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PLOTTING THE EVIDENCE: SOME ASPECTS OF THE RADIOCARBON CHRONOLOGY OF THE MESOLITHIC-NEOLITHIC TRANSITION IN THE MEDITERRANEAN BASIN

RIASSUNTO – *Il plotting dei dati: alcuni aspetti della cronologia radiocarbónica del periodo di transizione dal Mesolitico al Neolitico nel bacino del Mediterraneo.* Il presente lavoro prende in esame alcune delle sequenze stratigrafiche meglio radiodate di una regione del Mediterraneo compresa fra l'Egeo occidentale ed il Tirreno orientale. I risultati radiometrici di queste sequenze presentano sempre delle lacune di centinaia di anni, particolarmente evidenti nei diagrammi di calibrazione, che riguardano spesso il periodo di passaggio dallo stadio climatico Boreale all'Atlantico. Questo dato analitico, che non è mai stato preso in esame nel dibattito riguardante il processo di neolitizzazione del territorio in esame, merita una seria considerazione specialmente per quelle seriazioni che sono state talvolta considerate "continue" e fondamentali nell'interpretazione dei dati, spesso in realtà controversi e presentati, a seconda delle tendenze dei singoli autori, in modo discutibile.

SUMMARY – *Plotting the evidence: some aspects of the radiocarbon chronology of the Mesolithic-Neolithic transition in the Mediterranean basin.* This paper examines some of the best radiocarbon dated sequences of a well-defined Mediterranean region comprised between the west Aegean and the east Tyrrhenian Seas. The radiocarbon dates of these sequences always show clear gaps that are particularly evident in the calibration diagrams. These gaps, that cover spans of at least a few hundred years, often regard the period between the Boreal and the Atlantic climatic stages. This analytical datum, which has never been taken into question in the debate regarding the Neolithisation process in the area, needs serious consideration especially in the case of those sequences that have always been considered "continuous" and of fundamental importance for the understanding of the phenomenon. In fact, the data to date available are controversial. According to the different authors, they have sometimes been interpreted in opposite and often questionable ways.

1. PREFACE

During the last thirty years great emphasis has been given to the occurrence of "continuous" stratigraphic sequences (PERLES, 1999: 317) covering the last stages of the Pleistocene and/or the beginning of the Holocene in different areas of the Mediterranean. The interpretation of many of them has often been difficult for various reasons, sometimes also because of the lack of their detailed publication. The aim of this paper is to take into consideration some of the most important of these sequence from which a good series of radiocarbon dates has been obtained and to discuss their importance for the understanding of the Mesolithic/

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Neolithic transition in an area that lies between the western Aegean and the eastern Tyrrhenian Seas.

2. THE SITES

The sequences that have been taken into consideration for this paper are mainly from caves with the exception of that of the Romagnano rock-shelter in the south Alpine arc of Trentino. They are those of Cyclope in the Youra Island (GR), Theopetra in Thessaly (GR), Uzzo in north-western Sicily (I), Scaloria in Apulia (I), Grotta del Santuario della Madonna in north-west Calabria (I), Corbeddu in central-eastern Sardinia (I), Edera in the Trieste Karst (I), Arene Candide in western Liguria (I) and of the rock-shelter of Romagnano III in the Adige Valley (I) (fig. 1).

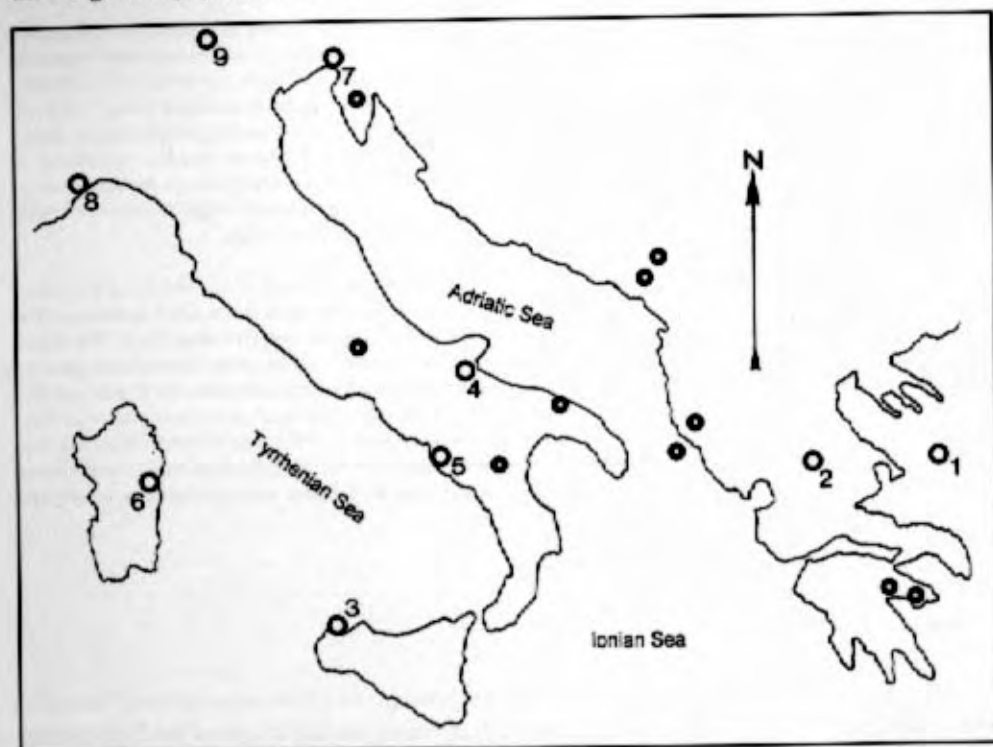


Fig. 1 - Distribution map of the archaeological sequences discussed in this paper: 1) Cyclope Cave, 2) Theopetra Cave, 3) Grotta dell'Uzzo, 4) Grotta Scaloria, 5) Grotta del Santuario della Madonna, 6) Grotta Corbeddu, 7) Grotta dell'Edera, 8) Grotta delle Arene Candide, 9) Romagnano III rock-shelter. The small circles indicate the location of other sequences of major importance discussed in this paper (drawn by P. Biagi).

2.1 CYCLOPE CAVE

The Cave of Cyclope is located in the Island of Youra, in the Northern Sporades. More precisely it opens "on the south-west side of the island, about 150 m. above sea level" (SAMP-

SON, 1998: 1). Excavations at the cave took place between 1992 and 1996. Two main trenches were opened, near the entrance and in the central part of the main hall, respectively called C and A (SAMPSON, 1998: 3). The excavations revealed that the site had been inhabited during the Mesolithic and the Neolithic periods, and that "two or more Mesolithic phases may exist in the cave" (SAMPSON, 1998: 12).

A good set of radiocarbon dates has been obtained, mainly from Trench C, from both charcoal and marine shellfish samples (fig. 2). Following SAMPSON *et al.* (1998: 125), the Mesolithic occupation (spits 20-8) has been dated between 9428 ± 52 BP (DEM-597: charcoal from spit 14) and 8218 ± 43 BP (DEM-368: marine shells from spit 6). The dating of the overlying Neolithic horizons is more complicated given that spit 7 has a date of 7803 ± 41 BP (DEM-369: from marine shells) and spit 6 two dates of 7971 ± 41 BP (DEM-370: from marine shells) and 7398 ± 64 BP respectively (DEM-393: from charcoal).

Recent research on the reservoir age in that part of the Mediterranean, has shown that a correction of some 520 years should be applied to the shell samples of that region (SIANI *et al.*, 2000: 273). This indicates that, after correction, the two dates DEM-370 and DEM-393 are almost identical and that the earliest Neolithic occupation of the cave most probably took place during the second half of the eighth millennium BP.

Regarding the stratigraphy of these horizons, SAMPSON (1998: 12) reports that "the transition from the ceramic to the aceramic levels of the pre-Neolithic stage is not always clear. A transitional layer of light brown colour, about 0.20 m. thick, existed in several squares of trench C, but was always totally absent in the rest of the trench and trench B".

The first Neolithic ceramic assemblage is mainly represented by monochrome and red-on-white painted wares of Sesklo type. The scarce chipped stone assemblage includes obsidian and flint tools, among which are sickle blades and geometric instruments such as lunates, triangles and bladelets with opposed, oblique truncations already recorded from the Mesolithic layers (SAMPSON *et al.*, 1998: 131). The presence of geometric tools from both Mesolithic and Neolithic layers could be explained in two ways: 1) this lithic industry might be compared to those of continental Greece and the Anatolian Peninsula that show an analogous development or 2) the geometries might derive from a contamination of the Mesolithic and of the Early Neolithic levels by obsidian artefacts from later Neolithic horizons (SAMPSON *et al.*, 1998: 133).

According to the radiocarbon evidence the cave was uninhabited between 7398 ± 64 BP (DEM-393) and 6834 ± 40 BP (DEM-266). It means that the radiocarbon gap between the Mesolithic and the first Neolithic, around the beginning of the Atlantic, is of some 550 radiocarbon years (fig. 3).

2.2 THEOPETRA CAVE

Theopetra Cave opens at the altitude of 280 m, along the north-western slope of an isolated limestone formation that faces the valley of the Pencios River (fig. 4), at the north-westernmost edge of the Thessalian Plain (KARKANAS, 1999: 241). The excavations began in 1987 and are still in progress. Theopetra is the only deposit in Greece that revealed a long sequence, some 6.5 m thick, ranging from the Middle Palaeolithic (FACORELLIS and MANIATIS, 1999) to the end of the Neolithic (ADAM, 1999: 266) including layers attributed to the Mesolithic and to the beginning of the Neolithic.

According to the excavator (KYPARISSI-APOSTOLIKA, 1998: 247) "the appearance of an

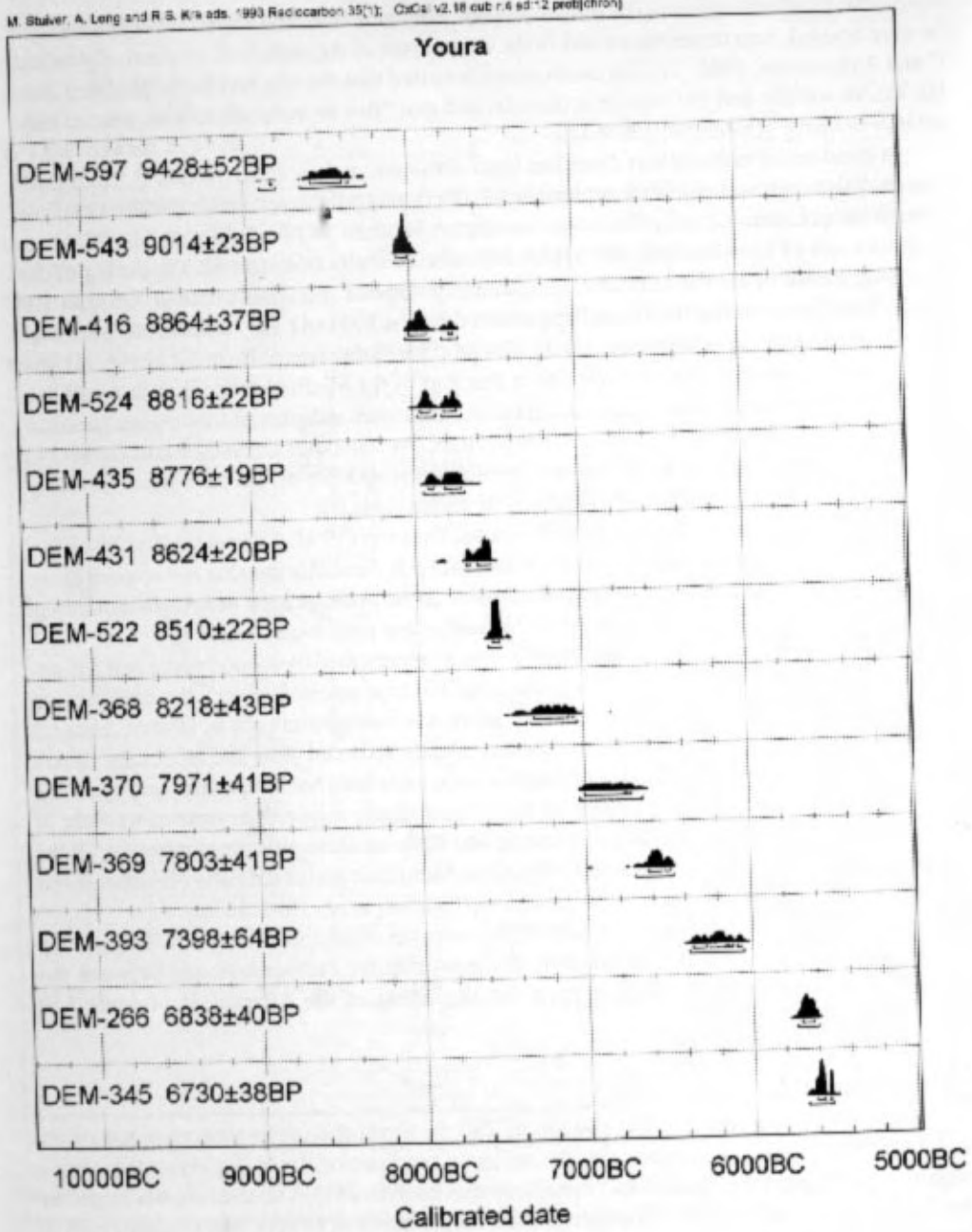


Fig. 2 - Cyclope Cave: graph of the radiocarbon dates calibrated using the OxCal (version 2.18) calibration program (Stalder *et al.*, 1993).

