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CALIB_SICILY: A NEW RADIOCARBON DATASET FOR PREHISTORIC SICILY. SPATIOTEMPORAL DYNAMICS FROM CA. 6.500 TO 1.500 CAL. BCE

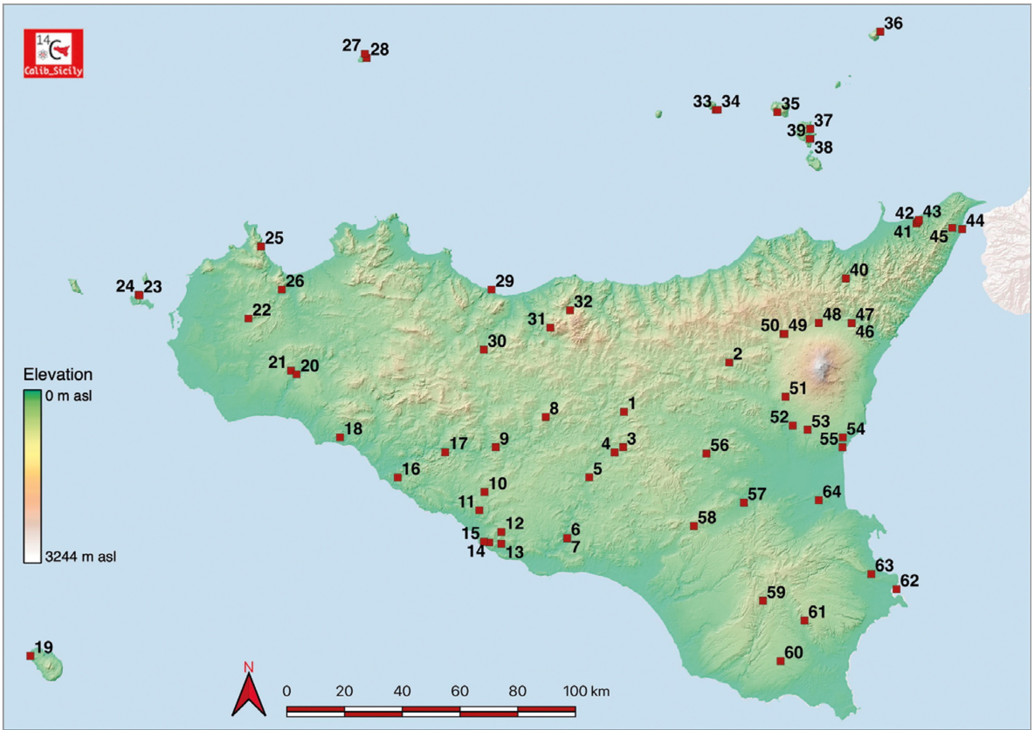
link al dataset: 10.13131/unipi/nqrg-e274

Abstract: The paper aims to introduce a newly updated list of 262 absolute dates available today for the prehistory of Sicily uploaded in the Mappa Open Data repository. The *Calib_Sicily* dataset represents the organic attempt to collect all the AMS and radiocarbon determinations published so far for the period ranging from the Early Neolithic to the Early Bronze Age. For a long time, radiocarbon dates had a limited impact on the definition of the chronologies of prehistoric Sicily. In the last decades, however, many projects have adopted a multidisciplinary approach, including a more extensive reliance on absolute dating. The *Calib_Sicily* dataset has been compiled precisely to register the present state of the art for about 5.000 years (6.500-1.500 cal BCE). It contains, where available, the reference to each sample's cultural, archaeological, and stratigraphic context. Its critical evaluation also evidences a series of blanks in the chronological range, pinpointing geographical areas and specific periods or contexts where it will be necessary to invest resources and investigations. The project consists of two distinct phases. In the first, careful and in-depth research was carried out in the vast literature concerning the island's prehistory, collecting and standardising all the published dates obtained from archaeological sites distributed throughout Sicily and the neighbouring islands. Thanks to the collaborative support of many colleagues, it also contains a series of unpublished dates. *Calib_Sicily* will further develop in a direction currently defined only preliminarily: however, it aims to make resources, specialists, and laboratories available to proceed with a new and exhaustive dating campaign as part of future research on the Sicilian prehistory, as well as to carry out targeted samplings in excavated contexts but never subjected to radiocarbon measurements. The final purpose thus is to increase the number of dates to fill those gaps highlighted in the current dataset through new field research and laboratory analysis, a vital step to revise our understanding of the complex dynamics of the prehistoric occupation of Sicily.

Keywords: Radiocarbon dates, Sicily, Neolithic, Copper Age, Early Bronze Age

1. Introduction

This paper aims to present a newly updated list of 262 absolute dates for the late prehistory of Sicily, obtained from 64 sites (fig. 1). The *Calib_Sicily* dataset represents the organic attempt to collect all the AMS and conventional radiocarbon determinations obtained on the island since the first list was published (Tusa, 1994). For a long time, radiocarbon dates had a limited impact on the definition of the chronologies of prehistoric Sicily. A methodological resistance to their extensive use has its roots, in many cases, in the unawareness of the scientific, mathematical, and statistical basis implied by absolute dating. Many scholars also were very cautious about adopting the radiocarbon method for a more 'philosophical' reason, considering that the first dates obtained in the '70s and '80s often contradicted the chrono-typological schemes defined in those years based on the first stratigraphic excavations conducted on the island.



1 Case Bastione	17 Monte Castello	33 Filo Braccio	49 Balze Soprane, village
2 Casa Sollima	18 Grotta del Kronio	34 La Montagnola	50 Balze Soprane, necropolis
3 Riparo San Tommaso	19 Mursia	35 Rinicedda	51 Contrada Scalonazzo
4 Borgo Cascino	20 Contrada Pergola	36 San Vincenzo	52 San Marco
5 Tornambè	21 Stretto	37 Gabellotto	53 Valcorrente
6 La Muculufa, Sanctuary	22 Casa Mueli	38 Lipari-Acropoli	54 Grotta Petralia
7 La Muculufa, Village	23 Grotta d'Oriente	39 Contrada Diana	55 Catania, Via Teatro Greco
8 Balate-Valle Oscura	24 Grotta del'Ucceria	40 Monte Bammina	56 Contrada Calderone
9 Mezzebi	25 Grotta dell'Uzzo	41 Venetico	57 Rocchicella
10 Scintilia	26 Grotta del Cavallo	42 Grangiara	58 Contrada Molona
11 Grotta Ticchiara	27 Faraglioni	43 San Martino	59 Calaforno
12 Grotta Infame Diavolo	28 Piano dei Cardoni	44 Messina, Is. 158	60 Calicantone
13 Grotta Zubbia	29 Riparo del Castello	45 Camaro	61 Castelluccio
14 Piano Vento	30 Fiaccati-Le Rocche	46 Grotta Marca	62 Siracusa, Piazza Duomo
15 Monte Grande	31 Vallone Inferno	47 Contrada Marca	63 Grotta Palombara
16 Vango del Lupo	32 Abisso del Vento	48 Contrada Ciarambello	64 Valsavoia

fig. 1. Distribution map of the Sicilian prehistoric sites with radiocarbon dates mentioned in the text.

