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CHAPTER TWENTY-TWO

AT THE EDGE OF THE MARSHES: NEW APPROACHES TO THE SADO VALLEY MESOLITHIC (SOUTHERN PORTUGAL)

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Abstract

Among the major European concentrations of Mesolithic settlements, the lower Sado valley is one of the least known. Despite the development of large systematic excavations in the mid twentieth century and recent attempts to re-examine some sites, only very partial information is available. Yet there are valuable unpublished archaeological collections in the National Museum of Archaeology in Lisbon, and the preservation of most of the sites is quite satisfactory. Moreover, the Sado shell middens are located in a very particular geographical setting, which opens up very interesting questions on the role of coastal and inland resources and landscapes among late hunter-gatherers. Since 2010, a Luso-Spanish interdisciplinary team has been systematically re-appraising this area within the framework of a research project on the transition to the Neolithic in coastal areas of SW Atlantic Europe. The project design and the preliminary results of the first fieldwork seasons are presented in this paper.

Introduction

The Sado shell middens constitute one of the classic references for the Mesolithic of southern Europe. Located in a Tertiary basin in coastal Alentejo, the eleven sites that were known prior to our research are concentrated in a 15 km sector of the valley (Fig. 22.1). Surprisingly they are located relatively upstream, as the lower sites are some 40 km from the current mouth of the river near Setúbal.

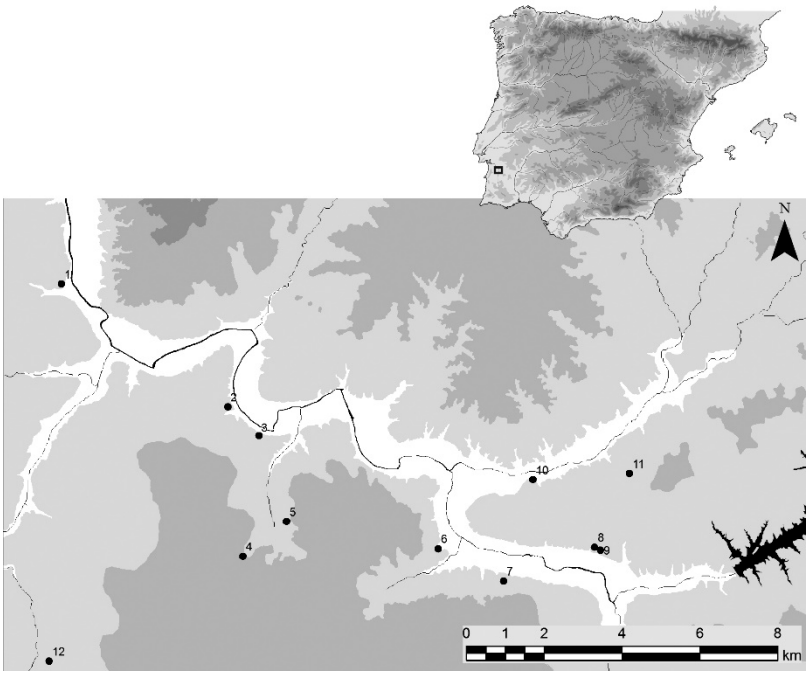

Fig. 22.1. Location of the shell middens in the Sado valley. Key: 1. Arapouco; 2. Cabeço do Rebolador; 3. Barreirão; 4. Poças de São Bento; 5. Fonte da Mina; 6. Barrada das Vieiras; 7. Cabeço das Amoreiras; 8. Vale de Romeiras; 9. Cabeço do Pez; 10. Várzea da Mó; 11. Barrada do Grilo; 12. Barranco da Moura.

The existence of shell middens in the area was first identified by L. Antunes Barradas in the 1930s (Barradas 1936), but it was only in the 1950s that the area was systematically explored. At that time, an extensive programme of excavations that lasted from 1955 to 1966 was developed by Manuel Heleno and his team of the *Museu Nacional de Arqueologia*

(National Museum of Archaeology) (Machado 1964). Unfortunately, notwithstanding some brief reports (Heleno 1956, Santos 1967, 1968, 1985, Santos et al., 1972, 1974) their results have remained mainly unpublished. In the 1980s an ambitious project of research was initiated by José M. Arnaud. This included a re-appraisal of Heleno's data and new excavations at the shell middens of Amoreiras, Cabeço do Pez and Poças de São Bento, the latter in collaboration with a Swedish team led by Lars Larsson (Arnaud 1987, 1989, 1990, 2000, Larsson 1993, 1996, 2010). However, this promising programme was interrupted before its completion, and the research in the Sado was nearly abandoned, in spite of some partial analyses of the archaeological material kept in the *Museu Nacional de Arqueologia* (see, for instance, Araújo 1995-97, Diniz 2010, Cunha and Umbelino 1995-97, 2001, Marchand 2001, Nukushina 2012, Umbelino 2006, Umbelino and Cunha 2012). Thus, the Sado Mesolithic remained poorly understood, just as one reference to the existence of cemeteries in shell middens, lacking updated information.

