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The chronology of the human colonization of the Canary Islands

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The human colonization of the Canary Islands represents the sole known expansion of Berber communities into the Atlantic Ocean and is an example of marine dispersal carried out by an African population. While this island colonization shows similarities to the populating of other islands across the world, several questions still need to be answered before this case can be included in wider debates regarding patterns of initial colonization and human settlement, human–environment interactions, and the emergence of island identities. Specifically, the chronology of the first human settlement of the Canary Islands remains disputed due to differing estimates of the timing of its first colonization. This absence of a consensus has resulted in divergent hypotheses regarding the motivations that led early settlers to migrate to the islands, e.g., ecological or demographic. Distinct motivations would imply differences in the strategies and dynamics of colonization; thus, identifying them is crucial to understanding how these populations developed in such environments. In response, the current study assembles a comprehensive dataset of the most reliable radiocarbon dates, which were used for building Bayesian models of colonization. The findings suggest that i) the Romans most likely discovered the islands around the 1st century BCE; ii) Berber groups from western North Africa first set foot on one of the islands closest to the African mainland sometime between the 1st and 3rd centuries CE; iii) Roman and Berber societies did not live simultaneously in the Canary Islands; and iv) the Berber people rapidly spread throughout the archipelago.

island colonization | human dispersal | radiocarbon | Bayesian modeling | Canary Islands

Significance

We provide insights into the period during which the Canary Islands were colonized and specifically the ways in which people dispersed throughout the archipelago. Our research indicates that the Romans first arrived on the islands around the 1st century BCE. Berber populations permanently settled the islands between the 1st and 4th centuries CE, leading to a rapid and complete colonization of the archipelago. This study sheds light on the coastal dynamics of northwestern African societies during the Late Holocene, revealing how the islands were colonized, and contributing to our understanding of the migrations of African farming communities.

The human colonization of the Canary Islands (Fig. 1) (*SI Appendix*) is a rare example of marine migration of Berber communities yet known and studied by archaeologists. More broadly, along the *Atlantic façade*, instances of island colonization by West African peoples of Bioko and Corisco in present-day Equatorial Guinea have also been documented (1–5). The colonization of the Canarian archipelago represents the westernmost limits of the Ancient Mediterranean "farming package", as the first settlers brought with them domesticated plants and animals from the mainland, as well as several parasitic species (4). This human-mediated translocation of domesticates allowed the transformation of diverse island ecologies with limited edible resources to anthropogenic landscapes that were more habitable for the settlers (6, 7). Research in other regions, including the Mediterranean (8), Pacific (9), Caribbean (10), and the Indian Ocean (11) has demonstrated that the combination of advances in maritime technology and the translocation of domesticates facilitated successful island colonization. Farming also played a key role in the sustained, long-term occupation of the offshore African islands of Zanzibar and Madagascar on the eastern *African façade*, and Corisco and Bioko on the western coast during the Bantu expansion (2, 3, 12, 13).

In Eastern Africa, the colonization of islands during the Middle and Late Holocene resulted from the adaptation of African communities to coastal environments (3, 11–13). Less attention has been given to similar adaptations along the western coast and to the colonization of islands such as Corisco, Bioko, and the Canarian archipelago (5, 14). Although it is well established that Indigenous Canarians are descended from North African autochthonous populations, more precisely from those referred to as the Berber people, also known as Amazigh (singular), Imazighen (plural), or Tamazight (feminine) (1), archaeological research has not explored connections between the coastal populations of northwestern Africa and the Canary Islands (3, 15). This oversight is largely a consequence of traditional narratives that associate the colonization of these islands with the long-distance explorations by Punic or Roman peoples along the Atlantic coast of northwestern Africa.

The Late Holocene witnessed significant developments in sailing technology that enabled the colonization of oceanic islands in Remote Oceania, Southeast Asia, the North Atlantic, and the Indian Ocean (16–18). These technological advancements also fostered a high degree of interconnectivity between these regions (2, 12, 16). There are, however, few ethnohistorical descriptions providing evidence of the Indigenous Canarian population having navigation

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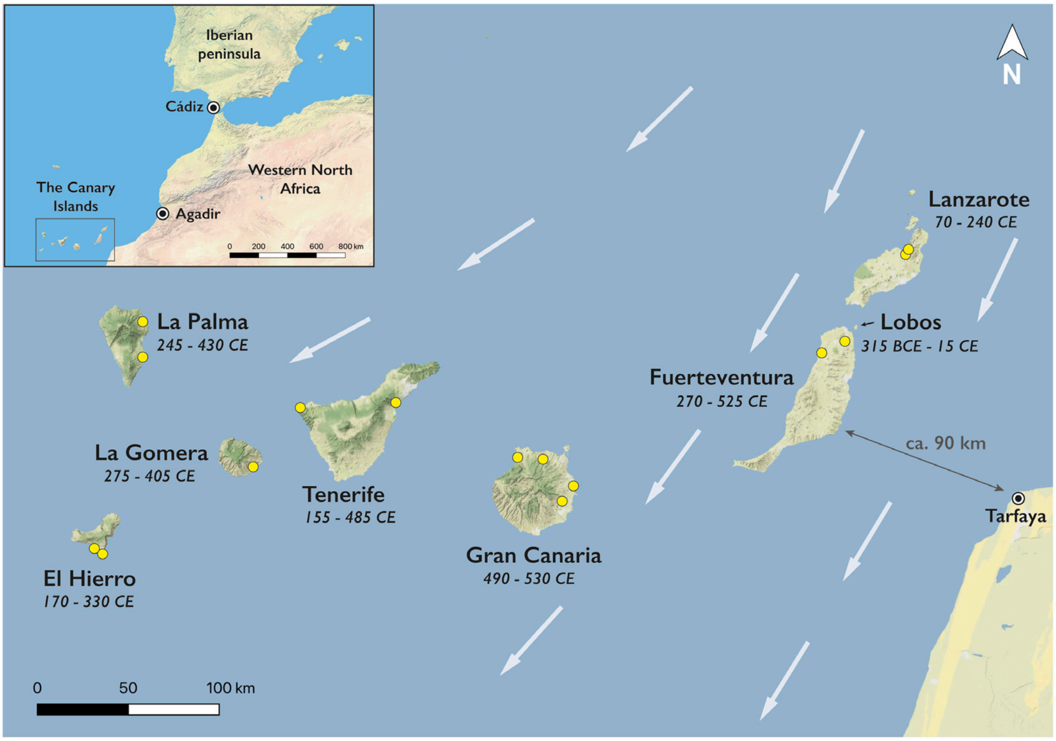

Fig. 1. Location of the Canary Islands. The figure includes the single-phase Bayesian modeled colonization time estimates (95% high probability density) for the seven major islands and the Islet of Lobos. The oldest archaeological sites are shown by yellow dots. The Berber people dispersed rapidly from the northeast to the west, facilitated by the stream of the Canary Current (white arrows) and the trade winds (from the northeast).

skills (19), and no archaeological remains of watercraft have yet been recorded. The Canarian archaeological record has traditionally been interpreted to suggest that the Berber people did not reach the Canary Islands independently, but were transported there by Phoenician, Punic, or Roman sailors during their voyages along the North African coastline. This hypothesis also implies that the seafaring capabilities of these cultures may have reduced the remoteness of the Canary Islands and encouraged their eventual colonization (20–22). However, the role of these groups in the discovery, exploration, and settling of the Canarian archipelago is still unclear. Furthermore, the absence of archaeological evidence for Berber watercraft does not preclude its existence. Indeed, it is common for such evidence to be absent, even in island settings where such technology was a prerequisite for colonization (16, 17).

The emergence of large-scale societies and their subsequent marine dispersal not only led to the colonization of new islands but resulted in their integration into complex socioeconomic networks worldwide, as occurred in eastern Africa, the Mediterranean, the Caribbean, and Southeast Asia (2). However, the available evidence suggests that the colonization of the Canary Islands did not result in the establishment of robust networks with the African mainland, nor did it lead to significant interisland connectivity beyond the first few centuries of colonization. Archaeological evidence suggests that the island cultures shared a common cultural and technological background, which is recorded mostly in the oldest archaeological sequences. Despite this, textual and archaeological evidence reveals that, when Europeans arrived in the Middle Ages, the Indigenous populations of the Canary Islands were highly diverse in terms of social organization, material culture, subsistence strategies, linguistics, and demography. Archaeologists consider that this cultural and technological variety among the islands arose from a period of isolation, driven by the lack of interisland navigation and differing island ecologies (14, 23–25).

