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ABSTRACT

To the Point. The Bone Tool Industry of the Ifri n´Etsedda, NE-Morocco

Sina Lehnig, Jörg Linstädter

This paper provides all bone artefacts recovered from the archaeological deposits of Ifri n'Etsedda, Eastern Rif, Morocco. Archaeological research has been carried out in the Eastern Rif since 1995 by a collaborative Moroccan-German research team. A major topic of the project is the transition from hunting-gathering to food production and related cultural developments. Innovations such as pottery, domesticated animals and the cultivation of cereals and pulses appeared around 7.6 ka calBP. Ifri n'Etsedda, a small shelter close to the lower reaches of the Moulouya river, is one of the most important sites in the area containing both Epipaleolithic as well as Neolithic deposits. While innovative technologies such as pottery production and cultivation indicate external influences during the Neolithic period, bone tools, similar to lithic artefacts, demonstrate local technologies of Epipaleolithic tradition. Therefore, the study of bone industries is crucial to understanding the nature of continuity and discontinuity between the hunting-gathering and agricultural populations in the Eastern Rif. The bone artefacts from Ifri n´Etsedda mainly consist of points. Despite their fragmentation and an intense transformation of the original bone, a techno-functional analysis provided information on raw material selection, production, use and maintenance. With the presentation of our results we intend to geographically extend the existing corpus of bone tool studies, which so far primarily focused on sites in present-day Algeria, Tunisia, Libya and Egypt, by adding our assemblage from the Moroccan Rif region, and thus make a contribution to the knowledge on Epipaleolithic and Neolithic bone industries in North Africa.

KEYWORDS

Bone tools, Morocco, Rif, Neolithic transition, Archaeozoology

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Introduction

1 The present publication is mainly dedicated to the bone industry of Ifri n'Etsedda. In addition to the sites of Ifri Oudadane and Hassi Ouenzga, the Ifri n'Etsedda rock shelter is one of the three most important archaeological sites in NE-Morocco, showing the process of transition to food production within the 8th millennium calBP.

2 The process of Neolithic transition in the Eastern Rif in general was subject to several publications within the last decade (Linstädter et al. 2016; Linstädter et al. 2012a). First evidences of Neolithic innovations are detected at Ifri Oudadane located at the Mediterranean coast 20 km west of the Melilla Peninsula (Fig. 1). Here, pottery (Linstädter – Wagner 2013), remains of domesticated cereals and pulses (Morales et al. 2013) as well as evidence of ovicaprids such as bones, coprolites (Linstädter – Kehl 2012) and coprophilous fungi (Zapata et al. 2013) show the arrival of knowledge of food production at about 7.6 ka calBP. Furthermore, pollen analysis indicates the arrival of cereals and in addition a decline of trees and shrubs probably connected to a transformation of the landscape that was then also used for herding and cultivation (Zapata et al. 2013). The study of the lithic industry provides no significant changes in raw material procurement, technology and tool composition between the Epipaleolithic and early Neolithic assemblage, thus suggesting a certain continuity across the Neolithic transition (Linstädter et al. 2015).

3 In the hinterland, pottery appears at the contemporaneous site of Hassi Ouenzga some 57 km further south of Ifri Oudadane also at about 7.6 ka calBP (Linstädter et al. 2016; Linstädter 2004). Clear evidence for food production at that time is still pending. These inland groups are seen as semi-sedentary local hunter-gatherers in Epipaleolithic tradition, which have adopted the knowledge of pottery production via contacts with the full-Neolithic groups. Beside Hassi Ouenzga the Epipaleolithic of this region around the Plain of Gerrouaou (Fig. 1) is also well represented by sites such as Ifri el Baroud (Potì et al. 2019; Nami 2007), Taghit Haddouch (Hutterer et al. 2011) and Ifri n'Ammar (Moser 2003).

4 Ifri n'Etsedda itself is located in a region, which is characterised by the presence of both Epipaleolithic and early Neolithic sites: the lower Moulouya River. Here,

Epipaleolithic occupation is represented by the sites of Mtlili 1, Hajra 3 and Taoungat 1, which date to around 10 and 7.8 ka calBP. Neolithic assemblages are documented at the sites of Mtlili 5 and 6, as well as Taoungat 7 (Linstädter et al. 2012b). All mentioned sites are open-air sites representing short periods of stay, subsequently covered by the flood deposits of the Moulouya River. Unlike in a rock shelter or cave, the occupation of the riverbank was often more extensive, which is why excavations here were only able to provide information on a limited spatial area of the actual sites. The most remarkable site of the region is El Zafrín located on the Chafarinas Islands. During the early Neolithic, the site was still part of the mainland, now separated due to Holocene sea level rise and processes of marine erosion (Rojo Guerra et al. 2010: 24). The site is dated between 6.4 and 6.0 ka calBP (Rojo Guerra et al. 2010: 159) and although it is an open air site, a remarkable abundance of archaeological material could be obtained, such as remains of dwellings, a rich pottery assemblage and palynological evidence of agricultural activities (López-Sáez et al. 2010). Results of archaeozoological and malacological studies provide evidence of the keeping of ovicaprides and the intense use of marine resources such as shells, fish and seals. Altogether, Ifri n'Etsedda, El Zafrín and the open air sites of the lower Moulouya valley represent three different places of residence within the land use system of the same group. While El Zafrín was dedicated to the exploitation of marine resources and Mtlili is connected to the use of alluvial resources, Ifri n'Etsedda reflects the specific opportunities of a mountain site.

5 The prehistoric occupation of Ifri n'Etsedda covers a timespan of about 4 millennia between 10.0 and 6.0 ka calBP. Thus, both Epipaleolithic as well as Early Neolithic deposits are evidenced. The onset of Neolithic occupation at Ifri n'Etsedda can be dated to around 7.2 ka calBP. Due to a hiatus between 8.4 and 7.2 ka calBP,

Fig. 1: Map showing the location of the Ifri n´Etsedda and other Epipaleolithic and Neolithic sites mentioned in the text

the transition process itself is not visible in the archaeological material. However, Ifri n'Etsedda has two peculiarities that distinguish it from other sites of the Eastern Rif. Firstly, two Epipaleolithic occupation phases can be distinguished, which are clearly separated by the 9.3 RCC event. This gives us for the first time the possibility to subdivide the Holocene Epipaleolithic in NE Morocco. In addition, the main Neolithic occupation phase dates into the final Early Neolithic (INES-7; ENC). This phase is represented only very sporadically at other sites. By the end of this phase around 6.3 ka calBP the Early Neolithic, i.e. the so-called Cardial, ends in the region. Pollen data from Ifri n'Etsedda indicate an increasing aridisation (Linstädter et al. 2016).

6 So far, the following studies on the site Ifri n'Etsedda have been published: The stratigraphy of the site including absolute dating as well as sediment and pollen analyses (Linstädter et al. 2016) and the technological and functional analysis of the stone assemblage. Here, it was possible to identify technological differences between the Epipaleolithic and the main Neolithic occupation phase. (Broich et al. 2020). The study of rock stone tools such as grinding stones, retouchers and hammer stones is published by Lucarini et al. (Lucarini et al. in prep.). Additionally, two special studies on the pottery have been published recently: the mineralogical, petrographical analysis (Stempfle et al. 2018) and the residual analysis of exemplary vessel units (Dunne et al. 2019). A complete presentation of the pottery is in progress. Further on-going research includes the comprehensive investigation of the faunal material (vertebrates and invertebrates), and the study of the botanical macro remains.

7 In addition to the finds mentioned above, a further group of artefacts was identified during the excavations: tools made of bone. Tools manufactured from hard animal materials experienced a wide use during the Epipaleolithic and Neolithic of Northern Africa and their typological, technological and functional analysis was able to create a better understanding of several archaeological sites over the course of recent years (e.g. Petrullo – Barich 2020; Mulazzani – Brugal 2016; Petrullo 2016a; Petrullo 2016b; Petrullo 2015; Mulazzani – Sidéra 2013; Petrullo – Legrand-Pineau 2013; Kaoun 2008). With the present publication we intend to geographically extend the existing corpus of bone tool studies, which so far primarily focused on sites in present-day Algeria, Tunisia, Libya and Egypt, by adding our assemblage from the Rif region, and thus make a contribution to the knowledge on Epipaleolithic and Neolithic bone industries in North Africa. In addition to the aim of providing a comprehensive presentation of all artefacts, the following research questions guided our study:

- How were the tools manufactured and did the production take place at our site, the Ifri n´Etsedda, or are we dealing with tools imported from somewhere else?
- Can we observe diachronic changes or continuities from the Epipaleolithic to the final Early Neolithic?
- What do supra-regional comparisons show, for example to the Capsian of the eastern Maghreb?

8 In order to answer these questions, the following sections will first characterise the site with its stratigraphy to provide a proper context for the studied artefacts. This is followed by a basic introduction to the bone tools, their temporal framework and state of preservation. Subsequently, we will proceed with the reconstruction of the artefact biographies, from the selection of raw materials, to their use and possible maintenance work.

Archaeological Setting: The Ifri n´Etsedda Rock Shelter

9 Ifri n'Etsedda is located at the eastern fringe of the northeast-Moroccan Rif range. The shelter (Berber: “lions cave”) opens towards the north at the end of a small Moulouya tributary within the southern facade of the Kebdana Mountains (Fig. 2). Ap-

Fig. 2: The Ifri n´Etsedda shelter within the southern facade of a limestone formation. The white tent of our guardsmen indicates the location of the shelter and the excavation

proximately seven km southwards, the lower Moulouya River course flows towards its near Mediterranean delta. The 12 x 13 m shelter, formed by karstic processes, is embedded in a steep rock face of limestone formation. Due to massive rock fall a small forecourt could develop, responsible for the preservation of approximately 140 cm of anthropogenic deposits hence kept inside the cavity.

