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The Balearic Paradox: Why Were the Islands Colonized So Late?

La paradoja balear: ¿por qué las islas fueron colonizadas tan tarde?

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Research on Mediterranean islands has pushed the evidence for initial human presence backwards in time, with 75% occupied by the 4th millennium BC. Yet data from the Balearics suggest that the most likely window for human arrival there is in the last half, and perhaps the final third, of the 3rd millennium BC. We refer to this disparity as the "Balearic paradox"—why were these large islands colonized so late? We contextualize the Balearic data, suggesting that "push" and "pull" factors would have affected the willingness of mainland-based agropastoralists to undertake colonization endeavors. We consider the need for improved understanding of socioeconomic, environmental, and climatic factors in likely colonist source areas.

KEYWORDS
BALEARIC ISLANDS, INITIAL COLONIZATION, RISK, CLIMATE CHANGE, INSULAR ADAPTATIONS

La investigación sobre las islas mediterráneas ha hecho retroceder en el tiempo las primeras evidencias de ocupación humana, con un 75% de ellas ocupadas en el IV milenio aC. Sin embargo, en las Baleares los datos sugieren la llegada de los primeros humanos en la segunda mitad, o tal vez el último cuarto, del III milenio aC. Nos referimos a esta disparidad como la «paradoja balear»; ¿por qué fueron estas grandes islas colonizadas tan tarde? En esta contribución, contextualizamos los datos de las Baleares y sugerimos que diversos factores de atracción y expulsión habrían afectado la voluntad de las comunidades agropastoriles de tierra firme por emprender esfuerzos colonizadores. Consideramos necesario mejorar nuestra comprensión de los factores socioeconómicos, medioambientales y climáticos en las posibles áreas de origen de las colonizaciones.

PALABRAS CLAVE
ISLAS BALEARES, PRIMERAS COLONIZACIONES, RIESGO, CAMBIO CLIMÁTICO, ADAPTACIONES INSULARES

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Introduction

Over the course of the past several decades of archaeological research on the Mediterranean islands, evidence has steadily accumulated that pushes the evidence for an initial human presence considerably earlier than was once thought. On Cyprus, for example, fieldwork has led to the recognition of the island's earliest colonization sites belonging to the Akrotiri phase in the Late Epipalaeolithic, as well as several phases of a previously unknown Early Aceramic Neolithic (Knapp, 2010; Manning *et al.*, 2010; Dawson, 2014: 139–145). Four millennia of occupation, between roughly 11,000 and 7,000 cal BC, have been added, rendering obsolete previous accounts of early Cypriot prehistory that began with the Late Aceramic Neolithic Khirokitia phase (ca. 7,000–5,500 BC). Crete—on which the earliest known site until recently was Aceramic layer X at Knossos, now dated to the early seventh millennium cal BC (see Douka *et al.*, 2017)—has recently produced numerous sites across the island classifiable on technological and morphological grounds (if not yet dated radiometrically) as Mesolithic (Strasser *et al.*, 2010, 2015). More surprising—and still very controversial—is the lithic industry found at nine findspots in southwestern Crete by the Plakias Survey, categorized by the project as dating to the Lower Palaeolithic, at least 130,000 years ago (Strasser *et al.*, 2010). In the Aegean islands, long thought mainly to have been settled by agropastoralists in the Early Bronze Age during the third millennium BC, there now exist numerous instances of Neolithic colonization between the sixth and fourth millennia, as well as several well-documented cases of Mesolithic occupation (Dawson, 2014: 126–136; Cherry and Leppard, 2017), and even, on Naxos, of all phases of the Palaeolithic (Skarpelis *et al.*, 2017). The situation in the central and western Mediterranean islands is broadly similar: certainly, the *rate* at which islands in the eastern *versus* western Mediterranean were taken into use during the Holocene is very nearly identical (Dawson, 2014, fig. 6.1). The extent of all these changes in our understanding of early insular Mediterranean prehistory can be gauged by comparing the reviews of the available evidence a generation ago (Cherry, 1981, 1990) with that compiled much more recently (Dawson, 2014).

Seen against this wider background, the pattern of first colonization of the Balearic island group appears strikingly anomalous: indeed, re-assessment of the situation has pushed the Balearics in the *opposite* direction, when compared to virtually all other islands of the Mediterranean. New discoveries, re-appraisal of older data, and—especially—the critical evaluation of the very large number of available ^{14}C dates (a decade ago said to number over 700: Micó, 2006: 421) have resulted in the elimination of all support for claims of a Neolithic or even pre-Neolithic colonization of these islands. As summarized below, there now exists a broad consensus that the most likely period for the earliest human arrival on Mallorca and Menorca falls in the later third millennium, after 2500, and most probably between ca. 2300 and 2050 cal BC; the evidence from Ibiza and Formentera is much less abundant, but points to a roughly comparable or slightly later colonization horizon.

Table 1. Islands of the Mediterranean over 300 sq. km. in size, ordered by date of the first evidence for a human presence on them. (Source of data: Dawson 2014, with modifications.)

Size (sq. km.)	Rank size	Island	Date (millennium cal BC)
25708	1	Sicily	>10
24089	2	Sardinia	>10
9251	3	Cyprus	>10
8259	5	Crete	>10
430	18	Naxos	>10
8722	4	Corsica	9
380	20	Thasos	6
303	22	Lefkas	6
300	24	Hvar	6
1633	7	Lesbos	5
1400	8	Rhodes	5
842	9	Chios	5
781	10	Kephalonia	5
593	12	Corfu	5
588	13	Solta	5
477	17	Samos	5
380	21	Andros	5
301	23	Karpathos	5
478	16	Lemnos	4
402	19	Zakynthos	4
3740	6	Mallorca	**3**
702	11	Menorca	**3**
572	14	Ibiza	**3**
568	15	Jerba	1

This is a remarkable conclusion for two reasons. The first, as can be seen from the review by Dawson (2014) of all the current evidence, is that about three-quarters of the Mediterranean islands had already been permanently settled by the fourth millennium cal BC, including virtually all of the larger ones, and thus well before the Balearics. Second, among the many hundreds of islands that exist within the Mediterranean basin, Mallorca, Menorca, and Ibiza occupy the ranks of sixth, eleventh, and fourteenth largest. Table 1 lists all the islands larger than 300 sq. km., ranked by size, together with the millennium in which each of them appears first to have seen human activity. The Balearic islands clearly represent an anomalous situation (i.e., large, but colonized late) that runs counter to the general expectation of island biogeography (discussed below) that—other things being equal—larger islands are more likely to see successful colonization earlier.

