

Hairs, feathers and fibres in Mesolithic contexts – recommendations for field archaeologists

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Microarchaeological research has drawn attention to new microscopic categories of finds such as charcoal and ash, archaeobotanical remains, and non-pollen palynomorphs, including textile fibres. These findings help us to reconstruct the site formation, activities, and the environment. In this paper, we present recent research on microscopic animal fibres, i.e. hairs and feathers that have accumulated in archaeological contexts and can be traced by microscopy as evidence of decayed soft organic materials such as clothing, grave furnishings and wrappings. Our examples cover a selection of Mesolithic burial sites in Northern Europe. We focus on presenting preliminary sampling recommendations for field archaeologists and the basics for laboratory work. We recommend that the collection of soil samples and their analysis for decayed organic materials should become a permanent task of archaeological excavations.

Keywords: soil, soil analysis, fibres, hairs, feathers, microarchaeology.



1. A view from ancient Donkalis to Lake Biržulis ca. 8000 years ago. The image is an artistic reconstruction based on the finds and fibres recovered from Grave 2, illustration by Tom Björklund

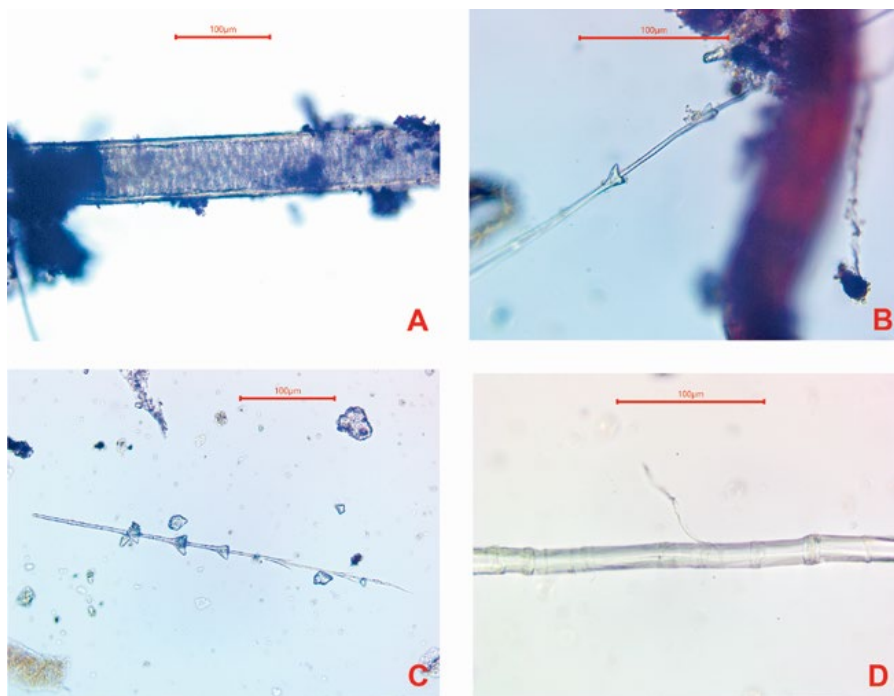
Vaizdas nuo Donkalnio į Biržulio ežerą maždaug prieš 8000 metų. Paveikslas - meninė rekonstrukcija pagal radinius ir pluoštus, rastus kape Nr. 2. Iliustracijos autorius Tomas Björklundas (Tom Björklund)

Introduction

Professor Adomas Butrimas is one of the key researchers who has worked with Mesolithic burial archaeology in the Baltic area. His careful search for Stone Age sites in Western Lithuania led to the discovery and excavation of several Stone Age burials in the Lake Biržulis area¹. These excavations along with an enormous number of publications based on Professor Butrimas' research – have significantly deepened our understanding of Mesolithic burial traditions and beliefs [Fig. 1].

For most of his career, Butrimas has been an important part of the community of archaeologists studying the burial traditions and material culture of prehistoric hunter-gatherers. Excavation methods have developed and new ways to study and interpret the burial customs of past

1 Adomas Butrimas, *Donkalnio ir Spigino Mezolito-Neolito kapinynai. Seniausi laidojimo paminklai Lietuvoje* (Vilnius: Vilniaus dailės akademijos leidykla, 2012); Adomas Butrimas, "Biržulis Lake Islands Donkalis and Spiginas Mesolithic Cemeteries (West Lithuania)," in *Mesolithic Burials – Rites, Symbols and Social Organisation of Early Postglacial Communities 18–21*. International Conference Halle (Saale), Germany, 18–21 September 2013, eds. Judith M. Grünberg, Bernhard Gramsch, Lars Larsson, Jörg Orschiedt and Harald Meller (Tagungen des Landesmuseums für Vorgeschichte Halle 13/1) (Halle (Saale): Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, 2016), 193–218.



