

Research Article

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Reflections on the Other Side. A Southern Iberia Origin for the First Pottery Production of Northern Morocco?

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Abstract: This work is a starting point for rethinking the role of the Iberian Peninsula in the neolithisation of northern Morocco. It focuses on the similarities and divergences between the first pottery productions and their decorations in both territories. This relationship is supported by the existence of an accurate chronological gradation between the first evidence of Neolithisation in Iberian Peninsula and that of northern Morocco which suggests a north–south direction. We also present arguments on the possible links between the early ceramics from the north of Morocco and those from the south of Iberia, providing a first approach to an issue that will need to be carefully analysed in future research.

Keywords: radiocarbon dating, northern Morocco, Early Neolithic, first pottery productions, southern Iberia, prehistoric navigation

1 Introduction

Throughout the twentieth century, the history of pottery use has been closely related to the economic changes triggered by agriculture and animal husbandry throughout the Holocene. However, the relationship between food production and pottery is now starting to be challenged in both Eurasia and the African continent (Jordan et al., 2016). Not only are the first phases of the neolithisation of Southwest Asia aceramic (Nieuwenhuys, Akkermans, & Van der Plicht, 2010), but also many cases of Mesolithic hunter-gatherers with a complete mastery of this technology have been recognised in Northern Europe, the Baltic, and the steppes

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north of the Caspian (Elliott et al., 2020). In Africa, Epipaleolithic groups in the so-called Green Sahara have been producing pottery at least since the 10th millennium cal. BC (Dunne et al., 2017; Huysecom et al., 2009). However, in Mediterranean Africa, this phenomenon has not been observed (Broodbank & Lucarini, 2019).

Looking at the central Euro-Mediterranean area, the first evidence of pottery is related to the impressed ware group (*Impressa Arcaica*) that appeared in Apulia together with the earliest evidence of agriculture and livestock c. 5900/6000 cal. BC. The origin of this pottery is located on the other side of the Strait of Otranto as documented in the site of Sidari (Corfu Island, Greece) (Guilaine, 2018). The main characteristics of this pottery include flat-based shapes, decorations using shell impressions (gastropods, but mostly striated or smooth shells, often forming simple vertical or rocking impressions), and fingerprints among other techniques (Pessina & Tiné, 2008). In barely a century, impressed wares spread together with food production throughout the Italian peninsula and Sicily (Natali & Forgia, 2018; Radi & Petrinelli Pannochia, 2018). Around 5850–5700 cal. BC, the complex of Ligurian *Impressa* pottery developed in the south of France and the Ligurian coast. Between 5700 and 5500 cal. BC, a hiatus without any occupation, a gap not yet explained, is detected in the region which was later followed by the so-called Cardial Horizon (Manen et al., 2019). At about the same time, as the first ceramics with similar features to those of central Italy (Lugliè, 2018) arrived to the islands of Corsica and Sardinia, c. 5650/5600 cal. BC, the new technology made its appearance in the Iberian Peninsula (Bernabeu Aubán, García Puchol, & Orozco Köhler, 2018).

Until very recently, discussion on the emergence of the first pottery in Iberia suggested an archaic horizon defined within the Cardial complex and characterised by a simple arrangement of motifs, involving simple vertical-edged impressions, and friezes (Bernabeu Aubán, Gómez Pérez, Molina Balaguer, & García Borja, 2011). This style was also identified in Catalonia and the Valencia region as *Cardial Arcaico*. The use of striated shells (hence cardial) points to cultural relations with the earlier impressed pottery (*Impressa*) of the central Mediterranean. However, ceramics assigned to the Ligurian *Impressa* complex have been recognised in the Valencia region with chronologies similar to the first Cardial examples in the region (Bernabeu Aubán, Molina Balaguer, Esquembre Bebia, Ortega, & Boronat Soler, 2009). The existence of the latter in Catalonia is currently under discussion (Oms Arias, Terradas, Morell, & Gibaja Bao, 2018).

In this regard, Andalusia has been considered traditionally a territory where Neolithic innovations were introduced later based on the limited presence of Impressed and Cardial groups, the much better representation of an early horizon of Almagra pottery, and the existence of more recent datings in contrast to earlier chronologies of the Valencia region and Catalonia (Pérez Bareas, Afonso Marrero, Cámara Serrano, Contreras Cortés, & Lizcano Prestel, 1999). In recent years, however, older datings have been gradually obtained pointing to a still mostly unknown archaic horizon in the south of Iberia, where impressed pottery (with a striated shell, comb, and rocker) may have been more significant. This is the case of the caves of Nerja (Maro, Malaga) and La Dehesilla (Algar, Cadiz), where dates on caprines (domestic sheep in the first case) provide an average of c. 5550 cal. BC (Aura Tortosa et al., 2013; García Rivero et al., 2018).

In turn, the neolithisation of Northwest Africa has been explained by a wide variety of hypotheses. While some researches have focused on endogenous developments, the neolithisation process has more often been attributed to events of interaction and transcultural diffusion, mainly cultural transmission from southwest Asia through the Mediterranean coast (Morales Mateos et al., 2016). Even though neolithisation routes were already suggested to Iberia from Northwest Africa (Bosch Gimpera, 1932), and from Sicily and southern Italy to the Tunisian coast, and from there to northwest Morocco and Andalusia (García Borja, Aura Tortosa, Bernabeu Aubán, & Jordá Pardo, 2010), different hypotheses, currently revitalised, emphasise the close relationships between the emergence of the Neolithic in southern and Mediterranean Iberia and its appearance in the north of Morocco, based on territorial proximity criteria and the existence of a chronological gradation of ^{14}C dates between both shores (Martínez Sánchez, Vera Rodríguez, Pérez-Jordà, Peña-Chocarro, & Bokbot, 2018).

In Morocco, dates on domestic and short-lived samples seem to be significantly more recent than in the Iberian Peninsula. Except for one date on *Lens cf. culinaris* c. 5650 cal. BC (Beta-295779, 6740 ± 50) (Linstädter, Medved, Solich, & Weniger, 2012), whose taxonomic and stratigraphic assignment has been questioned (Martins et al., 2015; Pardo-Gordó, 2020; Zilhão, 2014), the oldest published dates on domestic elements come from Kaf Taht el Ghar, associated with impressed and Cardial ceramics, three of them coincident around 5400–5350 cal. BC (Martínez Sánchez et al., 2018).

