

# Use-wear analysis of six bone tools found in the woman's grave of Bad Dürrenberg

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## Zusammenfassung

### Gebrauchsspurenanalyse an sechs Knochenwerkzeugen aus dem Frauengrab von Bad Dürrenberg

Die mikroskopische Analyse von sechs Knochenwerkzeugen aus dem »Schamaninnen«-Grab von Bad Dürrenberg, Saalekreis, ergab, dass sie nicht nur dieselbe Chaîne opératoire aufwiesen, sondern auch Teil eines Werkzeugsatzes waren, der für die Herstellung von Körben oder Kleidungsstücken aus pflanzlichen Materialien, wie Bast, Gräsern oder Nesseln bestimmt war. Alle Werkzeuge wurden aus Cervidenmetapodien gefertigt, entweder vom Rothirsch oder vom Reh, und durch Längsspaltung dieser hergestellt. Die Werkzeuge zeigen Spuren einer abschließenden Glättung und Politur durch Schachtelhalm, einer sehr abrasiven Pflanze, die häufig hierfür verwendet wurde. Obwohl die Werkzeuge aus Bad Dürrenberg nicht in einwandfreiem Erhaltungszustand waren und einige daher nicht im Detail untersucht werden konnten, brachte die mikroskopische Analyse einige Aspekte ihrer Entstehungsgeschichte ans Licht, die sonst nicht hätten wahrgenommen werden können.

**Schlagwörter** Knochenwerkzeuge, Gebrauchsspurenanalyse, Pflanzenverarbeitung, Grabbeigaben, Mesolithikum

## Summary

The microscopic analysis of six bone tools from the »shaman's« burial at Bad Dürrenberg, Saalekreis District (Germany), showed they not only share the same chaîne opératoire but also form part of one particular toolkit aimed at the production of baskets or garments made of plant-based materials, like bast, grasses or nettles. All tools are made on cervid metapodia, either of red deer or of roe deer, and are produced by longitudinal splitting. They all display the same process of finishing the tools, using horsetail, a very abrasive plant commonly used for this purpose. Although from Bad Dürrenberg tools were not in pristine condition and some could therefore not be studied in detail, microscopic analysis revealed some aspects of their biographies which are otherwise not recognised.

