Bell Beaker and the evolution of resource management strategies in the southwest of the Iberian Peninsula

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ABSTRACT
This paper addresses the plain common pottery associated with Beaker contexts in the Southwest of the Iberian Peninsula. The detailed systematic study focuses on the pottery assemblage provided by one of the region’s most important settlements, San Blas (Badajoz, Spain), while comparisons are made with other important sites in the study area. By means of the stratigraphic, typological and statistical analysis of the data, the main patterns of change in this material culture throughout the temporal sequence are identified and the historical explanatory factors are inferred. Specifically, during the second half of the 3rd millennium cal BC, an important change took place in the management of economic risk, which is materialised by a significant reduction in food storage and by the more immediate direct or indirect consumption of resources. We suggest that these patterns reflect a shift towards a short-term projection of the future, in a context with strong evidence of instability.

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1. Introduction

In the early 20th century, the Iberian Peninsula became associated with the development of the Bell Beaker phenomenon (Castillo, 1922, 1928; Blance, 1960; Schmidt, 1915; Siret, 1913) (Fig. 1), and many authors today still defend the estuary of the Tagus River as its place of origin (Case, 2004; Müller and van Willigen, 2001; Salanova, 2004, 2005; Strahm, 1979) (but see Alday, 2001; Lanting and van der Waals, 1976). The available data and the depth of knowledge on the Bell Beaker phenomenon in the Iberian Peninsula has grown considerably since the influential work by R. Harrison (1977) leading to a renewed and dynamic field of research (García Rivero, 2007, 2008; Garrido-Pena, 1997, 2000; Guerra and Liesau, 2016; Lazarich, 1999; Prieto-Martínez and Salanova, 2011; Rojo-Guerra et al., 2005).

There is, however, an important outstanding task in the study of Bell Beaker. Little is known about the plain common pottery (hereafter, PCP) that is found in Beaker contexts and, specifically, its typological evolution over time has not been addressed systematically. PCP from Beaker contexts has been studied in some European regions (Besse, 1996, 2004; Besse and Strahm, 2001; Leonini, 2004a,b; Shennan, 1976; Strahm, 2004), while in the Iberian Peninsula this material has rarely been the object of specific analyses (e.g. Cardoso, 2011a, 2011b; Cardoso et al., 2013; Prieto-Martínez, 2011a, 2011b; Tavares da Silva, 1971). The few existing studies provide the relative frequencies of the different forms in the overall site assemblages but have not addressed the evolution of PCP throughout the stratigraphic sequences. Seriations of pottery have been carried out for the site of Zambujal, but only on the decorated pottery (Beaker and acacia leaf) and the so-called copos cilíndricos (Kunst, 1995). A seriation of PCP has recently been put forward for the site of Porto das Carretas (Soares and Tavares da Silva, 2010). It compares the two general phases of the settlement (pre-Beaker and Beaker) but does not analyse the evolution of the PCP assemblages throughout the Beaker stratigraphy.

Our concept of evolution is based on the notion that the diversity within material culture assemblages changes over time and throughout space (see Lycett, 2015 for an updated theoretical review). The forces behind change are produced by behavioural innovation of individuals as well as by sorting processes that take place within the populations (García Rivero, 2016; Mesoudi, 2011; O’Brien and Lyman, 2000; Shennan, 2002). These sorting processes are generated by situations in which different types of pressure provoke a differential bias in the replication of the traits of
the cultural assemblage. The observation of different relative frequencies enables us to formulate and test hypotheses regarding the differential replication of cultural traits in assemblages over time. Such an approach helps understand the reasons behind the increase and decline of different archaeological materials and provides explanations of cultural change.

The study of the evolution of cultural traits and assemblages requires suitable units to be measured and tracked before they are systematically analysed and explained. In this paper, we are interested in the Bell Beaker phenomenon of the Middle Basin of the Guadiana River (Fig. 1). Our case study is the site of San Blas (Cheles, Badajoz, Spain). Previous work has been carried out on the pottery of this site (Kohring, 2011, 2012; Kohring et al., 2007), although from a different methodological and analytical perspective, and with different questions and aims from those presented in this paper. Our study addresses the typological and functional evolution of the PCP associated with the Beaker contexts of this site in order to explore the key factors behind cultural change in these populations during a specific time span. The central aim here is the creation of a model of change for these wares and the extraction of inferences regarding the main historical factors that may have influenced the use of the different pottery types over time. As we will see, a consistent hypothesis to explain our results is related to a change in the strategies of resource and risk management, as evidenced by the patterns of consumption and storage, during the second half of 3rd millennium cal BC.