A similar situation also occurred in the rest of Europe at the dawn of the 'radiocarbon revolution' (Renfrew, 1973), although the rapid development of 'scientific' archaeology overcame the resistance to its wider adoption. In Sicily, on the contrary, the persistence of a more traditional historical approach has brought many archaeologists for a long time not to venture into the wild and obscure world of scientific paradigms. However, the situation in the last decades is rapidly changing, with more projects carried out with multidisciplinary approaches, including a more extensive reliance on absolute dating.

The *Calib_Sicily* dataset, therefore, aims to register the present state of the affair. At the same time, its critical evaluation highlights blanks in the chronological range, pinpointing geographical areas and specific periods or contexts where it will be necessary to invest resources

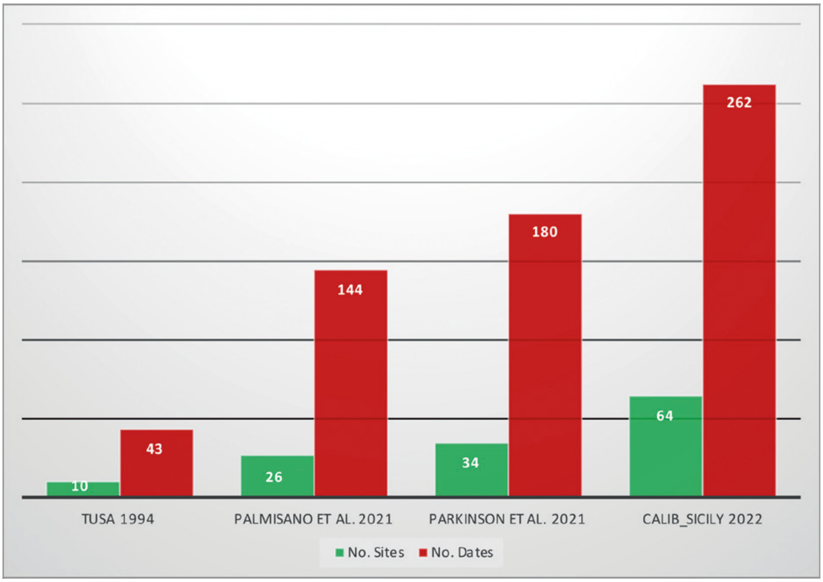


fig. 2. Comparison of published dataset concerning Sicily for archaeological sites and radiocarbon dates in the period 6.500-1.500 BCE.

and investigations. Filling these blanks and gaps through new field research and laboratory analyses is, in fact, vital if we want to upgrade our understanding of the complex dynamics of the prehistoric occupation of Sicily.

The first list of radiocarbon dates for Sicilian prehistory was published less than 30 years ago by Tusa (1994), including 72 dates ranging from the Upper Palaeolithic to the Iron Age: in the list, the dates relevant for the period from the Early Neolithic to the Early Bronze Age are only 43, obtained from 10 sites. Two seminal studies have been recently published, analysing the Sicilian context within the central Mediterranean, including advanced statistical modelling of the available AMS and radiocarbon dates. Palmisano et al. (2021) consider 4010 dates from the various Italian regions: 278 dates concern the entire prehistory of Sicily from the Mesolithic to the Early Iron Age. The dates covering our range are 144, obtained from 26 sites. Parkinson et al. (2021) analysis include 4515 dates from Italy, southern France, Corsica, and Malta. Of these, 233 dates have been listed for Sicily, with 180 dates obtained from 34 sites fitting the *Calib_Sicily* chronological span.

A simple visual analysis of the data discussed in the datasets available for the whole of prehistoric Sicily (including that discussed in this paper) highlights how the number of sites and radiocarbon dates has dramatically increased over the last decades (fig. 2). At the same time, the absolute numbers also show the long way still needed to be done for the research in Sicily before reaching the quantity and quality of radiocarbon dating comparable with that of other regions, such as the Italian peninsula, Malta, but also Iberia (Balsera et al., 2015) and Northern Africa (Lucarini et al., 2020), and those recently produced for specific periods of the Mediterranean prehistory (e.g., Martinelli & Valzolgher, 2011; Natali & Forgia, 2018; Mazzucco & Huet, 2021; Huet et al., 2022).

2. Method and materials

The *Calib_Sicily* dataset comprehends so far 262 dates obtained from 64 sites. The spatial boundaries of the research are easily definable, as comprehend the entire island of Sicily together with the small islands and archipelagos surrounding it. The only exception is for the Pelagie Islands, where a few prehistoric sites are known, all without radiocarbon dates. As for the time range, the dataset covers the period from the mid-7th to mid-2nd millennium cal BCE. These 5000 years have been chosen to keep together different phases of Sicily's human occupation that, however, constitute a homogeneous cultural whole. In this fundamental period, cultural, social, and economic changes and transformations of great importance occurred, such as the start and consolidation of the Neolithic economy and way of life, and then again, the beginning of metallurgy, advanced craft productions, the intensive exploitation of raw materials, such as obsidian, flint, sulphur, rock salt. The development of these economic processes is accompanied by the stabilisation of settlements, the materialisation of formal funerary and ritual spaces, and a growing social hierarchy of the Sicilian communities.

The cultural, economic, and chronological evidence for the Upper Palaeolithic and Mesolithic, with sites predominantly concentrated in the western part of the island, has been recently updated by new and accurate research, also including a growing number of ^{14}C dates (e.g., Lo Vetro and Martini, 2012). As for the cultural developments of the second part of the 2nd millennium BCE, dates are available only from the Middle Bronze Age settlements of Ustica and Madre Chiesa (Holloway and Lukesh, 1995; Castellana, 2000), the Final Bronze Age settlement of Cittadella at Morgantina (Leighton, 1993, 2012) and from the Aeolian Islands (Alberti, 2013; Martinelli, 2020). Different narratives and cultural developments characterise both these periods and, therefore, the 6.500-1.500 cal BCE range is considered here to avoid possible confusion or discussion on unbalanced contexts.

The *Calib_Sicily* dataset includes all known and published archaeological ^{14}C dates within the study area. Thanks to the collaborative support of many colleagues, it also contains a series of unpublished dates. Data were collected from online sources and databases and through an exhaustive in-depth search of published reports, journal articles, books, and conference proceedings. Quality control of the collected evidence has been obtained through a fruitful confrontation with those colleagues who produced the data.

The dataset is uploaded into the *Mappa Open Data* repository (MOD) as an Excel file containing the relevant information for the 262 dates and the 64 sites. It is organised as follows: *ID_site* is a progressive and unique number identifying every single site, also reported in the map of fig. 1. *Name*, *Municipality*, and *Province* refer to the administrative definition of the sites. The geographical distribution of sites in the study area is relatively uniform. However, there is a predominance for the larger eastern Sicily (provinces of Messina, Catania, Ragusa, Syracuse) to central Sicily (Agrigento, Caltanissetta, Enna) and western Sicily (Trapani, Palermo), due also to its longer history of archaeological research (fig. 3A).