This, then, is the "Balearic paradox" of our title. Others, of course, have noted the problem. Ramis and Alcover (2001: 267) concluded their review of the evidence for the earliest human presence in Mallorca—the first to argue for a late third millennium cal BC

date—by noting that this placed Mallorca and its surrounding islands as "the last territories in the whole Mediterranean to be colonized by humans." Gómez Bellard (1995) referred to Ibiza and Formentera as "islands out of the stream," while Guerrero (2001) dubbed the Balearics as "the furthest Mediterranean islands from the mainland." We lean towards scepticism about simplistic explanations for this colonization time lag that lay stress mainly on the remoteness of the Balearics from other islands and mainland coasts, and on the challenges of reaching them in simple watercraft; we explore this in more detail below. If we cannot account for the Balearic situation, then we may not yet have a satisfactory understanding of the overall patterns and processes of Mediterranean island colonization. Our aim in this article is not to resolve the paradox, but to consider the current evidence within a broader Mediterranean-wide context and offer some thoughts on potentially relevant factors.

Before proceeding to present the available data and our interpretations of them, it may be useful to acknowledge one strand of scholarship—with which we do have considerable sympathy—that emphasizes the paucity (or ambiguity) of the current chronometric evidence, particularly as it concerns Menorca. Our stance, not only with regard to the Balearic Islands, but on the question of Mediterranean island colonization far more widely, is that we may learn the most by working with the data we actually have now and developing interpretative frameworks to understand it. Inevitably, future discoveries may require significant re-evaluation to take account of new data. Our knowledge of these issues is thus inevitably provisional, and the suggestions that follow below are offered in that spirit.

Revisions to Early Balearic Prehistory: A Summary

For the purpose of the present article, there is no need to rehearse in detail the evidence for and arguments regarding the earliest human presence in each of the three largest Balearic islands. The revised, lower chronology has been presented in a series of contributions over the course of the last two decades (Ramis and Alcover, 2001; Ramis *et al.*, 2002; Micó, 2006; Alcover, 2008; Dawson, 2014: 70–81, with all relevant ^{14}C dates in table 4.2). These publications, moreover, provide thorough citation of earlier literature, most of whose conclusions should now be discounted.

Suffice it to say that the chronology of early Balearic prehistory has been subject to intensive and continuous evaluation for much of the past thirty to forty years (e.g., Waldren, 1982). Earlier reviews of the evidence, including that by one of the present authors (Cherry, 1984, 1990: 184–189), tended to favor a Neolithic colonization (at least for Mallorca), with the possibility of even earlier, pre-sixth millennium, sporadic visits prior to the establishment of stable, settled communities by about 3,000 BC (Guerrero, 2001: 148). The main evidence for a very early chronology was derived from three caves

or rock-shelters in the northern Jurassic sierras of Mallorca (Waldren, 1992)—Son Matge, Cova de Canet, and Cova de Moleta. All of this evidence, however, has subsequently been called into question (for detailed discussion, see Ramis *et al.*, 2002: 6–11). For example, at Cova de Canet, the ^{14}C dates come from fine charcoal layers sandwiched between layers of sterile alluvium, and Guerrero's (2001: 141) conjecture that this reflects deliberate fire-use by humans fails to take into account the very real difficulties in distinguishing anthropogenic from natural fire records (for wider discussion of this issue, see Cherry, 2018: 348–352). Likewise, Ramis *et al.* (2002: 9–11) rehearse no less than 16 detailed problems with the data from Son Matge that lead them to conclude that it "must be discarded as a key site in the early prehistory of the first human contact".

While few, if any, scholars now support a pre-Neolithic date for first colonization (the so-called "Early Arrival Model"), several have espoused a Neolithic date. Dawson (2014: 76–79) has recently summarized these arguments, showing that they find little or no support from the available evidence, which is mostly either unreliable or ambiguous. Leaving aside the radiocarbon dates, it is of course striking that the islands not only lack evidence of lithics with affinity to pre-Neolithic mainland industries, but have yet to produce sites containing classic early Neolithic cultural elements such as cardial pottery; obsidian is also absent, notwithstanding the vigorous distribution networks that characterize the central and western Mediterranean throughout much of the Neolithic. The earliest culturally diagnostic materials (e.g. megalithic architecture, tabular flint knives, wristguards, decorated pottery in Bell Beaker styles) are Chalcolithic or Bronze Age in date, and belong no earlier than the later third or second millennium BC.

Another strand of argument that has foundered upon closer inspection is the claim of a long temporal overlap between humans and the endemic artiodactyl *Myotragus balearicus*. There are no dated sites that conclusively indicate co-existence, let alone attempts at domestication, as has been proposed for several locations; at Son Matge, in particular, the accumulation of coprolites supposedly indicating stabling, and the alleged butchery marks on bones and horns, are now generally considered to be, respectively, a natural accumulation and the product of bone chewing by *Myotragus* itself (Ramis and Bover, 2001; Ramis *et al.*, 2002: 8–11). The general pattern of insular vertebrate extinction strongly suggests the disappearance of *Myotragus* extremely quickly, perhaps in little more than a century, after first exposure to human predation, making it rather unlikely that we will find archaeological sites with definitive evidence of contact (Alcover *et al.*, 1999; now Bover e*t al.*, 2016). Other attempts to detect markers of a human presence in the sixth to fourth millennia BC in potential anthropogenically-induced bird extinctions, vegetation changes, and sedimentary deposits (Ramis *et al.*, 2002: 16–17) at present lack adequate chronological and contextual resolution.