**Keywords** Bone tools, microwear analysis, plant-based crafts, grave goods, Mesolithic

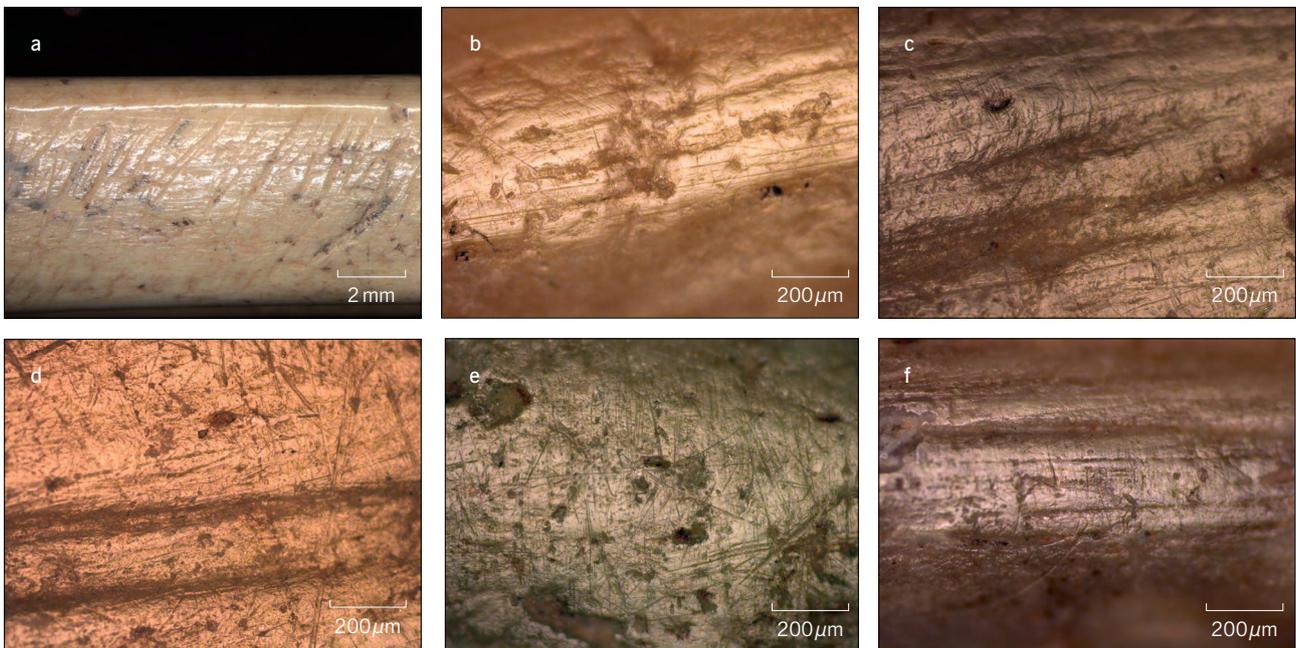
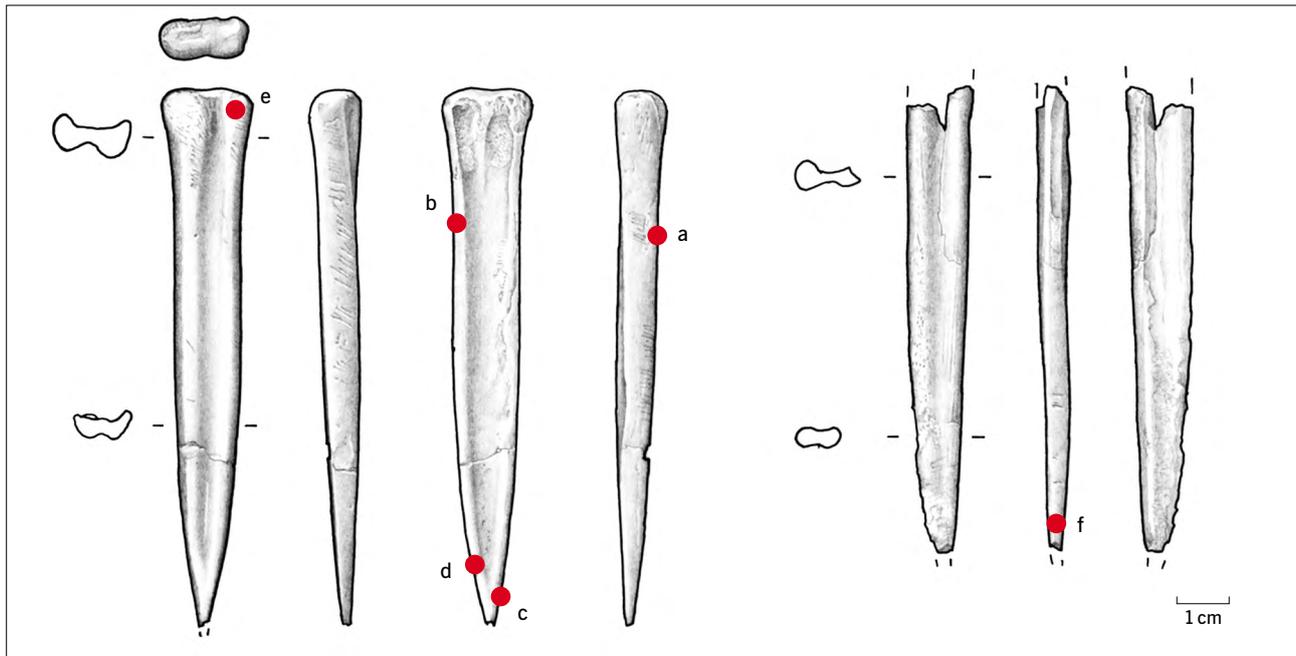
## 1 Introduction

The 1934 find of a double burial of a woman and child in the spa gardens of Bad Dürrenberg, Saalekreis District (Germany), is one of the most interesting graves from the Mesolithic. It is dated between 7000–6800 cal BC (Orschiedt et al. 2023) and thus predates any contact of the local Mesolithic population with Neolithic farmers. The woman was buried in a sitting position, with the child placed between her legs. She was surrounded by a large number and variety of grave goods. Amongst these were six bone implements, which were made on metapodia of red deer and roe deer. The grave was interpreted as the last resting place of a shaman (Grünberg et al. 2016), but research is ongoing (Orschiedt et al. 2023). The use-wear analysis performed on the six bone tools was intended to reveal the function of these objects and to see whether their biographies could shed more light on the interpretation of the grave.

## 2 Methodology

The six bone implements were sent by special delivery to the Laboratory for Material Culture Studies at the Faculty of Archaeology, Leiden University, and were treated with extreme caution. For this reason, we did not clean the artefacts apart from the very occasional and careful swipe with a bit of alcohol on a cotton tip. This meant that no attempt was made to remove the encrustations that covered large parts of the artefacts and impeded the microscopic analysis. These may be the remnants of the plastered wattle construction surrounding the grave. Generally, however, there were parts of the surface that were sufficiently clean to allow the interpretation of the traces of wear. We wore starch-free gloves at all times when handling the objects.

