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Neolithic transition and lithic technology: The Epipalaeolithic and Early Neolithic assemblages of Ifri Oudadane, NE-Morocco.

Neolithisierung und Steingeräteherstellung: Epipaläolithikum und Frühneolithikum der Ifri Oudadane, Nordost-Marokko.

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Abstract - Ifri Oudadane represents one of the few recently excavated sites in NW-Africa which permits a study of the Neolithic transition. The site is dated by 23 radiocarbon ages suggesting an occupation between 11.0 and 5.7 ka calBP. The well-documented Neolithic transition occurred at about 7.6 ka calBP. This transition is marked by the appearance of pottery, cereals and legumes. Furthermore, geochemistry and micromorphology indicate several changes in the sedimentation milieu.

One of the most interesting aspects of Neolithisation is the question of the continuity or discontinuity of this process. Does the transition to food production appear as part of a migration process or did local forager groups promote this develop-ment? Lithic material offers, as it appears through all periods, the best opportunity to study these developments. This paper presents an unchanging lithic industry across the Neolithisation regarding blank production, raw material supply, as well as tool composition. These results indicate an active role of local hunter-gatherers, and has therefore significant impact on the understanding of the Neolithisation process within the Western Mediterranean as a whole.

***Zusammenfassung -** Die im östlichen Rif in Marokko gelegene Fundstelle Ifri Oudadane ist eine der wenigen in letzter Zeit ausgegrabenen Fundstellen in Nordwest-Afrika, die es erlauben den Übergang vom Epipaläolithikum zum Neolithikum zu untersuchen. Die 23 ^{14}C-Daten belegen eine Nutzung des Abris im Zeitraum von 11,0 bis 5,7 ka calBP. Der sehr gut dokumentierte Übergang zum Neolithikum konnte in den Zeitraum um 7,6 ka calBP datiert werden und ist gekennzeichnet durch das Aufkommen von Keramik, Getreide und Hülsenfrüchten. Ferner belegen geochemische und mikromorphologische Untersuchungen einige Änderungen in der Sedimentation.*

Eine der interessantesten Aspekte der Neolithisierung ist die Frage nach Kontinuität oder Diskontinuität und damit ob der Übergang zur produzierenden Wirtschaftsweise in der Hauptsache durch Migration oder Akkulturation voran getrieben wurde. Die lithischen Artefakte bieten hierbei die einzigartige Möglichkeit kontinuierliche Entwicklungen am Übergang vom Epipaläolithikum zum Neolithikum zu entdecken, da sie in beiden Perioden auftreten. Die vorliegende Untersuchung belegt, dass sich die Steingeräteherstellung in Hinblick auf Grundformproduktion, Rohmaterialversorgung und den genutzten Werkzeugen während der Neolithisierung nicht veränderte. Dies deutet auf eine aktive Rolle der lokalen Jäger-Sammler-Gesellschaften in diesem Prozess hin und ist daher von außerordentlicher Bedeutung für das Verständnis der Neolithisierung im westlichen Mittelmeer.

Keywords - Neolithic transition, lithic industry, raw material, subsistence, use-wear, Morocco
Neolithisierung, Steingeräteherstellung, Rohmaterial, Subsistenz, Gebrauchsspuren, Marokko

Introduction

Neolithic transition and the lithic industry of Ifri Oudadane

Research dedicated to the Neolithisation of the Western Mediterranean focuses on two major topics: the spread of Neolithic innovations in this region and the mode of transition. While the first topic mainly deals with questions concerning chronology and characteristics, such as new components of material culture, forms of settlement, or the set of features of domestication, the second is linked to the question of continuity in occupation or migration. The first appearance of new features such as pottery or domesticated species is often obvious and easy to prove. However, the mechanism of transition is a much more complex issue which requires careful study of

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persisting components, such as lithic industry, in order to work out traditional and innovative elements.

The study of lithic industries from the Epipalaeolithic and Early Neolithic layers of Ifri Oudadane is dedicated to this question. The site itself offers perfect conditions for this type of study. Ifri Oudadane is one of the few recently excavated sites in NW-Africa whose deposits provide material dating to the Neolithic transition. The time frame of the sequence preserved in this shelter is well defined by 23 radiocarbon ages, attesting an occupation between 11.0 and 5.7 ka calBP. The Neolithic transition occurs at about 7.6 ka calBP, and is marked by the appearance of pottery, cereals, legumes and ovicaprids. Local environmental changes are recorded in the site's pollen record. Geochemistry and micromorphology indicate several changes in sedimentation and the management of fire.

The study of the Ifri Oudadane lithic assemblage concentrates on the following research questions:

- 1: How are the Epipalaeolithic and Neolithic sub-assemblages characterised, and are there detectable changes concerning technology, typology, and use of raw material?
- 2: What is the relation to other contemporary sites in the area? Are specialisations detectable at other sites, and to what extent are these factors related to particular environmental or topographic situations?
- 3: To what extent did the results of use wear analysis contribute to the study? Are use traces related to certain tool types; and are changes in subsistence activities visible?
- 4: Do the presented results have implications on current models of transition? Can statements be made concerning continuity or discontinuity between the Epipalaeolithic and the Neolithic at Ifri Oudadane, and to what degree can these statements be transferred to the Neolithic transition within the Western Mediterranean as a whole?

The site of Ifri Oudadane

The rock shelter of Ifri Oudadane is located in a coastal marble cliff, about 50 m above the current shoreline (Fig. 1: C). To the south, the inland terrain rises steeply up to altitudes of more than 150 m above sea level and flattens into a plateau covered by sandy Messinian marls. The shelter was probably formed by marine abrasion during a former phase of higher sea levels. This assumption is supported by beach-rock deposits partially filling the neighbouring shelter of Ifri Armas, located at the same altitude about 6 km away from Ifri Oudadane along the coastline to the west.

Today the shelter is cut off from the mountain chain by the so-called "Rocade", a coastal road built in 2005. To the south and east of the Ifri Oudadane shelter the former surface was significantly affected by roadworks and is now partly covered by crushed rock detritus (Fig. 1: D & F). However, remnants of the original surfaces, such as a few alluvial fans, are preserved at the base of the slope. Also due to the construction work the former floor of the shelter was buried beneath a layer of crushed rock detritus with a maximum thickness of 1 m (Fig. 1: E).

Four excavation campaigns were conducted in 2006, 2007, 2010 and 2011. During these campaigns, an area of 10 m^2 was excavated to a depth of 1 - 2 m, at which level bedrock was reached (Fig. 1: E). Sediments were excavated in artificial spits of 5 cm, and artefacts were recorded in a three dimensional grid system. Samples for the analysis of botanical macro-remains were extracted from each spit. Whereas sediment from the 8m^2 trench excavated in 2006 and 2007 was only dry-sieved, material excavated in 2010 and 2011 (4 m^2) was also treated by flotation, using a mesh width of 1 and 5 m, yielding an enormous amount of botanical and faunal remains that are currently under analysis.

The currently prevailing climate is Mediterranean, characterised by winter precipitation, associated with southwardly migrating westerly winds (Allen 1996: 308). Rainfall is mostly restricted to the coastal areas, amounts rapidly decreasing towards the south. Mean annual precipitation at the nearby meteorological station of Melilla (Fig. 1: A) is 377 mm/a (Tullot 2000), with values of 192 mm/a reached at Guersif (Ngadi 1995), located about 100 km to the south of Ifri Oudadane. In the mountains, precipitation increases with altitude with maximum measurements of about 500 mm/a. Average annual air temperatures show a concomitant decrease (Ngadi 1995). The mean annual air temperature at Melilla is 18.5 °C, the coldest month is characterised by a monthly mean of 13.2 °C (Tullot 2000). The summer is dominated by high temperatures (maximum monthly average air temperature 25.3°C; Tullot 2000) associated with the northwardly migrating subtropical high pressure cell, and is characterised by rare rainfall and frequent droughts (Allen 1996). Overall, the position of the Maghreb within the shifting zones of temperate and subtropical circulation cells, with the addition of Atlantic and continental influences, results in a complex climatic regime marked by frequent seasonal shifts. Following the bioclimatic classification after Sauvage (1963), the region is located in the transition zone between the Mediterranean-arid and Mediterranean-semiarid climate.

Results of other studies at the site

Stratigraphy, sedimentology, radiocarbon dating

Sedimentological, geochemical and micromorphological analyses combined with 23 radiocarbon ages and the distribution of archaeological material have revealed significant information regarding sedimentary units and site formation processes. Radiocarbon dates cover the time span from 11 to 5.7 ka calBP, which corresponds to the Epipalaeolithic

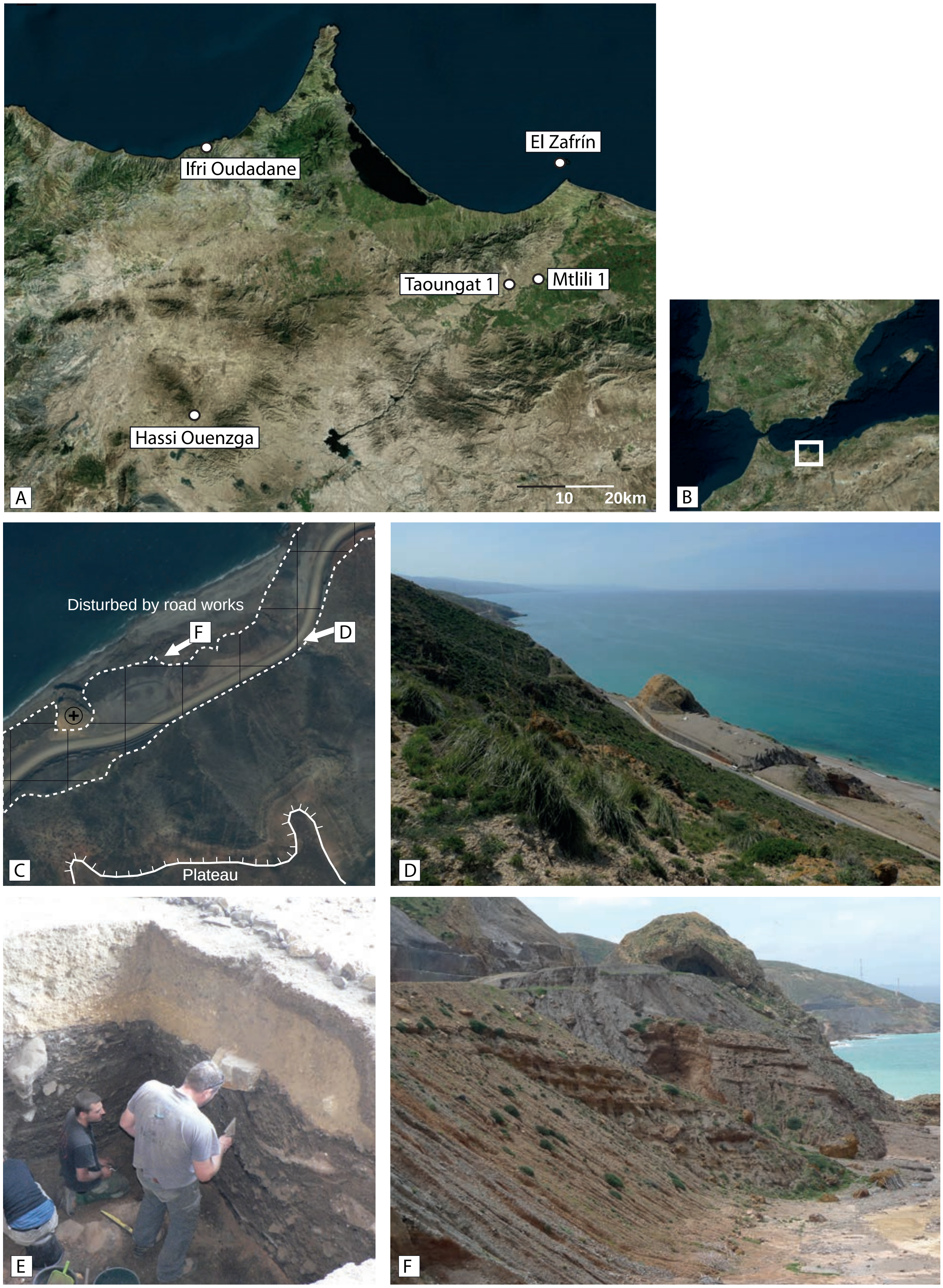


Fig. 1. Map showing study area and the location of Ifri Oudadane and other sites mentioned in the text (A+B). Pictures C, D and F show the cave and its direct surroundings. Picture E depicts a section of Ifri Oudadane during working progress. Map is taken from bing areal, the white box marks the research area.

Abb. 1. *Arbeitsgebiet und Lage von Ifri Oudadane als auch anderer im Text genannter Fundstellen (A+B). Die Abbildungen C, D und F zeigen das Abri und seine direkte Umgebung. Abbildung E gibt die Stratigrafie während der Arbeit wieder. Die Kartengrundlage ist bing areal, der weiße Rahmen markiert das Arbeitsgebiet.*

and the greater part of the Neolithic. The Ifri Oudadane record reflects an event-like or episodic occupation, as has been reported previously for other archaeological sites in the area. Single occupation events are difficult to identify due to the limited temporal resolution of ^{14}C data as well as limited possibilities to differentiate these on the basis of archaeological data, such as pottery production or raw material supply. Therefore, five occupational phases were established, each characterised by a coherent archaeological assemblage and defined chronologically by radiocarbon data (Fig. 2).

The sequence starts with an Epipalaeolithic deposit between 11.0 and 7.6 ka calBP, representing the last hunter-gatherer society of the region. The deposits are up to 100 cm thick and composed of brownish grey or black silty sands, containing numerous angular limestone clasts. The Epipalaeolithic layer shows a larger component of stone clasts in contrast to the Neolithic layers. This probably reflects enhanced spalting of the roof of the shelter, due to cooler climatic conditions intensifying processes of erosion. During the Epipalaeolithic occupation several cool and dry events are attested, e.g. at 10.2, 9.3 and 8.2 ka calBP (Cacho et al. 2001; Mayewski et al. 2004). Whether these cooling events were strong enough to accelerate physical weathering along the Medi terranean littoral is, however, difficult to determine. The higher proportion of weathering debris in the Epipalaeolithic layer could also correlate to lower inputs of anthropogenic materials over a long period, i.e. due to lower intensity of shelter usage.

The following Early Neolithic is subdivided into three phases. The first phase (ENA) between 7.6 and 7.3 ka calBP is characterised by the appearance of *Cardium*-decorated pottery and the remains of domesticated animals and plants. An increased accumulation rate in this period suggests a more dynamic occupation of the shelter. The use of maritime resources was still an important factor in the Early Neolithic. The layer is about 35 to 70 cm thick and more heterogeneous than the Epipalaeolithic deposit. It consists of several superimposed, thin layers of sediments rich in ash and charcoal, in some areas extending horizontally over 1 m. In addition to these elongated strips, ashes and charcoal rich sediment are also present in patches. The amount of clasts is much lower than in the Epipalaeolithic deposit and consists mainly of slightly rounded spalls of limestone and occasionally gravels, with a maximum diameter of 5 cm.

The second Early Neolithic Phase (ENB), between 7.1 and 6.7 ka calBP, represents the main occupation phase. The transition from ENA to ENB is marked by a gradual change from the greyish brown to dark brown silty loam deposited in ENB. It is up to 20 cm thick, contains less fragments of rock than in the lower strata, and has no clearly delineated ash or charcoal rich layers. The accumulation rate increases again and calcite spherulites document intensive penning of ovicaprids inside the shelter. While different cereals and legumes are evident, the use of maritime resources continued to play an important role.

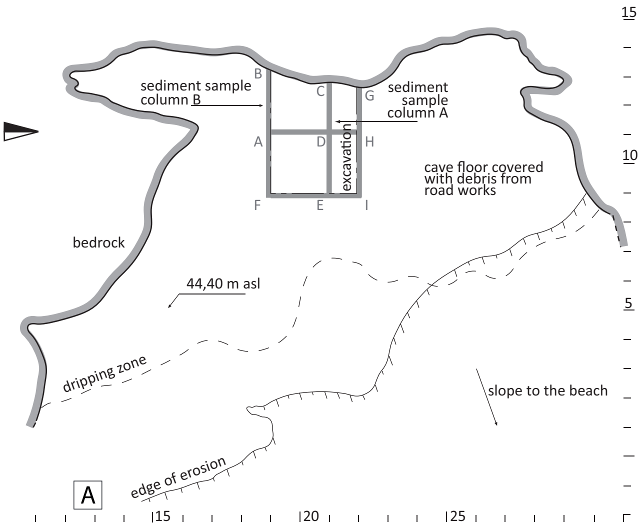
The third phase of the Early Neolithic (ENC), between 6.6 and 6.3 ka calBP, is characterised by a shallow deposit and only a few finds, suggesting a decline of settlement intensity. The unit consists of lighter coloured silty sand and shows similar features to the former deposit, albeit with a slightly higher ratio of clasts. Its lower boundary is marked locally by a discontinuous black layer rich in charcoal. Fragments of charcoal and a few chunks of burnt sediment are found in varying amounts throughout all the sedimentary layers bearing archaeological finds. In addition, these layers contain many shells of snails and bivalves, which are partly damaged by mechanical pressure due to the weight of the overlying sediment. The amount of shells and their state of preservation varies greatly in each layer and does not support a differentiation between layers.