2. Material and methods

Our study is based on the archaeological data provided by the excavations of the settlement of San Blas (Cheles, Badajoz) in which one of the authors took part (DGR). The choice of this case study is supported by several factors. Firstly, San Blas is one of the most important Copper Age sites of the region, both in size (Fig. 2) and in the diversity and complexity of its structures: the site is fortified by a system of ditches, walls and towers, with complex defensive systems in the accesses to the settlement (cf. Hurtado, 2004); domestic huts of different types and chronological phases are documented, as well as areas of technological production. Secondly, the site has provided a large volume of recent data from the open excavation of different areas. Particularly, the volume of PCP associated with Beaker contexts is substantial. Finally, the stratigraphic and chronological information is detailed and reliable, and is further supported by a number of radiocarbon dates.

Most of the excavated areas of the prehistoric settlement of San Blas display two well-differentiated chronological phases, characterised by two different models of round huts. Type A huts were built upon a stone base but had entirely organic walls and roof. This hut type is associated with the earliest phase of the settlement that spanned the late 4th millennium and the first half of the 3rd millennium cal BC (Table 1). Type B huts were built of dry stone wall with an organic roof, and were also slightly larger in diameter than the earlier structures. They belong to the second phase of the site, dated to the second half of the 3rd millennium cal BC.

Our interest here resides in the Beaker contexts, defined as all excavated archaeological structures and levels containing Beaker pottery. The Beaker contexts belong to three archaeological areas, J27, H22 and H23 (Fig. 2). All three display the two chronological phases outlined above. J27 is located inside the citadel and preserves the remains of an area of habitat with a superposition of domestic structures (Fig. 3). Two Type A huts are documented...
beneath one Type B hut. Areas H22 and H23 are contiguous and are located only a few metres outside of the citadel (Fig. 2). They provide a similar archaeological record with one Type A hut under two successive Type B huts (Fig. 4). With the exception of a single sherd in context 64 of Area H22, all of the Beaker contexts correspond to levels and structures belonging to the second phase of the settlement. Area J27 displays 6 Beaker contexts, Area H22 has 2 and Area H23 has 3 (Table 2).

Judging by their stratigraphic characteristics, these Beaker contexts may have been formed over long periods of time. A single radiocarbon date comes from H22 (2477 ± 2394 cal BCE) (Table 1), from a level located between its two Beaker contexts and belonging to the 1st use of the second Type B hut. Another radiocarbon sample dates a Type B hut context without Beaker pottery in Area K7 (Fig. 2) (2568 ± 2519 BCE) (Table 1). Both of these dates provide references for the beginning of the second phase of the settlement.

The analysis of the evolution of the PCP record carried out in this paper is related to this phase, materialised by the construction of dry stone wall huts (Type B), and dated to the second half of the 3rd millennium cal BC.

A pottery typology has been designed for the classification of the PCP of the Beaker contexts of San Blas. The classification system is structured essentially by morphology, and shape and size are considered as indicators of function. The close relationship between form and function has been explored extensively in archaeology (Hurt and Rakita, 2001; O’Brien and Lyman, 2003) and also in other fields of study such as biology (Gould, 2002) and engineering (Rinderle, 1987). The basic principle that supports the relationship between form and function is the same in all of these fields: all things possess a form, created by any number of traits, which act in concert to produce a functional unit. Pottery may be defined conceptually as a fundamental category of utilitarian material culture. This does not reduce the many dimensions of pottery, but rather acknowledges its central place in a wide spectrum of human activities, including the practices of food preparation, consumption and storage.

Ceramic ethnoarchaeology has been of great importance in exploring the relationships between the intended function and the actual use of pottery (Arnold, 1985; David and Kramer, 2001; Hegmon, 2000; Kramer, 1979; Longacre, 1991; Stark, 2003). Intended function, understood as the purpose for which a vessel is designed, is conditioned during pottery production by its technomorphological characteristics (Albero, 2014; Quinn, 2013; Rice, 1987). Vessel shape and size are arguably the main indicators of intended function, while relationships between form and fabric are far less definite. The archaeometric fabric analyses of Beaker

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Table 1 Radiocarbon dates from the settlement of San Blas. (Recalibrated by the authors from Hurtado, 2004).

