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# Dressing Central European prehistory – the sheep's contribution An interdisciplinary study about archaeological textile finds and archaeozoology

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(with 10 figures)

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**For Erich Pucher**

**Abstract**

The current article presents the archaeological and archaeozoological evidence about the exploitation and utility of sheep wool for garments in Austria and its neighbouring countries. For this aim, the finds of sheep bone and textiles will be discussed, combined and evaluated in order to gain insights into the history of sheep, and especially its economic exploitation. The finds derive mainly from sites in Austria from the Neolithic to the Roman period.

In present day, cattle and pigs are by far the most common farm animals in Austria; the wild forms of both species have/had their natural habitat here. Nevertheless, the archaeozoological and archaeological results show that sheep have gained a place in the cultural history of Austria too. To name one example, textiles from Hallstatt salt mine indicate that sheep wool products played a very important role in Central Europe as early as the Middle Bronze Age.

**Keywords:** prehistory, sheep, textiles, wool products, Central Europe.

## Introduction

The analysis of animal bones from archaeological excavations can deliver significant information about the economic importance and exploitation of the domesticated species. This type of analysis was always one of the main focuses for the archaeozoologist Erich PUCHER. In this context he has extensively discussed the question of sheep wool

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exploitation in different archaeological periods. The occupation as a scientist in an institution like the Natural History Museum Vienna enabled Erich Pucher to work on different topics and to pursue different research interests. In this regard, he was engaged with the archaeozoological analysis of many important Austrian sites from the Neolithic to the Early Modern period, resulting to a very long and important publication record.

Also important finds of archaeological textiles are kept at the Natural History Museum Vienna, in that case the Prehistoric Department. They have been found in the Bronze and Iron Age parts of the salt mine Hallstatt and are an essential source for our understanding of textile technology in prehistoric Central Europe.

In the following, a synthesis between archaeological textile finds and results gained from the study of archaeozoological material shall demonstrate the significance of sheep wool for prehistoric garments. An article about leather and fur is presented by Gabriela Russ-Popa (this volume).

## A sheep story: let the bones talk

Faunal remains that have been found in archaeological contexts carry essential information about past ways of life. Their investigation is a crucial step for archaeological analysis and interpretation, since they can be used as valuable indicators to better understand historical processes, connections, interactions, and social dynamics.

### Methods and Challenges

Archaeozoological analysis can contribute to our knowledge about the socio-economic organisation of past human societies; in this specific case, the interest focuses on the exploitation of sheep wool.

The identification, which is conducted at an element (animal bone) and species (cattle, pig, sheep, etc.) level, is the first step of the analysis. When identifying bones of small domestic ruminants (sheep and goats) there is often a respectable number of unidentified fragments summarized as sheep/goat (*Ovis/Capra*; O/C), illustrating the difficulties when trying to separate these two closely related species.

Although osteological criteria for distinguishing between sheep and goat have been established (Boessneck *et al.* 1964; Schramm 1967; Kratochvíl 1969; Gabler 1985; Payne 1985; Prummel & Frisch 1986; Helmer 2000; Halstead *et al.* 2002; Gillis *et al.* 2011; Himstedt 2014; Salvagno & Albarella 2017), it is not always possible to assign each animal bone to either sheep or goat. The degree of fragmentation and/or the lack of features and anatomical details, important for the species' identification, make this task even more challenging. Thus, only a small number of identified sheep bones remains, which actually discourages the statistical processing of the material.

Despite these difficulties it is of great importance for the archaeozoological and the archaeological analysis to distinguish between the two species, whenever possible; this is because sheep and goats exhibit crucial differences related to ecology, ethology, keeping, secondary exploitation, economy, and cultural background, which have a serious impact on the archaeological discussion and interpretation.

The aforementioned challenges should be also considered during the quantification of the archaeozoological material. The question about the presence or absence of species is decisive, but of equal importance is also the estimation of the percentages in which the species occur. In this way it is possible to find out which animals prevailed, and to develop preliminary observations about their economic significance of a specific site, region or period. However, the quantification methods reveal only general tendencies; the faunal remains – and especially small-bodied animals or very young individuals – are influenced by different taphonomic processes. Therefore, the social importance of numerically underrepresented species shall not be underestimated (SYKES 2015: pp. 9–10).

The next important step is the skeletal element representation. The presence or absence of body parts can provide significant information about the socioeconomic structure (supply, use imports, etc.). As an example, the processing and production of skin, pelt, and leather is usually linked to an over- or underrepresentation of specific skeletal elements, like horn cores, metapodials, and phalanges (PRUMMEL 1978; NOODLE 1994; BARTOSIEWICZ 1995; SALIARI & FELGENHAUER 2017). The analysis of modifications, such as cut marks, offers additional information about the economic activities that took place (BINFORD 1981; KNIGHT 2002; SEETAH 2005).

Another significant step to better understand the animals' management is the age and sex reconstruction. In this way it is possible to find out if the animals were important for the meat supply or if they were further exploited for milk and wool (ZEDER 2006; FISCHER 2014; MARCINIAK 2014). Concerning age distribution, when the exploitation of secondary products (such as milk or wool) is the main focus, adult individuals and in general older animals are more frequent. Age assessment is usually based on the teeth and the epiphyseal fusions. Mandibles and especially teeth belong to those elements that cannot be attributed with certainty to sheep or goats, and thus the age distribution usually concerns both species (sheep/goat).

Sex ratio provides additional information about the nature of the secondary exploitation. The predominance of female individuals is usually associated with milk production. In cases where wool exploitation is of central importance, sex distribution can vary and often a high number of male or castrated animals is observed. The various forms of exploitation (wool, milk) are osteologically more recognisable when they are conducted in an advanced and pronounced form; sometimes, there are only scarce (or no) indications.

The morphometric analysis is a fundamental step for the interpretation of the socioeconomic profiles. When essential morphometric similarities between the archaeozoological material and recent animal populations (in that case sheep) have been confirmed, it is expected that there would also be physiological similarities. This analogy is a very useful tool that helps us to extract vital information about properties and characteristics of past animal populations (for instance, if a specific population produced more meat, milk, or wool, or other observations related to the different product qualities).

The estimation of height at withers is an important part of the morphometric investigation and various bones can be used for its calculation. It is always advisable to note the bones used for the size reconstruction. This is because not all the bones – even if some are better preserved (*e.g.* talus bone) – are appropriate for estimating the height at withers. Moreover, as it has turned out, the factors that were proposed by various authors are not always reliable; these factors were often calculated based on modern material, requiring the final estimation to be corrected for the archaeological finds in many cases because of differences in the proportions.

Other important factors that should be taken into consideration during the archaeozoological analysis and interpretation are: taphonomic processes, dating (especially for isolated contexts), lack of organic remains (leather, skin etc.), archaeological context (rural settlement, mining settlements, graves etc.), cultural background (customs, traditions, taboos etc.), excavation techniques, and laboratory treatment.

Finally, every method has advantages and disadvantages and there are various systems that can be employed for the processing of the data. Based on the scientific question(s) and the research strategy, it is possible to choose among the proposed methods and systems.

## Neolithic: early sheep in Europe

The Neolithisation is characterised by technological achievements and important socio-economic changes. One of the most significant features of this period is the appearance of domestic animals (cattle, sheep/goat, pig, and dog). Domestication is "a complex biological and cultural process" (HERRE & RÖHRS 1971) and although the term "domestic animal" has universal meaning, fundamental questions regarding the processes underlying domestication remain largely unanswered (DOBNEY & LARSON 2006).