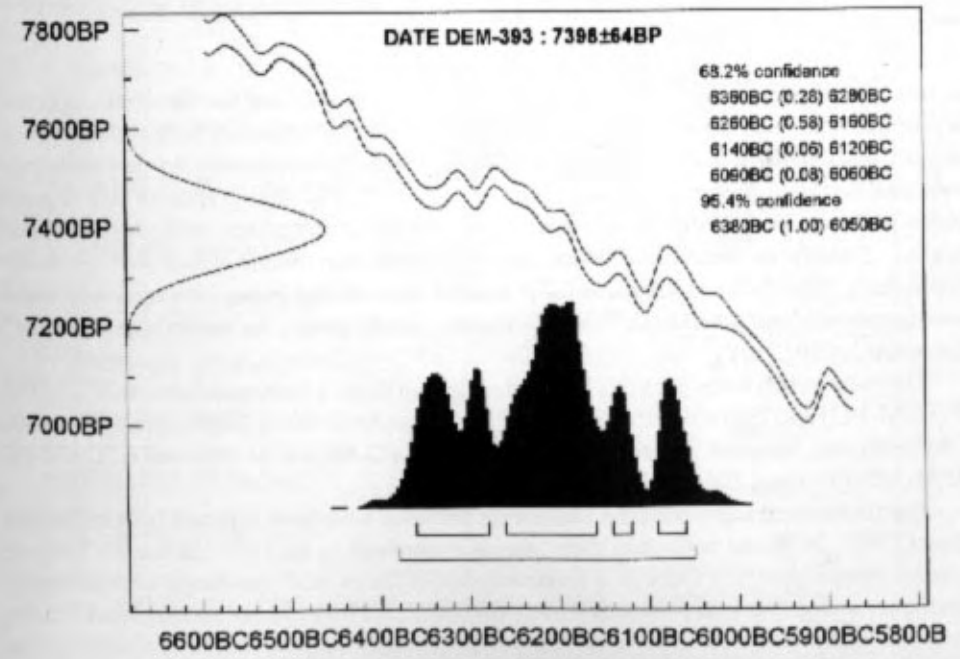
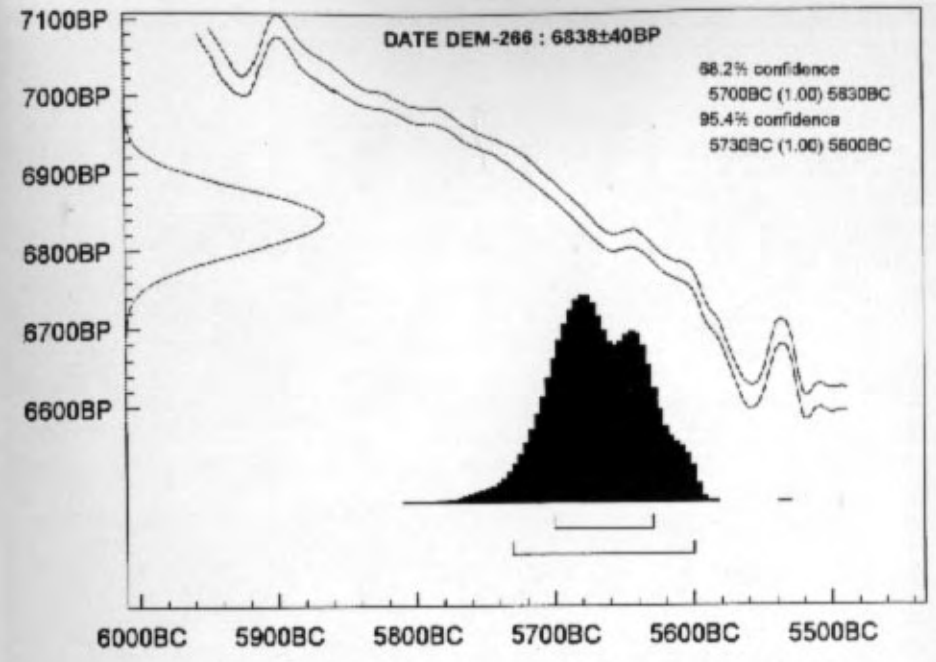


Fig. 3 - Cyclope Cave: graphs of the radiocarbon dates DEM-266 (top) and DEM-393 (bottom) calibrated using the OxCal (version 2.18) calibration program.

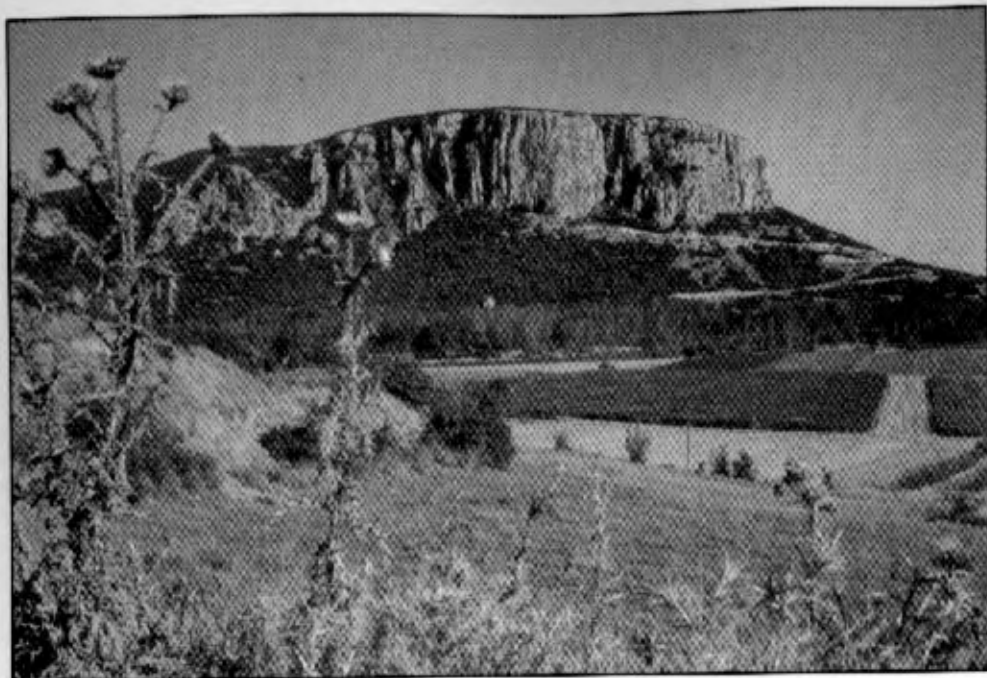


Fig. 4 - Theopetra Cave: view of the limestone hill where the cave opens at the bottom of the upper cliff, from the Peneios Valley (photo P. Biagi).

intervening sandy layer (90 cm thick) between the Palaeolithic and the Neolithic.....sets the problem of the existence of the Mesolithic in this cave. This layer, with characteristics of humidity and extensive use of fire in combination with use of clay locally, has not appeared under the Neolithic deposit in all the areas of the cave". The stratigraphy of this deposit seems to have been subject to "erosional events alternating with depositional ones.....Postglacial invasion of karstic waters formed deep troughs which were probably intentionally filled by loose soil material. A natural depositional event, interrupted by small burning episodes and dated to the Early Holocene, locally covers the underlying sequence" (KARNAKAS, 1999: 250).

The radiocarbon dates from this Mesolithic deposit cover a time-span between 9721±390 BP (DEM-142) and 7901±29 BP (DEM-918) (KYPARISSI-APOSTOLIKA, 2000: 136), while those of the overlying Neolithic layers range between 6890±43 BP (DEM-455) and 6222±38 BP (DEM-122) (THISSEN, 2000: 142).

The flint assemblages from the Mesolithic horizons have been summarily described by ADAM (1999: 267) who notes that they "are characterised by lack of evidence for laminar débitage production.....There is a large number of flakes with transverse or multidirectional dorsal negative and practically no bladelets.....There are no backed bladelets, no geometric microliths and no evidence for the practice of the microburin technique". The only illustrated tools are two notched flakelets and two fragmented instruments on blade. Compared with the Neolithic flint assemblage "arises a clear continuity with the Mesolith-

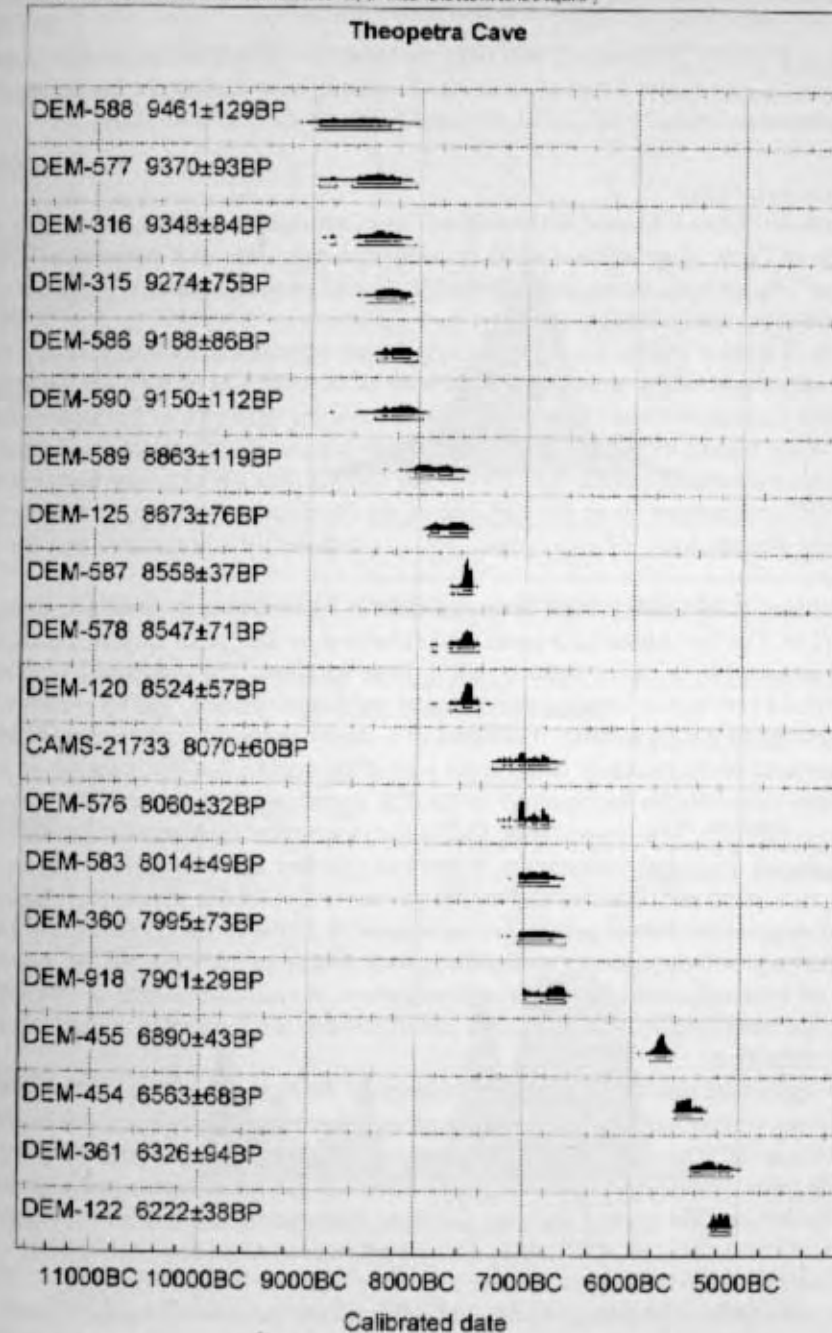


Fig. 5 - Theopetra Cave: graph of the radiocarbon dates calibrated using the OxCal (version 2.18) calibration program.

ic" in the use of the same raw material and in the technology of the implements (KYPARISSI-APOSTOLIKA, 2000: 135).

As already noted by THISEN (2000: 142), the Mesolithic-Neolithic radiocarbon sequence of this cave (fig. 5) shows a gap of some one thousand years around the beginning of the Atlantic, between 7901 ± 29 BP (DEM-918) and 6890 ± 43 BP (DEM-455) (fig. 6).

2.3 GROTTA DELL'UZZO

Grotta dell'Uzzo is located in the Gulf of Castellammare (north-western Sicily), south of S. Vito lo Capo, at an altitude of 65 m, along the right side of a gorge locally called "Canalone". Its opening, facing north, lies at the edge of a small, cultivated plain that slopes down gently into the Tyrrhenian sea (fig. 7).

It was first excavated by VAUFREY (1928) and later rediscovered by Borzatti von Löwestern. The importance of the archaeological deposit of the cave was pointed out by MANNINO (1973) who excavated a small test trench that revealed the existence of Epipalaeolithic industries at the bottom of the sequence. The Istituto Italiano di Paleontologia Umana later resumed the excavations during the 1980s. They showed that the cave had been inhabited through different periods, from the very end of the Pleistocene (PIPERNO, 1985: 83) to the Copper and Bronze Ages (TAGLIACCOZZO, 1993: 7) including the Mesolithic and the Early Neolithic.