Longitude, *Latitude*, and *Altitude* refer to the absolute position of the sites: using the ID_site as the main identifier, these have been positioned on Google Earth for first visual control and georeferenced with coordinates and altitude from the standard decimal WGS84 reference system. The KMZ file has been imported and reprojected into a QGIS project (EPSG 23033 ED50/UTM Zone 33N), using as base map the TINITALY DEM provided by INGV-Pisa, published with a CC BY 4.0 license (Tarquini et al. 2007). The study area boundaries are marked to the West by Mursia at Pantelleria (ID_Site n. 19, 36.81127E-11.92914N), which also marks the southernmost limit. Messina, Is. 158 (n. 44, 38.18347E-15.55714N) indicates the eastern boundary, while the northern one is set at San Vincenzo, Stromboli (n. 36, 38.80185E-15.23597N). As for altitude, the lowest is registered at Contrada Diana, Lipari (n. 39, 8 m asl) and the highest at Balze Soprane on the northern slope of Etna (n. 49, 860 m asl); the average altitude for the 64 sites is 280 m asl.

Elaborated on Lucarini et al. 2020, the localisation *accuracy* is defined on a scale from 1 (highest) to 3 (lowest). Grade 1 is assigned to a precise localisation, based on an absolute controlled positioning extrapolated from the bibliographic reference, for direct positioning with DPGS by the Author or for accurate information obtained directly by colleagues who excavated the sites. Grade 2 is for sites with coordinates not confirmed or based on uncontrolled information from the literature. Grade 3 is for sites lacking coordinates or further information: their position is estimated to be within a range of ± 1000 m. 55 sites have thus a

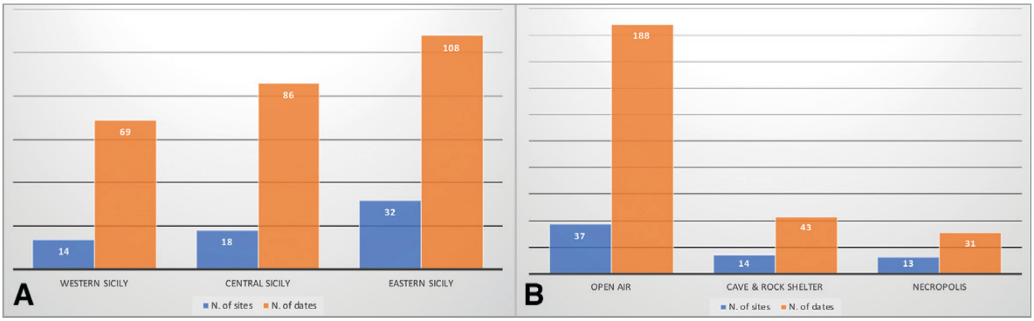
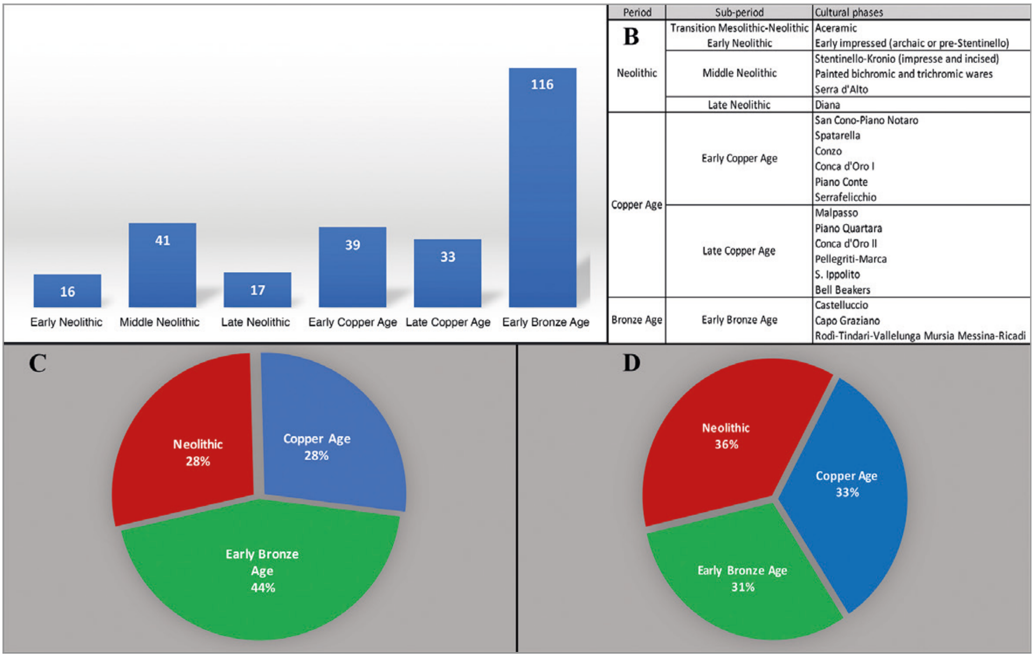


fig. 3. A) Geographical distribution of mentioned sites and dates; B) Site typology distribution of the radiocarbon dates.



Period	Sub-period	Cultural phases
Neolithic	Transition Mesolithic-Neolithic	Aceramic
	Early Neolithic	Early impressed (archaic or pre-Stentinello)
	Middle Neolithic	Stentinello-Kronio (impresse and incised)
		Painted bichromic and trichromic wares
		Serra d'Alto
	Late Neolithic	Diana
Copper Age	Early Copper Age	San Cono-Piano Notaro
		Spatarella
		Conzo
		Conca d'Oro I
		Piano Conte
		Serrafelicchio
	Late Copper Age	Malpasso
		Piano Quartara
		Conca d'Oro II
		Pellegriti-Marca
		S. Ippolito
		Bell Beakers
Bronze Age	Early Bronze Age	Castelluccio
		Capo Graziano
		Rodì-Tindari-Vallelunga Mursia Messina-Ricadi

fig. 4. A) Chronological distribution of the dates; B) Relative chronological scheme adopted in the text; C) Distribution of dates for chronological periods; D) Distribution of sites for chronological periods.

grade 1 of accuracy (85,2%), 5 sites have a grade 2 (7,8%), while only 4 sites have a grade 3 of accuracy (6,3%). The *Context* column contains the indication for the sites' type, with open-air settlement (57,8%), caves and rock shelters (21,9%) and open-air and rock-cut necropolis, also including funerary caves (20,3%) (fig. 3B).

The *Stratigraphic context* column reports the relevant stratigraphic information for each date, obtained and verified through the bibliographic search and, where possible, direct contacts with the excavators. This information is lacking only for the 19 dates from La Muculufa Sanctuary and from the Grotta dell'Infame Diavolo. In the *Periods* and *Cultural phase* columns, the 262 dates are attributed to the traditional chronological framework used in Sicily and to the phases defined by the associated material culture with the samples (fig. 4A-B). Neolithic and Copper Age dates have similar numbers, while 44% of the available samples are from the Early Bronze Age. As for the dated sites, there is a slight predominance of the Neolithic sites over the other two periods (fig. 4C-D).

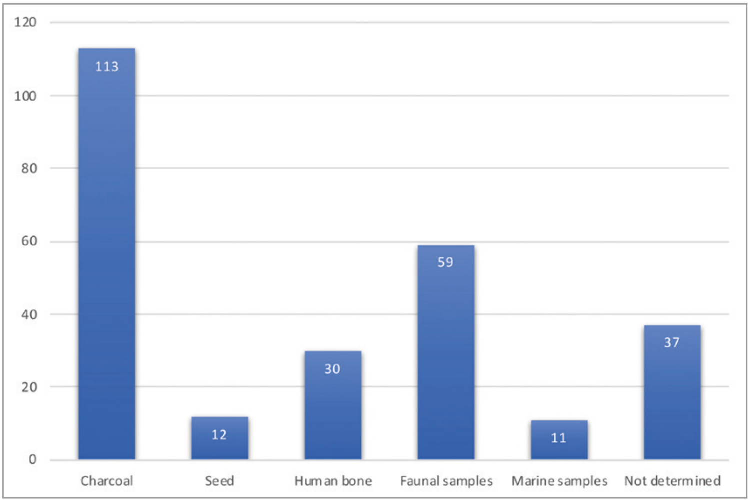


fig. 5. Percentages of material sampled for the AMS and radiocarbon dates.

