

The Palaeolithic origin of eyed needles

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Zusammenfassung

Der paläolithische Ursprung der Öhrnadeln

Verschiedene paläolithische Werkzeuge aus knöchernen Materialien können der Verarbeitung von Haut und Pflanzenfasern für die Herstellung von Kleidung zugeschrieben werden, wie z. B. Glätter, Ahlen und möglicherweise Doppelspitzen und épingles. Die Öhrnadel ist jedoch die technologische Innovation, die eindeutig den Beginn des aufwendigen Nähens im Paläolithikum markiert. Es handelt sich um ein Werkzeug, dessen Form und Verwendungsweise bis heute erhalten geblieben sind, auch wenn sich die Herstellungstechniken im Laufe der Zeit verändert haben. Dieses Werkzeug eignet sich perfekt für das manuelle Nähen, das von sich aus eine komplexe Angelegenheit ist, und hatte verschiedene technische, wirtschaftliche und kulturelle Auswirkungen auf die Jäger- und Sammlergesellschaften.

Wir legen hiermit einen kurzen und knappen Überblick über die veröffentlichte Forschung zum Ursprung der Öhrnadeln im Paläolithikum vor, die in verschiedenen Teilen der Welt zu unterschiedlichen Zeiten benutzt wurden, von Sibirien und dem Kaukasus bis nach China und Nordamerika, und über ihre Verbreitung in verschiedenen Gebieten mit ihrer Entwicklung und Formenvielfalt. Wir werden uns mit der Bedeutung morphometrischer Analysen befassen, die es uns ermöglichen, diese Entwicklung und Vielfalt innerhalb eines Technokomplexes und zwischen geografischen Gebieten und chronokulturellen Kontexten zu bewerten sowie verschiedene Hypothesen über ihren Ursprung und ihre Ausbreitung vorstellen.

Darüber hinaus erörtern wir technologische Fragen zu den verwendeten Rohstoffen (überwiegend Knochen, auch wenn einige Exemplare aus Geweih und Elfenbein gefunden wurden) und deren Umarbeitung zu Nadeln. Diesbezügliche Studien sind rar, und die meisten haben sich auf die Spätglazialzeit in Westeuropa konzentriert, gleichwohl sie sich allmählich auf andere geografische Gebiete und Epochen ausweiten. Daher untersuchen wir die unterschiedlichen Techniken, die bei der Herstellung ein und desselben Objekttyps zu verschiedenen Zeiten und an verschiedenen Orten der nördlichen Hemisphäre eingesetzt wurden.

Abschließend befassen wir uns mit der Frage nach der Verwendung der Nadeln, den Fäden, die möglicherweise verwendet wurden sowie Brüchen und Reparaturen dieser.

Schlagwörter Knochenindustrie, Knochenwerkzeuge, Nahttechniken, Öhrnadeln, Jungpaläolithikum

Summary

Various Palaeolithic tools made of osseous materials can be attributed to the processing of skin and plant fibres for clothing production, such as smoothers, awls, and possibly double points and épingles. However, the eyed needle is the technological innovation that unequivocally marks the beginning of intricate sewing in the Palaeolithic. It is a tool whose shape and mode of use have persisted until today, although its manufacturing techniques have changed over time. This tool is perfectly suited to manual sewing, which is inherently complex, and has various technical, economic, and cultural implications for hunter-gatherer societies.

We present a concise overview of the published research on the origin of eyed needles in the Palaeolithic, in different parts of the world and at different periods, from Siberia and the Caucasus to China and North America, and their spread across different territories with their evolution and diversity. We will address the importance of morphometric analyses that allow us to assess this evolution and diversity within a techno-complex and between geographic areas and chrono-cultural contexts, presenting different hypotheses proposed about their origin and dispersion.

Additionally, we discuss technological issues regarding the raw materials used (generally bone, although some specimens have been recovered in antler and ivory), and their transformation into needles. Studies in this regard are scarce, and most have focused on the Late Glacial period of Western Europe, although they are gradually extending to other geographic areas and periods. Thus, we examine the different techniques employed in producing the same object type at different times and places in the Northern Hemisphere.

Finally, we address the question of needle use, the threads that may have been used, fractures, and repairs.

Keywords Osseous industry, bone tools, sewing technologies, eyed needles, Upper Palaeolithic

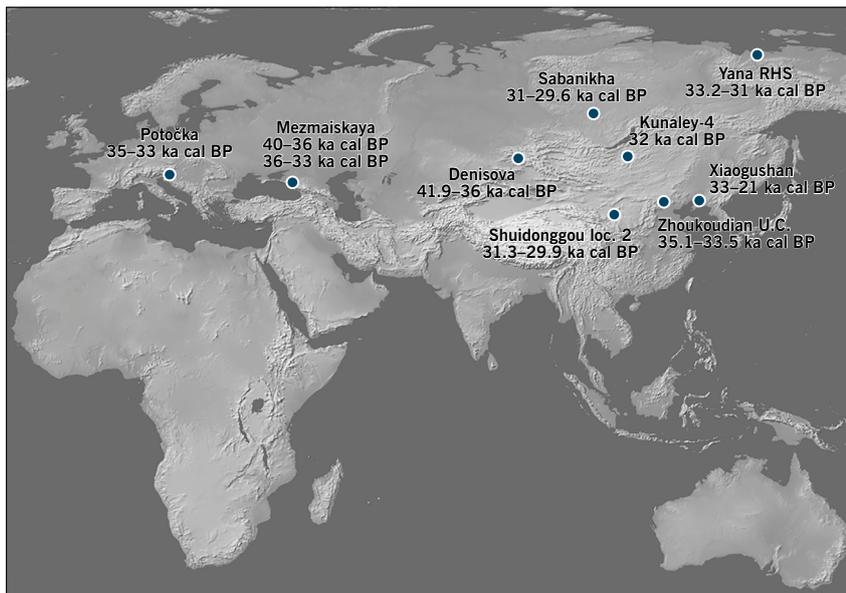


Fig. 1 Location of sites cited in the text with eyed needles in the chronological range 40–30 ka cal BP.

Abb. 1 Lage der im Text erwähnten Fundorte von Öhrnadeln im chronologischen Bereich 40–30 ka cal BP.

The Palaeolithic tools that may have been used for clothing manufacture

The earliest clothing discovered in prehistoric assemblages comes from Neolithic contexts with exceptional taphonomic conditions¹. However, various indirect evidence of clothing manufacture and use was found in Palaeolithic archaeological sites in Africa, Eurasia, and America. For example, seven footprints found inside Cussac Cave, Dép. Dordogne, France, were linked to the use of footwear by hunter-gatherers during the Middle Gravettian (Ledoux et al. 2021).

Nevertheless, archaeologists rely on the technological (including functional) analysis of tools that may have been involved during hide or plant fibre processing, which may be linked to the production of clothing. Many lithic tools show use-wear traces associated with the scraping, cutting or piercing of animal hides throughout the Palaeolithic. As early as 800–900 ka BP, lithic tools from the TD6 level at Gran Dolina, Burgos Province, Spain (Carbonell et al. 1999) exhibit hide-working traces. This activity has become progressively more observed on Palaeolithic objects from Lower, Middle or Upper Palaeolithic contexts around the world with the increase in the number of traceological analyses².

Due to the frequent post-depositional alterations, use-wear analyses of osseous materials have been conducted less frequently and less systematically. The oldest occurrence of bone tools associated with hide or plant fibre processing are bone smoothers, made from flakes of bones, from the Lower Palaeolithic level of Schöningen, Helmstedt District, Germany (Julien et al. 2015). These objects show use patterns consistent with the rubbing of animal hides. Similar osseous tools have been found at Middle Palaeolithic sites, some of which display use-wear traces typically linked to

hide processing³. Smoothers became more common during the Upper Palaeolithic. Made from flakes of bones, half ribs or antlers, they may have been used to transform hides or various plant materials⁴.

Awls, alongside smoothers, are the most frequent Palaeolithic osseous tools associated with processing hide or plant fibres. The earliest awls were found in the Middle Palaeolithic context of Blombos Cave, Western Cape Province, South Africa, dated c. 73–70 ka (d’Errico/Henshilwood 2007). The objects are often found in Upper Palaeolithic contexts, but a high morphological variability characterises them. They have been produced from flakes or segments of bone or antler, complete pointed bones, and segments of ivory. During the Upper Palaeolithic, some double points or *épingles* were produced using similar manufacturing processes to those used for awls. Small osseous pointed objects have been associated with hide or textile piercing activities, possibly during clothing manufacture or sewing operations. Although some functional analyses have identified traces of use linked to hide-working (Bradfield 2015; Pitulko/Pavlova 2022; Caurette 2024), traceological studies on Palaeolithic awls are still rare, and their functions within the *chaînes opératoires* of hide-working require further investigation.