<table>
<thead>
<tr>
<th>Sample location</th>
<th>Settlement phase</th>
<th>Lab code</th>
<th>RCBP</th>
<th>95.4% p cal BCE</th>
<th>p&lt;sup&gt;-&lt;/sup&gt;</th>
<th>68.2% p cal BCE</th>
<th>p&lt;sup&gt;-&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB/J27/8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1st Phase</td>
<td>Beta-178655</td>
<td>4560 ± 40 BP</td>
<td>3243–3102 BCE</td>
<td>0.540</td>
<td>3369–3327 BCE</td>
<td>0.404</td>
</tr>
<tr>
<td>SB/F5/33</td>
<td>1st Phase</td>
<td>Beta-169546</td>
<td>4420 ± 40 BP</td>
<td>3122–2918 BCE</td>
<td>0.773</td>
<td>3100–3006 BCE</td>
<td>0.652</td>
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<tr>
<td>SB/J25/12</td>
<td>1st Phase</td>
<td>Beta-178653</td>
<td>4330 ± 40 BP</td>
<td>3027–2887 BCE</td>
<td>0.967</td>
<td>2943–2998 BCE</td>
<td>0.576</td>
</tr>
<tr>
<td>SB/E9/38</td>
<td>1st Phase</td>
<td>Beta-178650</td>
<td>4030 ± 40 BP</td>
<td>2639–2468 BCE</td>
<td>0.946</td>
<td>2581–2481 BCE</td>
<td>1</td>
</tr>
<tr>
<td>SB/K7/37</td>
<td>2nd Phase</td>
<td>Beta-178654</td>
<td>3980 ± 40 BP</td>
<td>2581–2399 BCE</td>
<td>0.940</td>
<td>2568–2519 BCE</td>
<td>0.582</td>
</tr>
<tr>
<td>SB/H22/29</td>
<td>2nd Phase</td>
<td>Beta-178651</td>
<td>3930 ± 40 BP</td>
<td>2496–2293 BCE</td>
<td>0.932</td>
<td>2477–2394 BCE</td>
<td>0.683</td>
</tr>
<tr>
<td>SB/J24/15</td>
<td>2nd Phase</td>
<td>Beta-178652</td>
<td>3800 ± 40 BP</td>
<td>2350–2132 BCE</td>
<td>0.935</td>
<td>2293–2196 BCE</td>
<td>0.834</td>
</tr>
</tbody>
</table>

<sup>a</sup> Calibrations are made in software Calib 7.0 based on IntCal 13 data sets.

<sup>b</sup> Probability distribution according to Reimer et al., 2013.

<sup>c</sup> Settlement: San Blas.

<sup>d</sup> Area ID.

<sup>e</sup> Context number.

<sup>1</sup> The radiocarbon dates indicated in the text correspond to the 68.2% p calibration ranges.
assemblages (decorated and plain wares) carried out so far have not
detected any significant correlation between typology and composition (Prieto-Martínez et al., 2015; Soares and Tavares da Silva, 2010: 236). The absence of style-fabric relationships has been suggested for the coetaneous embossed, incised and plain pottery of La Pijotilla (Gómez et al., 1999). At the site of San Blas itself, fabric analysis indicates that while a number of chaines opératoires may have coexisted within a common technological framework, compositional and mineralogical differences are not detected between the different morphological types (Kohring, 2011; Kohring et al., 2007).

The refinement of the methods of use alteration analysis (Skibo, 2013) and lipid residue analysis (Nieuwenhuyse et al., 2015) is gradually providing evidence of the use of ceramics in archaeological contexts. Lipid residue analyses have been carried out on some Beaker and PCP (Bueno et al., 2005; Guerra, 2006; Prieto-Martínez, 2011c; Rojo-Guerra et al., 2006, 2008), but the data currently available does not support any exclusive relationship between pottery forms and contents.

Despite the introduction of new methods in the study of archaeological ceramics, typology remains a fundamental base to which all other levels of information may be added. Vessel shape and size enable us to establish broad formal groups with functional associations, which may be refined by further methods.
Fig. 4. Area H22 with the archaeological remains of several huts. The best-preserved, in the upper level, conserves the entire stone circle and several internal structures. Other walls are documented outside of the hut and are related to the main structure.