This is why in 2010 the SADO MESO project was launched. This is included in a larger programme of research, "Coastal Transitions: A comparative approach to the processes of neolithization in Atlantic Europe" (COASTTRAN), funded by the Spanish Ministry of Economy and Competitiveness (National Plan of R+D). The COASTTRAN project proposed a comparative approach to the processes of transition to the Neolithic in three areas of Atlantic Europe characterized by a high concentration of late Mesolithic settlement (mostly shell middens) and some early Neolithic sites in a restricted area, by the availability of relatively well-preserved sites of those periods and by the existence of partially exploited archaeological tradition, as some sites had been excavated in former times, and large (totally or partially unpublished) collections remained accessible in the Museums. Those regions were Southern Brittany, Cantabrian Spain and the Sado valley. The research was conceived as a coordinated program with three sub-projects involving respectively, excavation and archaeological study (led by P. Arias, University of Cantabria), archaeomalacology (Esteban Álvarez, University of Salamanca) and improvement in surveying techniques (Enrique Cerrillo, Consejo Superior de Investigaciones Científicas). Sixty-one researchers from Spain, Portugal, France, the United Kingdom, Germany, Ireland, Sweden and Canada participate in the program, with the very relevant participation of the teams from UNIARQ (University of Lisbon), led by M. Diniz, and the UMR 6566 CReAAH (Université de Rennes-CNRS) (Grégor Marchand). SADO MESO was simultaneously funded by a grant from the Portuguese Science Agency, *Fundação para a Ciência e*

a Tecnologia (FCT), for the project "Retorno ao Sado: Um caso entre os últimos caçadores-recolectores e a emergência das sociedades agropastorís no sul de Portugal" (PI: M. Diniz).

The main aims of SADO MESO (Diniz and Arias 2012, Arias and Diniz in press-a, in press-b) are the establishment of a very detailed chronology of the human presence in the Sado valley during the Mesolithic and the Neolithic, and the study of the taphonomic processes taking place at the shell middens, ultimately attempting to understand the economic, social and symbolic functions of these sites. To achieve these major goals, some intermediate techniques are being applied, such as the direct analysis of the shells, both for schlerochronology and stable isotopes analysis ($\delta^{13}C$ and $\delta^{18}O$), or the determination of a more reliable ΔR parameter for that section of the Portuguese coast (with the collaboration of António Monge Soares, of the *Instituto Tecnológico e Nuclear*). On a broader perspective, the possible complementarity with other kinds of coeval sites (both in the coastal areas themselves and in inland regions nearby) will be analysed, and very precise dating of the introduction of domestic species, either animals or plants, will be established. Moreover, an estimation of the relevance of marine resources in the diet of Mesolithic and early Neolithic populations, using stable isotope analysis ($\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$) will be made. We will also try to identify possible evidence of technical transfers between Mesolithic and Neolithic groups, and to assess the spatial relationship between the Mesolithic settlement and regional Neolithic. A re-analysis of the funerary real will also be attempted by the COASTTRAN member Rita P. Stjerna (Uppsala Universitet).

Fieldwork (2010-2013)

The first stage of our project included a systematic survey of the lower Sado valley and surrounding areas, performed by the team led by Enrique Cerrillo and Leonor Rocha (Rocha et al. 2013). Transects were made, focusing on areas where the morphological analysis showed that middle Holocene sediments might be preserved. Among the results of this research, we can highlight the discovery of a new Prehistoric shell midden in the lower Sado: the site of Barreirão (Fig. 22.1). This site is on the southern (left) bank of the Sado, not far from the shell middens of Cabeço do Rebolador and Poças de São Bento, in a small *cabeço* in the edge of the Tertiary plain located some 50 m above the current alluvial plain, a most typical location for the Sado valley shell middens.

Simultaneously, a survey to locate the source of lithic raw materials was made. This part of the research was directed by Nuno Pimentel

(Department of Geology, University of Lisbon), with the collaboration of Diana Nukushina. Their preliminary results show that most of the rocks knapped by the Mesolithic groups (siliceous slates, chert, jasper and quartz) may have been gathered in the Paleogene conglomerates that can be accessed between Torrão and Alcácer do Sal. (see Pimentel et al., this volume). As the authors of that chapter point out, it is worth analysing whether the availability of these kinds of resources might have influenced the location of the Mesolithic settlements.

