfish, they had to be chopped off. Cut marks are visible on some examples, such as the vertebra bead from Szczecin and Ostrów Lednicki (Table 1, Figure 7).

Following the acceptance of Christianity, fish vertebrae appear to have been used as rosary beads, as suggested for examples in Poland, England, and Iceland. The comparatively rarer use of marine and migratory species can be connected with the exploitation of the maritime environment by coastal communities. In other regions of Europe there is some variety in the representation of species, although data is generally lacking or inaccessible. The updated Polish dataset, alongside additional examples from elsewhere in Europe, provides a solid foundation for stakeholder groups to identify and report such artefacts. It is likely that examples remain undiscovered in museum collections, and on the basis of the data presented in this paper, they should also be looked for in cremation deposits, and their burnt/unburnt condition noted. It also allows for the future contextualisation of non-alimentary uses of fish remains, and their transformation into material culture.

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Figures

1. Map showing the location of Polish sites listed in Table 1 (Aleks Pluskowski).
2. The hip belt from Grave No. 4 in Brześć Kujawski Site 4, consisting of thirty clay beads and a similar number of perforated pike vertebrae arranged in an alternating sequence, with additional perforated shells (Jażdżewski, 1938, table 3) (Wiesław Ochotny)
3. Contrasting perforated vertebrae. A) Perforated pike vertebra from Wtórek, Poland (Wiesław Ochotny). The item displays several of the key characteristics of a fish vertebra adapted and utilised as a bead, including removal of protruding bony elements and traces of

wear. B) Perforated catfish vertebra from Sandomierz, Poland (Daniel Makowiecki). This example has roughly projecting bony stubs and less evident traces of wear.
4. Examples of perforated catfish vertebrae from Pietrele, Romania. They show a range of perforation sizes, as well as varied smoothing and retention of projecting elements around the centra (Ken Ritchie).
5. Examples of perforated fish bone from early medieval contexts in Poland: catfish vertebrae from (a) Giecz (Daniel Makowiecki), (b) Międzyrzecz (Daniel Makowiecki) and (c) Bydgoszcz (Jozef Los, Bydgoszcz Museum); and pike vertebrae from (d) Ciepłe (Archaeological Museum in Gdańsk) and (e) Płochocinek (Daniel Makowiecki).
6. A necklace of pike vertebrae painted red (purchased in the Folk and Art Industry Headquarters (Cepelia) in Poland in the 1960s, Daniel Makowiecki).
7. Catfish vertebrae from Ostrów Lednicki, site 2: (a) the specimen in comparison with modern catfish abdominal vertebrae, (b) cut marks reflecting the removal of the transverse processes (Wiesław Ochotny).

Tables

1. Perforated fish vertebrae from the territory of modern Poland included within this paper. Based on Makowiecki, Makowiecka 2017, revised and supplemented.

References

Abłamowicz R., Józefowska A. 2020. Wyroby z surowców pochodzenia zwierzęcego z cmentarzyska z epoki żelaza z Domasławia 10/11/12, gm. Kobierzyce. In *Cmentarzysko wczesnej epoki żelaza w Domasławiu 10/11/12, powiat wrocławski. Tom V. Opracowania specjalistyczne*, B. Gediga, A. Józefoska (eds.), Fundacja Przyjaciół Instytutu Archeologii i Etnologii Polskiej Akademii Nauk ; Instytut Archeologii i Etnologii Polskiej Akademii Nauk, Wrocław; 227-233.

Akerman, K. 2018. The esoteric and decorative use of bone, shell and teeth in Australia. In *The Archaeology of Portable Art: Southeast Asian, Pacific and Australian Perspectives*, MC Langley MC et al., (eds.). Routledge: London; 199-219.

Altamirano-Sierra A, Vargas-Nalvarte P. 2016. The white shark (*Carcharodon carcharias*) in the ancient Peruvian ceremonial centre of Huaca Pucllana. *International Journal of Osteoarchaeology* 26/1: 114-120.

Beldiman, C., Buzea, D-L, Sztancs, D-M and Briewig, B. 2015. Aeneolithic beads made of fish vertebra discovered at Păuleni-Ciuc – "Dâmbul Cetăţii", Harghita county, Romania, *Acta Terrae Septemcastrensis,* 14: 135-153.

Bērziņš, V., Brinker, U., Klein, C., Lübke, H., Meadows, J., Rudzīte, M., Schmölcke, U., Stümpel, H. and Zagorska, I. 2014. New research at Riņņukalns, a Neolithic freshwater shell midden in northern Latvia. *Antiquity*, 88/341: 715-732.