The deposits of trench F have been excavated in horizontal spits of 10 cm, down to a depth of 5 m. The lowermost layer (spits 48-33) belongs to the end of the Late Palaeolithic. It is characterised by a clayey deposit rich in large boulders. The uppermost spits of this layer yielded a very scarce, atypical flint industry and faunal remains. The layer above (spits 32-10) belongs to the Mesolithic. It consists of a clayey sediment, rich in clastic pebbles, whose number greatly increases in the upper part of the deposit that becomes almost exclusively stony. According to the typology of the flint assemblages it has been subdivided into two main complexes. The lower (spits 32-23) is characterised by triangular geometric microliths, abrupt retouched instruments, a few end scrapers and burins. It has been dated between $10,070 \pm 90$ BP (P-2736) and 9030 ± 100 BP (P-2556); the upper, attributed to an advanced stage of the Boreal period, has been dated to 8330 ± 80 BP (P-2735). It yielded a flint assemblage without geometric microliths, with unique instruments such as nosed end-scrapers on bilaterally notched blades and truncations. A radiocarbon date of 7910 ± 70 BP (P-2734) has been obtained from the upper part of this deposit, referred to as the Mesolithic-Neolithic transition.

The uppermost part of the sequence belongs to the Early Neolithic. This deposit, of brown colour, without pebbles, yielded a few structural remains consisting of one hearth and a curved stonewall. The material culture assemblage is represented by a lithic industry, with high blade index, including trapezoidal *flèche tranchant* arrowheads obtained with the microburin technique. The pottery includes *Cardium*, instrumental and finger Impressed Ware fragments (COSTANTINI *et al.*, 1987: 403). This layer has been dated to 6750 ± 70 BP (P-2733) and 6720 ± 80 BP (UD-165) (TAGLIACCOZZO, 1993: 11; SKEATES, 1994: 263) (fig. 8).

The radiocarbon chronology so far obtained from this cave shows a gap of some 1150 radiocarbon years between the "transitional" Meso-Neolithic occupation and the beginning of the Early Neolithic (fig. 9).

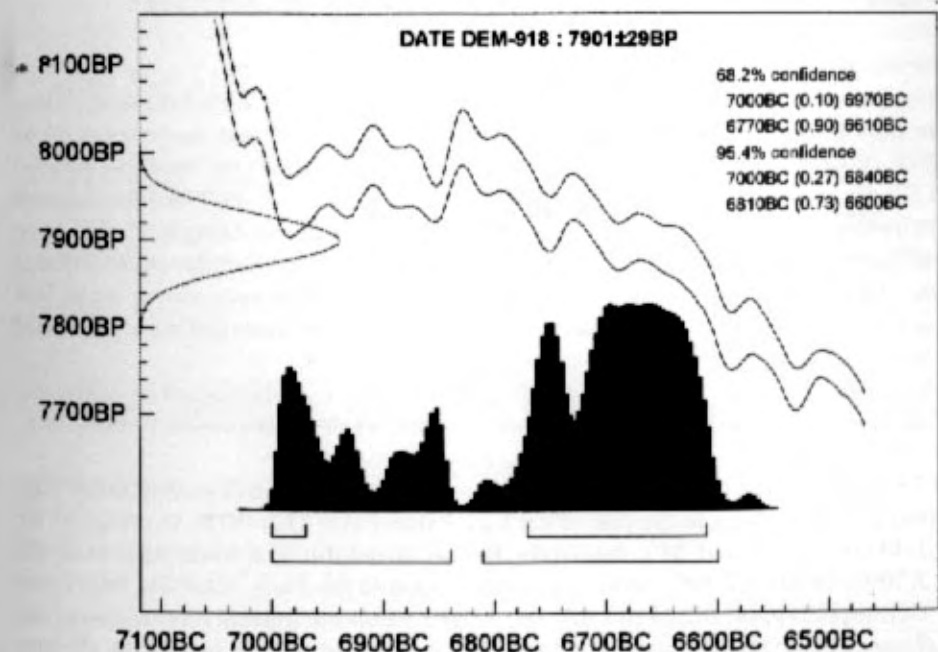
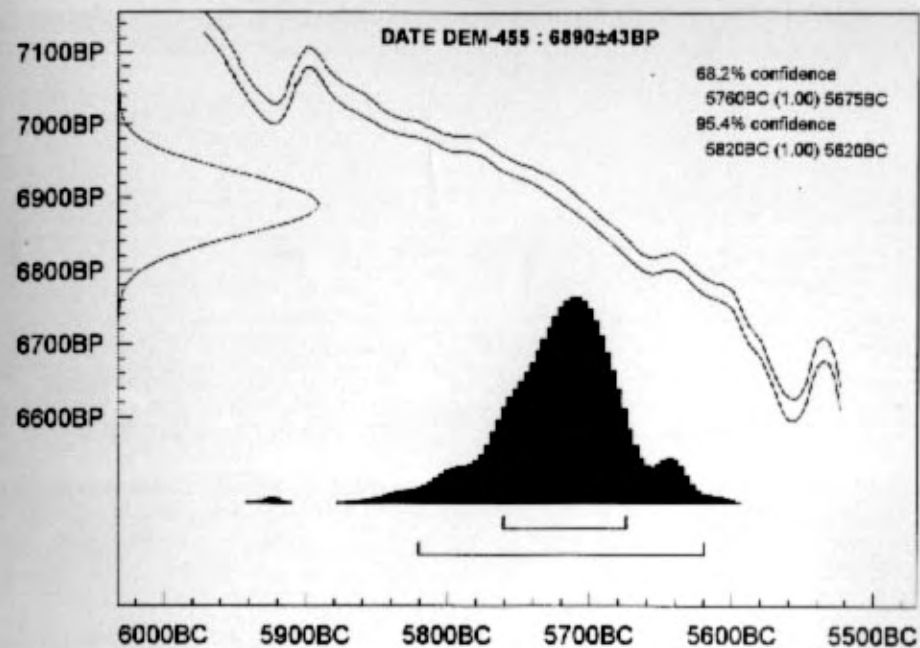


Fig. 6 - Theopetra Cave: graphs of the radiocarbon dates DEM-455 (top) and DEM-918 (bottom) calibrated using the OxCal (version 2.18) calibration program.



Fig. 7 - Grotta dell'Uzzo: view of the cave entrance from the Castellammare Gulf (photo P. Biagi).

2.4 GROTTA SCALORIA

The Scaloria Cave opens in the suburbs of Manfredonia at the altitude of 45 m, some 1.5 km from the present-day sea-shore. It was discovered in 1930 and later excavated by Quagliati (RELLINI, 1934: 76) who brought to light a great quantity of Neolithic painted wares. The excavations were later resumed by Tiné (TINÉ and ISETTI, 1975-80) who opened several trenches at the entrance and in the inner part of the "Camerone Quagliati". Although none of these trenches yielded a complete sequence of the cultural horizons represented at the cave, and none of their profiles has ever been published, they revealed that it had first been settled around the end of the Late Palaeolithic and then re-inhabited during different periods of the Neolithic.

According to the above-mentioned authors, the ceramic assemblages can be referred to the Neolithic cultural sequence already known from the Tavoliere (WHITEHOUSE, 1969; TINÉ, 1983: Tav. 126).

Charcoal samples from seven different trenches have been radiocarbon dated (fig. 10). Two of these belong to the end of the Late Palaeolithic (LJ-4979: 11,040±190 BP and LJ-4978: 10,790±210 BP), two to the Boreal Mesolithic (LJ-4982: 9560±140 BP and LJ-5098: 9030±120 BP), while the others belong to the Early Neolithic Impressed Ware Culture (LJ-4649: 6720±100 BP) and to later Neolithic aspects represented at the cave (LINICK, 1984: 99; WHITEHOUSE, 1986: 42). According to these results the chronological gap between the Mesolithic and the Early Neolithic is of at least 2300 radiocarbon years (fig. 11).

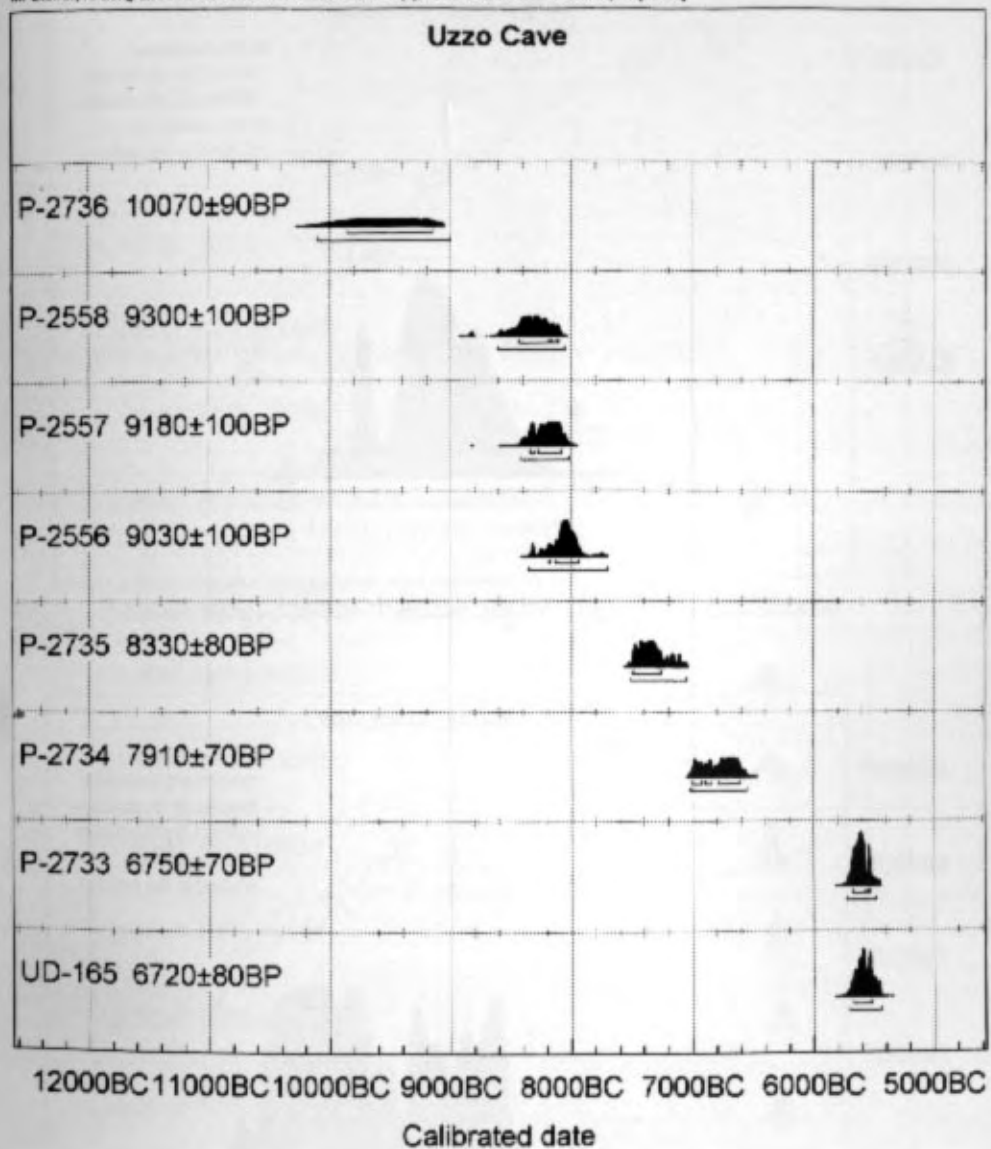


Fig. 8 - Grotta dell'Uzzo: graph of the radiocarbon dates calibrated using the OxCal (version 2.18) calibration program.

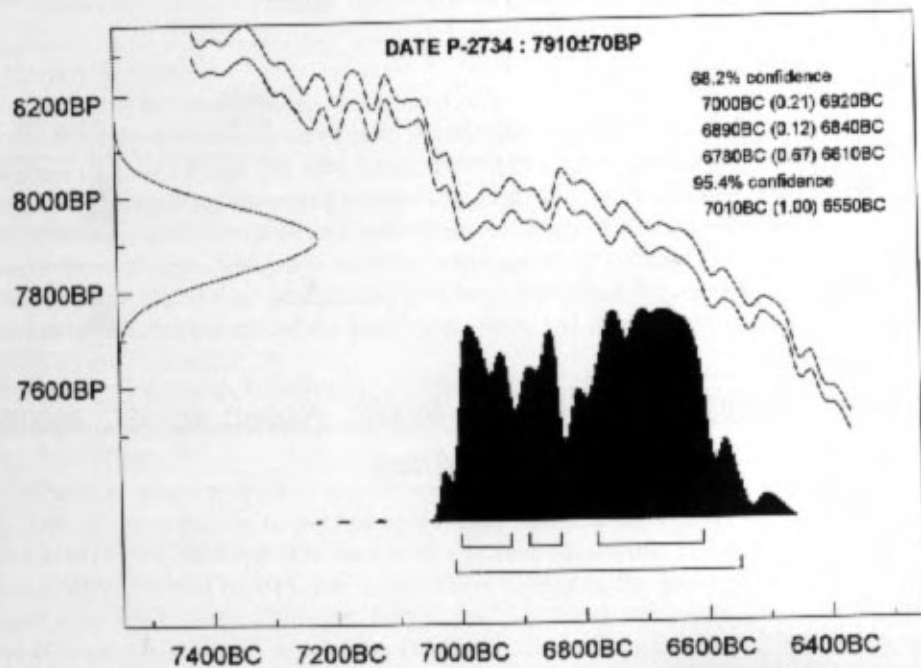
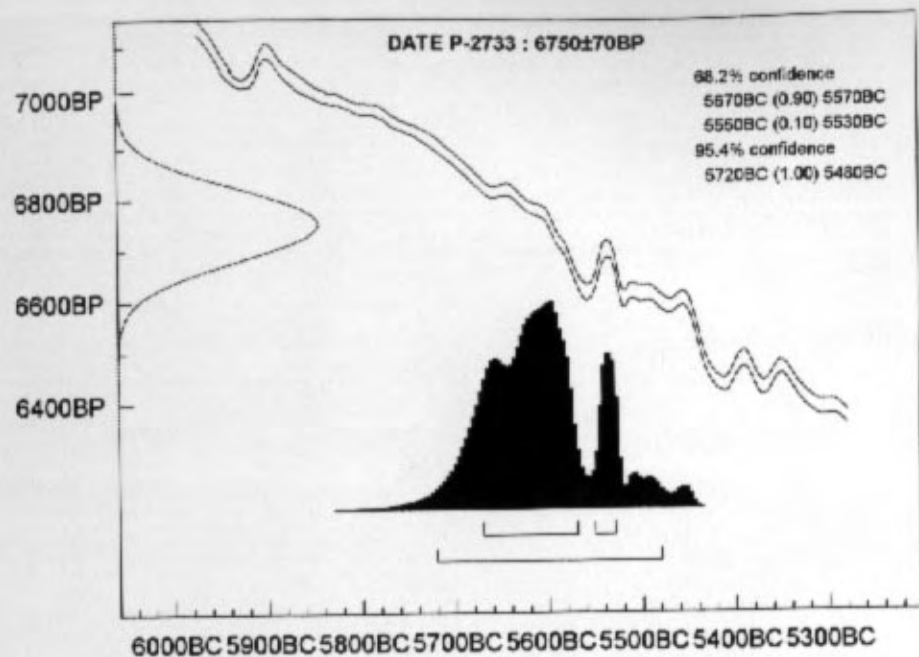


Fig. 9 - Grotta dell'Uzzo: graphs of the radiocarbon dates P-2733 (top) and P-2734 (bottom) calibrated using the OxCal (version 2.18) calibration program.