2. A) Mustelidae hair from Yuzhniy Oleniy Ostrov, B) Waterfowl, possibly the goose family (Anseriformes / Anserinae), barble from Donkalnis, C) Waterfowl, possibly the duck family (Anseriformes / Anatidae), bird feather fragments from Skateholm II, D) Bast fibre from Skateholm I, photos by Tuija Kirkinen

A) Kiauninių plaukai iš Yuzhniy Oleniy Ostrov, B) vandens paukščių, galbūt žąsinių (Anseriformes / Anserinae) šeimos, barbulės iš Donkalnio, C) vandens paukščių, galbūt ančių (Anseriformes / Anatidae) šeimos, paukščių plunksnų fragmentai iš Skateholmo II, D) karnos pluoštas iš Skateholmo I, Tuija Kirkinen nuotraukos

communities, as well as their art and ritual meanings have been discussed in publications and conferences².

New research on grave materials from Northern Europe has demonstrated that even soft parts such as hair, feathers and plant fibres can be

- 2 Judith M. Grünberg, Bernhard Gramsch, Lars Larsson, Jörg Orschiedt and Harald Meller, eds. *Mesolithic burials - Rites, symbols and social organisation of early postglacial communities*. International Conference Halle (Saale), Germany, 18–21 September 2013. Tagungen des Landesmuseums für Vorgeschichte Halle 13/I. (Haale (Salle): Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt - Landesmuseum für Vorgeschichte Halle (Saale), 2016); Judith M. Grünberg, Bernhard Gramsch, Erik Brinch Petersen, Tomasz Plonka and Harald Meller, eds. *Mesolithic Art – Abstraction, Decoration, Messages*. International Conference Halle (Saale), Germany, 19–21 September 2019. Tagungen des Landesmuseums für Vorgeschichte Halle 26/II. (Haale (Salle): Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt - Landesmuseum für Vorgeschichte Halle (Saale), 2023).

preserved in burial soil. This potential has only recently been studied³. In 2024, a new analysis of a red ochre sample from Donkalnis Grave 2 revealed fragments of animal hairs and feathers⁴. Animal fibres have also been found in Mesolithic burials in Majoonsuo (Finland), Yuzhniy Oleniy Ostrov (Russia), Zvejnieki (Latvia), and Skateholm (Sweden), and in a settlement site in Ljungaviken, Sweden⁵ [Fig. 2].

The promising results from various sites clearly indicate that microarchaeological analysis of soils from burial contexts can provide invaluable information about perishable materials like furs. We propose that microscopic analyses of soils should become an integrated part of archaeology and an obvious part of fieldwork, especially when human burials are excavated. In this paper, our aim is to 1) discuss the importance of microparticle analyses of soils in archaeology in general, and in mortuary archaeology in particular, and 2) present the first set of instructions aimed at archaeologists for field sampling. Our focus is on burials, but most parts are applicable to any archaeological excavation. These instructions are based on our still relatively brief experience in the field and in the laboratory, so they must be considered as directive, not all-inclusive or final.

- 3 Marja Ahola, Tuija Kirkinen, Krista Vajanto and Janne Ruokolainen, "On the scent of an animal skin: New evidence on Corded Ware mortuary practices and livelihoods in northern Europe," *Antiquity* 92, no. 361 (2018): 118–31, <https://doi.org/10.15184/aqy.2017.188>; Kristiina Mannermaa, Tuija Kirkinen and Tytti Juhola, "Nauji plunksnų naudojimo vėlyvojo mezolito ritualiniame kontekste įrodymai. Donkalio 2 kapo (Lietuva) mikroarcheologija (apie 6000 m. pr. Kr. (BC))," in *Biržulis. Medžiotojai, žvejai ir senieji žemdirbiai X–II tūkstantmetyje pr. Kr. Paminklų tyrinėjimai*, ed. Adomas Butrimas (Vilnius: Vilniaus dailės akademijos leidykla, 2019), 374–381; Kristiina Mannermaa and Tuija Kirkinen, "Tracing the Materiality of Feathers in Stone Age North-Eastern Europe," *Current Swedish Archaeology* 28 (2020): 23–46, <https://doi.org/10.37718/CSA.2020.02>; Tuija Kirkinen, Olalla López-Costas, Antonio Martínez Cortizas, Sanna P. Sihvo, Hanna Ruhanen, Reijo Käkälä et al., "Preservation of microscopic fur, feather, and bast fibers in the Mesolithic ochre grave of Majoonsuo, Eastern Finland," *Plos ONE* 17, no. 9 (2022): e0274849, <https://doi.org/10.1371/journal.pone.0274849>
- 4 Kirkinen et al., "The search for organic materials in Grave 2 in Donkalnis, Lithuania. New results in soil sample analysis," forthcoming.
- 5 Mannermaa and Kirkinen, "Tracing the materiality.;" Kirkinen et al., "Preservation of microscopic fur.;" Kirkinen et al., "The search for organic."