10 The site was discovered in 2008 following archaeological surveys in the area (Ibouhouten et al. 2010; Linstädter et al. 2012b). Three trenches of altogether 11 m^2 were opened between 2012 and 2014, reaching a depth of 80–130 cm. The excavated sequence consists of snail-rich deposits (*Escargotière*) superimposed by modern dung-rich sediment (Linstädter et al. 2016). In total, 21 radiocarbon ages combined with stratigraphical sections allowed us to subdivide the excavated sequence into 12 units (cf. Linstädter et al. 2016).

11 The lowest unit, INES-1, consists of altered bedrock and shows no traces of human occupation (Fig. 3). This unit is superimposed by a cluster of three units, attributed to the Epipaleolithic. Two distinct Epipaleolithic occupation phases could be defined, separated by a thousand-year gap. While the older "Early Epipaleolithic" (units INES-2 and INES-3) is dated to 9.8–9.6 ka calBP, the younger "Late Epipaleolithic" (INES-4) falls within a period of time between 8.8–8.6 ka calBP. The subsequent five units belong to the so-called Neolithic (Linstädter et al. 2018; Linstädter – Kehl 2012). Unit INES-5 corresponds to the Early Neolithic A (ENA; around 7.2 ka calBP), INES-6 to the Early Neolithic B (ENB; between 6.8–6.5 ka calBP), and INES-7 to Early Neolithic C (ENC; between 6.6–6.1 ka calBP). These Early Neolithic units are partly superimposed by a thin deposit (INES-8), which is not absolutely dated by 14C, but attributed to the Late Neolithic on the basis of its typical impressed pottery. In addition, a layer containing mainly Neolithic material (INES-9) and a burial were documented during the 2013 and 2014 excavations. None of the last two features could be dated so far, however the burial pit was dug into the Epipaleolithic deposit.

Material

12 In the course of the excavations and during the subsequent flotation and picking process, a total of 65 bones were identified that show evident traces of working and use (Fig. 4). The great majority (73%) of the pieces dates to the earliest Epipaleolithic occupation phases (INES-2/3 and INES-4) of the shelter, while only 6% have an origin in Neolithic strata (Fig. 5). Here, the small Neolithic collection is limited to the ENA (INES-5) and ENC (INES-7), whereas the ENB (INES-6) and the Late Neolithic (INES-8) units did

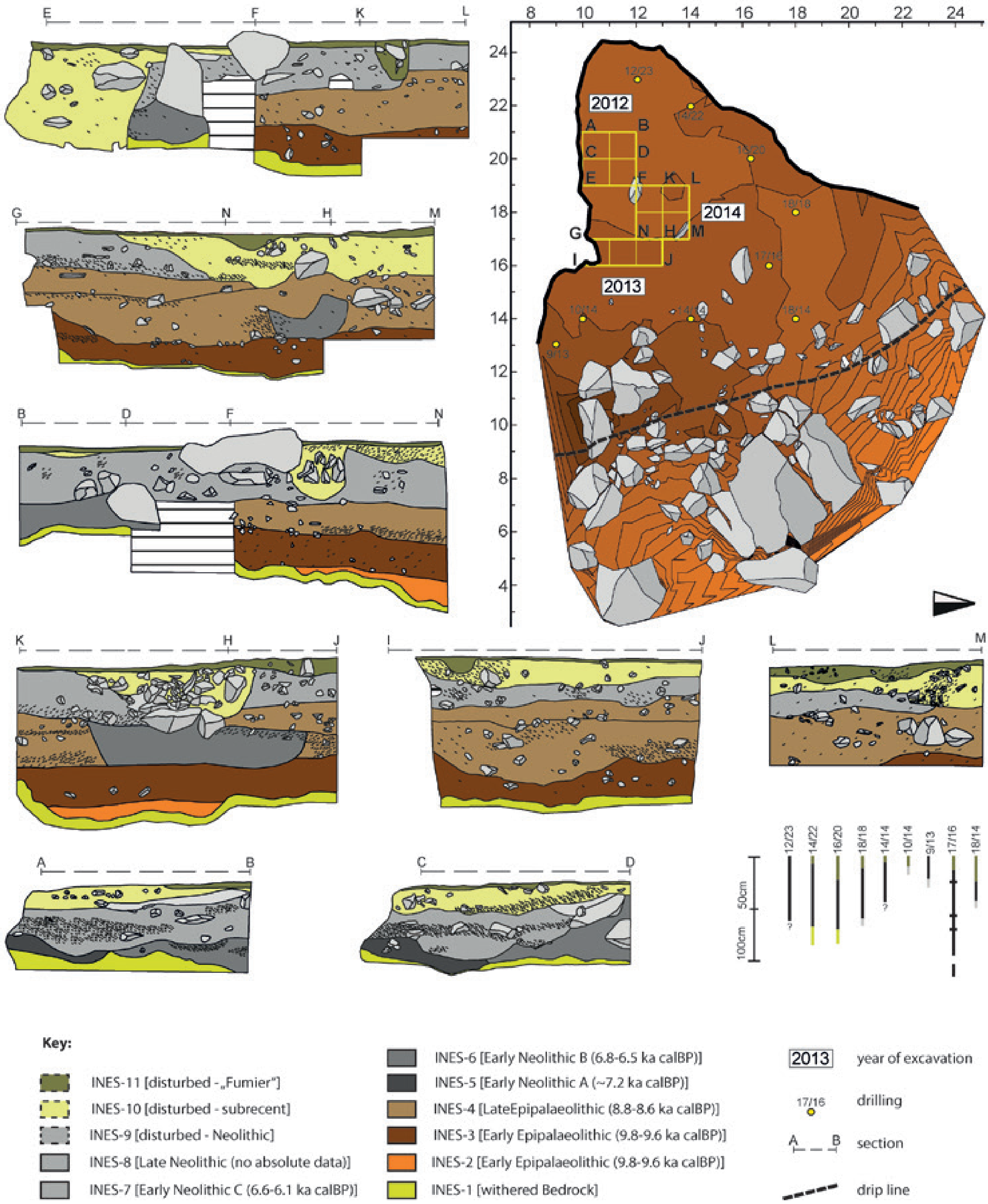


Fig. 3: Plan sections and drillings of Ifri n´Etsedda. The plan provides information on the position of the three different excavations carried out in the cave between 2012 and 2014. The thick continuous line indicates the cave wall, whereas the dashed line marks the dripping edge. Within the cave plan the brown colour scheme illustrates contours in 20 cm steps. The colour scheme of the different units detected during the excavation, is applied to the following tables as well

not yield any evidence of worked bones at all. Fourteen bone artefacts (22%) cannot be dated precisely since they were retrieved from disturbed units (INES-9 and INES-10).

13 The whole assemblage is characterised by a good state of preservation with a low frequency of weathering, decomposition or fire impact. Due to the covering nature of the rock shelter, the bone artefacts were largely protected from weathering influences. Bone preservation was further supported by the high calcite concentration in the soil of the Kebdana karst area (Linstädter et al. 2016). The carbonate mineral reduces