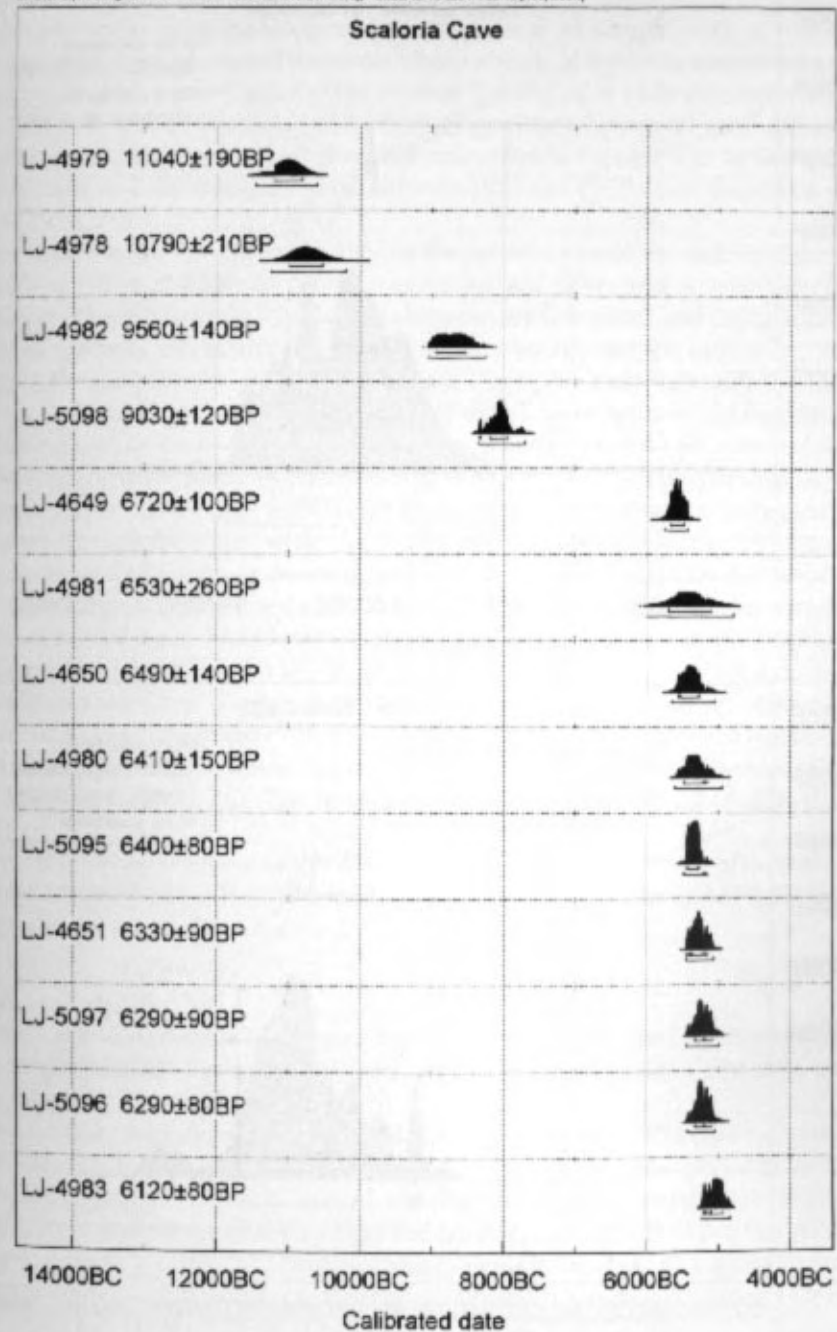


Fig. 10 - Grotta Scaloria: graph of the radiocarbon dates calibrated using the OxCal (version 2.18) calibration program.

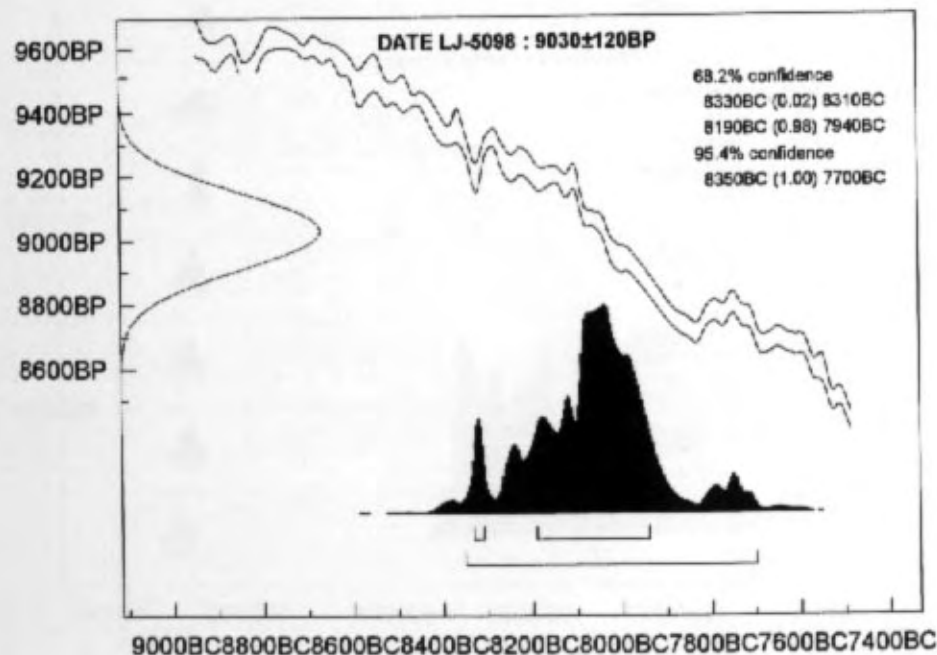
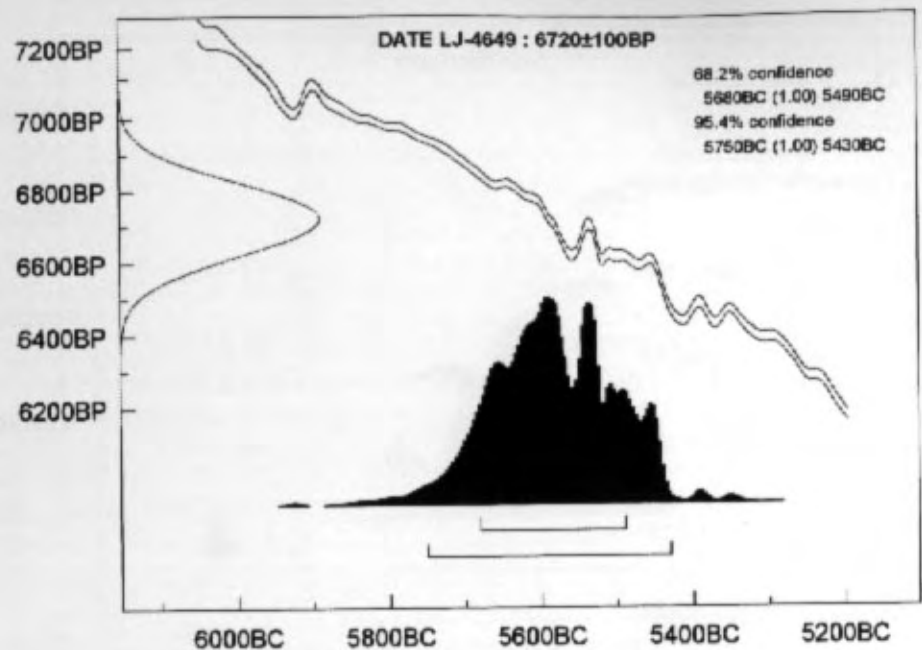


Fig. 11 - Grotta Scaloria: graphs of the radiocarbon dates LJ-4649 (top) and LJ-5098 (bottom) calibrated using the OxCal (version 2.18) calibration program.

2.5 GROTTA DEL SANTUARIO DELLA MADONNA

The cave opens along the slopes of Serra Vignolo, at an altitude of 42 m, some 500 m from the present coastline, east of the town of Praia a Mare, at the north-westernmost edge of the Province of Cosenza in Calabria. The site was first visited in 1879 and, between the end of the nineteenth and the beginning of the following century, by several other scholars both archaeologists and quaternary geologists. The excavation of the cave was carried out by the Istituto Italiano di Paleontologia Umana between 1957 and 1970 under the direction of L. CARDINI (1970: 34).

The main trench was opened in 1957 in the western side of the main hall down to a depth of 8 m, where a sterile clay deposit was reached and hand cored down to a depth of 12 more metres. The excavation of the deposits between the first trench and the staircase at the entrance of the cave, was carried out in 1960, while a smaller one was opened in 1968.

The first occupation of the cave took place during the Late Palaeolithic, Final Epi-gravettian Culture. The lowermost spits 71-72 of layer I. were dated to 12,100±150 BP (R-293: charcoal), while the over-lying ones, between spits 49-50 and 64-65, were radiocarbon dated between 10,850±100 BP (R-292: charcoal) and 9020±125 BP (R-286: charcoal). Spits 45-46 were attributed to the Mesolithic only on the basis of some changes in the structure of the chipped stone assemblage, while the deposit shows identical sedimentary characteristics. The lithic industry shows a decrease in the number of the abrupt retouched instruments, of both geometrics and points, and a rapid increase in the percentage of the side scrapers and of the denticulated tools. The Mesolithic layer I has been dated between 9070±80 BP (R-188: burnt bones) and 8735±80 BP (R-187: charcoal), while a more recent date has been obtained from a sample of *Trochus* shells collected from spits 49-50 (R-288: 8600±120 BP). The ceramic assemblage of the overlying Neolithic layer H is characterised by red-painted *figulina* wares associated to a few Impressed Ware potsherds of Stentinello type (BERNABÒ BREA and CAVALIER, 2000: 36). This layer has been dated to 7555±85 BP (R-285: charcoal) (fig. 12).

The radiocarbon sequence of this deposit should indicate an absence of human activity in this part of the cave of at least 1050 radiocarbon years, between the end of the Boreal and the beginning of the Atlantic climatic periods (fig. 13).

2.6 GROTTA CORBEDDU

Cave Corbeddu opens in the Jurassic limestone formation of the Lanaittu Valley, along the eastern slopes of Mt. Corrasi, near Oliena, in central-eastern Sardinia. The cave, some 80 m long, consists of four halls.

Two trenches were opened in halls 1 and 2 between 1982 and 1991 (KLEIN HOFMEIER *et al.*, 1987-88; SONDAAR *et al.*, 1993). Hall 1 revealed a stratigraphy composed of three main deposits, the uppermost of which, layer A, contained Bronze Age pottery; layer B yielded a material culture assemblage of different age and typology, whose bottom part has been dated to 8690±110 BP (Utc-726); the lowermost clayey deposit (layers C-F) yielded Pleistocene faunal remains associated with a scarce lithic assemblage. It was dated between 14,600±200 BP (Utc-725) and 11,200±170 BP (Utc-719).