Perishable materials in archaeology

Archaeologist Linda Hurcombe⁶ has coined the term ‘missing majority’ to describe organic materials that were once of great importance but are now absent in archaeological finds. Especially soft organic tissues, such as textiles, fur and feathers, are vulnerable to bacterial and fungal decay, leading to the destruction of organic materials. In archaeological contexts, the preservation of textiles and fur is usually due to favourable environmental conditions, such as aridity, cold and a lack of oxygen in water and bog environments⁷. Furthermore, the proximity to metal artefacts, specifically to toxic salts which tend to prevent the decaying process, is a well-known preservation agent, especially in Iron Age burial contexts⁸. In Mesolithic burial environments, our preliminary results underline the importance of soil grain size (preferably clay or silt) and soil acidity for the preservation of keratinous tissues⁹.

Knowledge of preserving microscopic organic particles in archaeological contexts is not new. For example, pollen, spores, phytoliths and insect remains have been studied by extracting particles from soil sediments and bogs. These analyses have been conducted for decades, and now form an integral part of the field of environmental archaeology¹⁰. Hairs have also been found in archaeological contexts for decades. As early as the 1980s and 1990s, complete hairs of mammals that have been extinct for thousands of years were detected in Palaeolithic sites¹¹. Tiny hair fragments have also

6 Linda Hurcombe, *Perishable Material Culture in Prehistory: Investigating the Missing Majority* (London: Routledge, 2014).

7 e.g. Antoinette Rast-Eicher, *Fibres. Microscopy of archaeological textiles and furs* (Budapest: Archaeolingua, 2016); Marianne Vedeler and Lena Hammarlund, “Reconstructing the tunic from Lendbreen in Norway,” *Archaeological textiles review* 59 (2017): 24–33.

8 Hsiou-Lien Chen, Kathryn A. Jakes and Dennis W. Foreman, “Preservation of archaeological textiles through fibre mineralization,” *Journal of Archaeological Science* 25, no. 10 (1998): 1015–1021; Rui Jia, Hailing Zheng, Haodong Chen, Min Feng, Jinpeng Jiao, Xiaojing Kang et al., “Archaeological textiles preserved by copper mineralization,” *Heritage Science* 12, no. 1 (2024): 312, <https://doi.org/10.1186/s40494-024-01418-8>

9 Kirkinen et al., “Preservation of microscopic fur”; Stephen Weiner, *Microarchaeology: beyond the visible archaeological record* (Cambridge: Cambridge University Press, 2010).

10 See Weiner, *Microarchaeology: beyond*; Amanda G. Henry, ed. *Handbook for the Analysis of Micro-particles in Archaeological Samples* (Cham: Springer, 2020).

11 e.g., Robson Bonnicksen, C.W. Bolen, M. Turner, J.C. Turner and M.T. Beatty, “Hair from Mammoth Meadow II, southwestern Montana,” *Current Research in the Pleistocene* 9, (1992): 75–78; Robson Bonnicksen, M.T. Beatty, M.D. Turner and M. Stoneking,

been found in coprolites¹² and as a byproduct of pollen analysis¹³. In our research, we have detected hair and bird feather fragments less than 1 mm long in contexts that are thousands of years old. The analyses of soil samples from legendary cemeteries such as Skateholm 1 and 2 in S Sweden, Yuzhniy Oleniy Ostrov in W Russia, Donkalis in Lithuania, and Zvejnieki and Rīņukalns in Latvia have yielded new information on the use of furs, bird skins and feathers, even in seemingly empty graves that lack other find materials¹⁴. For example, the analysis of a red ochre sample from the so-called shaman burial (Grave 2) in Donkalis cemetery revealed the presence of goose (Anserinae) and birds of prey (Accipitridae, i.e., hawks and eagles) feathers in the grave. Most of the feather barbules remained unidentified, but some were large, suggesting large species compared to, for instance, Passeriformes. In addition, mammal hairs were detected, though none could be identified.