Late Neolithic (LN) material is scattered on the surface and does not form a proper archaeological layer. An isolated hearth could be dated to around 5.7 ka calBP. This marks the final occupation phase of Ifri Oudadane during the first half of the sixth millennium calBP, coinciding with a general trend of climate deterioration affecting all settlement activity within the arid and semi-arid environments of Northern Africa.

Pottery

The pottery assemblage of Ifri Oudadane offers insights into the first appearance of pottery in Mediterranean NW-Africa and opens up the possibility for an internal classification of the Early Neolithic. However, stratigraphical analysis at Ifri Oudadane was complicated to a large degree by the sedimentological conditions at the site, while the fumier-like structure (see Angelucci et al. 2009) of the main occupation phase does not permit a clear division of occupation events. Furthermore, the Late Neolithic does not form a proper layer and its related artefacts are incorporated into the heavily compacted surface of the Late Early Neolithic layer. In both cases pottery analyses contributed to a further subdivision of these archaeological zones. Using descriptive and analytical statistical methods, in this case Correspondence Analysis and Canonical Correspondence Analysis, it was possible to classify and chronologically subdivide the Neolithic pottery from Ifri Oudadane. In this respect, techniques of decoration provided the most valuable criteria.

The sequence starts with the ENA (7.6 - 7.3 ka calBP). The decoration is dominated by *Cardium*-impressions (70 %). The remaining pots are decorated with plastic applications. In addition, there are vertical, horizontal and oblique impressions arranged in vertical bands, sometimes covering the handles found on several of the vessels.



B

Lab. No.	BP	calBP	Period	Species	
KIA 39296	5000 ± 30	5763 ± 80	LN	charcoal	*Juniperus sp.*
BETA 295772	5590 ± 40	6370 ± 39	ENC	seed	*Triticum aestivum/durum*
BETA 295777	5670 ± 40	6458 ± 38	ENC	seed	*Hordeum vulgare*
Erl 9987	5756 ± 48	6563 ± 62	ENC	charcoal	*Juniperus communis*
BETA 295776	5900 ± 40	6727 ± 44	ENB	seed	*Triticum aestivum/durum*
BETA 295775	5910 ± 40	6735 ± 45	ENB	seed	*Triticum aestivum/durum*
BETA 295778	5930 ± 40	6758 ± 54	ENB	seed	*Pisum sativum*
BETA 295773	5980 ± 40	6823 ± 54	ENB	seed	*Hordeum vulgare*
BETA 295774	5980 ± 40	6823 ± 54	ENB	seed	*Hordeum vulgare*
Erl 9989	6053 ± 50	6907 ± 70	ENB	charcoal	*Olea sp.*
KIA 39298	6085 ± 25	6951 ± 33	ENB	charcoal	*Juniperus sp.*
Oxa 23528	6136 ± 34	7058 ± 76	ENB	bone	*Capra hircus*
BETA 318608	6140 ± 30	7063 ± 73	ENB	seed	*Triticum* sp.
KIA 39297	6155 ± 30	7074 ± 63	ENB	charcoal	*Juniperus communis*
Erl 9988	6175 ± 50	7081 ± 70	ENB	charcoal	*Juniperus communis*
KIA 39299	6400 ± 90	7327 ± 81	ENA	charcoal	*Juniperus communis*
KIA 39299/2	6615 ± 30	7516 ± 37	ENA	humid acid	*Juniperus communis*
BETA 295779	6740 ± 50	7611 ± 37	ENA	seed	*Lens culinaris*
BETA 316137	6780+-40	7632 ± 29	EPI	seed	*Chamaeorops humilis*
BETA 313467	7080 ± 40	7979 ± 25	EPI	seed	*Chamaeorops humilis*
Erl 12419	7451 ± 56	8278 ± 61	EPI	bone	*Sus scofra*
BETA 313468	7970 ± 40	9028 ± 41	EPI	seed	*Chamaeorops humilis*
Erl 12418	9496 ± 183	10810 ± 262	EPI	bone	*Ammotragus lervia*

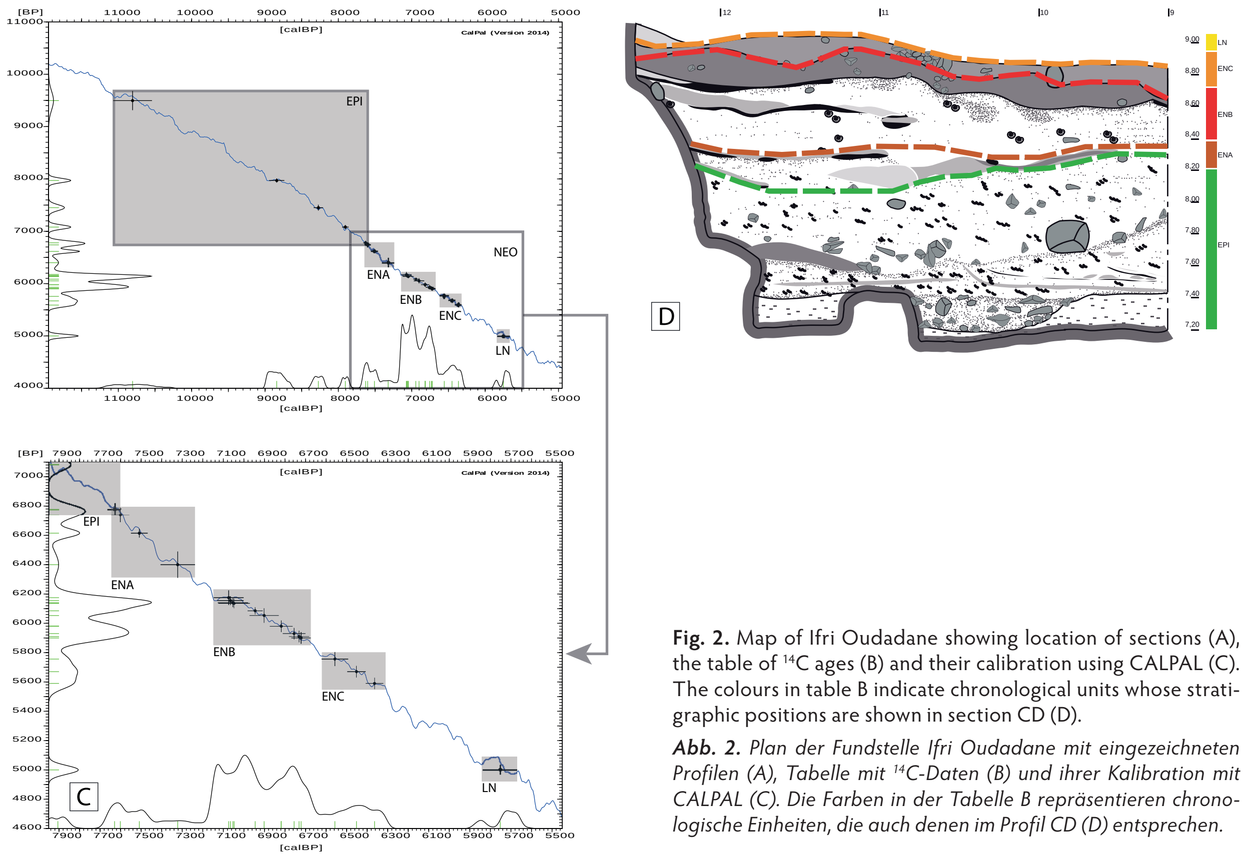


Fig. 2. Map of Ifri Oudadane showing location of sections (A), the table of ^{14}C ages (B) and their calibration using CALPAL (C). The colours in table B indicate chronological units whose stratigraphic positions are shown in section CD (D).

Abb. 2. *Plan der Fundstelle Ifri Oudadane mit eingezeichneten Profilen (A), Tabelle mit ^{14}C-Daten (B) und ihrer Kalibration mit CALPAL (C). Die Farben in der Tabelle B repräsentieren chronologische Einheiten, die auch denen im Profil CD (D) entsprechen.*

With the help of Correspondence and Canonical Correspondence Analysis, the ENB assemblage could be divided into two sub-assemblages: ENB1 and ENB2. The pots from ENB1 (7.1 - 6.9 ka calBP) are in the ENA tradition and predominantly decorated using single horizontal *Cardium*-impressions arranged horizontally and vertically. During the ENB2 sub phase (6.9 - 6.7 ka calBP), decorations using the rocker stamp technique replace single *Cardium*-impressions. In addition to the initial use of *Cardium* shells, the decoration tool kit was later supplemented by combs. Because of the rocker stamp technique, decorative elements were arranged predominantly in horizontal bands of mostly vertical impressions.

Only a few general trends concerning the third phase of the Early Neolithic and late Neolithic pottery can be sketched, due to mixing of ENC (6.6 - 6.3 ka calBP) and LN (around 5.7 ka calBP) material. The use of *Cardium* shells continued to decrease, while the amount of single impressions increased. Decorations using the rocker stamp technique and plastic applications still played an important role. Point impressions as well as herring bone decorations, made up of non-denticulated shell impressions, appear as the most recent features of decoration. However, herring bone decorations made with comb impressions seem to have already been present during the ENB2 sub phase, in the same chronological context in which the application of combs as decorating tools in the rocker stamp technique appeared. The chronological placement of this particular type of comb decoration appears to be too early in the regional context. However, it should be taken into account that only a single pot with this decoration was found at Ifri Oudadane.

In a regional context, the inventory of Ifri Oudadane has almost no parallels in the area. Temporal parallels are to be found in Hassi Ouenzga (ENA to the beginning of ENB2), although the pottery assemblage at this site is quite different. The best analogies to the features of the final phase of ENC can be found in the assemblage of El Zafrín. Equivalents to the Late Neolithic assemblage can be gathered from Hassi Ouenzga, Ifri Armas and the Chafarinas and can be dated to a very narrow time slot between 5.7 and 5.5 ka calBP.

Palaeobotany

Pollen and charcoal were studied in order to reconstruct Holocene environmental changes and human use of plant resources. Both sets of data offer different results that are complementary to each other (Zapata et al. 2013). According to current research, the littoral zone was characterised by a relatively dense arboreal cover of evergreen sclerophyllous oaks, arar tree, carob tree, and a well-preserved riparian forest (alder, ash, poplar and willow) in the local oued and river environments during the Epipalaeolithic (11.0 - 7.6 ka calBP). The climate at this time may have been warm and humid, as implied by the dominance of riparian forest and the xerothermophilous macchia composed mainly of wild olive and mastic. During this cultural phase, the landscape appears to have been scarcely altered by human activities.

During ENA and ENB (7.6 - 6.6 ka calBP) wild olive and mastic continued to be abundant as well as other elements of the xerothermophilous macchia and the riparian forest, reflecting a humid and warm climate. Nevertheless, there is a progressive decline in the arboreal quota in contrast to the Epipalaeolithic, mainly due to disappearing elements of the local forest, such as kermes/holm oak, alder, ash, poplar and willow. This seems to be related to two different processes: the beginning of a production-based economy (cultivation and herding) and progressive aridification. In fact, the Ifri Oudadane pollen sequence shows intense landscape transformation from the Epipalaeolithic to the Early Neolithic, which may have been the result of human activities, climate changes, or a combination of both.

After 6.6 ka calBP conditions became less favourable. Shrubs (*Tamarix*) and grasses (*Artemisia*) increased, indicating drier conditions and a degradation of forest into scrubland (macchia). Indicators for food production decrease at the same time as the markers for aridity rise. The end of the Ifri Oudadane Early Neolithic corresponds to a general gap in occupation between 6.6 and 6.0 ka calBP in arid and semiarid Morocco. Evidence for this change is also found in the alluvial deposits of the Moulouya, NE Morocco.

Furthermore, the ENA corresponds to the beginning of cultivation in the area, and therefore also with the occurrence of anthropic indicators and ruderal taxa (Zapata et al. 2013: 1293). This is consistent with other archaeobotanical studies (Ballouche & Marinval 2003; López-Sáez & López-Merino 2008; López-Sáez et al. 2011) that demonstrate the adoption of agriculture in the southern Iberian Peninsula and northern Morocco during the second half of the eighth millennium calBP. The carpological information in Ifri Oudadane shows that from around 7.6 ka calBP a wide array of cereals and legumes are being used at the site: barley (Hordeum vulgare), hulled wheat (*Triticum monococcum/Triticum dicoccum*), free-threshing wheat (*Triticum aestivum/Triticum durum*), hard wheat (*Triticum durum*), pea (*Pisum sativum*) and lentil (*Lens culinaris*). Contrary to what one might expect, the gathering of wild plants continues and even seems to increase during the Neolithic (Morales et al. 2013).

The palaeobotanical research carried out at Ifri Oudadane is an important step towards a better understanding of the Neolithic transition in North Africa. From a methodological point of view, this work highlights the need to collect and process as much sediment as possible by flotation in order to obtain a representative assemblage of plant remains. In fact, the absence of domesticated plants in North African Neolithic sites has traditionally been interpreted as the result of a pastoral economy. The research at Ifri Oudadane, on the other hand, has clearly shown that the absence of domesticated plants was simply due to lack of proper recovery techniques of plant remains.

Radiocarbon dated domesticated plant species of Neolithic sites from both Morocco and the Iberian Peninsula suggest a more or less contemporary spread of agriculture along both shores of the Western Mediterranean. Besides the gathering of wild food plants, there is tentative evidence of intensive use of esparto grass, which could be related to plaiting and basketry. Within the assemblage, domesticated species are represented by only a small number of seeds, which may indicate the significance of continuing foraging activities at the beginning of the Neolithic. It should be kept in mind, however, that the site was seasonally occupied in order to maximize the yield of some wild resources. Cultivated plants might therefore have played only a marginal role in the subsistence system, which was developed during the period the shelter was occupied. In the case of Ifri Oudadane this was in the second half of the year because most of the plants identified at the site produce fruits that ripen in autumn (Morales et al. 2013: 2667).

Faunal remains

In addition to remains associated with the hunting of game and the gathering of land snails, the archaeological assemblage provides substantial evidence for the exploitation of maritime resources, including fishing and the collection of marine molluscs. The study of the faunal remains shows a dominance of bird bones (more than 50 %) during the Epipalaeolithic (Roski 2015). During the Neolithic birds decline while fish bones increase significantly (more than 85 %). The second most important prey of the Epipalaeolithic period were rabbits. Turtles were hunted throughout the whole period. Large herbivores play a subordinate role and their percentages decrease towards the Neolithic. During the latter period ovicaprids (sheep and goat) appear, although their numbers make up less than ten percent of the whole Neolithic assemblage.

The study of terrestrial and marine molluscs is still in progress. A short survey of the land snails provide a dominance of genera *Otala* sp. throughout the whole sequence, followed by *Alabastrina* sp. (Hutterer et al. 2014: 86). A reason for the lack of temporal shifts may be the more stable humid conditions along the coastline compared to the dryer and more variable hinterland. Systematic perforations of the shells appear from ENA onwards, in accordance with other sites in the area (Hutterer 2014: 89). Marine molluscs were exemplarily sampled from the 2011 trench (Hutterer et al. unpubl. data). Altogether 8749 specimens (minimum number of individuals) of 38 species of shellfish were determined from the EPI to ENC layers. Limpets (Patellidae) dominate in the Epipalaeolithic, and topshells (Trochidae) in Neolithic layers. Evidence was found for a systematic butchering of topshells *Phorcusturbinatus*; shells in the Epipalaeolithic layers had been mostly smashed open, while topshells in Neolithic levels were usually opened in a uniform way. Seven species of molluscs showed traces of modification and had been used as ornaments or tools.