If smoothers and awls may have been used as active tools for working hides or plant fibres, an example of a bone anvil, which may have been involved during piercing hide operations, was found in the Aurignacian levels of Canyars, Barcelona Province in Spain (Doyon et al. 2023). A flat bone fragment of a large mammal exhibits several aligned puncture marks. They have been interpreted as the result of indirect percussion with a burin and a hammer, probably to pierce a soft material such as leather.

Finally, the last Palaeolithic osseous tool used to produce clothing is the needle. Exclusively associated with modern

1 Pütener/Moss 2010; Schlumbaum et al. 2010; Hafner 2012; Klügl et al. 2019; Rast-Eicher et al. 2021.

2 E.g. Keeley 1977; Rots et al. 2015; Lemorini et al. 2016; Gauvrit-Roux 2019; Venditti et al. 2019.

3 Mozota 2012; Soressi et al. 2013; Baumann et al. 2020; Hallett et al. 2021; Tartar et al. 2022.

4 E.g. Averbouh/Buisson 2003; Legrand 2004; Tartar 2009; Lacarrière et al. 2011.

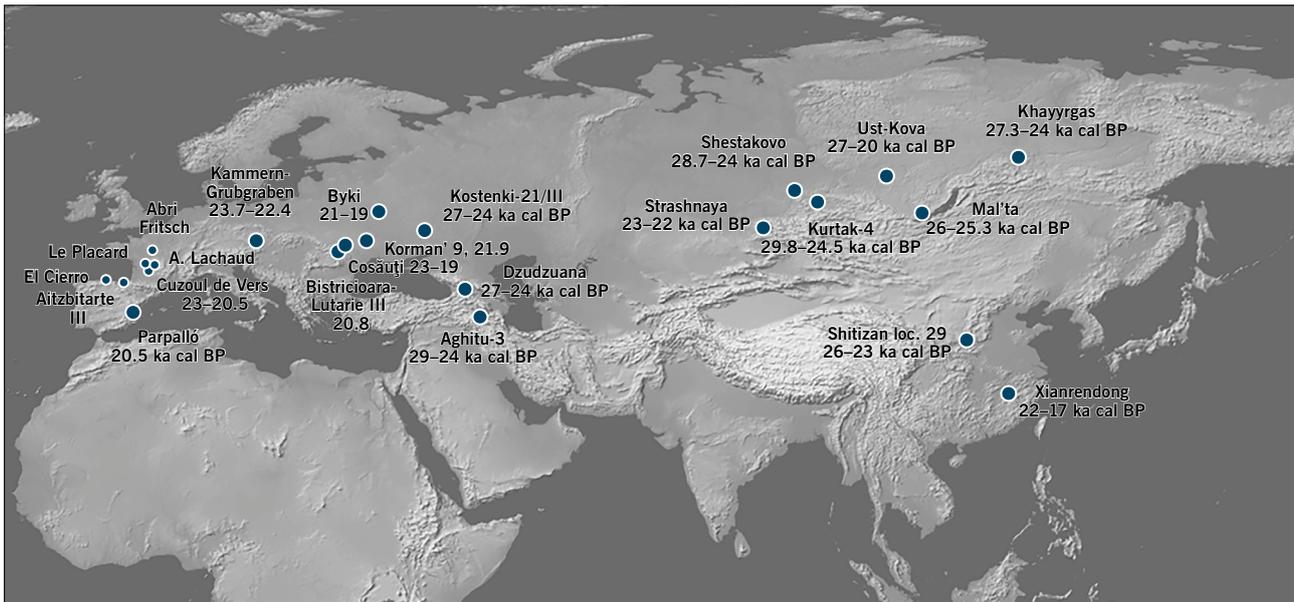


Fig. 2 Location of sites cited in the text with eyed needles in the chronological range 30–20 ka cal BP.

Abb. 2 Lage der im Text erwähnten Fundorte von Öhrnadeln im chronologischen Bereich 30–20 ka cal BP.

human contexts, the needle is evidence for the production of complex clothing with elaborate stitches.

The origin of eyed needles and their worldwide diffusion

The first eyed bone needles appeared in the Early Upper Palaeolithic. Where and when they first appeared, and their possible multiple origins, have been the subject of recent debate (Tab. 1; e.g. d'Errico et al. 2018; Fedorchenko/Belousova 2021; Gilligan et al. 2024). The earliest stratigraphies in which eyed bone needles have been identified are either not clearly defined, as is the case at Denisova, Altai Krai, Russia or are questionable due to bioturbations, such as at Strashnaya, Perm Krai, Russia. Denisova Cave has been ranked as the oldest site with eyed needles, with an age of 41.9–36 ka cal BP (Fig. 1) associated with the advent of the Anatomically Modern Human (AMH)⁵. Strashnaya Cave, on the other hand, has a needle in an undated context associated with a lithic industry characterised by the *Levallois* reduction concept⁶. The case of Mezmaiskaya, Republic of Adygea, Russia, is very similar. Layer 1C (c. 40–36 ka cal BP) has produced one eyed needles, but the highest numbers of needles appear in the succeeding younger layers 1B and 1A, dating to c. 36 and 33 ka cal BP, respectively (Golovanova et al. 2010; Golovanova 2017). The chronological range of est. 35–30 ka cal BP is when the eyed needles appear in Siberia, China and the Caucasus, in some cases as isolated finds, in others in larger numbers. The Yana RHS site, Far Eastern District in north-eastern Siberia, has produced an exceptional collection of 192 eyed needles and fragments dating to 33.2–31 ka cal BP (Fedorchenko/Belousova 2021;

Pitulko et al. 2012). Eyed needles appear at other Siberian sites such as Sabanikha, Krasnoyarsk Krai, Russia (31–29.6 ka cal BP) and Kunaley-4, Zabaykalsky Krai, Russia (32 ka cal BP; Fedorchenko/Belousova 2021). In China, several specimens have been uncovered at the Zhoukoudian Upper Cave, Beijing, China (< 35.1–33.5 ka cal BP; Li et al. 2018; Wang et al. 2020), at Xiaogushan, Liaoning Province, China (33–21 ka cal BP; Huang et al. 1986; Zhang et al. 1985, 2010; Wang et al. 2020) and at Shuidonggou loc. 2, Ningxia Hui Autonomous Region, China (31.3–29.9 ka BP)⁷. In the Caucasus, eight needles are recorded from layers 1B and 1A at Mezmaiskaya, dating in roughly the same time interval, as mentioned above. The westernmost evidence of needles at this time is Potočka Cave, eastern Karawanks, Slovenia, where Odar (2008; Odar 2011) mentions the presence of an eyed needle, possibly dating to 35–33 ka cal BP, whereas Moreau et al. (2015) hint at stratigraphical problems. Furthermore, the interpretation of the object as an eyed needle is questionable (Odar 2006, Fig. 8; referenced by Odar 2008 as a needle).

In the time interval between 30 and 25 ka cal BP (Fig. 2), we observe a significant westwards dispersion of this morphotype and a proliferation of sites in the east. Good examples of eyed needles found in Eastern Europe come from the sites Kostenki 15, Khokholsky District, Russia (30 ka cal BP; Hoffecker 2005) and layer III at Kostenki 21 (27.5–24.5 ka cal BP; Goutas 2013; Reynolds et al. 2019). In the Caucasus, we also find isolated artefacts at Aghitu-3, Syunik Province, Armenia (29–24 ka cal BP; Kandel et al. 2017) and at Dzudzuana, Imereti Region, Georgia (27–24 ka cal BP; Bar-Yosef et al. 2011; Tejero et al. 2021). In central and eastern Siberia, needles are found in Kurtak-4, Krasnoyarsk Krai, Russia