The trench opened in hall 2 showed a similar, even though more detailed stratigraphy. From the top to the bottom, layer 1 is a brown clayey level, 35 cm thick, with domestic fauna

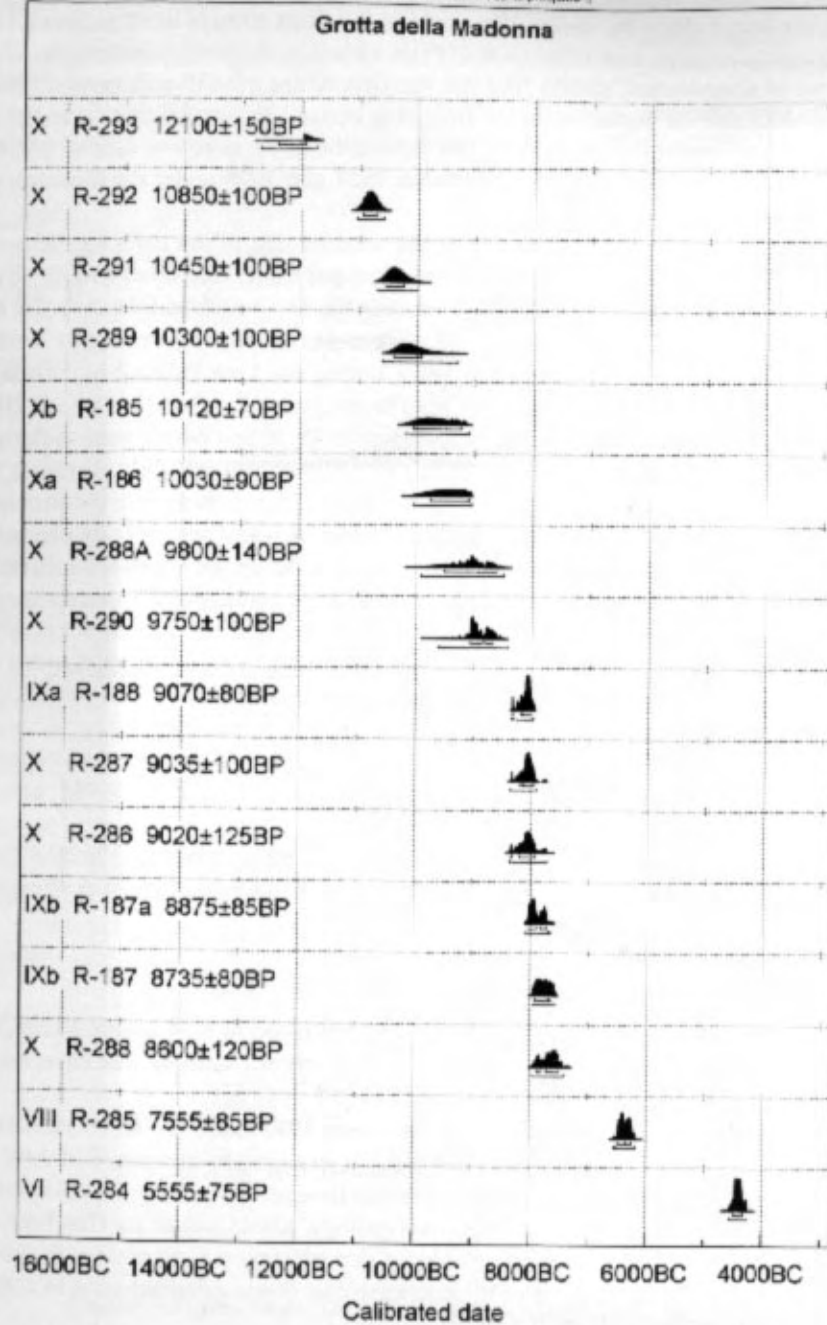


Fig. 12 - Grotta del Santuario della Madonna: graph of the radiocarbon dates calibrated using the OxCal (version 2.18) calibration program.

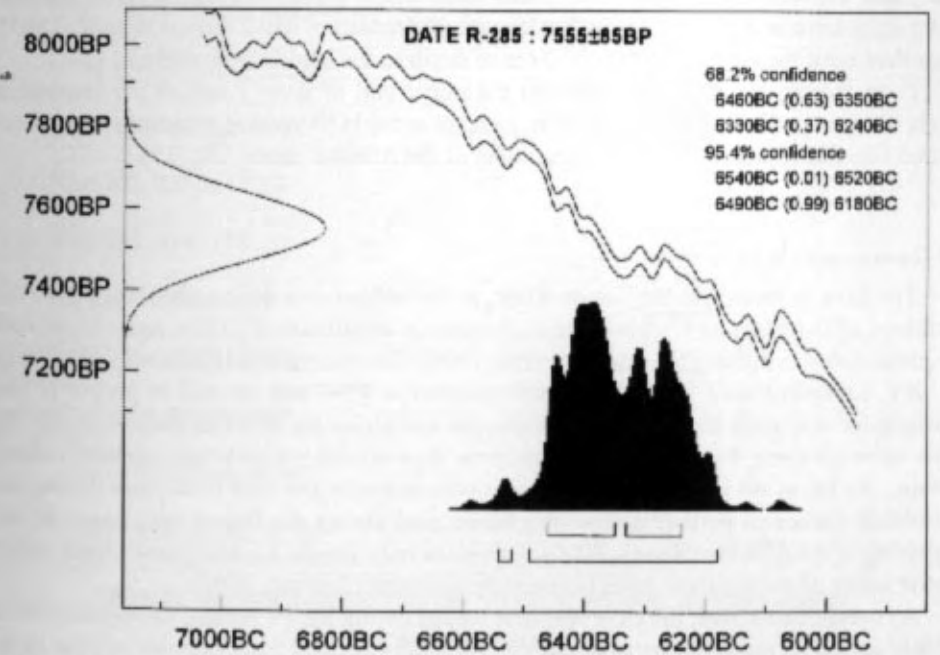
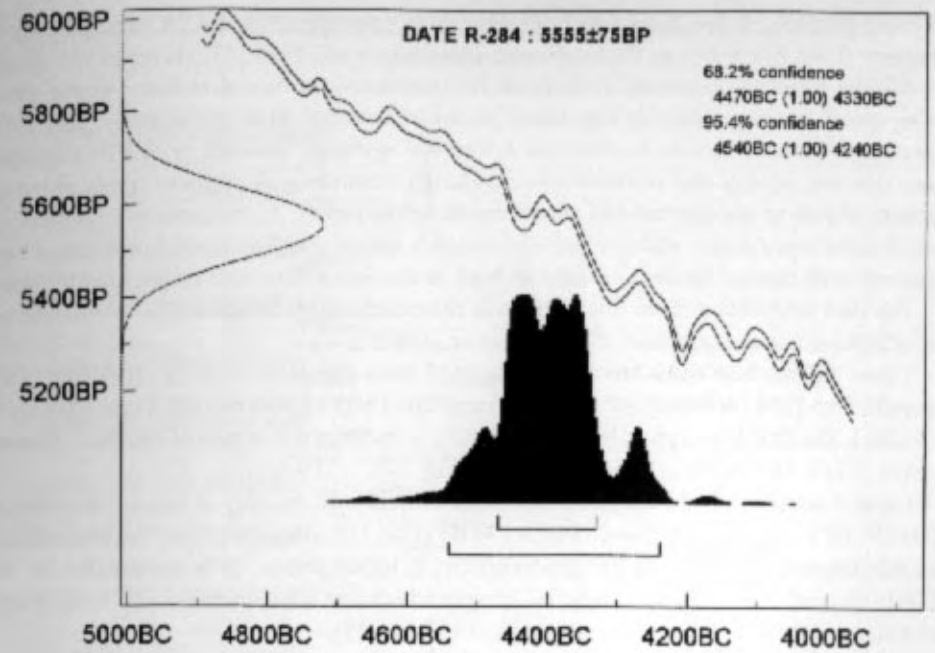


Fig. 13 - Grotta del Santuario della Madonna: graphs of the radiocarbon dates R-284 (top) and R-285 (bottom) calibrated using the OxCal (version 2.18) calibration program.

and lithic artefacts. It has been subdivided into two sub-layers, 1a and 1b, separated by a stalagmite floor. According to the excavators (SONDAAR *et al.*, 1988: 232) layer 1a contained only Middle Neolithic material, while layer 1b "characterized by a dark loose mould, containing small laminar scales of limestone, presents charcoal, bones of domestic and wild animals, of *Prolagus sardus*, marine and terrestrial molluscs, remains of fish and crustaceans, ceramic objects and obsidian lithic industry, sometimes at different levels showing alternate phases of occupation and abandonment of the cave.....Fragments of pottery of a rough unadorned paste, with grains, with roughly smoothed surfaces, handles and two fragments with cordial decoration take us back to the lower Neolithic of the Mediterranean". The flint assemblage from this horizon is characterized by obsidian "geometric micro-liths of different shape and size" (SONDAAR *et al.*, 1988: 233).

Three radiocarbon dates have been obtained from this layer, Utc-22 (8040±180 BP; charcoal), Utc-1251 (6690±80 BP; charcoal) and Utc-15/233 (6490±90 BP; bone) (SKEATES, 1994: 266). The first is preferred by the excavators to indicate the impact of Neolithic man in the cave (KLEIN HOFMEIJER *et al.*, 1987-88: 41) (fig. 14).

Layer 2 consists of a 50 cm thick limestone breccia with red clay. It was dated between 7860±130 BP (Utc-301: bone) and 11040±130 BP (Utc-250: charcoal). The flint assemblage from this deposit, attributed to the pre-Neolithic, is rather scarce. It is represented by six artefacts chipped from local raw material, among which one infra-marginal side scraper and one notched flakelet (KLEIN HOFMEIJER *et al.*, 1987-88: 49).

Layer 3 is a red clay deposit 75 cm thick, dated between 13,620±180 BP (Utc-239: bone) and 11,980±140 BP (Utc-241: bone) from which comes one single lithic artefact. Older dates have been obtained from the lowermost deposits of hall 2 (SONDAAR *et al.*, 1993). They date back the deposits below 5.50 cm of depth to the Middle Palaeolithic.

Even though the radiocarbon age of the upper part of layer 2 and of the lowermost levels of layer 1 of hall 2 is not very clear, a gap of some 1150 years is present between Utc-22 and Utc-1251, that is around the beginning of the Atlantic period (fig. 15).

2.7 GROTTA DELL'EDERA

The cave is located in the Trieste Karst, at the bottom of a doline (fig. 16), just to the northwest of the Aurisina marble quarries. It opens at an altitude of 238 m, some 3 km from the present-day coastline (BIAGI and VOYTEK, 1994). The excavation of the cave, discovered in 1969, continued until 1975. They were resumed in 1990 and are still in progress. The stratigraphic sequence includes both Pleistocene and Holocene deposits (BOSCHIAN, 1997); these latter are some 4 m thick. The Pleistocene deposits did not yield any material culture remain. As far as we know, the first human occupation of the cave took place during the Mesolithic Preboreal period; it was later reoccupied during the Boreal and, again, at the beginning of the Atlantic (NISBET, 2000). This is the only Trieste Karst sequence from which a good series of radiocarbon dates is currently available (SPATARO, 2001).

As mentioned above, the cave was first settled during the Preboreal, Sauveterrian Mesolithic period as indicated by two radiocarbon dates obtained from samples of pine charcoal from layer 3c: 9930±50 BP (GrA-14108) and 9810±70 BP (GrN-23130). The Boreal Sauveterrian occupation of layer 3b, produced structural remains among which are hearths

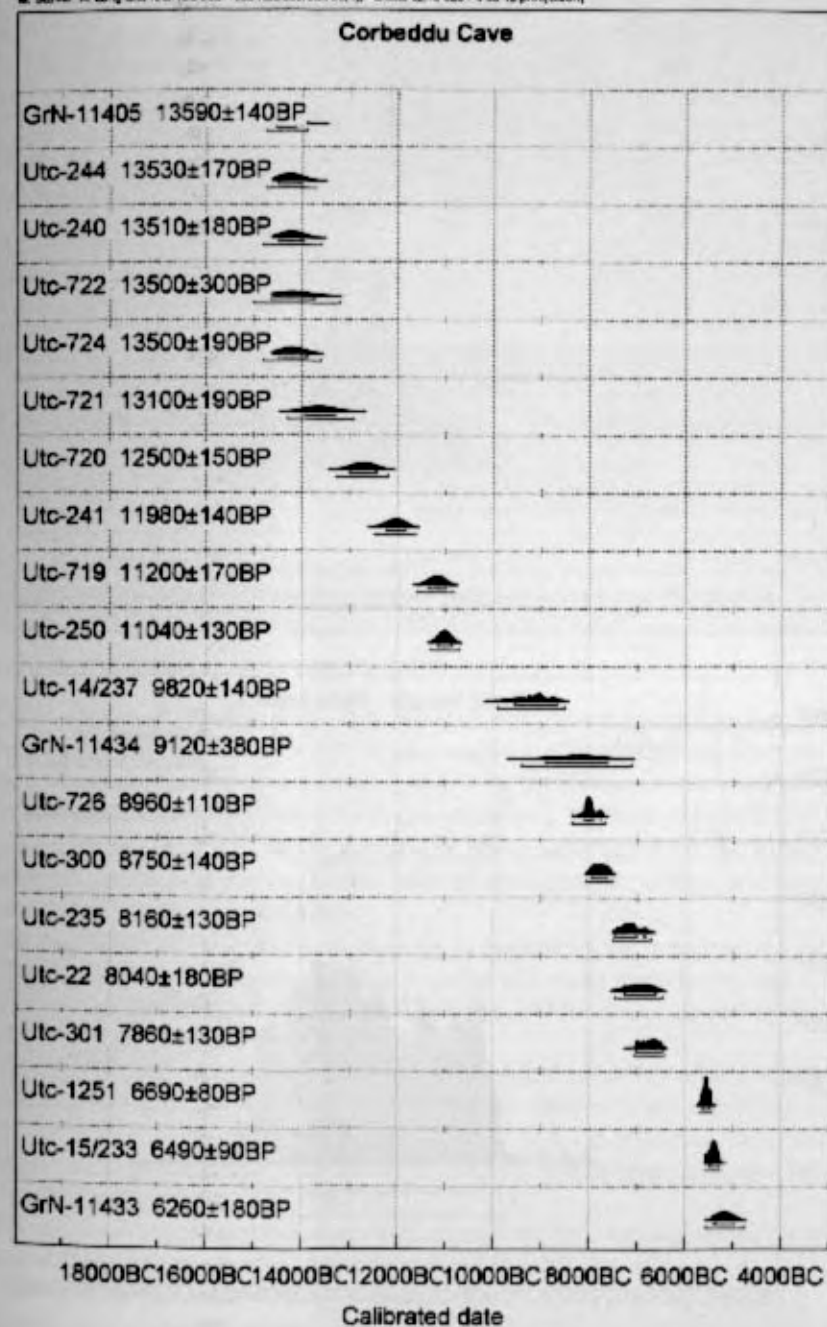


Fig. 14 - Grotta Corbeddu: graph of the radiocarbon dates calibrated using the OxCal (version 2.18) calibration program.