Results

Documentation

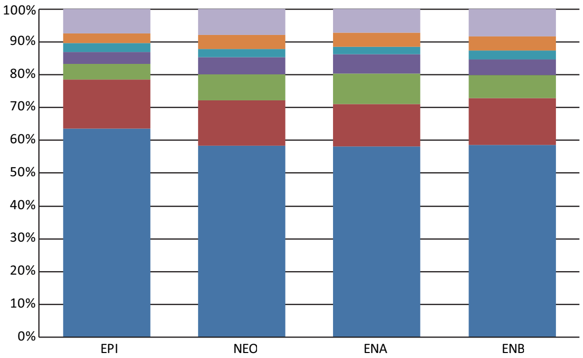
All tools, cores, management flakes as well as blanks with traces of use were documented photographically. A representative sample is arranged in figures 6, 7, 10 and 11. The depiction of individual artefacts is combined with several photographs and particular features are represented by signatures: a circle or filled circle indicates the location of a preserved or not preserved striking platform. Furthermore, stippled and dashed lines illustrate a steep retouch, a semi-steep retouch or use traces, respectively. A white arrow marks the direction of percussion of negatives; if a negative ends in a hinge, the letter "H" is printed at the tip of the arrow. Thin, short lines represent fractures.

Raw material analysis

Three main groups of raw materials and a few exotic varieties can be distinguished in the Ifri Oudadane assemblage (Fig. 3). It is already possible to differentiate these main groups into several subgroups, although further research is needed here for additional assessment. A systematical survey covering the entire research area, in particular the river banks of Oued Kert and Oued Moulouya and their tributaries, permitted a preliminary reconstruction of raw material procurement. Investigations with infrared spectroscopy, optical/polarized microscopes as well as X-Ray diffraction are in progress, with the intention of specifying the lithic raw material supply of this region.

The most frequent raw material of the Ifri Oudadane assemblage is a Black Silex of uncertain origin. Mineralogical analyses are still in progress. Initial pieces are small pebbles with a maximal diameter of 8 cm, displaying a cortex clearly characterised by alluvial transport. The raw material itself is of high quality, but due to the small dimensions of the pebbles, the blanks are very limited in size. None of these pebbles could be found in the nearby gravel beds of the lower Oued Kert. However, the large quantities of this raw material suggest an origin not far from the site. Further systematic surveys are needed to detect the primary or secondary deposits of the Black Silex.

The second main group of raw material can be found in the gravel banks of the Oued Moulouya. This group can be divided into two subgroups of unknown primary deposition. The first heterogeneous subgroup is our so-called "Moulouya Brown". Under this artificial term we subsumed diverse brownish to grey varieties. The second subgroup defines the more homogeneous type of "Moulouya White". Both of them appear as pebbles in the gravels of the Oued. The mainly yellowish cortex is heavily rounded due to fluvial transportation. The granularity of Moulouya Brown is usually fine and occasionally layered, whereas Moulouya White is characterized by a coarser granularity without any layering. Inclusions of quartz and fissures are visible in both types. Moulouya Brown can be further divided into two groups by colour: one group varies from light to dark brown, the other group from light to dark grey. More rarely, a reddish hue can be noticed in both groups. Usually the edges of the raw material are translucent, but there are pieces which are completely translucent. Most of the Moulouya Brown pieces have a matt to silky appearance. In contrast, Moulouya White features a homogeneous light grey to white colour. Additionally, the flint is opaque and matt. Based on their granularity, the fracture properties of Moulouya Brown is



	EPI		NEO		ENA		ENB	
undecidable	43	(7%)	43	(8%)	16	(7%)	27	(8%)
Vulkanite, general	4	(< 1%)	2	(< 1%)	-	-	2	(< 1%)
Silty Slate	-	-	2	(< 1%)	1	(< 1%)	1	(< 1%)
Quarzite	7	(1%)	10	(2%)	3	(1%)	7	(2%)
Gravel White	-	-	1	(< 1%)	-	-	1	(< 1%)
Exotic Fine Yellow	3	(< 1%)	1	(< 1%)	1	(< 1%)	-	-
Exotic Fine Red	2	(< 1%)	2	(< 1%)	2	(< 1%)	-	-
Moulouya White	1	(< 1%)	6	(1%)	3	(1%)	3	(< 1%)
Limestone	16	(3%)	14	(3%)	5	(2%)	9	(3%)
Oumazzine	21	(4%)	28	(5%)	13	(6%)	15	(5%)
Calzedon	27	(5%)	44	(8%)	21	(9%)	23	(7%)
Moulouya brown	86	(15%)	75	(14%)	29	(13%)	46	(14%)
Black Silex	366	(64%)	320	(58%)	130	(58%)	190	(59%)
total	576	(100%)	548	(100%)	224	(100%)	324	(100%)

Fig. 3. Cumulative bar diagram and table showing the use of raw materials during the different periods. Colours in the table correspond to colours in the bar diagram. The colour orange represents several raw materials which only occur in small quantities.

Abb. 3. *Das kumulative Balkendiagramm und die Tabelle zeigen die Anteile und absolute Anzahlen der genutzten Rohmaterialen während der verschiedenen Phasen. Die Farben in der Tabelle stimmen mit den Farben im Balkendiagramm überein. Orange repräsentiert mehrere Rohmaterialien, die nur in geringen Häufigkeiten auftreten.*

superior; this observation supports the idea that Moulouya White was used first for flake production. Both materials show conchoidal fractures. It should be mentioned that it is sometimes difficult to separate the grey varieties of Moulouya Brown from Black Silex, especially when cortex is absent.

The third main group is called "Oumazzine", which can be found as pebbles in the Oued Oumazzine and its tributaries, as well as in the delta of Oued Kert (Fig. 3). Its primary deposit is still unknown. The structure of the flint displays a fine to small granularity without any layering, but many inclusions. Fissures as well as fossils can be observed. The colour is mainly yellow or red with many black or grey spots of different sizes. Usually the flint is opaque and matt. The fracture properties can be described as good.

Finally, a few exotic raw materials were used. Firstly, there is a rather inhomogeneous, but to some extent knappable material named "Chalcedony" (see also Nami & Moser 2010: 53; Moser 2003: 25). The range of colours is large and many inclusions are visible. A potential source is unknown. Furthermore, limestone, quartzite, silty slate and unspecific vulcanites were used, available in the surroundings of the shelter. A few pieces of very fine red and yellow siliceous material defined as "Exotic Fine Red" and "Exotic Fine Yellow" complete the range of raw materials.

Operational sequence – production, use and discard of blanks and tools (integration of qualitative and quantitative data)

The following overview of raw material procurement, lithic technology and tool composition provides a picture of a relatively stable and continuous stone tool production from the Epipalaeolithic to the Early Neolithic at Ifri Oudadane. Therefore, the lithic assemblage can be presented here as a consistent operational sequence (*chaîne opératoire*). General differences between Epipalaeolithic and early Neolithic assemblages will be assessed based on quantitative data, such as artefact dimensions and technological features. The results of the quantitative studies are presented together with the general operational sequence within the respective phase of reduction. The operational sequence is subdivided into six steps: 1=raw material procurement, 2=decortication, 3=core preparation, 4=blank production, 5=corrections, 6=modification and use.

(1) Raw material procurement

The range of utilized raw material varieties is presented in chapter 2.2. Dominant raw material is the so-called Black Silex, followed by Moulouya Brown, Chalcedony and Oumazzine (Fig. 4). All of the initial pieces that were brought to the site were pebbles, therefore coming from secondary sources. Areas of origin are most likely the immediate surroundings of Ifri Oudadane and Oued Moulouya. Untested pebbles are only preserved in the Neolithic layers, unlike tested pieces which are present in both Neolithic and Epipalaeolithic layers (Fig. 5).

(2) Decortication

Cortical flakes, whose dorsal faces are covered entirely with cortex, attest to the production of cores at the site. The low percentage of complete cortical flakes, approximately 1 % within the Epipalaeolithic as well as the Neolithic assemblage (Fig. 5), suggests that only parts of the pebble were decorticated. The reason is the relatively small size of these pebbles, with a maximum of 8 cm in diameter. A complete decortication would result in a very small nucleus, unsuitable for further exploitation. As a result, nearly all remnant cores show remains of cortex (Figs. 6: 1, 3, 4 & 7: 1, 4, 6, 8).

(3) Core preparation

Blank production started immediately after core production. The technique of preparing a crest by alternating retouch from 90 degree is evident.

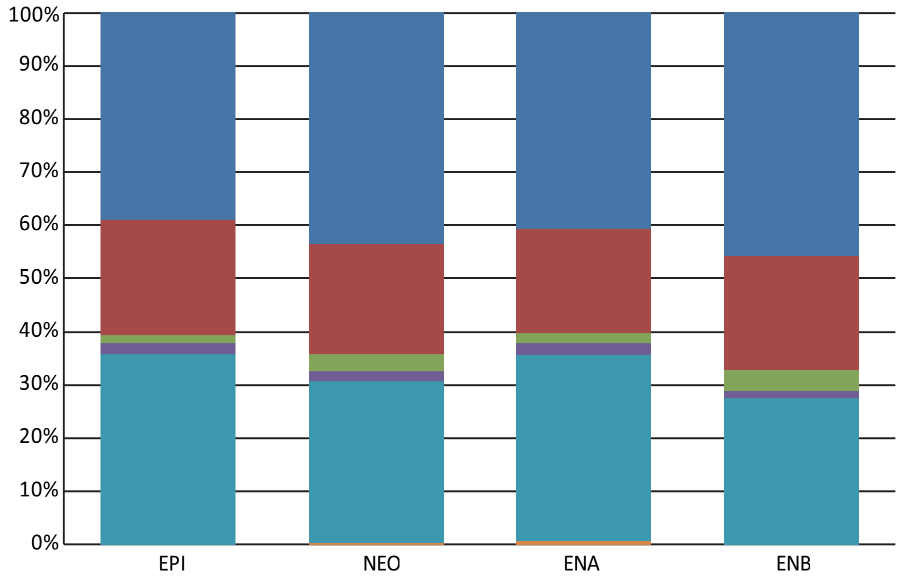
Fig. 4. Map of the study area showing sites mentioned in the text, raw material sources and main rivers systems. Only one primary raw material source, Ain Zohra, is known in the region. All other deposits are secondary sources and the raw material was collected most likely from river gravels (Oued Oumazzine, Oued Moulouya and Oued Kert). The origin of the dominant raw material in the Ifri Oudadane assemblage, Black Silex, is still unknown.

***Abb. 4.** Karte des Arbeitsgebietes mit im Text erwähnten Fundstellen, Rohmaterialquellen und den Hauptflusssystemen. In der Region ist nur eine primäre Lagerstätte, Ain Zohra, bekannt. Alle anderen Rohmaterialien stammen höchstwahrscheinlich aus Flussschottern (Oued Oumazzine, Oued Moulouya und Oued Kert) und damit sekundärer Lagerung. Die Herkunft des Black Silex, welcher das Inventar dominiert, ist bislang unbekannt.*

However, only a single specimen of a crested blade from the Epipalaeolithic as well as the Neolithic assemblage respectively shows that this technique was rarely applied. Alternatively, the edge between first negatives and remaining cortex was used as a crest. The huge amount of partial cortical flakes and particularly blades shows that these blanks were already seen as final products. Therefore, several retouched tools show remains of cortex (see Fig. 11: 6, 8, 16).

(4) Blank production

Target products were blades and flakes. Blades are defined as blanks with relatively parallel edges and a length more than twice the width. The term bladelet is used according to Tixier (1963: 36) for blades with a width smaller than 12 mm. Because more than three thirds of the Ifri Oudadane blades are bladelets, only the latter term will be used in the following, in particular in contrast to flakes. The fact that blades were outnumbered by flakes does not necessarily mean that flakes were the most valued final products. Instead, the quality and size of the initial pieces did not allow proper blade production. An alternative explanation is that more blades could have left the production sequence and been removed from the site as final products. The quality of the initial pieces could also be responsible for the relation of regular and irregular blades (Fig. 5). Furthermore, Floss (2013: 128) points to the fact that the removal of blanks frequently starts with blade production, and switches to the production of flakes with decreasing core size. The Ifri Oudadane sample may fit into this model. While a



			EPI		NEO		ENA		ENB	
knapped material	flakes	cortical flakes	7	(1%)	5	(< 1%)	2	(< 1%)	3	(< 1%)
		partially cortical flakes	106	(18%)	126	(30%)	46	(21%)	80	(25%)
		non-cortical flakes	111	(19%)	108	(20%)	43	(19%)	65	(20%)
	blades	partially cortical irregular blades	20	(3%)	19	(3%)	7	(3%)	12	(4%)
		non-cortical irregular blades	87	(15%)	74	(13%)	31	(14%)	43	(13%)
		partially cortical regular blades	2	(< 1%)	5	(< 1%)	1	(< 1%)	4	(1%)
		non-cortical regular blades	16	(3%)	15	(3%)	5	(2%)	10	(3%)
cores	flake cores	irregular with multiple platforms	5	(< 1%)	6	(1%)	2	(< 1%)	4	(1%)
		irregular with two platforms	-	-	3	(< 1%)	-	-	3	(< 1%)
		unipolar with one platform	2	(< 1%)	5	(< 1%)	1	(< 1%)	4	(1%)
	blade cores	unipolar with one platform	-	-	2	(< 1%)	1	(< 1%)	1	(< 1%)
		bipolar with two platforms	1	(< 1%)	-	-	-	-	-	-
	undeterminable	irregular with multiple platforms	-	-	1	(< 1%)	-	-	1	(< 1%)
		undeterminable	1	(< 1%)	-	-	-	-	-	-
core maintenance products	core tablets		1	(< 1%)	-	-	-	-	-	-
	partial core tablets		4	(< 1%)	2	(< 1%)	1	(< 1%)	1	(< 1%)
	core flanks		3	(< 1%)	3	(< 1%)	2	(< 1%)	1	(< 1%)
	crested blade		1	(< 1%)	1	(< 1%)	-	-	1	(< 1%)
	reverse hinge termination		3	(< 1%)	2	(< 1%)	-	-	2	(< 1%)
	core preparation flake		-	-	2	(< 1%)	2	(< 1%)	-	-
debris	shatter		202	(35%)	156	(28%)	71	(32%)	85	(26%)
	microburin		2	(< 1%)	2	(< 1%)	2	(< 1%)	-	-
	tested piece		1	(< 1%)	3	(< 1%)	1	(< 1%)	2	(< 1%)
	untested piece		-	-	6	(1%)	4	(2%)	2	(< 1%)
nucleus tools			-	-	2	(< 1%)	2	(< 1%)	-	-
undecidable			1	(< 1%)	-	-	-	-	-	-
total			576	(100%)	548	(100%)	224	(100%)	324	(100%)

Fig. 5. The table shows the amount and percentage of types of blanks according to occupation phases. The cumulative bar diagram depicts percentages of main blank types in the table. The colours indicated in the table correspond to the colours used in the bar diagram.

Abb. 5. *Die Tabelle zeigt Anzahl und Prozentsätze der Grundformen aus den Inventaren der jeweiligen Belegungsphasen. Die Farben in der Tabelle entsprechen denen des kumulativen Balkendiagramms.*

considerable number of blades and bladelets are preserved, hardly any of the cores bear negatives of blades or bladelets.

For each artefact the length, width and thickness were measured. During the analysis of these values, only intact pieces were considered. For this reason, the absolute numbers vary from one category to another. The results can be seen in figure 8. The minimum, first quartile, median, mean, third quartile, maximum and standard deviation were calculated and most values visualized in box plot diagrams.

Altogether, the results show that the Neolithic and Epipalaeolithic assemblages are very similar. Only a few, minor differences can be recognized: during the Neolithic bladelets seem to be slightly longer, and two outliers from this period are remarkable in their length. On the other hand, Epipalaeolithic bladelets seem to be narrower and thinner. Also noteworthy are three exceptionally long Epipalaeolithic flakes, even the measurements of the flakes in general, are very much the same. Moreover, the scatter plot and the table in figure 8 illustrate the similarity between the Epipalaeolithic and Neolithic assemblages. There are no recognizable differences within the group of flakes. Similar observations can be made for bladelets. To summarize, there are no changes in the metrics of lithic artefacts from the transition Epipalaeolithic to Neolithic at Ifri Oudadane. Instead, the similarity of the lithics from both periods is outstanding.