Betts MW, Blair SE, Black DW. 2012. Perspectivism, mortuary symbolism and human-shark relationships on the Maritime Peninsula. *American Antiquity* 77/4: 621-645.

Busch A. 1985. *Tierknochenfunde aus einer*. Dissertation. Institut für Paläoanatomie, Domestikationsforschung und Geschichte der Tiermedizin der Universität München, München.München.

Carenti G. 2013. Sant'Antioco (SW Sardinia, Italy): Fish and fishery resource exploitation in a western Phoenician Colony. *Archaeofauna* **22**: 37-49.

Chmielewski K. 1988. Wyniki ekspertyzy zoologicznej niektórych zabytków z cmentarzyska kultury łużyckiej w Laskach. In *Laski. Materiały z cmentarzyska kultury łużyckiej*. Malinowski T (ed.). Wyższa Szkoła Pedagogiczna w Słupsku: Słupsk; 73.

Cione AL, Bonomo M. 2003. Great white shark teeth used as pendants and possible tools by early-middle Holocene terrestrial mammal hunter-gatherers in the Eastern Pampas (southern south America). *International Journal of Osteoarchaeology* 13: 222-231.

Cooper JC. 1998. *Zwierzęta symboliczne i mityczne*. Rebis: Poznań.

Davis, SJM Gabriel, S, Simões T. 2018. Animal remains from Neolithic Lameiras, Sintra: the earliest domesticated sheep, goat, cattle and pigs in Portugal and some notes on their evolution. *Archaeofauna* **27**: 93-172.

Drozd-Lipińska A. 2020. Przepalone szczątki ludzkie. Opracowanie antropologiczne. In *Między Słupią a Wierzycą, cmentarzyska kultury pomorskiej z obszaru Kaszub i Kociewia*. Piotr Fudziński (ed.), Muzeum Archeologiczne: Gdańsk; 107-149.

Gál E. 2016. Objects made from tusk, bone and antler from the Ottoman-Turkish fort at Barcs, Hungary. In *"per sylvam et per lacus nimios" The Medieval and Ottoman Period in Southern Transdanubia, Southwest Hungary*: *The Contribution of the Natural Sciences*. Kovács G, Zatykó C (eds.). Institute of Archaeology, Research Centre for the Humanities, Hungarian Academy of Sciences: Budapest; 133-143.

Gediga B., Józefowska J. 2018. Cmentarzysko wczesnej epoki żelaza w Domasławiu 10/11/12, powiat wrocławski Tom I, Katalog. Fundacja Przyjaciół Instytutu Archeologii i Etnologii Polskiej Akademii Nauk Instytut Archeologii i Etnologii Polskiej Akademii Nauk: Wrocław.

Glykou A, Heinrich D, Enghoff IB, 2011. Bearbeitete Wirbel von Thunfischen, *Thunnus thynnus* (L. 1758) Frühneuzeitliche Objekte unbekannter Funktion. *Offa* **63/64**, 2006/07: 209-215.

Gorbanenko SA, Hoshko TY, Dzneladze OS, Kovalchuk OM, Milashevskyi OS, Nesterovskyi VA, Panikarskyi AV, Serheieva MS. 2018. Beads of the Wielbark culture from Khrinnyky. *Arheologia* **2**: 80-97.

Gorobets LV, Kovalchuk OM, Pshenichny YuL, Veiber AV. 2017. Animals in kitchen waste of Dubno Holy Transfiguration Monastery (Ukraine) from the time of its construction (16th century AD). *Proceedings of the National Museum of Natural History* **15**: 15-24.

Hałuszko A. 2017. Analizy antropologiczne szczątków kostnych z grobów ciałopalnych, ze stanowiska Wtórek 7 (AZP 69-36/51), gm. Ostrów Wielkopolski, Fundacja Archeolodzyorg, Wrocław (Unpublished).

Hamilton-Dyer S. 1997. The animal bones from late Saxon and medieval deposits. In *The Lower High Street Project,* Russel A. et al. (eds.) Unpublished report for Southampton City Archaeological Unit.

Hamilton-Dyer S. 2010. *Skriðuklaustur Monastery, Iceland. Animal Bones 2003-2007. Skýrslur Skriðuklaustursrannsókna XXVI*. Skriðuklaustursrannsóknir: Reykjavík.

Hansen, S., Toderas, M., Wunderlich, J. Beutler, K., Benecke, N., Dittus, A., Karaucak, M., Müller, M., Nowacki, D., Pint, A., Price, T.D., Ritchie, K., Steiniger, K. and Vachta, T. 2014. Pietrele am ,,Lacul Gorgana‘‘. Bericht u¨ber die Ausgrabungenin der neolithischen und kupferzeitlichen Siedlung und die geomorphologischen Untersuchungenin den Sommern 2012–2016. *Eurasia Antiqua* 20: 1-116.

