EXARC JOURNAL 2017/3
13 Articles | Open Access

Reviewed Article:

Research, Experimentation and Outreach in the Early Neolithic Site of La Draga (Banyoles-Spain)

Persistent Identifier: https://exarc.net/ark:/88735/10302

EXARC Journal Issue 2017/3 | **Publication Date:** 2017-08-30

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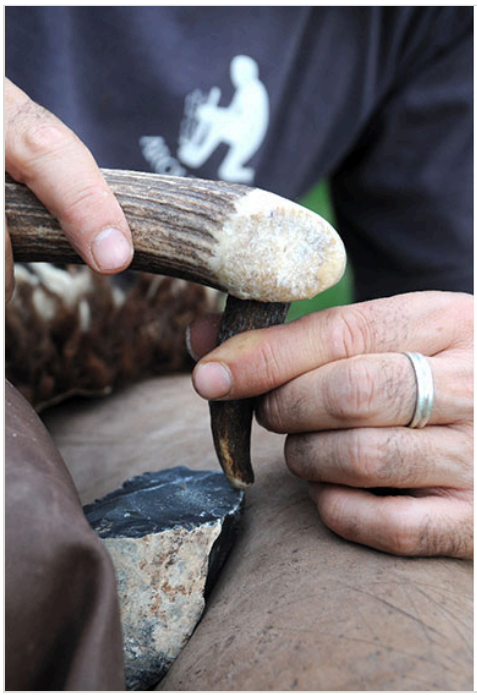

The exceptional preservation of organic material in the early Neolithic site of La Draga (Banyoles, north-east Iberian Peninsula) has allowed lines of research that had rarely been undertaken in the region. The research project carried out at the site of La Draga involves experimental archaeology as a methodological tool in order to characterize the technological procedures and to test the functional hypotheses of tools.

Data obtained in these investigations are the foundation stones for the pedagogical project of La Draga, mainly based on hands-on experience. These outreach activities are held in the Archaeological Park of the Neolithic Settlement of La Draga, where early farmers' dwellings, tools and agricultural plots have been replicated following the results of archaeological research. In this paper, some examples of the interaction between experimental research, digital technologies, and outreach activities will be described.

> Experimental research has been focused on several aspects of Neolithic technology. Archaeological research at La Draga involves the use of experimentation as a way of testing the hypotheses reached in the different analyses. In addition, the excellent conservation of archaeological materials provides a unique opportunity to understand technological processes hardly imaginable so far.

La Draga is a lake dwelling located in the North-East of the Iberian Peninsula, on the eastern shore of l'Estany de Banyoles (Lake Banyoles). This small lake is 170m above sea level, 40km from the Mediterranean coast, and 50km south of the Pyrenees. The settlement of La Draga is located half-way along the eastern shore of Lake Banyoles. The Lake has a figure-of-eight shape and the settlement stood at the narrowest point. In topographical terms, the area was a peninsula, and the ground sloped steadily from east to west and from north to south (See Figure 1).

The site has provided evidence of some of the earliest farming societies in open-air settlements in north-eastern Iberia, dated and calibrated to the late sixth millennium BC (Palomo, et al., 2014; Bogdanovic, et al., 2015). The numerous C-14 dates obtained for short-lived samples (seeds and bones) allow us to set the occupation of La Draga between 5350-4950 BC. The C-14 dates, calibrated to two sigma, show nochronologicalbreaks that would indicate aperiod of abandonmentof the site. La Draga is therefore one of the oldest open-air settlements in north-eastern Iberia.

From a cultural and chronological point of view, La Draga belongs to the end of the impressed Cardial-ware phase in the Western Mediterranean. Both radiocarbon dating and the relative data provided by the archaeological record including: ceramic pots, tools made from bone or antler, chipped and polished stone implements, ornaments and tools with wooden handles support this assertion.

La Draga was found in April 1990 and has been excavated in several field seasons up to the present day.The site must originally have occupied over 10,000 m2. 1500m2 were covered by the lake with the rest on the shore, being partially under the water table since the Neolithic. A total area of 963m2 has been excavated to date. The conservation of the recovered archaeological materials variesis, and is dependent on their position above or below the water table.

Two different phases of occupation with distinctive construction traditions have been documented so far. However, both of these belong to the late Cardial-Ware Neolithic culture according to the pottery style, and are dated to the late sixth millennium and early fifth millennium BC by the available radiocarbon dates.

Experimental research has been focused on several aspects of Neolithic technology. Archaeological research at La Draga involves the use of experimentation as a way of testing the hypotheses reached in the different analyses. In addition, the excellent conservation of archaeological materials provides a unique opportunity to understand technological processes hardly imaginable so far. For us, experimentation an integral part of the scientific method (Baena and Terradas, 2005). It is the basis of scientific research and also, therefore, of archaeological research.