5 Baumann et al. 2018; Derevianko et al. 2016; Fedorchenko/Belousova 2019; Shunkov et al. 2020.

6 Shalagina et al. 2018; Shunkov et al. 2020; Fedorchenko/Belousova 2021.

7 Guan et al. 2012; Li et al. 2013a; Li et al. 2013b; Wang et al. 2020.

Site	Country	Chronology ka cal BP	Needles number	Technology mentioned	Bibliography
Denisova	Russia	41.9–36.0	> 8	no	Baumann et al. 2018; Derevianko et al. 2016; Fedorchenko/Belousova 2019; Shunkov et al. 2020
Mezmaiskaya	Russia	40.0–36.0	1	no	Golovanova et al. 2010; Golovanova 2017
Yana RHS	Russia	33.2–31.0	192	yes	Ferdonchenko/Belousova 2021; Pitulko et al. 2012
Sabanikha	Russia	31.0–29.6	7	no	Fedorchenko/Belousova 2021
Kunaley-4	Russia	32.0	1	no	Fedorchenko/Belousova 2021
Zhoukoudian Upper Cave	China	35.1–33.5	1	no	Li et al. 2018; Wang et al. 2020
Xiaogushan	China	33.0–21.0	3	yes	Huang et al. 1986; Zhang et al. 1985; Zhang et al. 2010; Wang et al. 2020
Shuidonggou loc. 2	China	31.3–29.9	1	yes	Guan et al. 2012; Li et al. 2013; Li et al. 2013a; Wang et al. 2020
Mezmayskaya	Russia	36.0–33.0	8	no	Golovanova et al. 2010; Golovanova 2017
Potočka	Slovenia	35.0–33.0	1	no	Odar 2006; Odar 2008; Odar 2011
Kostenki 15	Russia	30.0	+	no	Hoffecker 2005
Kostenki 21/III	Russia	27.5–24.5	1	yes	Goutas 2013
Aghitu-3	Armenia	29.0–24.0	1	no	Kandel et al. 2017
Dzudzuana	Georgia	27.0–24.0	1	no	Bar-Yosef et al. 2011
Kurtak-4	Russia	29.8–24.5	1	no	Fedorchenko/Belousova 2021; Shunkov et al. 2020
Shestakovo	Russia	28.7–24.0	11	no	Fedorchenko/Belousova 2021
Ust-Kova	Russia	27.0–20.0	1	no	Fedorchenko/Belousova 2021
Khayrgas	Russia	27.3–24.0	9	no	Fedorchenko/Belousova 2021; Kuzmin et al. 2017
Mal'ta	Russia	26.0–25.3	70	no	Fedorchenko/Belousova 2021; Shunkov et al. 2020
Shizitan loc. 29	China	26.0–23.0	1	no	Song et al. 2016
Strashnaya	Russia	23.0–22.0	1	no	Krivoshapkin et al. 2018; Shalagina et al. 2018; Shunkov et al. 2020; Fedorchenko/Belousova 2021
Xiarendong	China	22.0–17.0	9	no	Wu et al. 2012; Wang et al. 2020
Cosăuți	Moldavia	23.0–19.0	51	yes	Pfeifer 2024
Byki	Czech Republic	21.0–19.0	17	yes	Demidenko 2020; Akhmetgaleeva/Burova 2021
Korman'9	Ukraine	21.9	1	no	Kulakovska et al. 2021
Bistricioara-Lutaire III	Romania	20.8	1	no	Anghelinu et al. 2017
Kammern-Grubgraben	Austria	23.7–22.4	18	yes	Pfeifer et al. 2024
Cuzoul de Vers	France	23.5–20.5	184	yes	Le Guillou 2012; Borao/Pétillon unpubl.
Abri Fritsch	France	23.5–20.5	71	yes	Malgarini 2022; Borao/Pétillon 2024
Abri Lachaud	France	23.5–20.5	27	yes	present study, J.-M. Pétillon and M. Borao
Le Placard	France	23.5–20.5	82	no	Breuil and Mortillet (S.D.), cited by Stordeur-Yedid 1979
El Cierro	Spain	17.0 uncal	+	no	Álvarez Fernández et al. 2016
Parpalló	Spain	c. 20.5	4	yes	Borao 2019; Borao 2022
Aitzbitarte III	Spain	28.0–22.0	+	no	Calvo/Arrizabalaga 2020
Afontova Gora II	Russia	16.0–12.0	> 7	no	Derevianko et al. 2017
Khayrgas	Russia	19.8–16.9	55	no	Fedorchenko/Belousova 2021; Kuzmin et al. 2017
Strashnaya	Russia	19.0	1	no	Shalagina et al. 2018
Shuidonggou loc. 12	China	12.2–11.1	11	yes	Zhang et al. 2016; d'Errico et al. 2018
Liyuzui	China	21.0–12.0	1	no	Doyon 2019
Bailaiandong	China	13.0	1	no	Doyon 2019
Shizitan loc. 9	China	12.8–11.7	2	no	Doyon 2019
Zengpiyan	China	12.0–10.0	2	no	Doyon 2019

Site	Country	Chronology ka cal BP	Needles number	Technology mentioned	Bibliography
Nanzhuangton	China	11.5–11.0	2	no	Doyon 2019
Gvardijilas Klde	Georgia	17.0–15.5	+	no	Golovanova et al. 2010; Golovanova et al. 2014; Golovanova 2017
Chygai	Russia	17.0–15.5	+	no	
Dvoynaya	Russia	17.0–15.5	+	no	
Zatsurbliia	Georgia	17.0–15.5	+	no	
Mezmaiskaya	Russia	17.0–15.5	1	no	
Skajia	Georgia	17.0–15.5	1	no	
Apiancha	Georgia	19.0–13.5	2	no	
Pekárna	Czech Republic	12.0	121	yes	Laznicková-Galetová 2010
Křížová		12.0	1	yes	
Žitného jeskyně		12.0	9	yes	
Býcí skála		12.0	5	yes	
Veruncina		12.0	2	yes	
Kůlna		12.0	3	yes	
Vogelherd	Germany	16.2–15.0	14	no	Schürch et al. 2024
Gönnersdorf	Germany	~ 15.8	63	yes	Bignon-Lau/Galetova 2016
Petersfels	Germany	15.5–13.0	~ 2000	yes	McCartin et al. 2023
Monruz	Switzerland	15.0–13.0	120	yes	Bullinger et al. 2006
Caldas	Spain	20.2–12.6	105	yes	Corchón/Garrido 2007, 2008
Parco	Spain	14.3	11	yes	Tejero/Fullola 2006, 2008
Bora Gran	Spain	Magdalenian	20	yes	Rueda/Torres 1987
Parpalló	Spain	14.0	13	yes	Borao 2019; Borao 2022
Cendres	Spain	16.8–14.3	23	yes	Borao 2012; Borao 2013; Villaverde et al. 2012
Nerja	Spain	14.2–13.1	7	yes	Aura et al. 2020
Church Hole	UK	13.0–12.0	1	no	Schawabedissen 1953, cited in Stordeur-Yedid 1979
Kent's Cavern	UK	13.0–12.0	1	no	Evans 1878, cited in Stordeur-Yedid 1979
Broken Mammoth	USA	14.0, 11.8	1	no	Osborn 2014; Hoffecker 2017 cited by Gilligan et al. 2024
Hell Gap		13.1	1	yes	Lyman 2015; Osborn 2014
La Prele		12.9	4	yes	Pelton et al. 2024
Agate Basin		12.7	16	yes	Lyman 2015; Osborn 2014
Lindenmeire		12.7	25	yes	Lyman 2015; Osborn 2014
Buhl Burial		12.6	1	yes	Lyman 2015; Osborn 2014
Allen Sile		12.5–11.9	5	yes	Lyman 2015; Osborn 2014
Bonneville Estates		12.2	1	yes	Lyman 2015; Osborn 2014
Lind-Coulee		11.7	18–20	yes	Lyman 2015; Osborn 2014
Sentinel Gap		11.7	1	yes	Lyman 2015
Marmes		11.5	10	yes	Lyman 2015; Osborn 2014
Tula Lake Rockshelter		11.4	4	yes	Erlanson et al. 2014
Horn Shelter		11.1	> 1	yes	Lyman 2015; Osborn 2014
Winkler		11.0	1	yes	Lyman 2015; Osborn 2014
O. V. Clay		10.1	2	yes	Lyman 2015

Tab. 1 Sites with eyed needles referenced in the text.

Tab. 1 Im Text erwähnte Fundorte von Öhrnadeln.

(29.8–24.5 ka cal BP; Fedorchenko/Belousova 2021; Shunkov et al. 2020), Shestakovo, Irkutsk Oblast, Russia (28.7–24 ka cal BP), Ust-Kova, Krasnoyarsk Krai, Russia (27–20 ka cal BP), Khayrgas, Republic of Sakha (Yakutia), Russia, layer 7 (27.3–24 ka cal BP; Fedorchenko/Belousova 2021; Kuzmin et al. 2017) and at Mal'ta, Irkutsk Oblast, Russia, at 26–25.3 ka cal BP, which yields some 70 needles (Fedorchenko/Belousova 2021; Shunkov et al. 2020). In China, Shizitan locality 29, Shanxi Province, dated to 26–23 ka cal BP, has produced one fragment of an eyed needle and a grey sandstone slab that displays grooves from the grinding of long and thin artefacts, most likely used in the production of needles (Song et al. 2016).