The 262 AMS and radiocarbon determinations are listed using the conventional lab codes, their uncalibrated BP determination, standard deviation (SD), and the values of the $\delta^{13}C$ isotope when available. Seven samples have been published without lab codes or incomplete information: Grotta Zubbia, one from Piano Vento, Contrada Calderone, Contrada Molona and Calaforno. The oldest date is MAMS-16238 (Grotta dell'Uzzo), while the youngest is LTL-15360A (Valcorrente). As for standard deviation, the dataset includes all published dates, even those with an SD larger than ±100 years. The average SD for the 262 dates is ±57.02, indicating how the Sicilian dataset is still highly influenced by traditional radiocarbon dates, generally showing a larger SD compared with AMS dates, nowadays returning SD ±20-30 years.

As for the dated material, it should be said that at present, there is no information for 37 dates (ca. 14,3%); 43,6% of the dates were obtained from charcoal samples, followed by faunal remains (21,2%), human bones (10%), seeds (4,6%) and marine shells or fish bones (4,2%) (fig. 5), with the latter obtained mainly from the Early Neolithic layers of Grotta dell'Uzzo, except for two marine samples from Grotta d'Oriente and San Vincenzo. A critical limitation of the dataset is represented by the almost complete absence of recognised taxa for most charcoal samples: only 18% have identified taxa. This issue could be crucial for the calibration process, quantitative age-modelling, and a correct interpretation of the data.

The following columns of the spreadsheet report the calibration results as unmodelled calendar dates. All the raw dates have been calibrated with OxCal 4.4 (https://c14.arch.ox.ac.uk/oxcal/OxCal.html, Bronk Ramsey, 2009) using the IntCal20 curve (Reimer et al., 2020) for the terrestrial samples and the Marine13 curve (Reimer et al., 2013) for the marine samples. As for the latter, the calendar ages of marine shells were corrected for the reservoir effect using the correction factor calculated by Siani et al. (2001) for Sicily (ΔR = 71±50). The calendar ages of fish bones were corrected for the reservoir effect using the correction estimated by Reimer, McCormac (2002) for the Mediterranean basin (ΔR = 58±85). The dates have been calibrated at 1 sigma (68,2%) and 2 sigmas (95,4%) confidence; BC and BP dates are reported together with the median value for each sample.

Some caution should derive from the unidentified samples, even if there is a high probability that they are all terrestrial samples. Another problem could be the calibration of human bones, particularly those yielded in coastal contexts since data about the food habits of those communities are largely missing. At Grotta dell'Uzzo, OxA-V-2364-43 was obtained from human bones belonging to an individual with a diet based on 40% of marine resources (fish), as proved by stable isotopes analysis (Mannino et al., 2015). The calibration performed at 60% with IntCal20 and 40% with Marine13 (ΔR = 58±85) returned a date almost 200 years younger than that performed using only IntCal20. Finally, the *References* column contains the condensed references used to collect the dates, with a separate RTF file containing the complete bibliographic list also uploaded in the MOD.

3. Preliminary comments on spatiotemporal dynamics for prehistoric Sicily

The 262 dates presented in the *Calib_Sicily* dataset suggest some preliminary comments on the spatiotemporal dynamics of the human communities who lived in Sicily during the 5000 years analysed. However, some cautions should be used because of the low number of ^{14}C dates, especially if the dataset is confronted with those currently available for the Mediterranean basin (see above).

For example, the 74 dates covering the Sicilian Neolithic (fig. 4A) have been obtained from only 26 sites. The known Neolithic sites on the island are today about 326, of which 108 have been excavated in one way or another, with the rest being attributed to the Neolithic only through the visual classification of ceramics collected from surface surveys (Giannitrapani, in press). Therefore, 24% of the excavated sites have been radiocarbon dated, which is only 8% of the total known Neolithic sites. Any interpretation of the evidence for this crucial period of Sicilian prehistory should be then implemented with new research and dating. At the same time, any attribution based solely on material culture analysis should be taken very prudently, if not rejected at all.

The quantitative analysis of the Neolithic dates highlights a qualitative problem, also concerning the whole Sicilian prehistory. The 16 dates defining the Early Neolithic have been obtained from only three sites: 14 dates from Grotta dell'Uzzo and 1 date each from Grotta d'Oriente and Grotta del Kronio. Middle Neolithic sites have returned an average of 2,8 dates each, with only 1,7 dates per site for the Late Neolithic. Similar figures can also be calculated for the other periods: 3,8 dates per site for the Early/Middle Copper Age, 1,9 for the late Copper Age, and 4,1 for the whole Early Bronze Age. It is evident, therefore, how archaeologists consider as fulfilled their 'absolute dating' duty by measuring each site only with a few dates, often on the false assumption that a determination indicates a precise point in time, enough to define the absolute chronology for that specific site or event. However, radiocarbon dates are 'simply' statistical estimations of the quantities of ^{14}C isotopes preserved in the organic sample after its death. That statistical count cannot mark a precise point in the time scale: to have reliable confidence in the validity of a radiocarbon determination, this must be converted to calendar age equivalents using a calibration curve compensating for fluctuations in atmospheric ^{14}C concentration (Reimer et al., 2020) and then modelled with other dates from the same event, feature, or layer within secure stratigraphies (Bronk Ramsey, 2009), provided the possibility to sample enough organic materials. It is not a case that the most reliable dated contexts are those sites, such as Grotta dell'Uzzo, Case Bastione, Filo Braccio, or Mursia, with more than 15-20 stratigraphically defined dates each.

Applying advanced statistical analyses (e.g., Bayesian, SPD, KDE modelling) to the *Calib_Sicily* dataset is out of the scope of this contribution, and it has been postponed to the subsequent development of the project. However, a specific case study is discussed here to demonstrate the potential usefulness of radiocarbon dates and their modelling for a more sensible interpretation of the dynamics of Sicilian prehistoric communities.