CODE	POS	INES	CHRONO	CULTURE	GROUP	PHOTO	PRESERVATION	LENGHT (mm)	WIDTH (mm)	THICKNESS (mm)	FIRE IMPACT
INES-BT-1	137	12	INES-7	ENC	B1	–	distal	20	4	2	–
INES-BT-2	490	12	INES-5	ENA	B1	Fig.7.6; Fig.14	distal	26	4	3	–
INES-BT-3	1042	12	INES-5	ENA	B2	Fig.8.3	distal	36	6	3	–
INES-BT-4	3555	12	INES-7	ENC	B1	–	medial	24	6	4	–
INES-BT-5	13169	13	INES-10	SUB	B3	Fig.8.7	distal	37	9	3	–
INES-BT-6	13170	13	INES-10	SUB	A3	–	medial	31	15	3	–
INES-BT-7	13331	13	INES-9	NEO	B1	–	medial	15	8	4	x
INES-BT-8	13344	13	INES-10	SUB	B1	Fig.7.16	distal	58	5	3	–
INES-BT-9	13377	13	INES-9	NEO	B2	–	medial	30	9	4	–
INES-BT-10	13379	13	INES-9	NEO	B1	Fig.7.17; Fig.14	distal	58	6	4	–
INES-BT-11	13420	13	INES-10	SUB	B1	–	medial	25	6	2	–
INES-BT-12	13492	13	INES-9	NEO	B1	–	medial	14	4	4	–
INES-BT-13	13600	13	INES-9	NEO	B1	Fig.7.5	distal	21	5	3	–
INES-BT-14	13702	13	INES-4	LEPI	B1	Fig.7.13; Fig.14	distal	36	4	4	–
INES-BT-15	13703	13	INES-4	LEPI	B3	Fig.8.9	proximal	44	10	3	–
INES-BT-16	13755	13	INES-4	LEPI	B1	Fig.14	medial	14	3	2	–
INES-BT-17	13795	13	INES-10	SUB	B1	–	medial	22	4	1	x
INES-BT-18	13826	13	INES-4	LEPI	B1	Fig.7.7	medial	23	6	2	–
INES-BT-19	13827	13	INES-4	LEPI	B2	–	medial	14	5	4	–
INES-BT-20	13940	13	INES-4	LEPI	B1	–	medial	32	4	1	–
INES-BT-21	13958	13	INES-4	LEPI	B1	Fig.7.8; Fig.13	distal	23	4	1	x
INES-BT-22	14083	13	INES-4	LEPI	B1	–	medial	16	3	2	–
INES-BT-23	14086	13	INES-4	LEPI	B1	–	medial	8	4	2	–
INES-BT-24	14162	13	INES-4	LEPI	B1	Fig.7.1	distal	18	2	1	–
INES-BT-25	14167	13	INES-4	LEPI	B1	Fig.7.14	medial	12	8	2	–
INES-BT-26	14167	13	INES-4	LEPI	B2	–	medial	41	7	2	–
INES-BT-27	14204	13	INES-4	LEPI	B2	Fig.8.5	medial	40	5	4	–
INES-BT-28	14264	13	INES-4	LEPI	B1	Fig.7.2	distal	14	3	1	–
INES-BT-29	14306	13	INES-4	LEPI	A1	Fig.6.6	distal	58	16	3	–
INES-BT-30	14324	13	INES-4	LEPI	B1	–	medial	14	3	2	–
INES-BT-31	14354	13	INES-4	LEPI	B3	Fig.8.8	proximal	32	9	2	–
INES-BT-32	14370	13	Burial	BUR	B1	Fig.7.3; Fig.15	distal	19	4	1	–
INES-BT-33	14415	13	INES-4	LEPI	B2	Fig.8.1; Fig.14	distal	11	3	1	x
INES-BT-34	14418	13	INES-4	LEPI	B1	Fig.15	distal	24	5	3	–
INES-BT-35	14525	13	INES-4	LEPI	B1	–	medial	9	3	2	–
INES-BT-36	14528	13	INES-3	EEPI	B2	Fig.15	medial	17	8	4	–
INES-BT-37	14538	13	INES-3	EEPI	A1	Fig.6.5	distal	53	19	2	–
INES-BT-38	14570	13	INES-4	LEPI	B1	Fig.7.11; Fig.15	distal	29	3	1	–
INES-BT-39	14611	13	INES-4	LEPI	B2	–	medial	24	5	2	–
INES-BT-40	14714	13	INES-3	EEPI	B1	–	medial	5	2	1	–
INES-BT-41	14755	13	INES-4	LEPI	A2	Fig.6.7	distal	64	20	2	–
INES-BT-42	14770	13	INES-4	LEPI	B1	–	medial	19	2	2	–
INES-BT-43	14825	13	INES-3	EEPI	A3	–	medial	14	11	3	x
INES-BT-44	14926	13	INES-3	EEPI	B1	Fig.7.12; Fig.14	distal	31	1	1	–
INES-BT-45	14950	13	INES-3	EEPI	B2	–	medial	28	6	4	–
INES-BT-46	15013	13	INES-3	EEPI	A1	Fig.6.1	distal	33	11	2	–
INES-BT-47	15055	13	INES-4	LEPI	A1	Fig.6.3	distal	61	6	1	–
INES-BT-48	16230	14	INES-9	NEO	B2	Fig.8.6; Fig.14	distal	49	5	2	–
INES-BT-49	16595	14	INES-9	NEO	B1	Fig.13	medial	24	8	3	x
INES-BT-50	16870	14	INES-4	LEPI	B1	–	medial	23	11	4	–
INES-BT-51	17102	14	INES-4	LEPI	B1	Fig.7.15; Fig.15	distal	89	4	3	–
INES-BT-52	17488	14	INES-9	NEO	B2	–	medial	14	9	2	–
INES-BT-53	17745	14	INES-4	LEPI	B1	Fig.7.10; Fig.13	distal	30	8	4	x
INES-BT-54	17771	14	INES-9	NEO	B2	–	medial	15	5	2	x
INES-BT-55	18239	14	INES-4	LEPI	B2	–	medial	27	4	4	–
INES-BT-56	18930	14	INES-4	LEPI	A1	Fig.6.2	distal	41	10	1	–
INES-BT-57	19447	14	INES-4	LEPI	B2	Fig.8.2; Fig.14	distal	26	6	1	x
INES-BT-58	19625	14	INES-3	EEPI	B2	Fig.8.4; Fig.14	complete	80	10	3	–
INES-BT-59	19653	14	INES-3	EEPI	B1	Fig.11	medial	36	10	3	–
INES-BT-60	19712	14	INES-3	EEPI	A1	–	medial	28	10	1	–
INES-BT-61	19712	14	INES-3	EEPI	B1	Fig.6.4; Fig.14	distal	20	5	3	–
INES-BT-62	19713	14	INES-3	EEPI	B1	Fig.7.18; Fig.12	complete	66	3	2	–
INES-BT-63	19794	14	INES-3	EEPI	B1	Fig.7.4; Fig.14	distal	17	2	1	–
INES-BT-64	20005	14	INES-3	EEPI	B1	Fig.7.9; Fig.14	distal	17	2	1	–
INES-BT-65	20005	14	INES-3	EEPI	B1	Fig.15	medial	24	6	4	–

Fig. 4: List of bone tools from the Ifri n´Etsedda

GROUP	EEPI	LEPI	ENA	ENB	ENC	LN	NEO-DIS	SUB	Total
A1	3	3							6
A2		1							1
A3	1							1	2
B1	8	19	1		2		5	3	38
B2	3	7	1				4		15
B3		2						1	3
Total	**15**	**32**	**2**	**0**	**2**	**0**	**9**	**5**	**65**

Fig. 5: Amount of bone tools arranged according to unit and type (A comprises tools produced from flat bones, with the subgroups A1 which are points, A2 are spatulas or spoons and A3 includes not further determined flat bone tools. Type B comprises tools manufactured from long bones. Here, subgroup B1 includes points that have been shaped to an oval or round cross section. Type B2 includes points with a preserved medullary cavity and in the tools of B3 the epiphysis is preserved)

soil acidity usually responsible for the decomposition of organic material. However, the high concentration of calcite has also led to a sinter crust formation on almost all artefacts to different degrees. In some instances, it was not possible to remove the solid incrustation either manually or by means of an ultrasonic bath without risking a modification or destruction of the bone surface. Therefore in a few cases the examination of production, use and maintenance traces was only possible to a limited extent.

14 Typologically speaking, both the Epipaleolithic and the Neolithic corpus show great homogeneity. Apart from a single item, which can be addressed as a kind of spatula or spoon, all other artefacts typologically correspond to the characteristics of points. Only 3% of the tools are completely preserved, whereas the great majority of the assemblage shows various degrees of fragmentation. In 45% only the distal part of the tool is present. This high proportion of pieces which are exclusively distally preserved is contrasted by the low amount of proximal parts (3%). A possible bias, caused by the fact that proximal ends which are sometimes not worked in the same intensity as their distal, active counterparts, may not have been recognised as artefacts. This phenomenon can also be observed in Capsian assemblages of the eastern Maghreb (Petrullo 2016b). In 49% of the tools only the medial part is preserved.

Methods

15 In order to guarantee the precise identification of the artefacts in the following, we have designed a code containing the acronym of the place of recovery, which is Ifri n´Etsedda (INES), the acronym for the type of artefact, which is bone tool (BT), and a consecutive individual number. Each artefact has been assigned such a code by which it can be identified in the tables, figures and text of the present study (e.g. INES-BT-XX).

16 The main aim of our study here is to describe the artefact biographies of the bone tools of Ifri n´Etsedda from the selection of the appropriate raw material, through their production (*débitage* and *façonnage*), to a limited extend the ways of use, maintenance and up to the time they went out of use. Here, we follow the techno-functional approach to bone tools that has become increasingly popular in recent years. Since the end of the 1960s the study of North African bone industries was strongly influenced by the "typological nomenclatures" established by Camps-Fabrer (Camps-Fabrer 1966). These consist of 55 morpho-functional types which were defined according to the character and extent of bone transformation. In contrast the techno-functional approach followed here, goes beyond a morphological description and classification of the artefact and considers them rather as a result of raw material selection, different manufacturing techniques, tool usages and maintenance works. By paying attention to the actions behind the actual tool, a wider range of information becomes accessible. Since these actions are strongly connected to knowledge and identity and change over space and time, they provide insight into socio-economic aspects and lifestyle of a studied group and are good criteria for a temporal and spatial comparison of different assemblages.

17 Our investigation of the bone tools followed a multi-level approach, in which we started with a first inspection of features visible to the naked eye and subsequently progressed into greater levels of detail. This first macroscopic examination allowed statements regarding the morphology, size and stylistic features of the tools, such as the shape of their outlines, distal and proximal ends (Fig. 4). Although the outline of the tool is also created by technical shaping processes, it is even more determined by the shape of the bone chosen for its production. Here, the preliminary results of the archaeozoological study of the Ifri n´Etsedda faunal assemblage provided further evidence regarding preferred taxa and skeletal elements used for the manufacturing of the tools. A microscopic examination, carried out by means of an AM7115MZT Dino-Lite Edge (20-220x), identified traces of production, use, repair and deformations of the active part.