During the succeeding millennia, between 25 and 20 ka cal BP (Fig. 2), eyed needles continue in Asia, with sites such as Strashnaya (23–22 ka cal BP)⁸ and Xiarendong, Jiangxi Province, China (22–17 ka cal BP; Wu et al. 2012; Wang et al. 2020), but now also become widespread all over Europe. In eastern Europe, at sites such as Cosăuți, Soroca District, Moldova, with 51 needles (c. 23–19 ka cal BP; Pfeifer 2024), Byki 7, Kursk Oblast, Russia (21–19 ka cal BP; Demidenko 2020; Akhmetgaleeva/Burova 2021), Korman'9, Chernivtsi Region, Ukraine (c. 21.9 ka cal BP; Kulakovska et al. 2021), and Bistricioara-Lutaire III, Bistrița County, Romania (20.8 ka BP; Anghelinu et al. 2017). In Central and Western Europe, eyed needles appear in Lower Austria, in Kammern-Grubgraben (23.7–22.4 ka cal BP; Pfeifer et al. 2024), and in France during the Badegoulian (23.5–20.5 ka cal BP) in sites like Cuzoul de Vers, Dép. Lot, with 184 needles (Le Guillou 2012; Borao/Pétillon unpubl.), and Abri Fritsch, Dép. Indre (Malgarini 2022a; Borao/Pétillon 2024). In Spain, they are documented at Parpalló, Valencia Province (Borao 2019; Borao 2022); in addition, Aitzbitarte III, Basque Autonomous Community (28–22 ka cal BP) has been recently referred to as a site with Solutrean needles (Gilligan et al. 2024), but as Calvo/Arrizabalaga (2020) point out, Solutrean and Badegoulian layers are mixed, and its chronology fits with the Badegoulian.

Between 20 and 10 ka cal BP (Fig. 3), eyed needles are widespread across the northern hemisphere, with specimens being identified in areas where they were already present, such as Siberia at Afontova Gora II, Krasnoyarsk Krai (16–12 ka BP; Derevianko et al. 2017), Khayrgas (19.8–16.9 ka cal BP; Fedorchenko/Belousova 2021; Kuzmin et al. 2017), and Strashnaya (19 ka cal BP; Shalagina et al. 2018), or in China in Shuidonggou loc. 12 (12.2–11.1 ka cal BP–Zhang et al. 2016; d'Errico et al. 2018), and other sites like Shizitan loc. 9 (12.8–11.7 ka cal BP), Liyuzui, Guangxi Zhuang Autonomous Region (21–12 ka cal BP), Bailaidong, Guangxi Zhuang Autonomous Region (c. 13 ka cal BP), Zengpiyan, Guangxi Zhuang Autonomous Region (12–10 ka cal BP) and Nanzhuangton (11.5–11 ka cal BP; Doyon 2019). They also continue to be present in the Caucasus at sites such as Gvardjilas Klde, Imereti Region, Georgia, Chugai, Dvoynaya, Zatsurbliya, all Kabardino-Balkarian

Republic, Russia, Mezmaiskaya layer 1–3 (17–15.5 ka cal BP), Skajia Cave, Imereti Region, Georgia and Apiancha (19–13.5 ka cal BP; Golovanova et al. 2010; Golovanova et al. 2014; Golovanova 2017).

In Europe, Magdalenian contexts, dated between c. 21 and 14 ka cal BP, yielded large assemblages of eyed needles. In Eastern Europe, we find important collections in the Czech Republic at sites such as Pekárna, Brno-Country District (with 121 needles), Křížová, Žitného, both Moravian-Silesian Region, Byčí skála, Blansko District, Verunčina, Blansko District, and Kůlna, Brno-County District (c. 12 ka BP; Lázničková-Galetová 2010). In Germany, the largest assemblage comes from Petersfels, Konstanz District, with over 2000 needles and by-products (15.5–13 ka cal BP; McCartin et al. 2023); other sites are Vogelherd, Heidenheim District (16.2–15 ka cal BP; Schürch et al. 2024), and Gönnersdorf, Neuwied District (15.8 ka cal BP; Bignon-Lau/Lázničková-Galetová 2016). In Switzerland, eyed needles were found in Monruz, Neuchâtel Canton (Bullinger et al. 2006). The high number of sites in France with large assemblages of needles is reviewed below. In Spain, the only technological studies reported are those from Las Caldas, Principality of Asturias (Corchón/Garrido 2007; Corchón/Garrido 2008), Parco, Province of Lleida (Tejero/Fullola 2006; Tejero/Fullola 2008), Bora Gran, Province of Girona (Rueda i Torres 1987), Parpalló, València Province (Borao 2022) and Cendres, Alicante Province (Borao 2012; Borao 2013).

Following the Magdalenian, eyed needles attributed to the Azilian technocomplex (c. 14–10 ka cal BP) come from French sites like Mas d'Azil, Dép. Ariège, Pégourié, Dép. Lot, Troubat, Dép. Hautes-Pyrénées, Tourasse, Dép. Haute-Garonne, and Bois-Ragot layer 3, Dép. Vienne, but are uncertain and debated due to possible stratigraphic admixtures⁹.

Between 13 and 11 ka cal BP, needles are present in the Creswellian of the United Kingdom at sites like Church Hole, Derbyshire County and Kent's Cavern, Devon County (Evans 1878; Schwabedissen 1954, both cited in Stordeur-Yédid 1979).

To finish this tour of the needles' dispersion, they appear in North America shortly after 13 ka cal BP (Osborn 2014), spreading throughout the continent at sites such as Hell Gap, Platte County, Wyoming, USA (13.1 ka cal BP), La Prele, Converse County, Wyoming, USA (12.9 ka cal BP; Pelton et al. 2024), Agate Basin, Niobrara County, Wyoming, USA and Lindenmeier, Larimer County, Colorado, USA (12.7 cal BP), Buhl Burial, Twin Falls County, Idaho, USA (12.6 ka cal BP), Allen Site, Frontier County, Nebraska, USA (12.5–11.9 ka cal BP), Bonneville Estates, Knox County, Tennessee, USA (12.2 ka cal BP), Broken Mammoth, Tanana River Valley, Alaska, USA (11.8 ka cal BP), Lind-Coulee and Sentinel Gap, both Grant County, Washington, USA (11.7 ka cal BP), Marmes, Franklin County, Washington, USA (11.5 ka cal BP), Tula Lake Rock Shelter, Siskiyou County, California, USA (11.4 ka cal BP), Horn Shelter, Bosque County, Texas, USA (11.1 ka cal BP), Winkler-1, Winkler County, Texas, USA (11.0 ka cal BP),

8 Krivoshapkin et al. 2018; Shalagina et al. 2018; Shunkov et al. 2020; Fedorchenko/Belousova 2021.

9 E.g. for a critical review of the stratigraphy from Pégourié, see Ducasse et al. 2019; for a discussion of the possible Magdalenian origin of the needle found in the Azilian level

of Bois-Ragot, see Christensen/Cholet 2005, 253–256; and for general statements on the disappearance of needles in the Azilian see Stordeur-Yédid 1979, 93.

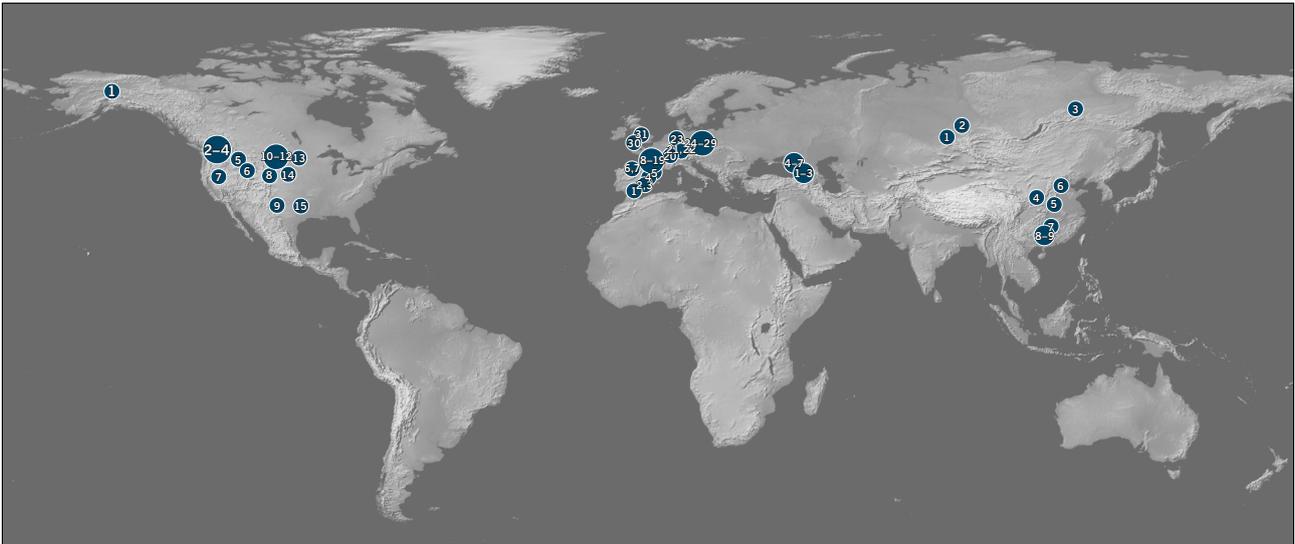


Fig. 3 Location of sites cited in the text with eyed needles in the chronological range 20–10 ka cal BP.

