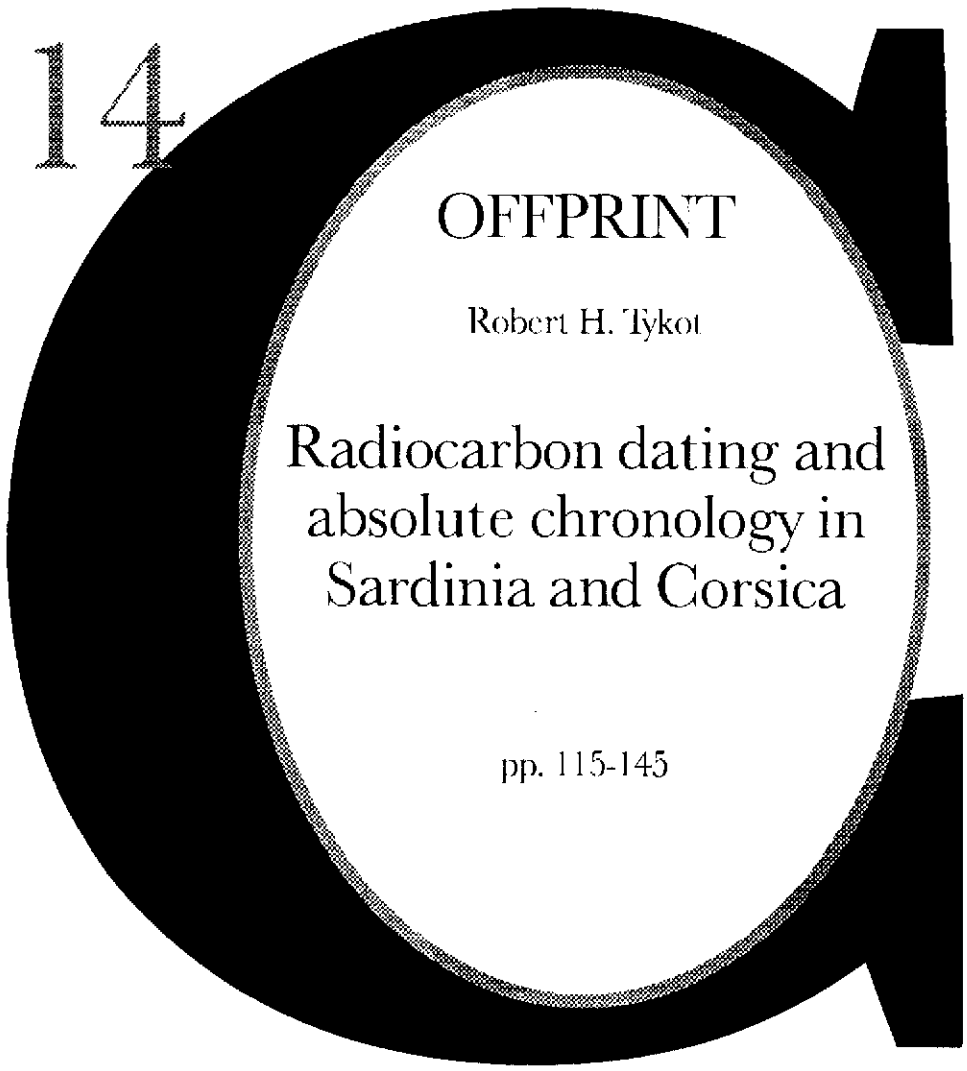
Radiocarbon Dating and Italian Prehistory

Edited by Robin Skeates and Ruth Whitehouse



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Radiocarbon dating and absolute chronology in Sardinia and Corsica

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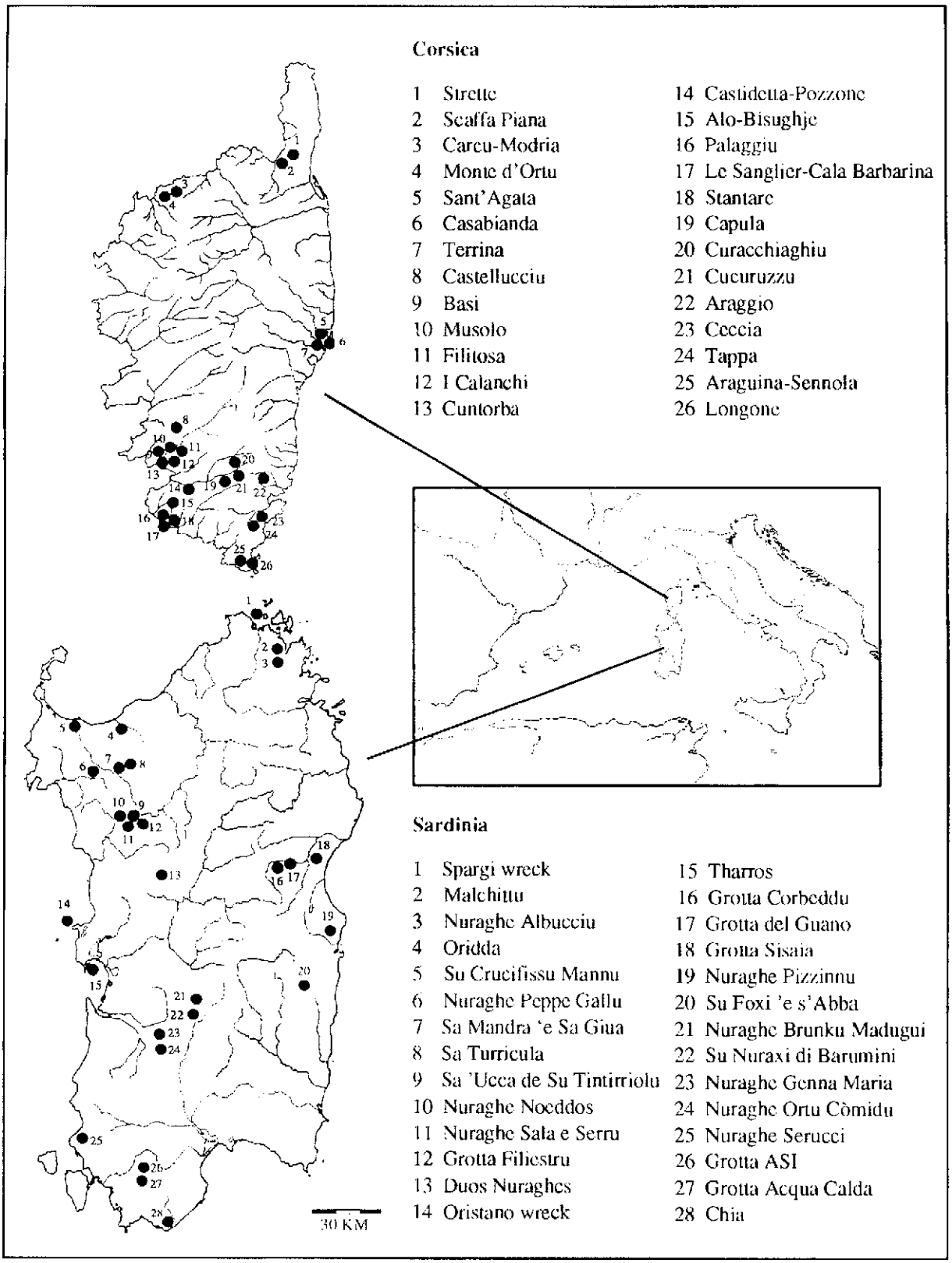
Introduction

The island of Sardinia, considered to have been outside the mainstream of Mediterranean prehistory until the last quarter of this century, is now recognised as having had a rich indigenous culture dating from at least the Mesolithic, if not the Upper Palaeolithic. Furthermore, it has become apparent that there was considerable interaction between Sardinia and mainland Europe throughout the Neolithic, and with both the Iberian Peninsula and the eastern Mediterranean in the Bronze Age. Establishing an absolute chronology for Sardinia is important, therefore, not only as a measure of Sardinian cultural development, but also as an independent assessment of regional chronological sequences. Such independent testing is necessary to address Mediterranean-wide issues such as early island settlement (Cherry 1990), and to confront some recent challenges to conventional chronology (e.g. James *et al.* 1991; Manning 1994). In this paper, I present the currently available radiocarbon data for Sardinia and to a certain extent Corsica, since the prehistory of these neighbouring islands is closely related (fig. 1). Tables 1 and 2, which list the radiocarbon dates for Sardinia and Corsica respectively, can be found at the end of the paper. Using the latest calibration curves, I outline an absolute chronology for the Sardinian cultural sequence.[1]

Our knowledge of Sardinian prehistory has benefitted in the past three decades not only from the use of absolute dating methods (mainly radiocarbon dating, plus some obsidian hydration), but also from an explosion of archaeological research. Of the 12 sites of the Early Neolithic, 15 of the Middle Neolithic, and 125 of the Late Neolithic known today (Lilliu 1988: 31; Atzeni 1981), only 47 were known in 1963, and 46 of them were considered Chalcolithic (Lilliu 1963: 28-9)! It would appear, however, that radiocarbon dating has been employed much less frequently in Sardinia than on the Italian mainland (cf. Allegri *et al.* 1987; Skeates, this volume). Burleigh (1984: 280) writes that 'it is evident at once that the overall coverage by radiocarbon dating of the western Mediterranean islands is exceptionally poor in relation to their total area and archaeological interest and importance.' A decade later, this situation has been addressed in the Balearic Islands (Waldren 1991), with little progress elsewhere. In Sardinia, only David Trump, working at three sites in the Bonu Ighinu Valley (Mara-SS), and Paul Sondaar's team excavating at Grotta Corbeddu (Olièna-NU) have produced series of radiocarbon dates from stratigraphic excavation contexts (Switsur & Trump 1983; Trump 1990; Switsur 1990; Klein Hofmeijer *et al.* 1987; 1989; Sondaar *et al.* 1984). In fact, only a dozen other dates have been published in the last ten years, mostly by American or Israeli investigators.[2]



1 Radiocarbon dated sites in Sardinia and Corsica.

It is unfortunate that so few archaeologists working in Sardinia have made use of radiocarbon dating, since this technique could make a significant contribution towards resolving several current archaeological issues. Certainly, the first 'radiocarbon revolution' (Renfrew 1973) had as much impact on early Sardinian chronology as elsewhere in Europe. By the late 1960s, Cardial Impressed Ware sites in Corsica and Sardinia were dated to at least 5000 BC; similarly, when the first radiocarbon dates for the Ozieri culture became available (Castaldi 1972), they were a millennium earlier than expected even before calibration! The second radiocarbon revolution, the use of dendrochronological data to calibrate radiocarbon dates into calendar ages, has been accepted more slowly (but see Lazrus 1992: 28-41). Contu (1980; 1982; 1988; 1992) has made full use of calibrated radiocarbon dates to derive an absolute chronology for Sardinia, but the newer calibration data (i.e. *Radiocarbon* 28B[1986]) were not yet available at the time his most recently published works were written (cf. Contu 1992: n. 12). The often-cited chronologies published by Lo Schiavo (1986: 20), Atzeni (1987), Lilliu (1988: 17-18), and others (cf. Balmuth 1992b: 668) are also based only on half-life corrected (raw date x 1.03) or at best calibrated dates using the now obsolete MASCA or Tucson tables. Using current calibration curves (i.e. *Radiocarbon* 35:1[1993]), the Middle and Late Neolithic can confidently be dated at least several hundred years earlier, while the dates for the Bronze Age and the earliest nuraghi towers can also be pushed back at least a few hundred years. I attempt here to make the most of the available data, but I strongly encourage archaeologists working in Sardinia to collect charcoal, bone, and other datable samples in the course of their excavations, and to collaborate with dating laboratories in their analysis, interpretation, and publication.