The experimental research program has focused on replicating the technological processes of production of different bone, wood and stone tools and artefacts, relating to the woodworking and the textile production process (Palomo, 2012; López, 2015). The aim has been to observe the effectiveness of tools and build up a reference collection of technological and functional traces. The identification of the manufacturing technique is achieved by comparing the marks that appear on the surfaces of the archaeological artefacts with those produced during experimentation. This way, we have been able to identify which tools were used during the manufacture of artefacts in order to acquire a better understanding of the woodworking and textile production processes.

Moreover, experimental research is the foundation stone for the pedagogical project of La Draga, as it is mainly based on hands-on experience (Buch, Comellas and Palomo, 2011). The outreach activities held in the Archaeological Park of the Neolithic Settlement of La Draga are the result of this experimental research.

In this presentation, some examples of the interaction between experimental research, digital technologies, and outreach activities will be given.

Adze handles

In recent years, several experimental studies have been conducted to verify different aspects relating to the production and function of wooden handles. To date, 10 elbow-shaped adze

handles have been identified, and none had the stone adze in place. All the handles have a similar morphology, consisting of a carved platform where the adze is attached. This forms an angle with the handle itself. The handles are manufactured using different species of wood. Most (six) are made of oak (*Quercus* sp. deciduous). In three other cases, the wood used is from a conifer although in each case a different one: pine (*Pinus* sp.), juniper (*Juniperus* sp.) and yew (*Taxus baccata*). The other handle is made of boxwood (*Buxus sempervirens*).

The objective of the experimentation was to check the hypothesis of the process of manufacture (See Figure 2).

Digging sticks

Digging sticks are the most abundant wooden tool in La Draga. These instruments are made entirely of wood, most of them of boxwood. In normal conditions, they would be completely invisible in the archaeological record.

The experimental work in this instance has a double objective. On the one hand to determine the production process and, on the other hand, to verify their function. The archaeological sticks display facets and various types of traces on their surfaces, some related to its manufacture and others being the result of use. Experimentation has shown we can discriminate one from the other, which has confirmed their use as digging sticks (See Figure 3).

The facets related to the production process are of different types. Facets produced using wooden wedges to split the branch are long and may have the same length as the stick, while the facets resulting from digging work are short and narrow. The experimental use of digging sticks has succeeded in showing their effectiveness in turning the soil. This work produced several macroscopic traces: striations, microscars, notches, fragmentation and flattening of the fibres, and polishing. These traces were also observed in the archaeological sticks. However, archaeological wooden objects present difficulties when studied with the usual techniques of use-wear analysis, as the objects are saturated in water when recovered, and the reflection of light on shiny surfaces does not permit a reliable reading of the traces. Moreover, once restored they become deformed, and some use and technological traces can be altered. However, the use of a 3D scanner allows for good reproduction and modelling of both the archaeological and the experimental objects, thus enabling the study of the traces.

Bows

Three bows, two fragmented and one whole, have been recovered. Even though they are different in size and shape, all of them were made with yew (*Taxus bacatta*). They are the earliest Neolithic bows documented in Europe so far (Piqué, et al*.,* 2015). The use of yew is

not by chance; yew wood has suitable physical conditions to be used for elaborate bows: hard, flexible and with good mechanical strength.

Almost no tool marks can be recognized on their surface. However, through anatomical inspection, it has been stated that all those bows found at La Draga were made of a segment of branch or trunk of yew. Those segments correspond to the last tree-rings of the stem (the ones that tend to be more flexible) with one face corresponding to the last growth ring. In all the cases, the bark was stripped from the surface and its small twigs removed. The other faces were elaborated through splitting, roughing down, and polishing.

The experimental work has been focused on replicating the technology of their manufacture (See Figure 4).

Flint-knapping

Our experimentation has also focused on the study of the production and use of stone tools. A wide range of lithic tools made from siliceous rocks, mainly chert, have been recovered at La Draga. This lithic production is characterized by blade products used primarily as the active elements in sickles, projectiles and drills. Various tools made from deer antler have been interpreted as a set of knapping implements used in indirect percussion. These tools have enabled the development of a pilot program to determine the technique used in blade production (See Figure 5).

The experiments focused on two main aspects:

1. Determining the technique used in blade production.
2. Testing the hypothesis that the deer antler objects were tools used for knapping.

Textile Technology

Textile technology is another of the topics of experimentation. Our objective has been to determine if the instruments from La Draga were used for textile production.