Table 2
Description of the Beaker contexts of Areas J27, H22 and H23.

<table>
<thead>
<tr>
<th>Area description</th>
<th>Context number</th>
<th>Context description</th>
</tr>
</thead>
<tbody>
<tr>
<td>J27 - Area description</td>
<td>11</td>
<td>Time</td>
</tr>
<tr>
<td>Inside the citadel. It includes two Type A huts beneath one Type B hut. All of the Beaker contexts of this area belong to the Type B hut</td>
<td>11</td>
<td>Radiocarbon date (2477-2394 cal BCE - 68.2% p)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>H22 - Area description</th>
<th>Context number</th>
<th>Context description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside of the citadel. It includes one Type A hut under two successive Type B huts</td>
<td>11</td>
<td>Time</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>H23 - Area description</th>
<th>Context number</th>
<th>Context description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contiguous to Area H22</td>
<td>6</td>
<td>Time</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>19</td>
</tr>
</tbody>
</table>

14
Assemblage assessment through morphometric typology is suitable for in- and off-site comparative studies of pottery assemblages. The types considered here are derived from the geometric relationship between the form of a vessel and the ideal representation of a sphere or ellipsoid as it is truncated progressively from top to bottom. Other morphological features such as the thickening of the rim or the presence of a carination have also been taken into account. Our PCP typology includes 7 types (Fig. 5). The correlations between each of the geometric definitions, their morphological descriptions, and their assumed functional categories and common names are detailed in Table 3, along with the available metric data. The size range of the different vessel types supports the validity of the proposed functions.

Once identified and classified according to typology, the PCP groups are quantified statistically and their relative frequencies are established, both for the overall assemblage and for the three archaeological areas under study – J27, H22, and H23. For each area, a temporal sequence is created which reflects the evolution of the relative frequencies of the different PCP types in the successive stratigraphic episodes.

A chi-squared test is conducted in order to establish whether no differences exist in the distribution of the pottery types between the three areas under study (H0) or, on the contrary, that there are significant differences (H1). This test enables us to verify that the relative frequencies of the types are similar in the different samples and, therefore, that the diversity of the samples is stable and comparable between areas. If this is the case then the typological patterns observed in any of the archaeological areas may be extrapolated and generalised with full assurance to the overall assemblage of PCP.

The areas with reliable contexts and quantitatively suitable pottery assemblages have been the object of several statistical analyses comparing the samples documented in each of the stratigraphic levels. The comparison of the distributions of the relative frequencies of the different pottery types throughout the sequence enables the observation of correlations between types and of significant changes in their evolution over time. Specifically, the tests conducted are: a) Kendall’s W to compare the samples from each context; b) Pearson correlations and c) linear regression to analyse the possible significant correlations between different pottery types.

The stratigraphic and typological analyses enable us to establish the evolutionary sequence of PCP. Moreover, the statistical analysis enables us to explore the underlying patterns of cultural change, and to assess the most relevant inferences and explanations for the reconstruction of its evolution, function and use.

3. Results

The 11 excavated Beaker contexts of San Blas (see Table 2) have yielded 20 Beaker pots. These are important in defining the
contexts and assemblages of PCP under analysis in this study, but they are not the focus of our attention here. The Beaker contexts of San Blas have also yielded a total of 302 PCP vessels, 196 of which can be classified typologically.

Fig. 6a illustrates the relative frequencies of the PCP types within the overall assemblage of the Beaker contexts, while Fig. 6b illustrates these frequencies for the three archaeological areas. The general pattern of typological diversity, with the exception of small details, is the same in the three areas. The predominant types, far ahead of the others, are Types IV, V and III—bowls, plates and cooking vessels (Table 3).

Area J27 has 14 Beaker pots (Figs. 7 and 8) and 169 PCP vessels (110 typologically identifiable) belonging to 6 contexts (Table 2). All of the contexts have between over 10 and over 30 typologically identifiable vessels. Fig. 9a illustrates the frequencies of the different pottery types throughout the stratigraphic sequence, while Fig. 9b shows a seriation of their relative percentages. The most common types—and those present in all levels—are Types IV, III and V: bowls, cooking vessels and plates. However, the temporal sequence indicates that the relative proportions of the different pottery types are not constant over time. There is a progressive increase of Type V (plates). The values of this type vary from <10% of the context assemblage of the initial stratigraphic level (context 50) to >30% in the last level of prehistoric use of the hut (context 28). (Context EM is later than the period of use of the hut). There is also a decrease of Type I (storage vessels) (Table 3). The percentage of this type drops from 25% of the context assemblage of context 50 to approximately 3% in context 28. There may be a slight increase in Type VII, drinking vessels similar to that of the typical Beaker forms, although this tendency must be taken with caution due to the later date of context EM.