Abb. 3 Lage der im Text genannten Fundorte von Öhrnadeln im chronologischen Bereich 20–10 ka cal BP.

North America/Nordamerika: 1 Broken Mammoth; 2 Lind-Coulee; 3 Sentinel Gap; 4 Marmes; 5 Buhl Burial; 6 Bonneville Estate; 7 Tula Lake Rock-shelter; 8 Lindenmeier; 9 Winkler-1; 10 La Prele; 11 Agate Basin; 12 Hell Gap; 13 O.V. Clay; 14 Allen Sile; 15 Horn Shelter.

Europe/Europa 1 Nerja; 2 Cendres; 3 Parpalló; 4 Bora Gran; 5 El Parco; 6 Caldas; 7 Le Morin; 8 Isturitz; 9 Gazel; 10 Arlay/Grappin; 11 Solutré Route de la Roche; 12 La Madeleine; 13 Aurenans; 14 Saint-Michel, d'Arudy; 15 Bois-Ragot; 16 La Vache; 17 Peyrazet; 18 Grotte des Romains; 19 Les Hoteaux; 20 Monruz; 21 Petersfeld; 22 Vogelherd; 23 Gonnarsdorf; 24 Külna; 25 Veruncina; 26 Býcí skála; 27 Žitného jeskyně; 28 Křížová; 29 Pekárna; 30 Kent's Cavern; 31 Church Hole.

Caucasus/Kaukasus 1 Skajia; 2 Zatsurbliia; 3 Gvardjilas Klde; 4 Mezmaiskaya; 5 Dvoynaya; 6 Chigay; 7 Apiancha.

Asia/Asien 1 Strashnaya; 2 Afontova Gora II; 3 Khayrgas; 4 Shuidonggou loc. 12; 5 Shitizan loc. 9; 6 Nanzhuangton; 7 Zengpiyan; 8 Bailaiandong; 9 Liyuzui.

and O.V. Clay, Garden County, Nebraska, USA (10.1 ka cal BP; Erlandson et al. 2014; Lyman, 2015; Osborn 2014). Eyed needles in North America are associated with the Younger Dryas chronozone (c. 12 900 to 11 600 cal BP) and are interpreted as a response to the return of a near-glacial climate (Pelton et al. 2024).

The manufacture of eyed needles around the world

Eyed needles, being very small tools, are particularly subject to stratigraphic admixtures and are often found outside of their original contexts. However, the association of manufacturing remains or by-products with the needles themselves is one of the strong arguments in favour of their linkage to a specific technocomplex. Therefore, the presence of different technical categories (blanks, preforms and waste products) is of great interest; such finds reveal that (and how) needles were manufactured in a specific archaeological assemblage at a specific site, enabling us not only to recognise different craft traditions and thus collaborate in the compilation of »cultural maps« and exchange networks, but also to corroborate their »cultural phylogeny«. Until today, the manufacturing of eyed needles has received little atten-

tion worldwide. Due to the low number of specialists in the field and the relatively recent development of dedicated methodologies for technological analysis (e.g. Averbouh 2000; Averbouh 2001; Averbouh 2010), this type of analysis has started to develop only in recent years, especially in Europe. Among the few available references to the manufacturing process, many focus on shaping and finishing techniques like drilling, surface polishing, and the presence or absence of repairs and resharpening.

The oldest evidence of needle manufacture comes from the Denisova Cave. Several publications describe debitage created by obtaining elongated blanks through longitudinal splitting or cutting. The blanks are then shaped by scraping, abrasion, and polishing; then, in the proximal part, there is a scraping reduction in order to perform the drilling, usually from two faces of the item¹⁰. However, by-products have not been described or published, and M. Baumann refers to their absence in the assemblages (pers. comm.). The Strashnaya site documents the same parameters underlying the debitage, the shaping, and the drilling process (Shalagina et al. 2018; Krivoschapkin et al. 2018), but the by-products of these processes have not been published.

Two different drilling techniques have been described in China: bifacial drilling in Xiaogushan and drilling by

¹⁰ Baumann et al. 2018; Derevianko et al. 2016; Shunkov et al. 2020; Shunkov et al. 2021.

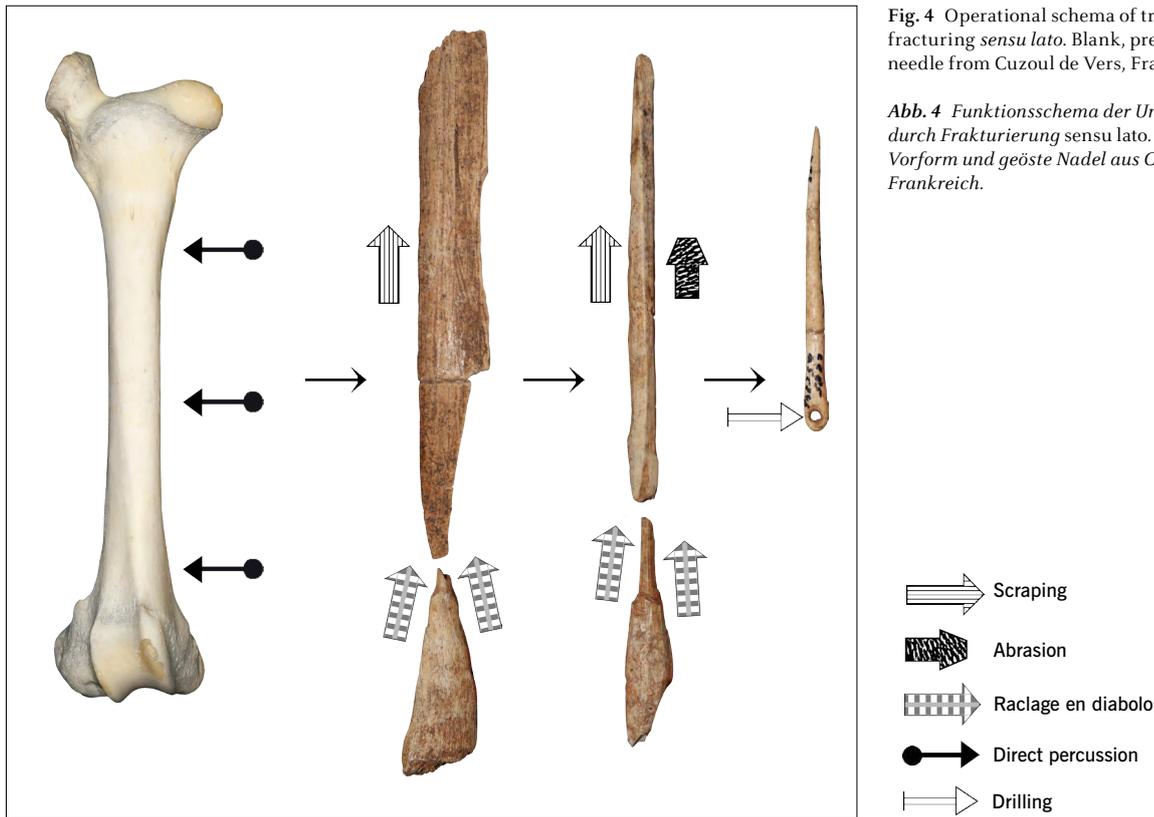


Fig. 4 Operational schema of transformation by fracturing *sensu lato*. Blank, preform and eyed needle from Cuzoul de Vers, France.

Abb. 4 Funktionsschema der Umwandlung durch Frakturierung *sensu lato*. Rohling, Vorform und geöste Nadel aus Cuzoul de Vers, Frankreich.

pressure in Zhoukoudian Upper Cave (Zhang et al. 1985; Huang et al. 1986). In addition, the use of sawing, cutting and scraping techniques has been described in the context of harpoon manufacture (Zhang et al. 1985). The technological observations on the latter's production could, perhaps, be transferred to the manufacture of needles, although no material evidence has been recovered, neither in Xiaogushan nor Shuidonggou loc. 2 (Guan et al. 2012).

In Austria, at the Kammern-Grubgraben site (23.7–22.4 ka cal BP), 16 bone and two ivory eyed needles were identified, as well as various manufacturing by-products (Pfeifer et al. 2024). The operational schema of transformation identified is by fracturing *sensu lato* as the blanks to produce needles are selected bone flakes. The blank is shaped by scraping, and the extremities are detached by *raclage en diabolo* to calibrate the tool. The needles are drilled either before or after the calibration.

In Cosăuți and Byki (Moldavia and Czech Republic; 23–19 ka cal BP), the operational schema of transformation by extraction is identified through the so-called Groove and Splinter Technique (GST) associated with the Early Epigravettian of the region (Pfeifer 2024; Akhmetgaleeva/Burova 2021).