Without question, the primary factor in the downward revision of an earliest date for the first human presence in the Balearic Islands have been the efforts, beginning with Ramis and Alcover (2001), to evaluate the relatively large number of available ^{14}C dates from a far more critical and skeptical standpoint. This application of more severe criteria

of acceptability has been termed "chronometric hygiene", and in other island theatres—such as parts of the Pacific (Spriggs, 1989) and the Caribbean (Fitzpatrick, 2006)—it has had a remarkably clarifying effect, especially with regard to claimed very early dates. Examination of dates cited in discussion of early Balearic prehistory revealed that many of them suffered from critical defects such as: the use of bulk samples; lack of sufficient provenience information indicating evidence of an archaeological context; not sampled using accelerator mass spectrometry (AMS); standard errors greater than 100 years; deficient information about the nature of the sample, including taxon; failure to take account of marine reservoir effects, etc. On this basis, all of the earlier dates from Son Matge and Cova de Moleta have been rejected, as have those from a number of other sites, including Son Ferrandell Olesa, Son Gallard, Escorca, Cova de Betlem, Caló des Cans, Cova de Tossa Alta, and Cova Murada (Alcover *et al.*, 2002: 7–13, with detailed discussion). More positively, Micó (2006: 428) identified two dozen dates (from Cova de Moleta, Cova des Càrritx, Cova des Moro, Cova des Mussol, Coval Simó, Mongofre Nou, Son Matge and Son Gallard) that collectively argue reliable evidence for the human use of some of these sites—all of them rockshelters or natural caves used variously for living activities or inhumation burials—no earlier than ca. 2300 cal BC. New evidence acquired since Micó's study a decade ago, however, now requires adjustment of this initial horizon slightly upwards.

At present, therefore, the most solid early evidence on Mallorca comes from Cova des Moro ca. 2470–2290 cal BC (KIA–30020, 3900±30 BP; Guerrero and Calvo, 2008); Cova de Muleta ca. 2460–2200 cal BC (KIA–20213, 3850±25 BP; Van Strydonck *et al.*, 2005); and Cova de Son Pellisser ca. 2470–2210 cal BC (KIA–20213, 3884±36 BP; Aramburu-Zabala and Martínez, 2015; Van Strydonck *et al.*, 2017). It may be noted that all these dates are on *non-native* human or ovicaprine bones. Some earlier writers claimed that the dates on human bone required downward adjustment to take account of a marine diet, but in fact recent isotopic studies have strongly suggested that Balearic communities were characterized by a mixed diet of animal and plant resources, and—except for some samples from Formentera that indicate a slight maritime component—did not systematically use marine or freshwater food items (Van Strydonck *et al.*, 2005). An additional new piece of information comes from recent excavations at Badia d'Alcúdia of a poorly preserved megalithic-style building interpreted as a *naveta*, associated with two ^{14}C determinations that overlap to provide a date of ca. 2150–1950 cal BC (Ramis, 2010, 2014).

On Menorca, there exist far less data, but also less controversy. The evidence from Cova des Tancats, on which the discussion of Guerrero (2001: 147) depends, is flawed. Fortunately, individuals buried in the cemetery associated with the two dolmen-like monuments at Biniai Nou have produced seven dates (Van Strydonck *et al.*, 2005: Table 1), the earliest of which is 2290–2030 cal BC, 2 sigma. As noted above, it was originally thought that these dates required adjustment for the marine component in the diet, leading to an approximation of the true age of the sample (indicating the presence of humans on Menorca) as about 1930 cal BC; but Van Strydonck *et al.*, 2005 have shown that these ^{14}C dates can be taken at face value.

In the Pitiussae Islands of Ibiza and Formentera, the initial colonization date of ca. 2000 BC suggested by Bellard (1995) still appears solid, and is compatible with the (admittedly limited) evidence discussed above. The sixth- and mid-fifth millennium cal BC ^{14}C dates on charred bones of endemic avifauna from Es Pouàs on Ibiza have been firmly rejected by most authors (since there is no direct link between the bird bones and human activity), making the earliest and clearest evidence for a human presence there the date of ca. 2290–2130 cal BC (KIA–29163, ±3785±25 BP; Alcover, 2008: Table 1). On Formentera, the earliest currently known date (López Garí *et al.*, 2013: 67) is from an ovicaprine mandible from the site of Cova des Riuets (Beta 171380, 2030–1870 cal BC, at 2 sigma). Two other dates (KIA–14329, 3595±35 BP; KIA–14330, 3535±40 BP) from Ca na Costa on the same island fall in roughly the same range (Costa and Guerrero, 2001; Van Strydonck *et al.*, 2005: Table 1), although these dates do need correction for a (limited) consumption of marine resources.

The combined impact of these most recently available dates is to move the earliest window for a recorded human presence in the Balearics (certainly, for Mallorca) slightly earlier from the 2300–2050 cal BC range (Dawson, 2014) to perhaps 2500–2300 cal BC. This, it may be noted, is still very significantly later than the dates suggested in the earlier literature for first human colonization of the Balearic Islands, and also out of keeping with the situation that obtains throughout much of the rest of the Mediterranean.

Balearic Colonization in Light of Patterns in the Wider Mediterranean

If this re-assessment of the dates for the initial presence of humans on the Balearic Islands is accurate—and we think this likely, as the available data of good quality cluster ever tighter in time—then we need to try to comprehend these puzzling data in the light of the current evidence for first occupation of the rest of the islands of the Mediterranean. Fresh discoveries and new dates notwithstanding, what is important are the overall patterns we can discern, recognizing (as noted above) that these are inevitably susceptible to revision when we take new future finds into account.

A recent paper by the present authors (Cherry and Leppard, 2017) has attempted to provide an overview of the currently available evidence for the pre-Neolithic colonization of the Mediterranean islands during the Late Pleistocene and early Holocene. In that study, and again in the present article, we left aside the still controversial evidence for an early human presence at Middle and Lower Palaeolithic sites in the insular Mediterranean, on islands including Crete, Gavdos, Melos, Naxos, Alonissos, Lesbos, Kephalonia, Sardinia, and several others. Not only is the evidence itself often in dispute (Leppard, 2014; Runnels, 2014): what even constitutes acceptable evidence is also a matter of debate (Leppard and

Runnels, 2017). Matters become somewhat more straightforward, however, when we enter the Upper Palaeolithic.