Challenges

Understanding the uses of animals and their roles in the most remote prehistoric economies and ideologies has traditionally been based on osseous materials – bones, antlers, teeth and shells. These hard organic materials can persist for thousands of years in a suitable environment and microenvironment. For example, areas with calcium-rich soil can preserve osseous materials better than acidic soils. The Boreal podsol soils of Finland

“What can be learned from hair? A hair record from the Mammoth Meadow locus, southwestern Montana,” in *Prehistoric mongoloid dispersals*, eds. T. Akazawa and E.J.E. Szathmáry (Oxford: Oxford University Press, 1996), 201–213; Robson Bonnicksen, L. Hodges, W. Ream, K.G. Field, D.L. Kirner, K. Selsor and R.E. Taylor, “Methods for the Study of Ancient Hair: Radiocarbon Dates and Gene Sequences from Individual Hairs,” *Journal of Archaeological Science* 28, no. 7 (2001): 775–785, <https://doi.org/10.1006/jasc.2000.0624>

- 12 Phillip Taru and Lucinda Backwell, “Identification of fossil hairs in Parahyaena brunnea coprolites from Middle Pleistocene deposits at Gladysvale cave, South Africa,” *Journal of Archaeological Science* 40, no. 10 (2013): 3674–85, <https://doi.org/10.1016/j.jas.2013.04.031>
- 13 Eliso Kvavadze, Goderdzi Narimanishvili and Liana Bitadze, “Fibres of Linum (flax), Gossypium (cotton) and animal wool as non-pollen palynomorphs in the late Bronze Age burials of Saphar-Kharaba, southern Georgia,” *Vegetation History and Archaeobotany* 19 (2010): 479–94, <https://doi.org/10.1007/s00334-010-0270-2>
- 14 Mannermaa and Kirkinen, “Tracing the materiality.”; Kirkinen et al., “Preservation of microscopic fur.”; Kirkinen et al. forthcoming, “The search for organic.”

generally offer weak possibilities for organic materials to survive longer than a few centuries¹⁵. In these environments, bone survives in Stone Age sites only when it is burnt. Since most known Stone Age burials in Europe are inhumation burials, skeletal remains have been preserved only in some areas. The exception is tooth enamel, the hardest substance in the skeleton, which has sometimes been found in burials, for example, in Finnish territory¹⁶. When osseous material has not survived, we accept that it is impossible to interpret the uses of organic materials like clothing, accessories, ornaments or wrappings, or to determine features of the deceased. However, in areas where osseous materials have been preserved in burials, we can learn a great deal about the deceased and the burial materials. Indeed, a wealth of literature has been published about burial sites in various parts of the world, based on morphologically visible finds in burials. When interpreting the so-called well-preserved burials, we often face another type of problem. We interpret burial rites and ornamentation based on visually observable finds, but we may not realise that many of the grave's features may have been overlooked. Hairs and feathers are materials that are not typically considered because they cannot be detected with the naked eye. This has implications for field archaeology and methods of collecting finds from burials as well as for their documentation. If we collect only the visible finds from burial pits, we may lose a wealth of information. Therefore, it has become clear that, to better understand a grave, soil samples must be taken and analysed microscopically.

Taking soil samples systematically is time-consuming. It is also challenging to determine exactly where the soil samples should be collected. The lack of specialists capable of analysing soil samples and identifying tiny fibre finds, as well as the lack of good reference collections for hair and feathers, are real challenges that hinder our ability to incorporate soil analysis into basic archaeological research.

- 15 Pirkko Ukkonen, *Shaped by the ice age: Reconstruction of the history of mammals in Finland during the Late Pleistocene and the Early Holocene* (Helsinki: University of Helsinki, 2001).
- 16 Kirkinen et al., "Preservation of microscopic fur."; Marja Ahola, Kati Salo and Kristiina Mannermaa, "Almost Gone: Human Skeletal Material from Finnish Stone Age Earth Graves," *Fennoscandia Archaeologica* XXXIII (2016): 95–122.

Work in the field

The instructions for collecting soil samples in the field are quite flexible. The first rule is that more means more and the larger the sample, the better. This means that the minimum sample size should be 100 g, and it is best to collect more soil, such as 200–300 g per sample, if possible. Additionally, the number of samples should be representative of the feature. By this, we mean that several samples from the same feature, with good contextual information, should be collected. Otherwise, the interpretation of the findings might be challenging.