All artefacts were first examined by means of a stereomicroscope (a Leica M80 Stereo instruction microscope fitted with a Leica MC120HD camera) to observe traces of manufacture and macroscopic features of wear like edge removals. Subsequently, use was made of a Leica DM2700 metallo-



**Fig. 1a–f** a Incisions on tool HK No. 34:823i1, an awl, made by means of a stereomicroscope; b lacquer-like manufacturing gloss from polishing the tool surface with *Equisetum*; c–d use wear polish and striations interpreted to be associated with contact with silicious plant and/or bast; e handling traces on the butt end of the awl, characterised by numerous »pinpricks«; f lacquer-like manufacturing polish seen on tool HK No. 34:823i2. b–f were taken with a metallographic microscope with original magnifications of 100x.

**Abb. 1a–f** a Einschnitte am Werkzeug HK-Nr. 34:823i1, einer Ahle, die Aufnahme wurde mit einem Stereomikroskop angefertigt; b lackartiger Herstellungsglanz vom Polieren der Werkzeugoberfläche mit *Equisetum*; c–d Abnutzungspolitur und Riefen, die mit dem Kontakt mit kieselhaltigen Pflanzen und/oder Bast in Verbindung gebracht werden können; e Handhabungsspuren am Ende der Ahle, gekennzeichnet durch zahlreiche »Nadelstiche«; f lackartige Herstellungspolitur am Werkzeug HK-Nr. 34:823i2. b–f wurden mit einem metallografischen Mikroskop mit einer Originalvergrößerung von 100x aufgenommen.

graphic microscope (magnifications of 50–300x), fitted with a Leica MC120HD camera to examine the polish, striations and rounding. Photos were taken using Leica's LAS 4.8 software.

It should be stressed that although we can determine the very presence of traces of use, like polish or striations, and describe their various features, it is not possible from a methodological perspective to determine the function

of these objects with certainty. We can only interpret the activity that caused these traces to develop (see van Gijn 2014). The inferences are always made on the basis of a likeness between experimentally obtained traces of wear and the traces we observe on our archaeological objects. We can never exclude that such traces could also have been caused by an activity that we did not explore experimen-

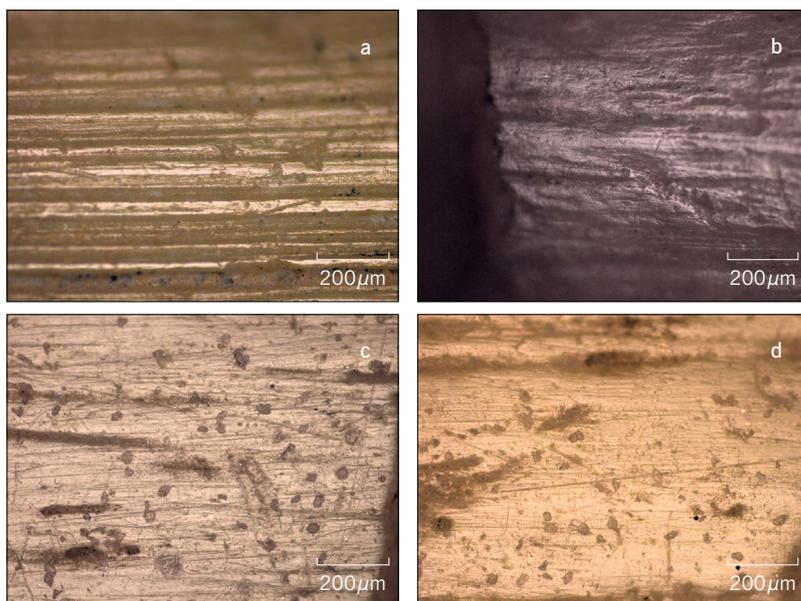
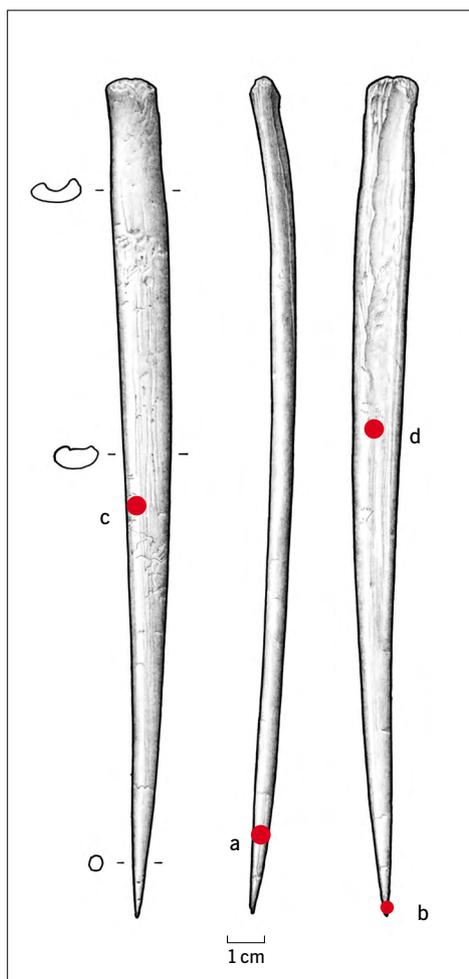