The current narrative for the passage from the Late Neolithic to the Early Copper Age considers these two periods as chronologically sequential. As traditionally proposed, radical changes in the cultural and economic structures within the Mediterranean basin, including Sicily, should have occurred at the end of the Neolithic. These changes should be evidenced by the rapid adoption of metallurgy, new pottery styles, and the wide diffusion of hypogeic funerary architectures and megalithic ritual monuments. In large part of current literature, the Sicilian Copper Age is still framed within the 3rd millennium BCE as suggested by Luigi

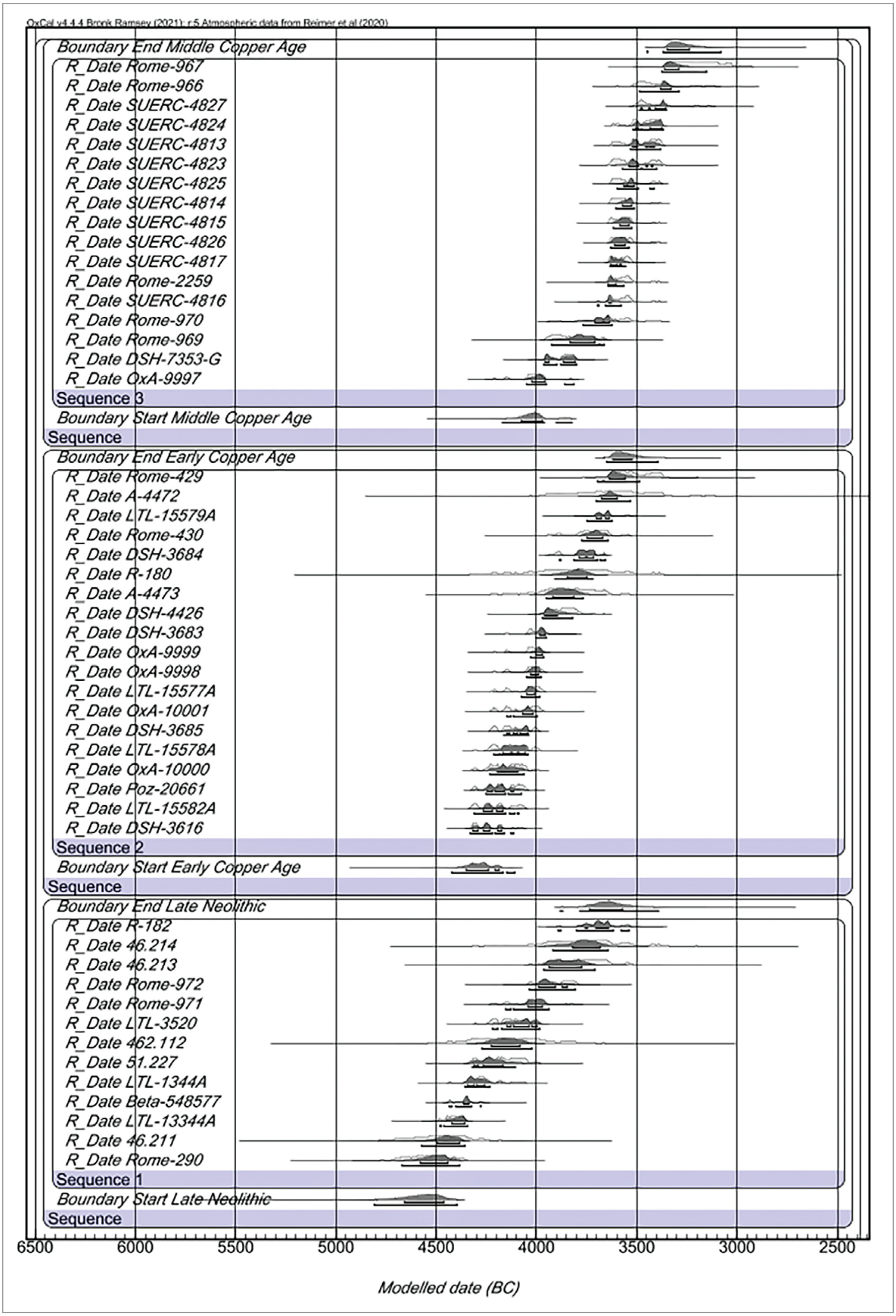


fig. 6. Phase modelling results showing the probability distribution of radiocarbon dates for the overlapping Late Neolithic and Early-Middle Copper Age phases.

Bernabò Brea more than 60 years ago (Bernabò Brea, 1958). Together with the 17 dates defining the Late Neolithic, 20 dates are currently available for the Early Copper Age, 19 for the middle, and 32 for the Late Copper Age. The unmodelled calibration of these dates frames the entire Copper Age from the late 5th to the end of the 3rd millennium cal BCE.

In Bayesian modelling, the *Boundary* command identifies an event that has not been directly dated and estimates a probability distribution for its occurrence based on the known dates included in the phases preceding and following the event (Bronk Ramsey 2009). Modelling in this way the Late Neolithic, Early, and Middle Copper Age sequences, the hypothesis according to which these follow each other is contradicted since they overlap for a large part of their duration (fig. 6). In Bayesian models, an agreement of 60.0 or higher is considered an acceptable result: in this case, the values range between 97.2 and 98.4, indicating the high reliability of the model.

The typological-classificatory paradigm employed to study Sicilian prehistory has traditionally provided the conceptual basis for the various definitions used to divide and organise the slow evolution of human time, such as Palaeolithic, Neolithic, Bronze Age. These definitions have taken on different meanings, from the technological one (chipped vs smoothed stone) to the typological and the economic ones (presence or absence of agriculture, trade, metallurgy), trying to attribute a meaning to the transformations and changes highlighted by the study of material culture. Despite having played a significant role in the past, they have now become epistemological tools no longer helpful to understand the complexity of the prehistoric societies of the island. This approach has taken an absolute value over time, effectively denying the possibility of reading the graduality and the slow transformation that characterises those ancient societies. It has brought the need to build chronological grids based not so much on consistent series of absolute datings but on the sequences of some key sites, often excavated without the rigorous use of the stratigraphic method. Furthermore, the study of ceramics, with changes in shape and style indicative a priori of cultural changes, has led to the definition of entire periods even in the absence of specific evidence that testifies the passage from one phase to the other.

According to the Bayesian model, human groups referring to diverse cultural traditions lived in Sicily in the period ranging from mid-5th to mid-4th millennium cal BCE (fig. 7). On one side, communities were characterised by the red-slipped Diana wares, burying their dead in earthen pit graves with single crouched depositions. At the same time, groups using the black incised San Cono-Piano Notaro pottery, the painted Conzo pottery and plain wares decorated with applied ribbons, clay bubbles, and small vertical ledge handles were also active. In central and eastern Sicily, these wares are also associated with ceramics decorated with the Spatarella style graffito patterns. Their funerary habits see the use of shaft graves cut in the bedrock with the deposition of one or two supine individuals, even if cases with secondary depositions are attested.

As for the domestic architecture, very little is known about the Diana communities, while the second group lived in long houses with the perimeter defined by post holes or rock-cut channels (Giannitrapani, 2018). The information on their economic or craft activities is still very scanty, but metallurgy in this phase is still absent. It has been preliminarily suggested that both groups relied on a pastoral mode of production. Evidence for these two contemporaneous groups has been collected on the whole island, but a geographical distinction can be suggested despite the low number of dated contexts (fig. 8), with sites of the first group concentrated mainly in central-eastern Sicily and those of the second group in the southern-western part of the island.