Our review of all the available evidence for Mediterranean island settlement in the Upper Palaeolithic, Epipalaeolithic, and Mesolithic, from well over 70 sites on 18 different islands, reveals some clear patterns (Figure 1). First of all, the "big five" (Corsica, Sardinia, Sicily, Crete, Cyprus) have all produced evidence of quite early occupation: Upper Palaeolithic on Sicily and Sardinia, Epipalaeolithic on Cyprus, and Mesolithic on Crete and Corsica. Some ability in undertaking over-water crossings thus seems apparent. Of course, this could have included the Balearics, especially Mallorca, the sixth largest Mediterranean island—but, apparently, it did not. In general, we can detect a gross correlation between the size of an island and the early presence of a hunter-gatherer population. There is also a tendency for islands with evidence of a human presence during the Upper Palaeolithic to Mesolithic periods to be proximate to adjacent mainlands: examples include Brač, Corfu, Ithaca, and Lemnos, although a difficulty here concerns our still very imprecise understanding of the point at which what are islands today became insular in the course of the global rise in sea-level since the Last Glacial Maximum. Notwithstanding the scorn with which some authors (e.g. Rainbird, 1999: 225–229) have treated attempts to invoke the general principles of island biogeography as explanatory factors for the human colonization of the Mediterranean islands, the accumulating evidence in fact seems to provide increasing support for them, even though we should also acknowledge the importance of target-distance ratios, winds, currents, and many other factors likely to have affected the ability of pre-Neolithic groups to reach islands.

But this evidence, much of it relatively new, itself poses a conundrum. If a number of islands have now yielded evidence of a pre-Neolithic presence, and if we can be relatively certain that pre-modern hominins (Neanderthals, probably, included) had the technological capability of traversing at least modest sea passages to reach islands, then why was it not until the Neolithic that widespread colonization of the vast majority of Mediterranean islands took place? We have argued (Cherry and Leppard, 2017) that the major impediment was the intrinsic trophic limitations of islands in general, and of Mediterranean islands—especially the smaller ones—in particular. Especially during the slow and variable transition towards Holocene aridity (Roberts *et al.*, 2011), faunally depauperate islands were bad places to be for a large-bodied species (*Homo sapiens*) with high calorific demands. The key development was the introduction of the southwest Asian Neolithic subsistence package, and its reliance on new, diverse, aridity-adapted domesticates, the goat in particular (Leppard and Pilaar Birch, 2016), alongside xeric-tolerant cereals and pulses. Island sedentism only became a viable and widespread strategy in the Mediterranean with the cultural creation of artificial new environments by means of the introduction of cereals, pulses and ovicaprids, all relatively tolerant of xeric conditions. This model to some extent mirrors Kirch's (1981) "transported landscapes", and also finds reflection in Zeder's (2016) recent discussion of domestication as a "model system for niche construction theory".

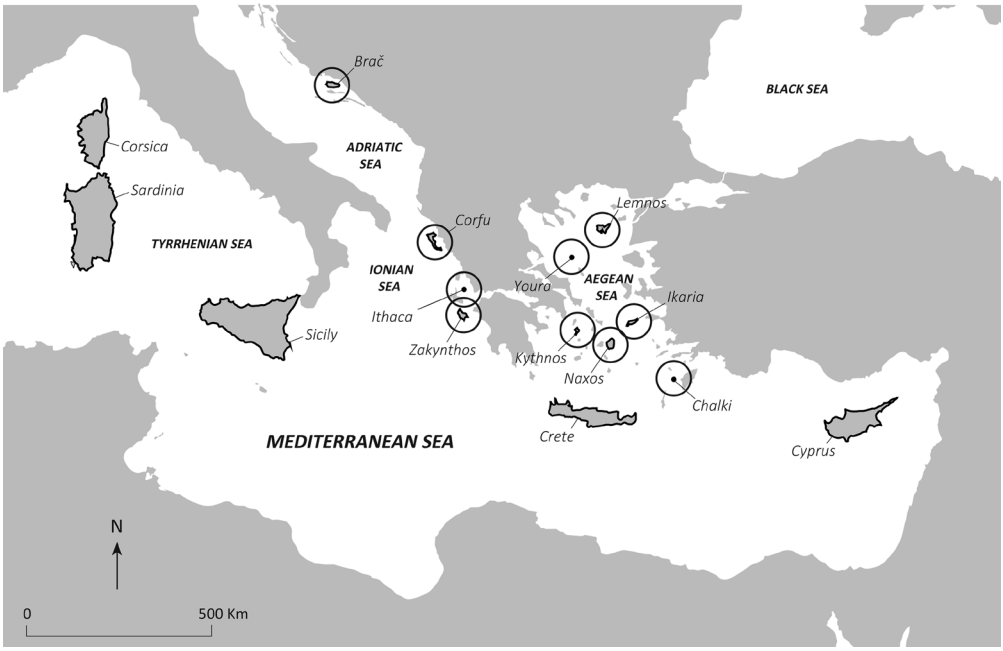

Figure 1. Map of the Mediterranean showing islands with evidence for a human presence between the Upper Palaeolithic and Mesolithic/Epipalaeolithic. The Big Five and smaller islands are indicated with coasts emboldened; for emphasis, the location of smaller islands is also indicated with a circle. (From Cherry and Leppard 2017.)

Back to the Balearic Paradox

In light of this general background, how are we to understand the seemingly late colonization of the Balearic islands? Their very size, relative to all the other islands of the Mediterranean, would suggest that they might have been reached at a relatively early stage. Hominin populations, after all, had been present on the adjacent Iberian and French mainlands for hundreds of thousands of years. The evidence has been growing, moreover, that Middle and Upper Palaeolithic peoples had a degree of sea-going skill that would have allowed them to reach some islands. Other large islands in the western Mediterranean (Sicily, Sardinia) have revealed an Upper Palaeolithic human presence. Why, then, not in the Balearics until many thousands of years later?

This relative lateness of permanent settlement in the Balearics has been previously explained in terms of their remoteness (Guerrero, 2001): that is, it was distance from inhabited mainlands that delayed human access until late in the third millennium BC. The Balearics are certainly remote in Mediterranean terms and possess a fairly low score in terms of target/distance ratios (a convenient index of the relative 'ease' of reaching any given island), although the Iberian coast and Ibiza are intervisible (Gomez Bellard, 1995:

449; cf. Alcover, 2008: 53), as are Ibiza and the Gymnesics. Alcover (2008) also highlights how prevailing winds and currents exacerbate this apparent remoteness, conspiring to render drift voyaging from Iberia very challenging (although not necessarily so from Languedoc). Is there any merit to this argument?