While the colonization of the Canaries shares similarities with the settling of other islands across the world, several questions remain to be answered before it can be included in wider debates regarding patterns of first colonization and human settlement, human–environment interactions, and the emergence of island identities (3, 26, 27). Questions regarding the chronology and pace of the initial human settlement of the archipelago (19, 28) have endured since Europeans first set foot on the islands toward the end of the Middle Ages (14th century CE). Ethnohistorical records from this period note that the Indigenous Canarian populations shared cultural elements with contemporary Amazigh populations in western North Africa (23, 29). Current archaeological, linguistic, and genetic evidence strongly supports these first impressions (23, 30–33). However, the dating of the colonization has altered with advances in radiocarbon dating methods and sampling procedures (19, 23). From the beginning of archaeological research in the late 19th century, Canarian cultures were thought to be linked to an earlier North African substrate (25, 34). Research conducted before the 1970 s led to the hypothesis that the islands were originally populated by North African Neolithic groups dating to the 3rd millennium BCE (35, 36). The application of radiocarbon dating in the eighties repositioned the colonization event at around the 1st millennium BCE (19). Specialists then postulated that the early migrations could be linked to economic and demographic processes provoked either by a progressive desiccation of the Sahara during this period (14, 23) or by the expansions of Carthage and Rome during the second half of the 1st millennium BCE (20–22, 37–39). Roman narratives suggest that the archipelago was discovered during the Roman expansion along the northwestern African coastline around the onset of the Common Era. The Roman discovery of the islands does not, however, explain why and how autochthonous North African people came to occupy the Canaries.

Although radiocarbon dating has been a great benefit to Canarian archaeological research in the last two decades (28, 40–42), not all studies have adopted a chronometric hygiene approach, i.e., eliminating dates identified as likely to be problematic (*Materials and Methods*) (18, 43). The exact nature of the first human presence in the Canary Islands thus remains disputed as a consequence of differing estimates of the chronology of initial colonization. This ambiguity has contributed to the continuing uncertainty surrounding the motivations behind the settlement

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of the Canarian archipelago (3, 5), leading to divergent hypotheses regarding the initial colonization of the archipelago. To settle this debate, we must consider the most recent archaeological research, which emphasizes the importance of finding unambiguous traces of human activity—such as artifacts, buildings, and domesticates—to confirm the peopling of landmasses such as America, Australia, and offshore islands. Such traces should be securely dated using radiocarbon dating and related methods, and be associated with undisturbed, primary archaeological deposits (43–47). Additionally, some investigations into the first human presence in different parts of the world, particularly oceanic islands, have involved describing ecological and landscape disturbances in otherwise pristine environments, interpreting these as evidence of human arrival, particularly for oceanic islands (6, 48, 49). Recent studies, however, have shown that such disturbances may not always be indicative of a permanent human presence and may predate the initial settlement of the region (3, 50, 51).

The application of chronometric hygiene protocols has become standard practice to enhance the accuracy of chronological estimations in island colonization studies (45, 50–52) (*Materials and Methods*). These protocols require the identification of radiocarbon dates that are clearly and directly associated with anthropogenic activity and have minimal intrinsic sources of potential error (3, 50, 51). Radiocarbon dates are then assigned to a reliability class so that questionable measurements can be removed, improving the overall quality of the dataset (51–53). Chronometric hygiene protocols particularly emphasize the radiocarbon dates from short-lived terrestrial specimens that are directly associated with cultural activities (54–56). This approach has been particularly effective in detecting the first human settlement of islands in Eastern Africa (18), Remote Oceania (45, 53), and the Caribbean (51). Further, the use of Bayesian analysis in examining radiocarbon dates with inherent age issues has been instrumental in producing more accurate and reliable estimates for island colonization (47, 56). Taken together, this approach yields more precise and dependable estimates regarding the initial settlement or colonization of specific areas or sites.

In the case of the Canarian archipelago, it is important to note that the chronological frameworks of several of the islands (El Hierro, Tenerife, Fuerteventura, and Lanzarote), still rely on radiocarbon dates from unsuitable samples such as undetermined charcoal, ash sediments and marine shell remains. These materials are prone to produce radiocarbon dates that are older than expected. This issue often stems from the "old wood" problem, which occurs when dating wood from species with a long lifespan or wood that was charred long after being cut down. It can also derive from the "old shell" problem, which arises from marine reservoir effects (MREs) that impact radiocarbon determinations (57). The MRE, caused by the slow mixing of atmospheric CO_2 in the upper ocean, results in marine samples having a radiocarbon composition approximately 400 y older than their atmospheric counterparts. In addition, the shells analyzed may not be directly related to the specific depositional events being dated (57). Previous applications of chronometric hygiene protocols to the radiocarbon dataset of the island of Gran Canaria have proved the negative impact of unreliable samples on estimates of island colonization (28, 58). Further uncertainties in radiocarbon dating can arise due to modern intrusions, such as those caused by rodents and lizards, as well as historical volcanic eruptions (59).

Canarian archaeological research has been particularly dependent on radiocarbon dates from human remains obtained during late 19th and early 20th century explorations (34) and from recent rescue archaeology projects at burial sites. Unfortunately, much of the archaeological evidence lacks the support of hypothesis-driven research programs with clearly defined aims and approaches. This issue is compounded by the random nature of both ancient anthropological collections and the ad hoc nature of rescue archaeology. Furthermore, most of the available evidence is concentrated on islands like Gran Canaria, Tenerife, La Gomera, and El Hierro, with specimens from Lanzarote, Fuerteventura, and La Palma being underrepresented. In addition, although the Indigenous populations were consumers of the rich marine resources of the islands (60, 61), analyses have not considered the MRE on marine and mixed terrestrial/marine samples (e.g., refs. 28, 40–42, and 62). In summary, the current chronological framework of the Canary Islands requires reevaluation using a chronometric hygiene approach that considers the influence of the MRE and overcomes previous sampling bias.

The Canarian colonization process is currently dominated by two main hypotheses. The first suggests that Phoenician-Punic seafarers from North Africa arrived in the 1st millennium BCE, establishing workshops, primarily on the easternmost islands, to exploit murex, tuna, and sea mammals (19, 21, 22). Under this scenario, these skilled navigators transported nonseafaring groups from North Africa to manage the workshops. This hypothesis stems from the Phoenician tale of the voyage of the Carthaginian king, Hanno, which alludes to islands, thought by some to be the Canary Islands (37, 39). The journey would have taken place around the 7th–6th centuries BCE when the colony of Mogador was founded, ca. 445 km north of the Canarian archipelago (63). Supporters of this hypothesis rely on radiocarbon analyses of nonidentified charcoal or ashy sediments yielding dates from the 1st millennium BCE (19) and the presence of archaeological materials similar to those from Phoenician-Punic sites (21, 26). However, no unambiguous evidence of Phoenician-Punic archaeological sites or remains is currently known in the Canary Islands. Moreover, possible affinities between artifacts can perhaps be attributed to Phoenician-Punic cultural influences on the autochthonous North African populations prior to the Berber colonization of the Canaries (37).

The second hypothesis proposes a Roman-mediated migration from the Strait of Gibraltar and/or North Africa, arriving in the Canaries around the 1st century BCE. In his *Naturalis Historia*, Pliny the Elder records explorations by North African Romans who encountered the archipelago during an endeavor sponsored by an ally of Rome, King Juba II (25 BCE to 23 CE) of Mauritania (modern northern Morocco) (64). Research undertaken at the short-term settlement of Lobos-1 on the Islet of Lobos offers unambiguous evidence of a Roman presence and points to the exploitation of marine resources (65). The relative chronology of the site's amphorae places Roman arrival between the 1st century BCE and 1st century CE (38). Roman amphorae have also been found underwater along the coastlines of Lanzarote and Fuerteventura (66). Notably, Pliny the Elder does not mention any human presence on the islands at the time and notes that they were beyond the Roman sphere of influence in North Africa (64).

