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The Strength of Diversity: Macrolithic Artefacts and Productive Forces During the Chalcolithic of Southern Iberia

Marina Eguíluz[1] · **Selina Delgado-Raack**[1] · **Roberto Risch**[1]

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Abstract
Any approach to the economic organization of a society depends on our knowledge of the productive forces and relations of production involved. In archaeology, this line of research requires an analysis of the technical quality and quantity of the means of production, as well as their spatial distribution and contextualisation. Macrolithic artefacts constituted the means of production in many of the productive processes of past communities, from the Neolithic period to the end of prehistory. This article seeks to utilize macrolithic data to gain a more comprehensive understanding of the economic organisation of the Chalcolithic communities in the southern half of the Iberian Peninsula between c. 3100 and 2200 cal BC. These communities produced one of the most outstanding, but at the same time puzzling archaeological records known in later prehistory. The main aim of this exploratory approach, the first of its kind, is to determine if the different forms of occupation of the Chalcolithic, namely monumental, ditched enclosures, fortified and unfortified hill-top settlements, and simple, open settlements were distinguished by specific modes of production. This issue is crucial to the on-going debate about the meaning and relevance of the notion of *social complexity* in the context of Chalcolithic societies and their political organisation. Our study describes the productive forces of the Chalcolithic settlements as highly variable, both in the type of productive tasks performed and in their intensity, and such variability is not explained by aspects like geographic location, form of occupation, or monumentality. The observed wealth and productive diversity, without signs of marked social hierarchies, emerge as a characteristic feature of what can be defined as *cooperative affluent societies*.

Keywords Cooperative affluent societies · Prehistoric economy · Macrolithic tools · Chalcolithic Iberia · Ditched enclosures · Fortified settlements

Extended author information available on the last page of the article

Introduction

The exceptional archaeological record of the Chalcolithic or Copper Age of the Iberian Peninsula, which can be dated to c. 3100–2200 cal BC, has become an arena of intense debate on the political organisation of societies which are usually defined as *complex* or *hierarchical* based on the monumentality of certain settlements and funerary structures, the quality of their crafts, and the wealth of their symbolic manifestations. A situation which is exceptional at a European scale developed in the southern half of the Iberian Peninsula, notably characterized by the contrast between generally small-sized settlements (covering < 1 ha), protected by fairly steep topographies and stone-built defensive systems, and areas demarcated by one or several perimeter ditches whose architecture basically made use of existing land conditions (e.g., Chapman, 2003; Delibes & Santiago, 1997; Gonçalves & Sousa, 2010; Márquez & Jiménez, 2013; Valera, 2013a, 2015; Jiménez-Jáimez, 2015; Risch, 2017) (Fig. 1). Moreover, the exceptional character of such 'monumental' sites tends to obscure the fact that much of the population lived in dispersed, mostly short-lived open settlements of highly varied location (e.g., Delibes et al., 1996; Soler

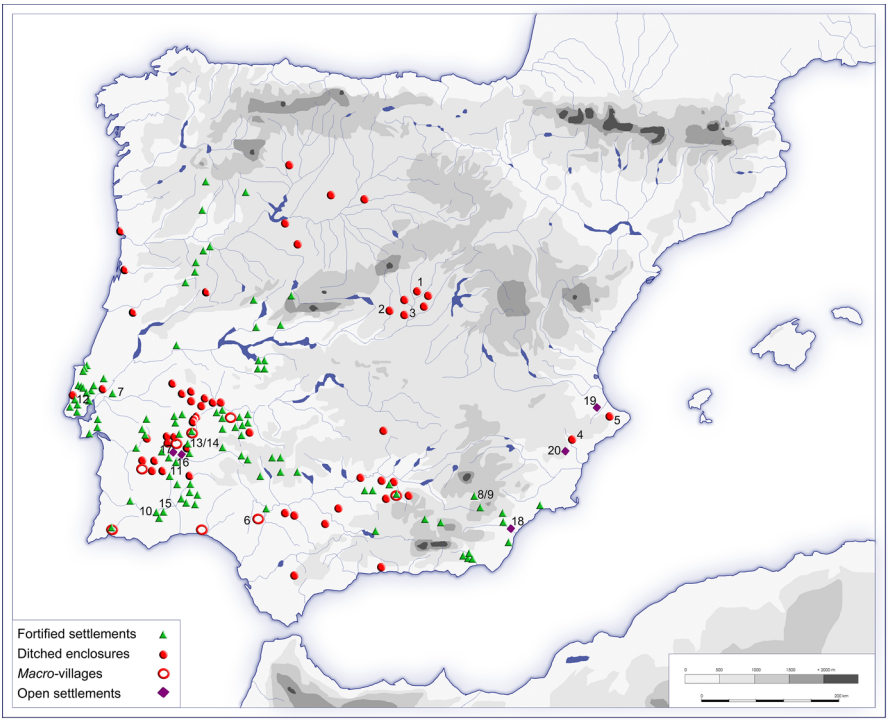

Fig. 1 Distribution of fortified and ditched settlements in Iberia. Settlements with macrolithic records included in the present study. 1–6) Ditched enclosures: Camino de las Yeseras, Fuente de la Mora, Gózquez, La Torreta, Niuet, Valencina de la Concepción. 7–15) Fortified settlements: Cabeço do Pé da Erra, Cerro de la Virgen, Castelo de Corte João Marques, Monte do Tosco, Penedo do Lexim, Porto das Carretas, Santa Justa. 16–17) Unfortified hill-top settlement: Julioa 4/ Luz 20, Moinho de Valadares. 18–20) Open lowland settlement: Almizaraque, Colata, Galanet

& Belmonte, 2006). This suggests that pastoral groups are probably overlooked in approaches to the Iberian Copper Age. The high number of known sites in the southern part of the Peninsula points to a dense occupation by small communities of a few dozen individuals. These presumably existed simultaneously with a number of large, fortified settlements, such as Los Millares (Almeria), which covered as much as 6 ha, and ditched enclosures (Fig. 1). Some of these, such as Marroquíes Bajos (Jaén) or Valencina de la Concepción (Seville), are of more than 100 or 200 ha in size, which has led to their classification as macro-villages (Zafra de la Torre et al., 1999). These settlements show marked disparities not only in size, duration, location and architecture, but also in terms of everyday goods, as may be observed, for instance, in their pottery, flaked stone technology, metallurgy and symbolic manifestations. The central question to emerge from a focus on settlements alone concerns the economic and political relations among and between communities of differing sizes and habitat practices. Is it possible to identify evidence supporting a hierarchical or exploitative organisation, or did cooperative relations prevail? Do settlement types and sizes tally with different productive tasks or storage capacities and, eventually, with surplus profits? What role did inter-group violence play in such a complex panorama?

If we consider the number of sites located and ^{14}C dates published as paleodemographic indicators, the Iberian Peninsula, especially its southern part, must have attained demographic levels that were exceptional by European standards in the third millennium BC (Balsera et al., 2015; Hinz et al., 2019). The people constituting the societies and at least some of their raw materials and products seem to have circulated over considerable distances and in considerable numbers, as is suggested both by available radiogenic (Sr) isotope studies (Díaz-Zorita et al., 2018; Valera et al., 2020), and characterisation analyses of axeheads, ivory, amber, etc. (e.g., Risch, 2011; Banerjee et al., 2012; Murillo-Barroso & Martinón-Torres, 2012).

The societies that fostered such rich, diverse, non-exclusive material manifestations do not fit easily with conventional functionalist and evolutionist typologies. While it is possible to consider the existence of relations of economic dependency and political domination (e.g., Nocete, 2001; Bernabeu et al., 2006; Morán, 2018, pp. 222–230; Molina & Cámara, 2005; Afonso et al., 2011; Soares, 2013), archaeological materiality fails to show a clear hierarchy of settlements and tombs according to wealth, productive forces, control of strategic forces or artefacts of symbolic communication (e.g., García Sanjuán & Hurtado Pérez, 1997; Chapman, 2003, 2008; Díaz del Río, 2011, 2013; Valera, 2013b; Delibes et al., 2016; Risch, 2002, pp. 237–247). The social materiality of the Chalcolithic is mainly characterised by a great diversity of contexts and combinations of artefacts. In the absence of clear evidence of political centralisation, this material diversity and richness has led to the consideration of the southern Iberian Chalcolithic as a case of *cooperative affluent societies* (Risch, 2018). However, explanations of the social reality that generated this period of exceptional production and circulation of wealth still lack an understanding of the economic foundations of its communities. Particular attention in this respect must be paid to the productive forces of settlements that varied in duration, extension, location, architectural planning and protection system.

While bio-archaeological information identifies which subsistence goods were produced and consumed, and archaeometallurgy provides information on one specific economic sector still confined to the production of a limited array of tools, weapons and ornaments, macrolithic artefacts, with their exceptional technical and functional potential, provide an ideal source of information not only on the range of activities performed in the settlements but also on their intensity. While flaked lithic instruments were essential in hunting and gathering economies, sedentism led to a notable expansion of productive tasks. Functional and ethnographic studies have identified the use of rocks in a multitude of tasks involving percussion, fracture, grinding, abrasion, polishing, cutting, and so on. The geological substrate offers a wide range of supports of varying hardness, resistance, density and abrasive capacity for the execution of a wide array of activities, especially food processing, tree-felling and woodworking, aspects of pottery production, such as burnishing, all metallurgical production from mining to metal sharpening, construction, stone working, or fishing. Moreover, their preservation and ubiquity in the archaeological record tends to be greater than that of other material assemblages, such as ceramics or bone or wood. Ultimately, any study of either the productive forces or the relations of production of later prehistory will have to pay attention to macrolithic artefacts in their various aspects, whether as raw material, manufactured products, working tools or waste (Risch, 2002, pp. 12–34; Martínez-Sevilla et al., 2020).

The prime objective of the present work is to carry out a paleoeconomic study on the basis of all the lithic records available so far, in order to determine the degree of specialisation, complementarity or economic dependency between communities of different size, location and architectural investment. For this purpose, the focus will be, above all, on the technical aspects, conservation, volume, and density of macrolithic and knapped artefacts registered in all the sites offering this type of information. This will lead to an assessment of the intensity of production in general, and the importance of cereal processing in particular, concerning the size and form of the Chalcolithic settlements. Finally, these results will be put in context with regard to other sources of paleoeconomic information from Chalcolithic Iberia. At a more general level, this study also aims to outline a methodology to approach prehistoric economies based on a comparative study of macrolithic artefacts.