We are skeptical of such models that emphasize intrinsic inaccessibility, especially in the Mediterranean. Obviously, at some spatial scales (in the Pacific, for example, or the South Atlantic), the 'tyranny of distance' has imposed a structuring effect on human access to very remote islands. The distance from Ibiza to the Valencian coast, however, is just under 90 km, and then approximately the same from Ibiza to the west coast of Mallorca—certainly challenging, but comparable to the distances to be overcome in reaching Cyprus or Pantelleria, both of which were colonized earlier (much earlier, in the former case) in the Holocene. An argument would, then, have to be constructed as to why this distance was achievable by mariners elsewhere in the Holocene Mediterranean, but not in its western extremity, until so much later. This argument could be bolstered by considering the substantial organizational challenges to be faced in initial island settlement. Alcover (2008), following Broodbank and Strasser (1991), drew attention to the logistical demands of successful long-distance transport of viable populations of people and animals. Resource-pooling and the co-ordination of a large group of people are just two aspects of a successful colonization process, and imply some sort of organizational or group-size threshold. Yet thresholds of this sort were presumably overcome during the crossing of water-gaps for island colonizations much earlier in Mediterranean prehistory; they may indeed have been important factors for coastwise colonization movements on the mainland as well (Isern *et al.*, 2017). Once again, the impression remains that, while permanent settlement of the Balearics was probably challenging, it was not insurmountably so in absolute technological terms when seen in the context of comparable behavior elsewhere during the Mediterranean Neolithic.

Thinking along these lines, however, allows us re-frame the problem in different terms. For the sake of this argument, let us grant that, while permanent colonization of the Balearics was doubtless intrinsically challenging from a logistical and technological perspective, it was nonetheless perhaps feasible for western Mediterranean Neolithic communities who were inclined to make the attempt. This suggests that we might consider the issue within a framework of risk tolerance and socially specific understandings of it. Arguably, other examples of Mediterranean island colonization (indeed, human dispersal more generally) were driven according to a cultural calculus in which the risks associated with long-distance movement of people and goods were balanced against some perceived 'good'—associated either with the benefits of the colonization of a new territory ('*pull factors*') or with the benefits of at least partially vacating previously settled territory ('*push factors*'). Until the pressure of such push and pull factors becomes strong, the benefits remain insufficiently attractive and the associated risks not worthwhile. So we might imagine that some hitherto unappreciated factor rendered the Balearics very unattractive, or the Iberian/southern French mainland superlatively attractive, to would-be Balearic colonists between the sixth and third millennia cal BC (when so many other Mediterranean islands were first being occupied)—either

because these potential source areas remained free of strong 'push' factors, or because the Balearics exerted no strong 'pull' effect on mainland populations. What may have made these islands unattractive, or generally not worth the effort of settling, from the perspective of the Iberian and French Neolithic? And what may have changed in the later part of the third millennium BC to alter this calculus?

Pulling-power: The Balearic Islands as Environmentally Marginal

The Mediterranean as a whole is usually characterized as seasonally warm/wet and hot/dry, but this is not in itself a particularly useful means of helping to explain spatial patterning in human behavior. Recognizing that the southwest Asian Neolithic (culturally and, partially, genetically ancestral to its Mediterranean variant) is itself an outcome of generally semi-arid conditions, it is more useful to think about how the Mediterranean varies along clines of aridity, temperature, and the extent of inter-seasonal change in these factors (Figure 2). While macro- and meso-scale climate organ-

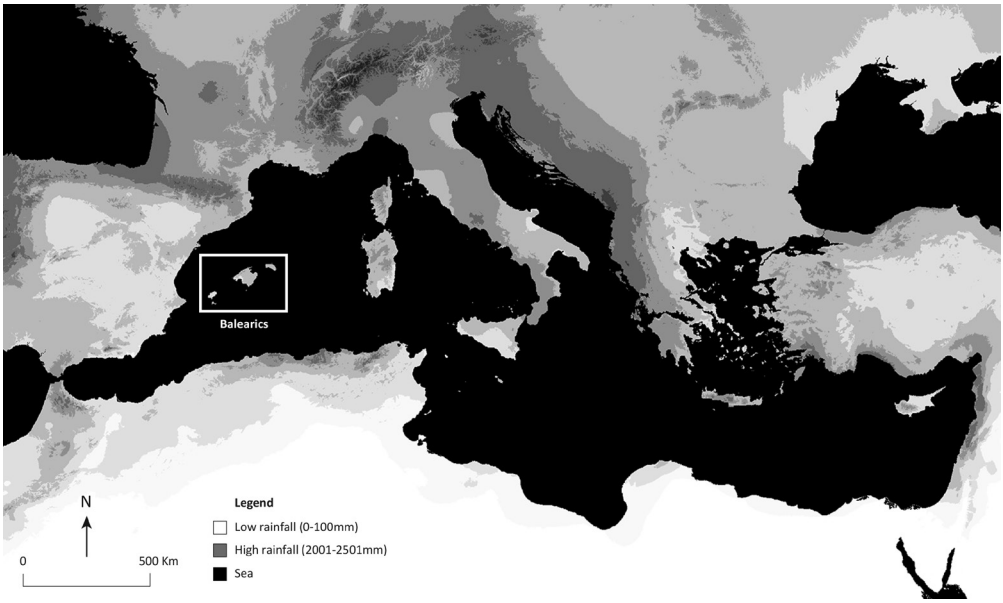

Figure 2. Mediterranean isohyet map, ranging from low (0-100 mm per annum) to high (2501-3000 mm per annum). The Mediterranean experiences enormous variability in mean rainfall over small spatial scales, thanks in part to its latitudinal position, highly varied relief (producing diverse patterns of orogenic rainfall), and prevailing westerlies. In rain-fed agropastoral systems, this heterogeneity conspires with other factors to drive highly varying yield potential. Rainfall in the Balearics is comparatively low by Mediterranean standards: Mallorca's current mean is between 450 and 650 mm per annum.

ization has been dynamic throughout the Holocene, driving changes in multi-year drought frequency, there are parts of the basin that, by virtue of their physiographic organization, we can imagine to have been comparatively more challenging environments for agropastoralists.