A large number of bone and wooden artefacts exceptionally preserved in anaerobic conditions have been recovered in the early phase of the site. Among the artefacts made of bone and wood found at La Draga were spindle-like objects, shuttles and combs made of wood, as well as bone needles, awls and other bone tools. All of these instruments are similar to those used by modern and ancient societies in the processes of weaving and spinning as a part of traditional textile production. Because of these similarities, it has been suggested that they were used to make textiles.

The objective of experimentation has been to generate a use-wear reference collection for studying the archaeological material and understanding the textile production processes.

(See Figure 6)

The actions performed during the experimentation of textile production process were:

- Use of combs for combing and carding wool.
- Long spindle-like object used as spindle for spinning and/or shuttles for weaving.
- Use of awls in weaving as weft beaters to increase the textile density and also to select and separate warp threads.

Outreach

The quality of the archaeological site of La Draga, as well as the research undertaken since 1991, meets all of the conditions of suitability for spreading knowledge about the life of the first farmers in Catalonia. In fact, the specificity of the place, its exceptional conservation, its location in a privileged environment and its ability to generate a large amount of data could also be a powerful engine for heritage dissemination.

After 25 years of research in the field and 20 years since the beginning of the outreach project, today the Neolithic settlement of La Draga has become a valuable site to use for dissemination of knowledge about the Neolithic to the general population.

The Neolithic village of La Draga consists of an area for hosting the public and experimenters (work areas and outdoor porches) and a space with several Neolithic huts, reconstructed according to research about Neolithic techniques. In the outdoor areas, several activity zones have been replicated: woodworking, experimental fields growing cereals and legumes, and a lithic reduction area.

Right from the start, the outreach proposals have been developed based on experience and have been profoundly influenced by the experimental methodologies implemented in the archaeological investigation of the site. In this regard, the active acquisition of knowledge allows the past to be relived through the experience and types of activities developed at the site. This type of activity is able to replicate processes and actions in the most realistic way using materials and techniques documented at La Draga.

The outreach activities consist of:

- Guided visit to La Draga Neolithic Park.
- Workshops. Activities are generally carried out under the supervision of an educator. After a theoretical explanation, the user practices or reproduces the process in order to experience how to do it. The experimental data obtained from our research is used in this case for producing replicas of the tools as well as to reproduce the actions performed during the workshops.

- Demonstration of Neolithic activities based on research developed by the La Draga team. The aim is the explanation of how, according to the results of our experimental work, tools were produced and used (See Figures 7, 8).

Our current objective is the development of 3D virtual models for archaeological dissemination. Specifically, our idea is to reconstruct the appearance of the Neolithic village of La Draga (Banyoles). The project will develop new and advanced forms of virtual representation (3D modelling) and new advanced user-computer interfaces that will allow virtual interaction with archaeological materials. In this way, visitors to the park will be able to experience how prehistoric and ancient people lived. In addition, the project aims to develop virtual e-learning systems based both on simulation of social dynamics in the past (artificial societies through agent-based distributed simulation) and "serious games", and on introducing academic knowledge relevant to the education of children (See Figure 9).