Archaeological as well as archaeozoological finds from Central Europe indicate that the earliest farming cultures spread through different ways (Balkan, Mediterranean). Nevertheless, during specific periods, the domestic animals from the Danube region and the alpine region suggest different origins and evolution. The investigation of the faunal assemblages from the Early Neolithic in Austria shows that the domesticated animals prevailed with 70 % of the total material (SCHMITZBERGER 2009a: p. 28, fig. 6). During the early phases of the Linear Pottery Culture (5500–4900 BC) sheep and goats were represented with more than 40 % (SCHMITZBERGER 2009a: p. 34, fig. 8). The prevalence of the small domestic ruminants has been linked to their Middle Eastern origins and the new subsistence strategy (PUCHER 1994, in press a). With the transition to the later phases of the Linear Pottery Culture, an essential change, and namely a decrease in the number of sheep and goats, was noted.

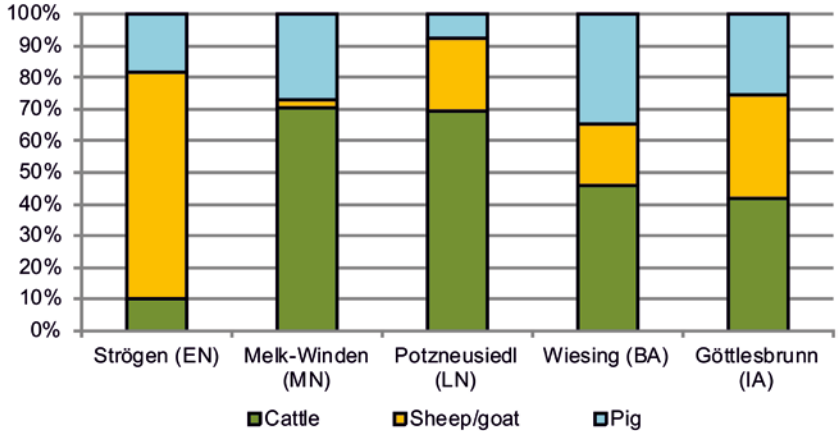



Fig. 1. Fauna composition from the Austrian sites Strögen (PUCHER 1987), Melk-Winden (PUCHER 2004a), Potzneusiedl (SCHMITZBERGER 2009b), Wiesing (PUCHER 1986b), Göttlesbrunn (PUCHER 2006). Abbreviations: EN: Early Neolithic, MN: Middle Neolithic, LN: Late Neolithic, BA: Bronze Age, IA: Iron Age.

At the beginning of the Middle Neolithic, c. 4900/4800 BC, two major structural changes took place (SCHMITZBERGER 2009a: p. 28): the number of small domestic ruminants dropped dramatically (Fig. 1), and the general percentage of the domesticated species was significantly reduced; at the same time the faunal assemblages exhibit intensive hunting activities. This noteworthy decrease in the number of sheep/goat was interpreted as the result of an adaptation process, during which only a few individuals survived (PUCHER in press a).

Environmental stress is thought to be one of the causes for these alterations (BARTOSIEWICZ 2008; PUCHER in press a). Sheep and goats, whose wild forms did not exist in Europe, come from semi-arid regions with warmer climate. In the Danube region, they already have to cope with less favourable habitats (BÖKÖNYI 1974: p. 56; PUCHER 2004a). Oral pathologies observed on sheep dentition from Austrian sites have been interpreted as markers of unsuitable pasture conditions (PUCHER in press a). Similar pathologies were found elsewhere too (compare BARTOSIEWICZ 2008).

For this reason, it has been suggested that the crisis observed on the species, which were not yet adjusted to the geographic and climatic conditions (especially sheep), caused an increase in hunting activities (PUCHER in press a); sheep and goats were at the beginning the prevalent species. Such a crisis would have seriously influenced the Neolithic economy and way of life. Thus, intensive hunting would have been an alternative way to survive. The earliest indications from the Stroke-ornamented ware culture (Stichbandkeramik) show that sheep and goats were present with just 10% of the total material. Other reasons that might have caused these dramatic changes, such as a social alteration, cannot be excluded, but it is difficult to find adequate evidence (BÖKÖNYI 1974: p. 56; PUCHER 2001; SCHMITZBERGER 2009a: p. 33).

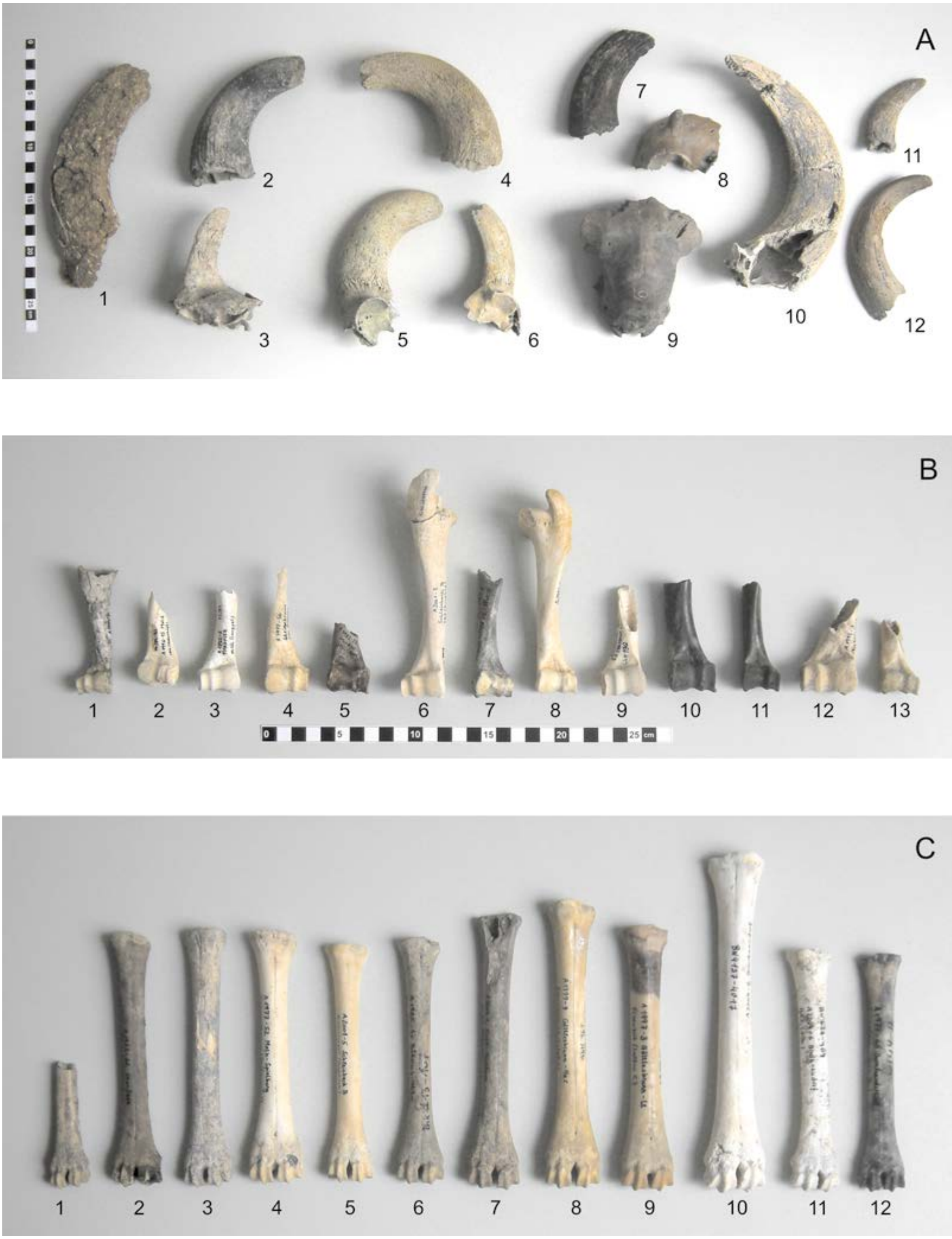

Fig. 2. Reconstruction of Neolithic pig (male), goat (male), sheep (male), and dog (male) by Erich PUCHER (in press a).