Good contexts for sampling are those where you suggest that something organic might have decayed, such as dark formations, graves, house floors, etc. Especially if the soil is fine grained or moist, acidic, or contains red ochre, there might be good chances for preservation. Do not sieve the soil before sampling, as the fibre material might be lost or the sample contaminated. The analyst will collect small bones, nut shells and other potential findings during the analysis.

The samples should be collected in plastic zip bags, sealed and stored in a fridge before being sent for analysis. If this is not possible, the sandy samples can be dried slowly by making a small hole in the bag. In this case, the bags should be stored in a very clean place to avoid contamination. Museums are not ideal for this purpose, as their air is often full of potential contaminants.

Work in the lab

To begin, the weight of the sample is measured, and a photo of a small amount of soil in a petri dish [Fig. 3] is taken. This will serve as a record of the grain size and colour of the sample. In addition, a spectrophotometer can be used to define the colour. In all cases, a description of the sample is recorded (e.g. the types and amounts of organic materials present in the sample, as well as the grain size and the colour of the soil). This information is needed for interpreting the results and the preservation conditions.

Next, the sample is studied with an optical microscope for macroscopic hairs and feathers, and other finds such as pieces of bone, plant parts,



3. Photo of a red ochre sample from Yuzhniy Oleniy Ostrov (Russia), photo by Tuija Kirkinen

Raudonos ochros mėginio iš Yuzhniy Oleniy Ostrov (Rusija) nuotrauka, Tuija Kirkinen nuotrauka

ceramics, shells, and charcoal. After that, ca 40 ml soil is separated for measuring the pH. If the soil is clayey and has hardened into clumps, it needs to be placed in a box with water and vortexed with a vortexer for about 20–60 minutes until the clay dissolves in the water.

Separating microscopic fibres from the soil is done by water sieving with 0.125- and 0.073-mm sieves. The soil is “washed” with water, and the washing water is then sieved. The material accumulated in the sieves is rinsed, and the rinsing water is divided into 15 ml centrifuge tubes. The tubes are then centrifuged at 2500–2700 rpm for 7–10 minutes. After centrifuging, the deposited material at the bottom of the tube is pipetted and placed on a microscope slide. The slide is covered with a cover glass for work under the transmitted light microscope. Observations are documented by photographing and the dimensions of the fibres are measured with microscope analytical tools. Finally, the fibres are identified using identification keys of hair atlases¹⁷ and by making comparisons with modern reference collections.

17 B. Teerink, *Hair of West-European mammals: Atlas and identification key* (Cambridge: Cambridge University Press, 2003); Mária Tóth, *Hair and fur atlas of Central European mammals* (Nagykovácsi: Pars Ltd, 2017), <https://doi.org/10.18655/hairatlas>; Rast-Eicher, *Fibres. Microscopy of*; Carla Dove and Sandra Koch, “Microscopy of feathers: A practical guide for forensic feather identification,” *The Microscope* 59, no. 2 (2011): 51–71.

Conclusions

In order to improve our understanding of the uses of soft materials in prehistoric burial practices in the future, we have proposed instructions for field archaeologists. These are primarily intended for burial excavations but can be applied to any excavation, regardless of the site type. Our research on Mesolithic period burials verifies that decayed organic materials can be traced with a microscope. We also recommend that soil sampling and analysis become a permanent part of excavations.

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Santrauka

Plaukai, plunksnos ir pluoštai mezolito kontekstuose – rekomendacijos lauko archeologams

Tuija Kirkinen, Kristiina Mannermaa

Reikšminiai žodžiai: dirvožemis, dirvožemio analizės, pluoštai, plaukai, plunksnos, mikroarcheologija.

Šiame straipsnyje aptariami mikroarcheologiniai tyrimai, susiję su minkštųjų organinių medžiagų, t. y. plaukų, plunksnų ir augalų pluoštų, tyrimais archeologiniuose kasinėjimuose. Analizuojant iki 1 mm ilgio pluoštus galima gauti vertingų įrodymų apie suirusius drabužius, kapo reikmenis ir medžiagas, į kurias buvo įvynioti mirusieji. Straipsnyje pateikiami preliminarūs atrinktų mezolito laidojimo vietų Šiaurės Europoje pavyzdžiai. Svarbiausia, straipsnyje aptariamos dirvožemio mėginių ėmimo rekomendacijos lauko archeologams ir laboratorinio darbo pagrindai. Šio straipsnios autorės rekomenduotų, kad dirvožemio mėginių ėmimas ir jų analizė ieškant suirusių organinių medžiagų, turėtų tapti nuolatine kasinėjimų užduotimi.