Macrolithic Artefacts and Paleoeconomic Analysis

Over the last few decades, a method for studying macrolithic artefacts has been developed, making it possible to analyse several thousand macrolithic tools from the Iberian Peninsula (Ache, 2019; Delgado-Raack, 2008, 2013; Eguíluz, 2018; Risch, 1995, 2002); Central Europe (Delgado-Raack et al., 2020a; Risch et al., 2021); Eastern Europe (Vučković, 2019); and India (Risch et al., 2011). Unfortunately, with regard to the Chalcolithic of southern Iberia, sites in which the macrolithic materials have been systematically recorded are few, and fewer still are studies containing a detailed geological and morphotechnic description of the artefacts. All in all, it has been possible to gather information from 18 settlements (Fig. 1; Table 1) in which some or all of the following five variables may be determined: (1) state of

preservation of the macrolithic tools; (2) *artefact types*; (3) & (4) *morphology and size of the active surfaces of the grinding slabs;* and (5) *density of tools* in the excavated settlements (Table 1). The macrolithic assemblages stem from four *forms of settlement* according to topographic and architectural characteristics: (a) ditched enclosures; (b) fortified hill-top settlements; (c) unfortified hill-top settlements; and d) open lowland settlements (Figs. 2 and 3). The sites are distributed in three large regions that correspond approximately to the peninsular *southwest*, *west* and *southeast* (Tables 2 and 3). We have not taken into account those macrolithic records in which the number of tools is small ($N < 20$), the contexts excavated are very partial, or the documentation shows a preference for certain states of preservation (preferentially fully preserved).

When it comes to validating any quantitative datum in an economic valuation of lithic assemblages, it is crucial to establish their *state of preservation*, as the intensity of productive processes also shows the greater or lesser fragmentation of the tools used. Grinding artefacts are especially suitable for this type of calculation, as their size and mechanical characteristics are relatively similar in all sites. Likewise, the *state of preservation* may shed light on post-depositional processes that occurred in a specific archaeological context and indicate whether macrolithic material has been systematically recorded in an excavation. In order to characterise the preservation of a tool, and in keeping with Risch's orientation guidelines for the pieces (Risch, 2002, Fig. 2.2), it has been divided into three parts (distal, medial and proximal) so that we may distinguish between those preserved in a full ($X = 3/3$), partial ($3/3 > X > 1/3$; abbreviated 2/3) or fragmented ($X \leq 1/3$) state (Fig. 4).

Regarding the *type of artefact,* although classification criteria may vary from one study to another, it is generally possible to distinguish between grinding artefacts, hammerstones, abraders and polished edge-ground tools. It is important to bear in mind that, as a general rule, macrolithic tools are associated with intense, long-term production processes rather than occasional activities. Ethnographic observations, experimental tests and use-wear analysis indicate that the lifespan of these tools may range from just a few years, as with certain hammerstones, to several decades, as with grinding instruments (for an overview, see Risch, 2002, pp. 86–110).

The descriptions and drawings in the publications consulted make it possible to basically differentiate between friction (levelled and striated surfaces) and percussion marks (fractured and pecked surfaces). With smaller artefacts, these criteria allow us to differentiate between *abraders* and *hammerstones*, even though both types of marks may appear in combination in what is known as an *abrader/hammerstone*. While hammerstones, with this kind of intense material wear, are usually linked to stone working (mostly, sharpening of grinding tools, flint working, and crushing of minerals and bone), abraders are linked to the processing of a whole series of raw materials and manufactured objects (e.g., de Beaune, 2000; Adams, 2002; Ache et al. 2017; Vučković & Risch, 2021).

It has been more difficult, and sometimes even impossible, to differentiate between grinding slabs and handstones, as their morphology and size may be similar in some cases or because there is not enough published information. It is for this reason that both types have been included in the *grinding artefact* category, as elements of the same technical equipment. The term *grinding* does

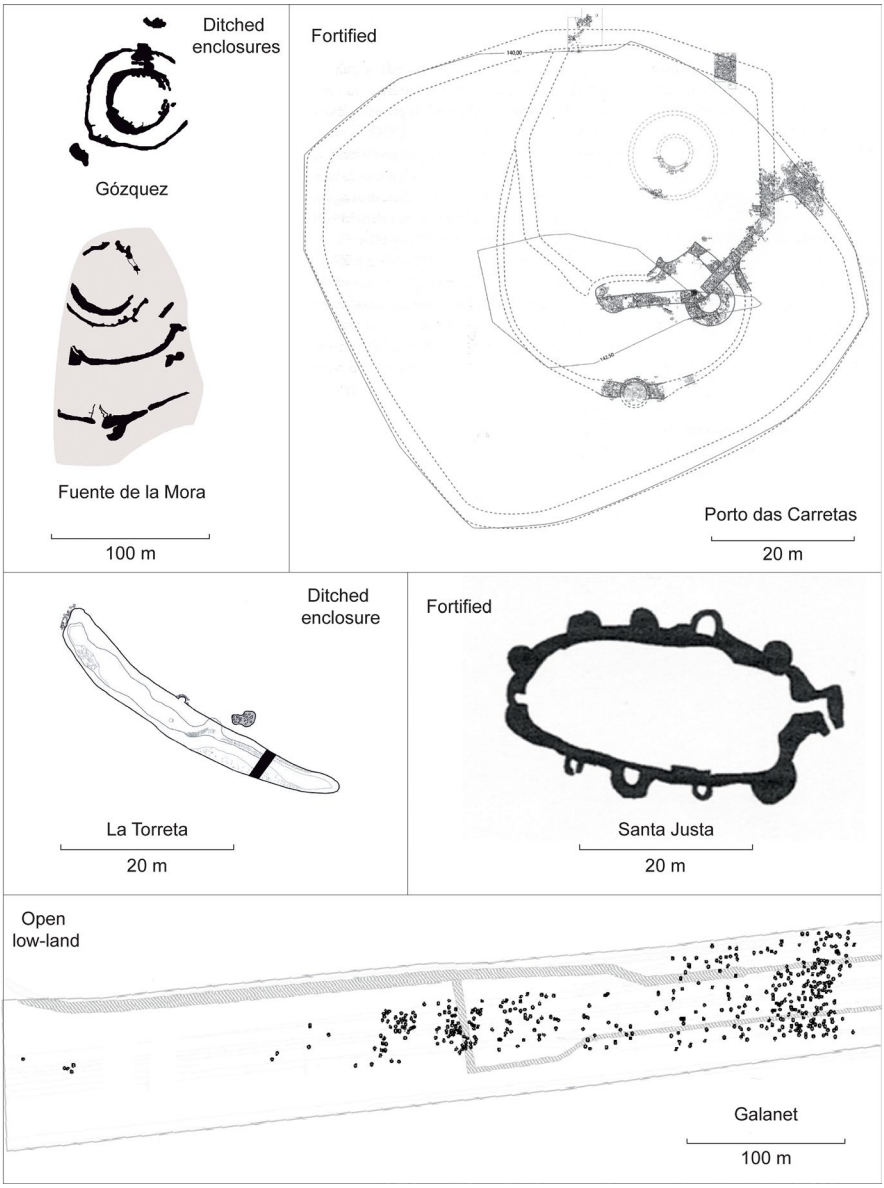

Fig. 2 Examples of ditched enclosures (Gózquez, Fuente de la Mora, La Torreta [modified after Díaz del Río, 2004; Jover, 2010]), fortified hill-top settlements (Porto das Carretas, Santa Justa [modified after Soares, 2013, p. 153; Gonçalves, 1989]), and open lowland settlements (Galanet [modified after Torregrosa Giménez & López Seguí, 2016, p. 21]), where macrolithic records have been studied

not invariably and exclusively mean that these are tools for processing cereal. A more accurate functional determination requires knowledge of the traces of use and a series of morphotechnic variables (Delgado-Raack & Risch, 2016), which

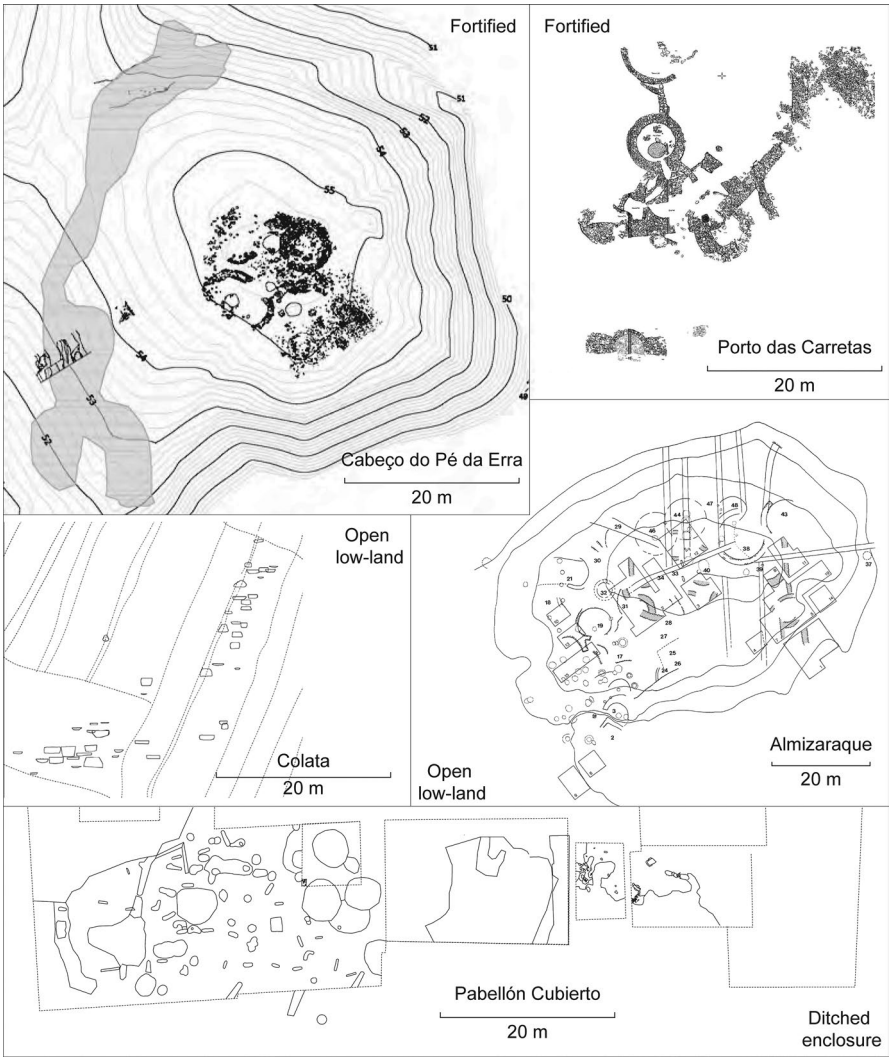

Fig. 3 Examples of architectural features in fortified hill-top settlements (Porto das Carretas; modified after Soares, 2013, p. 108), unfortified hill-top settlements (Cabeço Pé da Erra; modified after Gonçalves et al., 2017, p. 175), open lowland settlements (Almizaraque, Colata [modified after Delibes et al., 1986, p. 13; Gómez Puche et al., 2004, p. 60]), and ditched enclosures (Pabellón Cubierto; modified after Ortega Gordillo, 2013, p. 119), where macrolithic records have been studied

few publications have covered. We have tried to address the degree of specialisation of the grinding slabs in the processing of cereal or of their polyfunctionality based on the *morphotechnic standardization of their work surfaces*. This variable (along with the size of artefacts) directly affects the productivity of the technical equipment, that is to say, the volume of production per time unit (Delgado-Raack