Fig. 2a–d Traces observed on tool HK No. 34:823i3. a Lacquer-like gloss associated with the manufacturing stage; b tip of the tool with a roughly textured polish that is interpreted as coming from contact with bast; c »Pinpricks« associated with handling traces; d handling traces and the manufacturing gloss. All photos were taken by metallographic microscope with original magnifications of 100x.

Abb. 2a–d Auf dem Werkzeug HK-Nr. 34:823i3 erkennbare Spuren. a Lackartiger Glanz, der mit der Herstellungsphase in Verbindung steht; b Spitze des Werkzeugs mit einer groben Politur, die vom Kontakt mit Bast stammen könnte; c »Nadelstiche«, die mit Gebrauchsspuren in Verbindung gebracht werden; d Bearbeitungsspuren und Herstellungsglanz. Alle Fotos wurden mit einem metallografischen Mikroskop mit einer 100-fachen Vergrößerung aufgenommen.

tally. Moreover, the biography of many of these objects can be highly complex, with secondary use, repair, intentional destruction or other treatments resulting in the modification or even obliteration of previously present traces of use<sup>1</sup>. It is, therefore, very important to carefully examine the microstratigraphy of the various traces we observe on the tools in order to better understand their life histories.

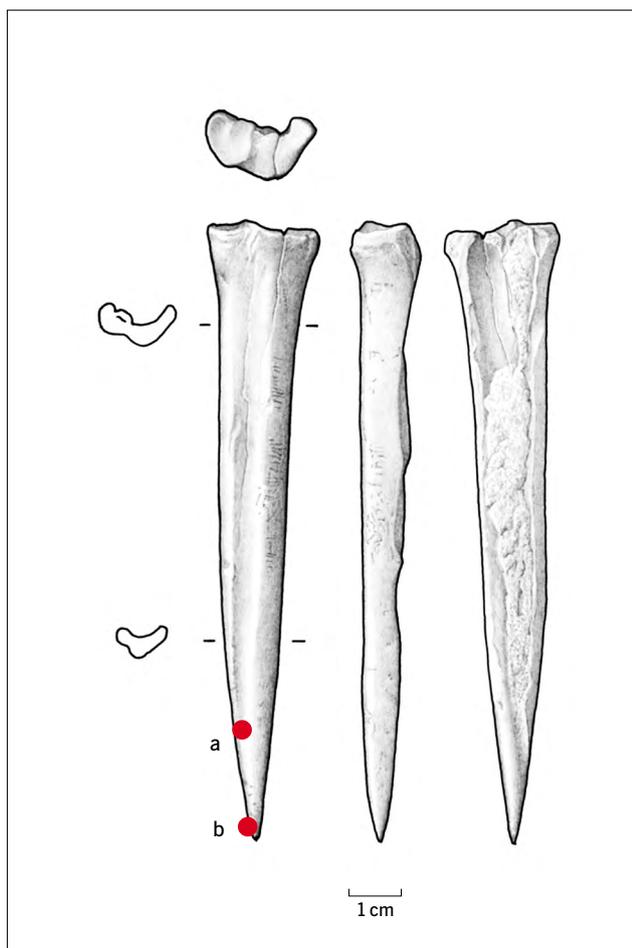
### 3 Results

**Find 34:823i1** is an awl, made on a left metatarsus of red deer (*Cervus elaphus*), split longitudinally, with a length of 10.3 cm and a width of 1.7 cm. It was made on the proximal end of the metatarsus. It displays some encrustations, possibly plaster from the grave construction mixed with ochre, but is generally in good condition. Unfortunately, the very tip of the object is missing, probably the result of a recent fracture. On one of the lateral edges, incisions are visible (Fig. 1a). The present author is not entirely sure whether these are indeed ornamental, as is suggested by J. Grünberg et al. (2016, 311), or whether they are linked to the intended function of the tool. The incisions are some-