A key issue in our research programme was the palaeoenvironmental reconstruction of the valley. It must be highlighted that the evolution of the Sado estuary during the Holocene, and especially during the Postglacial transgression maximum, is very poorly documented. With that aim, a program of sedimentological analysis of the alluvial plan has been attempted. That has included the geophysical profiles of the valley (Rogério Mota, of the Portuguese National Laboratory of Civil Engineering-LNEC) and several sedimentary cores in the area between Arez and São Romão do Sado (Conceição Freitas, César Andrade and colleagues from the Department of Geology of the University of Lisbon). One of the members of our team, Ana M. Costa, is working on this topic for her PhD dissertation. Although the sampling is still in progress, and the cores are currently being analysed, some stimulating preliminary results have arisen, suggesting that the conventional hypothesis that the palaeoestuary of the Sado reached the area of the shell middens might be inaccurate (Freitas, personal communication).

Geophysical techniques have also been applied at a micro-level in the shell middens. An extensive archaeomagnetic survey has been performed at the sites of Poças de São Bento and Vale de Romeiras by the COASTTRAN researcher Felix Teichner (Philipps-University at Marburg, Germany), with the collaboration of Christoph Salzmann (Ruprecht-Karls-Universität Heidelberg) and the Frankfurt branch of the German Archaeological Institute (*Römisch-Germanische Kommission*). A manual carrier (MAGNETO®-ARCH-5-canal-system), produced by the firm Sensys Sensorik & Systemtechnologie GmbH (Bad Saarow, Germany), with a measuring range of ±3,000 nT and an accuracy is 0.1 nT was used. Measurements were taken every 10 centimetres. The results were particularly relevant at Poças de São Bento, where several anomalies probably corresponding to Mesolithic features were detected. Some of them were explored by opening test pits during the 2013 excavations, confirming the hypothesis that they were related with earlier anthropic activities. Actually, they revealed a Mesolithic human burial (see below).

Research at Poças de São Bento also included the extraction of sedimentological cores. Four of them, 2m deep, were taken with a percussion window sampler in different parts of the site (Fig. 22.2). So far, a detailed chemostratigraphic analysis has been made for one of them (PSB/D) with a geochemical XRF core scanner, providing most valuable information on the environmental evolution and site formation processes (see Duarte *et al.*, this volume). Further analysis will be made in the framework of Carlos D. Duarte's PhD research, also relaying the micromorphology study that he is currently performing. With that aim, undisturbed stratigraphy blocks and bulk sediment samples have been taken at this site.

As stated above, one of the main goals of the SADO MESO project is to understand the formation processes of the shell middens. This was one of the aims of the archaeological excavations that we have been performed. We have selected two sites which were located in different topographical settings and which were apparently reasonably well preserved: Cabeço do Pez, placed in the most characteristic location (a promontory facing the alluvial plain) in the furthest part of the valley, and Poças de São Bento, near a lateral rivulet in the lower part of the section of the valley, 3 km distant from the Sado. Complementarily, test pits are being opened in other sites in order to obtain updated, statistically representative, samples of every shell midden in the area.

Cabeço do Pez is the largest shell midden of the Sado valley (around 4000 m^2). Extensive excavations by the MNA team and more limited work by J. Arnaud had cleared most of the central area of the Mesolithic settlement. Therefore our excavation focused on the edges of the shell midden, one of them in the top area and the other close to the upper part of the southern slope. They revealed a complex stratigraphy, with important lateral variability, and, in the latter, strong erosional processes.

Preservation of the shell midden was much better at Poças de São Bento. This site also occupies a large area (3500 m^2), although the limits are difficult to assess because the archaeological deposit does not exhibit any particular feature on the surface. Actually, Poças de Sao Bento, like the other Sado middens, and unlike their Muge counterparts, is not a mound, but a flat area where the only visible evidence of the existence of a Mesolithic deposit is the presence of archaeological items (mainly shells, but also some lithics) on the ground. Our excavations (Fig. 22.2) were centred on the NW edge of the site, on a gentle slope coming from a low height dominating the area. We also opened a pair of test pits in the central area, not far from the main trenches of the previous excavations, one of

them (S6) in an area where the geophysical survey (see above) suggested the existence of Prehistoric features.