Table 1 Economic variables and archaeological criteria addressed in the present study

Economic variables determined in the present study	Archaeological materials and observations used
Tool sample size and representativeness	< 5% of the site has been excavated
	> 20 tools per site
	≥ 50% of fragmented grinding stones
	No relation between nr. of fragments and nr. of grinding tools
Variety of productive activities	Grinding tools
	Hammerstones
	Abraders
	Abraders-hammerstones
	Edge-ground tools
	Other macrolithic tools
	Flaked stone tools
	Flaked arrow heads
Specialisation and intensity of cereal processing	Size and shape of grinding surfaces
Productive intensity	Macrolithic tool density
Agricultural intensity	Grinding tool density
Productive strength	Artefact density, based on *number of artefacts* per *excavation extension* and *settlement duration*
Work force (≈demographic strength)	Settlement extension

& Risch, 2009, 2016). Generally speaking, tools with larger work surfaces will produce more flour, as they allow more pressure on the product being processed.

As for *polished edge-ground tools*, such as axes, adzes and chisels, these are easy to identify as they are equipped with an edge composed of two converging, polished surfaces (Delgado-Raack et al., 2020b). They are usually associated with felling and woodworking activities, although in recent experimental work, we have been able to ascertain the utility of polished edge-ground tools in the quartering of animals and, especially, the fracturing of the bones of large and medium-sized animals for extracting the marrow (Masclans et al., 2017).

Finally, the *other artefacts* category has been added to group all those artefact types that, by virtue of their low frequency in the archaeological record or their specific traits, may be described as exceptional (e.g., stone platforms, perforated or unperforated plaques, mortars, forging tools, net weights).

The continued use of lithics for cutting once metal tools had begun to supersede them in particular contexts is of interest. Here we have considered *flaked tools* of flint (or similar rocks). However, given the lack of functional studies at most sites, we have abstained from differentiating specific uses solely on the basis of the presence of subsequent alterations and the morphology of the pieces. Generally speaking, we are dealing with instruments for cutting or, to a lesser extent, scraping and perforating a wide variety of materials. The *arrow points* have remained a separate artefact category due to their specific functional nature as a hunting projectile or weapon.

Table 2 Sites included in this study and their main archaeological features

Site	Region	ha	Excavated ha	Topography	Fortification/ditch	Silos	Chronology (cal BC)
1) Camino de las Yeseras[1]	San Fernando de Henares, Madrid	23.3	3	Lowland	Ditch	Yes	2900–1740
2) Fuente de la Mora[2]	Leganés, Madrid	1	1	Lowland	Ditch	Yes	2750–2550
3) Gózquez[3]	S. Martín de la Vega, Madrid	0.3	0.3	Lowland	Ditch	Yes	2750–2550
4) La Torreta[4]	Elda, Alicante	0.8	0.04	Lowland	Ditch	Yes	3000–2700
5) Niuet I/II[5]	L'Alqueria d'Asnar, Alicante	5	0.005	Lowland	Ditch	Yes	3200–2800
6) Pabellón Cubierto – Valencina[6]	Valencina de la Concepción, Sevilla	235.6	0.05	Choline	Ditch	Yes	2500–2250[5]
7) Cabeço do Pé da Erra[7]	Santarem, Ribatejo	0.13	0.08	Hill	Fortification	?	2750–2200
8-9) Cerro de la Virgen I/II[8]	Orce, Granada	1.3	0.06	Hill	Fortification	Yes	2500–2450 (I) 2450–2200 (II)
10) Castelo de Corte João Marques[9]	Loulé, Alto Algarve	0.09	0.02	Hill	Defensive ditch	No	2600–2300
11) Monte do Tosco I[10]	Évora, Alentejo	0.5	0.02	Hill	Fortification	Yes	2800–2500
12) Penedo do Lexim[11]	Mafra, Estremadura	1.05	0.04	Hill	Defensive ditch	No	2750–2400
13-14) Porto das Carretas I/II[12]	Évora, Alentejo	1	0.1	Hill	Fortification	Yes	2900–2650 (I) 2500–2300 (II)
15) Santa Justa[9]	Alcoutim, Alto Algarve	0.17	0.12	Hill	Fortification	No	3000–2400
16) Julioa 4/ Luz 20[9]	Évora, Alentejo	0.04	0.02	Hill	–	Yes	3000–2600
17) Moinho de Valadares I[9]	Évora, Alentejo	0.05	0.015	Hill	–	Yes	3100–2700
18) Almizaraque[12]	Cuevas, Almería	0.4	0.04	Lowland	–	Yes	2800–2300
19) Colata[13]	Montaverner, Valencia	>0.5	0.5	Lowland	–	Yes	3300–2900
20) Galanet[15]	Elche, Alicante	>7	1.5	Lowland	–	Yes	3000–2800

1: Ortiz et al. (2020); 2: Díaz del Río (2004); 3: Jover Maestre (2010); 4: Bernabeu et al. (1994); 5: Ortega Gordillo (2013); 6: T.X. Schuhmacher, personal communication; 7: Gonçalves and Sousa (2017); 8: Delgado-Raack (2013); 9: Gonçalves (1989); 10: Valera (2013b); 11: Sousa (2010); 12: Soares (2013); 13: Risch (1995, 2008); 14: Gómez Puche et al. (2004); 15: Jover Maestre (2014), Torregrosa-Giménez et al. (2014), Torregrosa-Giménez and López-Seguí (2016)

Table 3 The lithic record of the Chalcolithic sites of the southern half of the Iberian Peninsula (references as in Table 1)

Site	Region	Macrolithic artefacts	Grinding artefacts	Abrader	Abrader/hammerstones	Hammerstones	Axes	Other	Flaked artefacts	Flint arrow heads
1) Camino de las Yeseras	San Fernando de Henares, Madrid	>93	66	>1	>0	>7	>2	>9	?	8
2) Fuente de la Mora[1]	Leganés,Madrid	?	248	?	?	?	?	?	?	?
3) Gózquez[1]	S. Martín de la Vega, Madrid	?	138	?	?	?	?	?	?	?
4) La Torreta[2]	Elda, Alicante	85	49	14	0	5	6	11	84	12
5) Niuet I/II[3]	L'Alqueria d'Asnar, Alicante	21	6	4	0	3	6	2	93	21
6) Pabellón Cubierto – Valencina[4]	Valencina de la Concepción, Sevilla	154	24	32	26	50	2	20	?	?
7) Cabeço do Pé da Erra[6]	Santarém, Ribatejo	498	296	12	0	162	22	6	571	174
8) Cerro de la Virgen I[7]	Orce, Granada	36	15	8	0	2	2	9	28	1
9) Cerro de la Virgen II[7]	Orce, Granada	281	73	54	24	16	8	106	38	4
10) Castelo de Corte João Marques[8]	Loulé, Alto Algarve	306	176	24	0	90	10	6	15	6
11) Monte do Tosco I[9]	Évora, Alentejo	79	6	0	0	18	5	50	152	40
12) Penedo do Lexim[10]	Mafra, Estremadura	85	19	0	0	18	48	0	470	149
13) Porto das Carretas I[11]	Évora, Alentejo	152	47	1	0	56	15	33	211	5
14) Porto das Carretas II[11]	Évora, Alentejo	142	42	0	0	20	10	70	172	7
15) Santa Justa[8]	Alcoutim, Alto Algarve	583	270	152	0	145	16	0	139	46
16) Julioa 4/ Luz 20[9]	Évora, Alentejo	151	90	0	0	0	33	28	?	?
17) Moinho de Valadares I[9]	Évora, Alentejo	72	18	0	0	13	25	16	100	2
18) Almizaraque[12]	Cuevas, Almería	70	51	8	3	0	?	8	?	?
19) Colata[13]	Montaverner, Valencia	33	21	6	1	1	3	1	44	2
20) Galanet[14]	Elche, Alicante	36	27	2	0	3	2	2	23[14]	4

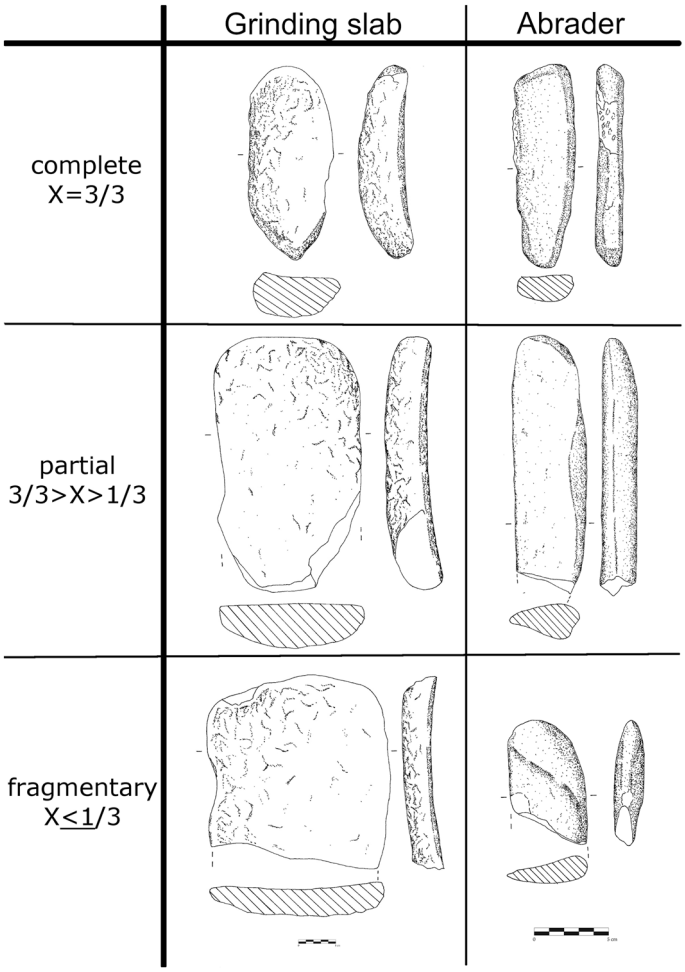

Fig. 4 Scheme illustrating different preservation states of macrolithic artefacts and their correspondence in the classification system