A further issue concerns the so-called Middle Copper Age that, according to the Bayesian model, cannot be identified as a standing alone cultural phase, defined by the painted black on red wares of the Serraferlicchio style. The consistency of this phase has already been questioned based on the stratigraphic and typological analysis of the evidence from the main sites where this peculiar ceramic has been found, starting from the eponymous site near Agrigento (Maniscalco, 2007; Adamo & Gullì, 2012). Leighton (1999) has proposed to divide the Sicilian

Late Neolithic	from	to	median	A%	Early Copper Age	from	to	median	A%	Middle Copper Age	from	to	median	A%
Start	4658	4461	4567	97.5	Start	4348	4188	4282	97.2	Start	4077	3972	4022	97.9
End	3737	3570	3640	98.4	End	3625	3517	3563	98.1	End	3347	3236	3282	98,0

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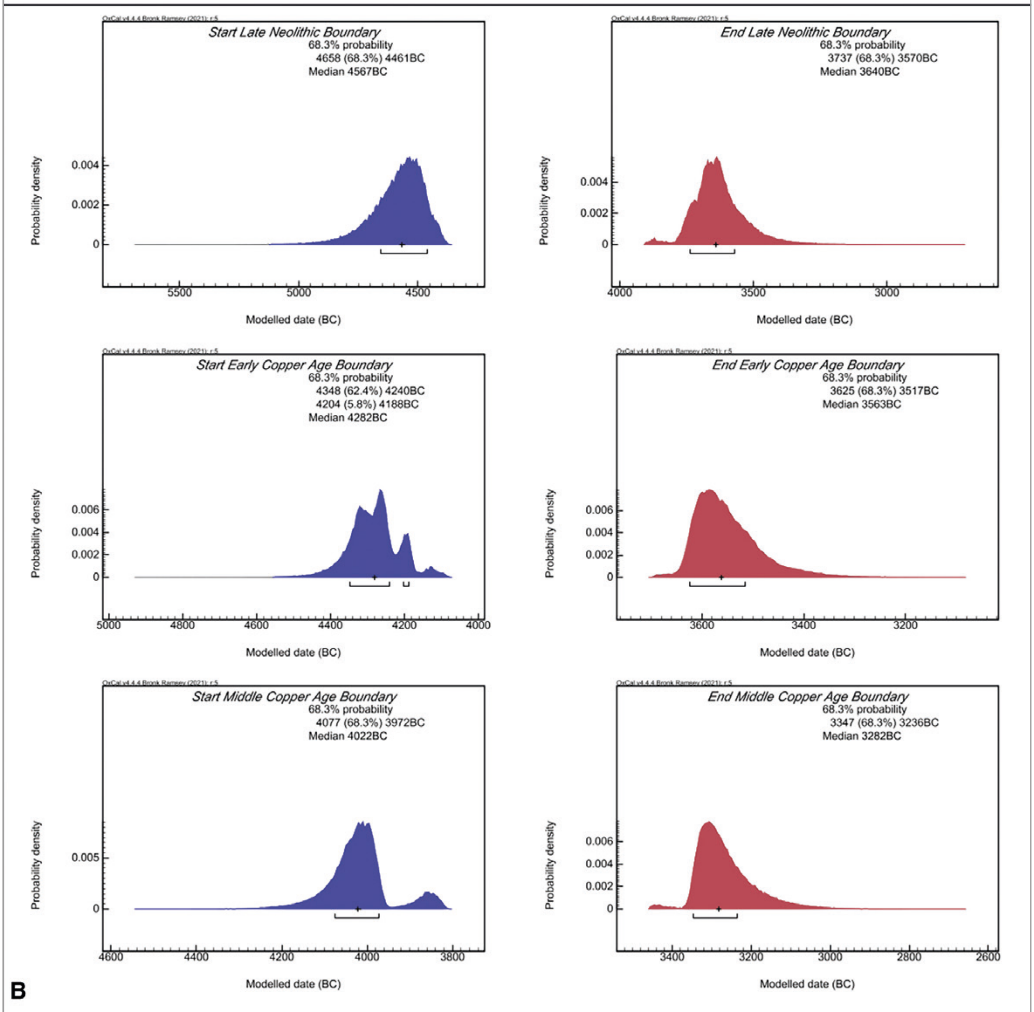


fig. 7. Bayesian sequence boundaries for the Sicilian Late Neolithic and Early-Middle Copper Age: A) tables; B) SPD.

Copper Age into only two sub-phases, with the earliest still connected with the late Neolithic cultural and social developments and the latest anticipating the following Early Bronze Age.

Such a hypothesis is now confirmed by the modelling of radiocarbon dates available from sites returning Serraferlicchio wares, often associated with those of the Piano Conte style. The modelled dates indicate how these two pottery styles started to diffuse on the island at the end of the 5th millennium cal BC, contemporaneously with the advanced development of the Diana and San Cono-Piano Notaro wares, and lasted until a few centuries after their end, around 3400 cal BC (figs. 7-8). Therefore, the Early and Middle Copper Age can be considered as two cultural traditions defined by different ceramic styles, whose formal and stratigraphic boundaries appear, however, rather blurred (Maniscalco, 2007). From an absolute chronological

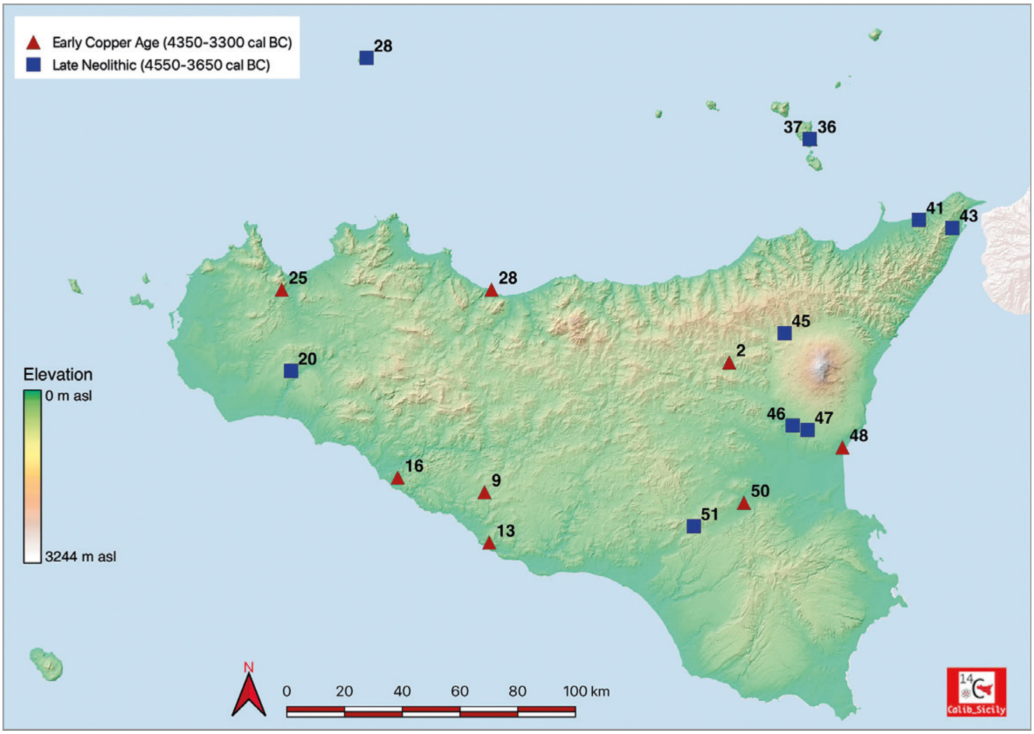
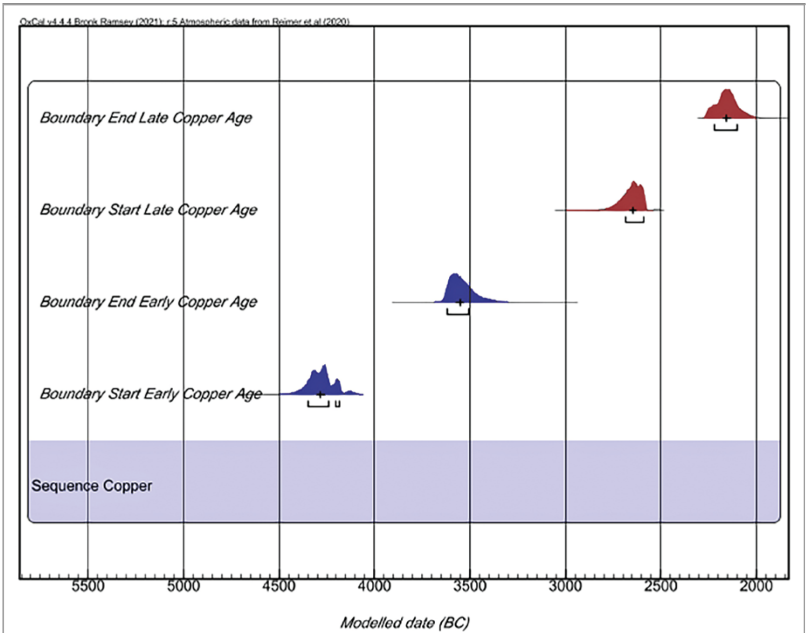