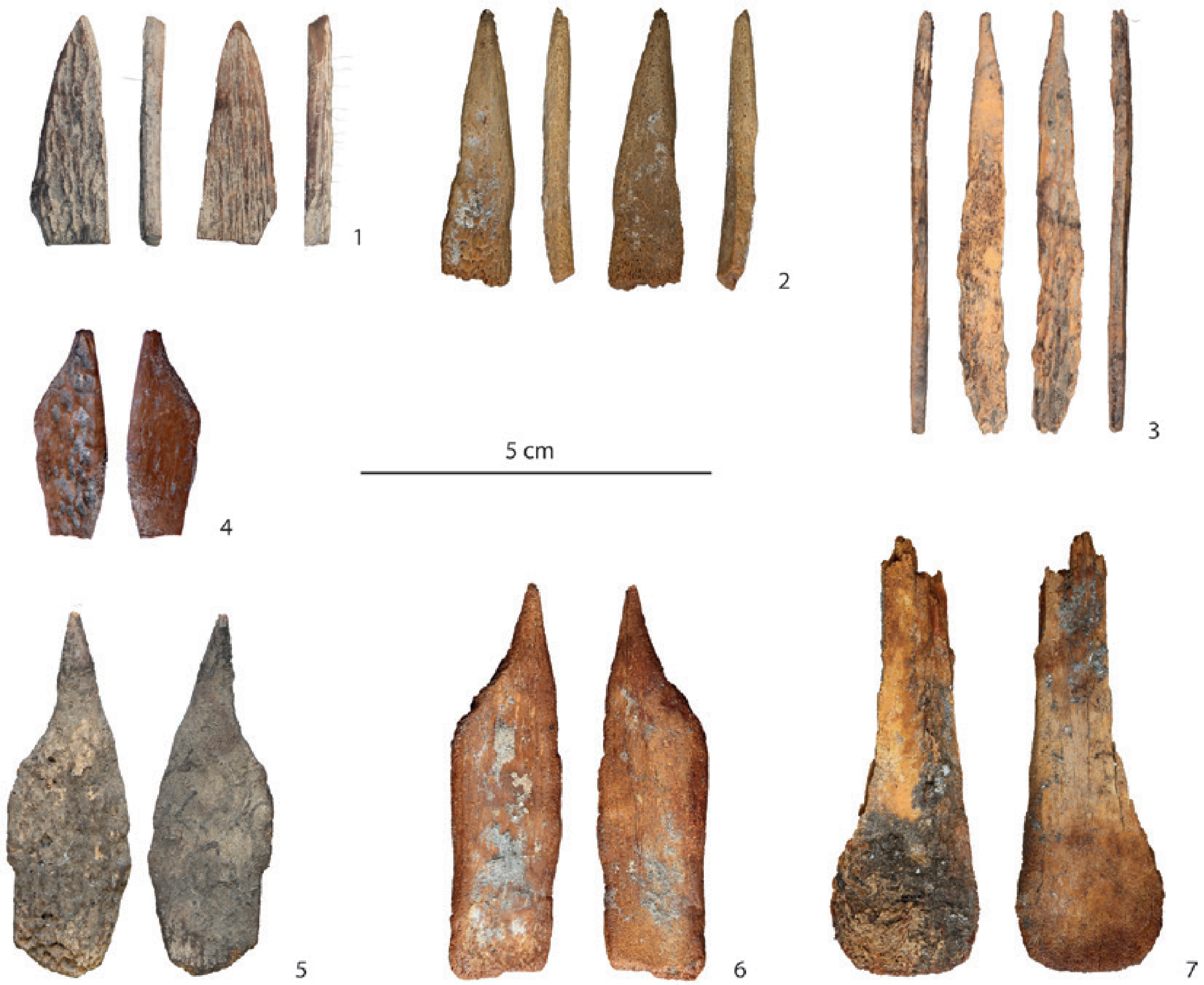


Fig. 6: Tools manufactured from flat bones (Group A): 1 INES-BT-64, 2 INES-BT-56, 3 INES-BT-47, 4 INES-BT-61, 5 INES-BT-37, 6 INES-BT-29, 7 INES-BT-41

18 Characteristic traces of production we looked for, include waste from the *débitage* process, an operation performed on an anatomical element to extract several blanks for tool production (see Petrullo 2016a). This was carried out by grooving along faces and edges of the diaphysis with a stone tool and removing the distal epiphysis by sawing and percussion. Following these typical traces of blank extraction, we were looking for signs of blank shaping. The shaping is the operation through which the final form of the object is obtained. Here, two shaping techniques are most relevant: the scraping and grinding of the blank. The scraping is carried out by means of a stone tool along the length of the distal end of the blank and leaves longitudinal striations (Petrullo 2016a). In contrast, the process of grinding is associated with striations running obliquely or transversally to the main axis of the tool. They appear superficial and closely spaced and are caused by contact with a coarse-grained surface. Grinding is applied to smooth the edges of the medullary cavity. On the one hand, the detection of production traces on the tools was difficult due to the extensive sinter cover on some items. On the other hand, production traces are often covered by use-wear and are not easily to distinguish from traces that are connected to later maintenance work on the tool.

19 For the characterisation of possible uses, our analysis focused on the detection of two indicative traces on the bone tools: the deformation of the active part and signs of polish.

20 The degree to which the active part is altered by wear can range from a dull, blunted appearance, commonly known as *émoussè*, to the destruction of this part of the tool by breakage. The characteristics of the deformation depend on several factors such

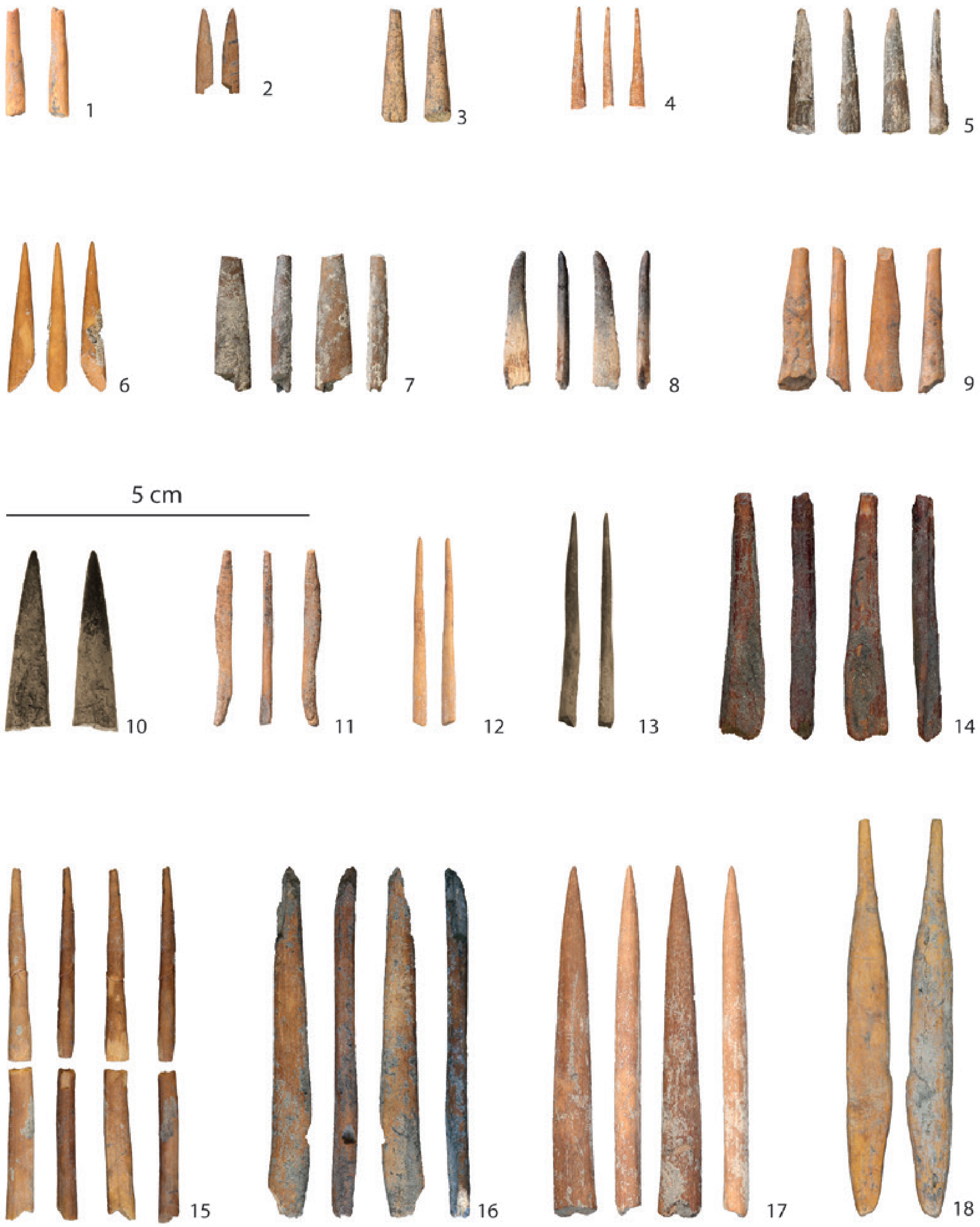


Fig. 7: Tools manufactured from long bones, completely worked with round or oval cross sections (Group B1) : 1 INES-BT-24, 2 INES-BT-28, 3 INES-BT-32, 4 INES-BT-63, 5 INES-BT-13, 6 INES-BT-2, 7 INES-BT-18, 8 INES-BT-21, 9 INES-BT-64, 10 INES-BT-53, 11 INES-BT-38, 12 INES-BT-44, 13 INES-BT-14, 14 INES-BT-25, 15 INES-BT-51, 16 INES-BT-8, 17 INES-BT-10, 18 INES-BT-62

as the consistency of the processed raw material, the frequency and duration of use, the pressure and angle of penetration and possible re-sharpening events. A further effect we observed on the tools is referred to here as polish. By polish we mean the extremely smooth and often darkish surface of the distal part of the tool, which is the result of frequent low-energy penetration of soft materials such as animal skin or plant material.

21 The observation and interpretation of the micro use-wear at high power magnification will be the subject of a future study.