Radiocarbon dates and calibration

In Tables 1 and 2, the *Radiocarbon* reference for dates is given whenever possible, even if the result was first published elsewhere. It is unfortunate for several reasons that radiocarbon laboratories have not kept up with the publication of date lists: (1) it is impossible for anyone without knowledge of and access to publications with limited circulation (of which there are all too many in Italy) to compile a thorough list of radiocarbon determinations (e.g. Brown 1992); (2) many of the citations in the archaeological literature do not include the full date information (i.e. lab number, uncalibrated date, error, material) necessary for calibration purposes; and (3) there appear to be a number of errors in citation of dates in the archaeological literature (cf. Lilliu 1967: 366, and Contu 1980: 18; 1992 n. 12 for the various citations of K-151 [1470 bc], revised from 1270, but then reported in some cases as 1460; Delibrias & Évin 1975: 284 and Delibrias *et al.* 1976: 881 refer to Gif-797 when they mean Gif-795, and the latter have a few other numerical errors; Delibrias *et al.* 1982: 186 list MC-1296 as charcoal, while Camps 1988a: 135 gives it as shell; Camps 1978: 15 and Lewthwaite 1983: 182 switch the data for Gif-2324 and Gif-2325; Camps 1979: 18 and Lewthwaite 1983: 182 give the age for MC-2075 as 2540 bc instead of 2740 bc; in Sondaar *et al.* 1984: 32, and hence Cherry 1990: 172, 176 and Lazrus 1992: 34, GrN-11435 should be GrN-11405; Camps 1988a: 266 mis-cites several of the lab errors; Lilliu 1988: 19 cites Q-3029 as Q-3030; Cherry 1990: 172 reports Ly-2837 [9140 BP] as Ly-2867 [9080 BP], and on p. 182 cites Gif-1851 as 7520 ± 150 BP instead of 7700 ± 150 BP; and Ferrarese Ceruti & Lo Schiavo 1992: 138 refer to Gif-242 as 1200 bc instead of 1220 bc). The scattered and incomplete citation of dates, and the errors associated with them, point out the need for all radiocarbon laboratories to continue publishing date lists.

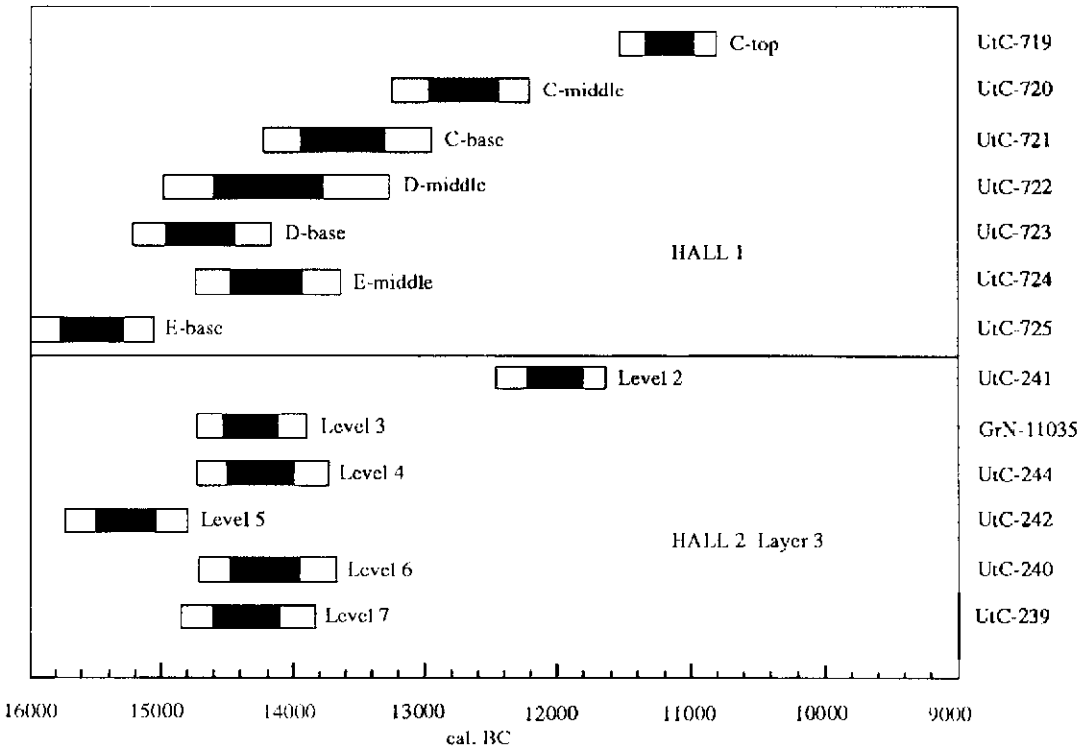
All of the Sardinian and Corsican radiocarbon dates have been calibrated using the Calib

age range (intercept[s] in parentheses), and bibliographic reference presented in Tables 1 and 2. The block plots in figs 2-9 were generated by the Calib 3.0.3 program. For charcoal and bone collagen samples, the bidecadal atmospheric/inferred atmospheric curve has been used up to 18,360 ^{14}C years BP; for shell, the marine calibration curve has been used up to 18,760 ^{14}C years BP. No additional lab error multipliers or systematic offsets have been used, and no additional correction for isotopic fractionation has been added. For best results, radiocarbon determinations on bone collagen from humans (or animals) with mixed terrestrial/marine diets (i.e. those living in island or coastal environments) should be interpolated based on the per cent marine carbon in the dated sample: a calibrated radiocarbon age, if determined without any marine correction, would be too old by about 100 years if the sample contained 25% marine carbon. Marine diet may be estimated from stable carbon and nitrogen isotope analyses of bone collagen, but only scant data are available for the Mediterranean region. In addition, local variation from the world ocean reservoir values (R[1830] = 402 yrs) used in the Calib 3.0.3 program should be determined, ideally near the source of the marine samples (see Stuiver & Braziunas 1993). In the absence of these corrections, one should consider that calibrated radiocarbon dates on shell (and bone collagen from humans/animals with a marine component to the diet), even when using the marine calibration curve, are subject to greater uncertainty than charcoal dates (because of local variation in the marine reservoir).

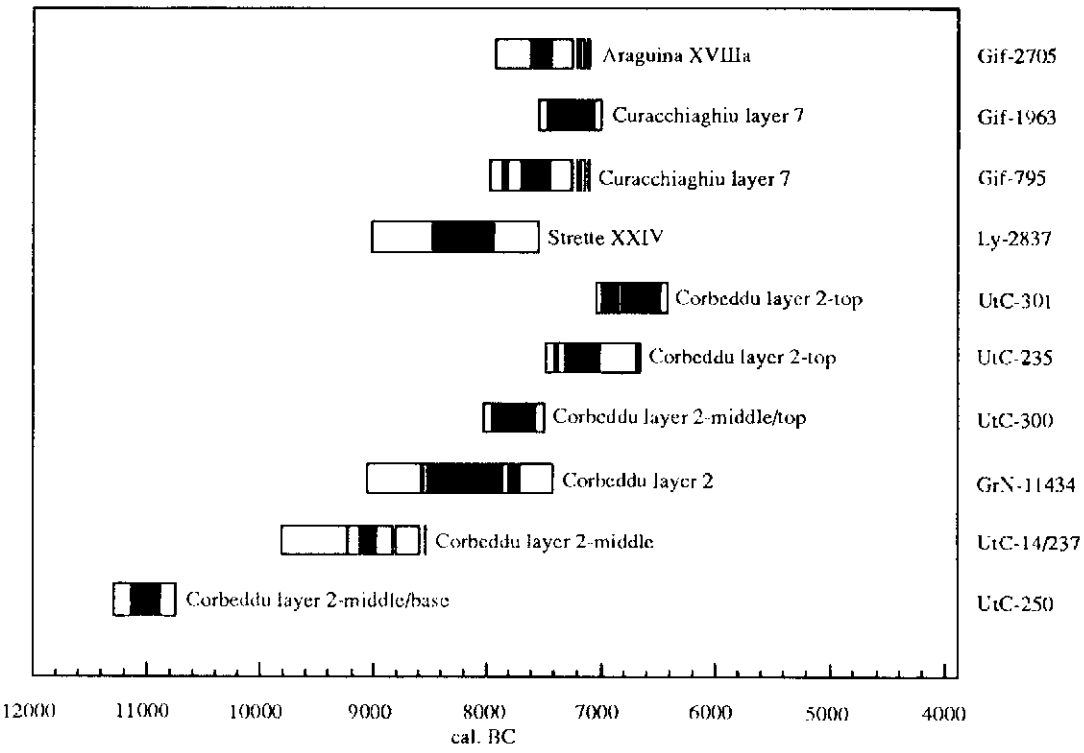
Fortunately, all of the radiocarbon dates from Sardinia are on charcoal, or bone collagen from animals unlikely to have had a marine component to their diet. For Corsica, two of the dates from Terrina IV (MC-1296 and MC-2078) are on shell; only those from Le Sanglier (Ly-2980) and from Roja (Ly-1912) are on bone collagen.

Palaeolithic and Mesolithic: initial settlement of Sardinia and Corsica

The question of when Sardinia and Corsica were first settled has been the subject of some debate in the last several years, with the 'Clactonian' lithic assemblages reported as Middle Pleistocene (c.200 ka) in age by Martini (1992) contested by Cherry (1992) and others who note the peculiarity of the tools themselves, the absence of palaeontological context and chronometric dates, and the exceptionality of the Sardinian situation relative to the known pattern of human colonisation of island environments. Within the reach of radiocarbon dating, and somewhat less controversial, are the Late Pleistocene/Early Holocene deposits of Grotta Corbeddu, excavated since 1982 by an interdisciplinary team, where over 30 radiocarbon dates (all but three by AMS) accompany a stratigraphic sequence from at least 42,000 BP to the Bronze Age (Klein Hofmeijer & Sondaar 1992; Klein Hofmeijer *et al.* 1987; 1989; Sondaar *et al.* 1984). Layer 3 in Hall 2, dated by a series of 6 radiocarbon measurements from 11,000 to 14,000 uncal. BP, contains a remarkable accumulation of deer bones including several mandibles thought to have been used as cutting or scraping tools (Klein Hofmeijer & Sondaar 1992: 52-55, figs 4-6). Several stone tools, described as 'very elementary' and 'complementing the more widescale use of naturally flaked material', have also been reported from Levels C-E of Hall 1 (Martini 1992: 44, fig. 4), which a series of 7 radiocarbon dates indicates were broadly contemporary with Layer 3 of Hall 2 (fig. 2). Four of the five radiocarbon dates from Layer 3, however, are not significantly different, suggesting that most of the Layer 3 deposits were laid down over a relatively short span of time; the Hall 1 radiocarbon dates, in contrast, indicate depositional continuity over several thousand years. It becomes difficult then to relate the alleged lithic industry of Hall 1 with the bone accumulation of Hall 2, and the human involvement in each deposit must therefore



2 Block plot with 1σ (68%; solid area) and 2σ (95%; hollow area) calibrated age ranges for radiocarbon dates for the Upper Palaeolithic from Grotta Corbeddu (Sardinia).



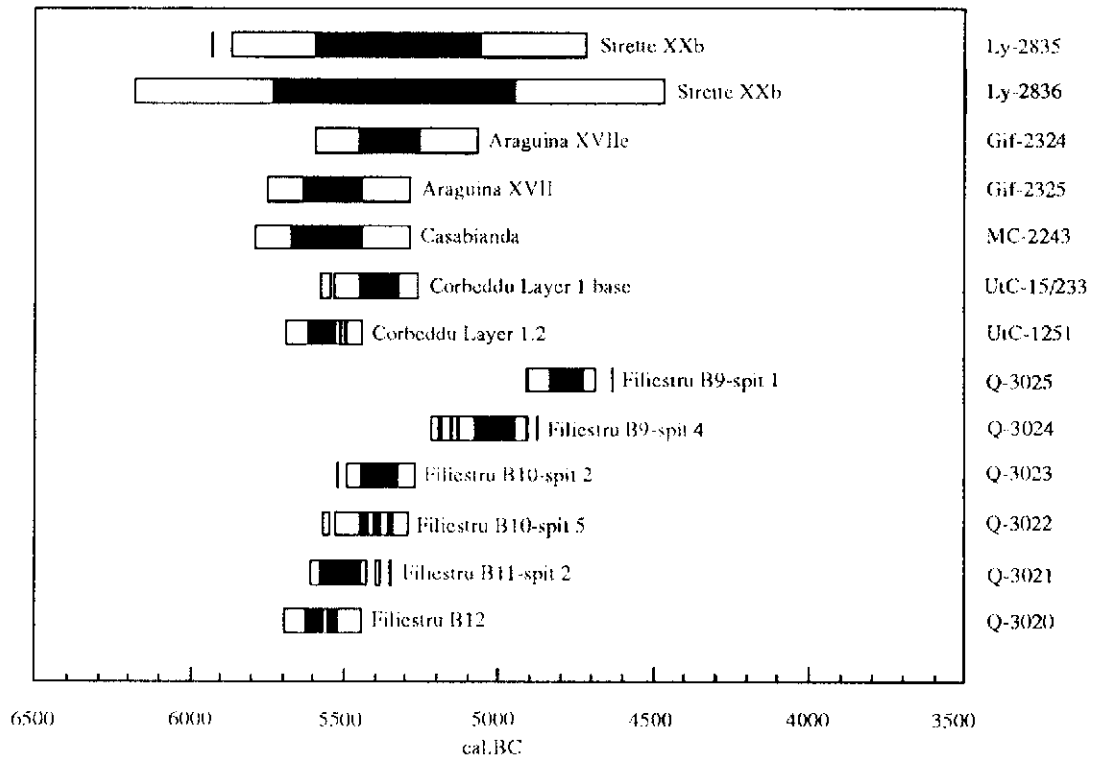
3 Block plot with 1σ (68%) and 2σ (95%) calibrated age ranges for radiocarbon dates for the Mesolithic in Sardinia and Corsica.

resolved, by disproving the hypothesis that they could be the result of non-human processes (see Cherry 1992: 31; 36), then Sardinia must have been settled by at least 14,000 cal. BC.