The transition from the macrolithic record to the economic organisation of the communities that generated it inevitably involves establishing the qualitative and quantitative parameters of the forces of production (Table 1). While the frequency of artefact types offers us some insight into the *variety of the means of production and production processes*, the volume of means of production gives a measure of the *productive capacity or strength* of the communities. This parameter, in archaeology, depends on three variables: (a) *the number of medial artefacts of each site and phase of occupation* (in archaeology, a *phase of occupation* usually denotes a cycle of inhabitation that begins with the construction or reuse of one or several architectural structures, continues with their occupation and ends at the moment of their destruction or abandonment); (b) *the volume of excavated sediment*, and (c)

the duration of site occupation. Although these variables can be easily documented, they are still, surprisingly, not common in systematic archaeological excavations and research in general. The volume of sediment excavated, which may function as an independent variable, against which all types of social materiality can be measured (Castro et al., 1999), is unknown in all Chalcolithic sites. By contrast, the *excavated surface* is usually given in publications and, as a result, is the sole dimension available to calculate a *density rate* of the materials in the space (*ID = No. of artefacts/m*^{2} *excavated*). The intensity of production, moreover, depends on the time of occupation of a place of habitation, as longer periods of time should produce more extensive material records. Unfortunately, radiocarbon dates are limited or non-existent at many of the sites. This lack of absolute dating also makes it impossible to determine if we are dealing with one continuous occupation or several occupations separated by hiatuses. This is why we have resorted to stratigraphy and ceramic typology as well as the radiometric dates available to establish the approximate *duration* of the occupations (Table 2).

Results

Representativeness and State of Preservation of the Macrolithic Record

The macrolithic studies conducted in the southeast of the Iberian Peninsula (Ache, 2019; Delgado-Raack, 2008; Eguíluz, 2018; Risch, 1995, 2002) and the Central Balkans (Vučković, 2019) have made it possible to establish the significance thresholds needed for a paleo-economic reading of the villages. Quantitatively speaking, all the sites included in this study meet the condition of having > 20 artefacts (Table 3).

Another significance threshold originates from the number of artefacts recorded and the representativeness of the excavated surface in relation to the total surface of the settlements. In the present case, only four of the 20 macrolithic records correspond to excavation surfaces of less than 5% of the estimated area of the settlement (Niuet, Penedo do Lexim [hereafter, P. do Lexim], Cerro de la Virgen and Valencina de la Concepción). Obviously, the excavation data of the Pabellón Cubierto in Valencina de la Concepción cannot be regarded as representative of a settlement covering an area of more than two hundred hectares. However, a recent study of the grinding stones from different sectors of Valencina (Martínez-Sevilla et al., 2020) suggests that the general conclusions we will reach in this study could be valid for large parts of this exceptional settlement. Moreover, there are at least six cases in which ≥ 40% of the settlement has been explored (Galanet I, Julioa4/Luz 20, Gózquez, Fuente de la Mora, Cabeço do Pé da Erra and Santa Justa).

Thirdly, systematic excavations with a comprehensive documentation of macrolithic material are noted for records with ≥ 50% of grinding slabs in a fragmentary state, independently of the form, geographical location and chronology of the settlement. This significance threshold can be found in practically all Chalcolithic sites with this type of information (Fig. 5). In all cases, the macrolithic record appears to have been documented with care. Only in the case of Almizaraque is this condition not fully met, as the material originates from rescue and cleaning campaigns carried

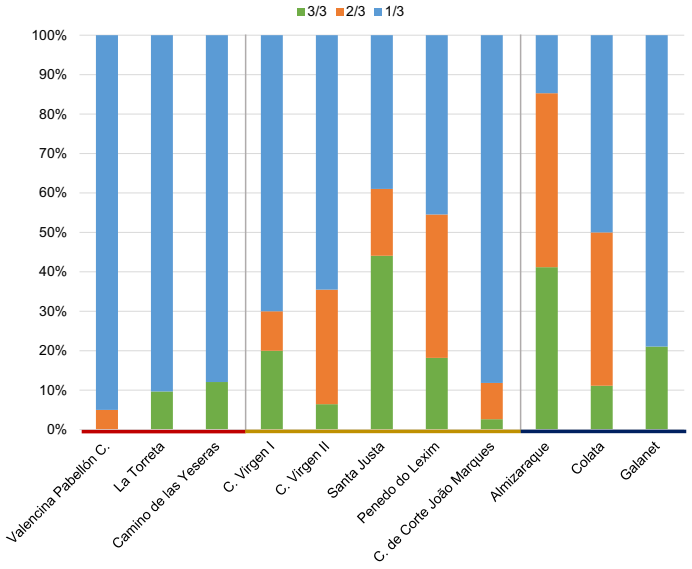

Fig. 5 Fragmentation of the grinding slabs in Chalcolithic settlements (N ≥ 10 grinding slabs): **a** ditched enclosures (marked in red); **b** fortified hill-top settlements (golden); c) open lowland settlements (blue)

out in the 1980s at a site that had been repeatedly disturbed by various people and teams since Luis Siret's excavations at the turn of the twentieth century (Delibes et al., 1986, 1994). One must also bear in mind that most of the grinding artefacts studied correspond to the oldest levels of the settlement (phases of occupation I and II), in which the state of preservation of the huts and outdoor spaces was especially good. At the same time, there is nothing to suggest any partiality in the documentation as regards the fortified town of Santa Justa, since it was excavated with the same methodology as Corte de João Marques, where the fragmentary material amounts to 88% (Fig. 5).

In view of the variable degree of fragmentation of the grinding slabs, it is germane to check whether the taphonomic processes affect the quantitative representativeness of the grinding artefacts in each settlement. As the grinding slabs *may* produce a higher number of fragments than any other type of macrolithic tool, it is important to forestall the possibility of their state of preservation leading to an over-representation of grinding over other productive activities. However, if one compares the percentage of fragmented specimens ($X \leq 1/3$) with the percentage number of grinding slabs in each sample (Fig. 6), what clearly emerges is an absolute lack of correlation between the two values ($R^2 = 0.0006$). It can therefore be said that the state of preservation of the grinding artefacts has no significant effect on their frequency, which means it will also have no impact on the economic assessment of the various settlements.

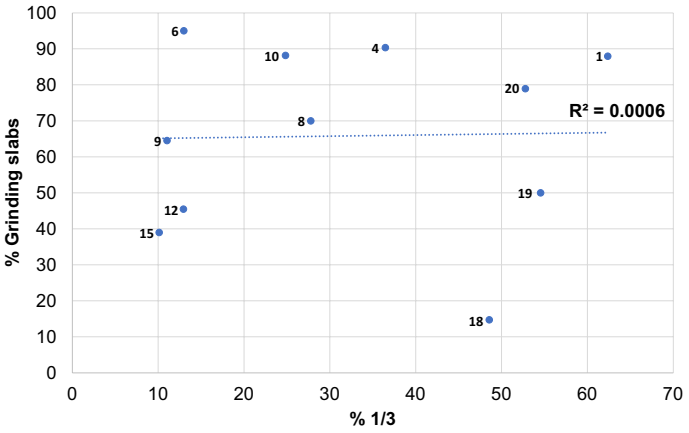

Fig. 6 Relationship between fragmented grinding slabs (X > 1/3) and proportion of grinding slabs in the macrolithic samples (settlement number according to Tables 1 and 2)

Variety of the Macrolithic Means of Production

The macrolithic assemblages available indicate, first of all, that cereal processing, as represented by *handstones* and *grinding slabs*, is present at all the settlements, even if its importance varies significantly, between 8% and 75% (Fig. 7). These figures point to the absence of a regular pattern as regards the availability of these means of production in the settlements. Nor is there a direct correlation between the various forms of settlement and the importance of grinding artefacts, which means that we cannot propose a greater or lesser economic specialisation in cereal production and processing on the basis of the protection structures of the settlements or a higher or lower number of storage pits. The size of the settlements appears to have no relation to the importance of cereal production in their economy (Fig. 8). Nor do the large ditched enclosures show a greater preference for grinding artefacts, as one might suspect from their high number of negative structures (Fig. 8). Quite the contrary, the importance of grinding slabs decreases in the larger ditched enclosures, such as Niuet and Valencina, where grinding slabs and handstones represent 29% and 14%, respectively, of the artefacts as a whole. By contrast, in the smallest settlements, Julioa4, Corte João Marques and Cabeço do Pé da Erra, these artefacts constitute almost 60% of the assemblage. The open lowland settlements of southeast Iberia (Almizaraque, Colata, and Galanet) constitute the only remarkable case in which these tools are dominant, with grinding slabs and handstones representing approximately 70% of the total (Figs. 7 and 8). Another nearby site in which grinding must have been of particular importance is the ditched settlement of La Torreta (58%), also in the southeast.