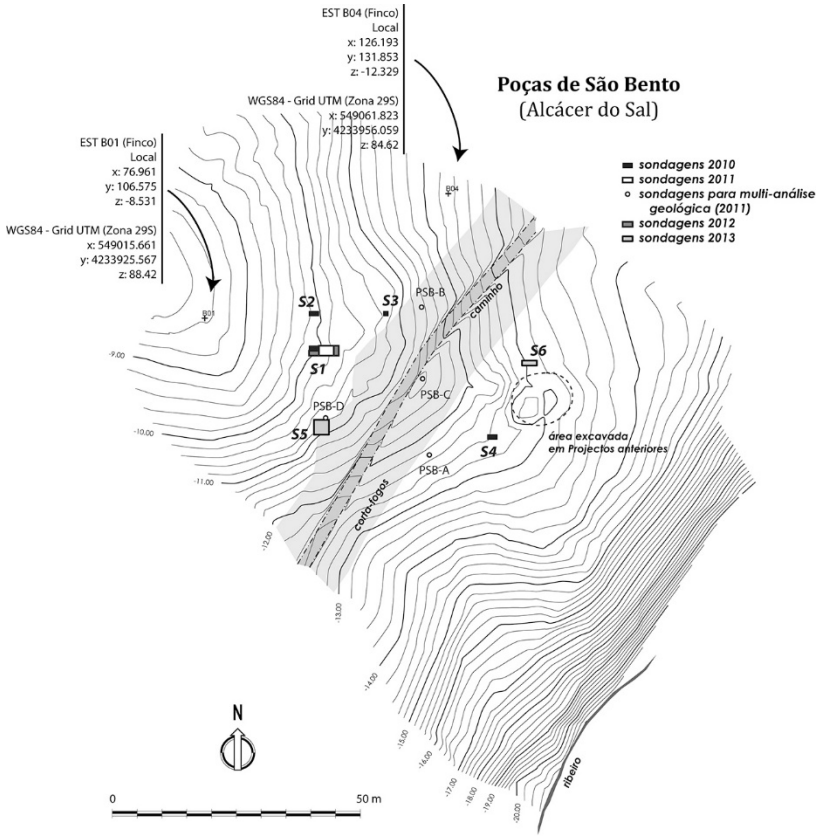

Fig. 22.2. Poças de São Bento. Excavated area.

A total surface of 29 m^2 has been opened. Although some lateral variations were found, especially in the thickness of the layers, the stratigraphy was quite consistent in most of the excavation areas. From top to bottom the following units were distinguished (Fig. 22.3; see also Araújo et al., this volume, Fig. 2):

- Surface. Modern soil;

- Phase D (not represented in the section reproduced in Fig. 22.3): Yellowish sand with a low density of archaeological remains, including some historical and modern ceramics;
- Phase C: Blackish sand with some allochthonous sandstone blocks, a low density of shells and sparse archaeological material, including lithics, bones and few Prehistoric (possibly Neolithic) pottery sherds. It appears to be a palaeosol;
- Phase B: A dense accumulation of mollusc shells (mainly *Scrobicularia plana* and in a smaller proportion *Cerastoderma edule*) in a sandy sediment with a low density of other kinds of archaeological materials;
- Phase A: Greyish sands with a low density of shells and lithics;
- Geological Substrate: Cenozoic ferruginous reddish or yellowish sandstone and sands.

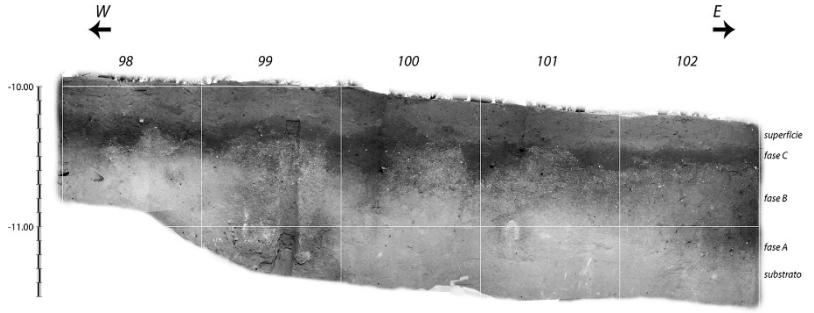

Fig. 22.3. Poças de São Bento. Stratigraphy in the northern section of excavation area 1.

There is a good agreement between this sequence and the stratigraphy defined, in a completely independent way, by the chemostratigraphical analysis of the sedimentary cores (see Duarte et al., this volume). Chemostratigraphic units F and E strictly correspond to the archaeological phases A and B. Moreover, chemostratigraphy confirmed that archaeological phase C was a palaeosol (Chemostratigraphic unit D), whereas archaeological phase D and the surface layer can be correlated to units C to A.

The main period of human activity in the site appears to be phase B, a typical Mesolithic shell midden dating to the first and second thirds of the sixth millennium cal BC. It is not completely clear whether there was a previous occupation or not, because the interpretation of phase A of the

sequence is not clear. It might be related to postdepositional processes displacing shells and other materials from upper layers to sterile sands below. Yet is cannot altogether be excluded that it derives from sparse or occasional human activity in the area during the earlier stages of the Mesolithic. We are currently facing that dilemma using taphonomic criteria and applying micromorphological techniques.

Phase B, the late Mesolithic shell midden, yielded a very high density of shells, but was not particularly rich in other kinds of archaeological materials. Lithic industries included the typical geometric microliths (see Araujo et al., this volume). Bone instruments and adornment items were also found, including ceramic pendants among the latter, similar to those recovered from the site by L. Larsson and J. Arnaud (Larsson 2010: 39, Fig. 10, 17-18). However, the most relevant result of our excavation has been the discovery of several anthropogenic structures, including pits that might be considered storage or cooking facilities (Fig. 22.4) and especially two burials: a dog grave and a human interment, the latter detected in the geophysical survey (see above). Both burials are currently under analysis and will soon be published in detail.