H22 has provided 2 Beaker pots (Figs. 8 and 10) and 84 PCP vessels (Table 3). Fig. 6a illustrates the relative frequencies of the different types of plain common pottery for (a) the overall assemblage under study, and (b) the three archaeological areas (J27, H22 and H23).
vessels (56 typologically identifiable). The best-represented pottery types are Types IV, III and V: bowls, plates and cooking vessels (Fig. 11a and b). The stratigraphical sequence of H22 includes only two contexts (Table 2), and the second contains only a dozen typologically identifiable vessels. The patterns of change inferred from this area must therefore be treated with caution. Type I—storage vessels—is present in the first stratigraphic level but absent from the second. On the contrary, Types VI and VII—dishes and drinking vessels—appear only in the second level. The proportion of Type V—plates—decreases between the first and second levels. Types III and IV are also less well represented in absolute values in the second level, although Fig. 11b indicates a relative increase of Type IV and a relative decrease of Type III over time.

Area H23 has provided 3 Beaker pots (Figs. 8 and 10) and 30 typologically identifiable PCP vessels from three contexts (Table 2). However, the detailed analysis of the stratigraphy and the materials recovered indicates that these contexts are affected by Roman activities. The prehistoric materials recovered from these contexts, although much more abundant than those from historical periods, have suffered changes in the precise location of the finds. It is therefore more reasonable and precautious to exclude the inferences obtained from the study of H23.

The chi-squared test to check for differences between the PCP assemblages of the three areas (Table 4) provides the value $p = 0.66$.
Fig. 8. Photographs of a selection of Beaker pots from Areas J27, H22, and H23. The identification codes for each pot contain the archaeological area, the context, and the sherd number.
There is therefore no evidence on the basis of which to reject H0. The three samples display similar compositions and the inferences extracted from any one of these samples may be extrapolated to the overall site assemblage of PCP. Therefore, we focus on Area J27, since it has the most reliable stratigraphy and quantitatively suitable pottery assemblage.

Kendall’s W test, conducted in order to establish whether there is a significant relationship between the 6 contexts of J27 on the basis of the frequencies of the PCP (Table 6), gives the coefficient 0.74 with a value $p = 0$ (Table 7). H0 is that there is no relationship between the samples, in this case the different context assemblages. The statistical evidence rejects H0 and supports the relationship between the contexts and the relative frequencies of their pottery types, and thus reinforces the functional unity of this area.

When the chronologically consecutive contexts are compared one to one, the situation is quite different (Table 8). A close relationship between consecutive contexts would be expected, in the sense that the diversity of the material culture contained in successive layers should not have changed much. There are two relationships within a 90% confidence interval, the transitions between contexts 68 and 45 and 28 and EM, but none of the five possible relationships (transitions) between the consecutive contexts display significant $p$ values on the basis of which to reject the null hypothesis. It may be suggested, therefore, that the differences in the variability of the PCP between the consecutive levels of J27 correspond to patterns of non-random change and constitute evidence of particular behavioural patterns. This empirical observation implies a historical explanatory factor, independently of whether we succeed in discovering it or not.

Pearson correlations and linear regressions have been conducted in order to detect the existence of strong relationships between any of the 7 pottery types (see Fig. 5 and Table 3). The Pearson coefficient can vary between −1 and 1. The closer it is to the extreme values, the stronger the relationship between two pottery types, that is, the higher their mutual dependence. On the contrary, the values closest to 0 reflect a greater independence. As is

![Graph](image-url)

**Fig. 9.** (a) Relative frequencies and (b) relative percentages of the different types of plain common pottery throughout the stratigraphic and chronological sequence of Area J27. The graph reads from left (the earliest context, 50) to right (the latest context, EM).

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summarised in Table 9, the closest correlations are established between Types III and IV (ρ = 0.91) and Types I and V (ρ = 0.67), i.e. between cooking vessels and bowls, on the one hand, and between storage vessels and plates, on the other (Fig. 5).