what irregular, whereas we would expect ornamentation to be done with more care. Moreover, such incisions have also been observed on awls from the Late Neolithic site of Heke-lingen III, South Holland Province, in the western Netherlands (pers. obs.), and experiments are currently underway to explore their potential significance in plant-based crafts. Along the length of this awl, a very shiny, lacquer-like polish can be seen (Fig. 1b). The fact that this highly lustrous gloss is visible along the entire length of the object suggests that it is linked to the manufacture and finishing of this awl, rather than its use. It is therefore suggested that the awl has been intentionally polished, most likely by horsetail (*Equisetum hyemale*), a plant which has a kind of sand-paper-like surface that causes a very shiny and smooth polish. Towards the tip of the awl, this polish is overlain by a polish with a rougher, more matt, and striated texture that is considered to result from the use of the tool. It resembles polish that was experimentally obtained by making coiled baskets with a core of grass (Fig. 1c–d). In other spots, the polish appears more like the polish that we experimentally obtain from working bast. The tip, in particular, also displays striations that point not only to a longitudinal but also rotating motion,

<sup>1</sup> Current experiments re-using awls on different materials and storing them in different ways has made us even more aware of the

difficulty of assigning one specific function to these objects.



**Fig. 3a–b** Traces observed on tool HK No. 34:823i4. a Manufacturing gloss which is partially overlain by the actual use-wear traces which are due to contact with plant material. b The heavily rounded tip of the awl displaying a somewhat rough texture polish associated with bast and possibly plant. The circular striations indicate that the tool was certainly heavily used as an awl. Both photos taken by metallographic microscope, with original magnifications of 200x (a) and 100x (b).

**Abb. 3a–b** Auf dem Werkzeug HK-Nr. 34:823i4 erkennbare Spuren. a Fertigungsglanz, der teilweise von den eigentlichen Gebrauchsspuren überlagert wird und auf den Kontakt mit pflanzlichen Materialien zurückzuführen ist. b Die stark abgerundete Spitze der Ahle weist eine etwas raue Textur auf, die mit Bast und möglicherweise Pflanzen in Verbindung zu bringen ist. Die kreisförmigen Riefen deuten darauf hin, dass das Werkzeug sicherlich intensiv als Ahle benutzt wurde. Beide Fotos wurden mit einem metallografischen Mikroskop aufgenommen, mit Originalvergrößerungen von 200x (a) und 100x (b).

indicating that this tool was indeed used as an awl, most probably in the processing of plant materials and/or in the production of basketry. The last features that could be observed were possible prehension traces where the original intentional polishing of the object was damaged, perhaps by the rubbing of grass between the fingers of the user and the tool and the acidity of the fingers (Fig. 1e). The tool seems to have been quite intensively used. **Find 34:823i2** is an awl made on a metapodium of a roe deer (*Capreolus capreolus*), with a length of 8.8 cm and a width of 1.2 cm. The tip is missing, as is the base of the tool. It is, therefore, not certain whether the tool was made on the distal or proximal part of a longitudinally split metapodium. This object is very poorly preserved, with encrustations covering almost all of the surface. It seems, however, that this tool, too, was intentionally polished with *Equisetum*, as here and there remnants of the very shiny lacquer-like gloss preserved (Fig. 1f). There are some very vague indications of use-wear traces, possibly from contact with plants, but

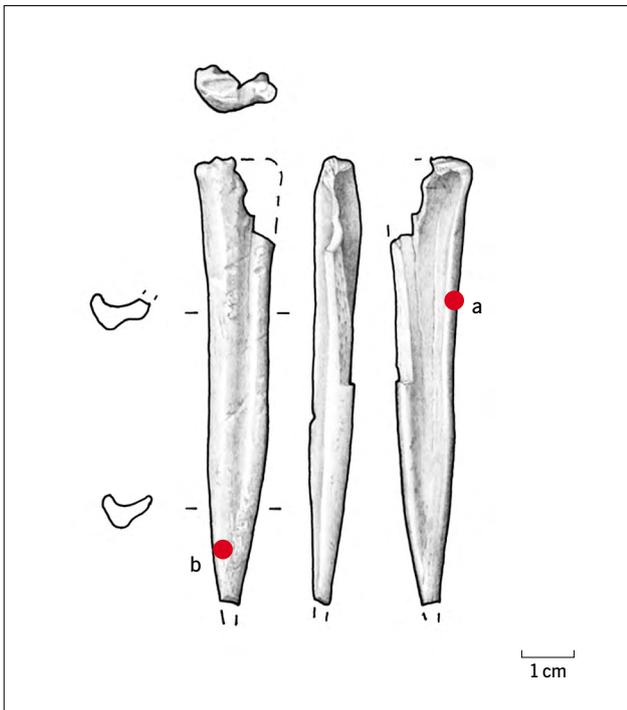
these are insufficiently clear to provide a basis for a more solid inference.