Fig. 23.4. Negative structure in Poças de São Bento.

Although absolute dates are not available at the moment, phase C appears to be separated from the shell midden by a chronological hiatus. A stratigraphic discordance between both layers was apparent, and there was a fairly sharp contrast in terms of sedimentology and archaeological

content, which, in the case of phase C included prehistoric pottery that might be attributed to the Neolithic. This suggests that the site, as some other Mesolithic settlements in the area (Diniz 2010), might have still been frequented (at least occasionally) by the early farming communities in the region. The possible existence of some continuity between the late Mesolithic and the Neolithic settlement is a most interesting topic in this area. That has led us to include in our project the systematic exploration of the Neolithic evidence in the lower Sado basin. This includes the study of some megaliths that are located near the shell midden concentration area, such as the passage grave of São Fausto, close to Torrão and 10 km from Cabeço do Pez.

At the Lab

The archaeological material obtained during the fieldwork was processed according to a detailed protocol developed by the COASTTRAN responsible for the field laboratory (Patricia Sánchez) with the collaboration of Jorge Vallejo and two of us (L.T. and P.A.). That protocol was explicitly formulated in a printed document that was available to every member of the fieldwork team. The excavation distinguished stratigraphic units (SU) following the criteria proposed by E. Harris (1989). The SU were recorded using the software Harris Matrix Composer and the project database (see below), and their geometry was collected creating microtopographies of the surface of each unit with the motorized total stations Leica TCRM!1205 and Leica TCRM1105plus and with photogrametric methods with a full frame camera Nikon D700 with a calibrated lens (AF Nikkor 24 mm; 1:2.8D). Geometric data were processed through the software n4ce (DTM's and codification), MicroStation (CAD system) and Photomodeller scanner (point clouds and meshes). Visible archaeological items were also georeferenced in the field with the same equipment. Inside each SU, sediments were recovered in 10dm^3 units (named CR: *Conjuntos de Recolha*). The coordinates of a central point at the bottom of each CR were taken with a total station, and this value was later attributed to the archaeological material recovered from the sediment. In this way, all the archaeological items from the site were georeferenced, the accuracy being either 1 cm (for the individual items), or < 13.4 cm (for the objects from the sediment samples). Every unit (either individual items or CR's) recovered in the field received an individual reference code, related to the database. That reference and a bar code were included on an adhesive unbreakable label adhered to the plastic bag that contained the

object or the sediment. This system allowed us to control the position of each unit in a fast and efficient way during the lab process.

During the fieldwork, provisional laboratories were installed in premises kindly provided by the owners of Poças de São Bento and Cabeço do Pez. There, all the stages of archaeological processing previous to analysis by specialists were performed, with the materials leaving the field ready for analysis or Museum storage. When it arrived at the field laboratory, 100% of the sediment was processed in a Syraf-type flotation machine and mesh to obtain archaeobotanic samples (see López-Dóriga et al., this volume). The floating material was recovered with a 250µm mesh, whereas the heavier sediment was recovered with a 2mm mesh. After drying in the shade, all the residues were eye-sorted to recover lithics, bone, pottery and adornments. A random subsample of the residues was obtained using a riffle box. The subsample, corresponding to 12.5% of the total ($1{:}2^3$), was sent to the colleagues in charge of marine archaeomalacology (Esteban Álvarez, University of Salamanca, and Catherine Dupont, University of Rennes), ichthyology (Sónia Gabriel, DGPC, Lisbon), the land snail study (Teresa Aparicio, National Museum of Natural Sciences, Madrid) and the micromammal analysis (Carmen Sesé, National Museum of Natural Sciences, Madrid) to be sorted under optical instruments. The sample was split again to obtain a random subsample of 1.56% ($1{:}2^6$) of the sediment for the quantitative analysis of *Scrobicularia plana* and *Cerastoderma edule*, which were so abundant that they could not be measured in larger samples. The remaining material from the analysed 12.5% subsample will be sent to the MNA for storage whereas the rest (87.5%) was used to backfill the excavation trenches after the excavation.

After sorting each kind of archaeological material, the inventory, which already included the items that had been georeferenced in the field, was completed. We used a specific database designed by COASTTRAN members Jorge Vallejo and Patricia Fernández by developing the software FileMaker Pro 12. It is conceived as a relational model around a central table built after the topographic information was provided by the total station. Related to this table are four more tables, controlling respectively the description of the SUs and associated graphic material, the processing stage of the sediment samples and items, the final inventory, and the location of the items in the storage section. However, in spite of its internal complexity, the database is operated through a user-friendly interface that can be easily learnt by any member of the team after a very short training time. Thus, the database permits control of the information on the topographic origin of the items and their classification. It also provides graphic information about the items and the SU, such as maps,

photographs of the items, and a form with the description of the sediments and the stratigraphic relations of each SU. It should be stressed that the database also includes information on the current location of the items and the processing stage they are in. The bar and QR codes used in the labels and on the objects permit an easy, fast and efficient control of this. The design of the database permits network use from different posts, allowing simultaneous updating in several places (field, laboratory and storage area). However, this option (which is currently being used in other projects developed by this team) was not used in the Sado sites because it requires every post to be connected by a WLAN or LAN network, and this is not available there at the moment.