fig. 8. Distribution map of Late Neolithic and Early-Middle Copper Age sites.



Early Copper Age	?	Late Copper Age
start 4350-4290 cal BC		**start** 2680-2590 cal BC
end 3620-3510 cal BC		**end** 2220-2100 cal BC

fig. 9. Bayesian sequence boundaries for the Sicilian Early-Middle and Late Copper Age.

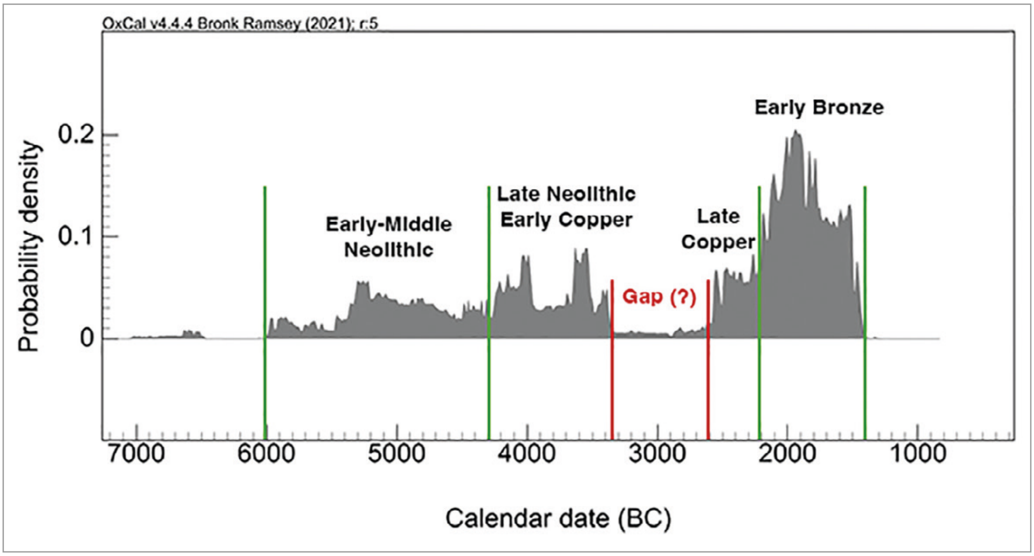


fig. 10. Summed distribution curve of the AMS and radiocarbon dates discussed in the tex.t

point of view, they developed almost simultaneously on the island, defining a period of about 700 years from the end of the 5th to the second half of the 4th millennium cal BC (fig. 9). This phase still needs to be better characterised with more consistent evidence for its cultural, economic, and social structures.

It precedes the Late Copper Age, lasting about 450 years from ca. 2600 to 2200 cal BC, characterised by impressive demographic growth, greater stability of the communities, evidenced by the appearance of substantial household clusters, and intensification of subsistence activities (Giannitrapani, 2018). These were increasingly focused on agricultural production, accompanied by specialised pastoralism with a significant role in the so-called secondary products and the exploitation of natural resources and raw materials, such as sulphur and rock salt, used as exchange goods to obtain resources, new technologies, and prestigious items, such as Bell Beakers, to affirm and consolidate rising authorities (Giannitrapani, 2009). In this context, new productions, such as weaving, secondary products, and metallurgy, played an increasingly incisive role in the constitution and organisation of new forms of labour and more complex articulation of the social forces, with an increase in emerging stratification and social inequality (Giannitrapani & Iannì, 2020).

The modelled dates for the Sicilian Copper Age leave therefore a gap of about 800 years. Looking at the probability density curve obtained summing all the unmodelled dates, it is possible to observe how the sequence shows a significative gap between ca. 3500 and 2700 cal BC (fig. 10). Is this gap due to a lack of research and dating? Or is it real? If the latter is true, how can we explain it? Does it correspond to a demographic crisis due to paleoclimatic changes preceding the Late Copper Age expansion? Or the archaeological evidence is now less visible because of the development of a more mobile settlement pattern, possibly caused by an intensification of pastoral activities, making the archaeological record less visible? (Speciale et al. submitted)

4. Conclusion

To the questions posed at the end of the last section and to others stemming from the analysis of the *Calib_Sicily* dataset, we can only answer by intensifying targeted field research, accompanied by more extensive use of bioarchaeological and archaeometric analysis.

Calib_Sicily will further develop in a direction currently defined only preliminarily: however, it aims to make resources, specialists, and laboratories available to proceed with a new and exhaustive dating campaign as part of future research projects on the Sicilian prehistory, offering the possibility of including a more extensive implementation of radiocarbon dating. The aim is to fill those gaps in geographical areas, site typologies, and chronological phases evidenced in the dataset. It could also be incremented through a targeted sampling strategy focused on excavated sites but never subjected to radiocarbon measurements, concentrating on samples yielded by controlled contexts. Of course, this would be more effective through collaborative and shared projects within the scientific community working on Sicilian and Mediterranean prehistory, adopting the concept of open data proposed by the Mappa Project.

The *Calib_Sicily* dataset can be used to produce advanced statistical modelling and more effective integration with economic and cultural data, aimed at a more contextual narrative of spatiotemporal dynamics for prehistoric Sicily. The dataset can also be usefully linked with the large radiocarbon databases published in recent years within the Mediterranean basin. Colleagues who wish to share freshly published archaeological ^{14}C dates or report any missing or incorrect information in the published dataset are welcome to contact the Author (e.giannitrapani1@gmail.com).

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References

Adamo, O. & Gullì, D. (2012). La ceramica Serraferlicchio da Serraferlicchio. In *Dai Ciclopi agli Ecisti. Società e Territorio nella Sicilia Preistorica e Protostorica*, *Atti della XLI Riunione Scientifica dell'IIPP* (pp. 601-609). Istituto Italiano di Preistoria e Protostoria.

Alberti, G. (2013). A Bayesian 14C chronology of Early and Middle Bronze Age in Sicily. Towards an independent absolute dating. *Journal of Archaeological Science, 40*, 2502-2514.