This information can be combined with that provided by the linear regressions (Fig. 12 and Table 10). The values with statistical significance in the ANOVA test indicate that the variables are related (H0 is that the degree of relationship between the variables is null). The best fitting regression is that of the relationship between Types III and IV, with a highly statistically significant value of p = 0.01. The evolution of these two pottery types over time, cooking vessels and bowls, is therefore significantly linked.

4. Discussion

The PCP record documented in the Beaker contexts of San Blas (Fig. 6) is dominated by bowls (Type IV) (as previously observed by Kohring et al., 2007), plates (Type V), and cooking vessels (Type III).

In terms of regional comparisons, the scarce studies that have quantified the PCP of the Beaker contexts of the Iberian Southwest focus essentially on the Tagus Estuary (Fig. 1). At the settlement of Penha Verde (Sintra), with an occupation throughout the whole of the second half of the 3rd millennium BC, the most frequent forms, in decreasing order of importance, are the homologues to our types IV, V and III (based on 75 vessels, cf. Cardoso, 2011b), thus displaying an identical pattern to that observed at San Blas (Fig. 6a). At Freiria (Cascais), occupied during the last quarter of the 3rd millennium BC, the predominant types are the homologues to our types IV and III, while our type V, well-represented at San Blas, is barely documented (based on 368 vessels, cf. Cardoso et al., 2013). A similar pattern is displayed at the settlement of Leitão (Oeiras) in which the most common types are again the homologues to our types IV and III (based on 49 vessels, cf. Cardoso, 2011a).

In proximity to San Blas, the site of Porto das Carretas displays similar patterns to those identified at San Blas. In the pottery sample belonging to the Beaker phase (2500–2200 cal BCE) (160 vessels), the most frequent forms are the homologues to our types IV and III (Soares and Tavares da Silva, 2010). The frequency and relative proportions of the different PCP types have been compared between the pre-Beaker and the Beaker phases of the settlement, but their evolution during the Beaker phase has not been addressed. The results from Porto das Carretas are therefore not immediately comparable to those of this study.

Our study of the PCP of San Blas has enabled us to detect some
very suggestive patterns of change throughout the Beaker phase of the site that require the formulation of appropriate historical hypotheses in order to identify the underlying factors that may explain the significant changes in the differential production and use of certain pottery types over time.

One of the most noteworthy patterns is the strong correlation between Types III and IV, that is, between cooking vessels and bowls. The Pearson coefficient and the linear regression indicate a significant statistical correlation between the two. This correlation is negative, indicating that the increase in one is directly proportional to the decrease in the other. We are therefore faced with a negative coevolution between the two most frequent pottery types of the settlement. It must be noted that the direction of change is not constant and does not display a clear accumulative linear direction. Rather it takes both directions throughout the sequence (note in Fig. 12 the way in which the pattern becomes inverted between one context and the next).

Another noteworthy pattern is the progressive decrease of Type I—storage vessels. Additionally, there is a decrease in the number of storage pits, or at least in their location inside of the huts, during the second phase of the site (Hurtado, 2004: 151). Both containers, storage vessels and pits located inside of the huts, thus converge in a tendency towards the reduction of the volume of food storage. Area H22 is a case in point, providing a radiocarbon date of 2477–2394 cal BCE, after which there are no Type I vessels.

Type V—plates—increases throughout the temporal sequence, thus indicating the more widespread use of this type of service form over time. This tendency may reflect the increase in the size of the units that ate together and it is interesting to note that the Type B huts (belonging to the second phase of the site, 2568–2196 cal BCE), are generally slightly larger in internal wall diameter than the Type A huts (belonging to the first phase, 3369–3272 cal BCE onwards) (cf. Table 1). Moreover, the increase of Type V and the decrease of Type I are significantly correlated by the Pearson value —0.67 (Table 9), thus the increase of the number of plates and the reduction of storage vessels are dependent.

During the chronological interval between 2568 and 2196 cal BCE at San Blas, an evolution of the economic and social systems took place, which appears to have caused major changes in the storage and consumption of resources and in the manipulation of the strategies for the management of risk. On the basis of our results, we may suggest that, over time, this population invested less in the storage of food for the months and year ahead and consumed the resources more immediately, either directly (food) or indirectly (secondary trade products). This behavioural shift appears to imply a short- rather than a mid- to long-term projection of the future, the reasons for which may have stemmed from a number of internal and external social and environmental circumstances.