The efficiency of the system was very good. At Poças de São Bento it allowed us to process 4,798 samples in 53 days of work (the inventory has reached 20,489 entries). Moreover, its reliability was very high, as the system worked with an extremely low rate of mistakes. Estimations were made on this issue each year, with the resulting errors ranging between 0.8 and 1.5%

Most of the analyses listed above are still in progress. However, some preliminary results are worth mentioning. Let us highlight the excellent returns of the systematic sampling for plant macro-remains. As shown in another chapter of these Proceedings (López-Dóriga et al.) the Sado sites have provided one of the best collections of plant macro-remains for the Mesolithic of SW Europe, opening up interesting insights into the use of vegetable resources by the last hunter-gatherers in the Iberian Peninsula. More surprising are the preliminary results of the geological and geomorphological research led by C. Freitas and colleagues at the Department of Geology in the University of Lisbon. The analysis so-far performed on the cores extracted from the Sado alluvial plane between Arez and São Romão have provided no evidence of a marine or estuarine facies in the upper 10 m of sediments, suggesting that the Holocene palaeoestuary of the Sado was not as deep as supposed (Conceição Freitas and Ana M. da Costa, personal communication). It is interesting to stress that this is consistent with the preliminary analysis of the fish remains from Poças de São Bento, which show a clear predominance of open-sea species such as sardines (*Sardina pilchardus*) over estuarine species (Sónia Gabriel, personal communication). If confirmed by further analysis, these results would challenge the conventional assumption that interprets the Sado shell middens as estuarine coastal settlements. We must also mention the micromorphology analysis currently in progress by Carlos Simões for his PhD dissertation and the XRF chemostratigraphic analysis

performed at Poças de São Bento by this researcher and Eneko Iriarte (see Duarte et al., this volume).

Preservation and Public Outreach

Research is not the only concern of SADO MESO. The preservation of Archaeological Heritage and public outreach are also among the aims of the project. A most relevant action from that point of view has been the preservation of the dog burial from Poças de São Bento in its context. Although the easiest and cheapest expedient would have been the conventional excavation of the structure, we considered that it would be worth maintaining the skeleton in the sediment which had contained it for thousands of years. That would permit new analyses of the structure in the future, and would provide a most interesting educational resource. The director of the National Museum at that time, Dr. Luis Raposo enthusiastically agreed to our proposals, and the Mesolithic burial was preserved and extracted with the most valuable collaboration of the technicians commissioned by the Museum (Matias Tissot and Mário Almeida) (Fig. 22.5). Moreover, that allowed us to finish the excavation of the dog skeleton with the best technical conditions in the Museum premises, with the active participation of the team members who are in charge of mammal analysis, Simon Davis and Cleia Detry. From the point of view of the public outreach of our research, the actions taken include numerous references in the media (TV, radio and press), articles in magazines oriented towards scientific dissemination (National Geographic), and lectures (Lisbon and Torrão). We are currently working with the MNA team on future actions, among them an exhibition on the dog burial.

Preliminary Results

SADO MESO is still an on-going project. Therefore, most of the results must be considered just provisional states-of-the-art to be revised in coming years.

Probably the most exciting hypothesis to be tested is the possibility of the palaeoestuary being much less deep than supposed. Were the shell middens really next to the salt water resources? If future geomorphological research were to confirm that the sites were actually much further from the estuarine resources than expected, a very different interpretation of the social and economic meaning of the Mesolithic settlement would arise. Are we facing in the Sado valley a case of long-distance procurement of

marine resources, as the fish record so far suggests? It is worth assessing to what extent seafood and fish were key factors for the explanation of Mesolithic settlement patterns in the Sado. The relevance of other resources such as the availability of fresh, drinkable, water, or the proximity to sources of lithic raw materials (see Pimentel et al., this volume) should be carefully analysed. Moreover, the role of other Mesolithic sites different from shell middens must be considered.

Fig. 24.5. The technicians of the Museu Nacional de Arqueologia at work for the preservation of the dog burial at Poças de São Bento in 2011.