Balsera, V., Bernabeu Aubán, J., Costa-Caramé, M., Díaz-del-Río, P., García Sanjuán, L. & Pardo, S. (2015). The radiocarbon chronology of Southern Spain's late prehistory (5600-1000 cal. BC): a comparative review. *Oxford Journal of Archaeology, 34 (2)*, 139-156.

Bernabò Brea, L. (1958). *La Sicilia prima dei Greci.* Il Saggiatore.

Bronk Ramsey, C. (2009). Bayesian analysis of radiocarbon dates. *Radiocarbon, 51(1)*, 337-360. https://doi.org/10.1017/s0033822200033865

Castellana, G. (2000). *La Cultura del Medio Bronzo nell'Agrigentino ed i Rapporti con il Mondo Miceneo*. Museo Archeologico Regionale di Agrigento.

Giannitrapani, E. (2009). Nuove considerazioni sulla presenza in Sicilia del Bicchiere Campaniforme. *Rivista di Scienze Preist*oriche, *LIX*, 219-242.

Giannitrapani, E. (2018). Le case dei vivi e le case dei morti. Architettura domestica e funeraria nella Sicilia centrale tra il IV e il II millennio a.C. *Rivista di Scienze Preistoriche, 68*, 191-228.

Giannitrapani, E. (in press). Nuove riflessioni sul Neolitico della Sicilia tra limiti metodologici, contesti archeologici e prospettive di ricerca. *Periplous: Il mare nella Preistoria mediterranea. LVII Riunione Scientifica dell'IIPP.* Syracuse, 19th-22nd October 2022.
Giannitrapani, E. & Iannì, F. (2020). Demographic dynamics, paleoenvironmental changes and social complexity in the late prehistory of central Sicily, in T. Lachenal, R. Roure & O. Lemercier (eds.), *Demography and Migration. Population Trajectories from the Neolithic to the Iron Age* (pp. 43-64). Archaeopress.
Holloway, R. R. & Lukesh, S. S. (1995). *Ustica I. Excavations of 1990 and 1991*. Center for Old World Archaeology and Art, Brown University – Université de Louvain.
Huet, T., Cubas, M., Gibaja, J.F., Oms, F.X. & Mazzucco, N. (2022). NeoNet Dataset. Radiocarbon Dates for the Late Mesolithic/Early Neolithic Transition in the North Central-Western Mediterranean Basin. *Journal of Open Archaeology Data*, *10*. http://doi.org/10.5334/joad.87
Maniscalco, L. (2007). Considerazioni sull'età del Rame nella media valle del Platani (Sicilia). *Rivista di Scienze Preistoriche,57*, 167-184.
Mannino, M. A., Thomas, K. D. (2007). New radiocarbon dates for hunter-gatherers and early farmers in Sicily. *Accordia Research Papers*, 10, 13-34.
Martinelli, M. C. (2020). *Isole Vicine. L'Arcipelago delle Isole Eolie e le Comunità Umane nella Preistoria Mediterranea*. Edizioni di Storia e Sudi Sociali.
Mazzucco, N. & Huet, T. (2021). NeoNet radiocarbon database version 1, Università di Pisa http://doi-org/10.13131/archelogicadata-yb11-yb66
Leighton, R. (1993). *The Protohistoric Settlement on the Cittadella, Morgantina Studies, Vol. IV*. Princeton University Press.
Leighton, R. (1999). *Sicily Before History. An Archaeological Survey from the Palaeolithic to the Iron Age.* Duckworth.
Leighton, R. (Ed.). (2012). *Prehistoric Houses at Morgantina. Excavations on the Cittadella of Morgantina in Sicily 1989-1994*, Accordia Specialist Studies on Italy vol. 15.
Lo Vetro, D. & Martini, F. (2012). Il Paleolitico e Mesolitico in Sicilia. In *Dai Ciclopi agli Ecisti. Società e Territorio nella Sicilia Preistorica e Protostorica*, *Atti della XLI Riunione Scientifica dell'IIPP* (pp. 19-47). Istituto Italiano di Preistoria e Protostoria.
Lucarini, G., Wilkinson, T., Crema, E. R., Palombini, A., Bevan, A & Broodbank, C. (2020). The MedAfriCarbon radiocarbon database and web application. Archaeological dynamics in Mediterranean Africa, ca. 9600-700 BC. *Journal of Archaeological Data, 8 (1)*. https://doi.org/10.5334/joad.60
Martinelli, N. & Valzolgher, E. (2011). Date radiometriche dell'età del Rame dall'Italia centrale e settentrionale: un bilancio critico. In *L'Età del Rame in Italia, Atti della XLIII Riunione Scientifica dell'IIPP* (pp. 33-38). Istituto Italiano di Preistoria e Protostoria.
Natali, E. & Forgia V. (2018). The beginning of the Neolithic in Southern Italy and Sicily, *Quaternary International* 470: pp. 253-269. https://doi.org/10.1016/j.quaint.2017.07.004
Palmisano, A., Bevan, A., Kabelindde, A., Roberts, N. & Shennan, S. (2021). Long-term demographic trends in prehistoric Italy: climate impacts and regionalised socio-ecological trajectories. *Journal of World Prehistory*. https://doi.org/10.1007/s10963-021-09159-3
Parkinson, E. W., McLaughlin, T. R., Esposito C., Stoddart, S. & Malone, C. (2021). Radiocarbon dated trends and central Mediterranean prehistory. *Journal of World Prehistory*. https://doi.org/10.1007/s10963-021-09158-4
Reimer, P. & McCormac, G. (2006). Marine Radiocarbon Reservoir Corrections for the Mediterranean and Aegean Seas. *Radiocarbon, 44 (1)*, 159. https://doi.org/10.1017/s0033822200064766
Reimer, P., Bard, E., Bayliss, A., Beck, J., Blackwell, P., Ramsey, C., . . . Van der Plicht, J. (2013). IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0-50,000 Years cal. BP. *Radiocarbon, 55 (4)*, 1869-1887. https://doi.org/10.2458/azu_js_rc.55.16947
Reimer, P., Austin, W., Bard, E., Bayliss, A., Blackwell, P., Bronk Ramsey, C., . . . Talamo, S. (2020). The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0-55 cal. BP). *Radiocarbon, 62 (4)*, 725-757. https://doi.org/10.1017/RDC.2020.41
Renfrew, C. (1973). *Before Civilization: The Radiocarbon Revolution and Prehistoric Europe*. Jonathan Cape.
Siani, G., Paterne, M., Michel, E., Sulpizio, R., Sbrana, A., Arnold, M. & Haddad, G. (2001). Mediterranean Sea surface radiocarbon reservoir age changes since the last glacial maximum. *Science, 294 (5548)*, 1917-1920. https://doi.org/10.1126/science.1063649
Speciale, C., Giannitrapani, E., Mercuri, A.M., Florenzano, A., Sadori, L. & Combourieu-Nebout, N. (in prep.). Sicily between Middle Neolithic and the beginning of the Iron Age (7.5-2.8 cal ka BP) as a Mediterranean critical study in the establishment of the agricultural landscape. *Human Ecology*, (submitted)
Tusa, S. (1994). Cronologia assoluta e sequenza culturale nella paletnologia siciliana. In R. Skeats & R. Whitehouse (eds.), *Radiocarbon Dating and Italian Prehistory* (pp. 99-114). Accordia Specialist Studies on Italy vol. 3 – Archaeological Monographs of the British School at Rome, vol. 8.