These first ceramics from the north of Morocco have been included in the Cardial spectrum related to those from the south of France and the first ones identified in the east of the Iberian Peninsula (El Idrissi, 2001; Gilman, 1975). There are also similarities between the ceramic sets with archaic features of Andalusia and the first known pottery in northern Morocco. Shared characteristics include the use of striated and smooth shell and comb impressions. This scenario makes it necessary to reopen the debate on the relationships that could have existed at the beginning of the Neolithic between the two shores of the Alboran Sea.

2 Two Shores: Forms, Decoration, and Timing

Clay is a very ductile and plastic material which adds resolution when identifying variations in decorative patterns derived from styles and techniques that often reflect cultural differences. As the vessel surfaces are a canvas to execute motifs and designs of an enormous technical variety in almost infinite combinations (Gifford, 1960), cultural differences are expressed both through the technology of pottery making and through its decoration. Techno-stylistic features can be replicated via processes of cultural transmission, training, and imitation through cross-cultural diffusion and uni- or multi-directional contacts (see the Lapita case in Sand et al., 2015). However, the incidence of convergence phenomena (proved through major differences in time and space) should not be excluded. In this sense, the invention of pottery within multiple and unrelated focuses (East Asia, the African Sahara, and the American continent, for example) is particularly significant, as well as it is suggestive of the use of similar decorative techniques by unrelated human groups. An illustrative case is represented by the cord-marked pottery, resulting from the use of *roulettes* made of wrapped cord to make impressed decorations in the early Holocene ceramics of Japan or central Sahara (Haour et al., 2010; Hurley, 1979), or the more recent pottery of different pre-contact cultures in North America (Ashley & Rolland, 2002).

As has been indicated in the case of Nerja (García Borja et al., 2010), some of the Andalusian ceramics with an archaic appearance have decorative patterns similar to those observed in southern Italy according to phylogenetic approaches (Pardo Gordó, García Rivero, & Bernabeu Aubán, 2019). In particular, similarities are established with the *Impressa Arcaica*, *Tirrenica*, and the later Guadone facies (5600–5300 cal. BC) (Fugazzola Delpino, Pessina, & Tiné, 2002; Pessina & Tiné, 2008), in the latter case perhaps as a result of a common origin. Once in Iberia, some with traits of the Italian *Impressa* can be found in the first ceramics of the Cardial group in the Valencia region (Sarsa, l'Or), which probably fully developed in c. 5600/5550 cal. BC. and characterised by simple motifs, absence of complex associations or *natis* impressions, simple shell impressions below the rim, in mosaic, or extending decoration over the surface of the vessel following simple patterns (Bernabeu Aubán et al., 2011).

Regarding northern Morocco, other than the traditional classification of the first ceramics as Cardial (El Idrissi, 2001), some specific analogies have been seen on both shores of the Alboran Sea in the pottery from the third quarter of the 6th millennium cal. BC, comprising the Andalusian side. Therefore, it is necessary to analyse the first potteries from both shores to evaluate or qualify the existence of common traits.

2.1 Andalusia

The pottery generally associated with the Early Neolithic period of the southern Iberian Peninsula (horizon known as *Cultura de las Cuevas* in the historiography) shows a remarkable diversity of forms and decorations. Traditionally, in opposition to what was common in the Valencia region and Catalonia, decorations made from striated shells and their associated motifs are of little significance. Instead, the early Andalusian Neolithic has been classified within a tradition where incised and impressed groove techniques and the use of red slip (Almagra technique) on the surfaces were dominant. This pointed to a very different tradition from the Cardial group in Valencia and Catalonia and from the Ligurian *Impressa*, and different as well from the so-called 'Moroccan Cardial', which characterised the first pottery tradition in northern Morocco. The

forms of the vessels are diverse: simple, and composed shapes characterised by “asa-pitorro” spout or multi-perforated handles. The ^{14}C data record of the Andalusian “*Cultura de las Cuevas*” pottery seems to be concentrated on the last third of the 6th millennium (5300–4900 cal BC) (Martín Socas, Cálalich Massieu, Caro Herrero, & Rodríguez-Santos, 2018).

However, some south Iberian sites have recorded ceramics with archaic-looking decorations, showing impressions with striated shells, but also with a multi-tipped instrument, or even smooth shells or *spatulae*, usually not associated with the Almagra technique. Although in most of the cases considered we lack well-dated stratigraphies that would allow to contextualise chronologically these materials, there are a number of examples associated with ancient levels and some early ^{14}C dates made on bulk shells such as El Retamar (Puerto de Santa María, Cádiz) (Ramos Muñoz & Lazarich González, 2002), or Cabecicos Negros (Vera, Almería) (Camalich Massieu & Martín Socas, 2013). Most of these ceramics come from cave or surface sites or multi-layered sites, lacking a clear chronological correlation. This would be the case of sites in Upper Andalusia such as Los Mármols and Murcielaguina caves (Priego de Córdoba), the Majolicas (Alfacar, Granada), Carigüela (Píñar, Granada), and along the coast of Granada, Cueva del Capitán, or Zacatín (Martínez Sánchez, Gámiz Caro, & Vera Rodríguez, 2020). In southern Portugal, we can also include Padrao (Algarve) (Carvalho, 2018). Ceramics with similar features associated with ^{14}C dates, close to 5550 cal BC., are documented in the oldest levels of the Neolithic occupation of Dehesilla Cave (Cádiz) and Nerja (García Borja et al., 2010; García Borja, Salazar-García, Jordá Pardo, Pérez Ripoll, & Aura Tortosa, 2018; García Rivero et al., 2018).

2.2 Morocco

Only 14 km of open sea separates the south of the Iberian Peninsula, on the European shore, from the north of Morocco, on the African coast. Today, the opposite coast can be observed with complete clarity on both sides of the Strait of Gibraltar, especially when the wind blows from the west (Figure 1: 1).