Harland, J Parks R. 2008. *Technical Report: The Fish Remains from the Holm of Papa Westray North, a Neolithic Chambered Tomb*. Centre for Human Palaeoecology, University of York: York.

Ifantidis F. 2019. *Practices of Personal Adornment in Neolithic Greece*. Archaeopress: Oxford.

Jażdżewski K. 1938. Cmentarzysko kultury ceramiki wstęgowej i związane z nim ślady osadnictwa w Brześciu Kujawskim. *Wiadomości Archeologiczne* **15**: 1-105.

Kołyszko M. 2013. *Dewocjonalia z końca XVI -XVIII wieku pochodzące z badań archeologicznych na terenie ziem polskich (stan zachowania, identyfikacja, zagadnienia konserwatorskie)*. UMK: Toruń.

Kopaliński W. 2006. *Słownik symboli*. Oficyna Wydawnicza Rytm: Warszawa.

Kozuch L. Fitzgerald C. 1989. A guide to identifying shark centra from southeastern archaeological sites. *Southeastern Archaeology* **8/2**: 146-157.

Kühl I. 1984. Animal remains in cremations from the Bronze Age to the Viking period in Schleswig -Holstein, North Germany. In *Animals and Archaeology*: *Husbandry in Europe*. Grigson C, Clutton-Brock J (eds.). Archaeopress: Oxford; 209-220.

Leavesley MG. 2007. A shark-tooth ornament from Pleistocene Sahul. *Antiquity* **81/312**: 308-315.

Lepiksaar J, Heinrich D. 1977. *Untersuchungen an Fischresten aus der frühmittelalterlichen Siedlung Haithabu*. Karl Wachholtz: Neumünster.

Lõugas L, Maldre L. 2021. Tallinna arheofaunast luu-uurijate pilgu läbi. In *Tallinna Linnamuuseumi Toimetised 2 = Proceedings of the Tallinn City Museum* (in press).

Luik H. 2018. Kaulo ir rago dirbiniai Vilniaus pilių komplekse. In *Vilniaus pilių fauna nuo kepsnio iki draugo*. Blazevičius P et al. (eds.) Vilniaus Universiteto Leidykla: Vilnius; 157-213.

MacGregor A. 1985. *Bone, Antler, Ivory and Horn: The Technology of Skeletal Materials Since the Roman Period*. Routledge: London.

Makowiecka M., Makowiecki D. 2017. Wyniki badań zwierzęcych szczątków kostnych z miejscowości Wtórek, stan. 7. Unpublished.

Makowiecki D, Makowiecka M. 2017. Kręgi, paciorki, wisiorki, talizmany, czyli przyczynek do poznania pozautylitarnego znaczenia ryb u ludów prahistorycznych i wczesnohistorycznych na ziemiach polskich. In *Gemma Gemmarum*. Różański A (ed.). PTPN: Poznań; 343-364.

Makowiecki D. 2003. *Historia ryb i rybołówstwa w holocenie na Niżu Polskim w świetle badań archeoichtiologicznych*. Instytut Archeologii i Etnologii Polskiej Akademii Nauk: Poznań.

Makowiecki D. 2010. *Wczesnośredniowieczna gospodarka zwierzętami i socjotopografi a* in Culmine *na Pomorzu Nadwiślańskim. Studium archeozoologiczne*. UMK: Toruń.

Makowiecki D. 2020. Charakterystyka archeozoologiczna szczątków zwierzęcych z cmentarzysk ludności kultury pomorskiej z Kaszub i Kociewia. In *Między Słupią a Wierzycą, cmentarzyska kultury pomorskiej z obszaru Kaszub i Kociewia*. Fudziński P. (ed.), Muzeum Archeologiczne: Gdańsk; 211-221.

Moszyński K. 1967. *Kultura ludowa Słowian, 2/1, Kultura duchowa*. Ksiażka i Wiedza: Warszawa.

Moszyński K. 1968. *Kultura ludowa Słowian, 2/2, Kultura duchowa*. Ksiażka i Wiedza: Warszawa.

Nowak M., Drążkowska A., Łyczak M. 2020. Wyposażenie grobowe, In *Krypty grobowe kościoła pw. św. Franciszka z Asyżu w Krakowie w świetle badań interdyscyplinarnych. Archeologia –Historia – Kostiumologia*, t. 1, A. Drążkowska (ed.) Wydawnictwo Naukowe Uniwersytetu Mikołaja Kopernika: Toruń; 179 –281.