At the end of the Chinese Upper Palaeolithic, it appears that two coetaneous operational schemas were identified in Shuidonggou loc. 12 (d'Errico et al. 2018). In both cases, blanks are produced by longitudinal splitting; the blank outline is then regularised by flaking or retouching and

finally shaped by scraping, abrasion, and drilling just on one side or by taking advantage of the natural foramen of the long bone without modifying it. Finally, the preform is polished and the needle is finished. The main difference between both needle reduction sequences is the raw material used. Flat bones like ribs are used in manufacturing flat needles with oval sections (with some exceptions), while diaphyseal long bones are used for needles with sub-circular cross-sections. It can thus be said that raw material morphology predetermines the shape of the final product, which does not occur randomly but is possibly due to functional intentionality or utilising the available materials.

Finally, around 12.9 ka cal BP, debitage by extraction is identified in La Prele, a Paleoindian site in Wyoming. Metapodials of *Canidae*, *Felidae* and *Leporidae* are debited through GST. Two preforms have been identified, but shaping traces are lacking, so we would classify them as blanks (Pelton et al. 2024). This technological analysis is of interest because there are convergences, on the one hand, between North American technical traits with the Magdalenian and, on the other, the use of bones of leporids used in the osseous industry¹¹.

Production of eyed needles in the Badegoulian

As noted above, Badegoulian needles have been recovered in France and Spain. In France, there are many sites with

11 E.g. Fontana/Chauvière 2007; Lázníčková-Galetová 2010; Boraó 2012; Boraó 2022;

Malgarini 2010; Malgarini 2022a; McCarthy et al. 2023.

Badegoulian eyed needles. Some of the largest assemblages are from Cuzoul de Vers, with 184 eyed needles and 71 by-products (Le Guillou 2012; present study, J.-M. Pétilion/M. Boraio), and Abri Fritsch, with 71 eyed needles and 15 by-products (Boraio/Pétilion 2024; Malgarini 2022a). In Spain, they have been identified at sites such as El Cierro, Principality of Asturias (Álvarez-Fernández et al. 2016) or Parpalló (Boraio 2019; Boraio 2022), but the number of specimens is low.

The objects and by-products studied from all these sites (except El Cierro, where the technology remains unstudied) show the same transformation operational schema by fracturing *sensu lato* (Fig. 4). This operational schema consists of selecting diaphyseal flakes derived from butchery activities based on their morphometric characteristics. These flakes are shaped by longitudinal scraping. Numerous waste products related to the shaping phase have been identified: they show fresh fracture planes on their sides, heavy scrap-

ing, and are sectioned from the blank using the *raclage en diabololo* plus bending techniques (Le Dosseur 2003). This technique is used to calibrate the object's length. Then, the preform is finished by abrasion and bi-conical drilling by alternate rotation. Finally, distal resharpening and repair of the perforations are observed in some pieces, as well as use-wear traces such as polishing and bending fractures, generally with »tongue« morphology.

Regarding morphometric characteristics, when focusing only on the Ancient Badegoulian of Cuzoul de Vers we observe a high degree of variability (Fig. 5). The eyed needles' lengths (of complete or almost specimens) measure between ~ 2 and 8.72 cm (mean \pm 4,31 cm), widths from 1.7 to 5 mm, and thicknesses from 1.1 to 3.5 mm; their section-shapes are circular (~ 52 %) or oval (~ 45 %). Contrary to what has been argued until now (e.g. d'Errico et al. 2018), it is not during the Magdalenian that morphometric variability appears, but already during the Badegoulian.



Fig. 5 Eyed needles from Cuzoul de Vers (France), Ancient Badegoulian.

Abb. 5 Öhrnadeln aus Cuzoul de Vers (Frankreich), Früheres Badegoulien.

		Les Scilles (Chauvière et al. in press)	Houleau (Chauvière et al. in press)	Taillis des Coteaux (Houmard 2023)	Saint-Germain-la-Rivière. Ensemble supérieur (Langlais et al. 2015)	Saint-Germain-la-Rivière. Ensemble inférieur (Langlais et al. 2015)	Gabilou (Langlais et al. 2023)	Roc-de-Marcamps (Langlais et al. 2015)	La Madeleine (Fontana/Chauvière 2007)	Les Petits Guinards (Fontana et al. 2003)	Grand Pastou (Chauvière 2006)	Dufaure (Chauvière 2006; Pétilion inédit)	Peyrazet (Pétilion 2021)	Solutré-Route de la Roche (Malgarini 2022a)	Arly-Grappin (Malgarini 2014)	Farincourt (Malgarini 2014)	Arancou (Bonnisent/Chauvière 1999)	Saint-Michel d'Arudy (inédit)	Bois ragot (Christensen/Chollet 2005)	Les Romains (Malgarini 2014)	Schweizersbild (Höneisen 1994)	Neuchâtel-Monruz (Bullinger/Müller 2006)	Hauterive-Champgréveyres (Leesch 1997)	Pincevent, IV-0 (Malgarini 2010)
<i>Ursus</i> sp.	metatarsus				x																			
<i>Canis lupus</i>	metacarpus				x																			
	radius														x									
<i>Alopex lagopus</i>	tibia																						x	
<i>Vulpes</i> sp.	tibia											x						x	x					
<i>Equus ferus</i>	hyoid bone																						x	
	ribs										x												x	
	radius																						x	
	metapodial							x		x				x	x							x		
	metatarsus				x									x										
	metacarpus									x														
<i>Rangifer tarandus</i>	scapula											x												
	radius																						x	
	ulna																						x	
	metapodial		x				x																x	x
	metatarsus				x									x				x		x				
	metacarpus			x																				
	tibia														x									
	radius-ulna																							
<i>Saiga tatarica</i>	ulna			x																				
	metapodial							x																
	metacarpus	x		x	x																			
<i>Rangifer/Capra</i>	radius-ulna																							x
<i>Capra ibex</i>	radius-ulna																x							
	metatarsus																x							
<i>Rupicapra rupicapra</i>	metapodial							x																
	metacarpus	x								x														
<i>Lepus timidus</i>	radius								x															
	femur								x															
	tibia								x															
	metatarsus								x															
<i>Lepus</i> sp.	humerus																							x
	tibia													x								x	x	x
<i>Aquila chrysaëtos</i>	tibiotarsus																			x				
	radius																			x				
<i>Nyctea scandiaca</i> L.	tibiotarsus					x																		
<i>Grus</i> sp.	ulna												x											
<i>Cygnus cygnus</i>	humerus																			x				x
	tibiotarsus																							x
<i>Cygnus olor</i>	humerus																			x				
<i>Anser</i> sp.	humerus				x																			x
<i>Gavia artica</i>	humerus																							x
Aves indet.	humerus																					x		x

Tab. 2 Raw material used for the production of Magdalenian needles in France and Switzerland.

Tab. 2 Rohmaterial für die Herstellung von Magdaléniennadeln in Frankreich und der Schweiz.

Production of eyed needles in the Magdalenian

Raw materials

The osseous material used to manufacture Magdalenian eyed needles is bone and, more rarely, antler (mainly for objects called «Bodkins», see below). In the case of specimens made of bone, the identification of the source of the blanks (animal species and skeletal elements) is essentially based on the analysis of the pieces of raw material (waste products). A few needles made from the bones of small species still show the marrow canal (Fig. 6,3.10) or the spongy tissue (cf. Fig. 6,8) on the lower side.

The animal species used are almost exclusively herbivores (mega- and mesofauna, from horse to *Leporidae*, reindeer, saiga, ibex, and so forth) and birds. Carnivores (fox, wolf, bear) received very little attention (Tab. 2). Animals and skeletal elements are acquired through hunting (bones of herbivores) and gathering (shed antler, and perhaps certain bird bones).

Apart from the reindeer antler, the hyoid bone is the only element of the cranial skeleton to have been exploited. Ultimately, it is the post-cranial skeleton which, for all the species identified, provides the blanks used for the manufacture of eyed needles. Among flat bones, while ribs were

regularly used, the scapula was only exceptionally used. Most identified waste products come from long bones: humerus, ulna and radius, tibia, and above all, the metapodials of large and medium-sized ungulates. We note the rare use of the tibiotarsus of certain birds, such as the whooper swan.

Manufacturing techniques

The selected bones undergo an initial surface preparation by scraping (to eliminate the rest of the soft tissue: flesh and periosteum).