Keywords education
woodworking
textile
stone
tools
wood
archery
flint knapping

Country Spain

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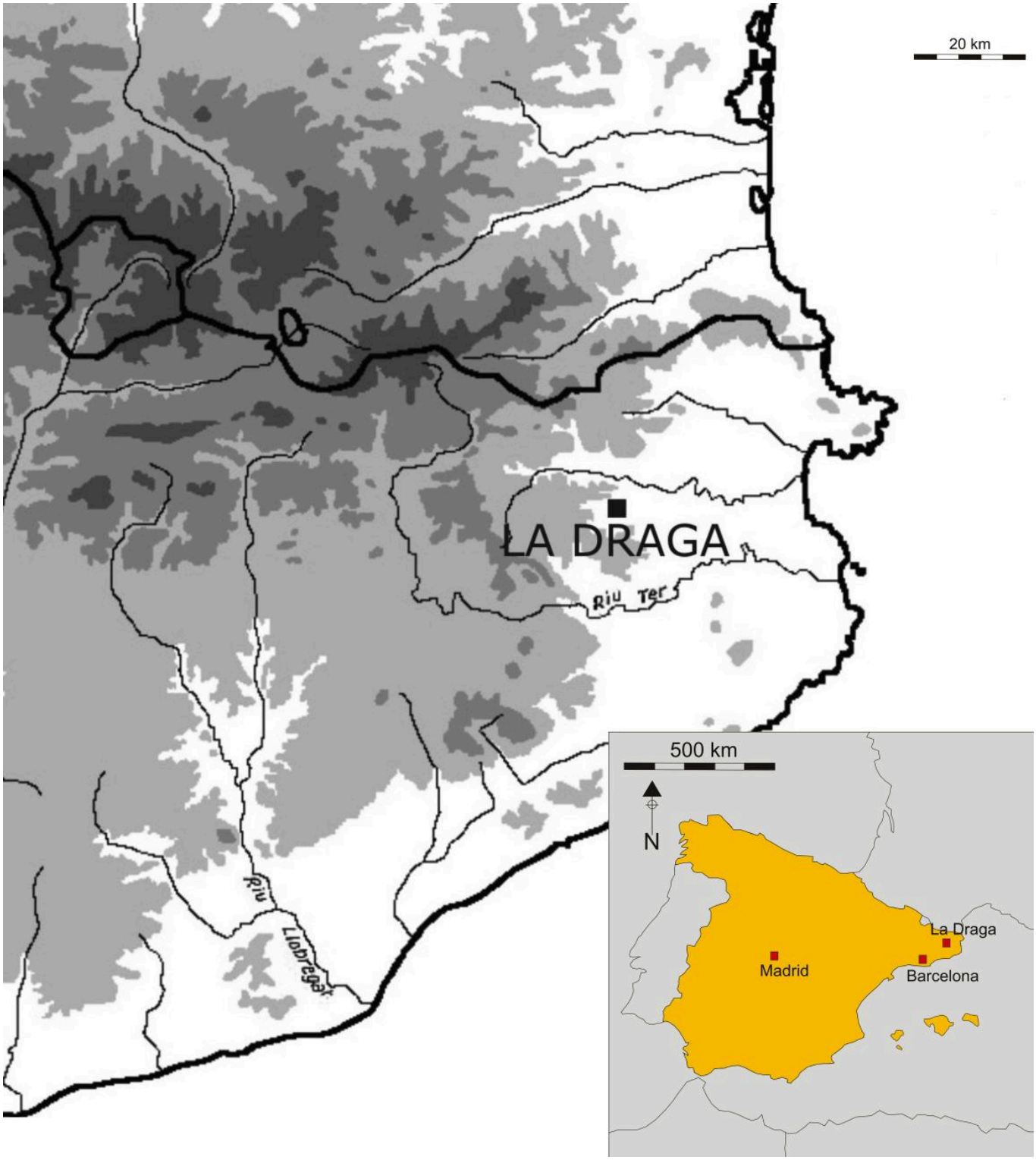

FIG 1. LOCATION OF THE NEOLITHIC SITE OF THE DRAGA

FIG 2. 1-SELECTING A SUITABLE PINE BRANCH; 2-REMOVING BARK WITH FLINT TOOLS OR AN ADZE; 3-SPLITTING; 4-5-6-WORKING WITH ADZE; 7-MAKING THE PLATFORM; 8-POLISHING WITH SANDSTONE; 9-FINISHED HANDLE

FIG 3. 1-MATERIALS USED FOR EXPERIMENTATION; 2 / 3 / 4/ 5 SPLITTING THE TRUNK; 6-WORKING WITH AN ADZE; 7-POLISHING THE SURFACE; 8-FINISHED DIGGING STICK; 9-USING THE EXPERIMENTAL DIGGING STICK

FIG 4. 1/2-SELECTING THE YEW BRANCH; 3-CUTTING THE YEW BRANCH WITH AN ADZE TO OBTAIN THE SUITABLE LENGTH; 4-SPLITTING THE BRANCH LONGITUDINALLY WITH BOXWOOD WEDGES; 5-CUTTING WITH ADZES TO CREATE THE SHAPE; 6-DRYING THE BOW: 15 DAYS; 7-SCRAPING THE SURFACE: 95 MINUTES; 8-POLISHING SURFACE IRREGULARITIES WITH SANDSTONE: 10 MIN; 9/10-CUTTING THE NOTCHES WITH ADZE AND FLAKE: 20 MIN; 11-EQUALISING THE TWO ARMS AND SCRAPING INFLEXIBLE PLACES: 10 MIN; 12- SHOOTING PROJECTILES

FIG 5. BLADE PRODUCTION BY INDIRECT PERCUSSION

FIG 6. 1-NEEDLE, COMB AND AWLS USED; 2/3-EXPERIMENTAL ACTIONS

FIG 7. ARCHAEOLOGICAL PARK OF LA DRAGA

FIG 8. DIDACTIC ACTIVITY IN THE ARCHAEOLOGICAL PARK OF LA DRAGA

FIG 9. VIRTUAL RECONSTRUCTION OF THE NEOLITHIC VILLAGE OF LA DRAGA