Uncontested are the deposits in Layer 2 of Hall 2, with 6 sequential radiocarbon dates from 11,000 to 8000 uncal. BP, one of which (UtC-300: 8750 ± 140 BP) is directly associated with two human fossils. These human remains are the oldest known from any of the Mediterranean islands, and indisputably demonstrate human presence in Sardinia by the early 8th millennium cal. BC. Such a date is consistent with that for the aceramic, pre-neolithic occupation levels at three sites in Corsica, Strette (Ly-2837: 9140 ± 300 BP), Curacchiaghiu (Gif-795: 8560 ± 170 BP; Gif-1963: 8300 ± 130 BP), and Araguina-Sennola (Gif-2705: 8520 ± 150 BP) (cf. also Cherry 1990: 178-84), and with the mesolithic levels at mainland sites such as Arma dello Stefanin (fig. 3).

Early Neolithic: Su Carroppu (Cardial), Filiestru, Grotta Verde

Early neolithic sites are much more numerous in both Sardinia and in Corsica, and a number of them have been dated by radiocarbon. Fig. 4 shows the sequence of calibrated dates for Corbeddu, and the Grotta Filiestru (Mara-SS), excavated by Trump (1983). The date BM-2139R (7760 ± 130 BP), originally reported as BM-2139 (7530 ± 80 BP), was revised after the laboratory error for British Museum dates issued between 1980 and 1984 was discovered (Bowman *et al.* 1990; Trump 1990: 21). The dated material was bone collagen from *Prolagus sardus* (a now-extinct lagomorph), from archaeologically sterile levels immediately beneath the occupational layers of Grotta Filiestru. This date (c.6500 cal. BC) has been considered a *terminus post quem* for the Sardinian Early Neolithic, a position now supported by the dates for the Pre-Neolithic at Grotta Corbeddu (UtC-301; UtC-235).



4 Block plot with 1σ (68%) and 2σ (95%) calibrated age ranges for radiocarbon dates for the Early Neolithic in Sardinia and Corsica.

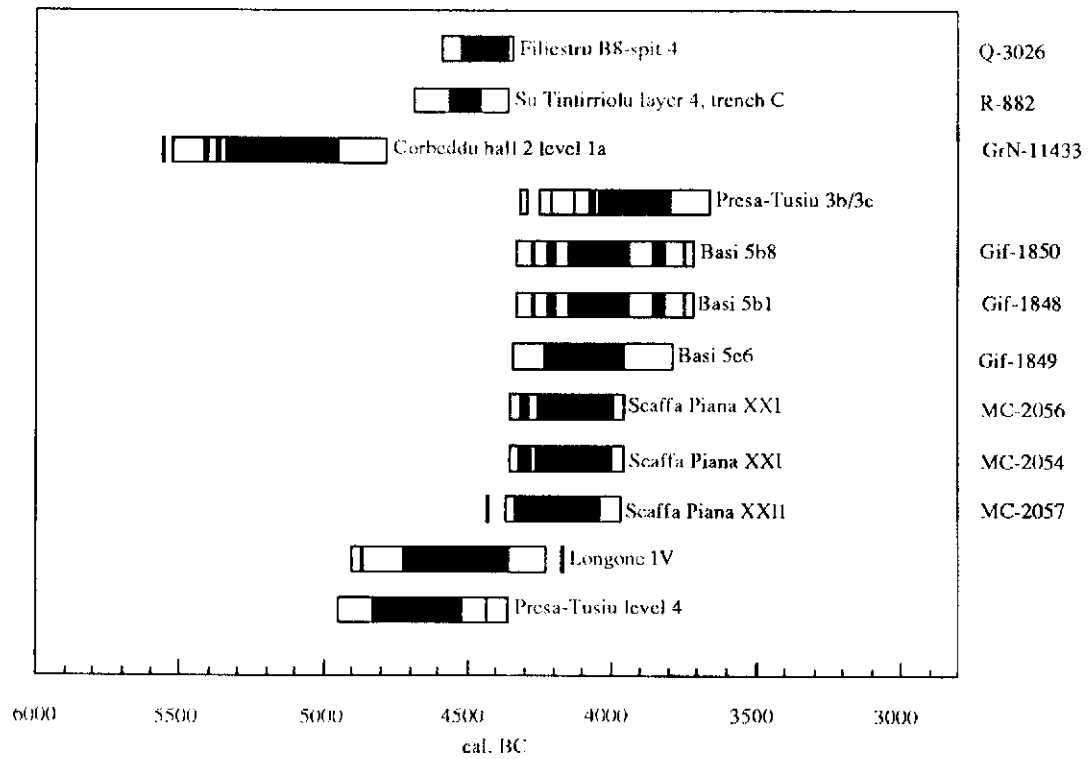
The remainder of the Grotta Filiestru sequence provides strong evidence for the chronological separation of the Cardial Impressed Ware phase (Q-3020; Q-3021; Q-3022; Q-3023) from the Filiestru phase (Q-3024; Q-3025) of the Early Neolithic. Two dates from the Cardial levels (UtC-1251; UtC-15/233) of Grotta Corbeddu agree well with the Grotta Filiestru dates. An earlier determination (UtC-22), from the same level as UtC-1251, previously described as the earliest Cardial date anywhere in the Mediterranean (Lewthwaite 1989: 546), is now rejected by the excavators who suggest that bioturbation must have transported some charcoal upward in the Corbeddu Hall 2 deposits (Klein Hofmeijer & Sondaar 1992: 50).

One can then suggest time ranges for the Cardial Early Neolithic of 5700 - 5300 cal. BC and for the Filiestru Phase of 5300 - 4700 cal. BC. This dating is supported by a series of 9 obsidian hydration dates (5550 to 4875 BC) associated with the early neolithic levels of Su Carroppu de Sirri in Sardinia (Michels *et al.* 1984). Radiocarbon dates from Casabianda (MC-2243), Araguina-Sennola (Gif-2325; Gif-2324), and Strette (Ly-2836; Ly-2835) in Corsica also calibrate to the middle half of the 6th millennium cal. BC. Earlier dates exist from both Basi and Curacchiaghiu, but the Curacchiaghiu stratigraphy is probably unreliable (Lewthwaite 1983: 151; Lanfranchi 1987). Although the Basi date (Gif-1851: 7700 ± 150 BP) appears to come from a secure context, it is 1000 ^{14}C years older than the remaining early neolithic dates from Corsica or Sardinia, and thus should not be used by itself to mark the beginning of the Early Neolithic. A third date from Strette (Gif-5520: 5910 ± 130 BP) comes from levels with both early and middle neolithic remains, and is consistent with the latter. In northern Italy, where Sardinian obsidian is found beginning in the Early Neolithic (Tykot 1992), 25 radiocarbon dates for the Ligurian and North Adriatic Impressed Ware cultures range from 7000 - 6000 uncal. BP (Bagolini & Biagi 1990); an equal number from Impressed Ware sites in southern Italy also date to the 7th millennium uncal. BP (Sargent 1985), suggesting caution throughout Italy when dealing with the few mid-8th millennium exceptions (cf. also Whitehouse 1978: 78 and this volume).

Middle Neolithic: Bonu Ighinu, San Ciriaco-Cuccuru S'Arriu facies

The Bonu Ighinu culture was first recognised in 1971 with the excavation of the cave known as Sa 'Ucca de Su Tintirriolu (Loria & Trump 1978). Although similar material had been found at a number of other sites in Sardinia, it was the clear stratigraphic position of Bonu Ighinu ceramics over a layer with Cardial Ware and beneath a layer with Ozieri ceramics that filled the embarrassing chronological gap between Early and Late Neolithic (Trump 1984: 6). Bonu Ighinu ceramics have since been found during the excavations at the Grotta Filiestru and at Grotta Corbeddu, but there are only a few radiocarbon dates pertaining to these middle neolithic contexts (fig. 5). The Corbeddu ceramics are currently being studied by M. Sanges, and additional radiocarbon dates will soon be published, but at the moment it is premature to discuss the neolithic *cultural* sequence at Corbeddu (G. Klein Hofmeijer, J. Kalis & P. Sondaar, pers. comm. 1993). A single published date (GrN-11433; c.5400 - 5000 cal. BC) is consistent with that suggested above for the end of the Early Neolithic; two dates from Grotta Filiestru (Q-3026) and Su Tintirriolu (R-882) are virtually identical (c.4600 - 4300 cal. BC). A second Su Tintirriolu date (R-879), several centuries younger, is associated primarily with Bonu Ighinu material, but comes from a context which did contain some Ozieri material (Alessio *et al.* 1978: 91).

There are 9 radiocarbon dates from 4 sites in Corsica to complement the meagre Sardinian evidence; the chronological and typological relationship among these sites, however, is less



5 Block plot with 1σ (68%) and 2σ (95%) calibrated age ranges for radiocarbon dates for the Middle Neolithic in Sardinia and Corsica.

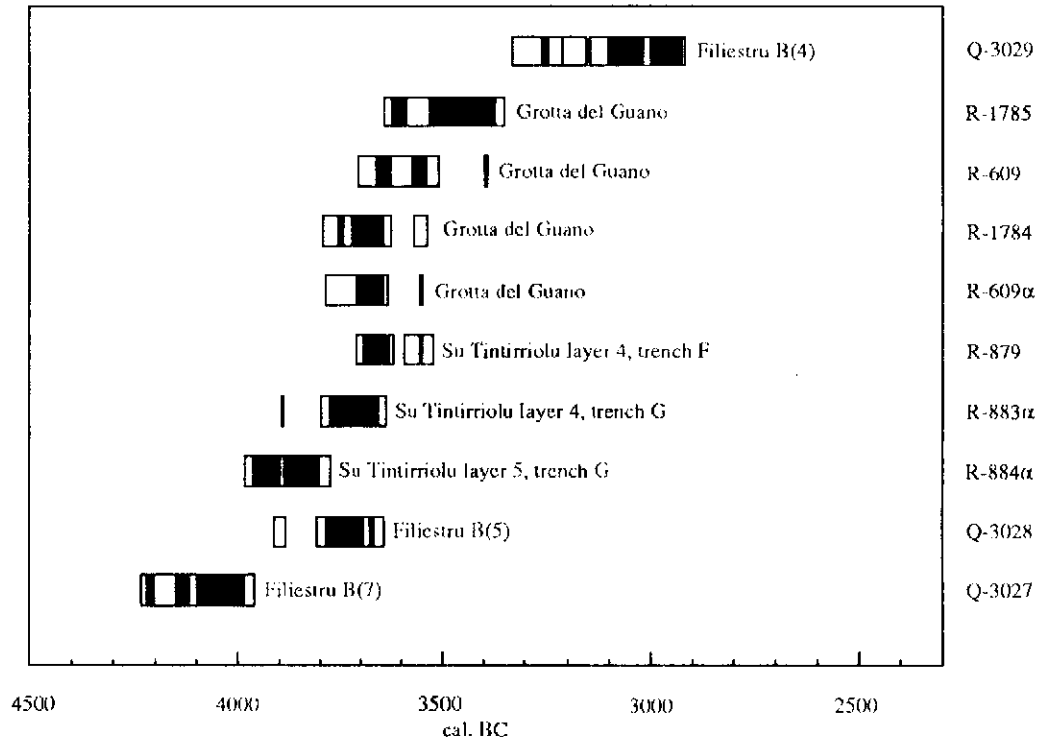
phase IV (5680 ± 160 BP), considered to be Epicardial, are similar to the Bonu Ighinu wares; those of the recently defined Presian culture (5820 ± 130 BP; 5150 ± 130 BP) are not (Lanfranchi 1992). The Basien culture, defined now as Middle Neolithic (Camps 1988a), must date from the second half of that period, with three dates each from Basi (level 5) and Scaffa Piana (Saint-Florent) calibrating to c.4300 - 3800 cal. BC. A date from Currachiaghiu level 5 (Gif-1960: 4930 ± 140 BP, c.3700 cal. BC) belongs to a later phase of the long-lived punch-decorated (Curasien) ceramic tradition, which began in the Early Neolithic and finally disappeared in the Chalcolithic (Araguina level VIj, Gif-779: 3980 ± 140 BP, c.2500 cal. BC). The concentric curvilinear designs on classic cordon-decorated vessels from these levels at Basi and Currachiaghiu have been frequently compared with Ozieri motifs (cf. Lewthwaite 1983: 164).