The first pottery recorded on the Maghreb coast, within a reliable chronological range, was found on the Tingitana peninsula. The ceramic assemblage includes mainly impressed vessels, many of which are



Figure 1: Satellite view of the Strait of Gibraltar in the geographical framing of southern Iberia and Northern Morocco. NASA archives. (1) in the upper-right angle, detail of African shore (Jebel Musa) from Andalusian (Tarifa) territory (2020, RMMS).

decorated with striated (cardial) shells, making simple motifs, rocker (also with smooth shells), or dragging. The channelled ware group shares with the previous one both vessel shapes and decorative arrangements. Decorations were made using cowries to produce comma-shaped prints, or by dragging and clay removal in order to make grooves. A third group shows comb-prints, forming simple or rocking decorations. Other types of impressed decorations, such as fingerprints and undulations or linear (*quadrillé*) among others, and modelled additions, mainly reinforcing cords, complete the picture (El Idrissi, 2001; Gilman, 1975). This whole set could be called the Tangerine cluster.

This package includes the sites near Tangier (Oued Tahadart, Magharat el Khil, Idoles, Mugaret el Aliya, and Mugaret es-Saifiya), Kaf Taht el Ghar and Kef Boussaria in Tetouan area, and Gar Cahal, near Ceuta. Chronologies span the second half of the 6th millennium cal. BC, with the beginning c. 5450 cal. BC, and a more difficult to define end. In this respect, the ENA and ENB phases of Ifri Oudadane, beginning c. 5100 cal. BC, comprise relatively analogous pottery, including cardinal decorations, but also comb impressions, with frequent rocking patterns (Linstädter & Wagner, 2013). In southern areas, the presence of cardinal and impressed ware is recorded in the Temara region (sites of El Mnasra 2 and El Harhoura 2) (El Idrissi, 2012) and in the foothills of the Middle Atlas (Ifri Namr ou Moussa, Khemisset). Their chronology remains uncertain in the case of the Temara sites, and it is later for the second case, being comparable to the oldest sites in the Eastern Rif (c. 5100 cal. BC) (Martínez Sánchez *et al.*, 2018).

2.3 Chronological Links Between Two Shores

To understand in detail the relationships between the first pottery productions in southern Iberia and northern Morocco, and establish synchronic and diachronic correlations, it is necessary to analyse not just the pottery itself, but also its detailed chronological dimension. Even though very few dates are still available, in the Andalusian case, the emergence of pottery has been considerably anticipated in recent years. In the case of Morocco, the recent application of radiocarbon hygiene protocols has notably increased the chronological resolution related to the appearance of the first pottery, the spread of livestock, and agriculture in Northwest Africa (Morales Mateos *et al.*, 2016).

Following strict criteria of radiocarbon dates, we propose a detailed chronological table of the Early Neolithic (dates before 6000 BP) in Andalusia ($N = 72$) and Morocco ($N = 21$) (see the supplementary information¹). The adoption of the Neolithic coincides with the simultaneous arrival of agriculture, animal husbandry, and pottery in both territories. Only dates obtained on short-lived samples, mostly from cultivated seeds and domestic animals with a small standard deviation—in this case, less than ± 85 —have been considered.

To explore chronological links, we have used the summed probability distribution since it allows going beyond the simple understanding of ^{14}C as absolute time. SPDs were built using R statistical computer language (Core Team, 2020), and more specifically, its package rcarbon v.1.4 (Crema & Bevan, 2021). We have not normalised our radiocarbon assemblages to solve artificial peaks and the bin-width value used is 50. After that, we have converted each SPD into a single radiocarbon date according to its BP and SD average, and we have finally applied the contemporaneity test (Ward & Wilson, 1978) to both dates to explore if the implementation of the Neolithic in both regions is statistically equal, based on $\alpha = 0.05$.

3 An Iberian Origin for the First Moroccan Potteries?

To compare the still poorly known archaic pottery productions of the early Andalusian Neolithic and the first Moroccan productions (Tangerine cluster), it is necessary to establish similarities and differences, that is the existence of shared techniques and styles in both groups. These technical and stylistic features

¹ See <https://doi.org/10.1515/opar-2020-0174>.

existing in both territories, interwoven in a tight chronological framework, can serve to evidence any possible connection. Similarly, the absence of any of these features on the opposite shore of the Strait of Gibraltar would serve to rule out such a possibility. This last conclusion neither considers short-term phenomena of loss of traditions, transformation, and simplification of styles after translocation events, nor does include the development of new traditions across the bottleneck provided by the Gibraltar strait's passage through the sea.

3.1 Techniques, Matches, and Divergences

One of the most distinctive features of the Ligurian *Impressa* ware is the slab-and-drag technique (often described as impressed groove technique or *sillon d'impressions*), assimilated to the Iberian peninsula's *boquique* decoration. This particular technique is present in some sites in the south of France, such as Peiro Signado, Pont de Roque Haute (Portiragnes), and La Farigoule (Aubord), since 5850 cal. BC (Manen et al., 2019), but also in the probably more recent Valencian sites of Mas d'Is and Barranquet (Bernabeu Aubán, Molina Balaguer, Esquembre Bebia, Ortega, & Boronat Soler, 2009). Centuries later, a comparable technique became a distinctive feature of the Andalusian Neolithic (*Cultura de las Cuevas*), but in this case, it is not an evidence of archaism. Thus, towards the last third of the sixth millennium Cal BC, impressed grooves of more evolved appearance were common along with other types of impressions, incisions, and red slip Almagra technique. So, in Andalusia, impressed grooves could already be included in the above-mentioned archaic phase. The existence of some slab-and-drag decorations more closely related to the *sillon d'impression* in their formal traits has been used to claim an old age at some sites (Cueva del Toro, Malaga and Cabecicos Negros, Almería) (Camalich Massieu & Martín Socas, 2013). Regarding the African shore, at present, there is no evidence to prove the existence of comparable techniques among the early Neolithic pottery in northern Morocco.

Rocking techniques, using shells or instruments, are a distinctive feature of the *Impressa Arcaica* group, specific to southern Italy in the first half of the sixth millennium BC and present on the Dalmatian coast some decades earlier (Podrug et al., 2018). Although these techniques are not unknown in the Tyrrhenian *Impressa* facies, they are absent in sites from southern France sites associated with Ligurian *Impressa* (Guilaine, 2018). Moreover, rocker impressions often using a striated shell, but also recorded with a comb or smooth shell, are identified in the Valencia region within the Impressed and Cardial complexes (Phase 1 and 2) (Bernabeu Aubán et al., 2011; García Borja, 2017). In the case of the Tangerine cluster and the eastern Rif first pottery, the common use of smooth or striated shells among other instruments (mainly combs) with rocker techniques is attested (El Idrissi, 2001; Gilman, 1975; Linstädter & Wagner, 2013) (Figure 2).