22 By maintenance we mean restoring the functionality of a piece that has already been used. This includes, the re-sharpening of the active zone, or the repair of

Fig. 8: Tools manufactured from long bones with preserved medullary cavity (Group B2): 1 INES-BT-33, 2 INES-BT-57, 3 INES-BT-3, 4 INES-BT-58, 5 INES-BT-25, 6 INES-BT-48, and with preserved epiphysis (Group B3): 7 INES-BT-5, 8 INES-BT-31, 9 INES-BT-15

broken working edges or tips. Since repair work is often performed by means of scraping, it is difficult to distinguish it from the scraping activity applied to shape a blank in the context of the manufacturing process. Therefore, we only addressed scraping marks as the result of maintenance work if they superimpose traces of use, such as the previously defined polish. As a hard criterion of maintenance work, we took observations of repeated scraping activity that resulted in a visible thinning of the distal end in contrast to a much broader medial and proximal part of the tool.

Results

Fauna and Raw Material Procurement

23 As raw materials for the production of bone tools we identified both flat bones (Group A; Fig. 6), such as ribs and scapulae, and to a far greater proportion, long bones, such as metapodials, humeri and tibiae (Group B; Fig. 7 and Fig. 8). Here, the use of flat bones can only be observed for the Epipaleolithic units, whereas the exploitation of long bones is indicated for both occupation phases (Fig. 5). However, the intense technical transformation of the tools, as well as the absence of diagnostic remnants in most cases, makes a taxonomical attribution and an identification of animals whose bones were exploited as raw materials difficult. A look at the analysed fauna of the site is able to

Taxon	INES-2/3 9.8-9.6		INES-4 8.8-8.6		INES-5 7.2		INES-6 6.8-6.5		INES-7 6.6-6.1		INES-8 LN		INES-9 NEO-DIS		INES-10 SUB		Total NISP
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	
Amphibia					5	2	2	*	3	*							10
Malacostraca			1	*													1
Reptilia	22	1	33	*	10	4	7	2	66	5	3	3	4	*	15	*	160
Mauremys leprosa			2	*	4	2	5	2	20	2					3	*	34
Testudo greaca					1	*	1	*	7	1					3	*	12
Testudo sp.	472	27	1101	29	2	1	4	1	22	2	1	1	274	22	236	10	2112
Chamaeleo sp.									3	*							3
Aves	27	2	120	3	6	2	4	1	103	8	5	6	64	5	176	8	505
Coturnix sp.							1	*									1
Columbidae															1	*	1
Struthio camelus (eggshell)	2	*	21	*	3	1	2	*	22	2	4	5	68	6	119	5	241
Mammalia	315	18	367	10	21	8	36	12	347	28	4	5	85	7	205	9	1380
Macaca sylvanus															1	*	1
Ammotragus lervia	12	*	44	1	1	*	2	*	5	*			11	1	5	*	80
Gazella cuvieri	20	1	39	1	8	3	9	3	10	1	3	3	14	1	26	1	129
Bos primigenius	2	*	1	*					5	*			2	*	6	*	16
Alcelaphus buselaphus									1	*					3	*	4
Ovicaprine			1	*	9	4	8	3	23	2					18	*	59
Ovis sp.									4	*					2	*	6
Ovis ammon									1	*							1
Bovidae	864	50	2103	55	179	71	203	70	572	47	66	76	728	58	1448	63	6163
Sus scrofa	1	*	3	*			3	1	1	*			4	*	5	*	17
Equus sp.					1	*	3	1	4	*	1	1					9
Eptesicus isabellinus									2	*							2
Leporidae									1	*					1	*	2
Lepus sp.															3	*	3
Oryctolagus cuniculus															3	*	3
Carnivora					1	*			2	*					2	*	5
Felis sp.															1	*	1
Vulpes sp.			2	*			1	*									3
Vulpes zerda															1	*	1
Hystrix cristata			3	*					5	*			3	*	8	*	19
Total NISP	**1737**		**3841**		**251**		**291**		**1229**		**87**		**1257**		**2291**		**10984**

Fig. 9: Number of identified specimens (NISP) from Ifri n´Etsedda, arranged according to units of recovery; *less than one percent

provide more insight into the potential raw material that could have been used for tool production: both Epipaleolithic and Neolithic units indicate a temporal continuity in the intense hunting of local game, including especially *Gazella cuvieri*, *Ammotragus lervia*, *Sus scrofa* and to a smaller extant *Bos primigenius* and *Alcelaphus buselaphus* (Fig. 9). The Neolithic assemblage shows a further expansion of exploited taxa to equids (*Equus* sp.), as well as mountain sheep (*Ovis ammon*) and possibly domesticated sheep and goats. All documented ungulate long bones – even the small phalanges – were subject to intensive bone breakage and cracking (Fig. 10) which created an extremely high amount of tiny splinters which make up the great majority of faunal remains at Ifri n´Etsedda. This observation suggests that the site was used after hunting activities for butchery and profound marrow extraction even of small bones with a low caloric return rate. This approach of bone fat exploitation was correlated with levels of resource stress or hunting success in earlier studies where high intensities of bone cracking were noticed in the framework of ethnographic research (Binford 1978), whereas others claim that divers factors such as sharing of the hunt (Jarvenpa – Brumbach 1983), culinary preferences (Jin – Mills 2011), transport costs (Lupo 2006) and taphonomic parameters (Lyman 1994) likewise could have been responsible for highly fragmented bone assemblages. However, while the exploitation of the identified animals as a food resource has been demonstrated, characteristic evidence of in situ bone tool production such as intermediate products and *débitage* waste as known from other sites in North Africa (e.g. Petrullo 2016a) is missing. The faunal assemblage therefore indicates that, although there was enough raw material available on site, mainly in form of bone

Fig. 10: Broken gazelle epiphysis (INES-4)

splinter from ungulate butchery waste, a reliable link of our bone tool collection to the faunal remains of the Ifri n´Etsedda, is not possible and does not exclude the import of the pieces. However, it is possible that remains of a local production simply were not recorded by our excavation, which covered only a part of the rock shelter. Apart from the mentioned larger mammals, the faunal assemblage at Ifri n´Etsedda is characterised by the presence of turtles, birds and small mammals such as foxes, porcupines, rabbits and hares. That the bones of the latter were exploited as raw material for the production of bone tools is indicated by a diagonally pointed humerus of a hare (INES-BT-5), on which the distal epiphysis is preserved and allowed for a more precise identification (Fig. 8.7). Again, a connection between the tool and the remains of hares in the faunal assemblage is not possible, since evidence of intermediate products or production waste is missing.

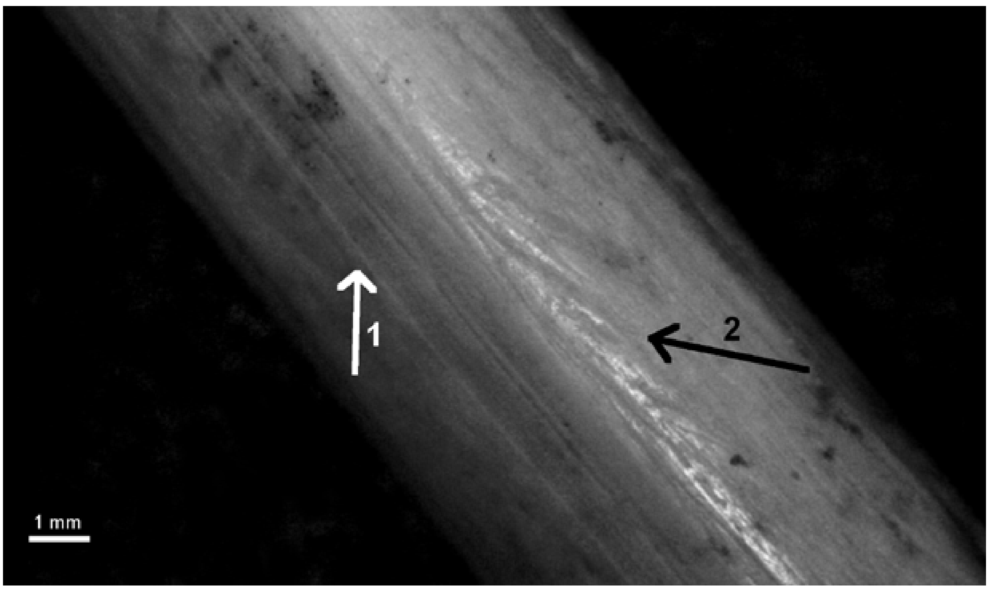
Manufacture

24 In a first step we had already differentiated tools made of flat bones (Group A) and long bones (Group B). These groups can be further broken down into subgroups defined according to the stylistic features of the tools and the technologies used to produce them.

25 The group of long bones is dominated by points of the subcategory B1 (58%), which are entirely shaped (Fig. 5 and Fig. 7). With the exception of three artefacts, they were given nearly straight, regular outlines with oval to round cross sections. Here, we were able to identify scraping and grinding applied to shape the tools (Fig. 11 and Fig. 12). Both techniques indicate a temporal continuity since they appear on tools from Epipaleolithic and Neolithic units. Grinding as a shaping technique appears in only 5% of the tools from group B1, while scraping activity could be detected in 18%. Unfortunately, we were not able to draw further conclusions on shaping techniques, since the majority of the tools is covered either by sinter or intense use-wear superimposing possible traces of the manufacturing process. In addition to these features, the tools from group B1 show a high metric diversity with widths between 1 and 11 mm (Fig. 4). Conclusions about the length of the artefacts are not possible as only one item is completely preserved (INES-BT-62). However, for the complete tool, it is possible to make statements about the treatment of its proximal end. Like the rest of the tool, it has been completely transformed and it was given a rounded shape (Fig. 12).