Fig. 3. Horn cores and cranial parts (A), humeri (B), and metacarpale (C) of sheep from Austrian sites from the Neolithic to the Roman period, kept at the Natural History Museum Vienna (Photo: E. PUCHER). Abbreviations: NÖ = Lower Austria (Niederösterreich), ♂/♀ = male/female individual. ▶

**A**: 1: ♂ Mold, NÖ (Early Neolithic, Linearbandkeramik); 2: ♂ Böheimkirchen, NÖ (Early Bronze Age); 3: ♀ Böheimkirchen, NÖ (Early Bronze Age); 4: ♂ Brixlegg, Tirol (Early Bronze Age); 5: castrate, Brixlegg, Tirol (Early Bronze Age); 6: ♀ Brixlegg, Tirol (Early Bronze Age); 7: ♂ Dürrnberg, Salzburg (Late Iron Age, Latène); 8–9: ♀ Dürrnberg, Salzburg (Late Iron Age, Latène); 10: Nickelsdorf, Burgenland (Roman period: italic fauna); 11–12: Bruckneudorf, Burgenland (Roman period: local fauna).

**B**: 1: Brunn 1, NÖ (Early Neolithic); 2: Mold, NÖ (Early Neolithic); 3: Friebritz, NÖ (Middle Neolithic); 4: Steinabrunn, NÖ (Late Neolithic: Funnelbeaker Culture/ Trichterbecherkultur); 5: Mondsee, Upper Austria (Spätneolithic); 6: Scheinbach, NÖ (Early Bronze Age); 7: Böheimkirchen, NÖ (Early/Middle Bronze Age); 8: Unterhautzenthal, NÖ (Late Bronze Age: Urnfield Culture/Urnenfelderkultur); 9: Göttlesbrunn, NÖ (Iron Age); 10–11: Dürrnberg, Salzburg (Iron Age: Latène); 12: Nickelsdorf, Burgenland (Roman period, italic fauna); 13: Bernhardsthal, NÖ (Roman period: local fauna).

**C**: 1: Brunn 1, NÖ (Early Neolithic); 2: Mondsee, Upper Austria (Spätneolithic); 3: Potzneusiedl (Late Neolithic: Baden Culture/Badener Kultur); 4: Melk-Spielberg, NÖ (Final Neolithic); 5: Schleinbach, NÖ (Early Bronze Age); 6: Böheimkirchen, NÖ (Early/Middle Bronze Age); 7: Pichl-Fischteich, Steiermark (Late Bronze Age: Urnfield Culture/Urnenfelderkultur); 8–9: Göttlesbrunn, NÖ (Iron Age); 10–11: Bruckneudorf, Burgenland (Roman period: italic and local fauna); 12: Bernhardsthal, NÖ (Roman Period: local fauna).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It seems that during the Lengyel culture (Lengyel-Kultur/ MBK I) the Neolithic economy was stabilized. Sheep and goats were better represented, but they did not reach the high percentages of the Early Neolithic (SCHMITZBERGER 2009a: p. 35). Only a few sheep survived the crisis and were ecologically suitable to form the basis of the future populations in northern Europe. Cattle and pigs, whose wild forms existed in Middle Europe, became the prevalent genera (PUCHER in press a).

At the end of the 4th millennium BC, the profiles of the domestic fauna remained stable; similar tendencies have been observed during the Late Neolithic. Sheep (and in general, small domestic ruminants) were however found in lower numbers (SCHMITZBERGER 2009a: p. 96). According to the present state of knowledge, the age and sex distribution suggests that the main role of these early sheep populations was meat supply and that they were only occasionally exploited for products such as wool (SCHMITZBERGER 2009a: p. 96).

Morphometric investigation (Fig. 3) shows that the first sheep populations of the Early and Middle Neolithic Period belonged to the small and gracile type with strong and robust mouflon-like horn cores (SCHMITZBERGER 2009a: p. 96; PUCHER in press a) (Fig. 2). One cranial find from Falkenstein (Lengyel culture, 4900–4300 BC) indicates the presence of a hornless female sheep (PUCHER 1986a). Female horn cores can significantly vary already during this period; this is also the case for the wild sheep. The height at withers was between 55–70 cm for female and male individuals (SCHMITZBERGER 2009a: p. 82, fig. 32). One talus bone from Mold (Linear Pottery Culture) with 33.5 mm (greatest length of the lateral half/ GLl) suggests that some individuals – probably males – could become astonishingly large with 75 cm height. No remarkable differences have been recorded regarding the size and shape of the Middle and Late Neolithic sheep in the Danube area.

In the second half of the 4th millennium and first half of the 3rd millennium BC remarkable regional differences can be recognized. The animals of the Mondsee culture (3800–3200 BC), located in Upper Austria, seem to be a special case. The analysis of sheep and goat remains from the site Mondsee suggests essential differences with contemporary sheep bones found in the Danube region (PUCHER & ENGL 1997).

Indeed, the investigated sheep remains from Mondsee exhibited individuals of smaller size (62.5–63 cm average withers height). Their horn cores were very close to the wild form, but smaller and with more similarities to animals from sites in Switzerland. Thus, it has been proposed that these animals might have reached Austria through the Alps. PUCHER & ENGL (1997) noted that the sheep and goats of the Mondsee culture exhibited an important grade of uniformity, but they demonstrated differences with the animals found in foreland. Also the cattle bones from Mondsee were of smaller size and much more gracile. The position and orientation of the horn cores shows more similarities with cattle deriving from southern regions.

Assemblages of the Baden culture (3500–2800 BC) from Slovakia and Hungary show remarkable differences in the morphometrics. The archaeozoological analysis indicated that the average withers height increased at about 10 cm (BÖKÖNYI 1974: pp. 169–171;

BENECKE 1994: p. 234). Similar changes were detected up to northern Germany and they were connected to the arrival of new sheep populations from the Middle East and the south-eastern Mediterranean. Such, the evidence was interpreted that the first woolly sheep appeared during the later phases of the Neolithic (BÖKÖNYI 1974: p. 169; BECKER *et al.* 2016).

Surprisingly enough, these changes have not been confirmed for the Austrian assemblages up to now (SCHMITZBERGER 2009a: p. 96). Newly excavated material from Weiden am See (Burgenland, Austria) seems to support this observation (SALIARI, unpublished data).

### Bronze Age sheep type

In the Bronze Age, in statistic data small domestic ruminants usually are represented in lower numbers than cattle or even than cattle and pig (during this period, pigs gained economic importance). In many assemblages sheep are more frequent than goats, which is mostly associated with their ecological background (Fig. 1).

Finds from Early Bronze Age (2200–1600 BC) settlements provide evidence for the secondary exploitation of the animals due to the age and sex distribution, but their weak representation suggests that they were economically of minor importance (PUCHER 1986b; BOSCHIN & RIEDEL 2009; TECCHIATI 2012). Although the prevalence of female sheep indicates milk exploitation (PUCHER & ENGL 1997), cows were the most significant milk suppliers (DESCHLER-ERB 2010; TECCHIATI 2012). Due to the low number of Middle Bronze Age settlement sites in Austria, it remains difficult to explain the role of the small domestic ruminants during that period.

A study from the site of Százhalombatta-Földvár in Hungary showed that meat production was the main reason for keeping sheep during the Early Bronze Age (VRETEMARK 2010). A decisive change took place in the transition to the Middle Bronze Age, when the importance of sheep increased and the age profiles suggest intensive sheep exploitation and a growing emphasis on wool production (VRETEMARK 2010).

More information derives from the Urnfield culture (Late Bronze Age, 1200–800 BC). During that period, the percentage of sheep (and goats) varies significantly. For instance, sheep and goats from Pichl (Early Urnfield culture) and Prigglitz Gasteil (Urnfield culture) were present with almost 20 % of the total material (in both cases the small domestic ruminants were dominated by sheep). The faunal assemblages of this period mainly derive from mining settlements (Bergbausiedlungen), like Prigglitz Gasteil (TREBSCHE & PUCHER 2013) and Hallstatt (PUCHER 2009, 2010, 2015), which archaeologically and archaeozoologically constitutes very special cases. The animal bones from these sites indicate the presence of consumers and not of producers (PUCHER 1999, 2015). In this context, and in order to better understand the role of the animals, it would have been preferable to have material from the producers too.