In Morocco, the comma-shaped impressions made with cowry along with grooves are the most characteristic sign of the Channelled group in the Tangerine cluster (Martínez Sánchez et al., 2017). The use of gastropods to make impressions can be traced back to the *Impressa Arcaica* and *Tirrenica* wares (Natali, 2009; Tozzi & Weiss, 2001) and, thus, the use of cowries siphonal notch is well-attested some time earlier (Le Secche, Giglio Island) (Brandaglia, 1991). Impressions made with double-pointed instruments, similar to the projected edges of the siphonal notch in species such as *Luria lurida*, can be found in the Ligurian *Impressa*, in pottery from Pont de Roque Haute and Peiro Signado (Manen & Guilaine, 2007; Manen et al., 2006), as well as in the Iberian examples from the Valencian Cardial (Bernabeu Aubán, 1989: Lam. V), and in later examples from Cendres (Alicante) (Bernabeu Aubán et al., 2009). Similar prints are also found in the south of Portugal (Salema, Sines), together with crescent impressions, perhaps made with a blunt-edged spatula (Tavares da Silva & Soares, 1981). Motifs very similar to this one, with precedents in the Ligurian *Impressa* (Bernabò Brea, 1946), have been assigned to an early Neolithic level in Cova d'en Pardo (Alicante) associated to old datings (c. 5550 cal. BC) (Soler et al., 2011). In Andalusia, though the published data are scarce, some similar impressions, most probably made with cowries, can be recognised at sites such as Cabecicos Negros (Vera, Almería) (Camalich Massieu, Martín Socas, González Quintero, Goñi, & Rodríguez, 2004: Figure 3; Medved, 2013: Figure 57, VU 585) or Carigüela (Píñar) (Layers XIV and XV) (Navarrete Enciso, 1976).

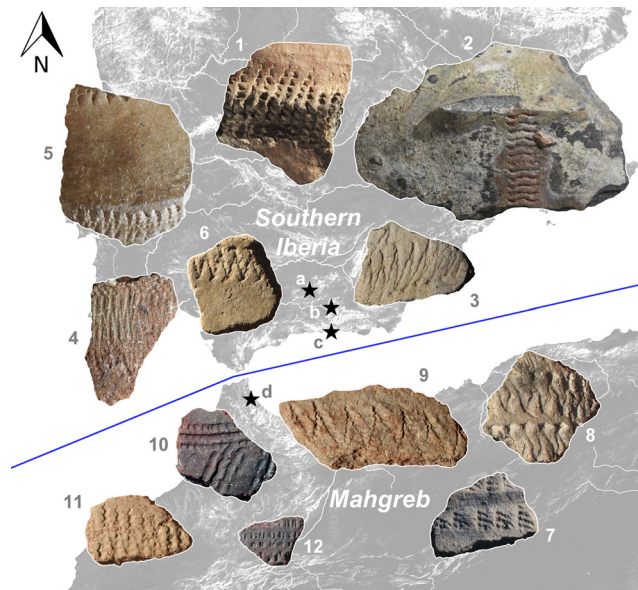


Figure 2: Some examples of impressed decorated potsherds from Andalusia (1–6) and Morocco (Kaf That el Ghar) (7–11). Simple impressions and rocker with striated shell (cardial and pecten impressions): (1–3, 6?, 7–9, 11) Rocker impressions with comb or multi-toothed instruments: (4, 5, 10, 12). (1 and b) Majolicas, Alfacar, Granada; (2 and c) Cueva de las Campanas, Gualchos, Granada; (3, 6, and a) Cueva de los Mármoles, Priego de Córdoba; (4 and c) Zacatin Rockshelter, Castell de Ferro, Granada; (5 and c) Cueva del Capitán, Lobres, Granada; (7–12 and d) Kaf Taht el Ghar Cave (Tetouan).

The red slip technique found in the “classic” period (*Cultura de las Cuevas*) of the Andalusian Neolithic (c. 5300–4700 cal. BC) is a defining feature of this horizon. Considered distinctive of the south of Spain and Portugal (equivalent to the Portuguese Style B), its origin is deeply rooted, in impressed assemblages from the central Mediterranean. This relationship particularly concerns the powder and colour of the paste (incrustation) applied to prints rather than the slip type (Pessina & Tiné, 2008). Slip colouring and incrustation were known in Morocco, but cases before the 5th millennium cal. BC. are unknown. The known examples are associated with the progressive arrival of stylistic features of Saharan origin, together with corded decoration, wavy line, or “*a roulette*” motifs (Linstädter & Wagner, 2013; Martínez Sánchez *et al.*, 2018).

Regarding forms and types, additions like means of prehension (composite or double handles) and spouts (“*asa-pitorro*” type) characteristic of the (“classic”) Andalusian Neolithic are also rather unknown in the early Moroccan Neolithic (Martínez Sánchez *et al.*, 2018). In the same way, in the Moroccan Cardial there are particular vessel forms, such as deep conical bottomed vases with constricted neck and everted rims. These forms, apparently divergent from the usual sixth millennium pottery productions of Mediterranean Europe, have sometimes been related to those found in Andalusia within the typical horizon of the Andalusian Neolithic (Linstädter *et al.*, 2012; Manen, Marchand, & Carvalho, 2007). However, these forms share features with other vessels with an everted rim and/or an impressed cord on the neckline, present at some typical Cardial sites in the Valencia region and Catalonia, such as Benàmer and Sarsa (Alicante) (vessels 321, 394), or Guixeres de Vilobí (Barcelona) (vessel 13) (García Atiénzar, Torregrosa Gimenez, Jover Maestre, & López Seguí, 2015; García Borja, 2017; Oms Arias, 2014). In turn, similar forms, although rare, were known in the *Impressa Tirrenica* complex (Brandaglia, 1991; Fugazzola Delpino *et al.*, 2002).