Whether the Romans truly colonized the Canary Islands or merely visited them for economic exploitation is still debated. Some scholars argue that they established a colonial foothold by moving Berber communities to the archipelago, specifically to exploit the natural coastal resources (20, 21). Alternative interpretations of classical narratives contend that the Romans deported Berber rebels from North Africa to the islands as a form of punishment (34). This interpretation is supported by the existence of similar ethnonyms in the archipelago and in North Africa (19). Notably, Pliny the Elder cites the *Canarii* people in North Africa, while Claudius Ptolemy refers in his *Geographia* to *Cape Gannaria* on the coast of North Africa (20). According to this hypothesis, the collapse of the Roman Empire resulted in the abandonment of these deported Berbers. Lacking seafaring knowledge, they may have remained isolated on the islands, eventually becoming the Indigenous groups met by Europeans in the late Middle Ages (29).

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Table 1. Summary of the radiocarbon dates of the different islands by class according to the chronometric hygiene protocol

Island	No. of sites	No. of radiocarbon dates	Class 1 %	Class 2 %	Class 3 %
Lobos	1	6	1 (17)	4 (67)	1 (17)
Lanzarote	11	60	4 (7)	35 (58)	21 (35)
Fuerteventura	8	25	5 (20)	14 (56)	6 (24)
Gran Canaria	60	349	110 (32)	209 (60)	30 (8)
Tenerife	50	103	7 (7)	38 (37)	58 (56)
La Gomera	30	74	24 (32)	48 (65)	2 (3)
La Palma	13	41	9 (22)	30 (73)	2 (5)
El Hierro	14	55	10 (18)	34 (60)	11 (22)
Total	217	713	170 (24)	412 (58)	131 (18)

In the present study, we used Bayesian statistical modeling (67) to investigate when the Canary Islands were colonized and to characterize human dispersal throughout the archipelago. We applied a chronometric hygienic approach, using MRE corrections and taking sampling bias into consideration to improve the accuracy of the Canarian radiocarbon dataset. We also evaluated the chronological framework of the Roman presence on the islands and the role of Rome in the discovery, exploration, and occupation of the archipelago. Finally, we examined the role of the autochthonous North African populations or Berber groups in the colonization process, considering their dispersal through the various islands, and their links with the Romans.

Results

Application of Hygiene Protocol and Dating Corrections. A total of 713 radiocarbon determinations were compiled from 217 sites (Table 1, *SI Appendix*, Table S1, and Dataset S1). After applying the chronometric hygiene protocol, 170 dates fell into Class 1 (24%), 412 into Class 2 (58%), and 131 into Class 3 (18%) (Table 1). Class 1 included the most reliable radiocarbon dates, directly linked to cultural activity with the fewest potential sources of error. These corresponded to dates from short-lived crop seeds (n = 79), desiccated insects (n = 7), and caprine bones (n = 87). Class 1 also included dates from short-lived parts of wild plants from secure archaeological contexts (n = 25) (*SI Appendix*, Table S1). Class 2 dates came from secure cultural deposits but included some with possible inherent issues such as human remains with potential effects related to a marine reservoir (n = 285), unidentified or long-lived charcoal samples (old wood, n = 91), and marine shells (n = 26) (*SI Appendix*, Table S1). Class 3 included unreliable dates not clearly associated with the target event, lacking crucial information, or suffering from calibration issues (*Materials and Methods*). Each island yielded at least four Class 1 dates, except for Lobos which yielded only one (Table 1).

Local Marine Reservoir Offsets (ΔR) for the Canary Islands. A weighted average of ΔR corrections was calculated to obtain a single representative ΔR value applicable to the Roman/Indigenous periods of the Canary Islands (*SI Appendix*, Tables S2 and S3). The error-weighted pooled mean of the ΔR value obtained in this study was −201.9 ± 32.4 y (*SI Appendix*, Table S4). This correction was applied to the radiocarbon dates of marine specimens and human remains with potential mixed dietary signatures (terrestrial/marine) (*SI Appendix*, Tables S2 and S3).

Bayesian Modeling of Radiocarbon Dates from the Canarian Archipelago. The seven major islands, as well as Lobos, all yielded Class 1 or Class 2 radiocarbon dates (n = 583, 81.5%) (Table 1 and *SI Appendix*, Table S1). The Bayesian analyses of these, the most reliable radiocarbon dates, provided model-based age estimates for the first colonization. The analyses included two levels of complexity: the first focused on the whole archipelago, while the second investigated each island individually. All referenced models and radiocarbon determinations are available in *SI Appendix* file, and a summary of the results of the models is listed in Table 2.

A Kernel Density Estimation (KDE) was applied to all the terrestrial Class 1 and 2 radiocarbon data from the whole archipelago (Fig. 2). This analysis provided a reliable distribution of the aggregated calibrated radiocarbon dates and their associated error to estimate the frequency and intensity of past human activity in the Canary Islands. The KDE model suggests a first phase starting around 200 cal BCE and a first decline in the frequency of dates at about 50 cal CE. After a short hiatus, a second phase begins with an increase in the frequency of dates after 250 cal CE (Fig. 2). Overall, the model reveals a gap between an initial phase of lower intensity and duration (mainly stemming from the dates of Lobos-1) and a second phase of greater intensity linked to dates from the Berber/Amazigh archaeological sites (*SI Appendix*, Table S1). A KDE model of two overlapping phases was designed to further examine the two main clusters (Fig. 2). The first corresponds to the "Roman" phase which consists of the dates from Lobos, while the second "Berber" phase aligns with the remaining dates from the Canary Islands. These results also suggest a short interval between the Roman and the Berber phases (Fig. 2).

The Bayesian single-phase models of the Roman (represented by the Islet of Lobos) and Berber dates are in good agreement (A_{model}: >60; $A_{overall}$: >60) (Table 2 and *SI Appendix*, Tables S5 and S6). The findings based on Class 1 and Class 2 dates point to a Roman phase beginning around 315 cal BCE to 15 cal CE (95% high probability density, henceforth HPD) and ending between 135 cal BCE and 160 cal CE (95% HPD) (Table 2 and *SI Appendix*, Table S5). The single-phase model of the Berber phase (Class 1 and 2 radiocarbon dates) yielded an estimate of between 295 and 340 cal CE for the initial settlement (95% HPD) (Table 2 and *SI Appendix*, Table S6). This model also highlights that the two clusters, linked to the Roman and subsequent Berber occupations respectively, were separated by a brief interval. Our findings also suggest that the Berber phase was continuous and did not include any hiatus.

A KDE model of two overlapped phases was performed to evaluate the frequency of radiocarbon dates from both coastal and inland sites of the Berber phase. The results show that the coastal areas were first occupied by the Berber people around the onset of the Common Era, while the inland regions were inhabited more recently, from about 400 cal CE (Fig. 3). The Bayesian multiphase model of the coastal and inland radiocarbon dates is also in good agreement (A_{model}: >60; $A_{overall}$: >60). The estimated range for the coastal sites places the Berber colonization between 235 and 315 cal CE (95% HPD); the inland dates yield a more recent modeled

Table 2. **Summary of the results of the Single-Phase and charcoal outlier Bayesian analyses of Class 1 and 2 radiocarbon determinations**