Included in this category, certainly, are the islands of the Mediterranean. With (*a*) their limited surface area precluding formation of large perennial river systems, (*b*) their tendency to be karstic, (*c*) the resulting quality and organization of their soils, (*d*) the fact that many of them are of rather low elevation (militating against orographic rainfall), but with rapid per unit distance changes in slope gradient, and (*e*) surrounded by waters that, in contrast to both higher-latitude oceans and comparable mid-latitude seas, are relatively depauperate, the Mediterranean islands in general are sub-optimal environments for Neolithic mixed-farming regimes (Braje *et al.*, 2017: 4–6). The Balearic Islands exemplify some of these characteristics. Menorca, Ibiza, and Formentera are low-lying and highly karstic, characterized by a lack of surface water, thin soils, and sclerophyllous vegetation. Physiographically, Mallorca is similarly organized, excepting the Serra de Tramuntana, the only Balearic topographic feature to surpass 1,000 m (and, perhaps not coincidentally, a focus for relatively early settlement). These environmental limitations have, in turn, resulted in predictable types of agropastoral regimes, at least in the ethnographic present: in general, modern patterns of rainfall are enough to sustain barley agriculture, but marginal for wheat and fruit cultivation in the absence of specialized water-management regimes. (Curiously, the medieval geographer Mohammed Ibn Abi Bakr al-Zuhri reported a preponderance of cattle and a dearth of sheep in Menorca, a situation remarkable by virtue of its comparative Mediterranean rarity: Barceló, 1975.) We return below to the relationship between marginality and climate as it pertains to the third millennium BC.

Relative Balearic marginality is arguably reflected in the organization of the agropastoral regimes associated with the earliest pre-Talayotic sites. Ramis (2014) has comprehensively reported various quantified faunal assemblages from Ca na Cotxera, Son Matge, Arenalet de Son Colom, Coval den Pap Rave, and Coval Simó. The outstanding trend is the reliance on ovicaprid husbandry, with sheep-goat regularly comprising as much as 95 per cent of a given assemblage. This is notable for several related reasons. It diverges markedly from comparable late third millennium Iberian and southern French (and even Sardinian) assemblages in its exaggerated skew towards ovicaprid husbandry, as Ramis points out. Rather, considering the preponderance of sheep-goat with only traces of the presence of cattle, these early Balearic assemblages are strongly reminiscent of Neolithic assemblages from other contexts associated with island colonization elsewhere in the Mediterranean. Leppard and Pilaar Birch (2016: 49-50), for example, cite average figures of 80-90 per cent sheep/goat for Aegean Neolithic sites relatively early in the colonization histories of their respective islands (i.e., Late and Final Neolithic Saliagos, Ftelia, and Kephala) (Figure 3). This emphasis on sheep and goat husbandry may well be a recurrent Mediterranean adaptation to marginal, small island environments, for

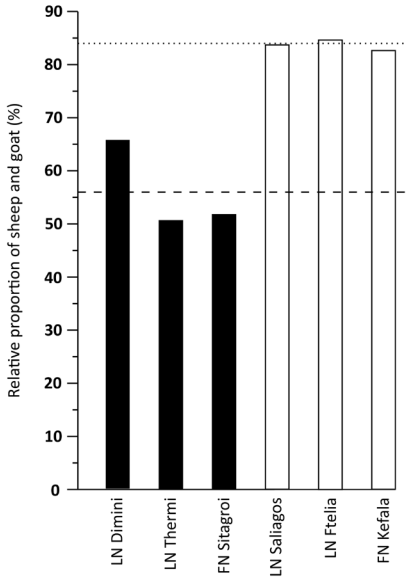

Figure 3. Exaggerated reliance on sheep-goat at island (open bar) vs mainland (solid bar) sites, as measured by NISP; mean mainland value indicated by long dashes, mean island value indicated by short dashes. (From Leppard and Pilaar Birch 2016.)

reasons that are fairly clear: the relatively low water requirements of ovicaprids and the capacity (especially of goats) to tolerate woody, scrubby morphologies in sclerophylls that have become increasingly prevalent in the Mediterranean in the course of the later Holocene (Rogosic *et al.*, 2006). An emphasis on tannin-tolerant ovicaprids may have been especially advantageous in a Balearic context, where predation pressure exerted by Myotragids during the Plio-Pleistocene may have selected for comparatively woody and unpalatable morphotypes.

Cattle frequencies at these Balearic sites are so low that the few oxen present are probably best interpreted as draught animals, with the protein component of the diet provided, either in primary- or secondary-product form, by sheep-goat, as Ramis (2017) suggests. Where we diverge from Ramis' interpretation is in his conclusion that ovicaprids were likely corralled as part of large pastoral systems. For a number of reasons this seems unlikely, not least the absence of large-scale cereal exploitation by centralizing political authorities in lowland areas, with which Mediterranean pastoral regimes have been so often symbiotically linked (Cherry, 1988; Halstead, 1996). Rather, Bogaard's (2005) mixed-farming model probably more closely approximates an agropastoral regime organized around very small and probably politically independent 'village' settlements. In either case, in the context of our current focus, this marked Balearic divergence from 'typical' late third millennium strategies suggests that the islands were viewed as marginal and challenging, and treated as such. This interpretation may also find some support in the relatively small mean size of bovids and ovicaprids in the third and second millennia, a feature which Ramis (2017) takes to be a function of environmental limitations.

It is certainly supported by the striking data from Cap de Barbaria II, on Formentera. This island is the smallest and driest of the Balearics, to the extent that scalar and ecological constraints on mixed farming and ovicaprid husbandry probably rendered these strategies extremely challenging. Consequently, the pronounced emphasis on maritime resources—and in particular molluscs—underscores the extent to which islanders were willing to adjust subsistence behaviors in the face of highly marginal regimes (Sureda *et al.*, 2017); in Formentera, so marginal that even a reliance on aridity-adapted domesticates was not viable.

Absence of Push? Southwestern Europe before the later third millennium BC

We have suggested above that the Balearics, being environmentally marginal for typical Neolithic farming, were probably not attractive to potential colonizing populations; but, equally, we know that other small, remote, and probably marginal Mediterranean islands were settled much earlier in the Holocene by Neolithic groups elsewhere. In such cases, the risks associated with long-distance colonization of marginal environments were presumably rendered acceptable by 'push' factors at work in source areas for colonists. Explaining the Balearic paradox, then, necessarily involves considering why such factors may not have existed in this part of the Mediterranean until the later third millennium BC. We assume here that populations on the facing coasts of Valencia, Catalonia, or (perhaps especially) Languedoc (see Alcover, 2008) represent the most likely source area(s) for initial Balearic colonization. This is a question that, frustratingly, remains unresolved, but it need not limit discussion. We suggest that a useful starting point in considering this relatively late appearance of 'push' factors may be the directionality of the initial Neolithicization of the western basin.