Morphometrically (Fig. 3) the sheep horn cores from the Early Bronze Age show significant similarities with the Neolithic sheep populations (PUCHER 1986a; H. BÖHM, pers. comm.); their examination demonstrates the same position and orientation with the Late Neolithic sheep.

Early Bronze Age faunal assemblages from Tyrol and Lower Austria show that the sheep populations north of the Alps were of bigger size than those at the southern part; at the northern part of Italy small-sized breeds have been found (PUCHER 1986b; RIEDEL 1998; BOSCHIN & RIEDEL 2009; TECCHIATI 2012; PUCHER 2014). It is interesting to mention that the sheep populations in the Alpine region exhibit a great variability and that the horn cores vary impressively from valley to valley (PUCHER pers. comm.).

The Early Bronze Age sheep also demonstrate morphometric similarities during the Middle and Late Bronze Age, representing a middle-sized population (RIEDEL 1998). Osteologically they are quite similar to the *Scottish Soay sheep,* with a withers height between 50 (female) and 60 (male) cm (SAMBRAUS 2001: p. 157). The average withers height of sheep found in the Eastern Alpine region was between 60 and 65 cm (PUCHER 2014). Differences of the average cannot be easily interpreted; they might reflect sexual dimorphism, local populations, or hybrids, which are not yet osteologically traceable. The low frequency of sheep bones also adds to the difficulties.

## Iron Age variety

During the Iron Age in Austria the frequency of domestic animals is stable and pretty similar to the profiles of the Bronze Age (PUCHER 1998; GALIK 1998; TREBSCHE 2007) (Fig. 1). Chronological differences among the sheep population of the Hallstatt Period (800–400 BC) and the Latène Period (400–15 BC) are not easily detectable, mainly because the presence of sheep was influenced by numerous factors, including geographic and climatic conditions (SALIARI *et al.* 2016).

The animal bones from the early Latène site Oberschauersberg suggest that both sheep and pigs contributed equally to the meat supply (SCHMITZBERGER, pers. comm.). In the case of Michelstetten during the Hallstatt Period sheep were the second most significant species after cattle, whereas during the Latène Period sheep appear in the statistics after cattle and pigs (SCHMITZBERGER 2010). According to the age and sex profiles, sheep were further exploited (milk and wool), but cattle was economically the most important species.

Faunal material from burials indicates that cattle (KUNST 2005; ABD EL KAREM 2014) and pigs (RAMSL 2011; BRUCKNER *et al.* 2006) were usually deposited as grave goods; the case of Statzendorf (Hallstatt period) is interesting, where it seems that sheep performed a crucial role at the local funerary practices (SCHMITZBERGER 2006).

The morphometric analysis of the archaeozoological material (Fig. 3) brought to light a lot of variations. The Iron Age sheep from the settlement Faggen exhibited 58–60 cm height at withers, indicating that the animals were a bit smaller than those from the Bronze Age, which were between 60–63 cm (TECCHIATI 2012). The height at withers for the sheep population from the Latène Period settlement in Göttlesbrunn varied between 56 and 65 cm with an average of 61 cm (PUCHER 2006). The same

Fig. 4. Reconstruction of Latène Period male and female sheep and goats by Erich PUCHER (2002).

range of variation was exhibited for the sheep population in Inzersdorf (PUCHER 1998) and Michelstetten (SCHMITZBERGER 2010). In general it could be said that the size of sheep ranged between 55 and 65 cm and that hornless female individuals became more frequent. The Iron Age sheep exhibit osteological similarities with the *Steinschaf*.

However, there are some noteworthy exceptions. The sheep bones from the settlement of Göttlesbrunn (Hallstatt period) exhibited some large-sized individuals with 76 cm height at withers (68.7 cm average) (PUCHER 2004b and compare with PUCHER 2006). They are bigger than the animals from the Latène Period settlement in Göttlesbrunn with an average of 61 cm (PUCHER 2006). Similar results come from Vienna-Oberlaa with 66 and 76 cm (CZEIKA 2006).

Sheep bones from Dürrnberg settlement indicate the presence of some large-sized animals with 66 cm (average withers height) were also found, holding a special position among the other studied Latène Period populations (Fig. 4) (PUCHER 1999). Similar values are reached by sheep during the Roman Period (when the average of imported and local sheep is calculated).

Based on the current state of knowledge it is difficult to explain the presence of these large-sized individuals. One important question is if these differences could be attributed to a mixed population or to sexual dimorphism. Morphologically there is no clear evidence for the appearance of a new sheep population. On the other hand, establishing the limits of sexual dimorphism is challenging because of difficulties in identifying castrated animals, the low number of sheep bones (which cannot be always statistically processed), and due to the concentrated presence of female animals, which affects the average withers height.

An interesting aspect regarding the large-sized sheep individuals is their archaeological context, especially for the cases of Dürrnberg and Göttlesbrunn. In both sites large-sized animals were found at a low quantity. In the case of Dürrnberg, the sex distribution showed an obvious prevalence of male/castrated animals. For this reason it would be logical to assume that some large-sized male or castrated sheep were delivered to the mining workers of Dürrnberg for meat supply. The large-sized animals from the settlement of Göttlesbrunn are mainly represented by metapodials found in craft contexts. Thus, a deliberate selection of large-sized bones for the manufacture of specific objects cannot be excluded.

### Addendum: Sheep bones from Roman contexts

A distinct change regarding the sheep population took place during the Roman Period (BENECKE 1994: pp. 235–236). The material from the Villa rustica in Nickelsdorf (Burgenland) provides evidence for the presence of italic animals; based on the talus bone, the sheep from this assemblage reached 74–85.5 cm withers high (RIEDEL 2004). An overlapping with large-sized individuals from the Iron Age was observed. The italic sheep population exhibited morphologically decisive differences and especially the horn cores were very characteristic. Even if the italic fauna appears regularly, the archaeological assemblages of this period suggest that local populations usually coexisted together with the newcomers (PUCHER *et al.* 2015; PUCHER in press b; SALIARI, unpublished data).

## A story of textiles and garments: fibres for clothing

In addition to the evidence provided by the archaeozoological analysis from Austrian sites, it is essential to discuss the products that can be gained from the exploitation of sheep in order to obtain a more concrete picture of their economic role and significance. This paper, which aims to investigate the contribution of sheep to the history of clothing in European prehistory, will now focus on sheep wool, and more particularly, on textiles made of sheep wool.

### Clothing before the woolly sheep: bast fibre and leather/fur

The European neolithic cultures based their cloth production mainly on bast fibres such as flax or tree bast (lime or oak: RAST-EICHER 2005), leather, and pelt (see RUSS-POPA this volume). Although flax was used for the production of woven textiles, it is difficult to recognize the shape and intention of the final product due to the small size of the finds which survived the various taphonomic processes.

Items and fragments of clothing are mainly noted in neolithic lakeside dwellings. The most significant finds have been discovered in Switzerland (RAST-EICHER & DIETRICH 2015) and Southern Germany (WININGER 1995); they include hats, shoes and fragments of cloaks. These finds indicate that various techniques have been used such as twinning or plaiting. Particularly well-known are the shoes from Allensbach and Sipplingen in Germany, both dated at around 3000 BC. Although they were not appropriate for the weather conditions in winter time, they protected the soles from rough surfaces. The finds from Hornstaad and Wangen, which are hat-like headcovers, had a very small diameter of only 30 cm; for this reason they are usually interpreted as hats for children (BANCK-BURGESS 2016: fig. 196–199; WININGER 1995: fig. 13).