26 The same straight outline and metric diversity was found for items in subgroup B2 (23%; Fig. 5 and Fig. 8). This group differs from B1 in that the tools have not been worked in the same intensity. The edges were smoothed and straightened by

Fig. 11: Surface of a point (INES-BT-59) which shows the impact of scraping (1) and grinding (2)



scraping; however, the medullary cavity of the long bone is still visible in the bone tools of this subgroup. This modus operandi resulted in an irregular cross section. Traces of grinding which were applied to shape the tools from group B1 were not found.

27 The artefacts from group B3 (5%) were produced from small mammal long bones and show only minimal impact of manufacture (Fig. 8). Due to their small size and naturally straight outline, they could be used as a tool without previous shaping. The humerus of a hare was just obliquely sharpened (INES-BT-5; Fig. 8.7). The small hole at its proximal end is connected to the natural shape of the bone and was not created by perforation. In general, no traces of perforation could be identified on any tool in the overall assemblage. However, the technique was known as indicated by the presence of perforated snails and ostrich eggshells.

Fig. 12: Completely preserved pointed tool from Group B1 (INES-BT-62). The thinned active part indicates the repeated shaping and sharpening of the tool. Its medial part shows traces of scraping and the smoothing of the edges. The same smoothing is visible at the proximal end of the tool whose edges were rounded

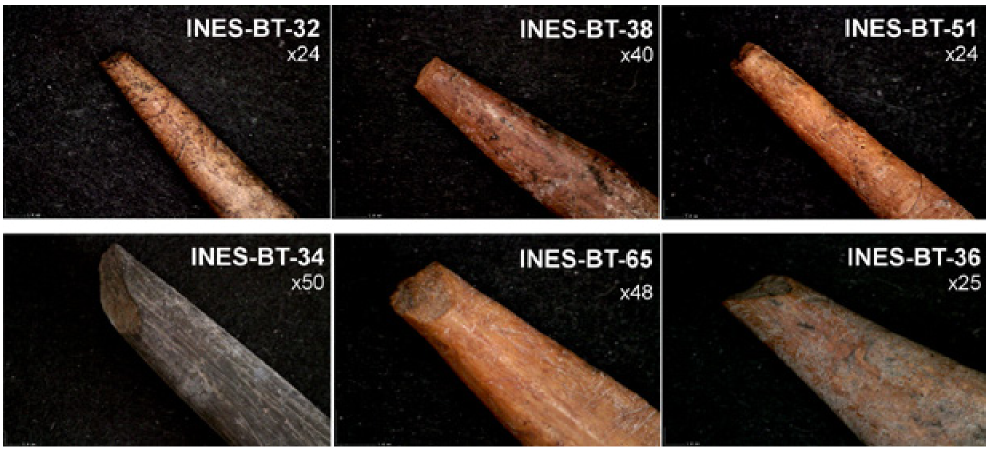
28 Group A (14%) comprises all artefacts made from flat bones, such as ribs (Fig. 5 and Fig. 6). Here three subgroups could be identified: pointed tools dominate the group (A1), while only one item could be identified as a spatula or spoon (A2; Fig. 6.7) and a further two objects could not be further determined (A3). The pointed tools of group A1 comprise shouldered objects in which the medial part is about one third as wide as the proximal part which has been worked to a point (e.g. Fig. 6.4; Fig. 6.5; Fig. 6.6). In addition, there are points where the broad natural shape of the flat bone has not been preserved in the same manner, but whose outlines are straight and without interruption (e.g. Fig. 6.1; Fig. 6.2; Fig. 6.3). In one object made from a rib blank both layers of compact bone are still connected (INES-BT-29; Fig. 6.6). In all other tools of this group, the layers of compact bone were separated, and the cancellous bone becomes visible on one side of the object. Traces indicating possible techniques used to separate both bone layers, could not be detected on the tools. While the cortical bone shows traces of shaping in form of scraping (22%) and grinding (11%), no efforts were made to shape the cancellous bone. Only the distal, pointed part of the tool experienced shaping from both sides (e.g. INES-BT-47; Fig. 6.3).

29 Another observation we were able to make is that eight artefacts (12%), show impact of fire (Fig. 13). The surface of the objects is characterised by a deep dark and shiny colour, which points to a low degree of carbonisation, connected to a short exposure to temperatures between 300 and 400°C (Swillens – Pollandt – Wahl 2003). Where

Fig. 13: Traces of heat impact on the active parts of selected points

Fig. 14: The active parts of selected points in 25-50x magnification. These examples show different degrees of dullness (émoussé), which can be connected to the kind of material (soft, hard, flexible, etc.) treated with the tool, the penetration intensity, the duration of its use and possible re-sharpening events

Fig. 15: Different fragmentations of the active part



the distal part is preserved it becomes apparent that not the whole tool was affected by heat, but only the tip and the medial part. The phenomenon could be identified for both Epipaleolithic occupation phases (INES-3, INES-4) and might occur during the Neolithic period as well. However, since many artefacts with signs of heat impact were recovered from mixed Neolithic units (INES-10), they can not be allocated with certainty.

Use

30 The Ifri n´Etsedda assemblage provides a clear dominance of pointed objects: a limited tool kit probably connected to a narrow range of activities carried out. Metrically, the tools show a high variance in their width (1–20 mm), but in general we are dealing here with very thin objects (1–4 mm thickness) on which no great pressure could be applied. In the majority of cases the epiphyses, which would provide stability and grip for coarser work, were removed from the examined objects.

31 At 50% of the preserved active parts, a smoothing effect which is noticeable in a blunted appearance of the used area, could be detected (Fig. 14). In some objects a particularly high degree of blunting is visible (e.g. INES-BT-56; INES-BT-44; INES-BT-62; INES-BT-16). Furthermore, at 65% of the objects, signs of polish connected to the frequent penetration into soft materials, could be detected.

32 In addition to these unfractured, blunted active parts, a further 18% of the points show two different forms of fracturing caused by usage (Fig. 15): at 6% the active part of the point is obliquely broken off (e.g. INES-BT-34; INES-BT-64; INES-BT-36), while at another 6% a straight break is visible (e.g. INES-BT-32; INES-BT-38; INES-BT-51). This is likely a result of using different angles and pressures during the processing of a given material. In addition, the broken objects usually do not show the same polish that was observed for the blunted points.

Maintenance

33 Traces of maintenance were found on 45% of the examined tools. The technique applied here was the scraping, mainly of the distal part of the objects. In some cases, the distal ends are highly finned and continue into a wide and thick medial and proximal part (e.g. INES-BT-62; Fig. 12). This observation indicates repeated sharping and shaping of the distal end, which has led to an increasing tapering and reduction of this part of the tool.

Discussion

34 In the following we want to discuss the results of the techno-functional analysis by means of the research-questions raised at the beginning. Here, considerations regarding the place of production of the tools, their possible usage and a temporal and spatial integration of the assemblage within the Epipaleolithic and Neolithic of North Africa, are of crucial interest.
How were the tools manufactured and did the production take place at Ifri n´Etsedda, or are we dealing with tools imported from somewhere else?

35 Although it is very likely that the tools were manufactured at the site, we have to note for now, that we lack direct evidence of local production, such as intermediate products and production waste. However, since the study of the artefacts and the archaeozoological remains were not able to provide such evidence, two possible scenarios are worth considering:

1. Import: The tools were produced at another place and remained in the rock shelter after discard
2. Local production: Bone tools were produced locally. However, potential intermediate products and *débitage* wastes were not found in the excavated areas or we are dealing with an opportunistic use of bone splinters that left no traces of production

36 An import of tools can never be excluded. However, the extensive faunal assemblage of Ifri n´Etsedda demonstrates, that the site was used specifically for the exploitation of animal-based dietary resources (consumption of land snails, butchery of hunted ungulates and domesticated ovicaprids during the Neolithic occupation). The

butchery activity connected to profound marrow extraction produced large quantities of tiny bone splinters. As reported from the Capéletti Cave in Algeria, bone tool production on the basis of the random selection of splinters with a suitable size and morphology was practiced during the Neolithic period (Petrullo 2016a). This would constitute a rather opportunistic approach to the production of bone tools. However, in the present case study we claim that the tools of the Ifri n´Etsedda assemblage are rather the product of a previously planned procedure. The pointed objects are characterised by a straight outline and a high metric diversity. These observation coincide with the characteristics of the well described *débitage* method, known from other North African sites (e.g. Mulazzani – Brugal 2016; Petrullo 2014; Petrullo 2016a; Petrullo 2019). The aim of this dissection method was to extract five to six straight and differently sized sections from a metapodial. This was carried out by grooving along faces and edges of the metapodial diaphysis with a stone tool and removing the distal epiphysis by sawing and percussion. Altogether the straight outline, as well as the high metric diversity of the majority of our bone tools, could be an indicator of this production method. Since the typical waste and intermediate products of *débitage* are missing, our observations strongly support a scenario in which the great majority of the bone tools was produced somewhere else than at Ifri n´ Etsedda. However, we have also been able to identify a few tools that were probably selected more opportunistically and were not subject to intense transformation. These include the points of group B3, obtained from the long bones of small mammals such as hares (Fig. 8). Nevertheless, on the basis of the information from our techno-functional and faunal analysis, we have not yet been able to arrive at satisfactory results. Therefore, we want to consult further material recovered from the site to solve the conflict between the import- and local production hypothesis:

37 A further important indicator that supports the hypothesis of local bone tool production comes from the analysis of stone artefacts (Broich et al. 2020). In this study 163 Ifri n'Etsedda stone tools were examined by Juan Gibaja. Among them several tools recovered from both Epipaleolithic and Neolithic deposits show traces of bone processing. Bone produces many overlapping scars and a very compact polish on stone tools. The lithic instruments on which traces of bone processing were found are primarily notched pieces. Traces of use were found both in the notches and on the edges. This led Gibaja to conclude that the notches were not created intentionally but were caused by the processing of hard animal materials. When the notches were too deep, another area of the tool was chosen for bone working activities. This resulted in stone artefacts characterised by multiple notches, as has been proven for Ifri n'Etsedda. Interestingly, the number of lithics with traces of bone working increases in the Neolithic units while simultaneously the amount of bone artefacts decreases. This paradox is not easy to resolve. It is possible that either the corresponding bone artefacts were not located in the excavation areas, which only cover a limited expanse of the rock shelter, or that the

Fig. 16: Several beads produced from ostrich eggshells were found at Ifri n´Etsedda together with their unfinished intermediate products. These finds constitute strong indicators for the use of the site for various manufacturing activities

tools produced at Ifri n´Etsedda were transported to another place. Another scenario could be that the stone tools were applied to work materials with consistencies similar to bone, such as wood which is difficult to distinguish from hard animal materials by means of use-wear analysis. Evidence of wooden tools from other North African sites indicates that different raw materials were used to produce similar objects (Petrullo – Barich 2020). Based on rare but significant finds like this, we have to assume that wood served as an important raw material, whose actual relevance is difficult to assess due to unfavourable conservation conditions. The decrease of bone tools observed in the Neolithic units, together with the simultaneous evidence for the working of medium-hard materials on lithics, might point to a changed raw material selection that favoured wood over bone.

Fig. 17: Highly polished marine shells (Glycymeris sp.) from Ifri n´Etsedda, recovered from the Epipaleolithic units of the site. Since a perforation is missing, the objects either represent unfinished pendants, or had another so far not clarified function

Fig. 18: One of several worked Antalis vulgaris snails from the Epipaleolithic units of Ifri n´Etsedda, probably used as a pendant

38 Beside wood and bone, the processing of other animal raw materials is proven in the rock shelter and might support the scenario that Ifri n´Etsedda was used for divers manufacturing activities. This includes amongst others the presence of ostrich eggshells beads, together with their unfinished intermediate products (Fig. 16). Whether the findings of polished (Fig. 17) and perforated (Fig. 18) marine molluscs (*Glycymeris* sp. and *Antalis vulgaris*) in the Epipaleolithic units (INES-3 and INES-4) are linked to in situ processing activities as well, or if they represent imported souvenirs or tools, must remain open so far.

39 As a further characteristic of the manufacturing process, we identified intentional heat treatment during the Epipaleolithic and possibly the Neolithic period. Two observation have led us to the conclusion that the burning of the tools was a planned process: On the one hand, there is no evidence for tools whose whole surfaces were affected by heat. Mostly the burned area is limited to the distal parts of the objects. On the other hand, the low degree of carbonisation (dark brown-black, shiny surface) points to a short exposure time to fire. Therefore, we may exclude an incidental burning of the tools. The impact of fire reduces moisture and destroys the organic components of the bone. This results in a harder, more compact but at the same time less flexible bone structure.

40 In Near Eastern Natufian and Neolithic sites, heat treatment has been observed as a widespread effect on bone tools. At least 12% in each studied assemblage show evidence of fire impact (Sidéra 2000). In these contexts, the phenomenon is often interpreted as being a technique used for representation purposes such as the decoration of the object.

Which activities were carried out by means of the tools?

41 We observed that the great majority of the preserved active parts is characterised by a dull appearance, commonly referred to as *émoussè*. Furthermore, the surfaces of the active parts show an even polish. The functional analysis of Capsian artefacts from Algeria connects macroscopic use wear as it was observed for Ifri n´Etsedda, to the processing of hides or plant materials (Petrullo 2016b). The processing of animal skins into clothing and other articles of daily use is extremely likely. This is supported by the use-wear analysis of the stone artefacts from Ifri n´Etsedda, which revealed activities such as in situ cutting and scraping of animal skins (Broich et al 2020). Furthermore, there also exists a wide range of possible items produced from plant materials. Both the analysis of macro-remains at Ifri Oudadane (Morales et al. 2013) and Ifri n'Etsedda (Perez Jorda, pers. com.) revealed the presence of so-called esparto grass. Morales et al. (Morales et al. 2015) presented a number of possible uses for esparto grass based on a series of ethnographic analogies. According to this research it can be used to manufacture containers such as baskets and bags, but also clothing such as shoes as well as mats or strings. This scenario not only sheds new light on the variety of possible everyday objects that usually do not preserve in the archaeological context, but also provides a possible link between traces of plant processing on the bone tools and related activities.

42 From a metrical perspective it must be mentioned that the great majority of the points is of small calibre. Therefore, the use of the points is likely related to activities that require only limited mechanical stress. Functional analyses of other bone tool assemblages connect these very thin points to the processing of soft and flexible materials such as plants or animal skin (Petrullo 2016b; Petrullo – Legrand-Pineau 2013), what would further support the above mentioned observations. The presence of ostrich egg beads and their intermediate products at Ifri n´Etsedda at first suggests the application of the bone points for the perforation of beads. However, experiments have shown that this scenario can be ruled out since the hardness and mechanical properties of bone points in general is not sufficient for processing ostrich eggshells (Petrullo 2014). Therefore, the local production of beads is rather linked to the use of lithic tools (Barich – Petrullo – Venir in press; Venir 2012).

43 Further pointed tools in our assemblage show an obliquely broken active part and unpolished surface. In contrast to the evenly blunted and polished tools, their use is rather related to activities which require different angles and higher pressures. Furthermore, we considered that these tools were applied to harder, less flexible materials than their blunted counterparts. The Neolithic units of the Ifri n´Etsedda are characterised by the presence of enormous quantities of perforated land snails. A phenomenon that has already been described for several sites in the region (Hutterer et al. 2014). For Ifri n'Etsedda both elongated and round perforations are documented at the shells (Hundsdörfer 2014). While the elongated perforations can be connected to the application of flint tools, bone needles are discussed as perforators of the round holes. Experiments to prove this hypothesis are still pending.

Can we observe diachronic changes or continuities from the Epipaleolithic to the final Early Neolithic?

44 The temporal localisation of the artefacts indicates that the production and use of tools made of bone seems to be a mainly Epipaleolithic phenomenon in the present case study of the Ifri n´Etsedda. In our material we can detect a sharp break between the Epipaleolithic and Neolithic units, associated with an 84% decrease in bone tools. Also, typologically a lower diversity can be observed in the Neolithic units, in which there is no evidence for the use of flat bones (Group A) as raw material. However, it must be noted that the ENA (INES-5), ENB (INES-6) and Late Neolithic (INES-8) occupation phases are not well-represented in the Ifri n´Etsedda, whereas the Epipaleolithic units produced major parts of the excavated material. This disparity can also be observed in the varying amounts of faunal remains retrieved from the different units (Fig. 9). Therefore, we must take into account that the temporal distribution of the bone artefacts could have been biased by this discrepancy. Only the Neolithic main occupation phase (ENC; INES-7) can be considered a comparable parameter for the Epipaleolithic units in terms of sediment thickness and produced material. Since only two bone artefacts were recovered from the ENC unit, our initial hypothesis of a Neolithic decline in bone tool production, can be supported. Based on these results we claim that traditions and knowledge of bone tool production, which were continuously passed down from generation to generation in the hunter-gatherer groups of the Epipaleolithic, only partially survived into the Neolithic. Although we suggest a population continuity (Broich et al. 2020) the transition period was connected to cultural changes that possibly resulted in lower demands for bone tools. Thus, the almost complete absence of bone artefacts is part of a longer series of transformations that can be observed in the Neolithic units of the Ifri n´Etsedda including new techniques such as pottery production, the perforation of land snails, and a modified reduction strategy for the production of lithic tools (Broich et al. 2020). As already mentioned above, the small number of bone artefacts contradicts the results of use-wear analysis on lithic tools which indicates their use for the processing of medium-hard material such as bone or wood. Therefore, on the basis of a nearly complete absence of bone tools, it must be considered that wood might have replaced bone as favoured raw material.

What do supra-regional comparisons show, for example to the Capsian of the eastern Maghreb?

45 Based on our technological and functional study, we are able to compare the bone artefacts from Ifri n´Etsedda to bone assemblages from other Epipaleolithic and Neolithic sites in North Africa. From a typological perspective, the clear dominance of pointed tools in the bone industry from Ifri n´Etsedda corresponds to the Capsian assemblages of Dra-Mta-el-Ma-el-Abiod (Petrullo 2016a; Petrullo 2014; Morel 1976), Medjez II (Camps-Fabrer 1975), Khanguet el Mouhaåd and Ain R´fana (Petrullo 2014; Petrullo 2016a), SHM-1 (Mulazzani – Sidéra 2013; Mulazzani – Sidéra 2012), Kef Zoura D and Ain Misteheyia (Mulazzani – Brugal 2016; Petrullo 2016b), Wadi Ti-n-Torha (Petrullo – Barich 2020) and to the Neolithic industries of Doukanet el Khoutifa (Zoughlami 2009), Capéletti Cave (Petrullo 2016a) and Caf Taht el Ghar (Kaoun 2008). However, a greater typological variety can be observed in the Neolithic assemblages of the research area. In addition to pointed tools we find implements with cutting sides and ornaments in the Capéletti Cave in Algeria (Petrullo 2016a; Petrullo 2014). The bone objects at the Moroccan site of Caf Taht el Gahr are especially divers, where knifes, tubes, smoothers, spatulas, whistles and combs appear beside pointed tools (Kaoun 2008). Due to the small number of bone artefacts in the Neolithic units of the Ifri n´Etsedda, such observations cannot be made here. Points are the only type of bone tool found in these units. Only in the Epipaleolithic strata a kind of spoon or spatula (Fig. 6.7) could be identified as another typological category. An equivalent to this object could possibly be found in

a spoon from the Capsian assemblage of SHM-1 (Mulazzani – Sidéra 2013) and in the Neolithic corpi of Doukanet el Khoutifa (Zoughlami 2009) and Caf That el Gahr (Kaoun 2008).