It is now reasonably clear that the southwest Asian Neolithic package was carried westwards into the Mediterranean and its littoral from Anatolia, and that demic movements via long-distance targeted niche colonization represent the most likely means of transmission (this does not rule out sporadic adoption and acculturation amongst remnant Mesolithic populations). This spread, as with other Neolithic expansions, exhibits a clear directionality, most evidently away from established populations and towards unexploited territory. As Broodbank (1993) and others have argued, there is certainly culturally-specific capital to be made from long-distance voyaging and 'pioneer' colonization. But this kind of patterning is nonetheless most readily explicable in terms of the perceived benefits of lower population densities. The detailed underlying motivations and mechanisms are doubtless complex, and this is not the place to discuss them. There is, however, a clear preference—perhaps most famously seen in the spread of Cardial-Impressed and Starčevo/Linearbandkeramik Neolithic cultures—for certain types of environment and, when these become fairly thoroughly settled, for further expansion to more distant, comparable niches.

This suggests that a primary driver of Neolithic expansion is demographic growth (Bocquet-Appel, 2002; Shennan *et al.*, 2013). The degree to which the experience of such growth encourages or impels further colonization is thus to some extent dependent on the physiographic organization of the landscape itself. We do not need to formalize this discussion in terms of models such as the Ideal Free Distribution (e.g., Kennett and Winterhalder, 2006) to recognize that the extent of available culturally desirable land will be a primary determinant of the temporal and spatial dynamics of expansion. In short, the various thresholds envisaged in abstractions such as the IFD would take longer to achieve in areas more amenable to Neolithic subsistence strategies, and it would help to know how far Iberia and southern France represent such expansive environments. 'Seeded' with the Neolithic comparatively late, and probably benefiting from relatively benign mid-Holocene climatic regimes, we suspect that southwestern Europe between 5000 and 3000 cal BC did not experience demographic and land-tenure pressures as acutely as they may have been felt in areas of Neolithic settlement farther east, such as, say, Ulucak at 7000 cal BC, or Thessaly at 6000 cal BC. This conjecture is one whose support would depend on detailed discussion of a sizeable body of data, and it is not our purpose to do so in this short article. Our general suggestion, however, is that a useful approach to the Balearic paradox involves understanding the attractive nature of mainland southwest Europe, and the unattractive nature of the Balearic islands, from a Neolithic perspective, and the relative lack of inclination on the part of southwestern European farmers to undertake risky, long-distance niche colonization—at least until there arose more substantial pressure to do so.

Discussing the combination of factors that may have constrained or prevented permanent Neolithic settlement of the Balearics prompts a series of questions regarding Mediterranean comparanda. We have noted above that other island groups in the Mediterranean are as marginal for Neolithic agropastoralism as are Mallorca, Menorca, Ibiza, and Formentera (although not, we emphasize, as marginal, as comparatively remote, as late in the Neolithicization sequence, and bordered by a very large landmass so suitable for agricultural exploitation, a unique constellation of factors which is probably explanatory). The Maltese islands in particular seem good candidates with which to challenge our general assertion. Here, we would point to accumulating evidence that the 'early' settlement of smaller islands in the central and eastern Mediterranean is, from a ^{14}C perspective, becoming increasingly complicated—not, we emphasize, in accuracy of initial colonization horizons, which remain comfortably Neolithic, but rather in subsequent settlement dynamics. From Malta itself, recent synthetic treatment of available radiocarbon data suggests a gap between Neolithic (Għar Dalam and Skorba) and Temple-phase settlement that might be interpreted as abandonment or depopulation followed by resettlement. Dynamics of this sort are also now alleged for Knossos; based on Bayesian modeling of AMS dates from Trench II (with a stratigraphy comparable to Evans' trench AC, both in the Central Court), a millennium-long gap (6500–5200 cal BC) separating the aceramic sequence from the EN1 sequence is now evident (Douka *et al.*, 2017). If it is hard to know how to understand these Cretan data, derived as they are from a relatively less mar-

ginal context, probable abandonment/resettlement of tiny Antikythera is more readily explicable in ecodynamic terms (Bevan and Conolly, 2013). (We avoid here a lengthy discussion of how best to interpret these processes, whether as 'abandonment' or as part of a more plastic settlement strategy in the face of environmental intransigence; Dawson, 2014.) In general, Neolithic settlement of smaller Mediterranean islands seems, then, to be a more complex proposition than had been assumed, with failure and resettlement very real possibilities. In response to the late colonization of the marginal Balearics being thrown into sharp relief by the earlier colonization of the Maltese archipelago, we would emphasize that, while different attractive factors may have been operating—Malta is less absolutely remote, for example, and Sicily (as a presumed point of origin) may conceivably have fewer ideal Neolithic agropastoral ecological niches than the southwestern European mainland—settlement of marginal and small islands was an intrinsically risky prospect.

Finally, we reflect on an intractable and probably unsolvable problem: if the Balearics were so marginal and unattractive, how did otherwise would-be colonists know? One way to approach this is to ponder what ephemeral exploration, and potentially even archaeologically invisible failed settlement (cf. Leppard and Runnels, 2017), may look like. There is now tantalizing evidence for large-scale successional vegetative change in Mallorca and Menorca in the mid-Holocene, including increases in weedy and sclerophyllous taxa (Burjachs *et al.*, 2017). A conservative attitude would suggest that this change should be understood in climatic-environmental terms, although ecological regime change in island contexts elsewhere, otherwise absent data for human presence, has been understood to be a reliable anthropic indicator (Siegel *et al.*, 2015); we have recently explored this issue in detail (Cherry, 2018; Leppard, 2017). In essence, however, exploratory voyages, followed by ephemeral or failed settlement, might be almost impossible to observe archeologically. A more obvious and parsimonious route to take here (albeit a speculative one) is that the marginality of the Balearics was an unknown quantity: that the Iberian mainland was so relatively ameliorative from a farming perspective that little motivation existed to travel to observable yet distant landmasses, with all the risks thereby entailed. This, of course, would suggest that 'push' factors here are much more relevant than 'pull' factors—that we should understand this late colonization as an outcome which has less to do with islands and marginality, and more to do with Iberian mainland dynamics. Accordingly, we turn to the broader context. What happens in the third millennium western Mediterranean which might have reconfigured, at a large scale, the calculus of cost and benefit in settlement ecology terms?