Concerning the history of clothes and clothing equipment, it is important to mention that materials and products coming from animals did not survive the impact of alkaline sediments at the lakeside dwellings; therefore there is a significant gap concerning our knowledge about the presence and use of objects made of leather and pelt in these settlements. However, there are some surprising exceptions, such as organic material from the Late Neolithic Period which survived thanks to favourable conditions in ice; the most famous example of this period is the frozen body of "Ötzi", which was found in 1991 on the Austrian-Italian borders (EGG & SPINDLER 2009).

## The impact of the woolly sheep

The first textiles made of wool are known from the later phases of the Late Neolithic Period (compilation: BENDER JØRGENSEN & RAST-EICHER 2015). The wool textile attached to a flint dagger from Wiepenkaten in Germany was published as one of the oldest so far, but there is some ongoing research with new $^{14}$C dates. From the lakeside dwelling Molina di Ledro in Italy, we know of a linen weave with decoration made with wool threads dated to around 2200–2100 BC. One other early textile made of wool was found in a grave in Tursko-Těšina (Czech Republic) dating at around 2000 BC. Also the Early Bronze Age fabric from Lenk-Schnidejoch (RAST-EICHER 2015: pp. 33–34) belongs to the very early wool textile finds.

During the Early and Middle Bronze Age the textile history changes fundamentally with the use of sheep wool. Some examples that mark these changes are the new weaving and patterning techniques such as twill (Fig. 5) (GRÖMER 2016: pp. 130–138) or dyeing, which are mainly related to the wool and its properties. This has a direct influence on products made of textiles and especially on clothes. During the Bronze Age the oldest examples of dyed fabrics from Central Europe (HOFMANN-DE KEIJZER 2016: fig. 84), include the woad-blue dyed textile from the Hallstatt salt mine in Upper Austria (at around 1500–1200 BC); dyestuff analysis also brought to light the oldest evidence for plant dyes for yellow and red on wool textiles from Pustopolje, Bosnia-Herzegovina (17$^{th}$ cent. BC) and Mitterberg in Salzburg (16$^{th}$ cent. BC).

The early wool textiles are still quite coarse, as the finds from Mitterberg in Austria (GRÖMER 2014: pp. 188–190) and Castione dei Marchesi in Italy (BAZZANELLA 2012: fig. 8.12; GLEBA 2012) indicate; interestingly enough they are much coarser than contemporary linen textiles which can be attributed to different causes. One explanation could be that due to the thermic properties of the sheep wool, such a coarse material was deliberately used for the production of more robust and warmer fabrics. However, the coarse quality of these early wool textiles could also be attributed to the primitive characteristics of the early sheep populations, whose wool was characterized by a high content of coarse guard hair (kemp: see Fig. 6).

There are only a few examples of complete garments from the Bronze Age. The most famous were found in oak coffin graves (Denmark), dating between 1500 and 1300 BC (BROHOLM & HALD 1940; MANNERING *et al.* 2012). In the graves of women, long woollen skirts, blouses, sprang bonnets, sashes and corded skirts were discovered, whereas

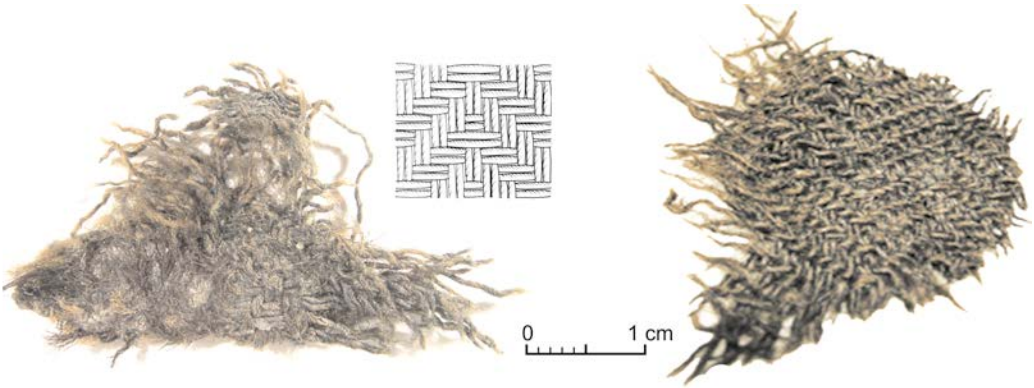


Fig. 5. Wool twill textiles from Hallstatt, Austria, 1500–1200 BC (HallTex 211 and 275) (© NHM, photo: A. RAUSCH).

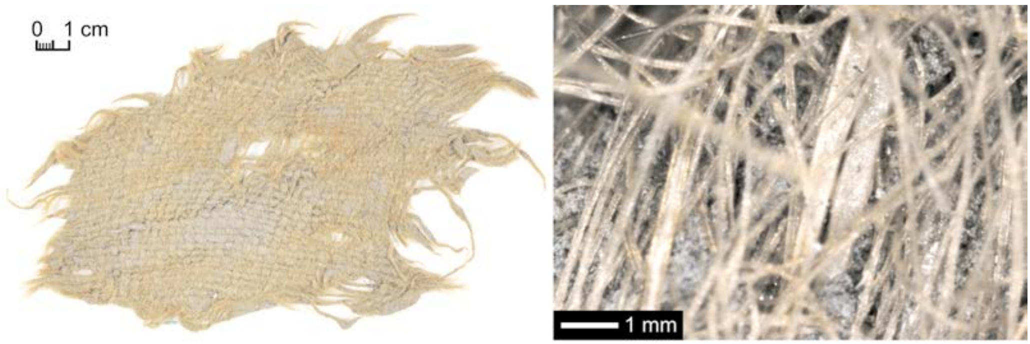


Fig. 6. Hallstatt, HallTex 209: coarse Bronze Age textile with microphoto of the fine fibres and kemp, 1500–1200 BC (© NHM, microphotos: K. GRÖMER).

the finds from the graves of men we found loincloth, knee-long wrap-around garments, and oval cloaks. The fabrics used in these garments were also coarse. Based on present finds and current studies we know of only one large wool textile from Central Europe; it derives from the Early Bronze Age grave of Pustopolje in Bosnia-Herzegovina (MARIĆ BAKOVIĆ & CAR 2014). Nowadays torn into pieces, it was reconstructed as a 1.70 × 3 m large wool tabby textile with selvedges. On this textile the starting border as well as the finishing border survived. Experimental archaeology has demonstrated that the textile could be used as a draped garment together with large pins and belts – as they are known for example from the Danube area (GRÖMER *et al.* 2013: fig. 7).

**Bronze Age to Iron Age: changes in the fleece type**

The fleece of sheep consists of different kinds of fibre: short guard hair, kemp and fine under wool (RAST-EICHER 2008: p. 122). The principal function of kemp is to provide water drainage, whereas the fine under wool keeps the animal warm.

For the production of textiles all of these different fibre types are of great significance. Fleece, which consists of many thick and stiff kemp, can also be spun but there are some limitations regarding the thickness of the threads; for example, finer threads cannot be produced (compare Rösel-Mautendorfer *et al.* 2012) due to the stiffness of kemp and such, a thread spun with this kind of coarse hair type appears to be quite irregular. On the contrary, when the fine underwool is used, thinner and more uniform threads can be produced. Fleece with fine fibres and the absence of kemp provides a higher comfort factor (comfortable to wear and pleasant to the skin, not scratchy). The role that this parameter played and how it influenced the choices and preferences of the people in prehistory remains unknown, but it is still worth mentioning.