Changing to a micro-scale, our excavations at Cabeço do Pez and Poças de São Bento confirm that the Sado shell middens cannot be described as mounds, like other sites of this kind elsewhere. Rather, they appear to be extended and heterogeneous surfaces with an irregular accumulation of shells and other coeval material. Certainly, there is a vertical, conventional sequence (see above), but also processes of lateral variation, like a kind of "horizontal stratigraphy", which makes the interpretation of these sites particular complicated. It must also be stressed that negative structures (already mentioned in the previous excavations, especially in Larsson's work at Poças de São Bento) were more abundant than expected.

No doubt, the most relevant information comes from the symbolic realm, especially the appearance of a dog burial, a typical feature in the northern European Mesolithic (Larsson 1990), which had not so far been confirmed in southern Europe, although some convincing evidence had been recovered from the materials recovered at Muge in the nineteenth century (Detry and Cardoso 2010).

Information on the human presence in the Sado valley immediately after the Mesolithic is still very scarce. What happened after the main phase of the occupation of the shell middens? It is interesting to note the existence of quite consistent information suggesting some kind of human activity in some sites during the Neolithic. More research on this issue is required, either into the shell middens themselves (or around them) and in other parts of the valley.

Finally, a reflection that is particularly fitting for a conference held in Muge. After 65 years of archaeological marriage, the time may be arriving for the Sado and Muge groups to split up. The evidence gathered by our project in the last four years tends to suggest that parallelism between the "twin" great areas of the Portuguese late Mesolithic might be more apparent than real. Crucial aspects such as the morphology of the sites, or their relationship with the environment, and particularly with the estuarine areas, appear to be quite different. It is possible that the similitude lies a great deal in appearance: the fact that both groups of sites include "shell middens". But is this a satisfactory concept, or just the consequence of a superficial appearance, masking the really meaningful features of the hunter-gatherers' life and organization? The fortunate circumstance that research is currently being conducted simultaneously at Muge and the Sado opens the gate for a fruitful debate in the coming years.

Acknowledgements

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References

Araújo, A.C., 1995-1997. A indústria lítico do concheiro de Poças de S. Bento (Vale do Sado) no seu contexto regional. *O Arqueólogo Português*, 4, 87-159.

Arias, P., Diniz, M.T., in press-a. O Mesolítico e o Neolítico antigo: o caso dos concheiros do Sado, in: *5º Congresso do Neolítico Peninsular*, Universidade de Lisboa, Lisboa.

Arias, P., Diniz, M.T., in press-b. Back in the Sado shell middens. A new research project on the late Mesolithic communities of the lower Sado valley (Portugal), in: *Gathering in the South: Proceedings of the Eighth International Conference on the Mesolithic in Europe*. Santander 13th-17th September, 2010, Arias, P. and Cueto, M. (Eds.), Oxbow, Oxford.

Arnaud, J. Morais, 1987. Os concheiros mesolíticos dos vales do Tejo e Sado: semelhanças e diferença*s*. *Arqueologia*, 15, 53-64.

—. 1989. The Mesolithic communities of the Sado valley, Portugal, in their ecological setting, in: *The Mesolithic in Europe*: Papers Presented at the Third International Symposium, Edinburgh 1985, Bonsall, C. (Ed.), John Donald, Edinburgh, pp. 614-631.

—. 1990. Le substrat mesolithique et le processus de neolithisation dans le sud du Portugal, in: *Rubané et Cardial*. Actes du Colloque de Liège,

Cahen, D. and Otte, M. (Eds.), Service de Préhistoire de la Université de Liège, Liège, pp. 437-446.

—. 2000. Os concheiros mesolíticos do vale do Sado e a exploraçao dos recursos estuarinos (nos tempos pré-históricos e na actualidade), in: *Actas do Encontro sobre Arqueologia da Arrábida*, Instituto Português de Arqueologia, Lisboa, pp. 21-43.

Barradas, L. Antunes, 1936. Concheiros do vale do Sado. *Anais da Faculdade de Ciências do Porto*, 21, 175-179.

Cunha, E., Umbelino, C., 1995-1997. Abordagem antropológica das comunidades mesolíticas dos concheiros do Sado. *O Arqueólogo Português*, IV, 161-179.

Cunha, E., Umbelino, C., 2001. Mesolithic people from Portugal: an approach to Sado osteological series. *Anthropologie*, 39, 125-132.

Detry, C., Cardoso, J.L., 2010. On some remains of dog (*Canis familiaris*) from the Mesolithic shell-middens of Muge, Portugal. *Journal of Archaeological Science,* 37, 2762-2774.

Diniz, M.T., 2010. O concheiro mesolítico do Cabeço das Amoreiras (S. Romão do Sado, Alcácer do Sal): um (outro) paradigma perdido?, in: *Os últimos caçadores-recolectores e as primeiras comunidades produtoras do sul da Península Ibérica e do norte de Marrocos*. Actas do Workshop (Faro, 2-4 de Novembro de 2009), Gibaja, J.F. and Carvalho, A.F. (Eds.), Faculdade de Ciéncias Humanas e Sociais da Universidade do Algarve, Faro, pp. 49-61.