Throughout all periods, the production process seems to have started with unipolar reduction. Only one Epipalaeolithic nucleus shows traces of bipolar reduction, with a nucleus providing two opposing and contemporarily used striking platforms. Seven flake cores and only one unipolar blade core left the production process as unipolar cores, probably due to the less advantageous shape of the initial piece (Fig. 7: 4) or unsuccessful reduction (Fig. 7: 6, 8). In cases where unipolar reduction was no longer promising, even though the core still offered enough mass to exploit, a second knapping platform could be created at an angle of 90 degrees. Three of these remnant cores are preserved from the ENB phase (Fig. 7: 5). In most cases, the final stage seems to have been an irregular reduction with multiple platforms. This opportunistic strategy was usually pursued to the absolute exhaustion of the core (Fig. 6: 8 & Fig. 7: 1).

Descriptions of knapping techniques are based on the study of butt form and butt type as well as the shaping of bulb and lip. The butt forms observed at Ifri Oudadane are very diverse. Irregular forms dominate. Furthermore, linear, oval, rectangular, trapezoid, rhomboidal, triangular, ridge-shaped and punctuate butts appear. The butt form gives only a vague indication of the applied knapping techniques. Floss and Weber (2013: 134) interpret ridge-shaped and punctuate butts as an indication of soft hammer technique. However, due to the high number of different butt forms, pressure flaking or indirect percussion cannot be excluded. A few extremely regular bladelets with parallel negatives support this interpretation (see Fig. 10: 4, 6, 20; Fig. 11: 10; Fig. 13: 2).

Faceted butts are also present. They occur at a later point in the *chaîne opératoire*. This indicates either a change of technique during knapping, or is simply the result of ridges stemming from the rotation of the nucleus due to irregular reduction. Within the Epipalaeolithic assemblage, faceting appears exclusively on pieces without any cortex. In contrast, Neolithic blanks already have faceted butts on pieces with cortex on more than two thirds of the find. The same is true for dorsal reduction.

Another technical characteristic connected with knapping techniques is the shaping of the lip. The total percentage of pronounced and less pronounced lips fluctuates between 20 and 50 %. Pronounced lips indicate tendentially hard and direct percussion. Less pronounced lips may have been produced by pressure flaking (Binder et al. 2012: 200), or even soft hammer technique (Floss & Weber 2013: 134). An identifiable bulb appears on 30 % of all pieces. There is no difference either in the relation to cortex cover between the Epipalaeolithic and Neolithic sub-assemblages.

When comparing flakes and blades or bladelets, no significant difference is detectable. The ratio of dorsal reduction, facetted butts as well as lips and bulbs is nearly identical in both assemblages. There are indications for direct hard and soft hammer techniques. Indirect percussion and pressure flaking also seems to be likely. Furthermore, no particular technique for blade or flake production was used.

(5) Corrections

Despite the predominantly opportunistic reduction strategy, several pieces show evidence of correction after accidents had occurred, as well as a regeneration of the longitudinal convexity. Six partial and one complete core tablet attest to the installation of a new platform after too many failed impacts. This kind of modification prevails in the Epipalaeolithic assemblage, suggesting more effort was invested in the preparation of cores during their use within this period. The reverse hinge termination or *outrepassé* is another artefact type which needs to be assigned to this phase of the reduction sequence. Floss (2013: 127) classifies *outrepassées* as serious accidents resulting, in general, in the abandonment of the core, as could be the case for the find shown in figure 6: 7. In certain cases (Figs. 6: 10 & 7: 3) an *outrepassé* might have been used to remove hinges and the remains of other accidents from the surface or to restore the longitudinal convexity of the reduction surface. So-called core flanks also derive from the cleaning of the debitage surface. However, in this case, a considerable part of the core itself was removed and not just a blade nor a flake, probably to repair more severe accidents during knapping (Fig. 6: 5 & 6).

(6) Modification and use

Some differences were observed in the composition of the toolkits from the Epipalaeolithic and Neolithic assemblages, but these do not appear to be highly significant. The percentage of tools, 13.2 % for the Epipalaeolithic and 12.6 % for the Neolithic period (ENA: 12.5 %; ENB: 12.6 %), also shows no noteworthy difference. Due to their limited number and in order

Fig. 6. Selected cores from the Epipalaeolithic layer and the transition zone between Epipalaeolithic and Early Neolithic A (ENA): 1: flake core, unipolar, one platform, Moulouya Brown; 2: flake core, irregular, multiple platforms, Black Silex; 3: flake core, irregular, multiple platforms, Moulouya Brown; 4: flake core, irregular, two platforms, Black Silex; 5: core flank, Black Silex; 6: core flank, Black Silex; 7: reverse hinge termination, Moulouya Brown; 8: flake core, irregular, multiple platforms, Black Silex; 9: bladelet core, unipolar, one platform, Black Silex: 10: reverse hinge termination, Black Silex.

continued →

Fig. 7. Selected cores of the Early Neolithic B (ENB) layer: 1: flake core, irregular, multiple platforms, Moulouya Brown; 2: blade core, unipolar, one platforms, Moulouya Brown; 3: reverse hinge termination, Black Silex; 4: flake core, unipolar, one platform, Chalcedony; 5: flake core, irregular, two platforms, undeterminable; 6: blade core, unipolar, one platform, Black Silex; 7: flake core, unipolar, one platform, Chalcedony; 8: flake core, unipolar, one platform, Black Silex.

Abb. 7. *Ausgewählte Kerne des Early Neolithic B (ENB): 1: Abschlagkern, irregulär, mehrere Schlagflächen, Moulouya Brown; 2: Klingenkern, unipolar, eine Schlagfläche, Moulouya Brown; 3: Kernfuß, Black Silex; 4: Abschlagkern, unipolar, eine Schlagfläche, Chalcedon; 5: Abschlagkern, irregulär, zwei Schlagflächen, unbekanntes Rohmaterial; 6: Klingenkern, unipolar, eine Schlagfläche, Black Silex; 7: Abschlagkern, unipolar, eine Schlagfläche, Chalcedon; 8: Abschlagkern, unipolar, eine Schlagfläche, Black Silex.*

Abb. 6. *Ausgewählte Kerne und Präparationsabschläge des Epipaläolithikums und aus dem Übergang von Epipaläolithikum zum Early Neolithic A (ENA): 1: Abschlagkern, unipolar, eine Schlagfläche, Moulouya Brown; 2: Abschlagkern, irregulär, mehrere Schlagflächen, Black Silex; 3: Abschlagkern, irregulär, mehrere Schlagflächen, Moulouya Brown; 4: Abschlagkern, irregulär, zwei Schlagflächen, Black Silex; 5: Kernflanke, Black Silex; 6: Kernflanke, Black Silex; 7: Kernfuß, Moulouya Brown; 8: Abschlagkern, irregulär, mehrere Schlagflächen, Black Silex; 9: Lamellenkern, unipolar, eine Schlagfläche, Black Silex; 10: Kernfuß, Black Silex.*

length of blades

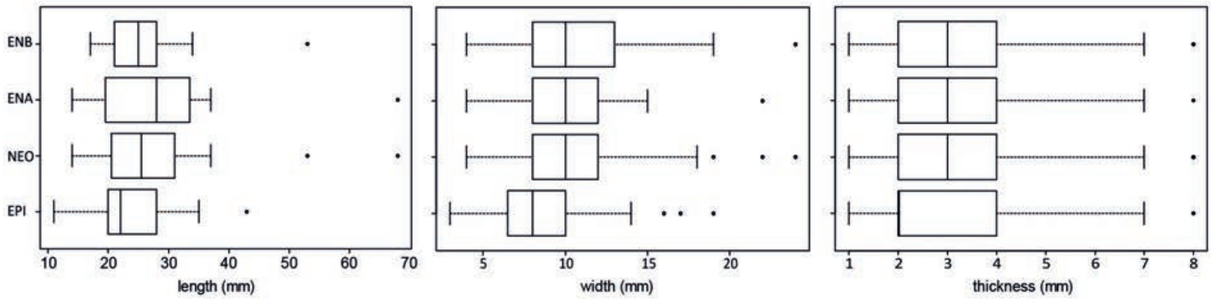
	n	min	1st Qu.	median	mean	3rd Qu.	max	std. dev.
ENB	17	17	21	25	26,53	28	53	28,32
ENA	11	14	19,5	28	29,36	33,5	68	14,97
NEO	28	14	20,75	25,5	27,64	30,5	68	11,23
EPI	25	11	20	22	23,6	28	43	8,02

width of blades

	n	min	1st Qu.	median	mean	3rd Qu.	max	std. dev.
ENB	57	4	8	10	10,72	13	24	3,73
ENA	36	4	8	10	10,25	12	22	3,53
NEO	93	4	8	10	10,54	12	24	3,64
EPI	112	3	6,75	8	8,59	10	19	2,85

thickness of blades

	n	min	1st Qu.	median	mean	3rd Qu.	max	std. dev.
ENB	73	1	2	3	3,55	4	8	1,64
ENA	44	1	2	3	3,41	4	8	1,52
NEO	117	1	2	3	3,47	4	8	1,59
EPI	127	1	2	2	2,83	4	8	1,41



length of flakes

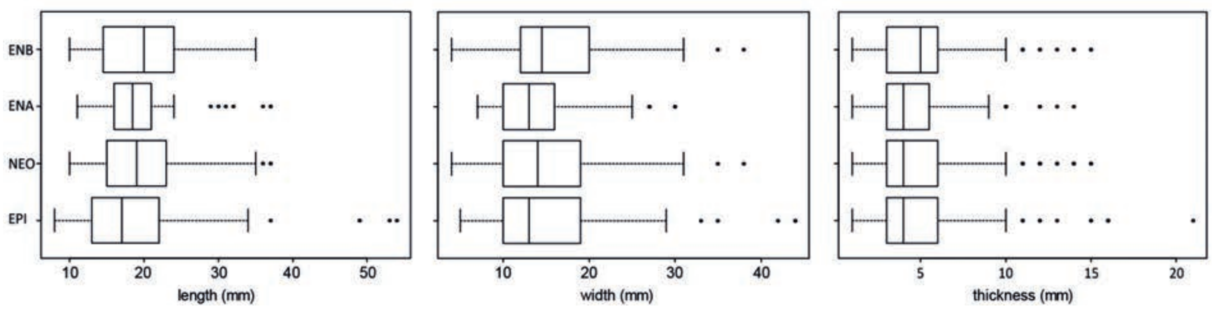
	n	min	1st Qu.	median	mean	3rd Qu.	max	std. dev.
ENB	87	10	14,5	20	19,77	24	35	6,28
ENA	46	11	16	18,5	19,76	21	37	6,62
NEO	133	10	15	19	19,77	23	37	6,37
EPI	102	8	13	17	18,86	22	54	8,81

width of flakes

	n	min	1st Qu.	median	mean	3rd Qu.	max	std. dev.
ENB	116	4	12	14,5	15,97	20	38	6,4
ENA	66	7	10	13	14,05	16	30	5,67
NEO	182	4	10	14	15,27	19	38	6,2
EPI	150	5	10	13	14,93	19	44	7,13

thickness of flakes

	n	min	1st Qu.	median	mean	3rd Qu.	max	std. dev.
ENB	149	1	3	5	5,23	6	15	2,98
ENA	96	1	3	4	4,63	5,25	14	2,68
NEO	245	1	3	4	4,99	6	15	2,87
EPI	231	1	3	4	4,68	6	21	3,02

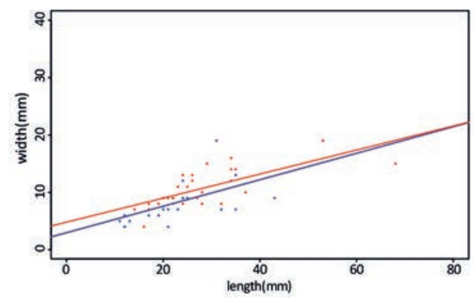


blades

	n	min	1st Qu.	median	mean	3rd Qu.	max	std. dev.
ENB	15	1,85	2,1	2,22	2,3	2,4	3	0,33
ENA	10	2	2,46	3,25	3,21	3,93	4,53	0,85
NEO	25	1,84	2,13	2,67	2,67	3	4,53	0,74
EPI	25	1,63	2,44	2,79	2,97	3,17	5,25	0,97

flakes

	n	min	1st Qu.	median	mean	3rd Qu.	max	std. dev.
ENB	87	0,37	0,91	1,18	1,27	1,51	2,67	0,44
ENA	46	0,87	1,23	1,46	1,46	1,7	2,14	0,32
NEO	133	0,37	1,07	1,28	1,34	1,61	2,67	0,41
EPI	102	0,33	1,05	1,29	1,34	1,6	3,14	0,49



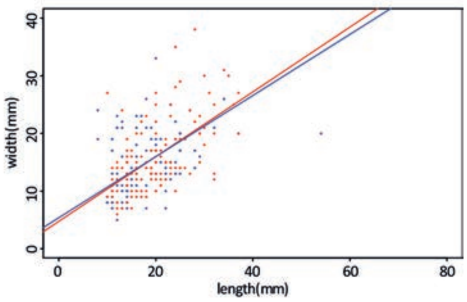
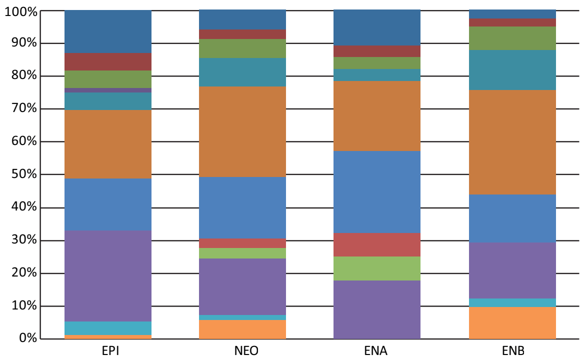


Fig. 8. Basic statistic values for blades and flakes from the Ifri Oudadane assemblage according to occupation phases. The bold line inside the box represents the median and the left and right part of the box show the lower and upper quartile, respectively. The dashed lines (whisker) display the minimum and maximum of the distribution. Points are outliers, which do not lie within a 1.5 interquartile range. There is almost no difference detectable between the Epipalaeolithic and Neolithic sub-assemblages.

Abb. 8. *Statistische Werte für Klingen und Abschläge. Die fette Linie innerhalb der Box stellt den Median dar, der linke bzw. rechte Teil der Box repräsentiert das untere bzw. ober Quartil. Die gestrichelten Linien stehen für das Minimum bzw. Maximum der Verteilung. Punkte sind Ausreißer, welche mehr als das 1,5-fache des Interquartilsabstandes vom Median abweichen. Zwischen den statistischen Werten der epipaläolithischen und neolithischen Inventare sind keine Unterschiede fest zustellen.*

to enable statistical comparability, the tools are not classified using the very detailed Tixier system (Tixier 1963), but are grouped as shown in figure 9. In addition, the low grade of standardisation often did not allow a distinct assignment to a certain Tixier-type.

Bladelets and flakes showing lateral retouch are the most frequent tools, in addition to pieces with unspecific retouch (Fig. 11: 1-7). Percentages range between 21 % (Epipalaeolithic) up to 31 % (ENB). The second most frequent tool types are notched pieces,



	EPI		NEO		ENA		ENB	
backed bladelet	10	(13%)	4	(6%)	3	(11%)	1	(2%)
microlith	4	(5%)	2	(3%)	1	(4%)	1	(2%)
burin	4	(5%)	4	(6%)	1	(4%)	3	(7%)
denticulated piece	1	(1%)	-	-	-	-	-	-
end retouch	4	(5%)	6	(9%)	1	(4%)	5	(12%)
lateral retouch	16	(21%)	19	(28%)	6	(21%)	13	(32%)
notched piece	12	(16%)	13	(19%)	7	(25%)	6	(15%)
nucleus tool	-	-	2	(3%)	2	(7%)	-	-
perforator	-	-	2	(3%)	2	(7%)	-	-
other retouch	21	(28%)	12	(17%)	5	(18%)	7	(17%)
scraper	3	(4%)	1	(1%)	-	-	1	(2%)
splintered piece	1	(1%)	4	(6%)	-	-	4	(10%)
total	76	(100%)	69	(100%)	28	(100%)	41	(100%)

Fig. 9. Cumulative bar diagram and table showing the percentages of stone tools according to occupation phases. Colours in the table correspond to colours in the bar diagram.