In the Magdalenian, the blanks are obtained by GST (parallel or convergent grooving; cf. Fig. 6,24–29). In the majority of cases, the blanks are made directly from the block of raw material (antler or bone) or from a secondary block (sectioned bez tine or split bone). The width of the rods is small (around 5 mm), and they are quadrangular in section. Depending on the dimensions of the bones and the species used (Fig. 7), several blanks can be extracted from the blocks: traces of multiple grooving are identified on one side (metapodials of horses [cf. Fig. 7,8–9, reindeer, cf. Fig. 7,1–3] or on the entire periphery of the block (bird

Assemblage	Phase	Number	Length	Width in mm	Thickness in mm	Reference
Gazel	MM	95 [14]	30–60 (Ø 47)	2–4	1–3	JMP unpubl.
Isturitz layer SI/Ew	MM	51 [4]	45–91	2–3	1–2	Chavigneaud 2004, 72
Isturitz layer II/E	MM	43 [16]	33–90	2.3–4.3 (Ø 2.9)	1.3–3.2 (Ø 2.5)	Chavigneaud 2005, 19
Arlay/Grappin	MM	6 [2]	43–55	1.9–3.0	1.6–2.3	Malgarini 2014
Solutré Route de la Roche	MM	57 [0]	not given	1.4–4.8	1.1–4.9	Malgarini 2022a
La Madeleine	MUM	23 [5]	generally 23–36 (max 66)	1.6–5.1	1.1–4.3	Treuil 2012, 214 Fig. 3
Aurensan	MUM	10 [1]	27	Ø 2	not given	Baumann 2007, 29
St-Michel, Arudy	MUM	10 [5]	43–63 (Ø 52)	1–3 (Ø 2.2)	1.0–2.5 (Ø 1.6)	Pujol 2009, 20
Bois-Ragot, layer 5	UM	99 [10]	34–70	1.0–3.2 (Ø 2.2)	1.2–4.4 (Ø 1.9)	Christensen/Chollet 2005, 234
La Vache	UM	423 [38]	generally 35–55	generally 2.0–2.5	generally 1.5–2.0	Chauvière 2003a, 327
El Parco	UM	10 [1]	51	1.5–3.0	1–2	Tejero/Fullola 2008, 11 Tab. 2
Le Morin	UM	111 [2]	39 and 49	2–4	1–3	McComb 1989, 201
Peyrazet	UM	23 [1]	56	1.7–3.5 (Ø 2.3)	1.1–2.6 (Ø 1.8)	Pétillon 2021, 104
Les Romains	UM	58 [0]	not given	»1.7–4.4 (Ø 2.5)«	»1.0–2,9 (Ø 1.6)«	Malgarini 2014
Les Hoteaux	UM	49 [1]	46	1.8–6.4	1.2–4.8	Malgarini unpubl.
Parpalló	UM	13 [3]	35–80	1.9–5.1	1.5–3.4	Borao 2022
Cendres	UM	13 [3]	32–81	2.1–3.9	1.0–2.4	Borao 2012; Borao 2013
Cendres	M	10 [2]	23–38	1.4–3.6	1.1–2.3	Borao/Villaverde unpubl.
Nerja	UM	7 [1]	62	2.7–7.0	0.9–2.0	Aura et al. 2020; Aura et al. 2021

Tab. 3 Morphometric attributes of Magdalenian bone needles from 14 assemblages in Southwest France and Spain. MM – Middle Magdalenian, MUM – Mid-Upper Magdalenian, UM – Upper Magdalenian, M – Magdalenian. Number in brackets – number of intact needles.

Tab. 3 Morphometrische Merkmale von magdalénienzeitlichen Knochennadeln aus 14 Assemblagen in Südwestfrankreich und Spanien. MM – Mittleres Magdalénien; MUM – Mittleres Oberes Magdalénien; UM – Oberes Magdalénien; M – Magdalénien. Zahl in Klammern – Anzahl der intakten Nadeln.



bones, cf. Fig. 7,6–7,10]). In some cases, bifacial grooving is used to extract rods on the edges of the ribs or on a bony crest (tibia, radio-ulna).

The blanks are detached by transverse sawing at the ends or by sawing and tearing. Sometimes, very long rods can be cut (at least) into two parts by sawing and bending or by *raclage en diabol* and bending. The ends of the rods, often irregular, are detached with the same techniques.

The blanks are shaped by scraping (or by abrasion in rare cases, e.g. at Rigney Cave, Dép. Doubs; Malgarini 2014): removal of the spongiosa, creation of a point, and thinning of the future envisaged proximal part. During this initial shaping, the eye is made by bifacial perforation with generally a bi-conical morphology. A finishing phase can take place with the help of a polisher (sandstone or pumice) to reduce the last irregularities and obtain a better surface condition. Surface modifications (such as decoration) are rare on Magdalenian needles and usually take the form of transversal incisions on the proximal part, just distal to the eye (e.g. at La Vache, Dép. Ariège: Chauvière 2003b, at Parpalló: Borao 2022, or at Tastet Cave, Dép. Pyrénées-Atlantiques: cf. Fig. 7,7).

Morphometry

The morphometric attributes of the Magdalenian bone needles are relatively constant. The objects usually have a circular or oval cross-section and straight sides. Data from 14 assemblages in Southwest France and Spain (Tab. 3) show that width generally varies between c. 1.5 and 4 mm (mean c. 2–3), thickness between c. 1 and 3 mm (mean c. 1.5–2), and length between c. 25 and 65 mm (mean c. 50 mm; for broadly similar figures, see also Stordeur 1979, 184; cf. Fig. 6,1–23). The shortest specimens are usually the result of resharpening (see below), and lengths c. 3 cm probably correspond to the minimum acceptable dimension for the use of the tool. D'Errico et al. (2018, 79) indicate that *specimens from the Moravian Magdalenian are significantly wider than their French counterparts*, but this does not appear to be supported by the published illustrations and scatterplot (d'Errico

et al. 2018, Fig. 8 and S10), which show a wide overlap of the two populations in the 2–3.5 mm range for width. Similarly, the dimensional heterogeneity found by Treuillot on needles from La Madeleine, Dép. Dordogne (Treuillot 2012, 198), is probably due to the presence of both bone needles and antler bodkins in his sample (see below), as the author points out.

Use, repair, and abandonment

The use of eyed needles in soft material assembly activities (essentially sewing) is characterised primarily by wear polishes on the surface of the artefacts. The fractures that affect most of the needles found in Magdalenian deposits – too systematic to be explained by post-depositional phenomena – are also indicative of how these objects functioned. These fractures concern either the eye or the shaft and point (with fracturing into three fragments, the so-called *»en nacelle«* fracture). After breakage, if needles are still long enough to be handled, they are repaired. These repairs may involve drilling a new eye in the immediate vicinity of the first one that has been broken. When the point is damaged, it can be resharpened by scraping. The scraping marks are clearly visible in this case, as the point is generally not re-polished. As a result, we are dealing with artefacts with very distinct surface finishes and parts that are shorter in length than they were originally.

Bodkins: large antler needles

A group of large needles made of antler has been termed *»bodkins«* (*»alènes«*) to distinguish them from the more common type (cf. Fig. 6,30–34). Compared to the common type, bodkins have a different raw material – antler – and are of larger dimensions: according to measurements taken on fragments, their width varies between c. 3.5 and 5.5 mm (mean: 4.7 mm) and their thickness between c. 3 and 5 mm (mean: 4.3 mm); the few complete and nearly complete specimens have lengths between c. 65 and 200 mm. They are often curved. The function of these infrequent objects might differ from that of the common, smaller bone needles (Bullinger et al. 2006, 142; Treuillot 2012, 198): one might interpret them as used in work requiring less precision. They are only known from some sites in Southwest France and in one part of the Magdalenian chronology. They might be present in the Early Lower Magdalenian (Lascaux, Dép. Dordogne: Chauvière et al. in press). They are known in the Late Lower Magdalenian (Saint-Germain-la-Rivière, Dép. Gironde, *»ensemble inférieur«*, perhaps Gabillou, Dép. Dordogne: Langlais et al. 2015, 27; Langlais et al. 2023, 75), in the Early Middle Magdalenian (Roc-de-Marcamps, Dép. Gironde, and Moulin-Neuf, Dép. Gironde, Marsoulas, Dép. Haute-Garonne: Kuntz et al. 2015, 492; J.-M. Pétilion pers. obs.), and in mixed assemblages that include material from the Early Middle Magdalenian (Les Harpons B-C, Dép. Haute-Garonne: J.-M. Pétilion, pers. obs.; Reverdit, Dép. Dordogne: Bourdier et al. 2014, 443; perhaps Le Placard, Dép. Charente, given the dimensions in Stordeur 1979, 185–186; and Solutré-Route de la Roche, Dép. Saône-et-Loire, Malgar-

Fig. 6 (left page) Sample of Magdalenian needles and bodkins. 1–29: bone; 30–34: antler. Early Lower Magdalenian: 1 Taillis des Coteaux EG-III. Late Lower Magdalenian: 2–3 Saint-Germain-la-Rivière lower stratigraphic unit. Early Middle Magdalenian: 4–6 Combe-Cullier UA4; 7 Tastet Cave US315. Late Middle Magdalenian: 8 Tastet Cave US308a; 9–14 Saint-Michel d'Arudy. Early Upper Magdalenian: 15–16 Combe-Cullier UA1b. Late Upper Magdalenian: 17–18 Combe-Cullier UA1a; 19–23 Peyrazet. Blanks and waste products of shaping: 24–25 Houleau (Early Lower Magdalenian); 26–29 Peyrazet (Late Upper Magdalenian). Antler bodkins: 30–31 Marsoulas; 32–34 Les Harpons B-C.