Diniz, M.T., Arias, P., 2012. O povoamento humano do paleo-estuário do Sado (Portugal): problemáticas em torno da ocupação dos concheiros mesolíticos, in: *Environmental changes and human interaction along the western Atlantic edge = Mundanças ambientais e interação humana na fachada atlântica ocidental*, Almeida, A.C., Bettencourt, A.M.S., Moura, D., Monteiro-Rodrigues, S. and Alves, M.I.C. (Eds.), APEQ-CITCEM-CEGOT-CGUP-CCT, Coimbra, pp. 139-157.

Harris, E.C., 1989. *Principles of Archaeological Stratigraphy*, 2nd ed. Academic Press, London.

Heleno, M., 1956. Um quarto de século de investigação arqueológica. *O Arqueólogo Português*, 2, 221-237.

Larsson, L., 1990. Dogs in fraction – Symbols in action, in: *Contributions to the Mesolithic in Europe*. Papers presented at the Fourth International Symposium 'The Mesolithic in Europe'. Leuven 1990, Vermeersch, P.M. and Peer, P.v. (Eds.), Leuven University Press, Leuven, pp. 153.

—. 1993. Kitchen middens. A familiar archaeological site in a new light, in: *Sources and Resources: Studies in Honour of Birgit Arrhenius*,

Arwidsson, G., Olausson, L.H. and Arrhenius, B. (Eds.), Conseil de l'Europe, Strasbourg, pp. 267-285.

—. 1996. Late Atlantic Settlement in Southern Portugal. Results of an excavation of a Mesolithic shell midden by the River Sado. *Current Swedish Archaeology*, 4, 123-139.

—. 2010. Shells in the sand. Poças de São Bento – a Mesolithic shell midden by the River Sado, Southern Portugal, in: *Beiträge zur Vor- und Frühgeschichte der Iberischen Halbinsel und Mitteleuropas. Studien in honorem Philine Kalb*. Armbruester, T. and Hegewisch, M. (Eds.), pp. 23-43.

Machado, J.L.S., 1964. Subsídios para a história do Museu Etnológico do Dr.Leite de Vasconcellos. *O Arqueólogo Português*, 5, 51-148.

Marchand, G., 2001. Les traditions techniques du Mésolithique final dans le sud de Portugal: les industries lithiques des amas coquilliers de Várzea da Mó et de Cabeço do Rebolador (fouilles M. Heleno). *Revista Portuguesa de Arqueologia*, 4, 47-110.

Nukushina, D., 2012. *Tecno-tipologia lítica e cronometria no Mesolítico final do vale do Sado o caso do concheiro das Amoreiras (Alcacer do Sal)*. Unpublished M.Sc. thesis. Universidad de Lisboa. Available at http://repositorio.ul.pt/handle/10451/7933

Rocha, L., Cerrillo Cuenca, E., Diniz, M.T., Arias, P., Santos, I., Liceras, R., Quintero, S., Naranjo, J., López, A., 2013. Novos dados sobre o povoamento arqueológico na bacia do Rio Sado (Portugal). Resultados preliminares das prospecções do projeto SADO-MESO". in: *I Congresso da Associação dos Arqueólogos Portugueses*, Associação dos Arqueólogos Portugueses, Lisboa, pp. 165-169.

Santos, M. Farinha dos. 1967. Concheiro mesolítico do Barranco da Moura. Grândola. *O Arqueólogo Português*, 3, 113-114.

—. 1968. Concheiro mesolítico da Fonte da Mina. Grândola. *O Arqueólogo Português*, 3, 183.

—. 1985. Pré-História de Portual, Verbo, Lisboa.

Santos, M. Farinha dos, Soares, J., Silva, C. Tavares da, 1972. Campaniforme da Barrada do Grilo (Torrão – vale do Sado). *O Arqueólogo Português*, 3, 163-192.

Santos, M. Farinha dos, Soares, J., Silva, C. Tavares da, 1974. O concheiro epipaleolítico do Cabeço do Pez (Vale do Sado – Torrão). Primeira notícia, in: *Actas do III Congresso Nacional de Arqueologia*, Imprensa Portuguesa, Porto, pp. 173-189.

Umbelino, C., 2006. *Outros sabores do passado: As análises de oligoelementos e de isótopos estáveis na reconstituição da dieta das comunidades humanas do Mesolítico Final e do Neolítico*

Final/Calcolítico do território português. Unpublished PhD thesis, Universidade de Coimbra.

Umbelino, C., Cunha, E., 2012. The Sado shell middens: Anthropological and palaeodietary depiction, in: Funerary Practices in *the Iberian Peninsula from the Mesolithic to the Chalcolithic*, Gibaja, J.F., Carvalho, A.F. and Chambon, P. (Eds.), Archaeopress, Oxford, pp. 91-102.