3.2 Timing for the Pillars of Hercules Crossing?

Figure 3 shows the summed probability distribution in both regions. Based on the visual exploration of both SPDs, we observe that the establishment of the Neolithic in Andalusia is around a century older than that in Morocco. Results are consistent with the available archaeological information. In the case of Andalusia,

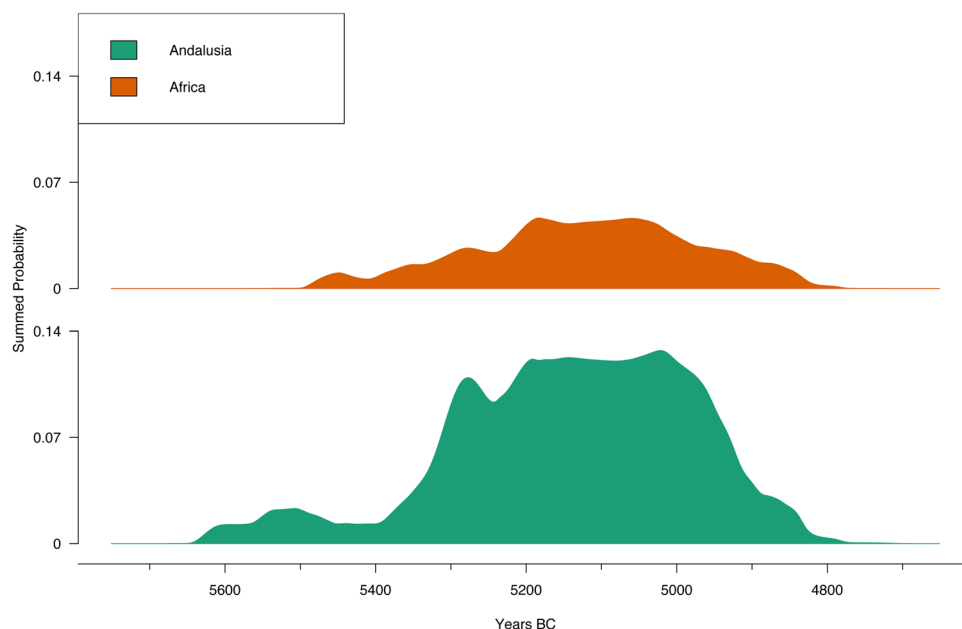


Figure 3: Summed probability distribution of Andalusia (lower graph) and Northern Morocco (upper graph). Rcarbon v.1.4 (Crema & Bevan, 2021).

thanks to recent research (Aura Tortosa et al., 2013; García Rivero et al., 2018), evidences of early pottery, agriculture, and animal husbandry have been pushed back reaching the barrier of 5500 cal. BC

In Northern Morocco, very old dates (up to before the seventh millennium cal. BC) were assumed for the first pottery production (Kaf That el Ghar, Tetouan) preventing any chronological discussion until very recently. Here, archaeological excavations during the 1980s and 1990s produced ^{14}C dates on charcoal coming from controversial layers (Daugas, El Idrissi, Ballouche, Marinval, & Ouchaou, 2008). Moreover, stratigraphic issues and palimpsest mixtures in the sequence of Kef Boussaria (Tetouan) did also influence these assumptions.

In the Moroccan Eastern Rif, the site of Ifri Oudadane has provided an early ^{14}C date (c. 5600 cal. BC) for the Early Neolithic A carried out on legume seed of controversial taxonomy (*Lens culinaris*). In this case, the results can be compared to other short-lived dates on wild elements of the last underlying Epipalaeolithic level. Further dates of other cultivated crops from the same site Early Neolithic A levels have provided dates close to 5100 cal. BC for both the first pottery and domestic species (Linstädter, Broich, & Weninger, 2018; Morales Mateos et al., 2016).

Following excavations by a Hispano–Moroccan team within the ERC AGRIWESTMED project, dates of cultivated wheat, sheep, and human bone were obtained from the first pottery levels at Kaf Taht el Ghar. Results place the 5400 cal. BC threshold as the oldest reliable timeline recognizable through radiocarbon of the Neolithic in Northwest Africa (Martínez Sánchez et al., 2018).

Then, can we tell if the Neolithic spread is contemporary in both regions? To explore this possibility, we have calculated the Ward and Wilson test (Andalusia_SPD_mean: 6195 ± 37 ; Morocco_SPD_mean: 6192 ± 38) and its results point to a contemporary process in both regions. But when we explore this contemporary spread based on the oldest radiocarbon dates of each region (Dehesilla [CNA-4241] and Kaf That el Ghar [Beta-295780]), the test indicates that both sites are not contemporary.

4 Conclusion

According to updated information, the Neolithic developed in Andalusia around 5550 cal. BC, while in neighbouring Morocco (Tingitana Peninsula) dates are delayed by one century. Nevertheless, this key

historical process can be considered contemporary based on statistical results. The next few years' research will witness an increase in the resolution of Neolithic chronologies in both regions. Future ^{14}C old dates, similar to those from Nerja and La Dehesilla, are expected in Andalusia.

Based on the available data, it is suggested that the neolithisation of southern Iberia and Morocco seems to respond to an event using navigation technology in a short time span. This can be interpreted as a result of the progressive occupation of the coastal strip of Southern Iberia during a short time equivalent to a few human generations. This phenomenon is probably reflected in the ceramic shapes and decorations. This hypothesis appears to be reinforced by the new findings.

While in the Northeast and the Valencia region, the existence of an *Impressa* horizon similar to that of Mediterranean France and related to the Ligurian style has been identified, in Andalusia this does not seem to be the case (Guilaine, 2018). Instead, the first Andalusian ceramics shared traits with those from the Italian Peninsula (*Impressa Arcaica*, Guadone Facies), and with some of the first pottery from the Iberian Mediterranean. These common traits were then projected to the early ceramics of northern Morocco, where the rocking decoration with smooth, striated shells and combs, cardial dragging, and the use of gastropods to make impressions was highly developed. The apparent lack of the impressed slab-and-drag technique and the red slip Almagra in this territory poses the question of whether such techniques were already present in Southern Iberia but were not transferred to North Africa, or whether at the time of transmission, probably occurring between 5550 and 5400 cal. BC, both techniques had still not reached the development achieved from the last third of the 6th millennium cal. BC in southern Iberia.

The origin and characteristics of the archaic Andalusian pottery are likely reviewed with more resolution in the coming years. In any case, it seems likely that the chronological gap between the first ceramics from the Iberian northeast and the Central Mediterranean, and those from the northern coast of the Alboran Sea and inland Upper Andalusia, will be progressively reduced. And so, it is possible to foresee the gradual arrival of different human groups across the Mediterranean. In the Valencia region, traces of those who left their mark in the South of France (*Ligurian Impressa*) have been recognised. Different groups associated with styles from southern Italy also left traces in Mediterranean Iberia and Andalusia and would leap the Strait of Gibraltar, playing a decisive role in the genesis of the so-called Moroccan Cardial.