Abb. 6 (linke Seite) Beispiele für magdalénienzeitliche Nadeln und Haarnadeln. 1–29: Knochen; 30–34: Geweih. Frühes Älteres Magdalénien: 1 Taillis des Coteaux EG-III. Spätes Unteres Magdalénien: 2–3 Saint-Germain-la-Rivière ensemble inférieur. Frühes Mittleres Magdalénien: 4–6 Combe-Cullier UA4; 7 Tastet-Höhle US315. Spätes Mittleres Magdalénien: 8 Tastet-Höhle US308a; 9–14 Saint-Michel d'Arudy. Frühes Oberes Magdalénien: 15–16 Combe-Cullier UA1b. Späteres Oberes Magdalénien: 17–18 Combe-Cullier UA1a; 19–23 Peyrazet. Rohlinge und Abfallprodukte der Formgebung: 24–25. Frühes Unteres Magdalénien: Houleau; 26–29. Späteres Oberes Magdalénien: Peyrazet. Geweihhaarnadeln: 30–31 Marsoulas; 32–34 Les Harpons B-C.



Fig. 7 (left page) Sample of Magdalenian waste products of manufacture of rods (needle blanks) with the groove and splinter technique. 1 Peyrazet, reindeer metatarsal; 2 Roc-de-Marcamps, reindeer metapodial; 3 La Croze, reindeer metapodia; 4 Saint-Germain-la-Rivière, upper stratigraphic unit, saiga antelope metacarpal; 5 Saint-Germain-la-Rivière, lower stratigraphic unit, bear metatarsal; 6 Monruz, swan tibiotarsus and humerus (Müller 2013); 7 Grotte des Romains, swan humerus; 8–9 Solutré Route de la Roche, horse metapodial; 10 Grotte des Romains, eagle tibiotarsus.

Abb. 7 (linke Seite) Beispiele von Abfallprodukten aus dem Magdalénien, die bei der Herstellung von Stäbchen (Nadelrohlingen) mit der Rillen- und Splittertechnik anfielen. 1 Peyrazet, Rentiermetatarsal; 2 Roc-de-Marcamps, Rentier-Metapodien; 3 La Croze, Rentier-Metapodium; 4 Saint-Germain-la-Rivière, obere stratigraphische Einheit, Mittelhandknochen einer Saigaantilope; 5 Saint-Germain-la-Rivière, untere stratigraphische Einheit, Mittelfußknochen eines Bären; 6 Monruz, Unterschenkelknochen und Humerus eines Schwans (Müller 2013); 7 Grotte des Romains, Humerus eines Schwans; 8–9 Solutré Route de la Roche, Pferdmetatarsal; 10 Grotte des Romains, Unterschenkelknochen eines Adlers.

ini unpubl.). They seem to disappear in the later stages of the Magdalenian (but see Treuillot 2012, 198 for La Madeleine, and Bullinger et al. 2006, 142 for Monruz).

Discussion and conclusions

Indirect evidence of clothing production has been discovered at Palaeolithic sites around the globe. Various lithic and osseous tools associated with processing hides and plant fibres have been found throughout the Palaeolithic. The osseous toolkit related to this activity includes smoothers, awls and possibly *épingles* and double points. Still, the eyed needle is the technological innovation that unequivocally marks the beginning of intricate sewing in the Palaeolithic.

Throughout the Upper Palaeolithic, eyed needles were used for sewing with different materials, such as sinews or plant fibres. These needles made it possible to sew garments, backpacks, or shoes and even to decorate them with ornaments and applications. The use and reuse of this tool have been observed through both use-wear traces and repairs of the perforation and distal end, the latter attesting to an object that has been used so intensively that it can no longer be deployed.

Eyed needles originated in the Altai and the Caucasus and initially spread throughout Central and East Russia and China. Their appearance has been attributed to the harsh climatological conditions of that area, which in turn led to the need for complex clothing and, consequently, the creation of complex technology such as eyed needles.

Technological studies allow us to compile »cultural maps« and propose hypotheses about knowledge dispersion and its variability or on the contrary, a new technological innovation. In this sense, the scarce information published on those first eyed needles points to a kind of technical uniformity (GST) but a high variability in size, for example, as in the Yana RHS site in Siberia (Fedorchenko/Belousova 2021; Pitulko et al. 2012). This could either indicate that the production is not standardised or suggest a diversity of functions.

Three aspects have been taken as a reference for situational convergences that give rise to the independent origin

proposed for the eyed needle: the technological context of the lithic industry, the morphometry of the needles (fundamentally the cross-section morphology), and the technology employed in the manufacture of eyed needles.

The appearance of eyed needles in Europe, at the Kammern-Grubgraben site (23.7–22.4 ka cal BP), and the Badegoulian sites (23.5–20.5 ka cal BP), is currently under consideration: on the one hand, because needles in Solutrean contexts are disputed and discussed as more plausibly attributed to the Badegoulian or the Magdalenian, and on the other, because of a possible independent origin of needles. The lithic industry during the Badegoulian is based on core and flake technology, and the technical traits involved in eyed needles' manufacture differ from those identified in Asia and East Europe, where GST is absent and they are produced by fracturing. A high morphometric variability accompanies this condition.

On this basis, in the case of China, with the arrival of lithic industries typical of Anatomically Modern Humans (micro-core and microblade industries), the morphology of the needle section changes and becomes more similar to specimens found in other regions of the continent. However, this situation changes in the Late Glacial with a process of regionalisation where the lithic industry is based on core and flake technology and a change in needle manufacture based on longitudinal splitting at the Shuidonggou loc. 12 site coincides with the Younger Dryas (YD). These situational convergences led to the proposal of an independent origin of innovation for the needles (Doyon 2019; d'Errico et al. 2018). With all this evidence, if we consider that the convergence of harsh climatic conditions (LGM [Last Glacial Maximum] or YD), a lithic industry based on flake technology, and a needle manufacture by percussion techniques refer to independent origins, then the Badegoulian would, indeed, mark an independent origin. However, we still do not have enough arguments for this affirmation or for the relation between the technological traits from Kammern-Grubgraben and the Badegoulian ones, although a possible origin of the Badegoulian in that area has been suggested.

The Magdalenian Culture in Europe shows technological homogenisation with the rest of Eurasia. Multiple parallel grooving points to standardised production, although size variability exists and could be due to diverse functional purposes.

Finally, the appearance of eyed needles in North America with a new climatic crisis (YD) is characterised technologically by the GST and a limited range of width (most of the needles are just fragments), making these the smallest examples – only comparable with the smallest Magdalenian needles from Moravia, France and Spain (d'Errico et al. 2018). The origin of this tool in North America is being discussed: an independent origin has been suggested as a consequence of the YD conditions (Pelton et al. 2024), but the hypothesis held so far is that the populations that crossed the Bering Strait carried this technology with them (d'Errico et al. 2018).

Regarding morphometry, its diversity could be analysed from two perspectives: the technological and the functional. Regarding technology, the use of the GST shows higher standardisation, while the use of percussion tech-

niques could be related to a higher disparity. The fact is that the variability in length exists independently of the techniques employed, so it must be related to functional purposes, especially when we find the use of other raw materials, such as antler in the case of bodkins.

As for the raw material used in the needles' manufacture, bone is the most common, although we can also find specimens in antler and ivory. The long bones of the selected species are those most consumed, including, for example, horse, reindeer, and ibex: species that vary according to ecological niche. However, we observe the use of small-sized species such as *Leporidae*, and small carnivores and birds in different parts of the planet, showing a certain versatility of these human groups and their use of all available resources.

What is certain is that, despite all the evidence for the presence of eyed needles and, in some cases, of their by-products, the question of their presence in some archaeological contexts continues to be affected by prob-

lems such as taphonomy, excavation methodology, or the absence of sieving. These problems result in a low representation of this tool in the assemblages or the likelihood of its presence outside its original context, such as the Solutrean or the Azilian. In this sense, the existence of by-products is key to identifying not only how needles were made but also whether they belong to a specific archaeological level. Nevertheless, direct dating would be the most direct and unequivocal way to resolve this question; since it is not currently possible, we must continue to depend on the context.

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Source of figures

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2–32 J.-M. Pétillon;
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