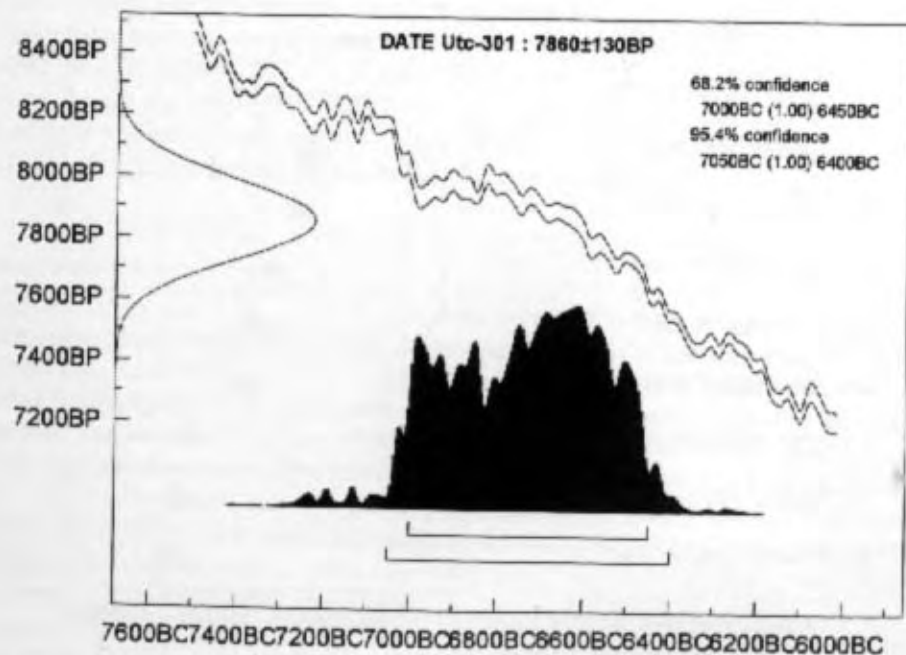
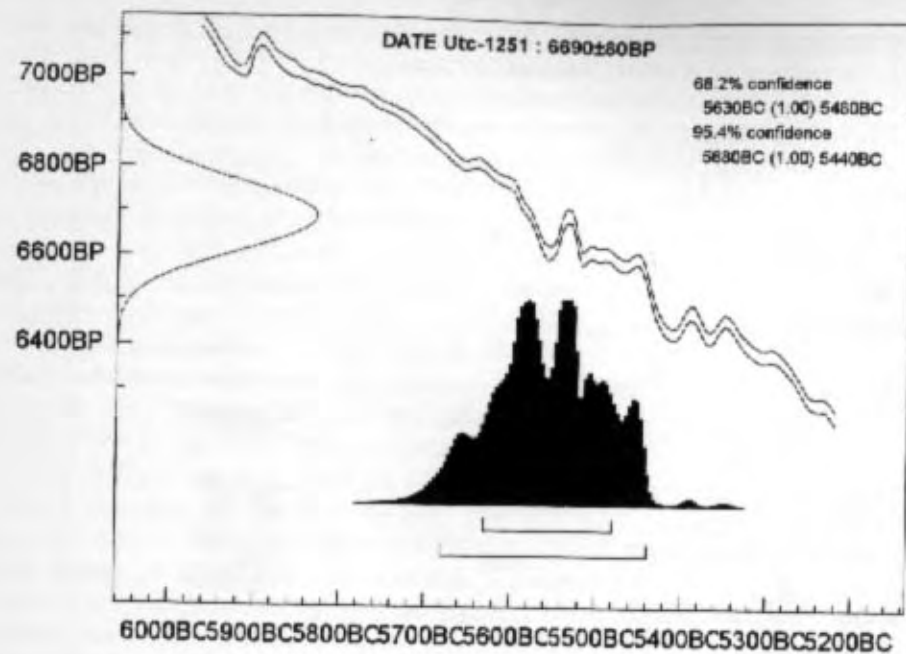


Fig. 15 - Grotta Corbeddu: graphs of the radiocarbon dates Utc-1251 (top) and Utc-310 (bottom) calibrated using the OxCal (version 2.18) calibration program.

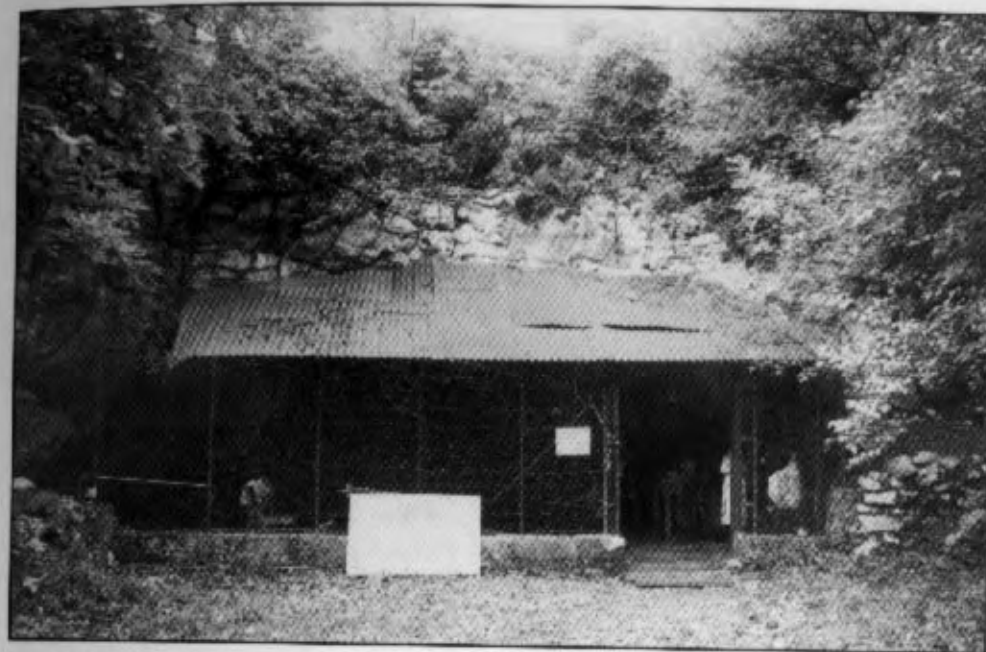


Fig. 16 - Grotta dell'Edera: view of the entrance (photo P. Biagi).

and a well-preserved palaeosurface with material culture and faunal remains. It has been dated between 8350 ± 120 BP (GrN-25139: charcoal) and 8250 ± 50 BP (GrA-11818: hazelnut shells), while the end of the same period produced the following results: 8110 ± 90 BP (GrN-25138: charcoal), 8100 ± 60 (GrA-17112: charred bone), 8060 ± 90 BP (GrN-25137: charcoal) and 8045 ± 40 BP (GrA-14106: bone). The flint assemblage from the Boreal levels is typical of the middle Sauveterrian Culture with hypermicrolithic, scalene triangles and very narrow, double, bilateral backed points.

The beginning of the Atlantic, in layer 3a, is marked by the presence of a hearth with Late Castelnovian flint artefacts including trapezes and many microburins and a few fragments of pottery. It was dated to 6700 ± 130 BP (GX-19569: charcoal) and to 6480 ± 40 BP (GrN-25474: *Patella caerulea* shells).

The layer above, 2a, belongs to the local aspect of the Early Neolithic Vlaška Group. Four radiocarbon dates, obtained from charcoal from three of seven overlying ash lenses, indicate that the Neolithisation of the Trieste Karst took place around the middle of the seventh millennium BP. These radiocarbon dates cover a time-span between 6590 ± 100 BP (GrN-23129) and 6305 ± 285 BP (GX-19022) (fig. 17).

The results of the radiocarbon dates indicate that the cave was not settled for some 1300 years around the beginning of the Atlantic period (fig. 18).

2.8 GROTTA DELLE ARENE CANDIDE

The cave opens along the southern slope of Mt. Caprazzoppa, at an altitude of 86 m, at some 250 m from the present-day coastline (fig. 19). A. Issel, who carried out the first exca-

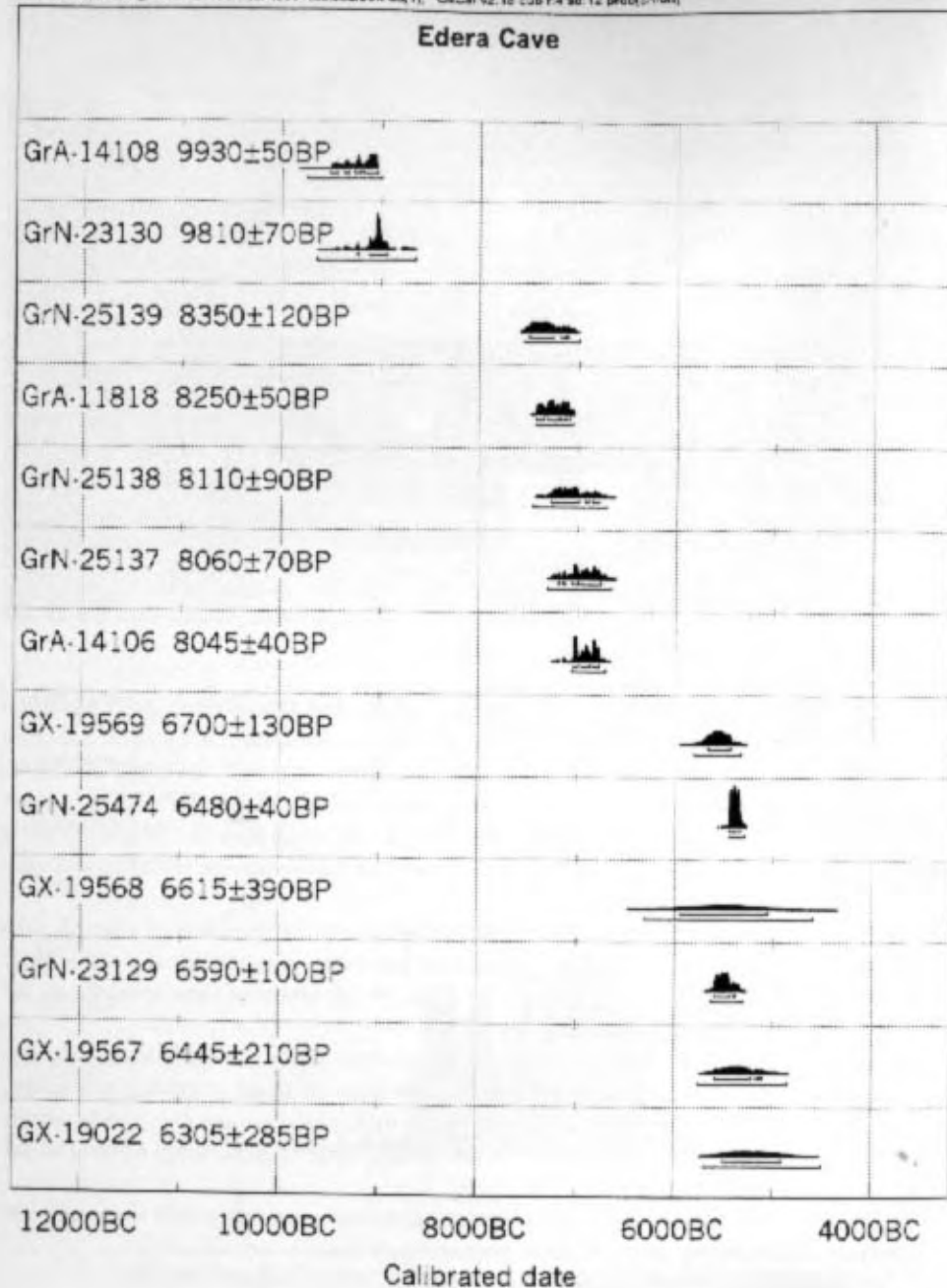


Fig. 17 - Grotta dell'Edera: graph of the radiocarbon dates calibrated using the OxCal (version 2.18) calibration program.