Island	Model	N radio-carbon dates	Results: Start 68% (cal BCE/CE) from	to	Start 95% (cal BCE/CE) from	to	End 68% (cal BCE/CE) from	to	End 95% (cal BCE/CE) from	to	Indices A_{model}	$A_{overall}$
Lobos/Roman	Single-phase	5	−172	−31	−315	15	−75	60	−135	160	121	117.5
Berber	Single-phase	578	305	325	295	340	1450	1465	1445	1470	195.9	87.9
Coastal	Multiphase	578	275	300	235	315	1470	1495	1465	1505	99.7	79.5
Inland			485	515	455	525	1490	1525	1425	1543		
Lanzarote	Single-phase	38	140	220	70	240	1335	1415	1310	1465	124.9	108.3
	Charcoal_Outlier		140	220	60	245	1335	1410	1315	1470	126.5	109.5
	Charcoal_Plus_Outlier		150	235	90	290	1335	1415	1310	1465	129.3	112.3
Fuerteventura	Single-phase	19	385	490	270	525	1250	1330	1230	1450	112.5	101.7
	Charcoal_Outlier		285	430	200	505	1285	1365	1275	1475	107.3	98.4
	Charcoal_Plus_Outlier		330	465	230	520	1275	1480	1280	1480	114.8	105.7
Gran Canaria	Single-phase	322	505	525	490	530	1490	1515	1480	1530	123.9	83.3
	Charcoal_Outlier		510	530	495	535	1490	1515	1480	1535	112.4	89
	Charcoal_Plus_Outlier		535	575	515	630	1460	1480	1450	1500	114.8	92.2
Tenerife	Single-phase	49	225	340	155	385	1450	1530	1440	1630	142.8	81
	Charcoal_Outlier		235	350	160	400	1450	1530	1440	1640	151.5	79.1
	Charcoal_Plus_Outlier		495	610	330	635	1455	1540	1440	1640	128.4	59.6*
La Gomera	Single-phase	73	315	395	275	405	1470	1560	1445	1615	126.7	96.3
La Palma	Single-phase	37	320	405	245	430	1340	1405	1325	1500	116.2	95
	Charcoal_Outlier		325	410	245	440	1335	1450	1325	1495	114.8	93.8
	Charcoal_Plus_Outlier		365	450	300	490	1335	1450	1320	1490	119.6	98.9
El Hierro	Single-phase	42	230	305	170	330	1415	1465	1385	1515	162.6	124.5
	Charcoal_Outlier		230	305	170	330	1415	1465	1385	1520	160.6	123
	Charcoal_Plus_Outlier		230	310	175	330	1415	1465	1385	1515	168	128.8

*The average overall index of the model drops below the minimum acceptable value of 60% (67).
Further results in *SI Appendix*.

range of between 455 and 525 cal CE (95% HPD) (Table 2 and *SI Appendix*, Table S7).

Bayesian Modeling at the Scale of Individual Islands. Bayesian single-phase models were designed for each island to explore human dispersal throughout the archipelago. This approach has proven to be the most reliable way to investigate when and how archipelagos were colonized (51). The models included a combination of both Class 1 and 2 dates as only a few Class 1 dates were available for some islands (Table 1). Two additional outlier models, Charcoal_Outlier and Charcoal_Plus_Outlier, offering different exponential distributions for potential outliers (*Materials and Methods*), were generated for each island to evaluate inbuilt age issues from unidentified wood charcoal, human remains and marine shells. The Bayesian models are in good agreement (A_{model}: >60; $A_{overall}$: >60) (Table 2).

Age estimates for the first colonization of Lanzarote range from 70 to 240 CE (95% HPD) using the single-phase model (Table 2 and *SI Appendix*, Table S8) (Fig. 3). Our results also suggest that the first human presence in Tenerife and El Hierro took place roughly between 155 and 385, and 170 and 330 cal CE (95% HPD), respectively (Fig. 3, Table 2, and *SI Appendix*, Tables S11 and S14, respectively). The dates stemming from the Charcoal_Outlier models offer analogous estimations, except for the Charcoal_Plus_Outlier_model of Tenerife (Table 2 and *SI Appendix*, Tables S20 and S26). The more accurate Bayesian models for La Palma yield ranges with negligible differences between 245 and 430 cal CE (95% HPD) (Table 2, *SI Appendix*, Tables S13 and S21, and Fig. 3). Comparable results are also obtained for the first human settlement of Fuerteventura, between 270 and 525 cal CE (95% HPD) (Table 2 and *SI Appendix*, Tables S9, S18, and S24) and La Gomera between 275 and 405 cal CE (95% HPD) (Fig. 3, Table 2, and *SI Appendix*, Table S12). Only Gran Canaria offered a very narrow HPD of cal CE 490 to 530 (95%) (Table 2 and *SI Appendix*, Tables S10, S19, and S25). This HPD is, however, later than the modeled estimation for all the islands using Class 1 and 2 radiocarbon dates (295 to 340 cal CE, 95% HPD) (Table 2).

A multiphase overlapping Bayesian model was also designed to focus on the chronological relationship between the dates of Lobos and Lanzarote as these two islands have the earliest evidence of human presence. The results by island are analogous (Table 3 and *SI Appendix*, Table S15) with a low probability of overlap between the end of the Roman presence on Lobos and the outset of the Indigenous activity on Lanzarote (−50 to 290 y, 95% HPD). Additionally, a sequential Bayesian model was used to investigate this potential overlap with an estimated range of 5 to 240 y (95% HPD), suggesting the existence of a short hiatus between the Roman site of Lobos and the subsequent Berber occupation of Lanzarote (Table 3 and *SI Appendix*, Table S16).

Discussion

The Initial Human Colonization of the Canary Islands. The results obtained from combining the Bayesian statistical modeling and chronometric hygiene protocol suggest that the first human presence in the Canary Islands was the Roman occupation of the Islet of Lobos between 315 cal BCE and 15 cal CE (95% HPD). This represents the westernmost limit of the Roman presence in antiquity. These modeled dates align with the relative chronology gleaned from the typology of the site's amphorae (Dressel 7/11, Haltern 70 and Oberaden 83/Haltern 71) (38), most of which were produced in southern Iberia and date between

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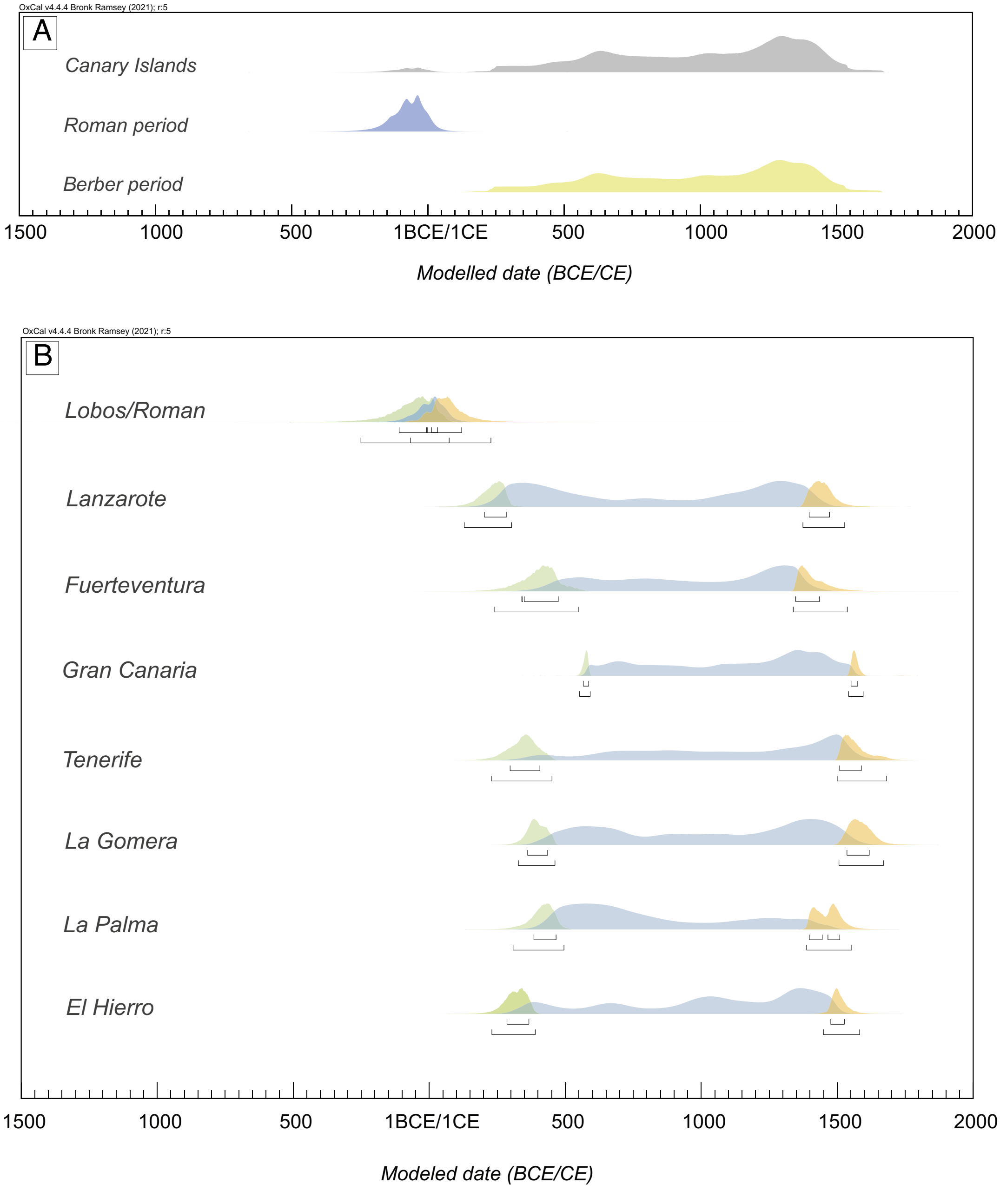