The recently defined San Ciriaco-Cuccuru S'Arriu facies (cf. Ugas 1990: 87-92), found stratigraphically between Bonu Ighinu and Ozieri levels at Cuccuru S'Arriu (Santoni *et al.* 1982), is transitional from Middle to Late Neolithic; this facies could certainly be accommodated within the final third of the 5th millennium cal. BC, thus filling the hiatus between the two Bonu Ighinu and the earliest Ozieri dates (cf. also Ugas 1990: 114-15, n. 65; Atzeni 1987: 392). The apparent contemporaneity between the Basien and San Ciriaco-Cuccuru S'Arriu facies, and with the more distant Sicilian Diana, is strengthened by the decorative ceramic parallels noted by Ugas (1990: 90).

These limited data for the Sardinian Middle Neolithic suggest that the Bonu Ighinu culture began in the first third of the 5th millennium cal. BC, and must have ended by about 4000 cal. BC if not sooner. This dating is in contrast to most published chronologies (e.g. Lilliu 1988: 18; *Sardegna Archeologica* 1991: 13; Balmuth 1992b: 668), which place the Bonu Ighinu culture in the first half of the 4th millennium BC, and more in line with that proposed

Late Neolithic: Ozieri, Gallurese facies

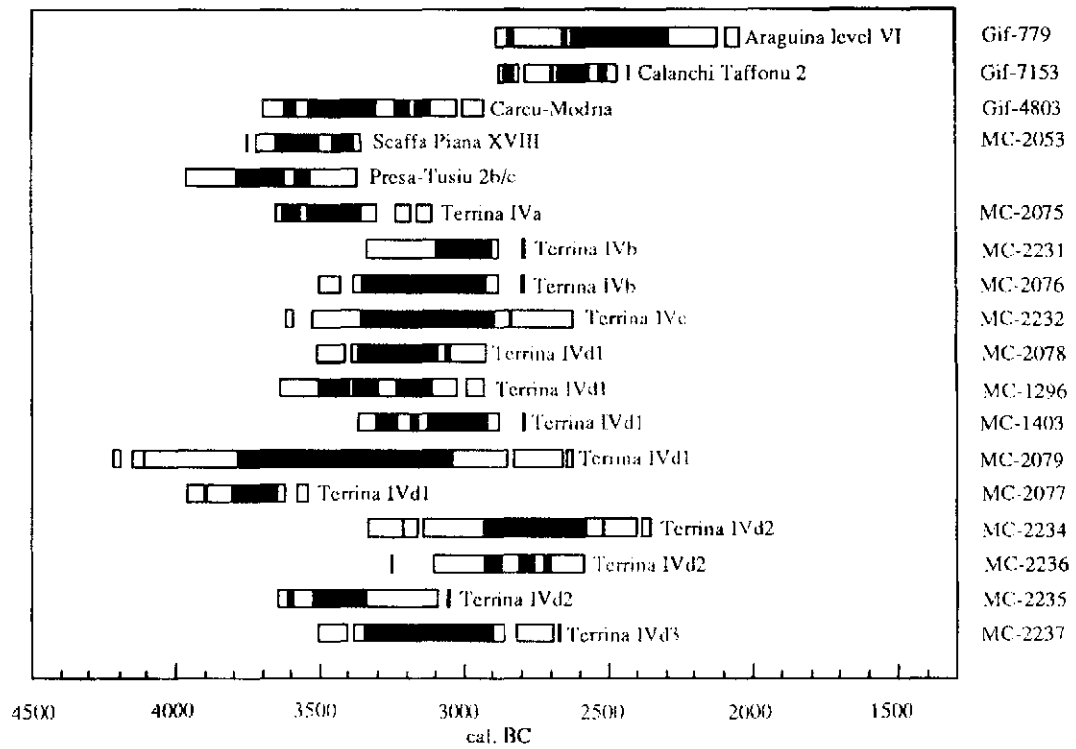
Despite 125 sites in Sardinia having been identified as belonging to the Ozieri (San Michele) culture, only 3 have been radiocarbon dated (fig. 6). The earliest date (Q-3027) is perhaps only a few centuries later than the most recent Bonu Ighinu date (Q-3026), both coming from the Grotta Filiestru (levels 7 and 8, respectively). A third date from the Grotta Filiestru (Q-3028, level 5), three dates from Sa 'Ucca de Su Tintirriolu, and four dates from the Grotta del Guano in Olièna (Castaldi 1980; 1972) all fall between 4000 and 3350 cal. BC, while a fourth date in the Filiestru sequence (Q-3029, level 4) provides a *terminus ante quem* of c.2900 cal. BC for the Ozieri culture (see below, and note 2). This proposed chronology again follows Contu (1982: 102; 1988: 441) more closely than the traditional scheme (c.3500 - 2700 BC). The schematic figurines attributed to the Ozieri culture (Antona Ruju 1980) thus are not likely to have been influenced (or imported) from the Aegean, where the well-known Cycladic types were produced mainly in the EC II period (c.3100 - 2400 cal. BC). Even the open-work type, perhaps of post-Ozieri, chalcolithic date, can then be understood as having developed from a long sequence of local prototypes. Santoni (1992) in fact has identified a 'sub-Ozieri' phase between Ozieri 'classico' and the full Chalcolithic at Cuccuru S'Arriu, where there is continuity with the preceding and succeeding periods, and contemporary architectural parallels at megalithic sites in Sardinia and Corsica.



6 Block plot with 1σ (68%) and 2σ (95%) calibrated age ranges for radiocarbon dates for the Late Neolithic in Sardinia.

The megalithic monuments of Sardinia and Corsica are not the result of diffusion from earlier (certainly not Near Eastern) cultures (Guilaine 1992). There is insufficient space here to delve into the complex subject of these monuments, few of which have been radiocarbon dated, other than to say that many (e.g. Li Muri, Pranu Mutteddu, Presa-Tusiu) definitely belong to the Ozieri and Terrinien cultures of the 4th/early 3rd millennium cal. BC (cf. Atzeni 1988; Cesari 1992; Lanfranchi 1992; Loussaume 1985; Whitehouse 1981). Copper artefacts

Thirteen radiocarbon dates from the typesite, Terrina IV (Camps 1979; 1988b), unfortunately not sequentially consistent within the four stratified levels at the site, range from c.3800 to 2600 cal. BC (fig. 7). Dates from Curacchiaghiu (Gif-1960, above), Presa-Tusiu, Scaffa Piana, and Carcu-Modria also belong to the middle half of the 4th millennium cal. BC; the radiocarbon dates for the terminal late neolithic ceramics found at I Calanchi (Taffonu 2), and at Araguina (level VI) are not necessarily more recent than the latest Terrina IV dates.



7 Block plot with 1σ (68%) and 2σ (95%) calibrated age ranges for radiocarbon dates for the Late Neolithic and Chalcolithic in Corsica.

Chalcolithic: Sub-Ozieri, Filigosa, Abealzu, Monte Claro, Beaker

The Chalcolithic in Sardinia is comprised of several cultures whose definition, sequence, and absolute chronology are still being refined (Santoni 1992; Atzeni *et al.* 1988; Lewthwaite 1985). A tetrapartite division is now widely accepted, although some consider Filigosa and Abealzu to be contemporary, Monte Claro has at least three regional variations, and there are no solely Beaker settlement sites. La Tomba dei Vasi Tetrapodi (Santu Pedru-Alghero) is the only site with all four components represented (Contu 1964). A single radiocarbon date for these cultures comes from the Grotta dell'Acqua Calda (Nuxis) where Monte Claro ceramics were discovered in a burial context.[2] This determination (R-677: c.2150-1950 cal. BC) has been considered too recent (Contu 1988: 442-3), but not necessarily by much if Monte Claro and Beaker overlap (cf. Ferrarese Ceruti 1988: 456). The limited data for Bonnanaro phase A suggest that this Early Bronze Age culture began by c.2200 cal. BC (see below). At the Grotta Filiestru, there is a hiatus after the Ozieri phase, and the level 4 date mentioned above (Q-3029), associated primarily with Bonnanaro rather than Monte Claro ceramics, does not help to date any of the Copper Age cultures. Furthermore, although recent excavations at Noeddos (Mara), only a few kilometres from the Grotta Filiestru, revealed four occupation phases beginning in the Chalcolithic and continuing through the Middle Bronze Age, the

unwilling to classify them according to the above scheme, other than stating that they are ultimately derived from debased Ozieri styles (Trump 1990: 14-15, 41). The Noeddos I and II phases can be roughly dated c.2500 - 1700 cal. BC.

The Beaker (Campaniforme) culture, with manifestations from Central Europe to the British Isles, is generally dated c.2700 - 1900 cal. BC (Harrison 1980); in Sardinia, Beaker material is found at sites above or alongside Monte Claro material, sometimes with Bonnanaro ceramics, and never alone at a settlement site (Ferrarese Ceruti 1981a; 1988). The Beaker Phase has been divided into A (decorated ceramics) and B (undecorated) phases in Sardinia (Ugas 1982), but no relationship between pottery style and date of deposition was found in a recent radiocarbon study of British Beaker contexts (Ambers *et al.* 1992). In the Balearic Islands, however, there is good radiocarbon evidence of early (c.2550 - 2100 cal. BC) and late (c.2100 - 1500 cal. BC) Beaker phases (Waldren 1991), a chronology which would fit extremely well with the Sardinian (Monte Claro and Bonnanaro) culture sequence. A single radiocarbon date from Taffonu 6 at I Calanchi (LGQ-279: 3910 ± 150 BP) in Corsica, associated with Beaker ceramics, calibrates to c.2500 - 2200 cal. BC. The Beaker pottery found in Sardinia has its closest parallels in Languedoc, and there is Fontbouïsse influence on Monte Claro ceramics and architecture (Harrison 1980: 116-7; Lilliu 1988: 155-6).