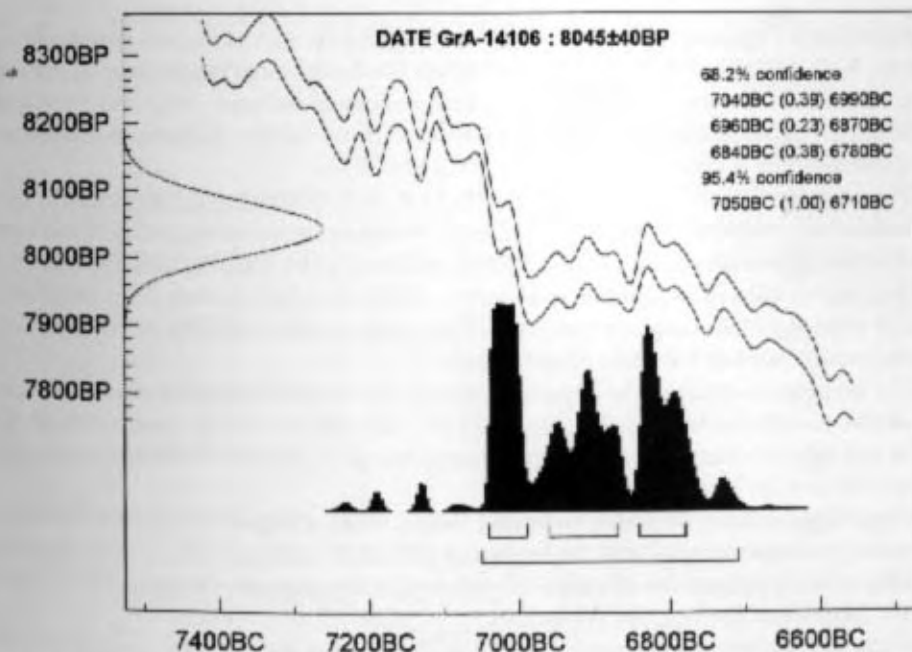
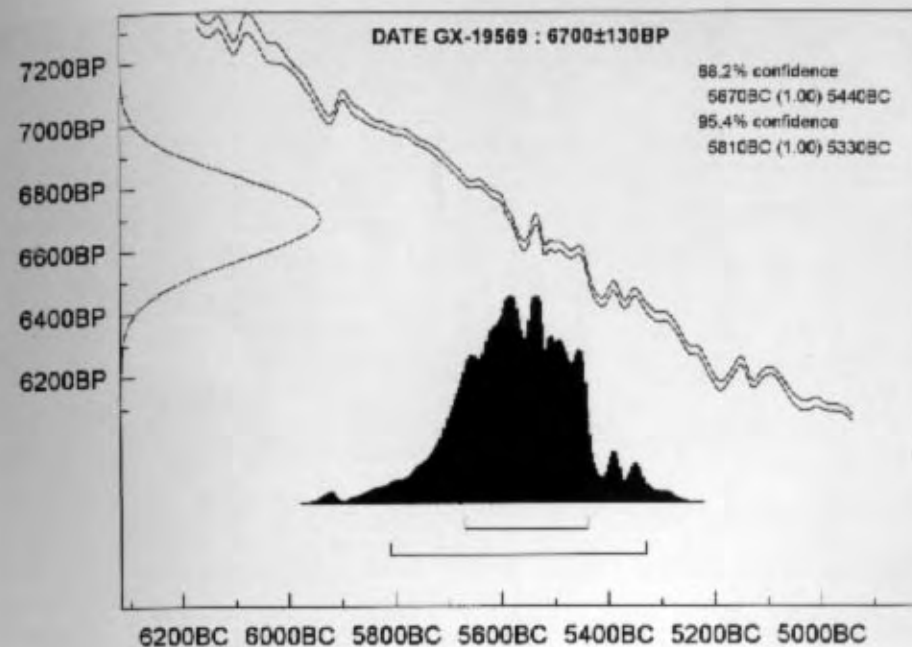


Fig. 18 - Grotta dell'Edera: graphs of the radiocarbon dates GX-19569 (top) and GrA-14106 (bottom) calibrated according the OxCal (version 2.18) calibration program.

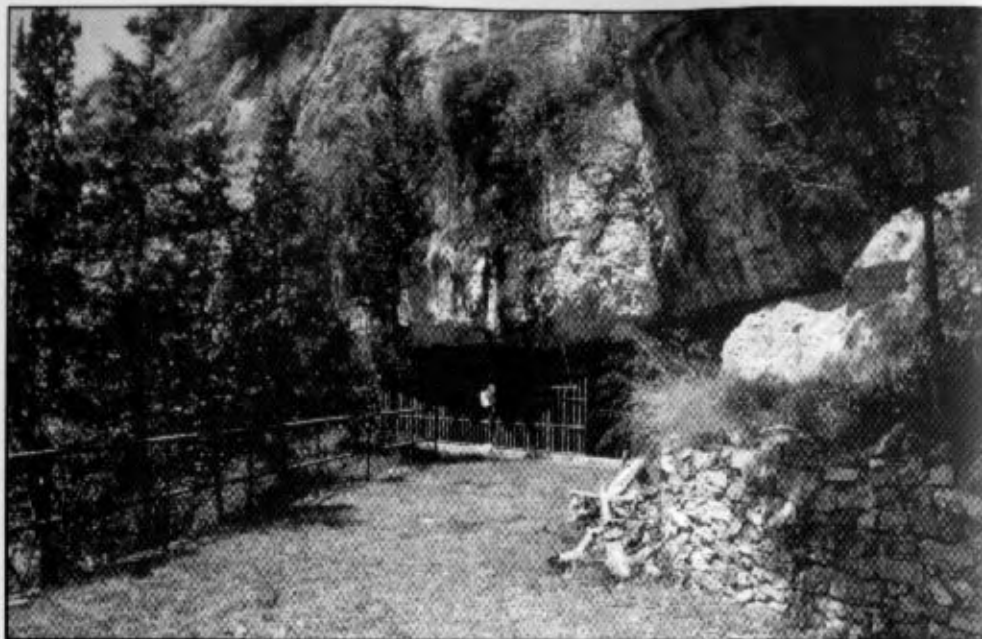


Fig. 19 - Grotta delle Arene Candide: view of the entrance (photo P. Biagi).

vations between 1864 and 1884, was the first to recognise the archaeological importance of the cave. Wall, Morelli, d'Alberti, Rossi and others conducted other excavations at the end of the nineteenth century. The excavations were re-opened between 1940 and 1950 and directed by L. Bernabò Brea and L. Cardini (BERNABÒ BREA, 1946). More recent researches were undertaken by S. TINI (1999) between 1972 and 1977.

The cave consists of a main hall, some 70x15 m, with three openings towards the sea. The excavations revealed that the cave had been inhabited since the beginning of the Late Epigravettian Palaeolithic and later re-inhabited at the end of the Late Palaeolithic when the cave was also employed as a cemetery (CARDINI, 1980). Five radiocarbon dates have been obtained from the Final Epigravettian layer. They range between 11,750±95 BP (R-473α: charcoal) and 9980±140 BP (Beta-48694: bone).

The cave was re-occupied by Impressed Ware Early Neolithic people around the beginning of the seventh millennium BP (MAGGI, 1997: 44) and repeatedly settled during the Middle and the Late Neolithic. More sporadically the cave was also inhabited during the Chalcolithic and the Bronze Age periods.

Regarding the Early Neolithic Impressed Ware Culture a long list of radiocarbon dates is currently available ranging from the beginning (UB-2423: 6980±115 BP: charcoal) to the end of the seventh millennium BP (MC-752: 6000±120 BP: charcoal) (SKEATES, 1994; MAGGI, 1997; MAGGI and CHELLA, 1999) (fig. 20).

According to the above-mentioned radiocarbon date lists the cave was uninhabited for some three thousand years between the beginning of the tenth and the beginning of the seventh millennium BP (fig. 21).

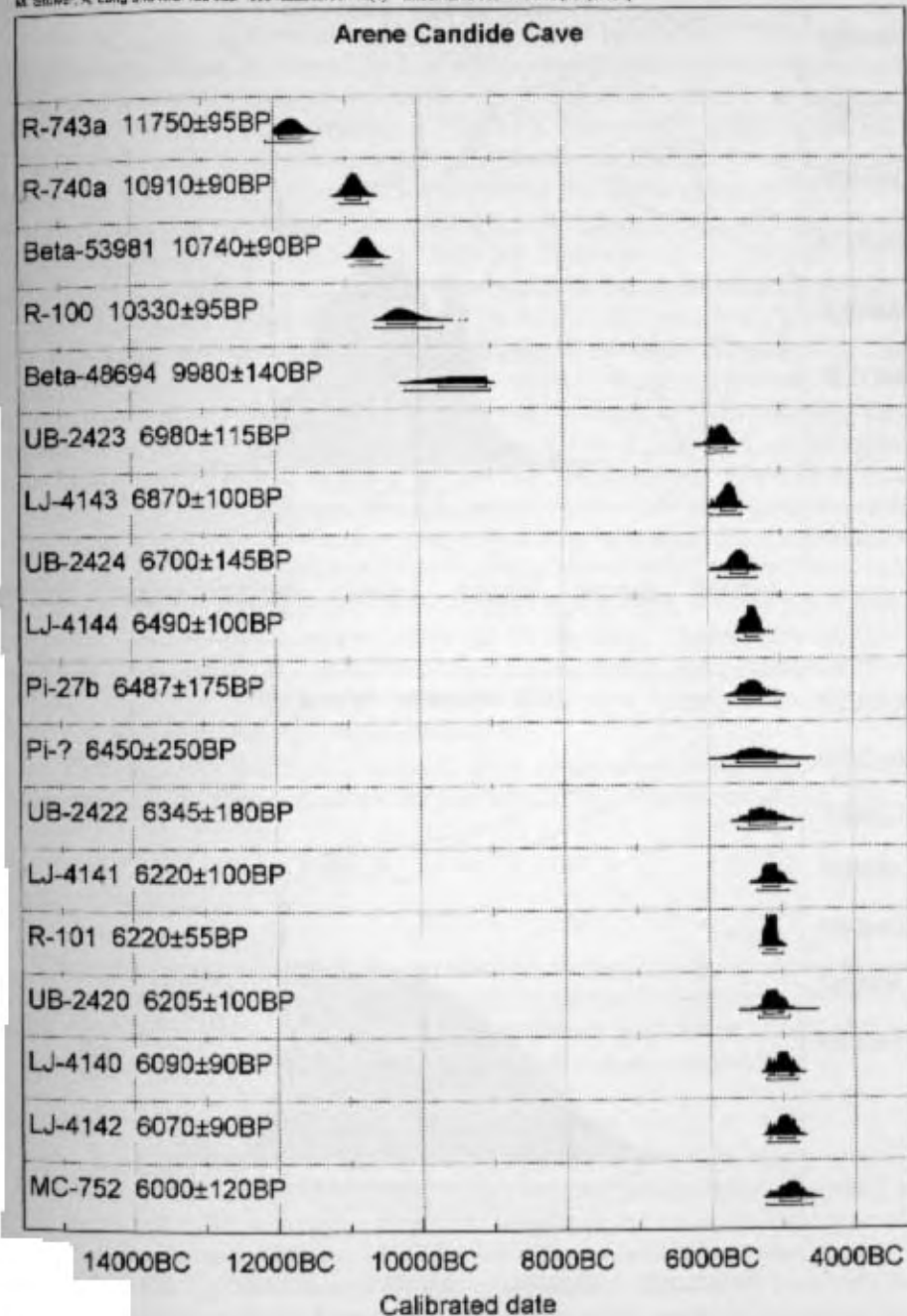


Fig. 20 - Grotta delle Arene Candide: graph of the radiocarbon dates calibrated using the OxCal (version 2.18) calibration program.

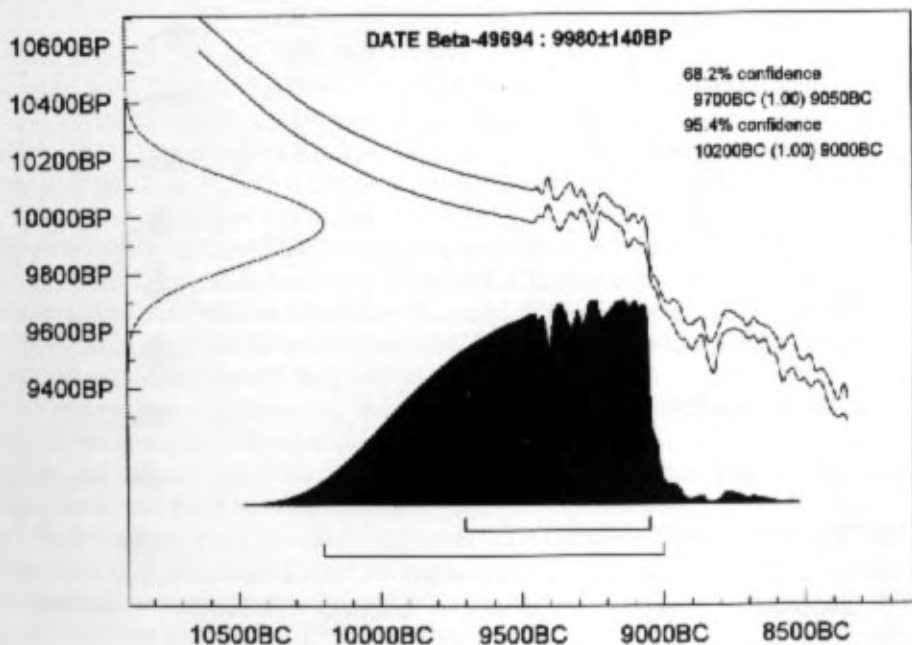
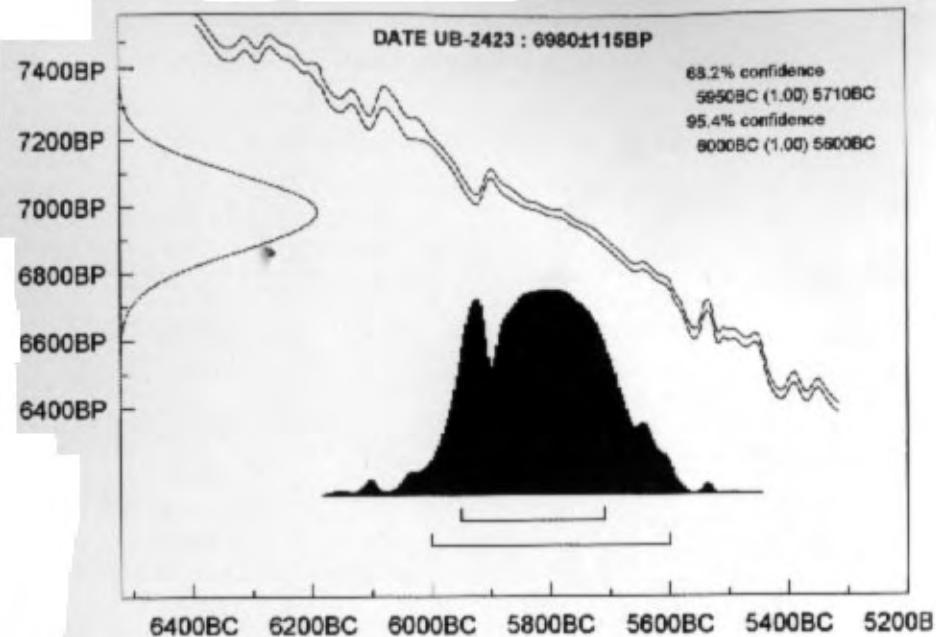