Other artefact categories display a different pattern to that of the grinding artefacts. The variability of small-sized abrasive artefacts or *abraders* is considerable (3%–27%). They tend to be relatively frequent in ditched enclosures, but not in all. They also played an important role in such fortified settlements as Cerro de

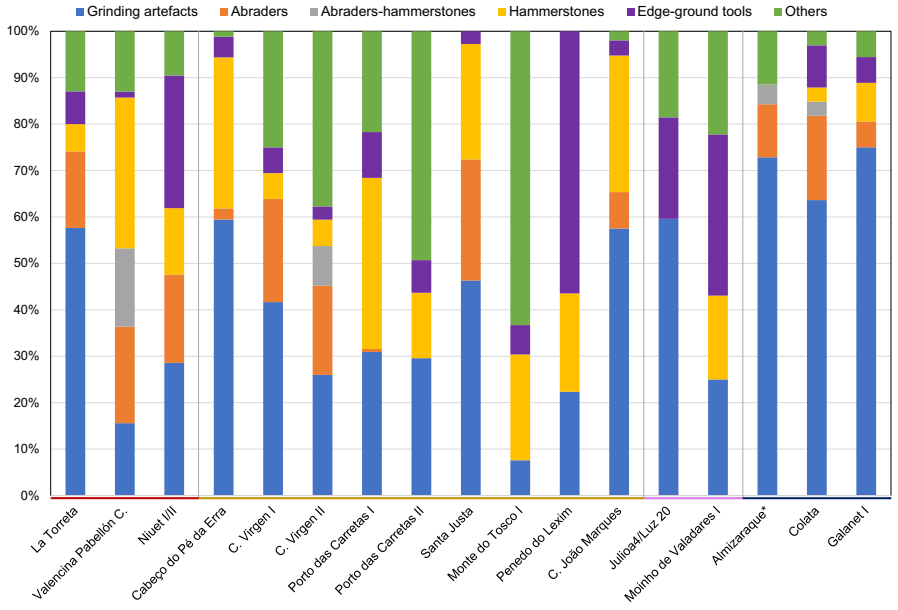

Fig. 7 Variability of the main macrolithic means of production in the different forms of occupation: **a** ditched enclosures (marked in red); **b** fortified hill-top settlements (golden); **c** unfortified hill-top settlements (pink); **d** open lowland settlements (blue). (*The number of edge-ground artefacts in Almizaraque is unknown)

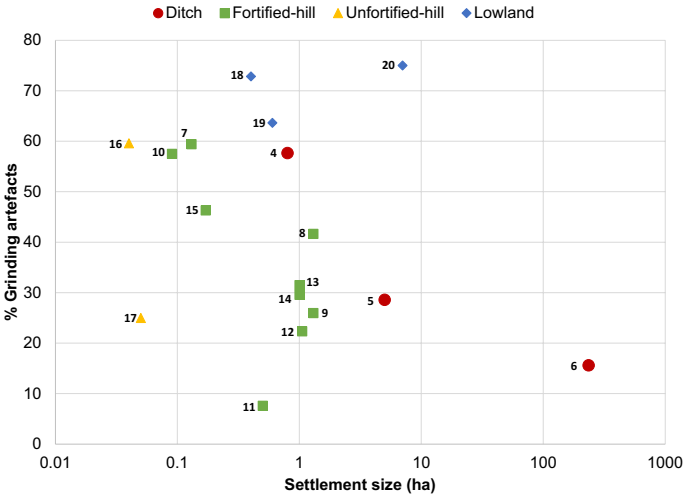

Fig. 8 Relationship between the size of the settlement (logarithmic scale) and the relative importance of grinding artefacts among macrolithic tools (settlement number according to Tables 1 and 2)

la Virgen (phases I and II) and Santa Justa, or in such open settlements as Colata. In general, small-sized abrasive artefacts are essential for the processing of various kinds of subsistence products, as well as for leather work. In the absence of a more detailed study of these active surfaces, it is impossible to assign one or several specific functionalities to these tools.

The *hammerstones*, among the most abundant tools identified in all the assemblages, are similar in their results to the abraders, as they represent between 5% and 36% of the macrolithic means of production. The positive correlation of hammerstones with grinding tools ($R^2 = 0.84$; Table 4), rather than with flint tools ($R^2 = 0.25$; Pearson Correlation Coefficient, hereinafter PCC = 0.497, $p = 0.07$), supports that, at least in some settlements (particularly, Corte de João Marques, Santa Justa, Cabeço de Pé da Erra), hammerstones were essential for the dressing of the grinding surfaces, while they probably played a secondary role in flint knapping or other activities.

The *abraders-hammerstones* used in both percussion and friction activities have only been identified in four settlements and show no remarkable trend or association.

Woodworking and/or the quartering of animals, associated with *edge-ground* tools, are likewise uneven in their importance, although this activity is documented in all settlements. Axes, adzes and chisels are abundant in the hill-top settlement P. do Lexim, composing more than 50%, and Julioa4 (22%), and in Niuet I/II (29%), a large settlement with an identified ditch segment. Elsewhere, the data is less obviously indicative, as is the case with the ditched enclosure of Valencina de la Concepción (3%). There is therefore nothing to indicate that woodworking or the processing of animals were linked to a specific form of settlement, location or geographical region. There is, however, an interesting possible correlation between edge-ground tools and cutting flint tools and arrow points (respectively, $R^2 = 0.54$ & $R^2 = 0.5$; PCC = 0.738 & 0.706, $p = < 0.01$), suggesting that all three artefact categories were related, at least partially, to animal hunting and processing. It is important to mention here that no particularities of the archaeological record nor of excavation methodologies used suggest that the arrow heads found in the settlements are dependent on taphonomic processes. Site-formation processes and archaeological recovery through sieving have been similar in sites with high numbers and low ones.

Finally, the artefacts included under the category of *other* allow one to recognise certain specificities related to some of the settlements under study. In this sense, ditched settlements are high on stone platforms, mortars, lids and scrapers on pebbles, whereas fortified enclosures boast a greater presence of tools related to metalworking, such as anvils/hammers, whetstones and polishers (e.g., Cerro de la Virgen, Cabeço de Pé da Erra). Exceptionally, two large accumulations of net weights are recorded in Porto das Carretas II and Monte do Tosco I. These tools have also given evidence of fishing in hill-top settlements such as Moinho de Valadares I, where there is a small number of polishers and lids. This variety of artefact types underscores the high economic diversity of these settlements; although most of the activities are common, their frequency and intensity seem to depend on factors specific to each site.

If we add the published flaked tools and arrow points to this comparison, there is still no evidence of normalised patterns (Fig. 9). Proportions vary significantly,

Table 4 Pearson correlation coefficients (PCC) and corresponding *p*-values for archaeological variables and number ofmacrolithic artefacts

Duration	−0.176	−0.216	*0.563*	0.329	−0.217	0.401	0.414	−0.302
0.499	**Settlement m²**	−0.061	−0.151	0.086	**0.712**	0.064	−0.219	−0.019
4.405	0.816	**Excavated m²**	−0.128	−0.088	−0.117	−0.162	−0.263	−0.208
0.019	0.563	0.624	**Grinding tools**	*0.602*	−0.115	**0.914**	0.204	−0.164
0.197	0.743	0.737	*0.011*	**Abraders**	0.234	*0.580*	−0.049	0.003
0.403	**0.001**	0.655	0.660	0.366	**Abraders – hammerstones**	−0.034	−0.251	*0.500*
0.111	0.807	0.534	**0.00001**	*0.015*	0.897	**Hammerstones**	0.175	−0.185
0.099	0.398	0.308	0.432	0.852	0.331	0.502	**Edge – ground tools**	−0.109
0.239	0.942	0.423	0.529	0.991	*0.041*	0.477	0.677	**Others**

Italics: $P < 0.001$; Bold: $P < 0.05$

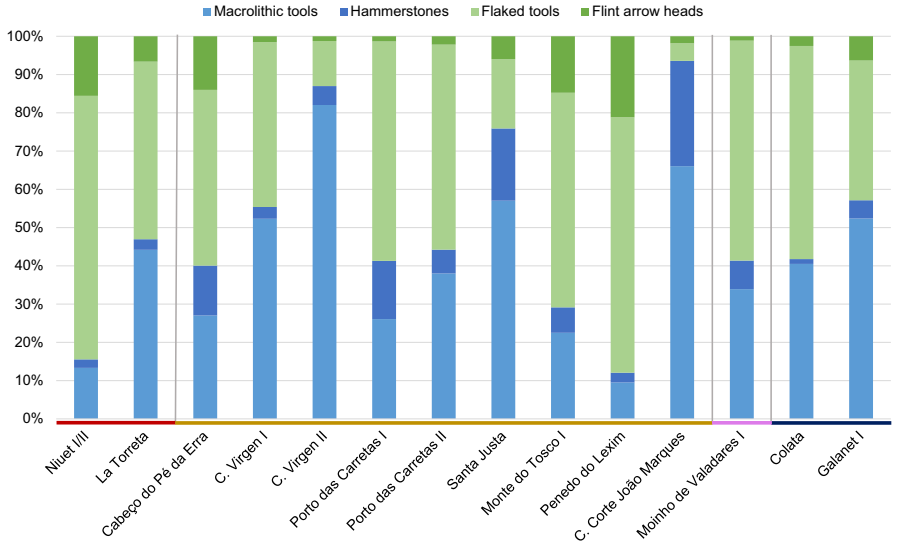

Fig. 9 Variability of flaked and macrolithic artefacts in the different forms of occupation: **a** ditched enclosures (marked in red); **b** fortified hill-top settlements (golden); **c** unfortified hill-top settlements (pink); **d** open lowland settlements (blue)

especially among the fortified settlements. While flaked artefacts make up a mere 6% of stone tools in Castelo de Corte Joâo Marques, in P. do Lexim the figure rises to 67%. We have already commented on the weak correlation between the number of hammerstones and flaking tools, which suggests that the former are not exclusively linked to flint-working (Fig. 9).

Arrow points are relatively abundant in the ditched enclosure of Niuet (16%) but also in some fortified settlements such as P. do Lexim (21%), Monte do Tosco I (15%) or Cabeço do Pé da Erra (14%). In almost all other assemblages, this type of projectile is of residual importance, less than 3%. In absolute terms, the excavations of these settlements have provided a few isolated points ($X \leq 8$). Once again, the uneven difference of the flaked tools, both at a regional level and in relation to the form, size, duration and location of the settlements, creates a markedly diverse economic scenario. One should also mention the lack of association between fortified settlements and the presence of projectiles, at least in the assemblages under study here. The apparent correlation between edge-ground artefacts and flint artefacts has been pointed out above. Generally speaking, arrow points are abundant in settlements with numerous flaked tools ($R^2 = 0.88$; PCC = 0,942, $p = < 0{,}001$). The positive relationship between the number of arrow points and the importance of hunting in the faunal record is confirmed in the ditched enclosure of Niuet. Eight percent of hunted animals among the remains identified constitutes a much higher value than usual in Chalcolithic sites (Pérez Ripoll, 1999, p. 96) (rabbit bones are excluded from all the values). The relationship between the two variables is supported by some sites with a small number of arrow points, such as Cerro de la Virgen or Papa Uvas, where the importance of wild animals

is also low (Pérez Ripoll, 1999, p. 96). A positive relationship between arrowheads and remains of hunted animals has also been observed in Ereta de Pedregal (Navarrés, Valencia) (Pérez Ripoll, 1990), Fuente Flores (Martínez Valle & Cabanilles, 1988) and São Pedro (Davis & Mataloto, 2012; see also Jover, 2014, pp. 189–190, fig. 16.6). By contrast, the high presence of arrow points in the settlement of P. do Lexim bears no relation to the importance of hunting (Sousa, 2010, pp. 356–366).