After investigating archaeological finds made of sheep wool, it can be suggested that Bronze Age and Iron Age people have also been able to influence the properties and characteristics of the wool, in order to optimize the material available for the production of textiles and clothing equipment. There have been two circumstances to do so:

- Breeding for finer qualities
- Wool selection

*Influencing fibre properties by sheep breeding*

A very efficient and long-term impact way to influence the properties of the fibres is targeted breeding. Based on archaeological textile finds from prehistoric sites of Central Europe, it seems that breeding efforts were concentrated on the properties of the fleece type, and more particularly on three essential components:

1. The first efforts concentrate on the reduction of the stiff and thick kemp fibres (Figs 4, 7), which have been a vital part of the earlier sheep populations (still detectable at some populations today, such as the primitive *Soay-sheep:* Rast-Eicher & Bender Jørgensen 2013). These changes had a positive impact on the spinning techniques and they improved the comfort factor. Thus, it can be proposed that a fleece type with fibre diameters of low variation was a decisive criterion. This has been also confirmed by the study of the archaeological material after conducting wool measurements (see Gleba 2012; Rast-Eicher 2008: pp. 122–149). For this, the dimensions of the fibres are measured on a statistically sufficient number of fibres (*c.* 100). The histogram plotted (Fig. 7) gives information about the sheep type (especially if skins are measured) and/or about the degree of processing up to the spun yarn (see Rast-Eicher 2013: pp. 166–168). Similar studies for the Bronze Age and Iron Age material from Hallstatt (measurements have been taken from sheep skins and textiles: Rast-Eicher 2013) provide evidence for breeding improvement, which also influenced the properties of the material. For Hallstatt Period, three different kinds of fleece types have been detected: still, a coarse category can be detected which resembles that of the Bronze Age quality. Other histograms display wider curves with bi-modal peak. Additionally there are high quality textiles with long staples and a peak around 21 µm.

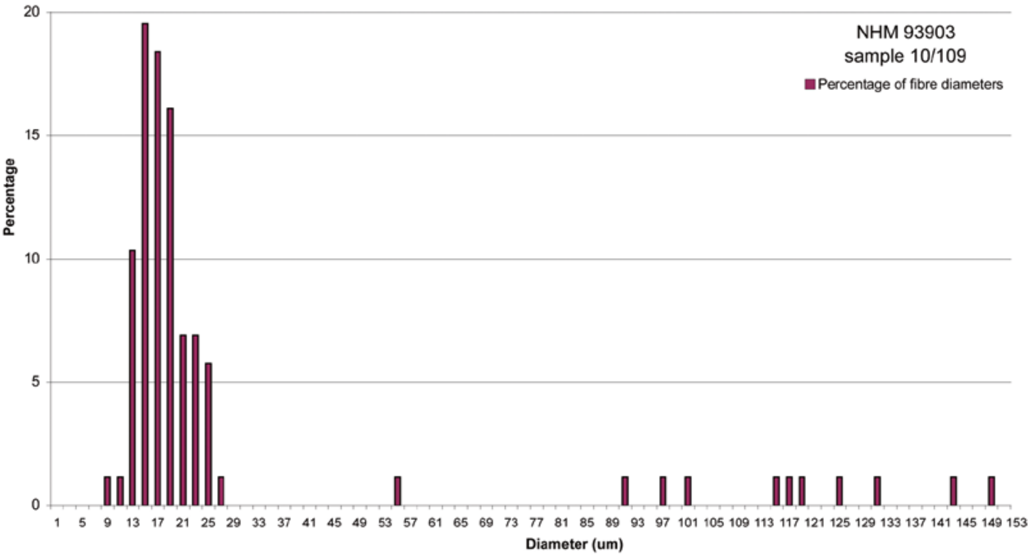


Fig. 7. Hallstatt wool measurements: Histogram of a Bronze Age skin with coarse kemp fibres (after Rast-Eicher 2013: fig. 61).

2. The manipulation of the length of the wool was also of great significance, since the so-called staple length (the average of the length of fibres in a sample, https://en.wikipedia.org/wiki/Staple_(wool)) can have a positive impact on the spinning techniques. The Bronze Age sheep wool finds from Hallstatt have a staple length of about 5 cm, whereas the Iron Age finds exhibit an increase in length of 7–8 cm (Rast-Eicher & Bender Jørgensen 2013: pp. 1227–2130).

3. The most impressive criterion seems to be the deliberate selection of particular colours. A special desideratum might have been the selection of bright and even white wool, because with this, good results in dyeing are possible. Particularly bright colors such as yellow and red could not be dyed with naturally dark pigmented wool (bleaching was seemingly not yet invented). Sheep skins and textiles found in the Hallstatt salt mine provide more evidence about the natural colour of the sheep (Fig. 8): there are 70 textile units from Bronze Age Hallstatt, but only 13 have exhibited highly pigmented wool what results into dark brown to blackish wool. The other remains indicate less pigmented or even non pigmented fibres, which include both the fine underwool as well as the kemp – it is a light, off-white wool (see Grömer *et al.* 2013: catalogue Bronze Age; Rast-Eicher 2013).

*Selection of the wool during the textile production process*

The selection of fibres in order to achieve specific characteristics can be carried out in various stages of the textile production process: during the exploitation of the raw

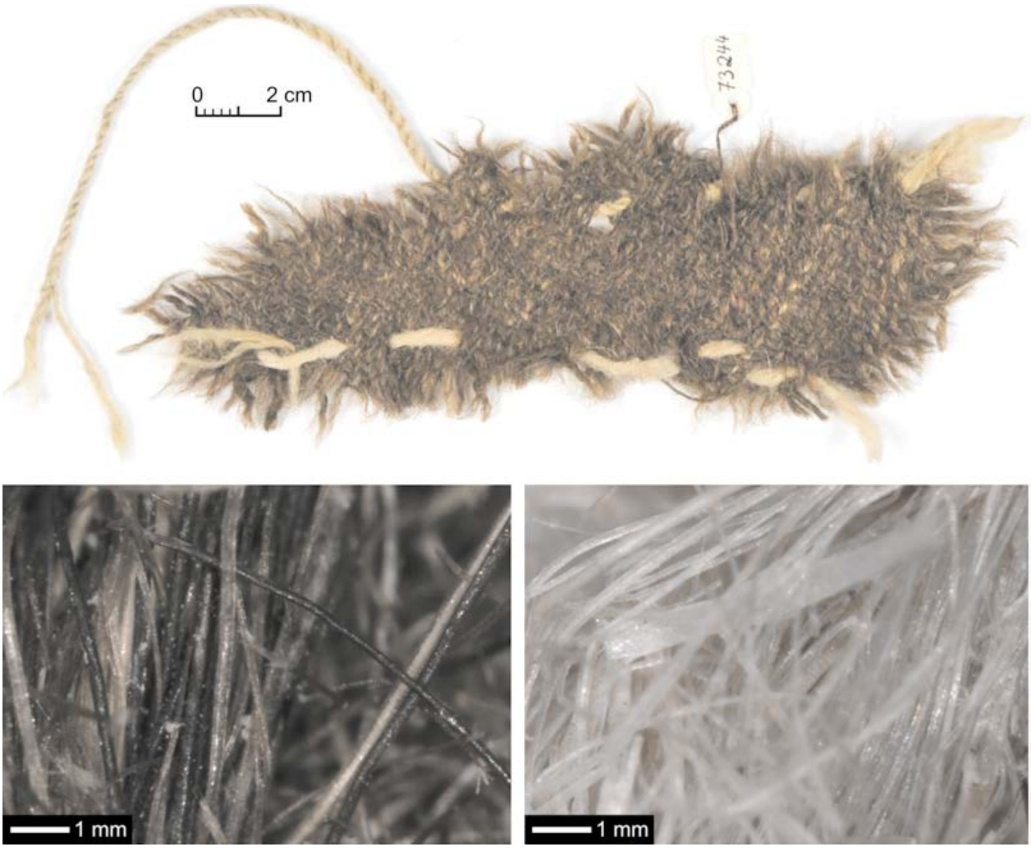


Fig. 8. Hallstatt, HallTex 45, white (less pigmented) wool and brown (highly pigmented) wool, both with fine fibres and kemp, 1500–1200 BC (© NHM, microphotos: K. GRÖMER).

material, the preparation, and even during spinning (GRÖMER 2016: pp. 69–71, 88–91) (Fig. 9).