Thus, the partial synchrony between the Andalusian Neolithic (*Cultura de las Cuevas*) of the last third of the 6th millennium and the beginning of the 5th and the Moroccan Cardial can be explained as a consequence of the differential evolution of both ceramic sets after the arrival to the African coast. In Andalusia, in few human generations, vessel forms developed into a multiplicity of types which showed geographical variation related to the use of Almagra slips, impressed groove decoration among other elaborated patterns, with typical forms (asa-pitorro type). At the same time, in the Tingitana peninsula and adjacent territories, a characteristic impressed cardial style that developed separately has been found. This particular style incorporated elements of Saharan origin well-advanced the 5th millennium cal. BC.

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References

- Ashley, K. H., & Rolland, V. (2002). St. Marys Cordmarked Pottery (Formerly Savannah fine cord marked of Northeastern Florida and Southeastern Georgia): A type description. *The Florida Anthropologist*, 55(1), 25–36.
- Aura Tortosa, J. E., Jordá Pardo, J. F., García Borja, P., García Puchol, O., Badal, E., Pérez Ripoll, M., ... Morales Pérez, J. V. (2013). Una perspectiva mediterránea sobre el proceso de neolitización. Los datos de la cueva de Nerja en el contexto de Andalucía (España). *Menga*, 4, 53–78.
- Bernabeu Aubán, J. (1989). *La tradición cultural de las cerámicas impresas en la zona oriental de la Península Ibérica*. Valencia: Servicio de Investigación Prehistórica. Diputación Provincial de Valencia.
- Bernabeu Aubán, J., García Puchol, O., & Orozco Köhler, T. (2018). New insights relating to the beginning of the Neolithic in the eastern Spain: Evaluating empirical data and modelled predictions. *Quaternary International*, 470B, 439–450.
- Bernabeu Aubán, J., Gómez Pérez, O., Molina Balaguer, L., & García Borja, P. (2011). La cerámica neolítica durante el VI milenio Cal AC en el Mediterráneo central peninsular. In J. Bernabeu Aubán, M. A. Rojo Guerra, & L. Molina Balaguer (Eds.), *Las primeras producciones cerámicas: El VI milenio Cal AC en la Península Ibérica* (pp. 153–178). Valencia: Universitat de València.
- Bernabeu Aubán, J., Molina Balaguer, L., Esquembre Bebia, M. A., Ortega, J. R., & Boronat Soler, J. R. (2009). La cerámica impresa mediterránea en el origen del Neolítico de la Península Ibérica. *De Méditerranée et d'ailleurs. Mélanges offerts à Jean Guilaine* (Collège de France ed., pp. 83–95). Toulouse: Les Archives d'Ecologie Préhistorique.
- Bernabò Brea, L. (1946). *Gli scavi nella caverna delle Arene Candide* (Vol. I-Glistrati con ceramiche). Bordighera: Istituto di Studi Luguri.
- Bosch Gimpera, P. (1932). *Etnologia de la Península Ibérica*. Barcelona: Alpha.
- Brandaglia, M. (1991). Il neolitico a ceramica impressa dal isola del Giglio. *La Ceramica. Studi Per l'Ecologia del Quaternario*, 13, 43–104.
- Broodbank, C., & Lucarini, G. (2019). The dynamics of mediterranean Africa, ca. 9600–1000 bc: An interpretative synthesis of knowns and unknowns. *Journal of Mediterranean Archaeology*, 32(2), 195–267.
- Camalich Massieu, M. D., & Martín Socas, D. (2013). Los inicios del Neolítico en Andalucía. Entre la tradición y la innovación. *Menga*, 4, 103–129.
- Cámlich Massieu, M. D., Martín Socas, D., González Quintero, P., Goñi, A., & Rodríguez, Á. (2004). The Neolithic in Almería: The valley of the Almanzora river and Vera Basin. *Documenta Praehistorica*, XXXI(Neolithic studies 11), 183–197.
- Carvalho, A. F. (2018). When the Mediterranean met the Atlantic. A socio-economic view on Early Neolithic in central-southern Portugal. *Quaternary International*, 470B, 472–484.
- Core Team. (2020). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. www.R-project.org
- Crema, E., & Bevan, A. (2021). Inference from large sets of radiocarbon dates: Software and methods. *Radiocarbon*. 63(1), 23–39. doi: 10.1017/RDC.2020.9.
- Daugas, J.-P., El Idrissi, A., Ballouche, A., Marínval, P., & Ouchau, B. (2008). Le Néolithique ancien au Maroc septentrional. *Bulletin de la Société Préhistorique Française*, 105(4), 787–812.
- Dunne, J., Mercuri, A. M., Evershed, R. P., Bruni, S., & di Lernia, S. (2017). Earliest direct evidence of plant processing in prehistoric Saharan pottery. *Nature Plants*, 3, 16194.
- El Idrissi, A. (2001). *Neolithique ancien du Maroc Septentrional dans son contexte regional* (3ème cycle en Sciences de l'Archéologie, Option Préhistoire). Rabat: Institut National de Sciences de l'Archéologie et du Patrimoine.
- El Idrissi, A. (2012). Le Néolithique du Maroc: État de la question. *Actas del congrés internacional Xarxes al Neolític – Neolithic networks*. Gavà-Bellaterra: Museu de Gavà.
- Elliott, B., Little, A., Warren, G., Lucquin, A., Blinkhorn, E., & Craig, O. E. (2020). No pottery at the western periphery of Europe: Why was the final Mesolithic of Britain and Ireland aceramic?. *Antiquity*, 94(377), 1152–1167.
- Fugazzola Delpino, M. A., Pessina, A., & Tiné, V. (2002). *Le ceramiche impresse nel Neolitico Antico. Italia e Mediterraneo*. Roma: Istituto Poligrafico e Zecca dello Stato.
- García Atiénzar, G., Torregrosa Gimenez, P., Jover Maestre, F. J., & López Seguí, E. (2015). La ocupación del Neolítico antiguo cardial de Benàmer (Muro de l'Alcoi, Alicante). In V. S. Gonçalves, M. Diniz, & A. C. Sousa (Eds.), *Actas do 5º Congresso do Neolítico Peninsular* (pp. 131–138). Lisboa: Uniarq.
- García Borja, P. (2017). *Las cerámicas neolíticas de la Cova de la Sarsa (Bocairent, Valencia)*. Tipología, estilo e identidad. Valencia: Servicio de Investigación Prehistórica. Diputación Provincial de Valencia.
- García Borja, P., Aura Tortosa, J. E., Bernabeu Aubán, J., & Jordá Pardo, J. F. (2010). Nuevas perspectivas sobre la neolitización en la Cueva de Nerja (Málaga, España): La cerámica de la sala del Vestíbulo. *Zephyrus*, LXVI, 109–132.