Morphotechnic Standardisation of the Grinding Tools

The grinding artefacts of the best-studied Chalcolithic deposits show a low standardisation of raw materials and morphologies. In the 10 assemblages where the longitudinal and transverse profiles of the active sides of the slabs have been described, a remarkable variety of shapes (Fig. 10) can be observed, even at the same site, as has been highlighted by Delgado-Raack and Risch (2015). The most recurrent shapes are straight–straight (ST/ST) and concave–concave (CV/CV), whereas typical active morphologies of the Bronze Age, such as concave–convex (CV/CX), are of limited importance. Although the dimensions of the grinding slabs have only been recorded at some settlements, their size is usually small. With average lengths of less than 300 mm, they reveal low-intensity grinding processes, except for the case of Santa Justa, whose grinding slabs are noticeably larger (mean length = 497; sd = 118; values based on 26 measurements) (Gonçalves, 1989, p. 239). Such parameters do not correspond to an economy based on intensive cereal agriculture, but to a diversified subsistence production (Adams, 1999; Delgado-Raack & Risch, 2009, 2016).

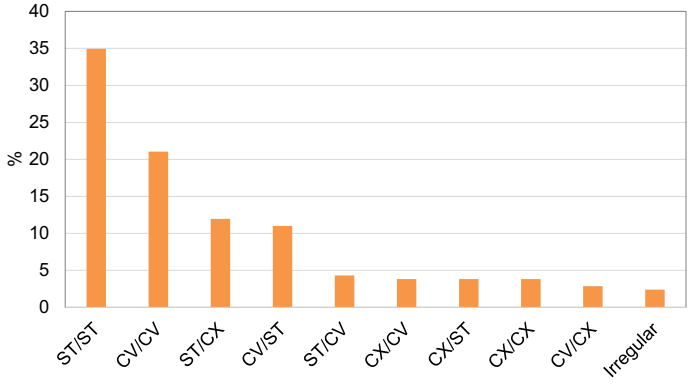

Fig. 10 Morphological variability (longitudinal and transversal axis of the active surface) of the grinding slabs (209 observations from 10 settlements; CX = convex; ST = straight; CV = concave)

The Productive Strength of the of the Chalcolithic Communities

It has been possible to calculate the *density of means of production* in relation to the duration of occupation at 15 sites with a total of 17 levels of occupation. Given the uncertainties in the recording of these variables, it is prudent to only attribute importance to the differences in volume of productive forces of the settlements that are reflected in orders of magnitude. Most of the settlements, regardless of geographical location and monumentality, have shown density values of between 0.14 and 0.5 macrolithic tools per m^2 excavated, that is to say, in the same order of magnitude (Tables 2 and 3). This proximity in values can be partially attributed to the correlation between the number of artefacts and the surface excavated ($R^2 = 0.47$; PCC = 0.683, $p = 0.007$; excluding the extremely high value yielded by the hill-top settlement of João Marques and the extremely low values of the Galanet I and Colata open settlements, for reasons specified below) (Fig. 11). Yet the best fit is obtained if we combine the surface excavated and the duration of the occupation, following the premise that a longer occupation of a given place will increase the number of artefacts recovered ($R^2 = 0.84$; PCC = 0.914, $p = 0{,}00001$; excluding the same sites as before). In other words, the longest-lived settlements and most extensive excavations have furnished proportionately the most abundant macrolithic records, independent of the noticeable technical differences between the settlements (Fig. 7). Despite the low chronological resolution, which bears on the limited number of absolute dates, these patterns suggest that, in most cases and phases of occupation, productive

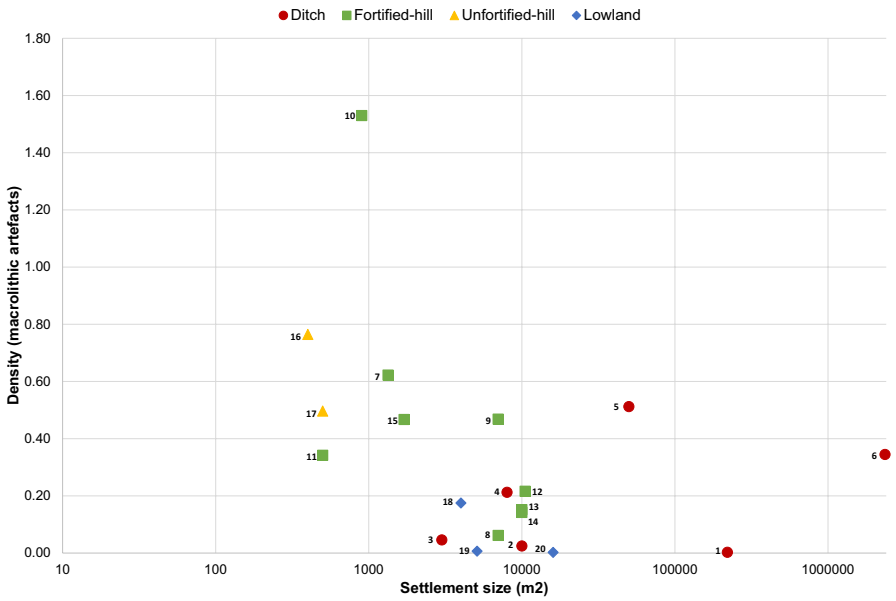

Fig. 11 Density of macrolithic artefacts (No. of tools/m^2 excavated) and total settlement size (m^2) in the different types of settlement (settlement number according to Tables 1 and 2)

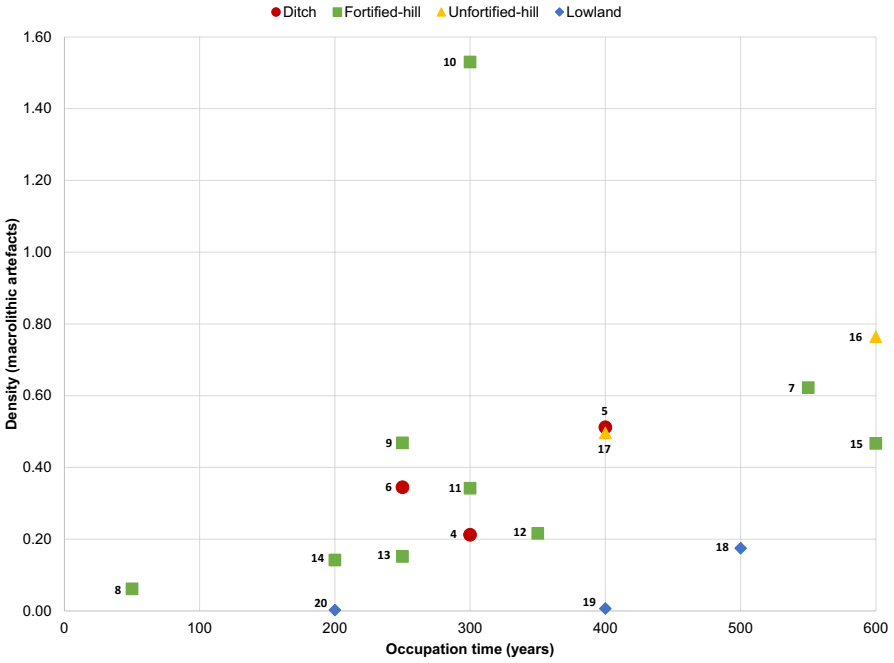

Fig. 12 Density of macrolithic artefacts (No. of tools/m^2 excavated) and time of occupation (years) in the different types of settlement (settlement number according to Tables 1 and 2)

strength was linearly related to the size and presumably the workforce of the settlements (Fig. 12).

At the same time, there are no significant differences between forms of settlement. Settlements with one or more perimeter ditches as well as abundant storage structures are not distinguished by a different density of means of production in comparison with fortified hill-top settlements (Fig. 12). Ultimately, there are no indications that ditched settlements had a significantly greater economic power than fortified villages, except for that resulting from differences in size. Only in the open lowland settlements of Galanet I and Colata are the forces of production significantly lower in density, which suggests that these occupations were intermittent or very brief. These are also the settlements where the emphasis on agriculture, to judge from the importance of the grinding slabs (Fig. 7), was most pronounced. The small community residing in Almizaraque, another open settlement in the southeast of the peninsula, may have developed a similar cereal-based economy.

If we accept the proportion of grinding slabs and handstones as the most reliable indicator of the degree of importance of cereal production and consumption in a settlement (Fig. 8), their density provides a reference concerning agricultural intensity. In addition to the 17 sites/phases of occupation with full macrolithic records, information is available on the volume of grinding tools in the ditched enclosures of Gózquez and Fuente de la Mora, both in the Community of Madrid (Díaz del Río, 2004). An assemblage of Camino de Yeseras grinding slabs and handstones

has been published (Ortiz et al., 2020), but its imprecise dating between 2900 and 1740 cal BC limits the statistical assessment of these data in the sense required here. From the data published, the rate of density of grinding artefacts would seem to be very low (0.002 artefacts/m^2 excavated). Most of these excavations have revealed densities between 0.025 and 0.24 grinding instruments per square metre excavated, but there is no correlation between the two parameters ($R^2 = 0.24$; excluding the extremely low values of the open settlements of Galanet I and Colata; see Table 4 for PCC) (Fig. 13). The variability in density of the grinding artefacts per m^2 may be attributed to some extent to the different duration of the occupations ($R^2 = 0.66$; excluding the extremely high values of João Marques, and the low values of Galanet I and Colata; Table 4 for PCC; Fig. 14). As the quantity of tools is expected to vary depending on the length of occupation, this observation suggests that the processing of cereals and other foodstuffs was linked, to a certain extent, to the size of the population rather than the different forms of settlement (Fig. 14), irrespective of the importance of grinding tools within the set of productive forces (Fig. 7). In this case, the open settlements of southeast Iberia (Galanet I and Colata) are once again exceptional for their low density of lithic instruments. Conversely, the hill-top settlements Corte João Marques y Julioa4 in the southwest, are distinguished by a significantly higher density of grinding artefacts. These settlements are both very small (0.09 and 0.04 ha, respectively), which certainly makes it difficult to interpret them as important centres for the storage and processing of cereals and other subsistence goods.