**Find 34:823i3** is classified as an awl, made on a longitudinally split right metacarpus of red deer (*Cervus elaphus*). It measures 22.1 cm in length and 1.4 cm in width. Again, the tip is unfortunately missing, probably a recent fracture. Along most of its length it displays polish resembling the one we experimentally obtain by contact with *Equisetum*. The tool was thus intentionally polished, most likely with the aid of horsetail (*Equisetum hyemale*) (Fig. 2a). Towards the tip the tool has a somewhat roughly textured polish that resembles the one produced by bast (Fig. 2b). Interestingly, evidence for a rotation motion is absent on this tool, with only longitudinally oriented scratches associated with plant working traces. This indicates that the tool was used in a pushing motion, like a needle, and did not twist in the contact material as an awl does. A final feature is the presence of prehension traces: little pinpricks (Fig. 2c–d; Maigrot 1997).

**Find 34:823i4** is described as an awl. It is made on the proximal end of the longitudinally split right metatarsus of *Capreolus capreolus* and has a length of 11.9 cm and a width of 2.1 cm. This tool is very well preserved overall, with fewer encrustations present (it does display some patches of plasticine from previous documentation, which I did not attempt to remove). All along the length of the tool, a very shiny lacquer-like polish has been preserved, with thin longitudinally oriented striations. As with the previous tools, I interpret these traces as manufacturing traces, associated with traces of polishing the tool with – most likely – horsetail (*Equisetum hyemale*; Fig. 3a). This shiny polish is destroyed to a large extent at the tip by the traces associated with the actual use of this awl: heavy rounding of the tip and a somewhat rougher but still bright polish that is associated with plant working. Here, striations also indicate a rotating motion, congruent with the use as an awl (Fig. 3b). Whether this concerns a silicious plant or bast is difficult to tell; most likely the awl was in contact with both materials, as suggested by the combination of a slightly rougher texture due to contact with bast, and a brighter somewhat smoother polish commonly seen from working (silicious) plants. Towards its base, the tool also displays an area of pinpricks, which are believed to be related to handling by bare hands.

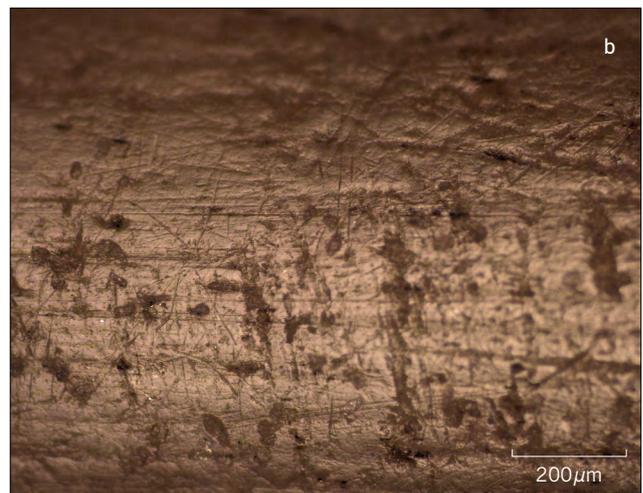
**Find 34:823i5**, again an awl, is made on the longitudinally split left metatarsus of a roe deer (*Capreolus capreolus*). It measures 8.5 cm in length by 1.4 cm in width. This tool is not very well preserved, and its tip and base are missing. It displays patches of the lacquer-like polish that is interpreted as being the result of intentional polishing with horsetail (Fig. 4a). Subsequent use and also post-depositional surface modifications have removed most of this manufacturing polish. The tip displays a bright, roughly textured polish interpreted as being the result of contact with plants, probably bast. The striations indicate a rotational motion in accordance with its classification as an awl. The use-wear polish extends quite far along the length of the tool, indicating that it penetrated the contact material quite deeply (c. 4 to 5 cm; Fig. 4b).