Fig. 2. KDE plots of the Canary Islands. (*A*) KDE plot of the overall dataset of radiocarbon determinations of the Canary Islands (all phases), KDE plot of the Roman phase of the Islet of Lobos (short-term settlement of Lobos-1) and KDE plot of the Berber/Indigenous phase of the Canary Islands. (*B*) KDE plots of the Islet of Lobos and the seven major islands. These KDE plots include Bayesian boundaries to prevent the overdispersal of the distributions.

the 1st century BCE and the 1st century CE (68, 69). Analyses of other Roman artifacts from Lobos also suggest an origin in the Strait of Gibraltar (38). Although the highest posterior density of the Bayesian model yielded a wider chronological framework, it is nevertheless encompassed by the range corresponding to the archaeological findings (Table 2). Our study therefore aligns with the archaeological evidence and the classical narratives that point to the arrival of Romans, from southern Iberia or North Africa, in the Canary Islands during the 1st century BCE (37, 38).

The findings reveal that the islands were permanently occupied only after the arrival of Berber populations around the 1st to 4th century CE. This timing aligns with the first settlement phase of other offshore African islands, such as Corisco on the western façade and Mafia, Kwale, and Koma on the eastern coast (3, 11). Contrasting with these instances, our KDE models for the various islands show a long-term trajectory of occupation that extended beyond the European arrival in the 14th century CE. This successful sustained occupation is largely attributed to the considerable size of the islands, their ecological diversity, and the presence of resources essential for supporting an agrarian population (e.g., arable land, spring water, and both wild plant and animal resources) (4, 5). Remarkably, the smaller islands of the Archipelago, such as El Hierro and La Gomera, were also successfully colonized (Fig. 1). In a broader context, the critical role of agriculture in supporting long-term, sustainable human settlements has also been noted on other African islands like Zanzibar, Corisco, and Madagascar (2, 3, 12).

The earliest evidence of Berber settlement is from the island of Lanzarote and dates between 70 and 240 cal CE (95% HPD). This differs from the previously established model, which did not use a chronometric hygiene protocol and placed the colonization of Lanzarote in the 10th century cal BCE (21). Instead, our findings align more closely with the most recent modeled estimate of 5 to 240 cal CE (70). Before this study, the oldest radiocarbon dates from Fuerteventura suggested that the Berber people reached the island in approximately the second half of the 2nd century CE (18). However, these results were derived from bulk sediments and unidentified charcoal samples that had not been analyzed using Bayesian methods or with a chronometric hygiene protocol. Our estimated range of 270

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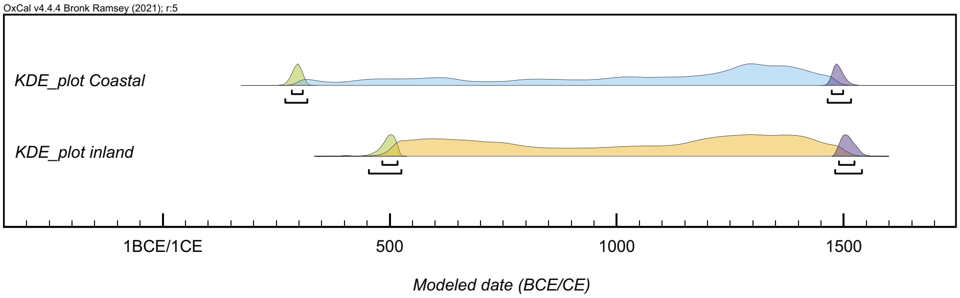

Fig. 3. KDE plots of radiocarbon dates from coastal and inland sites of the Canary Islands. The KDE models show the distribution of events, and each plot is based on the dated events constrained to be within the phase (coastal or inland). These KDE models include Bayesian boundaries to prevent the overdispersal of the distributions.

to 525 cal CE (95% HPD) is thus the first modeled estimate for the colonization of Fuerteventura (Fig. 4). Similarly to the dates obtained in this study, molecular dating of local Canarian barley suggests that the crop first arrived at the eastern islands before spreading to the central and western islands (71). The spread of the crop thus seems to have followed a similar route to that of human settlers during the colonization period (Table 2).

The prevailing trade winds and the southward-flowing Canary Current suggest a north-easterly point of origin for colonization (72) (Fig. 1). This implies a crossing from a more northerly latitude along the African coast to reach the northeastern edge of the archipelago. Lanzarote, rather than Fuerteventura, which is closest to the African mainland, was the first island reached by medieval Europeans (29). This suggests that departure points along the African coastline north of the archipelago, such as the mouth of the Sous Valley (today's Agadir), Sidi Ifni, or Massa might have been more suitable than the nearest point, currently Tarfaya, southeast of Fuerteventura (Fig. 1). Indeed, the Lybico-Berber alphabetic inscriptions discovered on El Hierro bear a significant resemblance to those found in western North Africa, dating to the early centuries of the 1st millennium CE (73).

Our estimate for the initial settlement of Gran Canaria (490 to 530 cal CE, Fig. 4) differs from an earlier estimate derived from summed probability distribution (SPD) analyses, which suggested a range of 230 to 435 cal CE (95% HPD) (74). The earlier estimate more closely aligns with the findings from our Bayesian model on the Berber colonization of the entire archipelago (295 to 340 cal CE, 95% HPD). However, the SPD model did not incorporate corrections for the MRE in human mixed diets (62) and merges temporal variations with chronological uncertainties, complicating the interpretation of the radiocarbon data (75). Our later estimate might be a result of the relative scarcity of radiocarbon dates from the first settlement compared to later periods. As shown in the KDE plot, there is a marked increase in radiocarbon dates after ca. 1000 cal CE (Fig. 2). This bias arises partly from the focus on analyzing human remains, predominantly from funerary caves in ravines and mountains, collected in the late 19th and early 20th centuries. This sampling criterion tends to underrepresent samples from coastal regions, where caves are less frequent (*SI Appendix*, Table S1 and Dataset S1). The composition of our dataset is also influenced by the prevalence of rescue archaeology at coastal open-air sites, often found at ravine mouths, rather than at more undisturbed coastal cave sites. Despite these challenges, our findings confirm that coastal areas were occupied during the earliest phases of human settlement on the island (e.g., Playa Chica, Aguadulce, and La Cerera). These insights underscore the need for more comprehensive and inclusive research into the coastal regions of Gran Canaria.

The timeframe we have determined for the initial colonization of Tenerife lies between 155 and 385 cal CE (95% HPD), which challenges earlier suggestions that the first human presence on this island occurred either in the 10th century cal BCE (19) or the 3rd century cal BCE (76). Excluding marine samples from our model significantly narrows the estimated range for Tenerife's first colonization to between 205 and 410 CE (95% HPD). This adjustment highlights the uncertainties linked to the inherent ages of two early marine samples, as demonstrated in the Bayesian model incorporating all Class 1 and 2 radiocarbon dates (Table 2). Our analyses also suggest that La Palma was colonized around 245 to 430 cal CE (95% HPD), contrary to the traditional view that it was settled in the late 1st millennium BCE (22). While our study confirms the established chronologies based on nonmodeled calibrated dates (77), it provides a more accurate and robust timeframe of between the 3rd and 5th centuries cal CE.