Pálsson G. 1994. The idea of fish: land and sea in the Icelandic world-view. In *Signifying Animals: Human Meaning in the Natural World*. Willis R (ed.). Routledge: London; 114-127.

Pluskowski AG. 2004. Narwhals or unicorns? Exotic animals as material culture in medieval Europe. *European Journal of Archaeology* **7/3**: 291-313.

Pluskowski AG (ed.) 2007. *Breaking and Shaping Beastly Bodies: Animals as Material Culture in the Middle Ages*. Oxbow: Oxford.

Pluskowski AG. 2013. The dragon's skull: How can zooarchaeologists contribute to our understanding of otherness in the Middle Ages? In *Animals and Otherness in the Middle*

Ages: Perspectives Across Disciplines. García García FdeA, Vadillo MAW, Chico Picaza MV (eds.). Archaeopress: Oxford; 109-124.

Ridler I. 2006. Early medieval fishing implements of bone and antler. In *Fishery, Trade and Piracy.* Pieters M (ed.) Vlaams Instituut voor het Onreorend Erfgoed: Brussels; 171-180.

Robson, HK. 2016. New ichthyoarchaeological data from the Mesolithic lakeshore settlement site of Friesack 4. In *Subsistenz und Umwelt der Feuchtbodenstation Friesack 4 im Havelland: Ergebnisse der naturwissenschaftlichen Untersuchungen*. ed. / Benecke N, Gramsch B, Jahns S, (eds.) BLDAM: Wünsdorf; 160-177.

Rulewicz M. 1994. *Rybołówstwo Gdańska na tle ośrodków miejskich Pomorza od IX do XIII wieku*. Zakład Narodowy im. Ossolińskich: Wrocław.

Rolik H, Rembiszewski JM. 1987. *Ryby i krągłouste (*Pisces et Cyclostomata*)*. Państwowe Wydawnictwo Naukowe: Warszawa.

Stallibrass S. 2002. The possible use of fish and cattle bones as rosary beads. *Finds Research Group 700 -1700*, Datasheet **29**: 1-4.

Stallibrass S. 2005. Art, archaeology, religion and dead fish: A medieval case study from northern England. In *Just Skin and Bones? New Perspectives on Human-Animal Relations in the Historical Past*. Pluskowski AG (ed.). Archaeopress: Oxford; 105-112.

Stallibrass S. 2007. Taphonomy or transfiguration: do we need to change the subject? In *Breaking and Shaping Beastly Bodies: Animals as Material Culture in the Middle Ages*. Pluskowski AG (ed.). Oxbow: Oxford; 52-64.

Stanc SM, Radu V, Bejenaru L. 2008. Analyse archéozoologique des restes de poisson provenant du site de Slava Rusa (Roumanie). In *Archéologie du poiss on. 30 ans d'archéo-ichtyologie au CNRS Hommage aux travaux de Jean Desse et Nathalie Desse-Berset. XXVIIIe rencontres internationales d'archéologie et d'histoire d'Antibes*. Béarez P, Grouard S, Clavel B (eds.). Ed APDCA: Antibes; 267-279.

Stanc SM. 2009. *Archeozoologia primului mileniu după Hristos pentru teritoriul cuprins între Dunăre şi Marea Neagră*. Editura Univrsităţii "Alexandru Ioan Cuza": Iaşi.

Sykes N. 2015. *Beastly Questions: Animal Answers to Archaeological Issues*. Bloomsbury: London.

Theodoropoulou, T. 2007. *L'exploitation des ressources aquatiques en Égée septentrionale aux périodes pré- et protohistoriques. PhD thesis, Université Paris I Pantheón-Sorbonne.*

Wilke G. 1936. *Die Heilkunde in der europäischen Vorzeit*. Rabitzsch: Leipzig.

Wilkens, B. 1995. La vertebre di salmonidi della triplice sepoltura del paleolitico superiore della Barma Grande (IM). *Atti del I Convegno nazionale di archeozoologia: Rovigo, Accademia dei Concordi, 5-7 marzo 1993. Padusa. Quaderni*, 1: 365.

Wrzosek A, Ćwirko-Godycki M. 1937. *Przedmioty z kości znalezione w grobach kultury łużyckiej na cmentarzysku w Laskach w powiecie kępińskim*. Przegląd Antropologiczny 11/2; 7-17.

Zalewska K. 1999. *Modlitwa i obraz. Średniowieczna ikonografia różańcowa*. Wydawnictwa Uniwersytetu Warszawskiego: Warszawa.