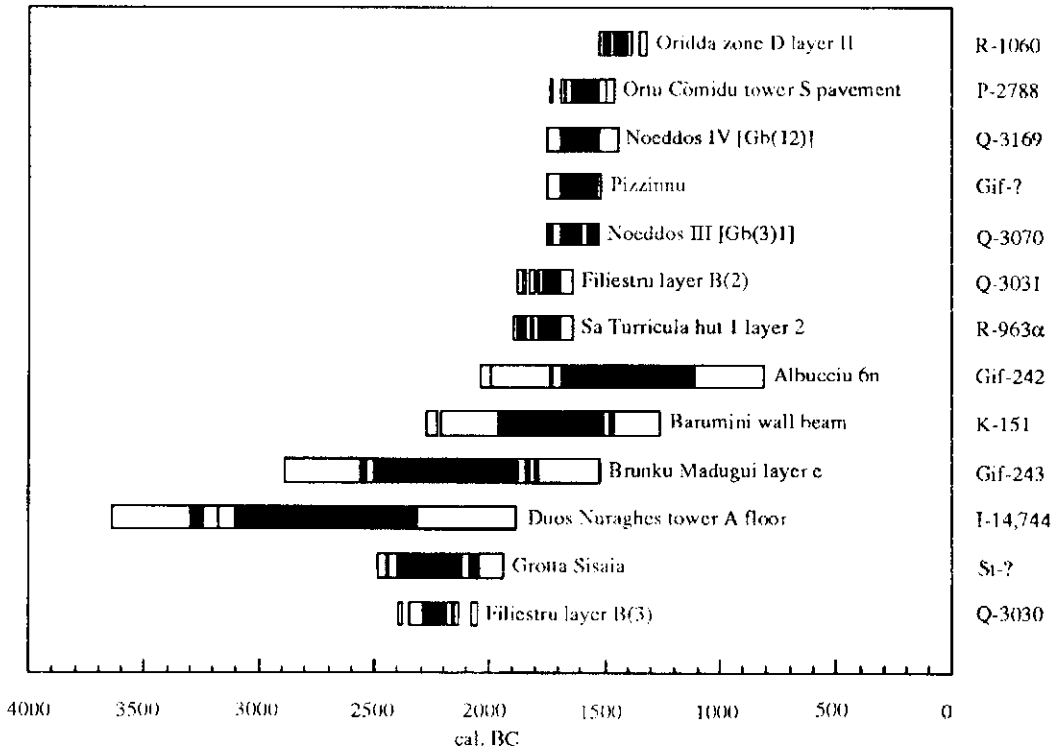
In outline form we can suggest then that the Chalcolithic began perhaps by 3000 cal. BC and ended by 2200 cal. BC. The sub-Ozieri, Filigosa and Abealzu belong in the first half of the 3rd millennium cal. BC, Monte Claro (and Noeddos I) primarily in the second half. The Beakers appear sometime during the Monte Claro culture and continue into the Early Bronze Age.

Bronze Age: Bonnanaro, Nuragic

The Sardinian Early Bronze Age begins with the Bonnanaro culture, divided into two phases (A = Corona Moltana facies; B = Sa Turricula facies). Late Beaker finds are sometimes associated with the earlier Bonnanaro A phase, which is known almost exclusively from funerary contexts, and there are also stylistic affinities with the Polada culture of northern Italy (Ferrarese Ceruti 1981b). Bonnanaro interments are usually collective secondary burials, many reusing *domus de janas* tombs constructed in the Late Neolithic or Chalcolithic. The two available radiocarbon dates, from the Grotta Filiestru (Q-3030) and the Grotta Sisaia (St-?), are clearly earlier than the Bonnanaro B/Early Nuragic dates, and suggest a start for the Early Bronze Age in the final third of the 3rd millennium cal. BC (fig. 8).

The Bonnanaro B phase is associated with the earliest nuraghi, the numerous stone towers which define the Bronze Age civilisation of Sardinia. Reminiscent in their construction of the Mycenaean tholos tombs, they are clearly an indigenous product predating the Aegean buildings by at least a few hundred years (Cavanagh & Laxton 1987; Santillo Frizell 1987; Lewthwaite 1985; cf. also Ugas 1992; Belli 1992). Radiocarbon dates for Bonnanaro B come from the Grotta Filiestru (Q-3031), the type-site of Sa Turricula (R-963a), Nuraghe Pizzinnu (Gif-?), Su Nuraxi di Barumini (K-151), and two more recently excavated nuraghi. Charcoal from the foundation layer of Nuraghe Noeddos (Q-3070), a classic tholos *monotorre*, has been dated c.1750 - 1500 cal. BC (Trump 1990: 13, 17), while Webster (1988: 467) argues for a date of c.2000 - 1800 cal. BC for the construction and initial use of Tower A at Duos Nuraghes despite the large error associated with the radiocarbon date (I-14,774).

The early date from the corridor nuraghe Brunku Madugui (Gif-243) convinced many



8 Block plot with 1σ (68%) and 2σ (95%) calibrated age ranges for radiocarbon dates for the Early and Middle Bronze Age in Sardinia.

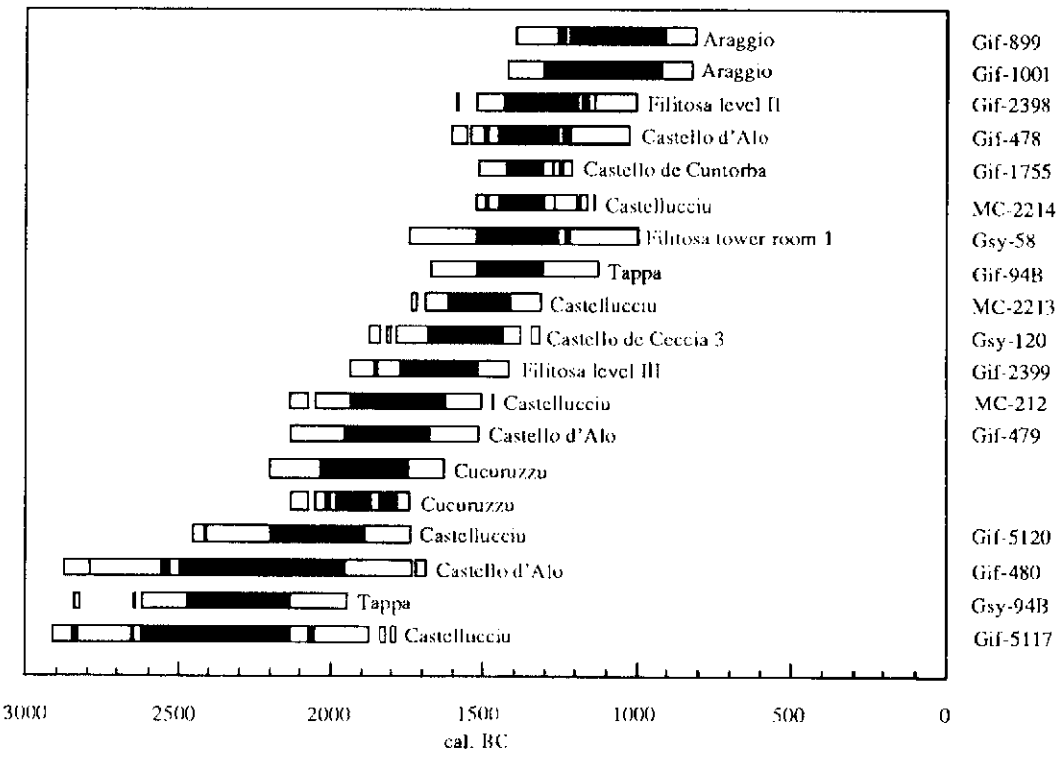
but the calibrated age range is too large to demonstrate this with any confidence. The date from Albucciu (Gif-242), another proto-nuraghe, is not as early, but may not date the construction of the monument. Recent work suggests that at least some proto-nuraghi were built at the same time as tholos nuraghi (Manca Demurtas & Demurtas 1992; Moravetti 1992), but until foundation levels of several proto-nuraghi have been dated, this issue will remain controversial. Ugas (1992) has recently dated the corridor and early tholos nuraghi to c.1600 - 1300 BC, and the floruit of the Nuragic civilisation to c.1300 - 1150 BC, a chronology which is compatible with the limited radiocarbon data. Thus, the only evidence for nuraghi earlier than c.1700 cal. BC are the Brunku Madugui, Duos Nuraghes, and Barumini dates, whose laboratory errors of 200 years or more instill little confidence in their value, not to mention the possibility that they relate to earlier occupations of the same sites (cf. Contu 1992: 16-17). If one excludes the few low-precision radiocarbon dates, it appears possible that the earliest *dated* nuraghi are slightly more recent than the two Bonnanaro B dates from sites without Nuragic towers.

Additional dates for this first phase of the Nuragic period, generally defined by the absence of comb-decorated (*a pettine*) ceramics, come from Noeddos (Q-3169) and Nuraghe Ortu Còmidu (P-2788). The comb-decorated wares, considered diagnostic of the Full Nuragic period (Middle-Late Bronze Age) (cf. Bafico & Rossi 1988; Fadda 1984) but showing some continuity with Bonnanaro B (Sebis 1992), are argued to be yet another example of a long-lived Nuragic ceramic type (Weiss Grele 1992: 277). Three radiocarbon dates from Duos Nuraghes (I-15,465, I-15,466, I-14,775), to which we can add one from Nuraghe Sala e Serru (Q-3170), three from levels 5-6 of Nuraghe Albucciu, and several from the Nuragic village of Sa Mandra 'e Sa Gina, support the interpretation that comb-stamped wares remained in use from the Middle Bronze Age to the Final Bronze/Early Iron Age (Teglund & Webster 1993: 21). Two series of radiocarbon dates refer to late or final occupations of Nuragic

the Late Iron Age, many Nuragic villages were still inhabited by indigenous Sards, and perhaps some Carthaginian and Roman settlers/merchants, since the few exclusively Punic or Roman settlements are near the coasts; some nuraghi were still occupied even in the early Medieval period (cf. Rowland 1992). Much of the complexity of Nuragic stratigraphy and chronology thus results from the re-use of many nuraghi for two thousand years. Nuragic chronology and ceramic typology will continue to be refined as more and more sites are scientifically excavated (cf. Ferrarese Ceruti & Lo Schiavo 1992; Contu 1992).

In Corsica, the unvaulted *castelli* at Castellucciu, Tappa (Gsy-94B=Gif-94A, cf. Lewthwaite 1983: 183), Cucurruzu, Alo, Ceccia, Cuntorba, and Araggio date from the late 3rd to the early 1st millennium cal. BC (fig. 9). Only a few true *torri*, better architectural analogues to the Sardinian nuraghi, have been dated; the radiocarbon evidence from the towers at Castello d'Alo (Gif-479; Gif-478), Tappa (Gif-94B), and Filitosa (Gsy-58; Gif-2398) ranges from the 18th-14th centuries cal. BC. With the late 3rd/early 2nd millennium BC sequence in Sardinia only sketchily defined, caution is warranted in discussions of the appearance, development, and reciprocal influence of the Sardinian and Corsican monuments (cf. Lewthwaite 1985; Contu 1992).

Radiocarbon dating has little to offer for the chronology of the religious manifestations of the Nuragic culture, the collective burials known as *tombe di giganti* (giants' tombs), and the *pozzi sacri* (sacred well-temples). The date for the giants' tomb Oridda (R-1060), associated with Early Nuragic ceramics, suggests that these tombs probably first appeared at the same time as the nuraghi themselves. The votive deposits at the Grotta ASI (R-492; R-492a) can be dated only to the 10th/9th century cal. BC, perhaps slightly earlier than those at Su Foxi 'e s'Abba (R-1065; R-1065a). It certainly remains possible that the presumably contemporary sacred wells are in some way related to eastern Mediterranean contacts (Belli 1992; Santillo Frizell 1992).



9 Block plot with 1σ (68%) and 2σ (95%) calibrated age ranges for radiocarbon dates from Corsican

Iron Age: Phoenician, Punic, Roman

Radiocarbon dating has hardly been applied to Iron Age materials in Sardinia. Two graves underneath a temple at Bithia were demonstrated to be from the Punic-Roman settlement (K-559; K-558), but radiocarbon dating indicated that an oak beam from a Sardinian bridge, now in the Museo delle Navi Romane, was not of Roman date (R-63). The wood used in the late 2nd century BC Roman shipwreck off Isola Spargi (P-851; P-850) has been dated to the 4th/3rd century cal. BC, but the sample from a shipwreck north of Oristano (RT-705) appears to be modern. Finally, three wood samples from the excavations of an offshore sea wall at Tharros (Linder 1987), perhaps part of the Phoenician port installations, have been recently analysed (RT-849A, RT-849B, RT-849C), all with first millennium AD dates.

Discussion

I offer fig. 10 as a very rough outline of Sardinian absolute chronology, based on the radiocarbon data presented above, to satisfy those who demand such heuristic schemes. I cannot stress enough how sketchy the data are for most of the cultural periods, and urge caution especially when considering their *termini*. The dates for the cultures of the Chalcolithic could very well be off by hundreds of years. In all likelihood there must be some degree of regional variation in this chronology as well. For the Late Bronze and Iron Ages, I have followed Ugas (1992) and others more expert than I in typological cross-dating.