Our modeled age estimates move forward the date of the initial human presence on La Gomera, previously thought to have occurred in the 1st century cal CE (41). The chronometric hygiene protocol used in the present study resulted in the rejection of one radiocarbon date obtained from an animal bone from stratigraphic layer IX of the archaeological site of Lomito de Enmedio (UCI-209630: 1900 ± 15 BP). However, a charred wheat seed from the same layer yielded a date of 1630 ± 30 BP (Beta-600220) (*SI Appendix*, Table S1). The isotope ratios of the animal bone ($\delta^{13}C = -17.4$; $\delta^{15}N = 9.9$) suggest that this individual incorporated a marine component into their diet (e.g., seaweed, sea spray effect on coastal plants), potentially resulting in a MRE. Previous

Table 3. Results of the multiphase overlapping and sequential models of Class 1 and 2 radiocarbon dates of the islands of Lobos and Lanzarote

			Results									
			Start				End					
			68% (cal BCE/CE)		95% (cal BCE/CE)		68% (cal BCE/CE)		95% (cal BCE/CE)			
Island	N radiocarbon dates	Model	from	to	from	to	from	to	from	to	A_{model}	$A_{overall}$
Lobos	5	Overlapping	−180	−30	−330	10	−75	50	−140	165	133.6	114.6
Lanzarote	38		110	190	50	220	1330	1410	1310	1460		
Difference							75	220	−50	290		
Lobos	5	Sequential	−170	−25	−305	15	−50	55	−100	120	132.6	114.5
Lanzarote	38		100	185	45	215	1335	1410	1310	1460		
Difference							65	195	5	240		

The OxCal's command *Difference* indicates the time interval between the end of Lobos and the start of Lanzarote according to each Bayesian model.

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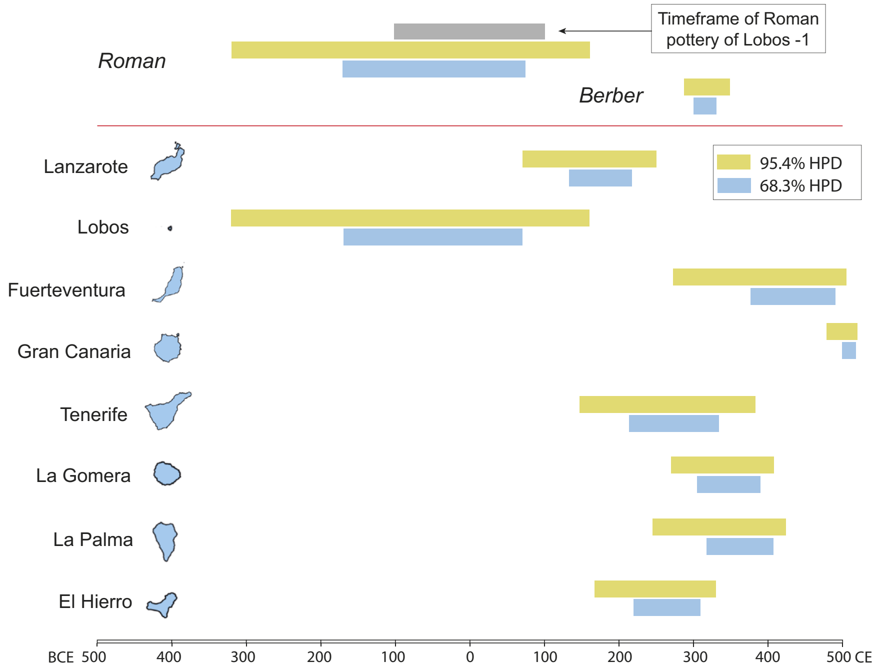

Fig. 4. Estimates for the timing of colonization for the Canary Islands. Estimated start ranges based on single-phase Bayesian modeling after chronometric hygiene assessment (Class 1 and 2). The figure also includes the estimated range of the Roman phase.

estimates place the first human settlement of El Hierro around the 5th century CE (78), but our current analysis, which expands the number of samples and applies both Bayesian modeling and the chronometric hygiene protocol, suggests an earlier settlement date between the late 2nd and the early 4th century cal CE.

Cohabitation of Romans and Berbers? Our Bayesian overlapping model points to a brief overlap of Roman and Berber populations in the Canary Islands around the 1st century CE, reinforcing the hypothesis that these two groups lived together in the archipelago from the 1st to the 2nd centuries cal CE. Evidence supporting cohabitation on Lanzarote includes the presence of amphorae sherds alongside possible hand-crafted Berber sherds at El Bebedero (21). Previously, occupation of the site was estimated to date between 960 and 330 cal BCE, based on bulk sediment samples and unidentified charcoal (21) (*SI Appendix*, Table S1 and Dataset S1). Our results suggest a more recent occupation from around the 1st to the 4th century CE (*SI Appendix*, Table S1 and Dataset S1). It should be noted that the site lies in a catchment area where, due to erosion, stratigraphic levels come from different areas having archaeological remains in a secondary position. The issue is further exacerbated by inconsistencies in the radiocarbon dates obtained from identical strata (*SI Appendix*, Table S1 and Dataset S1). The interpretation of archaeological evidence from El Bebedero is also debated. The amphorae sherds, for example, lack distinct diagnostic features, and stratigraphic layer II, spanning from the 5th to the 15th century CE (21), contains amphorae sherds such as medieval ware introduced to the islands by Europeans (66).

Previous models have suggested that the Berber settlement of the Canary Islands was a direct result of a forced colonization of the Berber people by the Romans (20). This idea was first proposed in the Norman narrative *Le Canarien*, written at the beginning of the 15th century (29); there are no extant Roman records describing such an event or any Roman involvement in the colonization of the Canarian archipelago. Indeed, historical accounts often depict the Romans as more inclined to enslave or annihilate groups, such as the Berbers, that they considered problematic (79). Our sequential Bayesian model reveals a clear separation between the end of the Roman presence on Lobos and the start of the Berber occupation on Lanzarote (Table 3). This model is similar to one used for overlapping phases (67) but specifically constrains the start of the Berber occupation in Lanzarote to occur after the Roman presence in Lobos. Notably, our Bayesian single-phase model shows no overlap between the Roman (Lobos) and Berber phases (Table 2 and Fig. 4). Furthermore, recent genomic studies on ancient DNA from the archipelago's archaeological populations reveal a genetic makeup of western North African ancestry prior to the impact of Roman and Arab expansions (31, 80). Besides the evidence from Lobos, there is no unequivocal proof of Roman presence or cultural exchange with the Berbers on any of the islands. The absence of Roman artifacts, especially in the oldest Indigenous sites where cultural traits align more closely with North African or Berber traditions, is particularly telling (23). Moreover, Berber archaeological features are markedly absent at the Roman site on Lobos (19).

The absence of overlap between the Roman and Berber phases reinforces the idea that, when an island is encountered, this does not necessarily lead to its permanent settlement (81, 82). Historical records show that oceanic islands are often explored, exploited, and inhabited only intermittently before this occurs (3, 83). Factors such as size, closeness to other land masses, ecological constraints, relative advantages of habitation, and the island's position within maritime trade networks have shaped human settlement patterns on islands (26, 84). Our results, when combined with archaeological, genetic, and linguistic evidence, suggest that the Romans did not attempt to colonize the Canary Islands, nor did they forcibly move Berber communities there. Instead, the Berbers likely arrived independently. This interpretation does not rule out that the Roman presence in North Africa motivated the Berber colonization. The impact of the Roman expansion on the local northwestern African populations together with a greater aridity in this region (85) could explain why some Berber groups eventually migrated to the Canary Islands. Other episodes of island colonization in the Late Holocene can also be associated with the emergence of complex societies and maritime trade from the Mediterranean, Northern Europe, and East Asia (2, 15). For example, the emergence and expansion of trans-Indian Ocean trade, particularly from the second half of the 1st millennium CE, significantly facilitated the colonization of islands off the eastern African coast (3). Such expansions can increase the mobility of neighboring communities, sometimes leading them to seek refuge on islands to avoid or mitigate conflicts (2).

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The Timing of Human Arrival and Its Role in the Transformation of Island Ecosystems. Human activities on the Canary Islands profoundly impacted island ecosystems, leading to faunal extinctions, vegetation changes, and the introduction of domesticated and commensal animals and plants (5–7), but debates continue regarding the date at which people first arrived and their potential role in faunal extinctions (5). Zooarchaeological analysis reveals that the early settlers consumed native species, such as the giant lizard *Gallotia goliath* (ca. 1 m in length) and the rabbit-sized giant rat (*Canariomys bravoi*), particularly at the Las Fuentes-Arenas site on Tenerife (86). While these remains lack direct radiocarbon dating, nearby sites like Las Estacas offer a date range of 80 to 415 cal CE (95% HPD) (*SI Appendix*, Table S1 and Dataset S1). Human consumption of *G. goliath* is also documented at Cueva de La Arena, Tenerife (120 to 405 cal CE, 95% HPD), Roque de Los Guerra (La Palma), and Guinea, El Hierro (590 to 825 cal CE, 95% HPD) (86) (*SI Appendix*, Table S1 and Dataset S1). Intriguingly, these species only disappeared from the islands' archaeological record long after the Berber settlement, in the early 2nd millennium CE (7, 86). Other species, including the giant rat of Gran Canaria (*Canariomys tamarani*), the eastern islands' lava mouse (*Malpaisomys insularis*), and bird species such as the lava shearwater (*Puffinus olsoni*) and the Canary Island quail (*Coturnix gomerae*), may have become extinct due to indirect human impact like habitat destruction, disease, and predation by introduced species such as dogs and cats (6).