The wool can be removed from the animal in various ways (see also RAST-EICHER 2013: pp. 170–172). Similarly to the wild animals, sheep populations with more primitive characteristics are characterized by an annual rhythm of natural hair change. The hair can be obtained by plucking or rooing, whereby they can also be selected. With rooing or plucking it is possible to achieve fine wool, but also the particular hues of different natural colours that might be found on one sheep can be selected deliberately; in this way it is feasible to obtain off-white, brown or black wool to be used for the production of patterned textiles.

Equipment that is related to sheep shearing has been found already during the Latène Period at the second half of the 4th century BC; the shears that were excavated at the graves of Pottenbrunn in Austria (RAMSL 2002) are well-known. In principle, it is also possible to remove the hair by the help of other sharp cutting tools, such as flint blades

Fig. 9. Spinning wool with kemp, removing the kemp while spinning fine threads (photo: K. GRÖMER).

or knives made of bronze or iron. Current studies associate the presence of animals with continuously growing fleece with the typological evolution of shears (RYDER 1997). After shearing, a selection of the fleece according to fibre quality and colour is feasible, as wool deriving from the belly and from the back of the animal can also be selected.

## Success: Clothing and textiles of the Iron Age

The textile culture from the Hallstatt Period is mainly based on sheep wool; between 800 and 400 BC it is statistically the most important raw material to produce fabrics and clothes (*e.g.* in the salt mine Hallstatt, GRÖMER *et al.* 2013: catalogue). The dominant use of wool changes during the Iron Age, as linen textiles tend to be dominant in the Late Iron Age (GRÖMER 2016: p. 46; Dürrnberg: STÖLLNER 2005).

During the early phases of the Iron Age, colourful and decorated textiles were preferred; the various properties of the wool were exploited in a skilful way. Sheep wool can be more easily dyed than plant fibers, as it absorbs the colour better, and when combined with mordants it produces light-fast and washable fabrics.

Not only were monochrome textiles produced, but also a variety of patterns were in use. The natural hues of wool as well as dyed yarn were employed to weave striped and checkered cloth. In the salt-mines Hallstatt und Dürrnberg both houndstooth-checks and larger block-pattern checks have been found, some of them resembling scottish tartans

(GRÖMER 2016: fig. 99; STÖLLNER 2002: colour plate 2–4). Similar fabrics also appear at the elite graves of Verucchio in Italy (STAUFFER 2012); there the houndstooth-pattern, for example, was preserved in red and blue.

Worth mentioning as well are decorative bands. A rigid heddle enables many various designs based on the use of different coloured warp threads. Depending on the arrangement of the threads, striped or even chess-board patterns are possible, as is demonstrated by the impressive Iron Age finds from Hallstatt (GRÖMER *et al.* 2013: fig. 29). Concerning the complex patterned tablet woven bands from Hallstatt and Dürrnberg (GRÖMER 2016: fig. 102), it could be proved that the threads used have usually been made of high-quality wool; this means that the material was carefully selected and prepared.

Among the different objects, a multi-coloured patterned band with floating warp threads was found in Hallstatt; in this example, hairs of horse have additionally been used, in order to take advantage of the special properties of this specific material. In this case, the stiffness and wear-resistance of the horse hair were of great significance. Consequently, the band should be on the one hand elastic and on the other hand dimensionally stable (GRÖMER 2016: fig. 24).

The so-called spin pattern is an interesting tone-on-tone pattern and appeared during the Hallstatt Period exclusively on wool textiles (GRÖMER 2016: pp. 171–173); it was made by the use of groups of z- and s-twisted yarn in warp and/or weft. This type of pattern can be connected to the material itself and its properties. Another significant characteristic of the textiles produced during the Hallstatt Period is the very fine quality of the objects.

Until now, complete Iron Age garments made of wool have been only rarely found in Central Europe. Some well-known examples derive from Italy, namely the cloaks and capes from Verucchio (STAUFFER 2012). The cloaks feature the typical checkered and spin patterns that are characteristic for other contemporary wool textiles. Moreover, various pieces of clothes and clothing equipment that date to the second half of the 1st century BC have been found in the bogs of northern Europe (HALD 1980; MANNERING *et al.* 2012): trousers, shirts, skirts, tube garments and cloaks.

## Addendum: Sheep use in Roman Period

At 15 BC the South Danubian part of Austria was integrated into the Roman Empire to form the provinces of Noricum and Pannonia. Similarly to the previous periods (Bronze and Iron Age), a great variety of finds related to the topic textiles and clothing came to light, including animal bones (see RIEDEL 2004), remains of textiles (GRÖMER 2014: catalogue) and textile equipment, but also a high number of pictorial sources like funeral stelae (GOSTENČNIK 2014) with depictions of textile tools. Additional to the biological remains and the archaeological finds, written sources add to our knowledge, offering a more complete picture of roman textile production.

To begin with a very interesting observation from Varro (ling. 5,54), an ancient roman writer from the 1st century BC: *"...ante tonsuram inventam vellere lanam..."* (…before shearing was invented the wool has been plucked). It seems that it was already known to the ancient authors that there were sheep with natural moulting, whose wool had to be plucked (rooing).

As it has already been confirmed by the textiles and the textile equipment of the Latène period, it is likely enough that in Central Europe, too, this change of animals with natural moult in springtime to such that have to be shorn because of continuous growing wool took place in the last BC centuries. However – as it is also evident from the roman sources – some "primitive" sheep populations should have coexisted together with the new sheep populations.

According to the written sources, during the Roman Period sheep were chosen and bred based on their colour and other properties/qualities (see Moeller 1976: pp. 9–10; Wild 1970: p. 10). Furthermore, there were specific regions of the Roman Empire which were known for specific wool qualities.

The art of breeding sheep with pure white wool is attributed to the regions around Mutina, Parma and Padua in Northern Italy (Plinius, Naturalis Historia VIII. 191). According to Columella (VII, 2.4.), sheep from Spain and Pollentia deliver black fleece (*velleres nigri*), sheep with reddish fleece (*color rutilus*) could be found in Spain and Asia Minor, whereas yellowish wool (*velleres fulvi*) was characteristic for Tarent and Canossa. Special interest presents the observation of Columella (VII, 2.5) that sheep from Tarent were even covered with fabrics (*oves pellitae*), so that the quality of wool would not be damaged by weathering and sunlight, while the hair grew at the back of the animal. According to Strabo (IV. 4.3) and Varro (Rust. II.2.18) the same was practiced in some regions of Greece and Northern Gaul (nowadays France). Varro (Rust. II.11.7) also mentions that during shearing of the different coloured sheep, particular caution was payed so that the various colours were carefully separated from each other and that coarse fleeces were not mixed with the finer ones. Finally, the sheep have been shorn on a mat, in order to avoid dirt on the precious fleece (Varro, Rust. II.11.8).

The mineralized textiles found in Roman Period graves from Austria present no evidence for colour and there are no wool measurements, which could be connected to specific fleece types. For Switzerland, the wool type known since Latène Period and in Roman Period has well as very fine wool (Rast-Eicher 2008: pp. 149–150), and at the end of Latène Period with the growing influence of the Romans, sheep with fine wool reaches the areas north of the Alps (Rast-Eicher 2013: p. 178).

Furthermore, as Kordula Gostenčnik (2014: p. 60) mentioned, the acuteness of the roman textiles is not only associated to the sheep populations and the type of fleece, but also to the techniques employed for cleaning and preparing the raw material. This is analogous to observations that have been made for the Iron Age textile production in Central Europe. Latin sources are also helpful here: the *lanarius purgator* cleans the wool, the *lanarius pectarius* is responsible for combing the clean wool, the *lanarius carminator* is the one who does the carding. Relevant equipment and tools have been discovered in several austrian sites (based on Gostenčnik 2014: p. 60, with further sources).

As it has been confirmed from grave finds, wool was also used during the Roman Period for the production of clothes and clothing equipment. The Edict on Maximum Prices, issued 301 AD by the roman Emperor Diocletian, suggest that special wool products were delivered from the province of Noricum to the entire Roman Empire (Ed. Diocl. 19 und 22; see also GOSTENČNIK 2014: Tab. 5).