There is clearly a need for more radiocarbon dates from Sardinia and Corsica, particularly strategically selected series of samples from stratified excavation contexts. The Mesolithic and Neolithic are broadly defined due to the sequences from Grotta Corbeddu, Grotta Filiestru, and Sa 'Ucca de Su Tintirriolu, and additional dates from Corbeddu are forthcoming. Dates from other sites could clarify the transitions from one culture to the next, as well as demonstrate the existence of regional variations in the chronological/cultural sequence. We desperately need to find and excavate multi-component sites which span the Chalcolithic, to verify and date the proposed cultural sequence. And we need more and better dates for the beginning of the Nuragic civilisation, to provide both a sound foundation for understanding the development of this architectural manifestation, and a framework for the emergence of marked social stratification in Sardinia (Webster 1991a; 1991b; Ugas 1990; Trump 1992). The current Nuragic radiocarbon evidence demonstrates the temporal priority of the nuraghi over Aegean buildings employing similar construction techniques, but the same cannot be said of the Sardinian sacred wells, none of which have been radiocarbon dated. The extent of Cypriot/Phoenician influence on the famous Sardinian *bronzetti* might also be better understood if those few from excavated contexts could be radiocarbon dated (cf. Barreca 1986; Stary 1991; Gallin & Tykot 1993).

The presence of Mycenaean artefacts in the western Mediterranean (cf. Tykot 1994) makes it particularly possible for Sardinia, with its many findspots of Mycenaean pottery and oxhide ingots (Stos-Gale & Gale 1992; Lo Schiavo *et al.* 1990), to make a contribution to Aegean chronology, a phenomenon termed the Ialysos effect (Balmuth 1993). Radiocarbon dating of Nuragic sites with Mycenaean materials such as Antigori (Ferrarese Ceruti 1986) and most recently, Arrubiu (Lo Schiavo 1993) not only would shed light on Late Bronze Age east-west interaction networks, but would provide an independent test of Aegean absolute chronology (cf. Manning 1994). Similarly, radiocarbon dating of Final Bronze/Early Iron Age sites such as Su Muru Mannu (Bernardini 1989) can help establish the chronology of the 'Dark Age' and bridge the gap between Mycenaean contact and Phoenician colonisation of Sardinia

UPPER PALAEOLITHIC	LOWER	CLACTONIAN?		> 150,000 BC
	MIDDLE			
	UPPER	GROTTA CORBEDDU		15,000 - 11,000 BC
MESOLITHIC				11,000 - 6000 BC
NEOLITHIC	EARLY	SU CARROPPU		6000? - 5300 BC
		FILIESTRU - GROTTA VERDE		5300 - 4700 BC
	MIDDLE	BONU IGHINU ------ (SAN CIRIACO) ------		4700 - 4000 BC
	LATE	OZIERI		4000 - 3200? BC
ENEOLITHIC (COPPER AGE)	INITIAL	SUB-OZIERI FILIGOSA ABEALZU		3200? - 2700? BC
	FULL	MONTE CLARO	BEAKER A	2700? - 2200? BC
	FINAL			
BRONZE AGE	EARLY	BONNANARO A	BEAKER B	2200 - 1900 BC
	MIDDLE	BONNANARO B		1900 - 1600 BC
		NURAGIC I		1600 - 1300 BC
	LATE	NURAGIC II		1300 - 1150 BC
	FINAL	NURAGIC III		1150 - 850 BC
EARLY IRON AGE	GEOMETRIC	PHOENICIAN	NURAGIC IV	850 - 730 BC
	ORIENTALISING			730 - 580 BC
	ARCHAIC			580 - 510 BC
LATE IRON AGE	PUNIC		NURAGIC V	510 - 238 BC
	ROMAN	REPUBLICAN		238 - 1 BC
		IMPERIAL		1 AD - 476 AD

10 Outline chronology of Sardinian prehistory. All dates are in calendar years.

I believe that this presentation of the existing radiocarbon data for Sardinia and Corsica has demonstrated the ability of this method to answer archaeological questions, especially when series of samples are carefully selected from stratified sites. I also hope that the positive results accumulated so far will encourage archaeologists to employ radiocarbon dating to a greater extent in their efforts at reconstructing the prehistory of the Tyrrhenian islands.

Table 1 Radiocarbon dates from Sardinia.

Site	Context	Lab. No.	^{14}C age	Error	2σ Calibrated age range (CALIB 3.0.3)	Reference
Grotta Corbeddu	Hall 1 Quadrant R07	UtC-243	25700	± 400		*RC* 31(3)(1989): 988
Grotta Corbeddu	Hall 1 Layer F	UtC-718	17700	± 200	cal.BC 19757 (19145) 18475	*RC* 31(3)(1989): 988
Grotta Corbeddu	Hall 1 Layer E-base	UtC-725	14600	± 200	cal.BC 16002 (15532) 15047	*RC* 31(3)(1989): 988
Grotta Corbeddu	Hall 2 Layer 3 level 5	UtC-242	14370	± 190	cal.BC 15730 (15274) 14798	*RC* 29(1987): 167
Grotta Corbeddu	Hall 1 Layer D-base	UtC-723	13900	± 200	cal.BC 15224 (14722) 14180	*RC* 31(3)(1989): 988
Grotta Corbeddu	Hall 2 Layer 3 level 7	UtC-239	13620	± 180	cal.BC 14853 (14371) 13843	*RC* 29(1987): 167
Grotta Corbeddu	Hall 2 Layer 3	GrN-11405	13590	± 140	cal.BC 14729 (14332) 13904	BAR 229(1984): 32
Grotta Corbeddu	Hall 2 Layer 3 level 4	UtC-244	13530	± 170	cal.BC 14722 (14253) 13738	*RC* 29(1987): 167
Grotta Corbeddu	Hall 2 Layer 3 level 6	UtC-240	13510	± 180	cal.BC 14720 (14226) 13680	*RC* 29(1987): 167
Grotta Corbeddu	Hall 1 Layer D-mid	UtC-722	13500	± 300	cal.BC 14982 (14213) 13287	*RC* 31(3)(1989): 988
Grotta Corbeddu	Hall 1 Layer E-mid	UtC-724	13500	± 190	cal.BC 14731 (14213) 13636	*RC* 31(3)(1989): 988
Grotta Corbeddu	Hall 1 Layer C-base	UtC-721	13100	± 190	cal.BC 14221 (13644) 12956	*RC* 31(3)(1989): 988
Grotta Corbeddu	Hall 1 Layer C-mid	UtC-720	12500	± 150	cal.BC 13241 (12699) 12217	*RC* 31(3)(1989): 988
Grotta Corbeddu	Hall 2 Layer 3 level 2	UtC-241	11980	± 140	cal.BC 12461 (12018) 11641	*RC* 29(1987): 167
Grotta Corbeddu	Hall 1 Layer C-top	UtC-719	11200	± 170	cal.BC 11546 (11158) 10819	*RC* 31(3)(1989): 988
Grotta Corbeddu	Hall 2 Lay. 2 mid/base	UtC-250	11040	± 130	cal.BC 11283 (11005) 10736	*RC* 29(1987): 167
Grotta Corbeddu	Hall 2 Layer 2 mid	UtC-14/237	9820	± 140	cal.BC 9812 (9044) 8539	*RC* 29(1987): 167
Grotta Corbeddu	Hall 2 level 2 (60-85)	GrN-11434	9120	± 380	cal.BC 9053 (8088) 7428	BAR 229(1984): 32
Grotta Corbeddu	Hall 1 Layer B-base	UtC-726	8960	± 110	cal.BC 8321 (8018) 7705	*RC* 31(3)(1989): 988
Grotta Corbeddu	Hall 2 Lay. 2 mid/top	UtC-300	8750	± 140	cal.BC 8039 (7877, 7812, 7710) 7497	*RC* 29(1987): 167
Grotta Corbeddu	Hall 2 Layer 2 top	UtC-235	8160	± 130	cal.BC 7486 (7192, 7189, 7134, 7127, 7049) 6652	*RC* 29(1987): 167
Grotta Corbeddu	Hall 2 level 1b	UtC-22	8040	± 180	cal.BC 7480 (7008) 6462	*RC* 29(1987): 167
Grotta Corbeddu	Hall 2 Layer 2 top	UtC-301	7860	± 130	cal.BC 7043 (6617) 6418	*RC* 29(1987): 167
Grotta Filiestru	Trench D Layers 7-9	BM-2139R	7760	± 130	cal.BC 7006 (6544) 6267	*RC* 32(1990): 76
Grotta Filiestru	Layer B(12)	Q-3020	6710	± 75	cal.BC 5693 (5587) 5444	*PACT* 8(1983): 460
Grotta Corbeddu	Hall 2 level 1b	UtC-1251	6690	± 80	cal.BC 5687 (5579) 5440	MMA 3(1992): 50
Grotta Filiestru	Layer B(11) spit 2	Q-3021	6615	± 75	cal.BC 5607 (5561, 5557, 5522) 5350	*PACT* 8(1983): 460
Grotta Filiestru	Layer B(10) spit 5	Q-3022	6515	± 65	cal.BC 5570 (5437) 5290	*PACT* 8(1983): 460
Grotta Corbeddu	Hall 2 Layer 1 base	UtC-15/233	6490	± 90	cal.BC 5576 (5433) 5259	*RC* 29(1987): 167
Grotta Filiestru	Layer B(10) spit 2	Q-3023	6470	± 65	cal.BC 5521 (5430, 5394, 5386) 5269	*PACT* 8(1983): 460
Grotta Corbeddu	Hall 2 Level 1a	GrN-11433	6260	± 180	cal.BC 5563 (5226) 4783	BAR 229(1984): 32
Grotta Filiestru	Layer B(9) spit 1	Q-3024	6170	± 55	cal.BC 5218 (5051) 4870	*PACT* 8(1983): 460

Su Tintirriolu	Layer 4 Trench C	R-882	5680	± 160	cal.BC 4905 (4507) 4170	*RC* 20(1978): 91
Grotta Filiestru	Layer B(8) spit 4	Q-3026	5625	± 65	cal.BC 4592 (4461) 4343	*PACT* 8(1983): 460
Grotta Filiestru	Layer B(7)	Q-3027	5250	± 60	cal.BC 4233 (4038, 4015, 4006) 3957	*PACT* 8(1983): 460
Su Tintirriolu	Layer 5 Trench G	R-884α	5090	± 50	cal.BC 3982 (3942, 3845, 3824) 3776	*RC* 20(1978): 91
Grotta Filiestru	Layer B(5) spit 2	Q-3028	4950	± 50	cal.BC 3907 (3709) 3643	*PACT* 8(1983): 460
Su Tintirriolu	Layer 4 Trench G	R-883α	4930	± 50	cal.BC 3892 (3702) 3638	*RC* 20(1978): 91
Grotta del Guano	Below stalagmite layer	R-609α	4900	± 50	cal.BC 3784 (3692, 3670) 3547	*RC* 13(1971): 399
Grotta del Guano		R-1784	4900	± 60	cal.BC 3793 (3692, 3670) 3538	Allegri *et al.* 1987: 76
Su Tintirriolu	Layer 4 Trench F	R-879	4850	± 50	cal.BC 3710 (3644) 3523	*RC* 20(1978): 91
Grotta del Guano	Below stalagmite layer	R-609	4830	± 50	cal.BC 3703 (3639) 3389	*RC* 13(1971): 399
Grotta del Guano		R-1785	4700	± 60	cal.BC 3637 (3503, 3416, 3383) 3349	Allegri *et al.* 1987: 76
Grotta Filiestru	Layer B(4)	Q-3029	4430	± 50	cal.BC 3333 (3075, 3067, 3040) 2915	*PACT* 8(1983): 460
Duos Nuraghes	Tower A floor	I-14,774	4180	± 320	cal.BC 3636 (2868, 2805, 2770, 2719, 2703) 1881	MMA 3(1992): 278
Nuraghe Noeddos	Bd(3)5	Q-3069	4030	± 50	cal.BC 2854 (2563, 2524, 2500) 2456	Trump 1990
Grotta Filiestru	Layer B(3)	Q-3030	3805	± 40	cal.BC 2396 (2270, 2268, 2202) 2049	*PACT* 8(1983): 460
Grotta Sisaia		St-?	3800	± 100	cal.BC 2489 (2200) 1934	Lilliu 1988: 20
Brunku Madugui	Layer e	Gif-243	3770	± 250	cal.BC 2888 (2190, 2160, 2145) 1520	*RC* 8(1966): 86
Grotta Acqua Calda	Inner chamber	R-677	3690	± 60	cal.BC 2274 (2112, 2089, 2038) 1890	*RC* 12(1970): 607
Nuraghe Noeddos	Gb(4)5	Q-3071	3590	± 50	cal.BC 2114 (1926) 1771	Trump 1990
Nuraghe Noeddos	Ge(5)5	Q-3168	3585	± 80	cal.BC 2139 (1919) 1690	Trump 1990
Nuraghe Noeddos	Ge(4)	Q-3167	3480	± 70	cal.BC 1966 (1758) 1618	Trump 1990
Sa Turricula	Hut 1, Layer 2	R-963α	3460	± 50	cal.BC 1888 (1745) 1630	*RC* 18(1976): 334
Grotta Filiestru	Layer B(2)	Q-3031	3440	± 40	cal.BC 1876 (1740) 1630	*PACT* 8(1983): 460
Bartumini	Beam, main chamber	K-151	3420	± 200	cal.BC 2277 (1734, 1721, 1689) 1262	*RC* 2(1960): 10
Nuraghe Noeddos	Gb(3)1	Q-3070	3360	± 50	cal.BC 1746 (1671, 1664, 1636) 1517	Trump 1990
Nuraghe Pizzinnu	Tower	Gif-?	3350	± 50	cal.BC 1743 (1625) 1515	Lilliu 1966: 12
Nuraghe Noeddos	Gb(12)	Q-3169	3330	± 70	cal.BC 1749 (1613) 1434	Trump 1990
Ortu Cómidu	Pavement, tower S	P-2788	3310	± 50	cal.BC 1732 (1597, 1568, 1529) 1449	*RC* 23(1981): 231
Nuraghe Albucciu	Lower layer 6	Gif-242	3170	± 250	cal.BC 2032 (1424) 813	*RC* 8(1966): 86