### Table 4

<table>
<thead>
<tr>
<th>Area</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
<th>TNVA</th>
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</thead>
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<tr>
<td>J27</td>
<td>9</td>
<td>3</td>
<td>26</td>
<td>40</td>
<td>25</td>
<td>3</td>
<td>4</td>
<td>110</td>
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<tr>
<td>H22</td>
<td>3</td>
<td>0</td>
<td>10</td>
<td>21</td>
<td>18</td>
<td>2</td>
<td>2</td>
<td>56</td>
</tr>
<tr>
<td>H23</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>7</td>
<td>13</td>
<td>1</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>TNVT</td>
<td>14</td>
<td>3</td>
<td>41</td>
<td>68</td>
<td>56</td>
<td>6</td>
<td>8</td>
<td>196</td>
</tr>
</tbody>
</table>

* TNVA: Total number of vessels per area.
* TNVT: Total number of vessels per type.

### Table 5

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
<th>df</th>
<th>Sig. Asint. (2-Tails)</th>
</tr>
</thead>
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<tr>
<td>Pearson chi-squared</td>
<td>5.53</td>
<td>12.00</td>
<td>0.66</td>
</tr>
<tr>
<td>Similarity</td>
<td>10.52</td>
<td>12.00</td>
<td>0.57</td>
</tr>
<tr>
<td>Lineal-by-Lineal Association</td>
<td>4.07</td>
<td>1.00</td>
<td>0.04</td>
</tr>
<tr>
<td>N valid cases</td>
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</tr>
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</table>

### Table 6

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<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>68</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>0</td>
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<tr>
<td>45</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>31</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>28</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>EM</td>
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<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 7

Kendall’s W test for the frequencies of the different types of plain common pottery for the area assemblage of J27.

<table>
<thead>
<tr>
<th></th>
<th>Mid-range</th>
</tr>
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<tbody>
<tr>
<td>Type I</td>
<td>3.67</td>
</tr>
<tr>
<td>Type II</td>
<td>2.17</td>
</tr>
<tr>
<td>Type III</td>
<td>5.67</td>
</tr>
<tr>
<td>Type IV</td>
<td>6.67</td>
</tr>
<tr>
<td>Type V</td>
<td>5.00</td>
</tr>
<tr>
<td>Type VI</td>
<td>2.17</td>
</tr>
<tr>
<td>Type VII</td>
<td>2.67</td>
</tr>
<tr>
<td>N</td>
<td>6</td>
</tr>
</tbody>
</table>

### Table 8

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1st – 50’</td>
<td>0.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd–68</td>
<td></td>
<td>0.09</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd–45</td>
<td></td>
<td></td>
<td>0.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th–31</td>
<td></td>
<td></td>
<td></td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>5th–28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.08</td>
</tr>
</tbody>
</table>

* Note that the table reads from left to right. For example, the relationship between the first two consecutive contexts (50 and 68) has a p value of 0.11. (See Table 2 for the descriptions of J27 contexts.)

### Table 9

Pearson correlation values between the different types of plain common pottery from Area J27.

<table>
<thead>
<tr>
<th></th>
<th>Type II</th>
<th>Type III</th>
<th>Type IV</th>
<th>Type V</th>
<th>Type VI</th>
<th>Type VII</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>0.03</td>
<td>–0.26</td>
<td>0.48</td>
<td>–0.67</td>
<td>–0.53</td>
<td>–0.09</td>
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<tr>
<td>Type II</td>
<td>–0.18</td>
<td>0.05</td>
<td>0.28</td>
<td>–0.28</td>
<td>–0.30</td>
<td></td>
</tr>
<tr>
<td>Type III</td>
<td>–0.91</td>
<td>0.02</td>
<td>0.08</td>
<td>0.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type IV</td>
<td>–0.16</td>
<td>–0.15</td>
<td>–0.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type V</td>
<td>–0.19</td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type VI</td>
<td>–1.29</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
The explanation of this change in the strategies of resource and risk management in this population is beyond the scope of the present study since this question requires further approaches to the assessment, analysis and testing of the available archaeological information. We cannot at present confirm that the main cause of this change was related to the internal evolution of the population and an accelerated process of social hierarchization based on prestige economies (e.g. García Rivero, 2008; 2009; Garrido-Pena, 2000; Hurtado, 2005). The economic and social inferences of our study are based on the Beaker contexts of San Blas. Considering the specific nature of these contexts, we must consider that our results may not necessarily be extensive to the population of the settlement as a whole. In this sense it will be interesting to follow up in future work on whether the evolution of the PCP assemblages is similar throughout all of the areas of the settlements or whether there are different evolutionary patterns that may indicate significant intrademic differences.