## Interlacing sheep and textile history

Combining that evidence, the textile finds (together with them also the possibility to analyse wool fleece types) as well as archaeozoological material, it is a challenge to get a conclusive picture of sheep economy from Neolithic to Roman Period in Austria. Here we discuss some first ideas, but in awareness that we have to be carefully in interpreting the evidence.

The majority of identified bones in prehistoric settlements in Austria usually belongs to the category of sheep/goat. This means that there is a respectable amount of unidentified material – at species level – and thus the number of identified sheep bones to draw conclusions is usually low. In order to understand the socioeconomic organisation of past human societies, which is linked to all the aforementioned steps (age and sex reconstruction, skeletal element representation, and morphometric investigation), more material is necessary. For systematic archaeozoological research on Austrian material, Erich PUCHER plays an important role. He analysed some significant faunal assemblages which produced crucial results, also concerning the role of sheep and their exploitation. Examples are Mondsee (Late Neolithic), Bachsfall (Early/Middle Bronze Age), Dürrnberg (Latène A-C) and Bruckneudorf (1st century AD.).

Based on the present state of research it seems that during the Neolithic sheep mainly served as meat suppliers. Though Late Neolithic finds from Slovakia and Hungary have been interpreted to belong to the first woolly sheep that arrived Central Europe from South-East through the Balkans (see in a compilation BECKER *et al.* 2016), similar evidence for Austria have not been yet found.

Organic finds such as textiles are rare and we have a lot of gaps, nevertheless, there is sound evidence that Neolithic textile culture was based on plant material. The beginning of sheep wool use for spinning threads and weaving fabrics seem to date to the 3rd millennium BC, and we know the earliest wool tabbies from *c.* 2000 BC.

Although sheep (and goats) were usually among the main three domesticated species during the Bronze and Iron Age in settlements in Austria, the relatively weak representation of sheep bones suggests that economically they played a secondary role. The age and sex profiles of the animals indicate that wool was widely used during the Early and Middle Bronze Age, as they have been kept to an older age and adult ewes appear in the material.

From the point of view of archaeological textile research, there is a definitive intensification of wool use from the transition Early/Middle Bronze Age (*c.* 1600 BC) on; wool is then the dominant fibre type till the beginning of the Latène period. The increased use of sheep wool from the Middle Bronze Age changed the way people understood clothing and thus the appearance of the prehistoric people. Wool offers new possibilities such as dyeing and colour-patterns. Together with metal objects, new ways of representative and individual expression were created.

Even if at the current state of research does not allow to draw a clear direct connection between archaeozoological evidence and the textile and skin finds, our attention has to be drawn to some interesting observations: As mentioned, the Early and Middle Bronze Age sheep show osteological similarities to *Scottish Soay sheep*. Interestingly, recent investigations on Bronze Age textiles and sheep skin can be linked with that – as wool fineness measurements demonstrated, that the wool of *Soay sheep* is also the closest comparison material. Both, Bronze Age wool and *Soay sheep* display kemp with diameters up to 120 µm, whilst most fibres are of fine underwool around 17 µm (Rast-Eicher 2013: p. 177). From a *Soay sheep* 0.5–1.5 kg wool can be obtained (Sambraus 2001: p. 157).

The evidence is not yet that clear for the Iron Age mainly because of the low number of archaeozoological finds that could be studied and due to the fact that the morphometric observations cannot be easily interpreted. In general it could be said that the Iron Age sheep demonstrate osteological similarities with the *Steinschaf,* with a withers height between 60 cm (female) and 80 cm (male) cm (Sambraus 1994: pp. 320–321). One very interesting question that still remains open is the appearance of some large-sized animals during the Hallstatt and Latène periods. The morphometric analysis of the faunal remains from Dürrnberg was of great significance (Pucher 1999). The relatively large-sized sheep (average withers height 66 cm) were for the region and the period especially remarkable. It is still not yet clear if these individuals represent a local or a mixed sheep population.

Wool measurements carried out with Iron Age sheep skins and textiles, *e. g.*, from Hallstatt, display the evidence of three different fleece types. As described, one of them resembles the Bronze Age fleece type. The other fleece type with a histogram with bi-modal peak, has a strong similarity to today's old breeds, *e. g*., the *Alpines Steinschaf* (Rast-Eicher 2013: pp. 176–177). Whereas the finest quality from Hallstatt (Fig. 10) resembles the Vrin sheep, which seems to be more developed than the *Alpines Steinschaf*.

Clearly, from Bronze Age on, but especially in Iron Age, people tried to gain the most suitable wool for high quality textile products, i. e. fine, bright fibres. That was tried to do by selection of wool during the textile production process, or by breeding – and maybe by importing and cross-breeding new sheep breeds. Future research in combination with advanced methods might give more insight into how that osteological and fleece type evidence can be drawn together.

Concerning Iron Age economics, the textile finds themselves clearly demonstrate that sheep wool has been the most important fibre source for cloth production, especially between 800 and 400 BC. Nevertheless, osteological material found in Austrian settlements, indicate that sheep have been less important in local economy compared with cattle and pig. The reason for that might be that sheep bones in settlements are the result

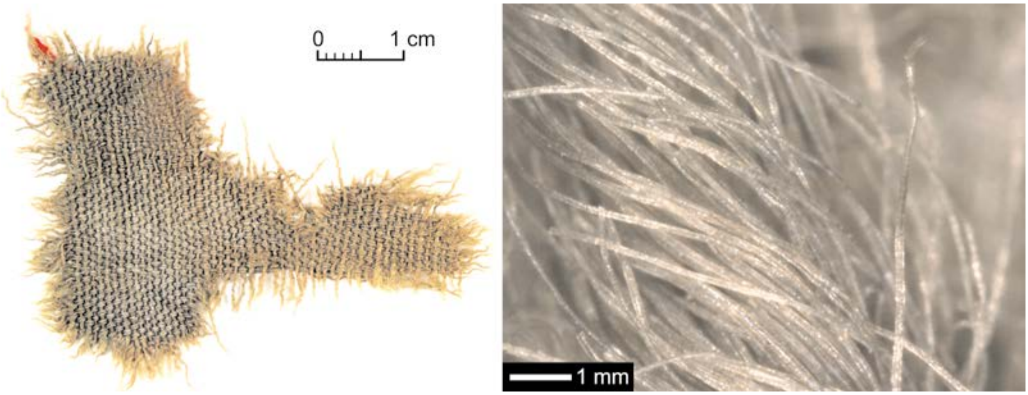


Fig. 10. Hallstatt Textile 98 with fine fibres, 800–400 BC (© NHM, photo A. RAUSCH, microphoto: K. GRÖMER).

of primary use, i. e. meat and skin use, while wool is a secondary product (see BECKER *et al.* 2016) that can be gained lifelong. In that respect, the sex/age ratio helps to understand the type of secondary exploitation.

The morphometric observations so far demonstrate that a new sheep population arrives with the Romans. The animal bones from the Roman site of Bruckneudorf aroused great interest, since Erich PUCHER was able to identify different animal populations attributed to the local and italic domestic fauna (PUCHER in press b); this distinction was also possible in the case of the sheep population. These new animals, which are connected to the appearance of fine wool in Austria, seem to be an early form of the later *Merino sheep,* with withers height of 75 cm (female) to 100 (male) cm. Annually 4–5 kg wool can be obtained from the female individuals (SAMBRAUS 2001: p. 107).

So far, we cannot prove that with wool measurements on textile material from the Danube provinces, but literary sources point to a variety of special breeds (especially for different colours and wool qualities) among the roman textile economy.

The analysis of textiles, fibres from sheep skins and sheep bones brought to light many challenges and highlighted the need for a systematic survey together with the application of new methods, in order to gain more information about past subsistence strategies.

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