Nuraghe Noeddos	Fd(3)2	Q-3068	3145	± 50	cal.BC 1515 (1412) 1268	Trump 1990
Duos Nuraghes	Tower A	I-15,465	3110	± 90	cal.BC 1525 (1396) 1119	MMA 3(1992): 278
Ortu Còmidu	Area M, 40-50cm	P-2401	3080	± 60	cal.BC 1444 (1381, 1342, 1321) 1133	*RC* 19(1977): 194
Sa Mandra 'e Sa Giua	Near Hut A	R-1094α	3050	± 50	cal.BC 1416 (1306) 1128	*RC* 20(1978): 72-3
Nuraghe Sala e Serm	Trench A(2)	Q-3170	3010	± 70	cal.BC 1416 (1259, 1232, 1227) 1009	Trump 1990
Ortu Còmidu	Area M, 40-50cm	P-2402	2970	± 50	cal.BC 1377 (1196, 1181, 1165, 1141, 1139) 1009	*RC* 19(1977): 194
Nuraghe Albucciu	5-6, n		2950	± 60	cal.BC 1377 (1152, 1149, 1130) 941	Contu 1980: 18
Nuraghe Albucciu	5-6, n		2940	± 50	cal.BC 1299 (1125) 992	Contu 1980: 18
Nuraghe Serucci	Fill, chamber 10	PIT-0517	2930	± 50	cal.BC 1266 (1120) 941	Balmuth 1992b: 679
Genna Maria	Hut 17, S corner	P-2403	2920	± 50	cal.BC 1263 (1116) 932	*RC* 19(1977): 194
Ortu Còmidu	Area N,3; 30-40 cm	P-2399	2910	± 250	cal.BC 1731 (1112, 1101, 1130) 941	*RC* 19(1977): 194
Ortu Còmidu	Area N,4,5,7; 40-79cm	P-2400	2910	± 220	cal.BC 1626 (1112, 1101, 1064) 533	*RC* 19(1977): 194
Su Foxi 'e s'Abba	Wooden vessel in cave	R-1074α	2910	± 50	cal.BC 1260 (1112, 1101, 1064) 925	*RC* 20 (1978): 92
Duos Nuraghes	Tower A	I-15,466	2880	± 80	cal.BC 1297 (1022) 836	MMA 3(1992): 278
Nuraghe Albucciu	5-6, n		2870	± 50	cal.BC 1199 (1009) 905	Contu 1980: 18
Malchittu	Floor-level hearth	R-344α	2870	± 70	cal.BC 1260 (1009) 842	*RC* 11(2)1969: 490-1
Duos Nuraghes	Hearth, Tower A	I-14,775	2830	± 90	cal.BC 1260 (987, 956, 944) 807	MMA 3(1992): 278
Sa Mandra 'e Sa Giua	Hut A	R-1096	2810	± 50	cal.BC 1113 (927) 830	*RC* 20(1978): 72-3
Sa Mandra 'e Sa Giua	Hut A, upper layer I	R-1097	2800	± 50	cal.BC 1047 (922) 826	*RC* 20(1978): 72-3
Nuraghe Serucci	Fill, chamber 10	PIT-0518	2795	± 30	cal.BC 1003 (919) 843	Balmuth 1992b: 679
Grotta ASI	inner chamber	R-492	2770	± 60	cal.BC 1036 (906) 807	*RC* 12(1970): 606-7
Sa Mandra 'e Sa Giua	Hut B, lower layer II	R-1092α	2740	± 50	cal.BC 995 (893, 882, 848) 805	*RC* 20(1978): 72-3
Nuraghe Albucciu	6-7, n		2740	± 50	cal.BC 995 (893, 882, 848) 805	Contu 1980: 18
Nuraghe Albucciu	6-7, n		2720	± 50	cal.BC 978 (837) 800	Contu 1980: 18
Nuraghe Serucci	Fill, chamber 10	PIT-0516	2710	± 45	cal.BC 924 (832) 800	Balmuth 1992b: 679
Sa Mandra 'e Sa Giua	Near Hut A	R-1093α	2690	± 50	cal.BC 918 (822) 794	*RC* 20(1978): 72-3
Grotta ASI	Inner chamber	R-492α	2680	± 60	cal.BC 923 (818) 783	*RC* 12(1970): 606-7
Sa Mandra 'e Sa Giua	Hut A, older layer II	R-1098	2670	± 50	cal.BC 907 (814) 790	*RC* 20(1978): 72-3
Su Foxi 'e s'Abba	Cave deposit	R-1065α	2670	± 50	cal.BC 907 (814) 790	*RC* 20 (1978): 92
Su Foxi 'e s'Abba	Cave deposit	R-1065	2650	± 50	cal.BC 899 (807) 775	*RC* 20 (1978): 92
Sa Mandra 'e Sa Giua	Near Hut B	R-347	2600	± 70	cal.BC 894 (797) 525	*RC* 11(2)1969: 491

Sa Mandra 'e Sa Giua	Hut B upper layer	R-346	2460	± 70	cal.BC 797 (750, 746, 526) 391	*RC* 11(2)1969: 491
Peppe Gallu	Nuraghe	Pi-?			"6th-4th century BC"	Lilliu 1962: 42
Chia	Grave 1	K-559	2290	± 120	cal.BC 769 (381) 40	*RC* 6(1964): 223
Isola Spargi	Frame of wreck	P-851	2265	± 53	cal.BC 402 (370) 187	*RC* 8(1966): 354
Isola Spargi	Frame of wreck	P-850	2254	± 52	cal.BC 399 (366, 273, 267) 180	*RC* 8(1966): 354
Chia	Grave no. 2	K-558	2140	± 120	cal.BC 403 (173) cal.AD 120	*RC* 6(1964): 223
Su Tintirriolu	Layer 1b Trench C-8	R-885	1890	± 50	cal.AD 18 (125) 245	*RC* 20(1978): 91-2
Tharros	Area C, 2.8m bsl	RT-849B	1870	± 110	cal.BC 91 (cal.AD 135) cal.AD 416	*RC* 34(1)1992: 118
Tharros	Area C, 2.8m bsl	RT-849C	1640	± 130	cal.AD 119 (419) 660	*RC* 34(1)1992: 118
Tharros	Area C, 2.8m bsl	RT-849A	1190	± 160	cal.AD 562 (881) 1199	*RC* 34(1)1992: 118
Su Crucifissu Mannu	Tomb XVI layer 2	R-916	790	± 50	cal.AD 1167 (1263) 1296	*RC* 18(1976): 334
Oristano shipwreck	Sunken ship, 2m bsl	RT-705	100	± 100	cal.AD 1641 (1889, 1907, 1954) 1955	*RC* 29(1987): 102
Roman? bridge	Oak beam from bridge	R-63	340	± 60	cal.AD 1440 (1520, 1569, 1627) 1952	*RC* 6(1964): 82

Table 2 Radiocarbon dates from Corsica.

Site	Context	Lab. No.	^{14}C age	Error	2σ Calibrated age range (CALIB 3.0.3)	Reference
Strette	Layer XXIV	Ly-2837	9140	± 300	cal.BC 9015 (8091) 7538	*RC* 27(1985):437
Curacchiaghiu	Level 7	Gif-795	8560	+ 170	cal.BC 7967 (7543) 7106	*RC* 13(1971):221
Araguina-Sennola	Hearth, level XVIIIa	Gif-2705	8520	± 150	cal.BC 7923 (7535) 7105	*RC* 28(1986):20
Curacchiaghiu	Layer 7	Gif-1963	8300	± 130	cal.BC 7546 (7412, 7363, 7313) 7007	*RC* 16(1974):34
Basi	Level 7, site 1	Gif-1851	7700	± 150	cal.BC 7002 (6467) 6187	*RC* 16(1974):33
Curacchiaghiu	Layer 6c	Gif-1962	7600	± 180	cal.BC 6994 (6419) 6038	*RC* 16(1974):34
Curacchiaghiu	Layer 6a	Gif-1961	7310	± 170	cal.BC 6456 (6156, 6144, 6125, 6084, 6070) 5779	*RC* 16(1974):34
Curacchiaghiu	Level 6	Gif-796	7300	± 160	cal.BC 6426 (6122, 6087, 6063) 5805	*RC* 13(1971):221
Casabianda	Hearth 1	MC-2243	6670	+ 150	cal.BC 5784 (5575, 5543, 5528) 5283	Camps 1979:6
Araguina-Sennola	Hearth Level XVII	Gif-2325	6650	± 140	cal.BC 5742 (5571, 5546, 5526) 5283	*RC* 28(1986):20

Strette	Layer XXb	Ly-2836	6480	± 430	cal.BC 6172 (5432, 5390, 5390) 4460	*RC* 27(1985):437
Araguina-Sennola	Hearth F 3', Level XVIIe	Gif-2324	6430	± 140	cal.BC 5588 (5410, 5373, 5366, 5336) 5063	*RC* 28(1986):20
Strette	Layer XXb	Ly-2835	6420	± 300	cal.BC 5923 (5332) 4712	*RC* 27(1985):437
Strette	Couche XI-XIV	Gif-5520	5910	± 130	cal.BC 5194 (4787) 4466	Delibrias *et al.* 1987:221
Presa-Tusiu	Level 4		5820	± 130	cal.BC 4951 (4712) 4363	Lanfranchi 1992:120
Longone	Phase IV		5680	± 160	cal.BC 4905 (4507) 4170	Lanfranchi 1992:118
Tappa	Level VI, abri E AI	Gif-2104	5650	± 150	cal.BC 4833 (4466) 4164	*RC* 16(1974):34-5
Scaffa Piana	Couche XXII	MC-2057	5360	± 100	cal.BC 4435 (4228) 3969	Delibrias *et al.* 1982:186
Scaffa Piana	Couche XXI	MC-2054	5330	± 100	cal.BC 4355 (4222, 4192, 4156) 3957	Delibrias *et al.* 1982:186
Scaffa Piana	Couche XXI	MC-2056	5320	± 100	cal.BC 4352 (4220, 4195, 4151, 4111, 4107) 3953	Delibrias *et al.* 1982:186
Basi	Level 5e6	Gif-1849	5250	± 120	cal.BC 4343 (4038, 4015, 4006) 3786	*RC* 16(1974):33
Basi	Level 5b1	Gif-1848	5200	± 120	cal.BC 4328 (3986) 3716	*RC* 16(1974):33
Basi	Level 5b8	Gif-1850	5200	± 120	cal.BC 4328 (3986) 3716	*RC* 16(1974):33
Presa-Tusiu	Level 3b/3c		5150	± 130	cal.BC 4315 (3965) 3662	Lanfranchi 1992:120
Araggio	Hearth, room S	Gif-1000	5130	± 130	cal.BC 4244 (3958) 3649	*RC* 13(1971):221
Terrina IV	Level d1	MC-2077	4950	± 90	cal.BC 3958 (3709) 3535	Camps 1979:18
Curacchiaghiu	Layer 5	Gif-1960	4930	± 140	cal.BC 3990 (3702) 3372	*RC* 16(1974):34
Presa-Tusiu	Level 2b/2c		4890	± 130	cal.BC 3966 (3663) 3366	Lanfranchi 1992:120
Scaffa Piana	Couche XVIII	MC-2053	4775	± 90	cal.BC 3751 (3624, 3573, 3538) 3354	Delibrias *et al.* 1982:186
Terrina IV	Level d1	MC-2079	4720	± 300	cal.BC 4220 (3508, 3400, 3387) 2621	Camps 1979:18
Terrina IV	Level a	MC-2075	4690	± 90	cal.BC 3650 (3501, 3424, 3381) 3110	Camps 1979:18
Terrina IV	Level d2	MC-2235	4650	± 100	cal.BC 3645 (3491, 3483, 3372) 3046	Camps 1979:18
Carco-Modria	Level 4	Gif-4803	4640	± 130	cal.BC 3692 (3370) 2925	Delibrias *et al.* 1982:186
Terrina IV	Shell: Level d1	MC-1296	4610	± 110	cal.BC 3116 (2871) 256	Delibrias *et al.* 1982:186