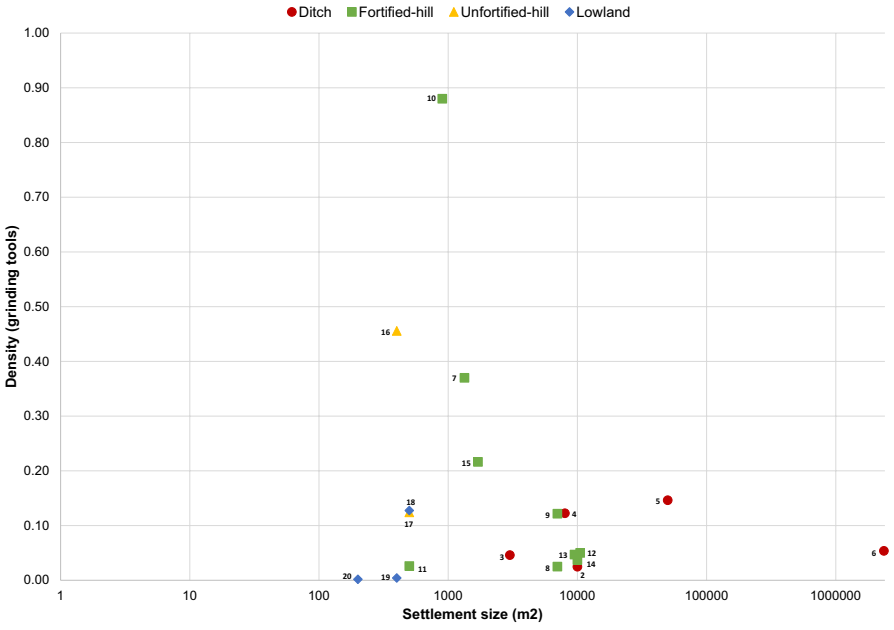

Fig. 13 Density of grinding instruments (grinding slabs and handstones/m^2 excavated) and total extension of the settlement (m^2) of the Chalcolithic settlements (settlement number according to Tables 1 and 2)

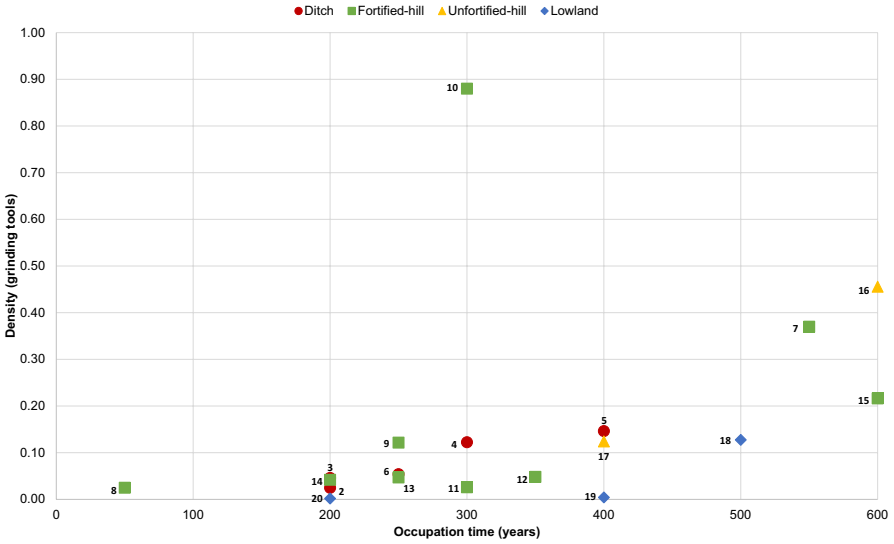

Fig. 14 Density of grinding instruments (grinding slabs and handstones/m^2 excavated) and time of occupation (years) of the Chalcolithic settlements (settlement number according to Tables 1 and 2)

In the light of available evidence, one can rule out an economic scenario in which the intensity of production of the settlements increased according to their size (this conclusion can also be reached in the fortified settlement of Zambujal, with four fortification lines and an area of 6.6 ha, where only 40 grinding slabs were recorded during recent excavations; we thank Michael Kunst for this information). This magnitude remained similar in most settlements; thus, it suggests that the productive strength of the communities was more or less equivalent to their demography. If confirmed, this pattern would rule out a situation of subordination or dependency of some communities with respect to others, at least as far as cereal processing, control and consumption are concerned.

Although the number of full records is limited, the available evidence does not show any significant changes in productive capacity throughout the Chalcolithic Age. Corte João Marques and Julioa4, the only sites with a considerable concentration of means in relation to their very small size, are from the Middle Chalcolithic. Cerro de la Virgen, a well-studied site of the final, Bell Beaker, centuries of the Chalcolithic, conforms to the average density of artefacts. Apparently, there were no major changes between c. 3100 and 2200 cal BC regarding the organisation of work or the intensity of cereal production. At a geographical level, there is a noticeably low density of means of production, albeit with a clear orientation towards cereal in large, open settlements of the southeast, such as Colata and Galanet I.

Economic Organisation According to Bio-Archaeological Information

The results presented here are subject to the limitations entailed in assessing records with disparate documentation. It is not possible with such information to perform an analysis of the relations of production within communities, as this would require knowledge of, above all else, the distribution of artefacts inside the settlements. Where artefact distribution has been documented, the majority of tools are found in open areas, rather than inside dwelling structures (for Almizaraque see Risch, 2008; for Cerro de la Virgen, see Delgado-Raack, 2013; for Porto das Carretas, see Soares, 2013). Many productive activities, including specialised ones such as metal working, seem to have been performed in open spaces between the huts (Fig. 3).

Since the macrolithic assemblages almost invariably originate from partial excavations, the extrapolations we propose may be qualified once records of different sectors of the settlements become available. Still, the use of data common to most of them—such as the area excavated or the form of settlement, along with the type and quantity of artefacts, their state of preservation and, in some cases, their technological characteristics—has yielded some initial insights into the productive forces of the Chalcolithic communities of the southern half of the Iberian Peninsula. At this stage it is possible to put the results provided by the lithic tools in the context of the economic information derived from other sources of evidence, mainly faunal, botanical, stable-isotope and anthropological data. While the first two allow us to assess the diversity of the subsistence goods produced, the latter provide insight into the living conditions of the Chalcolithic communities. Unfortunately, as the sites with a well-documented lithic record do not necessarily provide bio-archaeological evidence, and vice versa, only a general approach to subsistence production and consumption during the Chalcolithic can be offered.

The diversity of available meat sources becomes apparent when we look at the differing importance of domestic vs. wild animals in the faunal records studied so far. The percentage of domestic animals ranges from 38.1% in Fuente Flores (Valencia) to 96.5% in Cueva de Nerja (Málaga). While in some sites, such as Niuet, Jovades (both in Alacant), Arenal de la Costa (Valencia) or Valencina de la Concepción (Seville), hunting was a minor productive activity (3–12%), other sites, such as Terrera Ventura (Almería), Fuente Flores, Cerro de la Horca (Cáceres), Los Castillejos III (Granada) or Las Cabeceras (Madrid), seem to have relied heavily on wild animals (> 20%), with deer being the most appreciated species (Ziegler, 1990; Pérez Ripoll, 1999; Davis & Mataloto, 2012; Valente & Carvalho, 2014; Liesau et al., 2014; Moreno & Sousa, 2016; Moreno-García & Cantalapiedra-Jiménez, 2020). Horse—the wild or domestic character of which remains unclear—tends to be of marginal importance (Peters & van den Driesch, 1990). However, at Fuente Flores (Valencia) and Cerro de la Horca (Cáceres) it represents, respectively, 33.1% and 17.2% of faunal remains (Pérez Ripoll, 1999). Fish and seafood appears to have been an occasional additional source of protein, as is also suggested by the presence of net weights (Porto das Carretas II, Monte do Tosco I).

The higher ages at death and the sex ratios of domestic animals have also been interpreted in terms of an increasing diversification in the exploitation of

the livestock from the late Neolithic onwards (e.g., Peters & van den Driesch, 1990; Pérez Ripoll, 1999; Moreno-García & Cantalapiedra-Jiménez, 2020). In some settlements (Cerro de la Virgen, Granada; Ereta del Pedregal, Valencia; Arenal de la Costa, Valencia; Jovades, Alacant) mostly old bovines were being slaughtered, suggesting their use as draft animals and for dairy production. By contrast, in Zambujal (Estremadura) and Valencina (Seville) young and subadult animals represent nearly 50% of the sample (Pérez Ripoll, 1999, Table 2). In some cases, such as Arenal de la Costa, the increase of goat in relation to sheep, with animals being slaughtered in adulthood and old age, is interpreted as indicating a more intensive breeding economy, oriented to dairy production and involving some kind of transhumance (Pérez Ripoll, 1999, p. 98). Regarding pork, the exchange of suckling pigs at local and regional level has been proposed for Las Cabeceras (Madrid), based on the absence of immature specimens and the predominance of mature sows (Moreno-García & Cantalapiedra-Jiménez, 2020).

The botanical record of the southern half of the Iberian Peninsula reveals an agricultural practice focused on cereal cultivation under rain-fed conditions, while pulses were irrigated through seasonal flooding (Araus et al., 1997; Hopf, 1991, p. 400; Stika, 1988, pp. 34–36). However, the importance of different types of cereals and pulses varies between as well as within regions. For example, the consumption of barley ranges from 20% in Las Pilas to 98% in Campos, although the two sites are located in similar geographical positions, in Almería (Buxó, 1997; Stika & Jurich, 1999; Rovira, 2007, figs. 6, 7 & 8). The cultivation of wheat ranges from 1% in Campos to 88% in Colata, although both sites are situated in arid southeast Iberia. The record of Colata is considered the first example of a monospecific agriculture in the eastern area of the Iberian Peninsula (Pérez Jordá, 2013). This result is in perfect agreement with the predominance of grinding tools observed in the macrolithic record of this settlement (Figs. 7 & 8). In the present day province of Jaén, the proportions of barley and wheat vary from one site to another, and even between different areas of the same site, as has been observed in the macro-settlement of Marroquíes Bajos (Montes Moya, 2011, fig. 2b; 2014: figs. 111 & 116). Agricultural variability is also expressed in the proportions of naked and hulled cereals in the Levante and the Southeast (Buxó, 1997; Pérez Jordá, 2013). The contrast between sites with a more wheat-based agriculture (e.g., Colata) and those relying on barley (e.g. Campos, Arenal de la Costa) can only partly by explained as a response to increasingly arid conditions during the second half of the 3rd millennium BC.