Abb. 9. *Das kumulative Balkendiagramm und die Tabelle zeigen die Prozentsätze und absoluten Zahlen der Werkzeuge nach Phasen. Die Farben in der Tabelle entsprechen jenen im Diagramm.*

with nearly equal percentages in all assemblages. Notches are found on blades (Fig. 11: 6) as well as on flakes (Fig. 11: 9). Noticeable within the assemblages are long notched blades made out of rare Oumazzine Silex, most frequently found within the transition between Epipalaeolithic and Neolithic layers (Fig. 11: 14-18), but also common within the ENA and ENB assemblages (Fig. 11: 5, 13). The retouch forming the notches appears on the dorsal as well as on the ventral faces of the blanks. A single denticulated piece is preserved from the Epipalaeolithic layer. Richter (2013: 293) defines denticulated pieces as blanks showing a number of connected steep to semi-steep notches. Use wear analysis has shown that denticulated pieces may in some cases represent notched pieces which were used for a long period of time, which in turn could indicate an extended occupation of the site (Dibble 1988). Accordingly, the low ratio of denticulates to notched pieces within the Ifri Oudadane assemblage may point towards shorter occupational events.

The following tool types only occur in smaller percentages (2 - 7 %). A few pieces show end retouch (Fig. 11: 4). The function of these pieces is rather unclear and might be manifold. Following Pasda (2013: 435), this kind of retouch could result from the shaping of the artefact in the context of hafting or in forming a working edge. The latter can only be verified by use wear analysis. Only two perforators are present and they originate from the ENA assemblage. Following the terminology of Tixier, these are referred to as *perçoir simple*. However, according to Floss (2013: 479), perforators with a massive tip in the longitudinal axis are termed as bec (Fig. 11: 8). A considerable amount of perforators are associated with several hundreds of ostrich eggshell beads in the contemporary Epipalaeolithic assemblage of Hassi Ouenzga Abri. A correlation between these perforators and bead production is probable (Linstädter 2003, 2004). The few ostrich eggshell beads from Ifri Oudadane are more or less concentrated in the ENB.

In total there are five endscrapers, three from the Epipalaeolithic layers, one from the ENB assemblage, and one from the mixed zone between the Epipalaeolithic and ENA layers (Fig. 11: 16). It is assumed that scrapers were used to treat soft material such as skin; but hard materials such as bone, ivory, antler or wood were also processed (Kind 2013: 416). Thus, only use wear analysis can possibly give insights into the actual function of these finds. Several burins are also evident, almost uniformly distributed in the Epipalaeolithic and Neolithic assemblages. The interpretation of the function of burins is as difficult as for other tool types (Pasda 2013: 426). It has been frequently suggested these artefacts were utilised when working hard materials such as bone and antler in the context of the groove and splinter technique. The Ifri Oudadane burins are simple tools on flakes without any preparation of an end retouch before performing the burin blow. One of the pieces can be identified as a "*burin d'angle sur troncature convexe*" according to Tixier (Fig. 11: 10), another is a so-called dihedral burin (Fig. 11: 11). Splintered pieces are the last category of common, medium- sized tools. We classify splintered pieces (*pièce esquillée*) as rectangular pieces with dorso-ventral chipping at two opposing edges. They are predominantly interpreted as cores or punches used to break up hard organic material such as bone (Le Brun-Ricalens 2013: 445). Even though it cannot be excluded that they were used as cores, their function as intermediate pieces seems more likely when use wear traces (Fig. 11: 13) and fractures (Fig. 11: 12) are considered.

The last category presented here are microlithic tools, usually assumed to have functioned as arrowheads or other implements. This category is of particular interest as microlithic tools are occasionally used when assigning an assemblage to a cultural or chronological group, due to the presence or absence of these tools on the one hand or the percentage of geometrics or backed bladelets on the other. However, as already mentioned, the quantities of these tools are

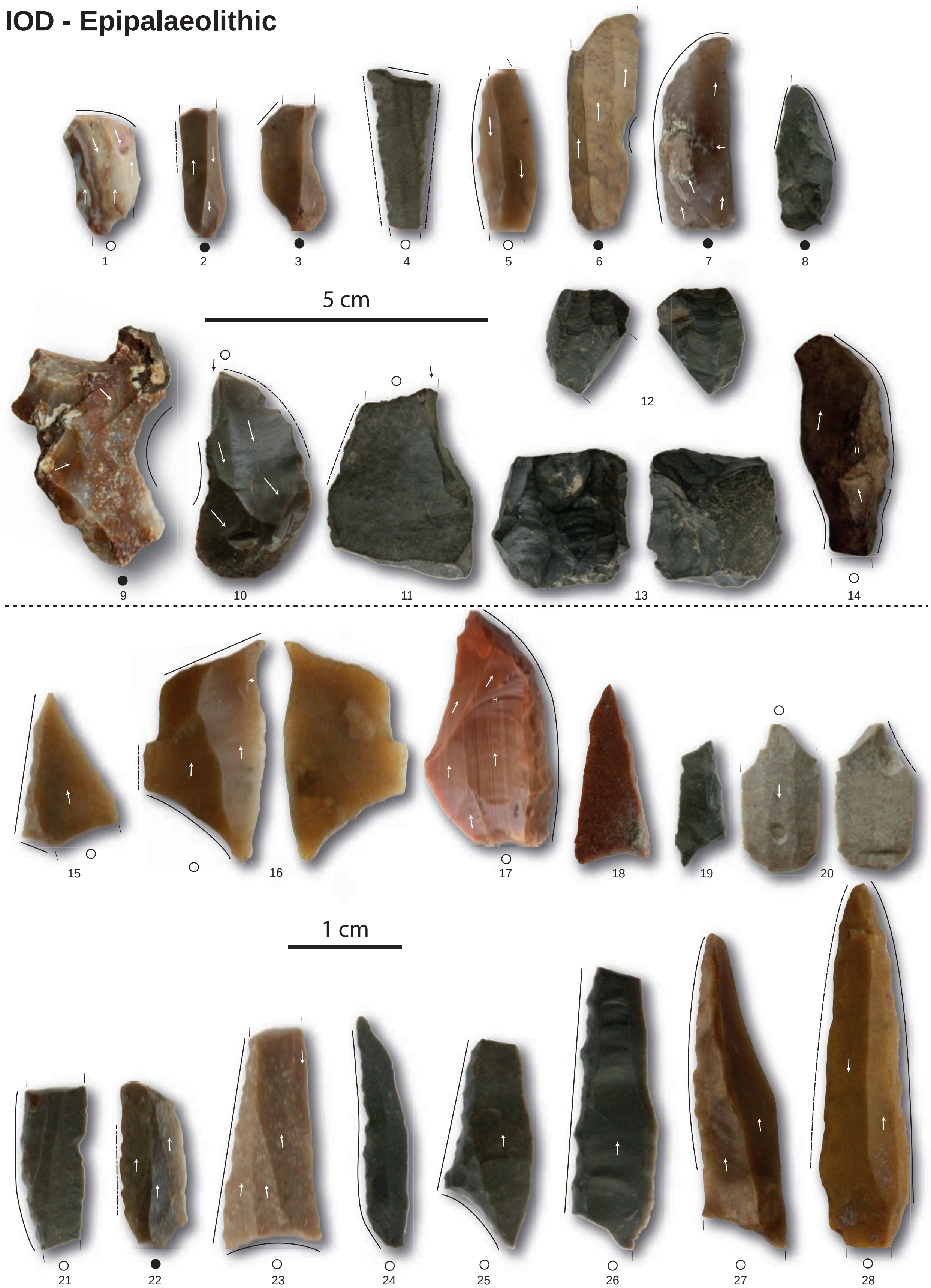


Fig. 10. Legend on following double page.

Abb. 10. *Legende auf folgender Doppelseite.*

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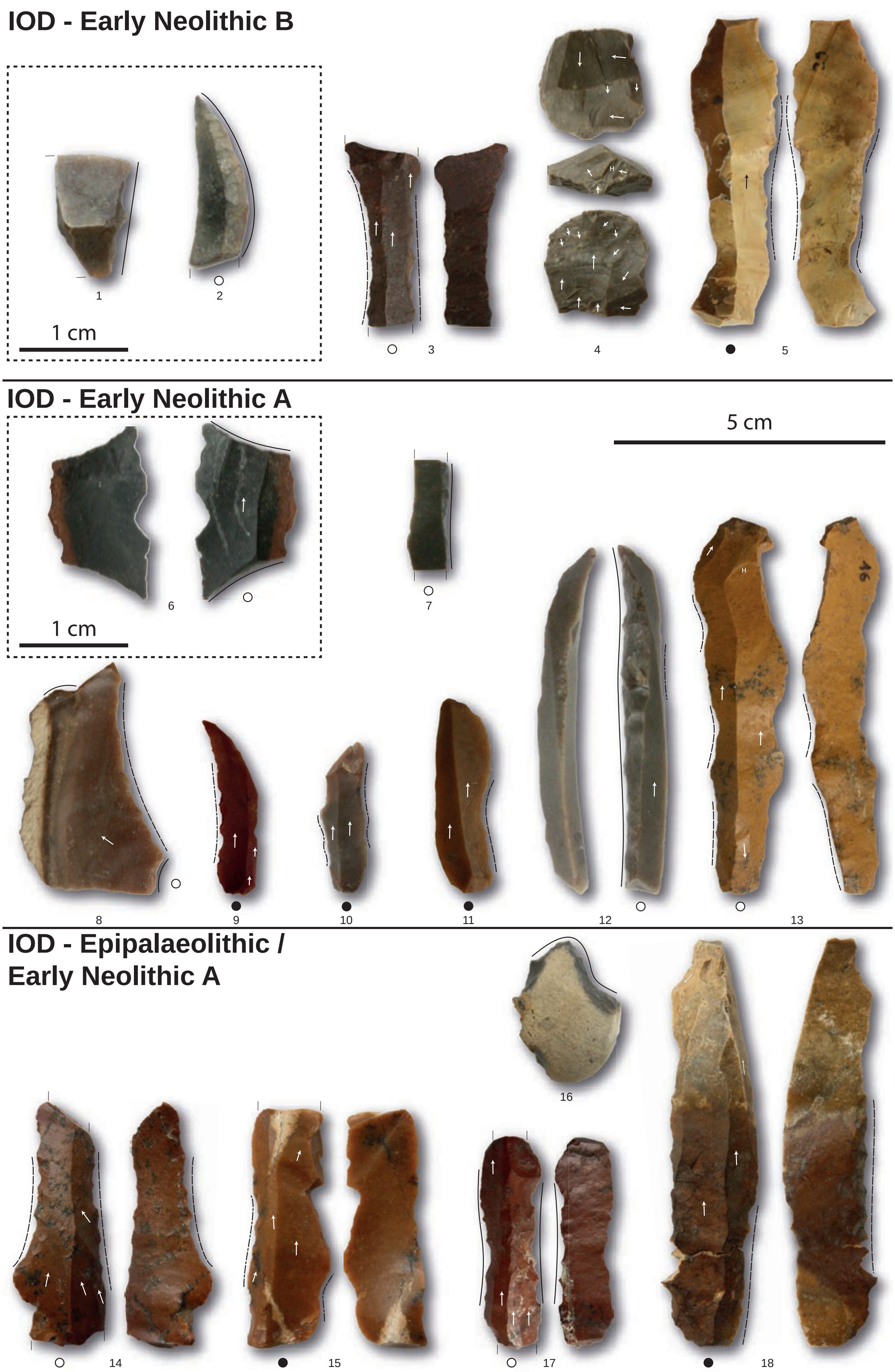

IOD - Early Neolithic B
1 cm
1
2
3
4
5
IOD - Early Neolithic A
5 cm
1 cm
6
7
8
9
10
11
12
13
IOD - Epipalaeolithic /
Early Neolithic A
16
14
15
17
18

Fig. 10. Epipalaeolithic tools from Ifri Oudadane: 1: end retouch, chalcedony; 2: use trace, Moulouya Brown; 3: end retouch, Moulouya Brown; 4: lateral and end retouch, projectile (?), Black Silex; 5: backed bladelet, Moulouya Brown; 6: notched piece, Moulouya Brown; 7: lateral retouch, Moulouya Brown; 8: perforator, Black Silex; 9: notched piece, Chalcedony; 10: burin, notched piece, Black Silex; 11: burin, Black Silex; 12: pièce esquille, Black Silex; 13: pièce esquille, Black Silex; 14: tanged piece, MP (?), Moulouya White; 15: microlith, Moulouya Brown; 16: trapeze, Exotic Fine Yellow; 17: backed bladelet, Exotic Fine Red; 18: backed bladelet, Moulouya Brown; 19: asymmetric triangle, Black Silex; 20: microburin, Black Silex; 21: backed bladelet, Black Silex; 22: use trace, Moulouya Brown; 23: backed bladelet, Moulouya Brown; 24: backed bladelet, Black Silex; 25: asymmetric triangle, Black Silex; 26: backed bladelet, Black Silex; 27: backed bladelet, Moulouya Brown; 28: backed bladelet, Exotic Fine Yellow.

Abb. 10. *Epipaläolithische Werkzeuge der Ifri Oudadane: 1: Endretusche, Chalcedon; 2: Gebrauchsspuren, Moulouya Brown; 3: Endretusche, Moulouya Brown; 4: laterale Retusche und Endretusche, Projektil (?), Black Silex; 5: rückengestumpfte Lamelle, Moulouya Brown; 6: gekerbtes Stück, Moulouya Brown; 7: laterale Retusche, Moulouya Brown; 8: Bohrer, Black Silex; 9: gekerbtes Stück, Chalcedon; 10: Stichel und gekerbtes Stück, Black Silex; 11: Stichel, Black Silex; 12: ausgesplittertes Stück, Black Silex; 13: ausgesplittertes Stück, Black Silex; 14: gestieltes Stück, Mittelpaläolithikum (?), Moulouya White; 15: Mikrolith, Moulouya Brown; 16: Trapez, Exotic Fine Yellow; 17: rückengestumpfte Lamelle, Exotic Fine Red; 18: rückengestumpfte Lamelle, Moulouya Brown; 19: asymmetrisches Dreieck, Black Silex; 20: Kerbrest, Black Silex; 21: rückengestumpfte Lamelle, Black Silex; 22: Gebrauchsspuren, Moulouya Brown; 23: rückengestumpfte Lamelle, Moulouya Brown; 24: rückengestumpfte Lamelle, Black Silex; 25: asymmetrisches Dreieck, Black Silex; 26: rückengestumpfte Lamelle, Black Silex; 27: rückengestumpfte Lamelle, Moulouya Brown; 28: rückengestumpfte Lamelle, Exotic Fine Yellow.*

Fig. 11. Neolithic tools from Ifri Oudadane: 1: microlith, Moulouya Brown; 2: backed bladelet, Black Silex; 3: lateral retouch and reverse hinge termination, Oumazzine; 4: splintered piece, Moulouya Brown; 5: notched piece and use trace, Oumazzine; 6: transverse arrowhead, Black Silex; 7: backed bladelet, Black Silex; 8: lateral retouch, Moulouya Brown; 9: use trace, Exotic Fine Red; 10: use trace, Moulouya Brown; 11: notched piece, Exotic Fine Yellow; 12: backed bladelet, Black Silex; 13: notched piece and lateral retouch, Oumazzine; 14: denticulated piece, Oumazzine; 15: use trace, Oumazzine; 16: scrapper, Black Silex; 17: denticulated piece, Oumazzine; 18: denticulated piece, Oumazzine.

Abb. 11. *Neolithische Werkzeuge der Ifri Oudadane: 1: Mikrolith, Moulouya Brown; 2: rückengestumpfte Lamelle, Black Silex; 3: laterale Retusche und Kernfuß, Oumazzine; 4: ausgesplittertes Stück, Moulouya Brown; 5:gekerbtes Stück und Gebrauchsspuren, Oumazzine; 6: Querschneider, Black Silex; 7: rückengestumpfte Lamelle, Black Silex; 8: laterale Retusche, Moulouya Brown; 9: Gebrauchsspuren, exotic fine red; 10: Gebrauchsspuren, Moulouya Brown; 11: gekerbtes Stück, exotic fine yellow; 12: rückengestumpfte Lamelle, Black Silex; 13: gekerbtes Stück und laterale Retusche, Oumazzine; 14: gezähntes Stück, Oumazzine; 15: Gebrauchsspuren, Oumazzine; 16: Kratzer, Black Silex; 17: gezähntes Stück, Oumazzine; 18: gezähntes Stück, Oumazzine.*

quite low and the standardisation is too indistinct to permit wide-ranging statements. Because of this, a differentiation between a *lamelle aiguë à bord abattu rectiligne* and a *triangle scalène allongé à petit côtè concave* according to Tixier was not possible in many cases. Nevertheless, several backed bladelets are evident. As they are often fragmented, further classification is difficult (Fig. 11: 21 & 26). Some of the partial damages can be interpreted as impact fractures, suggesting possible use as arrowheads. Backed bladelets are more frequent during the Epipalaeolithic (Fig. 9). Geometric microliths are even less frequent, but present. These include trapezes resembling the Tixier types *trapèze à un côté concave* (Fig. 11: 16) and *trapèze à deux côtés concaves* (Fig. 11: 6), *triangle scalène allongé à petit côtè concave* (Fig. 11: 19 & 25) as well as a transversal arrowhead (Fig. 11: 1). Damages on different edges (Fig. 11: 6) can also be explained as impact fractures.