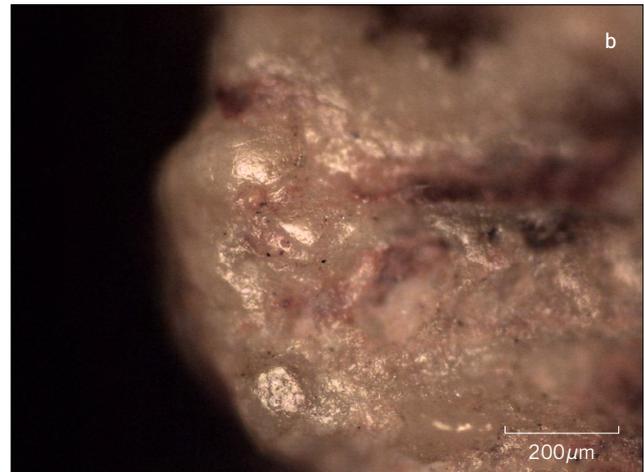
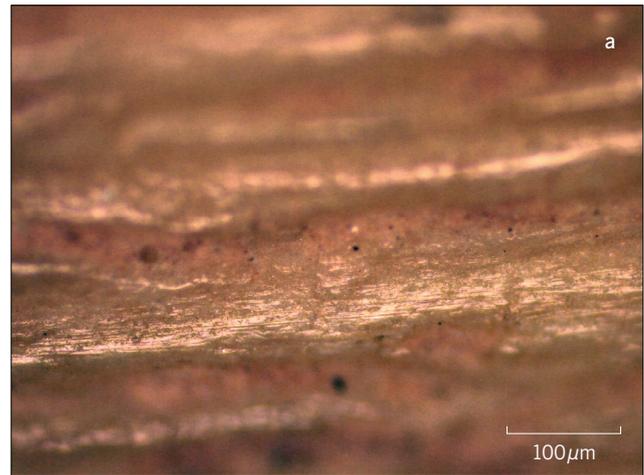
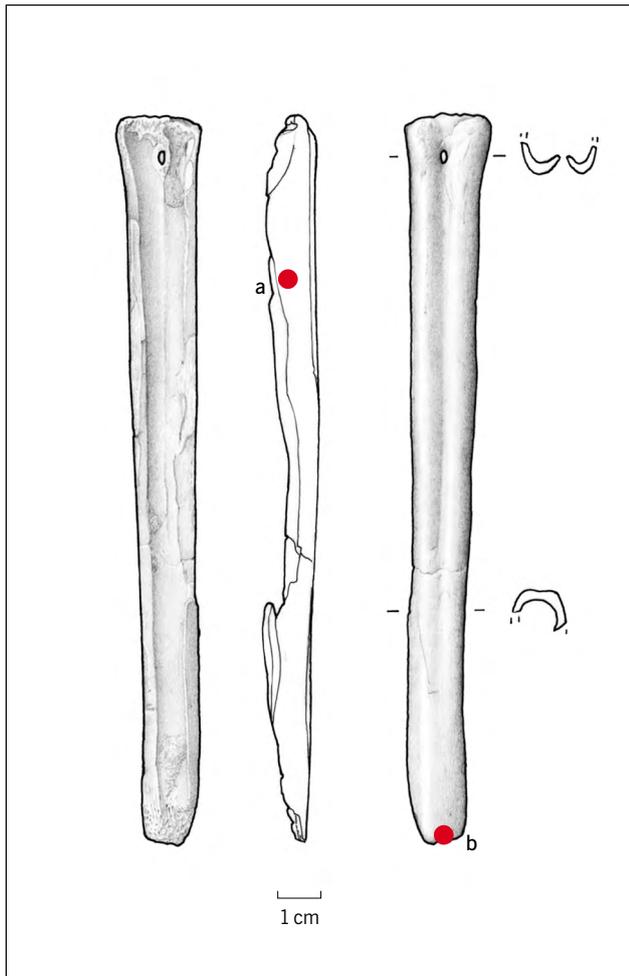
**Find 34:823i6** is classified as a spatula. It is made on a longitudinally split metatarsus of *Cervus elaphus* and measures 16.4 cm in length and 1.8 cm in width. It is poorly preserved, and the large numbers written on its surface, as well as the presence of glue, render it basically unsuited for use-wear analysis. However, along the length of the tool, small patches of the lacquer-like polish were detected, indicating that this tool was finished in the same way as the other five, most likely by polishing with horsetail (Fig. 5a). The bevelled edge of the chisel end shows some ochre and is also quite rounded. There is also a small spot of flat, bright pol-



**Fig. 4a–b** Traces observed on tool HK No. 34:823i5. a The smooth manufacturing polish from *Equisetum* seen along the length of the tool; b Use wear polish and striations indicating a circular motion and contact with plant material like bast. Both photos taken by metallographic microscope with original magnifications of 100x.