Terrina IV	Level b	MC-2076	4450	± 120	cal.BC 3501 (3091, 3055, 3372) 3046	Camps 1979:1
Terrina IV	Level d3	MC-2237	4430	± 140	cal.BC 3506 (3075, 3067, 3040) 2669	Camps 1979:18
Terrina IV	Level c	MC-2232	4430	± 160	cal.BC 3616 (3075, 3067, 3040) 2618	Camps 1979:18
Terrina IV	Level d1	MC-1403	4420	± 100	cal.BC 3364 (3036) 2788	Camps 1979:18
Terrina IV	Level b	MC-2231	4380	± 80	cal.BC 3336 (3015, 2998, 2926) 2788	Camps 1979:18
Terrina IV	Level d2	MC-2236	4270	± 100	cal.BC 3254 (2888) 2581	Camps 1979:18
Terrina IV	Level d2	MC-2234	4210	± 160	cal.BC 3332 (2875, 2794, 2784) 2347	Camps 1979:18
I Calanchi Taffonu 2		Gif-7153	4080	± 60	cal.BC 2874 (2586) 2463	Cesari 1987b:321
Le Sanglier	Layer III	Ly-2980	4020	± 140	cal.BC 2907 (2558, 2530, 2497) 2137	*RC* 27(1985):429
Araguina-Sennola	Hearth F3, Level VI	Gif-779	3980	± 140	cal.BC 2886 (2468) 2041	*RC* 13(1971)220
Calzola-Castellucciu	Central monument	Gif-5117	3920	± 200	cal.BC 2913 (2455, 2412, 2409) 1785	Delibrias *et al.* 1982:186
I Calanchi Taffonu 6		LGQ-279	3910	± 150	cal.BC 2875 (2452, 2423, 2405) 1943	Camps & Cesari 1991:32
Tappa	Hearth, Niche B	Gsy-94B	3865	± 125	cal.BC 2844 (2321) 1947	*RC* 8(1966):130
Tappa	Niche B, hearth	Gif-94A	3857	± 100	cal.BC 2576 (2311) 1983	Grosjean 1962:214
Alo	Hearth, room W	Gif-480	3820	± 200	cal.BC 2877 (2277, 2225, 2207) 1689	*RC* 12(1970):424
I Calanchi Taffonu 3		Gif-7154	3740	± 60	cal.BC 2318 (2137) 1949	Cesari 1987b:354
Calzola-Castellucciu	Rockshelter 1, pt. E	Gif-5120	3680	± 120	cal.BC 2455 (2035) 1739	Delibrias *et al.* 1982:186
Cucurruzu			3580	± 70	cal.BC 2133 (1911) 1739	Camps 1988:198
Basi	Level IIIb	Gif-1847	3570	± 110	cal.BC 2197 (1892) 1625	*RC* 16(1974):33
Cucurruzu			3570	± 110	cal.BC 2197 (1892) 1625	Camps 1988:266
Araguina-Sennola	Level VII	Gif-778	3550	± 120	cal.BC 2197 (1884) 1529	*RC* 13(1971):220
Alo	Monument E floor	Gif-479	3500	± 120	cal.BC 2138 (1868, 1843, 1776) 1517	*RC* 12(1970):424
Monte d'Ortu			3490	± 190	cal.BC 2328 (1859, 1847, 1772) 1396	Camps 1988:266

Capula I	Level VII, Hearth FI	Gif-3530	3410	± 100	cal.BC 1945 (1731, 1728, 1686) 1449	*RC* 30(1)1988:77
Capula I	Level VIII	Gif-4033	3400	± 110	cal.BC 1962 (1683) 1428	*RC* 30(1)1988:77
Filitosa	Hearth, Level III	Gif-2399	3380	± 110	cal.BC 1937 (1677) 1419	*RC* 16(1974):34
Basi	Level IIIa	Gif-1846	3350	± 110	cal.BC 1895 (1625) 1404	*RC* 16(1974):33
Araguina Sennola	Level VId, Area A6	Gif-777	3300	± 120	cal.BC 1882 (1527) 1312	*RC* 13(1971):220
Castello de Ceccia 3	Lower layer	Gsy-120	3295	± 110	cal.BC 1874 (1526) 1318	*RC* 8(1966):130
Sant'Agata		MC-?	3290	± 80	cal.BC 1743 (1525) 1404	Camps 1979:20
Calzola Castellucciu	Sector I	MC-2213	3240	± 90	cal.BC 1734 (1513) 1311	Cesari 1987a:105
Curracchiaghiu	Hearth, Layer 3	Gif-1959	3230	± 130	cal.BC 1860 (1511) 1139	*RC* 16(1974):33
Tappa	Bottom of cella	Gif-94B	3168	± 110	cal.BC 1680 (1423) 1128	Grosjean 1962:214
Filitosa	Hearth, Room I	Gsy-58	3150	± 150	cal.BC 1743 (1414) 999	*RC* 8(1966):130
Calzola-Castellucciu	Sector I	MC 2214	3130	± 80	cal.BC 1525 (1405) 1138	Cesari 1987a:105
Cuntorba		Gif-1755	3110	± 60	cal.BC 1512 (1396) 1211	Delibrias *et al.* 1976
Alo	Hearth, monument E	Gif-478	3100	± 110	cal.BC 1606 (1392, 1332, 1329) 1021	*RC* 12(1970):424
Filitosa	Hearth, Level II	Gif-2398	3080	± 110	cal.BC 1590 (1381, 1342, 1321) 1004	*RC* 16(1974):34
Araguina-Sennola	Level VIa	Gif-776	3040	± 110	cal.BC 1518 (1294, 1284, 1268) 933	*RC* 13(1971):220
Capula I	Level VIb	Gif-3529	2960	± 100	cal.BC 1420 (1158, 1145, 1134) 901	*RC* 30(1)1988:76
Calzola-Castellucciu	Couche B1a	Gif-6133	2960	± 60	cal.BC 1382 (1158, 1145, 1134) 993	Cesari 1987a:105
Stantare	5th monolith	Gif-1396	2950	± 110	cal.BC 1425 (1152, 1149, 1130) 842	*RC* 13(1971):220
Araggio	Hearth A, Room N	Gif-1001	2930	± 120	cal.BC 1425 (1120) 822	*RC* 13(1971):221
Araggio	Hearth, Room E	Gif-899	2890	± 110	cal.BC 1397 (1034) 813	*RC* 13(1971):220
Castidetta-Pozzone	Main room of tower	LGQ-272	2870	± 140	cal.BC 1415 (1009) 795	Cesari 1992:115
Cucuruzzu	Area B.C.II, part Ba	Gif-241	2830	± 150	cal.BC 1406 (987, 956, 944) 768	*RC* 8(1966):86
Cucuruzzu	Corridor C I	Gif-240	2775	± 150	cal.BC 1379 (908) 536	Delibrias *et al.* 1976:893
Palaggiu	Base of menhirs	Gif-477	2680	± 150	cal.BC 1251 (818) 403	*RC* 12(1970):424

Palaggiu	Funeral Chest A	Gif-476	2650	± 150	cal.BC 1153 (807) 397	*RC* 12(1970):424
Calzola-Castellucciu	Sector I monument	Gif-5118	2650	± 90	cal.BC 988 (807) 532	Cesari 1987a:105
Tappa	Tower interior	Gsy-94A	2630	± 200	cal.BC 1265 (803) 247	*RC* 8(1966):130
Cucuruzzu	Sector A C II	Gif-239	2610	± 150	cal.BC 1112 (799) 388	*RC* 8(1966):86
Curracchiaghiu	Hearth F1, Layer 2	Gif-1958	2610	± 110	cal.BC 988 (799) 405	*RC* 16(1974):33
Calzola-Castellucciu	Couche A1b	Gif-5956	2580	± 90	cal.BC 902 (793) 407	Cesari 1987a:105
Filitosa	Bottom of Hut B	Gif-150	2550	± 170	cal.BC 1035 (778) 204	*RC* 8(1966):85
Araggio	Hearth A, room N	Gif-898	2500	± 110	cal.BC 838 (760, 672, 665, 632, 592, 584, 560) 376	*RC* 13(1971):220
Roja	Rockshelter (-20cm)	Ly-1912	2420	± 180	cal.BC 911 (413) 45	*RC* 25(1983):94
Calzola-Castellucciu	Cabane 2, couche A1	MC-2080	2330	± 80	cal.BC 759 (393) 192	Cesari 1987a:105
Stantare	Base of 5th monolith	Gif-1397	2120	± 110	cal.BC 395 (157, 137, 125) cal.AD 120	*RC* 13(1971):220
Stantare	Base of monolith	Gif-2103	2080	± 110	cal.BC 385 (58) cal.AD 141	*RC* 16(1974):34
Musolo	Base of statue menhir	Gif-151	1540	± 150	cal.AD 214 (544) 783	*RC* 8(1966):86
Calzola-Castellucciu	Abri I, couche A1b	Gif-5119	430	± 80	cal.AD 1397 (1449) 1651	Cesari 1987a:105

Abbreviations used in table

BAR: British Archaeological Reports

MMA: Monographs in Mediterranean Archaeology

PACT: *Journal of the European Study Group on Physics, Chemistry and Mathematical Technology Applied to Archaeology*

RC: *Radiocarbon*

Notes

1 A preliminary version of this paper was presented at the 93rd Annual Meeting of the Archaeological Institute of America, December 30, 1991, in Chicago, Illinois (abstract published in *American Journal of Archaeology* 96, 2: 371-2).

2 Since this article was written, six new radiocarbon dates from Monte d'Accoddi, several km south-east of Porto Torres in north-west Sardinia, have been reported (Tinè 1992). The first, UZ-2475 (4440 ± 85, c.3360 - 2890 cal. BC), pertains to the collapse of a large menhir pre-dating the construction of the first sanctuary on the site. This date has thus been considered a *terminus ante quem* for the abandonment of the Ozieri village (Tinè & Traverso 1992: xxxiii-xxxiv) and is in excellent agreement as such with other Ozieri dates and the chronological scheme proposed above.

Four dates from the Sanctuary's first phase, two from the pavement of the *sacello* and all associated with sub-Ozieri or Filigosa ceramics, are statistically identical, averaging 4890 ± 32 BP (UtC-1465, 4870 ± 50 BP; UtC-1466, 4810 ± 80 BP; UtC-1467, 4970 ± 100 BP; UtC-1468, 4920 ± 50 BP). The calibrated range for these dates (3750 - 3630 cal. BC) seems to be a few centuries too old for the sub-Ozieri and suggests either re-use of wood from the underlying Ozieri village, or the possibility that the Sanctuary was actually first erected late in the Ozieri period.

The sixth date, associated with Abealzu ceramics from the second phase of the Sanctuary (UtC-1464, 4540 ± 90 BP, c.3510 - 2920 cal. BC), is consistent with the early 3rd millennium BC date I have proposed here for the Abealzu culture. Further radiocarbon dates from Monte d'Accoddi and other sites will continue to refine the late neolithic and chalcolithic chronology of Sardinia.

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