- García Borja, P., Salazar-García, D., Jordá Pardo, J. F., Pérez Ripoll, M., & Aura Tortosa, J. E. (2018). El inicio del Neolítico en la cueva de Nerja y la Cova de la Sarsa. Contexto arqueológico y dataciones radiocarbónicas. *Pyrenae*, 49(2), 7–36.
- García Rivero, D., Vera Rodríguez, J. C., Díaz Rodríguez, M. J., Barrera Cruz, M., Taylor, R., Pérez Aguilar, L. G., & Umbelino, C. (2018). La Cueva de la Dehesilla (Sierra de Cádiz): Vuelta a un sitio clave para el Neolítico del sur de la península ibérica. *Munibe. Antropología-Arkeología*, 69, 123–144.
- Gifford, J. C. (1960). The type-variety method of ceramic classification as an indicator of cultural phenomena. *American Antiquity*, 25(3), 341–347.
- Gilman, A. (1975). *A Later Prehistory of Tangier, Morocco* (Vol. 29). Cambridge, Massachusetts: American School of Prehistoric Research, Peabody Museum, Harvard University.
- Guilaine, J. (2018). A personal view of the neolithisation of the Western Mediterranean. *Quaternary International*, 470B, 211–225.
- Haour, A., Manning, K., Arazi, N., Gosselain, O., Guèye, N. S., Keita, D., ... Vernet, R. (2010). *African pottery roulettes, past and present. Techniques, identification and distribution*. Oxford: Oxbow Books.
- Hurley, W. M. (1979). *Prehistoric cordage. Identification of impressions on pottery*. Washington: Taraxacum.
- Huysecom, E., Rasse, M., Lespez, L., Neumann, K., Fahmy, A., Ballouche, A., ... Soriano, S. (2009). The emergence of pottery in Africa during the 10th millennium CalBC: New evidence from Ounjougou (Mali). *Antiquity*, 83(322), 905–917.
- Jordan, P., Gibbs, K., Hommel, P., Piezonka, H., Silva, F., & Steele, J. (2016). Modelling the diffusion of pottery technologies across Afro-Eurasia: Emerging insights and future research. *Antiquity*, 90(351), 590–603.
- Linstädter, J., Broich, M., & Weninger, B. (2018). Defining the Early Neolithic of the Eastern Rif, Morocco-Spatial distribution, chronological framework, and impact of environmental changes. *Quaternary International*, 472B, 272–282.
- Linstädter, J., Medved, I., Solich, M., & Weniger, G.-C. (2012). Towards a comprehensive model of the Neolithisation process in the Western Mediterranean. Reply to: Aziz Ballouche, Brahim Ouchau & Abdelaziz El Idrissi: More on Neolithisation process within the Alboran territory. *Quaternary International*, 274, 177–178.
- Linstädter, J., & Wagner, G. (2013). The early neolithic pottery of Ifri Oudadane, NE Morocco-Qualitative and quantitative evidence. *Journal of African Archaeology*, 11(2), 155–196.
- Lugliè, C. (2018). Your path led through the sea. The emergence of Neolithic in Sardinia and Corsica. *Quaternary International*, 470B, 285–300.
- Manen, C., Convertini, F., Binder, D., Beeching, A., Briois, F., Bruixelles, L., ... Sénépart, I. (2006). Premiers résultats du projet ACR. « Productions céramiques des premières sociétés paysannes ». L'exemple des faciès impressa du Sud de la France Présentation du projet ACR. "Organisation et fonctionnement des premières sociétés paysannes". L'exemple des faciès impressa du Sud de la France (pp. 213–232). Périgueux: Cœdition ADRAHP-PSO.
- Manen, C., & Guilaine, J. (2007). La céramique: Présentation du corpus. In J. Guilaine, C. Manen, & J.-D. Vigne (Eds.), *Pont de Roque Haute. Nouveaux regards sur la Néolithisation de la France Méditerranéenne*. Toulouse: Les Archives d'Ecologie Préhistorique.
- Manen, C., Marchand, G., & Calvalho, A. F. (2007). Le Néolithique ancien de la Péninsule Ibérique: Vers une nouvelle évaluation du mirage africain?. *Paper presented at the Actes du XXVIe Congrès préhistorique de France. Congrès du Centenaire: Un siècle de construction du discours scientifique en Préhistoire*. Avignon: Les Archives d'Ecologie Préhistorique.
- Manen, C., Perrin, T., Raux, A., Binder, D., Le Bourdonnec, F.-X., Briois, F., ... Queffelec, A. (2019). Le sommet de l'iceberg? Colonisation pionnière et néolithisation de la France méditerranéenne. *Bulletin de la Société Préhistorique Française*, 116(2), 317–361.
- Martín Socas, D., Càmlich Massieu, M. D., Caro Herrero, J. L., & Rodríguez-Santos, F. J. (2018). The beginning of the Neolithic in Andalusia. *Quaternary International*, 470B, 451–471.
- Martínez Sánchez, R. M., Gámiz Caro, J., & Vera Rodríguez, J. C. (2020). Cerámicas impresas de aspecto arcaico en la Alta Andalucía. ¿Una fase 0 para el Neolítico Andaluz?. In S. Pardo Gordó, A. Gómez Bach, M. Molist Montaña, & J. Bernabeu Aubán (Eds.), *Contextualizando la cerámica Impresa: Horizontes culturales en la Península Ibérica*. Barcelona: Publicacions UAB.
- Martínez Sánchez, R. M., Vera Rodríguez, J. C., Moreno García, M., Pérez Jordà, G., Peña-Chocarro, L., & Bokbot, Y. (2017). Beyond adornment: Cowry use as potter's tool in the first impressed wares of the Southwestern Mediterranean Coast (Northern Morocco). *Journal of Island and Coastal Archaeology*, 13(3), 420–437.
- Martínez Sánchez, R. M., Vera Rodríguez, J. C., Pérez Jordà, G., Peña-Chocarro, L., & Bokbot, Y. (2018). The beginning of the Neolithic in northwestern Morocco. *Quaternary International*, 470B, 485–596.
- Martins, H., Oms, F. X., Pereira, L., Pike, A. W. G., Rowsell, K., & Zilhão, J. (2015). Radiocarbon dating the beginning of the Neolithic in Iberia: New results, new problems. *Journal of Mediterranean Archaeology*, 28(1), 105–131.
- Medved, I. (2013). *Continuity vs. Discontinuity. Epipaleolithic and early Neolithic in the Mediterranean Southeast of the Iberian Peninsula*. (PhD thesis). Universität zu Köln, Kohl.
- Morales Mateos, J., Pérez Jordà, G., Peña-Chocarro, L., Bokbot, Y., Vera Rodríguez, J. C., Martínez Sánchez, R. M., & Linstädter, J. (2016). The introduction of South-Western Asian domesticated plants in North-Western Africa: An archaeobotanical contribution from Neolithic Morocco. *Quaternary International*, 412, 96–109.