**Abb. 4a–b** Auf dem Werkzeug HK-Nr. 34:823i5 erkennbare Spuren. a Glatte Herstellungspolitur, stammend von *Equisetum*, über die gesamte Länge des Werkzeugs; b Abnutzungspolitur und Riefen, die auf eine kreisförmige Bewegung und Kontakt mit Pflanzenmaterial, wie zum Beispiel Bast, hinweisen. Beide Fotos wurden mit einem metallografischen Mikroskop bei 100-facher Vergrößerung aufgenommen.





**Fig. 5a–b** Traces observed on tool HK No. 34:823i6. a Lacquer-like gloss associated with the manufacturing stage. b A somewhat smooth and bright polish interpreted as being associated with contact with mineral material. Both photos taken by metallographic microscope with original magnifications of 100x

**Abb. 5a–b** Auf dem Werkzeug HK- Nr. 34:823i6 erkennbare Spuren. a Lackartiger Glanz, der mit der Herstellungsphase in Verbindung gebracht wird. b Eine leicht glatte und helle Politur, die für einen Kontakt mit mineralischem Material spricht. Beide Fotos wurden mit einem metallografischen Mikroskop mit 100-facher Vergrößerung aufgenommen.

ish presents that may be associated with contact with a mineral material, in this case probably ochre, but this is a very tentative inference (Fig. 5b).

#### 4 Conclusion

The six tools examined for traces of manufacture and use were all produced in a similar manner: they were made on split metapodia of either roe deer or red deer. Especially red deer seem to have a special significance in Mesolithic cosmology (see a.o. Conneller 2011). Choosing metapodia as the raw material is logical as these bones carry the weight of hooved animals and are ›designed‹ to sustain a large amount of pressure. This is, in principle, a very common technological choice when producing implements that must sustain longitudinally oriented pressure or impact, like awls or chisels. Given this, the use of metapodia in tool manufacture and use has been observed at countless Mesolithic and Neolithic sites (e.g. van Gijn 2005; van Gijn 2007), with the sole, possibly culturally determined technological

choice being whether to retain the distal or the proximal end of the bone. In the case of the two awls from Bad Dürrenberg where this was possible to determine, the choice was to retain the proximal end for the base of the tool. The specimens studied also share similar finishing stages: they were all highly polished along their entire length. Most likely this was done by rubbing horsetail (*Equisetum hyemale*) along the length, which resulted in a lacquer-like polish that is highly reflective, very regular and quite smooth, but with a multitude of thin, narrow striations that run along the length of the tools.

In terms of use, the objects can be regarded as a toolkit for plant working activities, most likely involved in basketry. The microscopic analysis of the items reveals the practice of otherwise hidden technologies, the products of which have not been preserved (Hurcombe 2014; van Gijn/Little 2016). The awls display longitudinal scratches as well as perpendicular ones in the tip regions, indicating that they were pushed into the contact material and twisted. The polish is somewhat rough and matt in texture, although in some places, it resembles silicious plant polish because of

its brightness and smoothness. Most likely, the tools were in touch with both bast fibres (causing the rougher textured polish) and silicious plants (causing the brighter polish). A possible interpretation is that they were involved in making coiled basketry, but this variation in polish could also be due to their use in diverse plant-based crafts, involving different plant-based raw materials. The large needle-like awl had been used to push material and was used only in a longitudinal motion, in contrast to the awls. It is likely part of the same basketry-making toolkit as the awls. Interpreting the chisel is a bit more complicated as this tool was very poorly preserved and could not be fully studied. However, it may have been used to apply ochre to the baskets.

To conclude, the Bad Dürrenberg bone tools seem to have been part of a single toolkit, manufactured in the same way

and used for the same activity. As such, they share similar biographies. Use-wear analysis of other categories of material culture, like flint or stone, may show whether such tools were also part of this toolkit. If the interpretation of this set of tools as being related to plant working – more specifically, basket making – is correct, the question remains how this fits in with the interpretation of the woman as a shaman. Plant-based crafts like basketry and weaving are notoriously time-consuming and often seen as women's activities. Because of the length of time required to make an item, be it a finely crafted basket or a woven garment, these activities are sometimes seen as representing the flow of life (Barber 1994). From that perspective, adding a plant-working toolkit to the burial gifts of a ›shaman‹ may be quite appropriate.

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## Source of figures

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