Pulses (*Vicia* sp., *Pisum* sp., *Lathyrus* sp.) show a similar variability in importance between sites, but no chronological or geographical pattern emerges from the available data. Pulses represent between 2% and 11.6% of the charred seeds (Delgado-Raack & Risch, 2015; Montes Moya, 2011). Only in Les Moreres (Alicante) are beans the dominant crop, next to barley (Pérez Jordá, 2013, pp. 93–94). Flax, poppy, grape, olive and acorn were additional species consumed. Again, their identification and frequency in the botanical record is highly site specific.

In sum, according to the available paleofaunal and paleobotanical evidence, Chalcolithic subsistence relied, at a general level, on fluctuating proportions of different domestic animals and plants, supplemented by an array of wild resources.

Subsistence production appears to have been highly variable between sites, supporting the results derived from the lithic records.

As production does not necessarily match with consumption, insight into the trophic chains of the Chalcolithic communities is necessary to follow the complete subsistence cycle. A recent overview of the available stable isotopic measurements of human bone collagen from six Chalcolithic cemeteries of southern Iberia concludes that the diet was based on C_3 plants and terrestrial animals, with no evidence of any relevant consumption of marine resources (Díaz-Zorita et al., 2019). This surprisingly uniform diet is also confirmed by stable carbon and nitrogen isotope values from other Chalcolithic funerary sites (Molina-González et al., 2019). Although stable isotope analysis is not sufficiently fine-grained to trace minor food sources, the discrepancy between the evidence on subsistence production and consumption would imply that economically diverse communities were exchanging or sharing their subsistence goods to some degree, allowing them to follow similar diets. Similarity in living conditions is also supported by anthropological evidence. A study of 157 individuals from different sites of the Spanish Meseta provided evidence for two pathologies, one related to aging degeneration, and the other linked to occupational stress that revealed physically demanding living conditions (Carmona-Ballestero et al., 2013). However, evidence of occupational stress and nutritional deficiency, such as *cribra orbitalia*, appears in early as well as in late Chalcolithic (Bell Beaker) graves, regardless of their monumentality, the presence/absence of grave goods, or the types of grave-good assemblages. No significant differences are detected between the mortality curves from populations of Upper Andalusia and the middle river Tajo valley (Pérez-Villa, 2015, p. 313). In sum, clear social differences in health conditions and diet, as have been recognised for the El Argar Bronze Age (e.g., Díaz-Zorita et al., 2019; Molina-González et al., 2019; Knipper et al., 2020), are hard to trace in the Chalcolithic period.

Conclusions

The available macrolithic assemblages as well as subsistence data do not reflect any marked differences between the three geographical areas under comparison (southwest, west and southeast). As we have observed from the artefact categories, and confirmed with the faunal and botanical records, productive diversity is the trait that best defines the economies of the Chalcolithic settlements. All the regions give evidence of settlements with highly varied means of work, as is obvious in the Évora region (Fig. 1, nr. 10, 12, 14, 15). Considering that cereal grinding is one of the most taxing activities performed by peasant communities, it is important to note the unspecificity of its geographical locations with regards to high agricultural potentials. It is similarly noteworthy that the relative importance of cereal processing among the productive forces of the settlements was not conditioned by the size of the communities. In other words, the intensity of agricultural production does not appear to have been proportionally greater in large population agglomerations than in small settlements (Fig. 13). In the largest known site so far, Valencina de la Concepción, the number and density of cereal-processing tools is particularly low. The

grinding slabs tend not to show any technological standardisation, contrary to what one might expect in an economic context of intensified cereal consumption and to what does occur in subsequent periods of the Bronze Age. Particularly in the central hill-top settlements of El Argar, a rather uniform variety, proportion and (high) volume of stone tools are observed, suggesting that their productive organisation followed similar economic and political principles (Ache, 2019; Ache et al., 2017; Delgado-Raack, 2008; Risch, 2002). For the time being, there is nothing to indicate any productive specialisation at a regional level during the Chalcolithic, apart from an arguably greater importance of cereal production in the lowland settlements of the peninsular southeast, which is also confirmed by the botanical record (Pérez Jordá, 2013).

It is difficult to find economic patterns that are common among settlements or associated with forms of settlement, other than a basic subsistence orientation that appears to have varied according to the needs of each community. Some settlements show a greater emphasis on cereal processing (João Marques, Julioa4, Cabeço do Pé da Erra, Almizaraque, Colata, Galanet I), whereas other communities seem to have dedicated themselves with greater intensity to woodworking and/or hunting and the processing of animal products (P. do Lexim, Moinho de Valadares I, Niuet, and, perhaps, Valencina). While the former activities would be linked to an agricultural orientation, the latter could suggest the importance of a pastoral economy. Fishing seems to have been an important subsistence resource in settlements dominated by net weights (Porto das Carretas II, Monte do Tosco I). Other sites indicate a more diversified economy, in which metallurgy and other crafts appear to have played an important role (Cerro de la Virgen, Santa Justa). Ultimately, the macrolithic records as well as the flaked tools and arrow points recorded in the Chalcolithic sites suggest that there were notable differences between more-or-less neighbouring communities, especially in relation to the types of tools and, therefore, the productive activities executed. The available faunal and botanical records trace a similar economic situation. However, these differences in the variety of lithic means of production and subsistence goods would seem not to be linked to the topography of the settlements (hill-top vs. lowland), their temporality and size, their architecture (ditches or stone fortifications), or the presence and number of structures. Nothing indicates that the small communities protected by fortifications and abrupt topographies constituted a different social class or one that depended on the large, ditched enclosures or even the 'macro-settlements', such as Valencina de la Concepción. Furthermore, a particularly symbolic or political character of the ditched enclosures must be ruled out. Their means of production do not stand out in either quality or quantity, or in terms of their fragmentation from other settlements, whose status as habitats is generally seen as unquestionable. Nor is there a positive correlation between the number of arrow points and the settlements with stone fortifications. The presence of projectiles points more to the economic importance of hunting, though their use in intra-group conflicts cannot be ruled out.

Additionally, the positive relationship between the quantity of macrolithic artefacts and both the area covered by the sites and the duration of their occupation suggests that the productive strength of the settlements, at a given moment, was basically related to the size and therefore to available work force. The larger-sized

settlements presumably had more means of production due to a higher population, but they do not appear to have hoarded disproportionate volumes of economic resources in relation to the smaller settlements or those with a different architecture. Although the importance of each type of tool and its corresponding economic activity varies from one settlement to the other, the productive force per inhabitant of all the communities appears to have been comparable. This trend is particularly conspicuous when it comes to the processing and consumption of cereal and other plant foods, but has also been observed in other spheres of the Chalcolithic reality. In the case of the *tholoi* of Los Millares, the size of these collective funerary structures and the importance of copper among the grave goods deposited therein is mainly ascribable to the work force (Lull et al., 2010; Micó, 1992). In such a socio-economic situation, the observed similarities in health conditions and diet are not surprising.

In general, it can be concluded that, in all the settlements, productive effort, including cereal processing, was more or less in accordance with available workforce. This is only belied by a few hill-top settlements covering less than 1000 m^2, such as Julioa4/Luz 20 and Corte João Marques, which gathered a clearly greater volume of means of production, especially grinding artefacts, than was the rule in most of these settlements.The accumulation of grinding artefacts has also been documented in Fort 1 of Los Millares, dated between c. 2500 and 2200 cal BC (Molina & Cámara, 2005). From such exceptional cases, one may consider the possibility of productive forces in certain hill-top enclaves, even if their small size hardly suggests they were strategic economic centres.

A final remark is necessary concerning workshops and specialized productions, which are a recurring feature in Chalcolithic settlements (e.g., Micó, 1991; Ramos Millán, 1998; Nocete, 2004; Nocete et al., 2008, 2013; Delgado-Raack, 2013). The macrolithic records available suggest that there must have been economic differences between neighbouring communities, but there are no indications yet of a concentration of productive forces or a hierarchy of settlements based on these forces. An economic dispersion and generalised accessibility to the means of production has also been observed within the area of Chalcolithic metallurgical production (Kunst, 2013; Lull et al., 2010) or in the circulation and use of symbolic objects (García Pérez et al., 2020). Specialised copper smelting and forging spaces have been identified in all settlement forms, fortified as well as unfortified, and regardless of their architectural monumentality and size. Clear differences must have existed between settlements concerning the volume of metal processed (Nocete, 2004), but nothing suggests that less productive, smaller communities were subordinated to the more productive sites.

In sum, the Chalcolithic societies of southern Iberia developed an economic organisation in which productive diversity prevailed over intensification, particularly in relation to cereal production. Such a strategy constitutes one of the distinctive traits of what appear to have been the *cooperative affluent societies* of the later prehistory of Europe and the Middle East (Risch, 2018). In such modes of production and consumption, the diversity of productive forces is decisive in generating considerable material wealth and at the same time limiting the possibility of exploitation of the workforce and, consequently, the production of surplus profit, as will be seen in the case of the class societies of the Bronze Age, such as El Argar in southeast

Iberia or Únětice in central Europe (Lull et al., 2011; Risch et al. 2021). Such a situation, however, does not imply that violence was an alien element in Chalcolithic Iberia; indeed, the number of arrow heads at some sites suggests it was not. Strategies preventing surplus accumulation and political centralisation do not appear naturally but represent a socially constructed reality, as much as does a state organisation. As politically complex and economically wealthy organisations, *cooperative affluent societies* are vulnerable to conflict. However, the motivations for violence are radically different from those in situations where relations of work exploitation form the backbone of surplus production. Rather than being a means to subjugate and demand obedience, violence can also be a strategy to achieve the opposite. However, the anthropological record does not suggest that armed conflict was pervasive in the societies discussed (e.g., Pérez-Villa, 2015). Hopefully, a greater number of studies on macrolithic material from prehistoric settlements will make it possible to complete and enrich these initial insights.

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Authors and Affiliations

Marina Eguíluz[1] · Selina Delgado-Raack[1] · Roberto Risch[1]

✉ Roberto Risch
Robert.Risch@uab.cat

Marina Eguíluz
marina.eguiluz@autonoma.cat

Selina Delgado-Raack
selina.delgado@uab.cat

[1] Department of Prehistory, Edifici B, Universitat Autònoma de Barcelona, Bellaterra, 08193 Barcelona, Spain