Our results also provide an accurate timeframe within which to consider human impact on island ecologies on an island-by-island basis. Paleoecological records reveal variations in forest composition, shifts in fire regimes, and increased soil erosion dating from around 490 BCE to 130 CE in Gran Canaria, 165 BCE to 24 CE in Tenerife, and approximately 150 CE in La Gomera (87). These disturbances, including changes in sediment sources and amounts due to large-scale landscape alterations through burning and grazing, align with previous models positing early human settlement in the first millennium BCE (18, 20, 22). However, our Bayesian analysis suggests colonization occurred several hundred years after these ecological disturbances. This discrepancy is possibly due to methodological limitations in interpreting paleoenvironmental data based on a limited number of radiocarbon dates from bulk sediment samples (5). Wood charcoal analysis at Cueva de Villaverde in Fuerteventura shows the presence of now-extinct tree species in layers dating from the 3rd to 7th centuries CE, but these disappeared by the 9th century (88). Similarly, La Palma and Tenerife show a decline in local taxa and an increase in higher altitude species during the early 2nd millennium CE, indicative of deliberate deforestation for fuel and to enable agricultural and grazing practices (7). In Lanzarote, early human occupation at the El Bebedero site shows intense erosion from animal trampling, coinciding with the introduction of domesticated animals like goats and pigs (5).

The Bayesian estimates for the first colonization of the Canary Islands, along with direct radiocarbon dates on introduced species, establish a direct connection between ecological disturbances and the introduction of farming to create "transported landscapes" (89). Radiocarbon dates for barley (*Hordeum vulgare*) and wheat (*Triticum durum*) grains from around the 3rd to 5th century cal CE in La Palma, La Gomera, and Fuerteventura highlight the rapid introduction of agriculture (4). Radiocarbon dating also reveals early evidence of domesticated animals at the Roman site of Lobos I, and at the Berber sites of El Bebedero (Lanzarote) and Cueva de La Herradura (El Hierro) during the early occupation of the archipelago (Dataset S1). A consequence of human colonization was the arrival of permanent populations of the Canarian Egyptian vulture (*Neophron percnopterus majorensis*). Based on coalescent ages, the insular population of this vulture is estimated to have split from the mainland population around 2900 BP; this is corroborated by the absence of an earlier fossil record (90). The lack of native medium–large-size terrestrial animals in the archipelago perhaps prevented the settlement of permanent Egyptian vulture populations prior to human colonization.

While Roman activities may have modified island environments in a precolonization phase, the concurrence of ecological disturbances with unambiguous signs of human presence makes it more likely that these changes began with the Berber colonization between the 1st and 4th centuries CE, or even later. This pattern aligns with the model of Neolithic landscape change in the Mediterranean, marked by the significant impact of agriculture and caprine livestock (5, 91). It is important to consider that the Canary Islands represent a unique case as the only offshore African islands to have been colonized by populations bringing the Mediterranean Neolithic domestic package (4).

Berber Dispersal across the Canary Islands. Our Bayesian age modeling reveals that the Berber colonization of the Canary Islands was a rapid process, taking around 200 y (Fig. 4). The estimates for initial colonization show that the eastern, central, and western islands were populated around the same time. Dating based on genetic coalescent modeling has suggested a stepwise cessation of seed exchange between the islands (71). However, it should be noted that the end of this activity may not necessarily have coincided with permanent settlement and that the method used allowed only relatively imprecise date estimates (71). A rapid colonization process, such as that described here, better explains the high degree of homogeneity across the island cultures in the first centuries after their settlement. Archaeological, linguistic, and genomic evidence all point to a shared cultural, technological, and biological background among the Canarian Berber populations (5, 23). Archaeobotanical and archeozoological remains suggest that the settlers introduced a homogeneous farming "package" throughout the archipelago, consisting of goats, sheep, pigs, barley, durum wheat, lentils, peas, broad beans, and figs (4). Over time, the lives of the societies of each island began to diverge as a consequence of isolation, environmental constraints, and population bottleneck effects (5, 23, 80). Archaeobotanical evidence highlights the particular agricultural paths followed by the different islands, with a decline in crop diversity over time (except for Gran Canaria) (4). The rapid colonization model may also explain the common use of decorative techniques, including incision, grooving, and impression, on the pottery vessels of many of the islands. It further corresponds with typological similarities seen between geographical extremes within the archipelago, such as the occurrence of shapes known as "*tofios*" or "*tabajostes*"—types recorded on both Fuerteventura and La Palma (92) (Fig. 1).

A rapid colonization means that the eastern islands could not have been extensively occupied when the Berber settlers started their move westward. This simultaneous colonization distinguishes the Canary Islands from other African islands, with the notable exceptions of Cape Verde and the Comoros in the western Indian Ocean during the European expansion (5). Archaeological research across the Pacific, Caribbean, and Mediterranean regions shows that coastal and island colonization by farming populations is often characterized by rapid dispersals followed by periods of inactivity (2, 16, 92, 93). Colonization surges often occur within the same latitudes, as domesticated plants are constrained by specific growth conditions (2, 94). This global pattern is evident in the peopling of the Canary Islands, where the Berber population migrated from east to west across islands with a Mediterranean-like climate, closely resembling the environmental conditions of western North Africa. The settlement of the Canary Islands highlights the importance of farming and niche construction in the successful colonization of oceanic islands. An equivalent hunter-gatherer endeavor may have failed since the Canary

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Islands lack native edible resources such as large land mammals and starch-rich plant foods (4, 6, 7). In fact, the initial settlement of most African islands typically involved farming societies (3, 12).

The integration of Bayesian modeling of radiocarbon dates with paleogenomic studies reveals a complex pattern of island colonization in the Canary Islands. For the islands of Gran Canaria and Tenerife, paleogenomic data is consistent with bottleneck events happening between the 4th century BCE and 2nd century CE, and the 1st century BCE and 3rd century CE, respectively (80). These results are compatible with those from the Bayesian modeling of radiocarbon dates, collectively placing the peopling of the Canary Islands in the first centuries CE. For the island of El Hierro, a strong bottleneck event is seen between the 7th and 12th centuries CE. As the Bayesian age estimate for the initial occupation of El Hierro is placed around the 2nd and 4th centuries CE (Table 2), the bottleneck event must be related to a later catastrophic incident that reduced the population size of the island. Paleogenomic analyses of the Canarian Indigenous populations do not show a decrease in genetic diversity from the eastern to the western islands, as would be expected in a stepping-stone colonization model. Instead, there is an asymmetrical distribution of both mitochondrial DNA and genome-wide diversity within the populations across the archipelago (30, 80). A similar genetic pattern is seen when comparing present-day landrace barley of Indigenous origin (95). These genetic insights correlate with a rapid colonization process marked by simultaneous bottleneck episodes occurring around the time of the first settlement of the islands. This finding provides a key to understanding of the patterns and mechanisms of human migration and colonization in island environments.