Simpson-Index

The Simpson-Index was developed in 1949 by Edward H. Simpson to measure diversity (Simpson 1949: 688).

$$D = \frac{\sum(n(n-1)}{N(N-1)}$$

Originally designed for the evaluation of biodiversity, it has been broadly applied to archaeology, especially to lithic assemblages (see Dibble & Mellars 1992; Richter 1990; Uthmeier 2004; Medved 2013). It considers the number of different tool types as well as their abundance:

Where n is the absolute frequency of a tool type and N the absolute number of all tools. The exponentially increasing index can have values between 0 and 1, whereby 0 represents a highly diverse assemblage and 1 points towards a specialisation in the toolset. Richter (1990) compared the Simpson-Index of 91 late Magdalenian sites in Central Europe. The results reflect three distinct site types, each one occupied within a shifting activity cycle. The longer the site was used, the more pronounced its diversity. Even so, some preconditions do have to be fulfilled prior to the application of this method. First, the site should have been completely excavated in order to reveal activity zones. In addition, the stratigraphy should permit the distinction of two or more occupational events. In the best scenario, it should be possible to isolate short-time occupational events within one stratigraphic layer. Furthermore, different types of sites should be included since the Simpson-Index only gives insights into diversity when sites are compared.

The Simpson-Indexes for Ifri Oudadane and nearby Epipalaeolithic and Neolithic sites of the eastern Rif are shown in figure 12. It can be clearly seen, that all sites have low index values, which means that the diversity at each site is rather high, whereas the variation between sites is low. A higher Simpson-Index for four localities might be explained by low numbers of recorded tools at each site. It was not possible to clearly identify short-term occupations.

A necessary precondition for the definition of short-term occupations is the identification of single occupation events. This could only be achieved at open-air sites such as Mtlili or Hajra (Fig. 12). Due to dynamic syn- and post-depositional processes in shelter deposits, single events are hardly traceable. Long-term occupations can therefore be regarded as indisputable facts, while short-term stays can only be presumed. In contrast, open-air sites show evidence for long-term occupations as well as shorter stays, the latter with a Simpson-Index higher than 0.3. This can be seen as one of the most interesting results of the application of this method. However, the data should not be simply interpreted as "shelter-long-term" and "open-air-short-term" land use system, since open-air sites were also used as a type of base camp, making the record complex in a specific way.

All things considered, the indices of the Epipalaeolithic and Neolithic sites lie within the same range of variation. Therefore, from this point of view, one can assume that no major changes took place during the Neolithic transition in this region and continuity is a more probable description of the process. The calculations of the Simpson-Index for several Epipalaeolithic and Neolithic sites in southern Spain (Medved 2013) show the same low values. This opens the possibility that the activity cycle in southern Spain was similar to the one in the eastern Rif.

Ultimately, it is hard to describe an activity cycle for the Epipalaeolithic or Neolithic in the eastern Rif at this point. More data is needed for this purpose, e.g. studies concerning animal and plant exploitation at the sites as well as the investigation of additional open-air sites.

Use-wear analysis

The lithic assemblage from Ifri Oudadane was submitted for use wear analysis with the intention of gaining information on the activities of the humans who had deposited the material. The lithic artefacts we examined came from three different archaeological layers: Epipalaeolithic, Early Neolithic A and Early Neolithic B. This examination not only investigated possible changes in the utilisation of the artefacts, but also to see if such changes could be correlated to the Neolithic transition.

The small assemblage of Early Neolithic C artefacts was not considered, as it did not render any relevant information. Lithic pieces from chronologically disturbed squares were also not taken in account.

A binocular microscope Leica MZ16A with a magnification of 10x – 90x was used for these studies. It was combined with an electron microscope of the type Olympus BH2, with a magnification range lying between 50x – 400x and equipped with a Canon 450D camera. To obtain fully focussed pictures,

site	time	number of tools	Simpson-Index	excavated area	occupation	site type
Ifri n'Etsedda	NEO	19	0.14	< 50%	period	shelter
Ifri Oudadane	NEO	69	0.15	< 50%	period	shelter
Ifri Oudadane	EPI	76	0.16	< 50%	period	shelter
Taoungat 7	NEO	4	0.17	complete	event	open-air
Taoungat 1	EPI	20	0.17	unknown	period	open-air
Mtlili 6	NEO	5	0.20	unknown	event	open-air
Ifri n'Etsedda	late EPI	124	0.21	< 50%	period	shelter
Ifri n'Etsedda	early EPI	56	0.23	< 50%	period	shelter
Hassi Ouenzga	EPI Trans	101	0.24	< 50%	period	shelter
Mtlili 1 (layer 3)	EPI	10	0.24	unknown	event	open-air
El Zafrín	NEO	186	0.28	unknown	period	open-air
Mtlili 1 (layer 1)	EPI	5	0.3	unknown	event	open-air
Mtlili 1 (layer 2)	EPI	50	0.33	unknown	event	open-air
Hajra 1	EPI	9	0.36	unknown	event	open-air
Mtlili 5	NEO	9	0.50	unknown	event	open-air
Hajra 3	EPI	4	0.50	unknown	event	open-air

Fig. 12. Simpson-Indexes for Ifri Oudadane and nearby Epipalaeolithic and Neolithic sites of the eastern Rif. All sites have low index values, which means that the tool diversity at each site is rather high (long-term stay), whereas the variation between sites is low. No significant differences between Epipalaeolithic and Neolithic sites can be observed. Therefore, it can be assumed that during the Neolithic transition process in this region, no major changes regarding land use patterns occurred.

Abb. 12. *Simpson-Indices berechnet für die verschiedenen Phasen der Ifri Oudadane und nahegelegener epipaläolithischer und neolithischer Fundstellen des östlichen Rifs. Alle Fundstellen weisen niedrige Werte auf, sodass die Werkzeug-Diversität als hoch anzusprechen ist (long-term stay). Zwischen den epipaläolithischen und neolithischen Inventaren können keine Unterschiede festgestellt werden. Daher kann davon ausgegangen werden, dass es während der Neolithisierung nicht zu grundlegenden Veränderung der Landnutzungsmuster gekommen ist.*

the software Helicón Focus v. 4.62 was used. The combination of these two different microscopes is common in use-wear analysis research (Plisson 1985; Van Gijn 1989; González & Ibáñez 1994; Gassin 1996).

It is important to note that every piece was examined independently regarding its preservation, size, raw material or morphology. We avoided biasing by studying all of the artefacts, since a selection of particular types of tools would have led to an over- or underrepresentation of certain activities. A total of 166 pieces were analysed, comprising finds from the Epipalaeolithic (80 pieces), Early Neolithic A (38 pieces) and Early Neolithic B (48 pieces). The selection of finds intended for use wear analysis was carried out as follows. All finds were examined using a binocular (macroscopic analysis). Not studied were finds that are 1) very weathered and 2) smaller than 20 mm, except retouched pieces such as backed bladelets and microliths.

The Epipalaeolithic tools

Out of the 80 selected finds from the Epipalaeolithic assemblage, 32 show use traces and nine have no traces of use. Unfortunately, 39 artefacts could not be analysed because the use traces had been obliterated or the existing modifications could no longer be attributable to the original use of the artefact.

Of the 32 artefacts with traces of use, five displayed two zones of usage, so that a total of 37 different activity zones could be analysed. As shown in figure 13, most of the artefacts were utilised as projectiles, followed by tools for cutting meat and those for treating bone. Only small amounts of finds featured use wear traces deriving from the processing of wood or mineral materials. None of the artefacts clearly indicate a cutting of plants.

The group of projectiles comprise geometric microliths or small backed bladelets (Fig. 13: 1). Impact fractures can be observed on the points of these finds, as well as damages on the non-backed lateral edges. The location of the use traces suggests these types of projectiles can be classified as points or barbs. However there are other, morphologically very similar pieces, which do not bear these types of fractures. In these cases, it is impossible to decide whether they were used as projectiles or not. This does not necessarily mean these finds were not utilised as projectiles, but that utilisation had not left any traces, such as impact fractures. Numerous researchers dealing with experiments on projectiles have commented on this topic (Odell & Odell-Vereecken 1981; Barton & Bergman 1982; Fischer et al. 1984; González & Ibáñez 1994; Gibaja & Palomo 2004). If a projectile does not hit a part of the skeleton of the animal, impact fractures are not usually visible.

Traces produced during butchering or the processing of animal skins were usually observed on non-retouched bladelets with rather sharp edges, which made them extremely effective as tools for these types of activities (Fig. 13: 2). However, these tools are rather hard to identify since their usage only produces small areas of faint traces. Furthermore, only very slight modifications of the find can mask, or even destroy, this type of use wear. Against this background it is possible that some of the artefacts classified as "unanalysable" or "used to cut soft materials" were, in fact, utilised to process meat, fish or skins.

For other purposes, such as scraping animal skins, processing bone or horn, retouched bladelets and flakes (notched pieces and scrapers) were preferred (Fig. 13: 3). These types of tools usually have blunt edges, which are more effective when processing abrasive or durable materials. The working edges of those pieces assigned to bone and horn processing (notched pieces on bladelets or small retouched edges of several flakes) indicate they must have been used to manufacture other tools like arrow shafts, handles, needles, points, etc. (Fig. 13: 4).

The ENA tools

Out of the 38 analysed artefacts linked to the ENA, 22 show use wear traces, 4 did not have any traces of wear, while 14 had to be classified as unanalysable. In total, 29 separate zones of working could be determined, since five artefacts each displayed two zones of working and an additional artefact had been utilised in three places. There is an observable difference between the Epipalaeolithic and the ENA, as table 1 and figure 14 clearly show. In the ENA, the number of projectiles decreased considerably; there was no evidence for the working of animal skins and tools used to process wood or non-wood-like plants increased. The percentage of tools for cutting meat and processing bone/horn remained stable, while the percentage of tools used for the processing of mineral materials increased slightly (Fig. 14: 2).

All three artefacts with projectile-like impact fractures were made on backed bladelets. Continuing in the Epipalaeolithic tradition and undoubtedly for functional reasons, artefacts for cutting meat were made exclusively on blades without retouch, but with sharp edges, whereas retouched bladelets or flakes pieces were commonly used for treating bone/horn or mineral materials. All artefacts with unspecific traces of use, but assigned to the processing of soft or hard materials, are morphologically similar: namely bladelets without retouch or flakes with abrupt retouch respectively. Unfortunately, it is impossible to specify the material that was worked due to the relatively poor preservation of the finds.

Scraping wood was executed with retouched bladelets or flakes (Fig. 14: 1), while cutting vegetable material was performed with non-retouched bladelets. One bladelet, in particular, showed marks deriving from cutting plants and secondary modification. One edge had been retouched to reshape the artefact for another task, as can be deduced from the absence of plant cutting traces on the interior of the retouch.

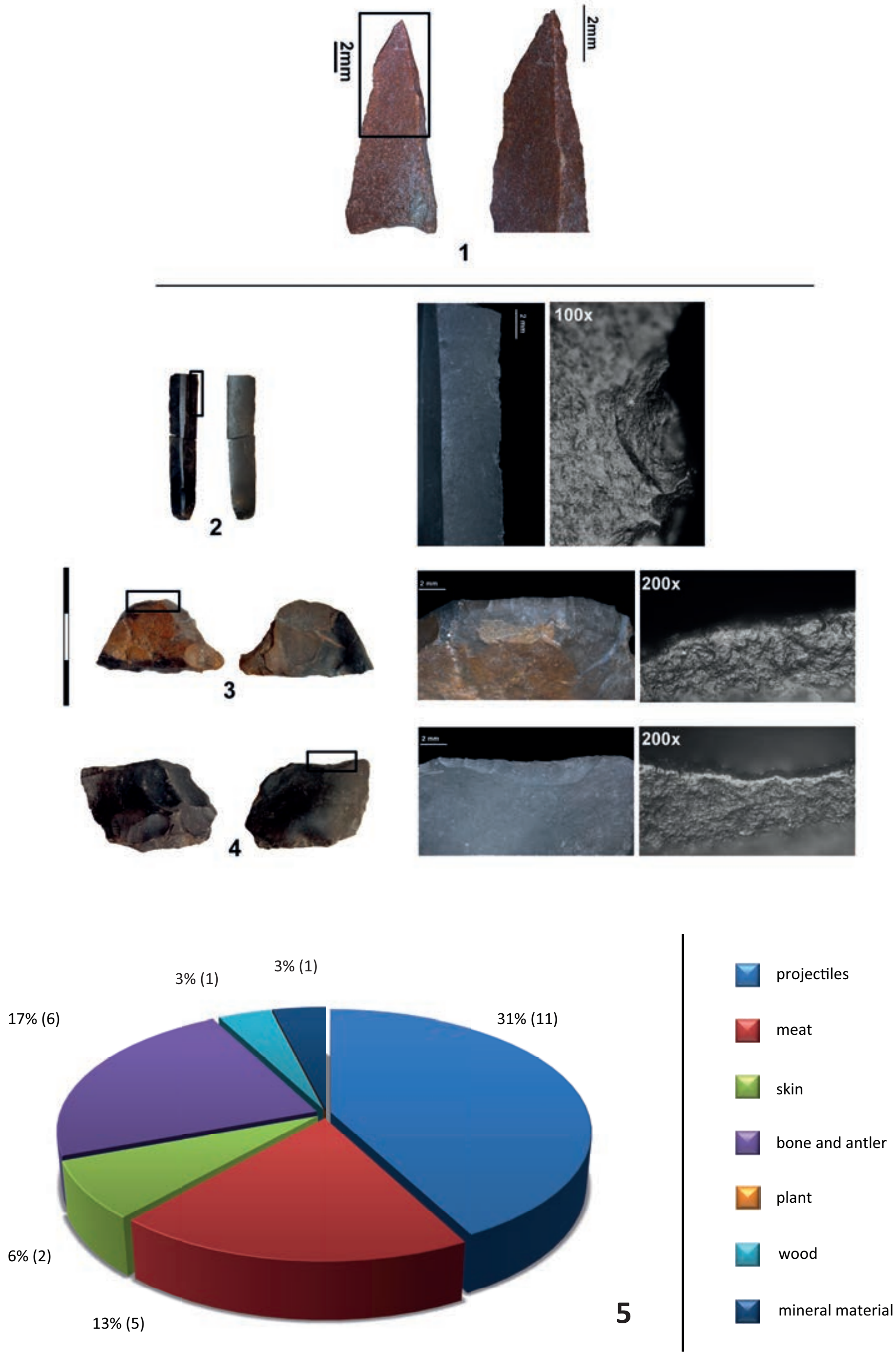


Fig. 13. Results of use-wear analysis, Epipalaeolithic tools: 1: Projectile with burin fracture; 2: bladelet used for butchering; 3: scraper used for working dry hide; 4: notched piece for scraping bone. The diagram provides a clear dominance of projectiles. All other tools show traces related to the treatment of animal products. No processing of plant materials is recorded.

Abb. 13. *Ergebnisse der Gebrauchsspuren-Analyse epipaläolithischer Werkzeuge: 1: Projektil mit Stichelbahn; 2: Lamelle genutzt beim Zerlegen von Tieren; 3: Kratzer mit dem Leder bearbeitet wurde; 4: gekerbtes Stück, genutzt um Knochen zu bearbeiten. Das Diagramm zeigt eine eindeutige Dominanz von Projektilen. Im Epipaläolithikum konnten keine Spuren festgestellt werden, die auf das Bearbeiten von pflanzlichen Materialien hindeuten.*

The artefacts of ENB

Only 16 of the 48 pieces from the ENB assemblage show traces of use, whereas eight artefacts do not feature any kind of use traces and 24 were classified as unanalysable. Many of the lithic artefacts in this level were likely altered by post-depositional processes. There are four artefacts with two working zones each; therefore a total of 20 working zones is represented in the ENB assemblage.