46 In addition to the observed typological homogeneity of most Epipaleolithic bone industries, there is also a technical standardisation visible in the assemblages of the research area. This begins with the selection of raw material. A continuity in the preference for long bones, especially metapodials, is visible both in the Epipaleolithic and Neolithic assemblages. The naturally straight morphology of the bone offered the best basis for the production of the desired pointed tools. However, an increasing variability in the use of raw materials is indicated in most Neolithic sites. Although long bones are still preferred here, in the Capéletti Cave, bone tools are increasingly produced from short and flat bones such as ribs and scapulae (Petrullo 2016a). This observation might correspond to the contemporaneous increase in typological diversity, with both likely connected to changed activities and demands of the Neolithic groups. In contrast to the above examples, flat bones were exclusively used as raw material in the Epipaleolithic bone industry of the Ifri n´Etsedda, whereas the Neolithic artefacts were solely produced from long bones. Despite a preferential use of metapodials in most sites, a variability in the selection of taxa from which these were obtained can be observed. In most Epipaleolithic assemblages a selection of different wild taxa, including mainly medium-sized to large ruminants such as *Gazella dorcas*, *Alecelaphus Buselaphus* and *Ammotragus lervia*, but also birds and small mammals like hares and foxes, becomes apparent (e.g. Petrullo – Barich 2020; Mulazzani – Sidéra 2012; Kaoun 2008; Camps-Fabrer 1975). Despite the selection of different taxa, metapodials are preferred in all of them. This phenomenon is visible in our assemblage as well, where we found predominantly artefacts made of ruminant long bones, but also a lagomorph bone artefact (INES-BT-5; Fig. 8.7). In most Neolithic sites the previously exploited wild taxa are then replaced by the use of domesticated animals for bone tool production (Petrullo 2016a; Kaoun 2008). Due to the small size of the Neolithic inventory of Ifri n´Etsedda, no conclusion can be made on a possible change of exploited taxa.

47 In terms of manufacturing techniques, it was observed that most Capsian assemblages are characterised by the typical *débitage* method, which makes use of stone tools to longitudinally cut and saw long bone diaphyses in up to seven sections (Petrullo 2019; Petrullo 2016a; Petrullo 2014; Mulazzani – Sidéra 2013; Morel 1976; Camps-Fabrer 1975; Camps-Fabrer 1966). The aim here was to obtain points, which typologically dominate most Epipaleolithic industries. As a result of the *débitage* technique and the subsequent shaping of the devices by abrasion and scraping, fully shaped points with straight edges and rounded or squared proximal ends were produced (Petrullo – Barich 2020; Petrullo 2016a; Mulazzani – Brugal 2016). Similar straight outlines and the practice of rounding off the proximal part of the tool, could be established for the Epipaleolithic of the Ifri n´Etsedda as well. Although stronger evidence of production in the rock shelter is still pending, these observations might indicate a connection to the classic *débitage* methods of the Capsian tradition.

48 Contrary to this multi-structured cutting method applied on metapodials to previously define the shape of the future bone tool, another approach to the production of tools was postulated for some Neolithic industries (Petrullo 2016a). Here, the cutting of diaphyses was abandoned in favour of a random selection of bone splinters that corresponded to the desired size and shape to produce a tool. The final shaping of the tool by means of scraping and grinding now fulfils the function of previously performed by the cutting of the diaphysis. Both processes required a process of planning.

49 As for the heat treatment found at Ifri n´Etsedda, similar observations were noted for the assemblages of SHM-1 in Tunisia (Mulazzani – Sidéra 2012), Kef Zoura D and Ain Misteheyia in Algeria (Petrullo 2016b) and Caf Taht el Gahr in Morocco (Kaoun

2008). However, this technique needs further investigation in North African archaeological settings.

50 For the pointed tools of North African assemblages where a functional analysis was carried out, a use on plant or animal material was postulated (Petrullo 2016b; Petrullo 2014; Petrullo – Legrand-Pineau 2013). Treatment of harder materials like ostrich eggshells was regarded as doubtful due to the metric characteristics and material properties of the objects. We suspect similar results for the small calibre points of the Ifri n´Etsedda, many of which show an even dull appearance of their active parts. A future functional analysis of the bone tools will provide more detailed insight into aspects of usage.

Conclusion

51 To conclude our techno-functional analysis of the bone artefacts from Ifri n´Etsedda, we want to present the most important features of the industry. A peak in the use of bone tools could be identified in the Epipaleolithic occupation phases of the rock shelter, whereas a dramatic decrease was observed in the Neolithic units. As a trigger for this development we suspect either a cultural upheaval in the Neolithic connected to changed activities and needs, or a displacement of bone as a source for tool production by another raw material such as wood. Typologically, with the exception of a spoon or spatula, a dominance of points was found, a homogeneity which is characteristic of many Epipaleolithic assemblages. The majority of the points was produced from ungulate long and flat bones. Whereas production of tools made from long bones continues into the Neolithic occupation phase, there is no evidence of flat bone use following the Epipaleolithic. One point could be determined as coming from the humerus of a hare. However, most of the ungulate bones lack diagnostic features which would allow for a more precise identification, since the epiphyses were removed or are not preserved. The majority of points obtained from long bones is entirely shaped and has edges straightened by scraping activity which resulted in round to oval cross sections. Others are characterised by irregular cross sections because the medullary cavity of the long bone was preserved. In general, these observations indicate a previously planned *débitage* method as known from many Capsian sites of North Africa, where the diaphysis was cut longitudinally to extract several blanks with straight outlines. However, since the assemblage lacks direct evidence of *débitage* waste or different stages of tool production, a final conclusion is still pending. The same applies to the question of whether the objects were produced locally, or if they were imported to Ifri n´Etsedda. However, we were able to prove the local production of beads made of ostrich eggshells, what might indicate that the rock shelter was used for more varied activities than animal butchery and land snail consumption. A future functional analysis will provide detailed insight into questions regarding the use of the tools. Based on the macroscopic observations we have made so far, we suspect that the majority of tools was primarily used for processing soft materials such as plants or animal skin. Many tips are characterised by a dull active part and a uniform polish. Typical traces of plant or hide treatment. Furthermore, their metric features and the observed practice of removing the distal epiphysis, indicate that most of the points were related to activities that require only limited mechanical stress. In some points the evenly polish is missing, and the active part is obliquely broken. Here, we assume that the artefacts were used for activities connected to the exertion of more pressure. A possible application of pointed tools would be the perforation of land snail shells, which were found in enormous quantities at Ifri n´Etsedda, to easily extract their flesh. While the square perforations observed on the shells are connected to the use of lithic tools, other perforations have a round outline and might indicate the application of bone tools. However, this assumption will need further examination in the future.

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ZUSAMMENFASSUNG

To the Point. The Bone Tool Industry of the Ifri n´Etsedda, NE-Morocco

Sina Lehnig, Jörg Linstädter

Der Artikel beschäftigt sich mit den epipaläolithischen und neolithischen Knochenartefakten der Fundstelle Ifri n´Etsedda, östliches Rif, Marokko. Seit 1995 wird die Region durch ein marokkanisch-deutsches Team archäologisch erforscht, wobei ein Schwerpunkt auf der Untersuchung des Übergangs von aneignender zu produzierender Wirtschaftsweise sowie den hiermit einhergehenden kulturellen Entwicklungen liegt. Innovationen wie Keramikproduktion, domestizierte Tiere und die Kultivierung von Getreiden und Hülsenfrüchten konnten im Rahmen des Projekte ab etwa 7.6 calBP nachgewiesen werden. Die Ifri n´Etsedda, ein kleines Abri nahe des Unterlaufes der Moulouya, ist eine der wichtigsten Fundstellen des östlichen Rif, da hier sowohl epipaläolithische als auch neolithische Ablagerungen untersucht werden können. Während die hier gefundene Keramik auf externe Einflüsse hindeutet, die während des Neolithikums auf die kulturellen Entwicklungen der Region eingewirkt haben, verweisen sowohl Knochenwerkzeuge als auch lithische Artefakte auf lokale, epipaläolithische Traditionen. Die Untersuchung der Knochenwerkzeuge ist daher entscheidend für ein besseres Verständnis von Kontinuität und Diskontinuität zwischen dem Übergang von aneignender zu produzierender Wirtschaftsweise im östlichen Rif. Trotz einer teilweise starken Fragmentierung und intensiver Überformung der Knochenartefakte konnten im Rahmen der vorliegenden techno-funktionalen Analyse, Informationen zu Aspekten der Rohstoffauswahl sowie Produktion, Nutzung und Instandhaltung der Geräte gewonnen werden. Daneben ermöglicht die Präsentation der Ergebnisse eine geographische Erweiterung des bestehenden Corpus an Studien zu epipaläolithischen und neolithischen Knochenartefakten aus Nordafrika, die sich bislang primär auf Fundstellen im heutigen Algerien, Tunesien, Libyen und Ägypten konzentrieren.

SCHLAGWORTE

Knochenartefakte, Marokko, Rif, Neolithisierung, Archäozoologie

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