High demographic density, competition for resources, and environmental decline do not, therefore, appear to have driven the colonization of the western islands. Instead, our results suggest that a rapid spread was stimulated by other causes that, once started, led to dispersion throughout the archipelago. This pattern fits well with the concept of autocatalysis, where the discovery of the initial islands leads to an expectation that more will be discovered, as Keegan and Diamond (94) described for several islands of the Pacific, the North Atlantic, and the Indian Ocean. A local autocatalysis sequence may explain why the smaller islands with few natural resources were colonized while the more ecologically rich islands such as Gran Canaria and Tenerife were still scarcely populated. Smaller islands should have been less attractive to predominantly agricultural populations in various regions, unless substantial changes tipped the balance in favor of moving over remaining. However, factors such as the distance from other populated areas and the environmental diversity of small islands can mitigate their unattractiveness (2). The intervisibility of the various Canarian isles must surely have played a role when pioneers were planning their next journey, enabling the colonization of the smaller islands in the Archipelago. From Lanzarote, the largest marine stretch is ca. 80 km between Fuerteventura and Gran Canaria, shorter than the gap between Africa and Lanzarote, already colonized (Fig. 1). Evidence from both archaeology and paleogenomics reveals that shortly after the first phase of colonization, there was a significant decrease in interisland mobility within the Canarian archipelago (23, 32, 80). Consequently, the colonization of the Canary Islands appears to have been a constrained pulse of dispersal, possibly facilitated by knowledge bought from Roman voyagers or earlier Berber explorations.

Our findings reveal that the earliest occupations in the Canary Islands focused on the coastal areas, combining farming with the exploitation of shoreline resources (Figs. 1 and 3). While earlier models suggested that the first colonizers preferred the inland regions (20, 40), our results indicate that initial settlements along the coast were key for the successful colonization of the archipelago, as marine environments provided more regular and reliable resources than areas further inland. These findings also support the hypothesis that the Canarian Berber population possessed seafaring skills, allowing them to spread throughout the archipelago. Recent studies on the eastern African coast highlight the complex adaptive processes of Middle and Late Holocene populations, including the exploitation of marine resources, island colonization, and maritime technology—a process that was neither linear nor continuous (11, 13). The initial settlement of the Canaries may reflect similar developments among communities along the western coast of North Africa. Future research should focus on understanding how northwestern African communities settled in coastal areas and interacted with the marine environment during the Late Holocene. Such research is essential for understanding the reasons behind the colonization of the Canary Islands and the factors contingent on the emergence of dynamic coastal adaptations in western North Africa.

In summary, our study shows that Romans first set foot on the Canary Islands around the 1st century BCE and settled on the Islet of Lobos in the first half of the 2nd century CE. The results also show that the Berbers arrived on Lanzarote sometime between the 1st and 3rd centuries CE, and eventually became the Indigenous communities met by European seafarers in the late medieval period. Our analysis further suggests that Romans and Berber people may have cohabited in the Canary Islands for some time (Fig. 4), but if there was contact between them, it did not lead to any substantial cultural or genetic exchange. This supports the hypothesis that the Berber people arrived on the islands by their own means. The findings also reveal that the dispersion of the Berber populations throughout the islands was a rapid process, completed within 200 y (Fig. 4), and with the westernmost islands populated around the same time as their easternmost counterparts. Overall, this study provides a verifiable chronological framework for the initial colonization of the Canary Islands, laying a foundation for future research into the questions of where, when, and how the archipelago was colonized.

Materials and Methods

Radiocarbon Data. Radiocarbon dates were compiled through an extensive literature review of site reports, journal articles, and books in both Spanish and English. This exercise increased the number of radiocarbon dates available for consideration from 434 in the most recently published appraisal (28) to 715 in the present study (Dataset S1). The data also included 93 unpublished radiocarbon dates focusing on islands that have previously received little attention (e.g., Fuerteventura and El Hierro).

Chronometric Hygiene Protocol. A chronometric hygiene protocol was applied to obtain a more reliable set of data through a critical assessment of their relevance to the events under investigation (50). Issues considered included the old wood and the old shell problems (57, 96), and the local reservoir offset (ΔR) between ^{14}C in marine and freshwater settings compared to that in the atmosphere (97). Thermoluminescence dates were not included in this study since high CI are typically associated with this method when applied to oceanic volcanic island contexts (98). Paleoenvironmental radiocarbon dates were likewise rejected when not clearly linked to anthropogenic activities as they potentially predate the arrival of human settlers (51, 52).

Three classes were defined, following criteria suggested by prior research into island archaeology (51, 53, 54). The Class 1 designation was assigned to radiocarbon dates conducted by accelerator mass spectrometry (with a label, laboratory name, and number) of short-lived terrestrial samples identified to the level of species, collected from secure cultural layers. Class 2 included unidentified wood charcoal, long-lived terrestrial samples, marine shells identified to the taxon level, and human samples, all from secure contexts and bearing the laboratory name and number. Class 3 included unreliable dates stemming from uncertain cultural layers, and lacking information about context, laboratory, and number. This last class also included samples collected from bulk sediments, dates with a laboratory error of more than 10% mean radiocarbon age, and analyses by the Gakushuin laboratory because of reliability issues (99).

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Local Marine Reservoir Offsets (ΔR) for the Canary Islands. ΔR values compensate local offsets stemming from the global MRE linked to surface waters (100–103). Three ΔR values were established using pairs of strongly associated terrestrial archaeological samples originating from three archaeological contexts and from three different islands (Gran Canaria, El Hierro, and La Palma). A weighted average of ΔR corrections was calculated following DiNapoli et al. (103) to reach a single representative ΔR value applicable to the Canary Islands (*SI Appendix*).

Calibration. The radiocarbon dates of terrestrial samples were calibrated with the IntCal20 curve (104), while those of marine samples were calibrated with the Marine20 curve (101) considering the local marine reservoir corrections (ΔR) of the Canary Islands (*SI Appendix*). The radiocarbon dates of human bones were calibrated by applying an 87%:13% IntCal20/Marine20 curve with a ±10% error to account for a mixed marine and terrestrial diet (*SI Appendix*). The ratio is based on earlier stable isotope analyses of Canarian human remains (105) (*SI Appendix*). This calibration method has proven effective in prior research focused on the initial colonization of islands (51). Additionally, radiocarbon dates on human remains were calibrated using the local marine reservoir corrections (ΔR) specific to the Canary Islands (*SI Appendix*).

Bayesian Analyses. The radiocarbon measurements from Classes 1 and 2 were subjected to Bayesian analyses to obtain reliable estimates for the archipelago's colonization. Bayesian models were thereafter used as simple structural frameworks to investigate the beginnings of human colonization (44, 51). Nonparametric statistical methods based on KDE (106) were applied as an exploratory model to characterize the potential phases of colonization (*SI Appendix*). The radiocarbon dates were subjected to KDE analyses using the KDE_Plot command of the OxCal 4.4 application (67) in combination with a Bayesian phase model to gather the maximum values for the ranges of the human settlement of the islands.

Uncalibrated dates were modeled using single-phase and multiphase Bayesian models with the OxCal 4.4 application (67). As some islands only have a few Class 1 radiocarbon dates, single-phase Bayesian models were developed using both Classes 1 and 2. Calibrated models for each island were developed using OxCal commands (*Sequence*, *Boundary*, *Phase*, and *Difference*) and calibration curves (IntCal20, Marine20, and Mixed) (*SI Appendix*). This method combines the radiocarbon dates in a uniform distribution model-based on the hypothesis that all the dated events have the same likelihood of occurring at any time. Class 1 and Class 2 radiocarbon dates were also modeled using the Charcoal_Outlier model (52, 107, 108). This model tends to yield younger age estimates as the correct age of the modeled events is younger than the nonmodeled calibrated dates (108). The Charcoal_Outlier model assigns charcoal samples a 100% prior probability of being an outlier and adjusts each sample using an exponential distribution to improve the accuracy of the dating process. Lobos and La Gomera were not subjected to this type of Bayesian modeling as none of the analyses were undertaken on unidentified or long-lived charcoal samples. A Charcoal_Plus_Outlier model was also developed to categorize all the Class 1 and Class 2 dates. This model offers a less flexible exponential distribution for outliers as samples with inbuilt ages can yield an exponential end for the old age range (107, 108). Marine and human samples were assigned a 5% prior probability of being outliers as these taxa contain carbon affected by the MRE, leading to an overestimation of dates (*SI Appendix*).

Our study investigated the timeframe of the radiocarbon dates from coastal and inland areas through a Bayesian multiphase model. Coastal sites are defined as less than 4 km from the island shorelines or below 300 m.a.s.l., while inland sites exceed these parameters. The rationale of this approach is that the ethnographic evidence shows that traditional farming populations generally constrain their daily mobility to an area within an hour's travel on foot from the settlements (ca. 4 km) (109).

Data, Materials, and Software Availability. The data and code required to perform the weighted average of ΔR corrections are available in an OSF repository (110). All other data are included in the manuscript and/or *SI Appendix*.

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