An external factor, namely environmental change, may have had an equally decisive impact on the strategies of resource and risk management of the populations under study. Recent palaeoclimatic studies of the Iberian Peninsula have detected a sharp fall in the salinity index of the lacustrine waters between 2500 and 2000 cal BCE, which would reflect a decrease in the level of humidity of the environment (Morellon et al., 2008). According to the main reconstructions of the Iberian palaeoclimate, generalised conditions of relative aridity were reached by 2000 cal BCE (Cacho et al., 2010: 19 ff.). In the southwest of the Iberian Peninsula, specifically, recent assessments based on high-resolution palynological records have highlighted 2200 cal BCE (Lillios et al., 2016: 147 ff.) as the point of inflexion of the increase in aridity.

Independently of whether the primary cause behind the changes in resource and risk management strategies throughout the 2568–2196 cal BCE timespan was internal or external to these societies, there is further archaeological evidence of factors that may have fueled the changes in the economy and future planning of these groups. In Western European Prehistory, the increase in the volume of archaeological evidences of violence and warfare is dated in the 3rd millennium BCE (Guilaine and Zammit, 2005: 124 ff.). In the Southwest of the Iberian Peninsula (see Chapman, 2008; Kunst, 2006; Valera, 2013), large scale defensive structures become a common feature of settlements, with the digging of ditches and the construction of fortifications including walls and towers, arrowheads become numerous and are worked on both sides and in perfect symmetry, and by around 2500 cal BCE other weapons such as metal daggers and spears become widespread. Close to San Blas, there are evidences of settlements that were destroyed and burnt violently in the second half of the 3rd millennium BCE, and that display later phases of reconstruction of the houses and the fortifications (Enriquez, 1990; Hurtado and Enriquez, 1991).

New questions and techniques in forensic research have provided direct evidence of interpersonal violence in the Late Prehistory of the Iberian Peninsula (Armendariz et al., 1994; Kunst, 2000;
Mercadal and Agustí, 2006; Vegas et al., 2012). In the particular case of the Southwest of the Iberian Peninsula, there is a significant number of burials dated in the 3rd millennium BCE that display fractured bones, cutmarks and embedded arrowheads that are consistent with violent deaths (Oosterbeek and Tomé, 2012; Silva and Marques, 2010; Silva et al., 2012, 2014).

The wealth of archaeological evidence of diverse nature— including the changes observed in material culture assemblages, climatic and palynological alterations, and anthropological evidence of interpersonal violence—provide indications of factors that influenced and possibly promoted the rapid collapse of the Chalcolithic period around 2200–2000 cal BCE. Although some authors maintain the idea of a gradual transition between Chalcolithic and Bronze Age (see Hurtado, 2000; Pavón, 2008; 7; Schubart, 1991), the southern regions of the Iberian Peninsula as a whole display evidence of a considerable change between the archaeological records of the two periods. In the Southwest, Bronze Age populations appear to be substitutes rather than heirs of the previous societies (García Rivero and Escacena, 2015). In the Southeast, at the same date, most Chalcolithic settlements were burnt to the ground and abandoned, and most Bronze Age settlements occupied new locations (Lull et al., 2010: 14).

The tendencies observed in the PCP record of the Beaker contexts of San Blas are strongly suggestive of important changes in the strategies of resource and risk management. Whatever the primary reason behind the drastic economic and social changes that took place during the second half of the 3rd millennium cal BCE in the Southwest of the Iberian Peninsula, just before the collapse of the Copper Age, the unstable and disrupted social context suggested by this study is highly plausible. Future studies and the application of new perspectives and methods (e.g. Selover, 2015; Smith, 2015) may help broaden the explanatory model set out in this paper and address issues of great relevance for the knowledge of human cultural change not only in the past but also in the present (White, 2010).

Acknowledgments

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References


Castillo, A., 1922. La cerámica incisa de la cultura de las cuevas del Penaltram, La Cuenca Extremadura del Guadiana: Los poblados. Museo Arqueológico Provincial de Badajoz, Badajoz.


Guilfl treasury Theory 7 (3), 129–137.