What Changes in the later third millennium BC?

The final element of the argument, then, requires explaining why the various types of constraint on colonization that we have outlined above may have been relaxed in the later third millennium. In the terminology adopted here, 'push' and 'pull' factors should have

been felt as increasingly acute pressures, such that the risks involved with risky colonization of marginal environments finally became more tolerable. We frankly admit that we do not have a solution to this part of the explanatory problem, largely because potentially relevant data do not exist at a requisite scale of resolution; so we merely highlight information that may well prove suggestive.

Probably important, especially considering the emphasis we have placed on marginality and the significance of returns from agropastoral subsistence regimes, is long-term dynamism in climate. How extensively does the modern situation differ from the mid- to late Holocene? The reconstruction of past climate at suitably fine spatial and temporal scales is problematic from a number of methodological perspectives; there are further limitations when it comes to providing mechanisms that link large-scale climate dynamism with social and behavioral change (Manning, in press). That said, it is possible nonetheless to grasp some general trends in aridity gradients (especially important if surface water availability is the key constraint in Balearic agropastoralism), as well as higher-impact events over more constrained timescales.

In terms of the former, the overall trend since the Holocene optimum has been one of increasing aridification, although at finer temporal scales this trend has periodically been reversed. The rate at which this process occurred, however, has varied substantially across the basin, and recent studies suggest that truly 'Mediterranean' conditions may have arrived in its western extremities comparatively late; Roberts *et al.*, (2011) report winter precipitation maxima in the western basin ca. 6000–3000 cal BP. This notwithstanding, certain areas are likely to have been more readily responsive to large-scale change than others. As regards the latter (short-term and high-impact events), the well-known 4.2 kya event—one of the most severe during the entire Holocene—looms large (Staubwasser and Weiss, 2006; Weiss *et al.*, 1993). It is generally supposed that the effects of this short period of exacerbated aridification were felt more acutely in the eastern Mediterranean; there it has been argued to have been widely implicated in the breakdown of large agrarian systems at around 2200 cal BC (e.g., the Akkadian Empire, Old Kingdom Egypt, and the Early Bronze Age 'Corridor House' societies of the Aegean mainland). In Iberia, the 4.2 kya event overlaps with the breakdown of the comparatively large, fortified sites of the Millaran tradition, including the eponymous type-site of Los Millares itself, as well as Cerro de le Virgen and the very large sites at Valencina de la Concepción and Perdigoes (Broodbank, 2013: 350). We should be wary of equating increasing aridity and 'collapse' in a simplistic cause-and-effect correlation, and degrees of environmental sensitivity in the Atlantic façade, the Guadalquivir, and the Mediterranean littoral are likely to have varied (perhaps reflected in scalar differences in settlement between the Guadalquivir and points east; Sanjuán *et al.*, 2017). Yet the extent to which some of the Millaran megasites co-occur with an ecological zone which, according to modern climate models, exhibits exaggerated responsiveness to moisture gradients (Guiot and Cramer, 2016) is perhaps suggestive.

What is going on in the western Mediterranean basin at 2500–2000 cal BC? The short answer is that we do not know, but a number of elements suggest comparatively abrupt and

large-scale social change. Conspicuous and ostentatious funerary and consumptive ritual seems to reach its apogee in southern Iberia in the mid-third millennium (Sanjuán *et al.*, 2017), followed by the breakdown of Millaran power dynamics in southern Iberia and the emergence of the Argaric system of fortified settlement. More widely, there is substantial spatial reorganization of the Beaker phenomenon. In the context of rapid, short-term climate dynamics driving up drought frequencies in the second half of the third millennium (climaxing at around 2200 cal BC, in the aftermath of Mallorcan colonization) and the florescence and sudden decay of established systems of value, landscape organization, and social power, we might expect the settlement landscape to be highly dynamic. Are large-scale reconfigurations of power in southwestern Iberia driving changes in economic integration and political centralization across the southwestern extremity of the Bell Beaker world? We do not know; but in a broader context of settlement-ecological and climatic dynamism, we might easily expect the emergence of 'push' factors to render the Iberian and southern French hinterlands less attractive than during preceding millennia. Accordingly, the risks associated with long-distance colonization may have been outweighed by new risks deriving from a more fluid social and political situation on the mainland.

Conclusion: Better late than never?

Viewed in the context of Mediterranean-wide patterning in the spread of the farming lifestyle, the Balearic Islands were colonized remarkably late. This is in principle explicable, however, and we need neither to invoke an early settlement horizon which is curiously invisible, nor fall back on special pleading regarding remoteness. Rather, we would argue that the factors that encouraged initial island colonization elsewhere in the Mediterranean during Neolithicization (and then during the 'in-filling' of the fourth millennium) were not operating in the western extremity of the basin until the second half of the third millennium BC. When material and environmental conditions alter such that colonization *did* occur, it is striking and instructive just how 'Neolithic' initial post-colonization subsistence strategies actually look.

What are future challenges? If we are interested in more narrowly defining a source area for Balearic colonization, then stable isotope data are an under-utilized resource, especially considering the rich funerary record of Mallorca and Menorca. Another interesting avenue, however, might involve further consideration of social choices made after colonization such that, for much of the second millennium BC, the Balearics seem largely cut off from wider Mediterranean social and cultural integration. How does this apparent lack of interest—on the part of both Balearic islanders and outsiders—relate to the aberrantly late settlement horizon? Why are the islands briefly and intensely linked to the mainland at around ca. 2400-2200 cal BC, only to become once again largely ignored until well into the first millennium BC? Again, we suggest that intrinsic unattractiveness

or resource poverty may be productive routes to explore, recognizing that the best explanations for the incorporation of Mediterranean islands into, and then their dislocation from, larger socioeconomic structures are most likely to be built on demand tapping into big demographic concentrations, nodal anchorages and transshipment points, and desirable resources. In their absence, islands such as the Balearics could remain 'out of the stream' (Gómez Bellard, 1995) over the very long-term.

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