Although only a few artefacts show use traces, the analyses produced some insightful results, especially in comparison with the two previous chronological units. On the one hand, there is a complete absence of projectiles, but on the other an increase in the number

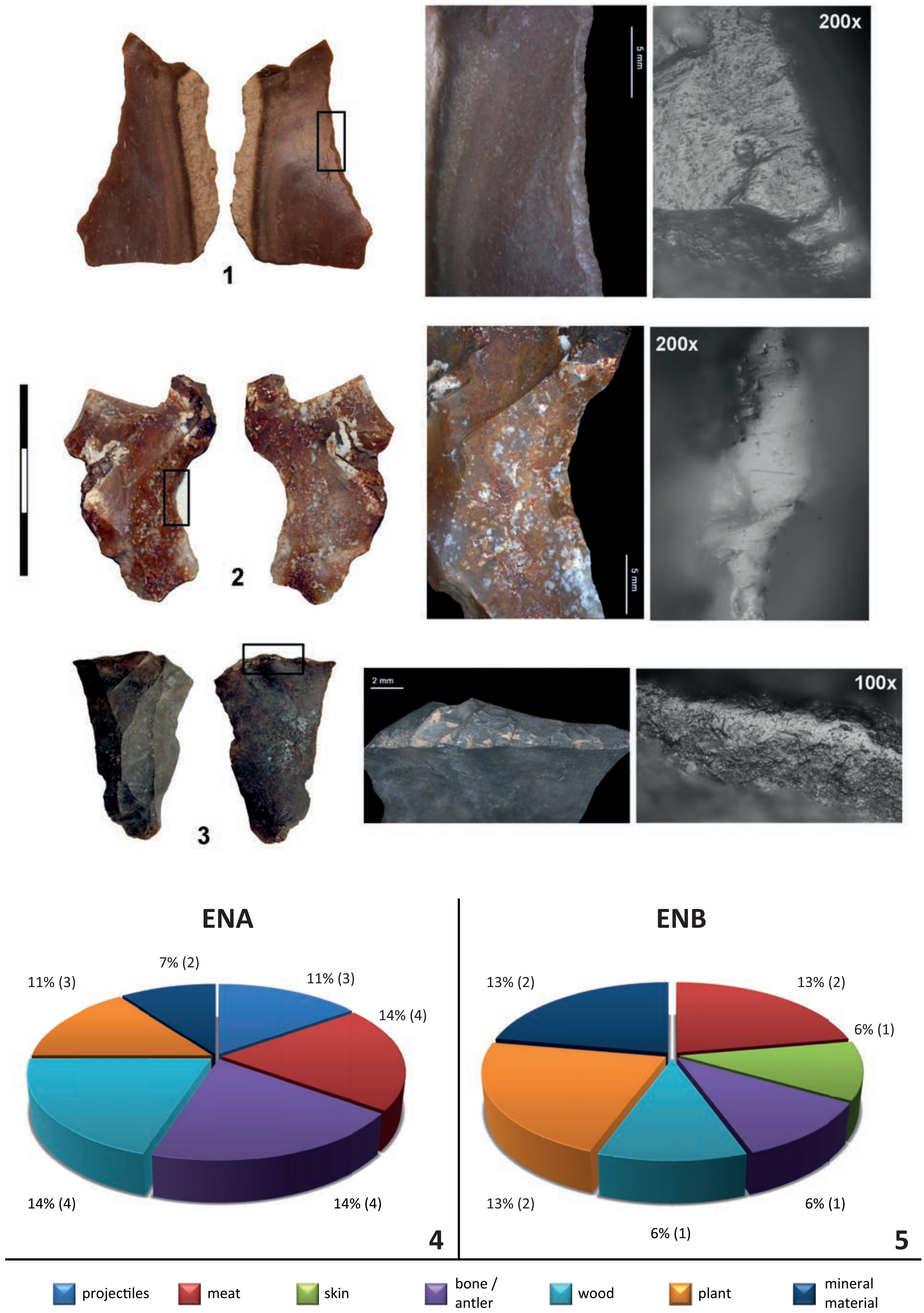


Fig. 14. Results of use-wear analysis, Neolithic tools: 1: Retouched flake for scraping wood; 2: notched piece for scraping bone, both ENA; 3: Scraper to work mineral material, ENB. Both Neolithic sub-assemblages provide tools showing traces of plant processing. The number of projectiles decreases in ENA; during ENB they are completely absent. continued next page: →

of artefacts used for cutting non-wooden plants and processing mineral materials (Fig. 14: 3). Once again, the percentage of tools used for cutting meat remains stable. Other artefact types used to process skin, wood and bone/horn, retain more or less the same level of abundance as observed in the preceding chronological unit.

The artefacts used for cutting soft materials such as meat, skin or plants, were bladelets or flakes without retouch and a sharp edge. Many of the pieces used to process an indeterminable soft material show the same characteristics as mentioned above; therefore, it is rather probable that they were used for exactly the same materials. A morphological continuity can also be recognized for those pieces used for processing hard materials such as bone or minerals. Usually these are notched bladelets or artefacts with zones of abrupt retouches, although these traces can also be observed on flakes without retouch.

Percussion tools

According to Weiner (2013: 147), retouchers are mainly made of flat, round to elongated oval pebbles of hard and tough rock. They have retoucher damage (scars as well as scratches) at least at one end, but in most cases at two or more locations. Retouchers were used as pressure tools as well as striking tools. In the latter case, they served for blade and bladelet production and for the retouching of points and edges.

The six retouchers from Ifri Oudadane clearly lack detectable scratches. In terms of raw material, quartzite prevails. Pebbles with a nearly standardised length-width relation of, on average, 1:1.28, and a weight of approximately 130 g were used. At least half of the pieces have more than one working edge (Fig. 15).

Four of the six retouchers are assigned to the ENA phase and two to the Epipalaeolithic. The latter two come from the uppermost spits of the Epipalaeolithic deposits. A mixing of late Epipalaeolithic and early Neolithic layers in this part of the stratigraphic sequence cannot be excluded. If these two pieces are intrusions from upper layers, then retouchers could be an exclusive feature of the Neolithic.

Discussion

1: What are the characteristics of the Epipalaeolithic and Neolithic sub-assemblages, and are there observable changes between these sub-assemblages in terms of technology, typology, and use of raw material?

The most important fact that needs to be mentioned is the similarity between the Epipalaeolithic and Neolithic assemblages of Ifri Oudadane. This becomes particularly evident in comparison with other contemporary sites in the area. Similarities can be observed in the supply of raw material, blank production and the composition of the tool kit. Approximately 60 % of the lithic artefacts from all phases are made of Black Silex. The material was brought to the shelter as small pebbles, indicating a secondary source. The source itself is not known yet, however the nearby gravel beds of the lower Oued Kert or the beach deposits close to the shelter are likely sources of this material. The second most frequently used raw material (between 13 and 15 %) in all phases is a brownish variety of Silex that probably was brought to the site from the banks of the Moulouya River, more than 65 km east of Ifri Oudadane. An inhomogeneous group of uncertain origin with the working title "Chalcedony" (see also Nami & Moser 2010: 53; Moser 2003: 25) turns out to be the third most frequent variety. The same material is used predominantly during the ENA period. Other categories that need to be mentioned are a red and a yellow very fine Silex, also of unknown origin. Both varieties were exploited during the Epipalaeolithic and ENA phase, but were not used throughout the ENB phase. However, these variants are represented by only very low counts, which prevent further interpretations.

As mentioned above, even methods of blank production in the Epipalaeolithic and Neolithic show no significant differences. A main strategy, the unipolar reduction of single platform cores with the intention of producing bladelets as well as flakes in later stages of the production process, can be observed. Bipolar reduction plays a minor role. In order to fully exploit the volume of the core, remnant cores were rotated by 90 degrees and finally reduced irregularly. A few core tablets, core flanks and *outrepassées* show an occasional cleaning of hinges and other accidents as well as the correction of the longitudinal convexity.

In general, all tool types appear in each phase (Fig. 9). Only a few exceptions, such as perforators, splintered or denticulated pieces, are represented in extremely low numbers. Lateral retouch, the most frequent type of modification, may have been applied for several purposes. However, this type of modification does not shed light on distinct activities executed at the site since it was used, in particular, to reshape blanks. Notched blades and flakes comprise the second most frequent tool type and may indicate woodworking. Microlithic tools, such as backed bladelets and a few geometric microliths, show distinct fractures and impact traces, and can therefore be identified as projectiles or implements. Other tools, such as perforators, burins, scrapers or splintered

Abb. 14. *Ergebnisse der Gebrauchsspuren-Analyse an neolithischen Werkzeuge: 1: Retuschierte Abschlag genutzt zur Bearbeitung von Holz (ENA); 2: gekerbtes Stück genutzt zur Bearbeitung von Knochen (ENA); 3: Kratzer genutzt zur Bearbeitung von tierischem Material (ENB); die Werkzeuge beider neolithischer Phasen weisen Spuren auf, die auf das Bearbeiten von pflanzlichen Materialien hindeuten. Die Anzahl der als Projektil genutzten Werkzeuge verringert sich im ENA; während des ENB sind gar keine Projektile mehr vorhanden.*

Fig. 15. Retoucher: 1: quartzite; 2: rhyolite; 3: quartzite; 4: quartzite; 5: quartzite; 6: quartzite.

Abb. 15. *Schlaggeräte: 1: Quarzit; 2: Rhyolith; 3: Quarzit; 4: Quarzit; 5: Quarzit; 6: Quarzit.*

pieces are present, although in small quantities and without visible spatial and chronological distribution. Overall, the tool kit does not change significantly between the Epipalaeolithic and the distinct Neolithic phases. As a whole, the assemblage points to activities ranging from hunting to the treatment of soft (meat, skin) and hard (bone, wood, shell) organic material. This is consistent with multifaceted activities as indicated by other archaeological materials found at the site, such as plant remains, bones or molluscs.

2*: What is the relation to other contemporary sites in the area?*

The extent of the similarity of the Epipalaeolithic and Neolithic assemblages from Ifri Oudadane becomes apparent when they are compared to contemporary assemblages from the research area. In this respect, we have to emphasize the importance of raw material sources at the other sites. As can be expected, the Moulouya sites are dominated by Moulouya flint (90 %). The Early Neolithic open-air site of El Zafrín was supplied with local Radiolarite. Located between different raw material sources, the Epipalaeolithic transitional site of Hassi Ouenzga features an assemblage which is composed of 86 % of Moulouya and 14 % of Ain Zora Silex.

Less obvious, but present, are differences in the production of blanks. The early Epipalaeolithic assemblage of Mtlili 1 (Linstädter et al. 2012) is characterized by over 70 % flakes, nearly twice as much as in the Epipalaeolithic assemblage of Ifri Oudadane (Fig. 16). Meanwhile, the percentage of blades is three times higher at Ifri Oudadane than Mtlili 1. According to these observations, there is a significant trend towards flake production. The composition of the tool kit from Mtlili 1 is considerably different to that from Ifri Oudadane (Fig. 17). Backed bladelets, burins and denticulates are missing completely. In contrast, artefacts with end and lateral retouch, as well as scrapers, increase substantially, suggesting different activities performed at this open-air site.

The late Epipalaeolithic assemblage of Taoungat 1 (Aschrafi 2010; Linstädter et al. 2012) seems to occupy an intermediate position between Ifri Oudadane and Mtlili 1. Here percentages of blades and flakes are more balanced between the extremes observed at the other sites; the proportion of bladelets is however very similar (around 20 %). It should be noted that the tool kit of Taoungat 1 is rather small, comprising only 20 pieces, so that a comparison of proportions is less appropriate. In spite of this, it is notable that backed bladelets are present at the site.

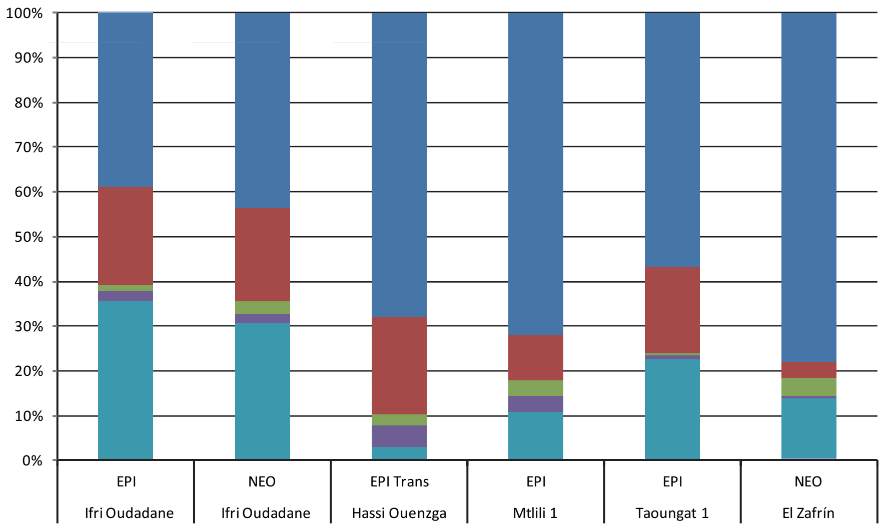
Remarkable differences in blank production and tool composition can also be found between the Neolithic assemblage of Ifri Oudadane and the one from El Zafrín open-air site (Carvalho 2010; Gibaja et al. 2012). As with the Epipalaeolithic sites of the lower Moulouya valley, the amount of flakes appears to be extremely high at El Zafrín. According to the current state of knowledge, it is difficult to say whether this is related to the above-average quality of the raw material or to a particular sub regional Moulouya lithic tradition. Even though El Zafrín is located today on an island off the coast of Morocco, during the early and middle Holocene it was part of the continental land mass and therefore connected with the Moulouya region. The extraordinary high proportion of perforators and scrapers at El Zafrín is striking. In addition, the amount of laterally retouched pieces is rather high, whereas pieces with end retouch and burins are missing.

The Abri of Hassi Ouenzga (Linstädter 2003, 2004) is the last site to be mentioned in this context. The site is important because of its intermediate position. The assemblage is dated between 7.6 and 6.9 ka calBP and is contemporaneous with the Early Neolithic assemblage of Ifri Oudadane. Pottery is present, but no indications of food production are found. The pottery is significantly different to that from Ifri Oudadane and the dwellers of Hassi Ouenzga are seen to have belonged to a different cultural group of hunter-gatherers within the local continental Epipalaeolithic tradition. Two noticeable observations become apparent when the composition of the blanks from the two sites is compared. On the one hand, the percentage of bladelets at Ifri Oudadane and Hassi Ouenzga is more or less the same (around 21 %) but on the other, there is a remarkable difference in the percentages of flakes, with approximately 44 % at Ifri Oudadane and 68 % at Hassi Ouenzga. The high amount of flakes in Hassi Ouenzga is associated with an extremely low amount of debris. This striking difference is hard to explain. In general, the percentage of maintenance debris is slightly higher at Hassi Ouenzga, possibly pointing to a more sustainable and efficient exploitation of the cores. This could be related to the relative remoteness of raw material sources such as Ain Zohra or the Moulouya valley, which are both at least 30 km away.

3: To what extent has use wear analysis contributed to this study?

Analysis of use traces on the lithic artefacts of Ifri Oudadane has yielded some important results: the three purportedly chronological units can be distinguished by notable differences in the use of tools. The importance of projectiles during the Epipalaeolithic is most intriguing. With the onset of the Neolithic, the amount of projectiles decreased, reflecting the diminishing importance of hunting game.