- Natali, E. (2009). Le ceramiche impresse arcaiche. In V. Tiné (Ed.), *Favella. Un villaggio neolitico nella Sibaritide* (Ministerio per i Beni e le Attività Culturali. Soprintendenza al Museo Nazionale Preistorico Etnografico “L. Pigorini” ed., pp. 227–311). Roma: Istituto Poligrafico e Zecca dello Stato.
- Natali, E., & Forgia, V. (2018). The beginning of the Neolithic in Southern Italy and Sicily. *Quaternary International*, 470B, 253–269.
- Navarrete Enciso, S. (1976). *La Cultura de las Cuevas con cerámica decorada en Andalucía oriental*. Granada: Caja de Ahorros de Granada – Universidad de Granada.
- Nieuwenhuys, O. P., Akkermans, P. M., & Van der Plicht, J. (2010). Not so coarse, nor always plain – The earliest pottery of Syria. *Antiquity*, 84, 71–85.
- Oms Arias, F. X. (2014). *La neolitització del Nord-Est de la Península Ibèrica a partir de les datacions de Carboni 14 i les primeres ceràmiques impresse c. 5600–4600 cal BC*. (PhD thesis). Universitat de Barcelona, Barcelona.
- Oms Arias, F. X., Terradas, X., Morell, B., & Gibaja Bao, J. F. (2018). Mesolithic-Neolithic transition in the northeast of Iberia: Chronology and socioeconomic dynamics. *Quaternary International*, 470B, 383–397.
- Pardo Gordó, S., García Rivero, D., & Bernabeu Aubán, J. (2019). Evidences of branching and blending phenomena in the pottery decoration during the dispersal of the Early Neolithic across Western Europe. *Journal of Archaeological Science: Reports*, 23, 252–264.
- Pérez Bareas, C., Afonso Marrero, J. A., Cámara Serrano, J. A., Contreras Cortés, F., & Lizcano Prestel, R. (1999). Clasificación cultural, periodización y problemas de compartimentación en el Neolítico de la Alta Andalucía. In J. Bernabeu Aubán & T. Orozco Köhler (Eds.), *Actas del II congrés del Neolític a la Península Ibèrica* (pp. 485–492). Valencia: Univeritat de València.
- Pardo-Gordó, S. (2020). ¿Efecto de los huesos de ovicaprinos domésticos en las fechas radiocarbónicas? Un primer ensayo metodológico a partir de los datos disponibles en relación con las primeras sociedades neolíticas de la Península Ibérica. *Archivo de Prehistoria Levantina*, XXXIII, 55–76.
- Pessina, A., & Tiné, V. (2008). *Archeologia del Neolitico. L'Italia tra VI e IV millennio a.C.* Roma: Carocci.
- Podrug, E., McClure, S. B., Perhoc, Z., Kacar, S., Reed, K., & Zavodny, E. (2018). Rašinovac near Ždrapanj (Northern Dalmatia) – An early neolithic site. *Archeologia Adriatica*, 12, 47–97.
- Radi, G., & Petrinelli Pannochia, C. (2018). The beginning of the Neolithic era in Central Italy. *Quaternary International*, 470B, 270–284.
- Ramos Muñoz, J., & Lazarich González, M. (2002). *El asentamiento de “El Retamar” (Puerto Real, Cádiz): Contribución al estudio de la formación social tribal y a los inicios de la economía de producción en la Bahía de Cádiz*. Servicio de Publicaciones, Universidad de Cádiz.
- Sand, C., Chiu, S., & Hogg, N. (2015). The Lapita Complex in time and space: Expansion routes, chronologies and typologies. *Archeologia Pasifika*, 4, 220. Nouméa (Nouvelle Calédonie): Institut d'archéologie de la Nouvelle-Calédonie et du Pacifique.
- Soler Díaz, J. A., Gómez Pérez, O., García Atiénzar, G., & Roca de Togores Muñoz, C. (2011). Sobre el primer horizonte neolítico en la Cova d'En Pardo (Planes, Alicante). Su evaluación desde el registro cerámico. In J. Bernabeu Aubán, M. A. Rojo Guerra, & L. Molina Balaguer (Eds.), *Las primeras producciones cerámicas: El VI milenio Cal AC en la Península Ibérica* (pp. 201–212). Valencia: Univeritat de València.
- Tavares da Silva, C., & Soares, J. (1981). *A Pré-história da área de sines*. Lisboa: Gabinete da Área de Sines.
- Tozzi, C., & Weiss, M.-C. (2001). Nouvelles données sur le Néolithique ancien de l'aire Corso-toscane. *Bulletin de la Société Préhistorique Française*, 98(3), 445–458.
- Ward, G. K., & Wilson, S. R. (1978). Procedures for comparing and combining radiocarbon age determinations: A critique. *Archaeometry*, 20, 19–31.
- Zilhão, J. (2014). Early prehistoric navigation in the western Mediterranean: Implications for the Neolithic transition in Iberia and the Magherb. *Eurasian Prehistory*, 11(1–2), 185–200.