In contrast to the decreasing significance of projectiles, tools for processing plants became more important during the Neolithic. These tools may have been used for the cutting of cereals, but since the traces on these finds are not distinct, it is impossible to decide whether cereals or other wild plants were processed at all. The first unambiguous sickle can be dated to the ENC. This is in accordance with the results



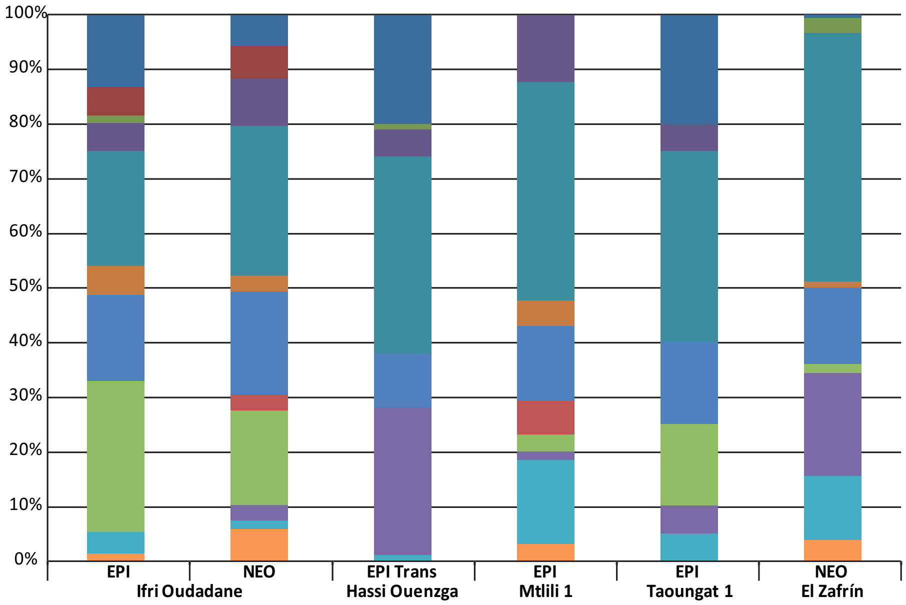
			Ifri Oudadane				Hassi Ouenzga		Mtlili 1		Taoungat 1		El Zafrin	
			EPI		NEO		EPI_NEO		EPI		EPI		NEO	
knapped material	flakes	cortical flakes	7	(1%)	5	(1%)	27	(3%)	30	(4%)	23	(3%)	150	(10%)
		partially cortical flakes	106	(18%)	126	(23%)	355	(36%)	247	(33%)	234	(30%)	229	(16%)
		non-cortical flakes	111	(19%)	108	(20%)	286	(29%)	267	(35%)	190	(24%)	730	(51%)
	blades	cortical blades	-	-	-	-	1	(< 1%)	-	-	2	(< 1%)	-	-
		partially cortical blades	22	(4%)	24	(4%)	71	(7%)	22	(3%)	59	(7%)	4	(< 1%)
		non-cortical blades	103	(18%)	89	(16%)	145	(15%)	55	(7%)	92	(12%)	45	3%
cores	flake cores	irregular with multiple platforms	5	(1%)	6	(1%)	12	(1%)	14	(2%)	-	-	-	-
		irregular with two platforms	-	-	3	(1%)	-	-	-	-	-	-	1	(< 1%)
		unipolar with one platform	2	(< 1%)	5	(1%)	2	(< 1%)	-	-	2	(< 1%)	9	(1%)
		bipolar with two platforms	-	-	-	-	3	(< 1%)	3	(< 1%)	1	(< 1%)	18	(1%)
		undeterminable	-	-	-	-	-	-	-	-	-	-	30	(2%)
	blade cores	irregular with multiple platforms	-	-	-	-	-	-	5	(1%)	-	-	-	-
		unipolar with one platform	-	-	2	(< 1%)	2	(< 1%)	2	(< 1%)	2	(< 1%)	-	-
		bipolar with two platforms	1	(< 1%)	-	-	2	(< 1%)	-	-	-	-	-	-
	undeterminable	irregular with multiple platforms	-	-	1	(< 1%)	2	(< 1%)	1	(< 1%)	-	-	-	-
		undeterminable	1	(< 1%)	-	-	-	-	1	(< 1%)	1	(< 1%)	-	-
core maintenance products	core tablets		1	(< 1%)	-	-	-	-	-	-	1	(< 1%)	5	(< 1%)
	partial core tablets		4	(1%)	2	(< 1%)	6	(1%)	-	-	-	-	-	-
	core flanks		3	(1%)	3	(1%)	14	(1%)	15	(2%)	-	-	2	(< 1%)
	crested blade		1	(< 1%)	1	(< 1%)	18	(2%)	3	(< 1%)	1	(< 1%)	-	-
	reverse hinge termination		3	(1%)	2	(< 1%)	9	(1%)	7	(1%)	2	(< 1%)	1	(< 1%)
	core preparation flake		-	-	2	(< 1%)	2	(< 1%)	2	(< 1%)	1	(< 1%)	-	-
debris	shatter		202	(35%)	156	(28%)	23	(2%)	75	(10%)	175	(22%)	191	(13%)
	microburin		2	(< 1%)	2	(< 1%)	-	-	-	-	4	(1%)	-	-
	burin spall		-	-	-	-	5	(1%)	-	-	-	-	1	(< 1%)
	tested piece		1	(< 1%)	3	(1%)	2	(< 1%)	-	-	1	(< 1%)	-	-
	untested piece		-	-	6	(1%)	-	-	8	(1%)	-	-	-	-
nucleus tools			-	-	2	(< 1%)	-	-	-	-	-	-	-	-
undecidable			1	(< 1%)	-	-	-	-	-	-	-	-	7	(< 1%)
total			576	(100%)	548	(100%)	987	(100%)	757	(100%)	791	(100%)	1423	(100%)

Fig. 16. The table provides the amount and percentage of blank types of Ifri Oudadane, Hassi Ouenzga, Taoungat, Mtlili and El Zafrín according to the respective occupation phases. The cumulative bar diagram visualizes percentages of main blank types in the table for intra-site comparison. The colours indicated in the table correspond to the colours used in the bar diagram.

Abb. 16. *Die Tabelle zeigt die absoluten Anzahlen sowie Prozentsätze von Grundformen der epipaläolithischen und neolithischen Inventare aus Ifri Oudadane, Hassi Ouenzga, Taoungat, Mtlili, und El Zafrín. Das Balkendiagramm visualisiert die Prozentsätze. Die Farben in der Tabelle entsprechen jenen im Balkendiagramm.*

of the carpological analyses, proving that domesticated cereals became important during the ENB (Morales et al. 2013).

Although activities changed over time, the morphology of the tools does not change. This is also true for projectiles, which are still made of geometric microliths or backed bladelets. To cut meat, skin or non-wooden plants and possibly fish, bladelets or flakes without retouch were used. In contrast, bladelets and flakes with an abrupt retouch were preferred for processing hard materials like bones and minerals. Most of the pieces have notches. Perhaps some pieces classified as "used to process indeterminable hard materials", were utilised when working shells. In the



	Ifri Oudadane				Hassi Ouenzga		Mtlili 1		Taoungat 1		El Zafrín	
	EPI		NEO		EPI Trans		EPI		EPI		NEO	
backed bladelet	10	(13%)	4	(6%)	20	(20%)	-	-	4	(20%)	1	(< 1%)
burin	4	(5%)	4	(6%)	-	-	-	-	-	-	-	-
denticulated piece	1	(1%)	-	-	1	(1%)	-	-	-	-	5	(3%)
end retouch	4	(5%)	6	(9%)	5	(5%)	8	(12%)	1	(5%)	-	-
lateral retouch	16	(21%)	19	(28%)	36	(36%)	26	(40%)	7	(35%)	85	(46%)
microlith	4	(5%)	2	(3%)	-	-	3	(5%)	-	-	2	(1%)
notched piece	12	(16%)	13	(19%)	10	(10%)	9	(14%)	3	(15%)	26	(14%)
nucleus tool	-	-	2	(3%)	-	-	4	(6%)	-	-	-	-
other retouch	21	(28%)	12	(17%)	-	-	2	(3%)	3	(15%)	3	(2%)
perforator	-	-	2	(3%)	27	(27%)	1	(2%)	1	-	35	(19%)
scraper	3	(4%)	1	(1%)	1	(1%)	10	(15%)	1	(5%)	22	(12%)
splintered piece	1	(1%)	4	(6%)	-	-	2	(3%)	-	-	7	(4%)
total	76	(100%)	69	(100%)	100	(100%)	65	(100%)	20	(100%)	186	(100%)

Fig. 17. The table provides the amount and percentage of tool types of Ifri Oudadane, Hassi Ouenzga, Taoungat, Mtlili and El Zafrín according to the respective occupation phases. The cumulative bar diagram visualizes percentages of main tool types in the table for intra-site comparison. The colours indicated in the table correspond to the colours used in the bar diagram.

Abb. 17. *Die Tabelle zeigt die absoluten Anzahlen sowie Prozentsätze von Werkzeuge der epipaläolithischen und neolithischen Inventare aus Ifri Oudadane, Hassi Ouenzga, Taoungat Mtlili und El Zafrin. Das Balkendiagramm visualisiert die Prozentsätze der Werkzeuge. Die Farben in der Tabelle entsprechen jenen im Balkendiagramm.*

light of these results, it is clear that a continuation of use-wear analysis on lithic artefacts at other sites is of great importance, as comparative data for further studies should be obtained.-

4: Implications on current models of transition?

The lithic assemblage of Ifri Oudadane plays a key role in the understanding of the Neolithic tradition in the study area and provides valuable data within the supra-regional context of the Western Mediterranean as a whole. In contrast to pottery, stone tools are present in both Epipalaeolithic and Neolithic contexts and therefore offer the opportunity of a comparative study. Two aspects are of particular importance: first, the study of raw materials, blank production and tool kit has provided clear evidence for a continuous use of the shelter during the Neolithic transition and second, the same type of raw material was used and processed in the same way even after the appearance of Neolithic innovations (Fig. 18).

There is a noticeable difference between the Ifri Oudadane assemblage and lithic assemblages from contemporary sites in the area. The Epipalaeolithic assemblage of Ifri Oudadane covers a period which also includes the Early Epipalaeolithic of Mtlili 1 and the Late Epipalaeolithic of Taoungat 1. Distinct topographical locations and therefore varying raw material procurement as well as functional variation due to specific activities performed at these sites resulted in the slightly diverse characteristics of these three Epipalaeolithic lithic assemblages. The Neolithic lithic assemblage from Ifri Oudadane provides a

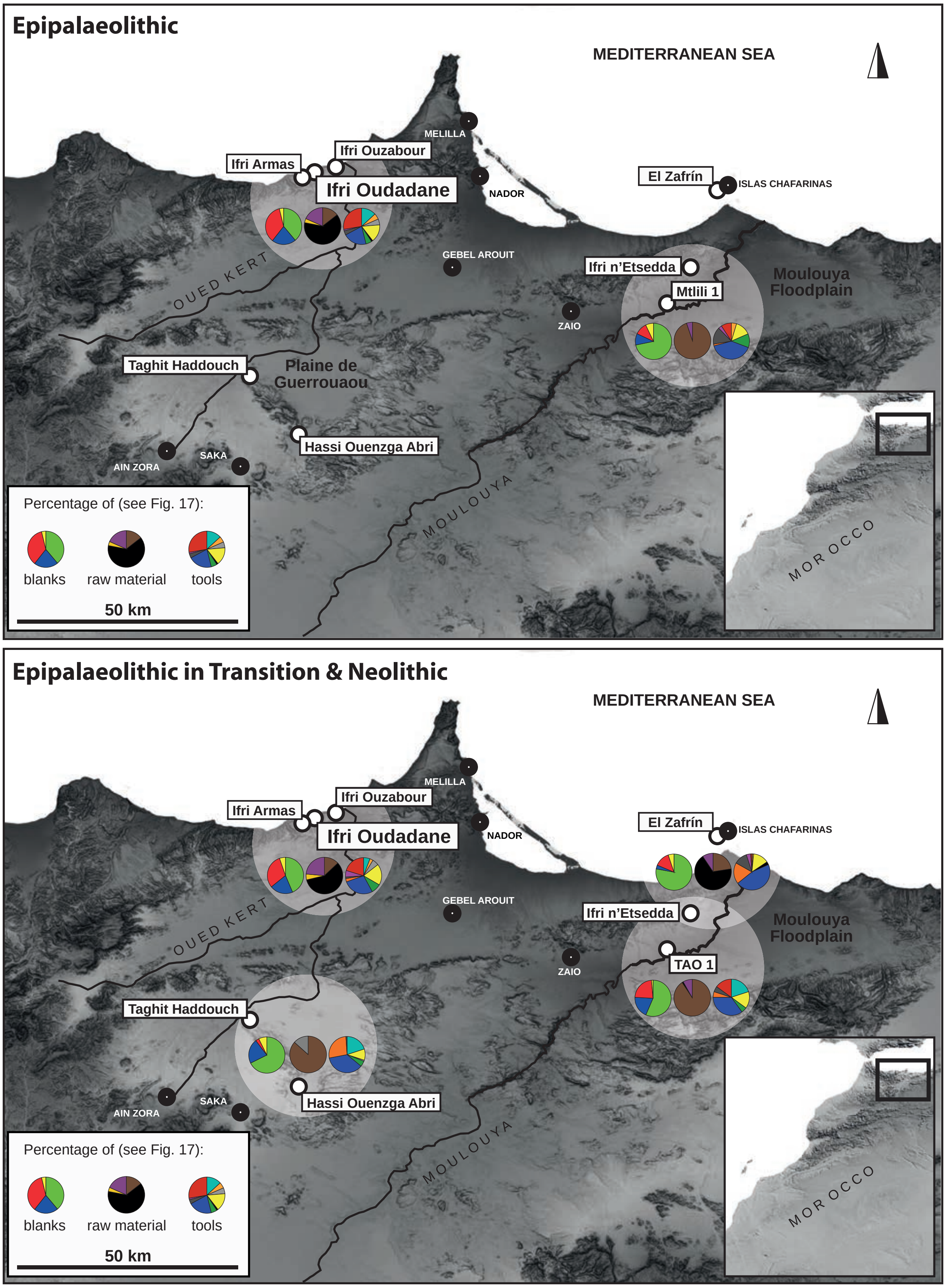


Fig. 18. Map of the eastern Rif area showing sites mentioned in the text and characteristics of their stone assemblages (see Fig. 17). A high diversity in blank production, raw material supply and tool composition is visible. The dominance of particular raw materials is clearly linked to the distance to the source. Tool composition shows significant trends towards an increase in lateral retouch or notched pieces, as well as rather rare tools such as burins or splintered pieces. Local shifts in abundance may be linked to particular activities performed at the site. The only striking feature is the conformity of the Epipalaeolithic and Neolithic assemblage of Ifri Oudadane. Furthermore, similarities are visible between the Early Epipalaeolithic assemblage of Mtlili 1 and the late Epipalaeolithic assemblage of Taoungat 1. This is primarily due to the same proximity to biotic and abiotic resources, although it could be an indication for continuous occupation of the area. continued →

certain local peculiarity too. The contemporaneous assemblage of El Zafrín is characteristically different to the one from Ifri Oudadane, even though the location of El Zafrín at the coast suggests similar activities took place at both sites.

All these features demonstrate a local continuity with regional variability within a certain period. At Ifri Oudadane, the current results suggest continuous, local occupation of the site. The idea of immigrants coming ashore and introducing Neolithic innovations thus loses credibility. Instead, local forager groups seem to have incorporated new technologies such as pottery and food production into their subsistence strategies. Additional systematic studies of lithic assemblages from late hunter-gatherer and early Neolithic contexts of the Western Mediterranean are needed before this particular course of Neolithic transition can be defined geographically within the region.

Since the Epipalaeolithic deposit could not subdivided further, the Ifri Oudadane assemblage cannot contribute to the issues surrounding the so-called "Second Mesolithic" (Perrin et al. 2009; Binder et al. 2012) within the study area. The Second Mesolithic appears from the 9th millennium BP in central-western Mediterranean lithic assemblages and is characterized by the introduction of pressure and indirect percussion techniques, as well as the appearance of trapezes industries. As mentioned above, the application of pressure flaking and indirect percussion techniques at Ifri Oudadane is most likely. However, the available resolution and the low amount of diagnostic pieces (only two trapezes) do not provide sufficient information on this issue.

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Abb. 18. *Karte des östlichen Rifs mit im Text genannten Fundstellen und den Charakteristika ihrer Stein-Inventare (vgl. Abb. 17). Betrachtet man Grundformproduktion, Rohmaterialverteilung und die hergestellten Werkzeugtypen in den einzelnen Inventaren der Fundstellen, so wird eine große Heterogenität sichtbar. Das genutzte Rohmaterial wurde überwiegend nach der Nähe zur Lagerstätte ausgewählt. Bei den Werkzeugen dominieren laterale Retuschen und gekerbte Stücke aber auch Stichel und ausgesplitterte Stücke kommen vor. Lokale Unterschiede in den Anteilen genutzter Werkzeuge können durch spezielle Aktivitäten, welche an der jeweiligen Fundstelle durchgeführt wurden, erklärt werden. Mit ihrer hohen Ähnlichkeit stechen die epipaläolithischen und neolithischen Inventare der Ifri Oudadane hervor. Ferner sind Ähnlichkeiten zwischen der früh-epipaläolithischen Fundstelle Mtlili 1 und der spät-epipaläolithischen Fundstelle von Taoungat 1 feststellbar, was wahrscheinlich durch die Nähe zu den gleichen biotischen und abiotischen Ressourcen bedingt ist, ggf. lässt sich aber auch eine Kontinuität fassen.*

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