Fig. 21 - Grotta delle Arene Candide: graphs of the radiocarbon dates UB-2423 (top) and Beta-49694 (bottom) calibrated using the OxCal (version 2.18) calibration program

2.9 ROMAGNANO III ROCK-SHELTER

The rock-shelter of Romagnano III is located some 8 km south of Trento along the right side of the Adige River. It is one of the four archaeological sites discovered on the right side of the Rio Bondone, close to its confluence into the Adige. The sites of Romagnano were accidentally discovered in the autumn of 1968 by R. PERINI (1971: 7) during the quarrying of the alluvial deposits which formed the conoid that had buried the Romagnano rock-shelters. The excavation of site I was carried out during the winter-spring of 1969, while the excavation of site III was begun in the summer of 1969 (PERINI, 1971: 89). They revealed a stratigraphic sequence some 8 m thick from the Historical Age to the beginning of the Mesolithic. The excavation of the deposits belonging to the period between the Historical Age and the Early Neolithic were excavated by PERINI (1971) in 1969-70, while BROGLIO (1971) excavated the lower-lying Mesolithic sequence between 1971 and 1973. The flint assemblages from this latter layers were published first by Broglio (1971) and then by BROGLIO and KOZŁOWSKI (1983). A good set of radiocarbon dates, all from charcoal, has been obtained from the Romagnano III sequence (ALESSIO *et al.*, 1978). Many of these were obtained from the Mesolithic sequence that has been dated between 9830±90 BP (R-1147: Early Sauveterrian layer AF) and 7500±160 BP (R-1137A: Late Mesolithic layer AB 2-1) (ALESSIO *et al.*, 1983) (fig. 22). The overlying layer AA has been radiocarbon dated to 6480±50 BP (R-1136). This layer, from which come a few pieces of pottery (BROGLIO, 1971: 185), has been attributed to the Castelnovian Late Mesolithic with pottery. The Early Neolithic layer T3-4 above has produced a result of 6060±50 BP (R-7814). The problem related to the occurrence of pottery in the Castelnovian layer AA has already been questioned (BAGOLINI and BIAGI, 1977: 229; BAZZANELLA *et al.*, 2000: 165) mainly because of the intrusive character of the ceramic potsherds found in this layer.

Even considering acceptable the date R-7814, a chronological gap of some 1000 radiocarbon years can be observed around the beginning of the Atlantic period (fig. 23).

3. DISCUSSION

Given the great geographical difference and the number of cultural aspects represented in the area considered in this work, the discussion regarding the sequences described in the preceding chapter will be made separately starting from south-east to north-west, that is from Greece and the eastern Ionian and Adriatic coast to north-western Italy.

3.1 GREECE AND THE EASTERN IONIAN AND ADRIATIC COASTS

The number of Mesolithic sites currently known in Greece is extremely scarce (RUNNELS, 2001; 2001a; HARROLD *et al.*, 2001). Apart from the two sequences described in this paper, three more have produced evidence of Mesolithic habitation levels: Franchthi and Klisoura Caves in Argolis (PERLÉS, 1999; KOUMOUZELIS *et al.*, 1996) and Sidari on the Isle of Corfu (SORDINAS, 1969). The Franchthi radiocarbon sequence has already been presented by THISEN (2000: 149) with the same method employed in this paper. It is evident from the results shown by this author that the radiocarbon dates comprised between the beginning of the eighth and the beginning of the seventh millennium BP fall into two well-defined blocks,

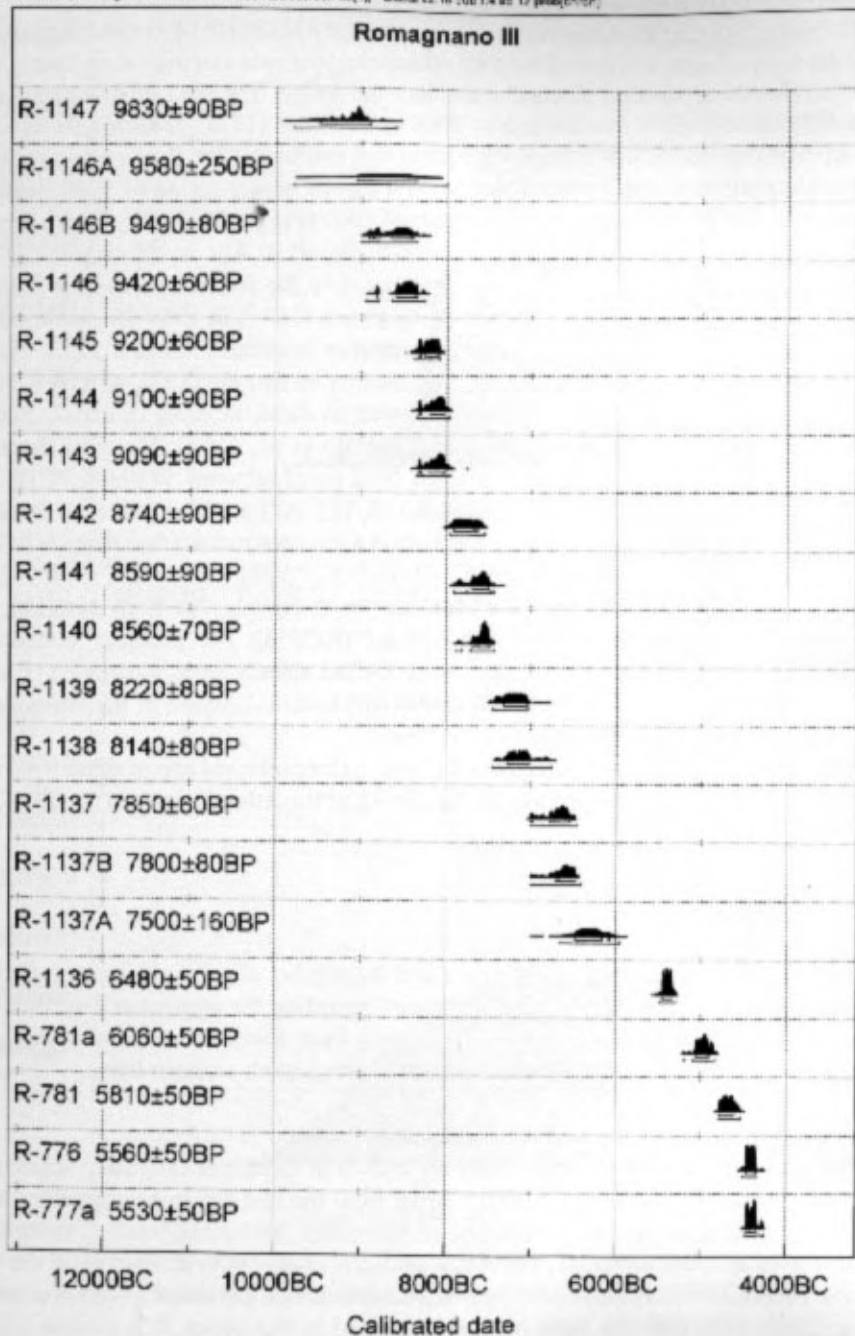


Fig. 22 - Romagnano III rock-shelter: graph of the radiocarbon dates calibrated using the OxCal (version 2.18) calibration program.

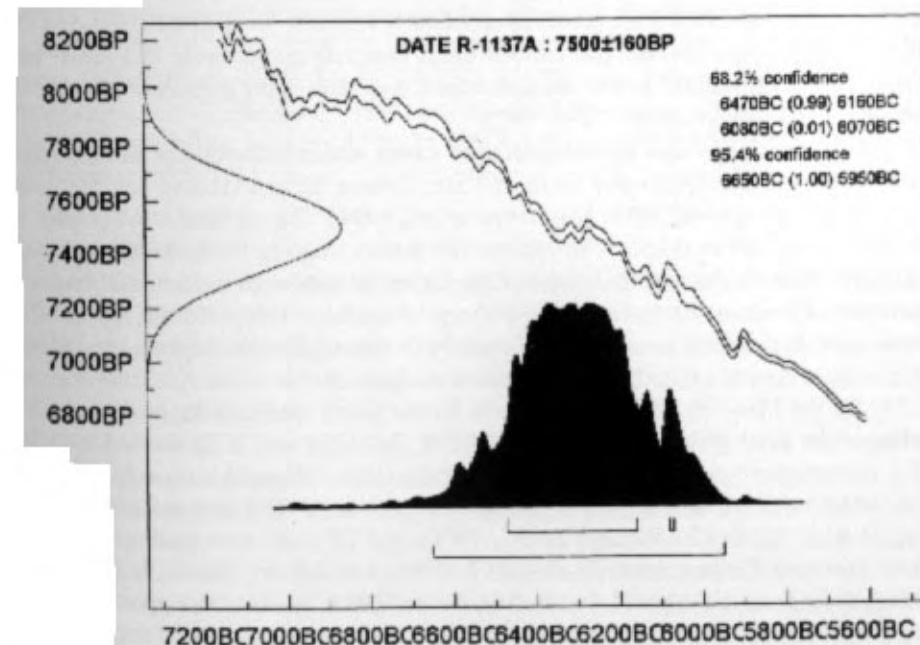
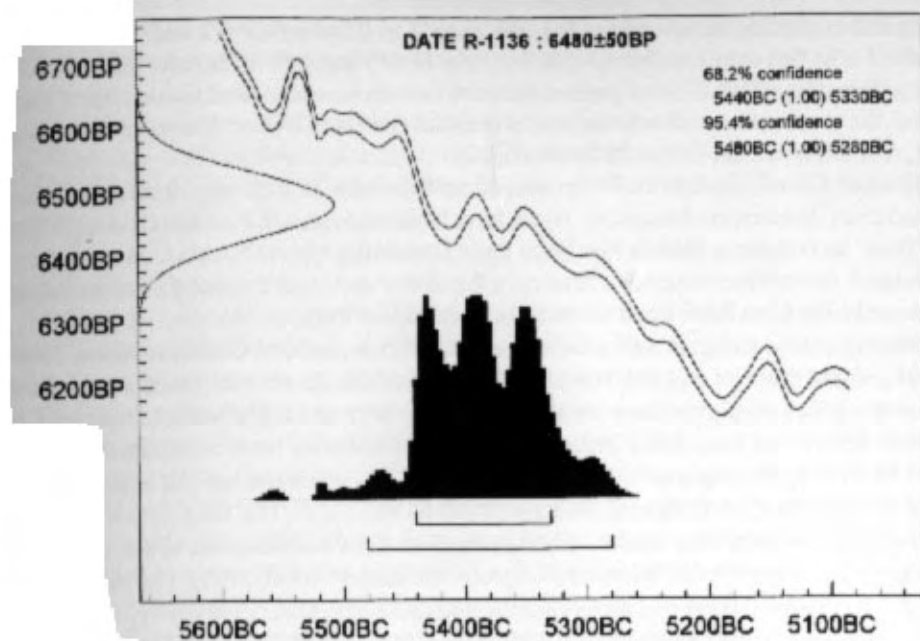


Fig. 23 - Romagnano III rock-shelter: graphs of the radiocarbon dates R-1136 (top) and R-1137A (bottom) calibrated using the OxCal (version 2.18) calibration program.

the first corresponding to Interphase 0/1, the second to Phases FCP 2.2 and 2.3. Between these there is in fact only one date (P-1667: 7280±90 BP) that falls within the middle of the eighth millennium BP. It fills the gap between the two above-mentioned blocks. Apart from this date, the graph of the radiometric results is rather similar to that of Theopetra Cave (fig. 5) and, to a lesser extent, to that of Youra (fig. 2).

Klisoura Cave 1, in Argolis, has produced another thick stratigraphy, from which Sauveterrian and Castelnuvian Mesolithic layers have been excavated (Koumouzelis *et al.*, 1996: 147). They lie beneath a Middle Neolithic layer containing typical Sesklo Culture pottery. The undated Mesolithic sequence of this cave lies above an Upper Palaeolithic series whose uppermost levels have been dated to 16,130±40 BP (Gd-3790).

Other sequences of great interest are those of Sidari in northern Corfu (Sordinas, 1969) and of Konispol Cave in south Albania, just in front of the above-mentioned island. Both these sites yielded stratigraphies with both Late Mesolithic and Early Neolithic occupation layers. At Sidari, the Late Mesolithic-Early Neolithic horizons have been dated between 7770±340 BP (GXO-770) and 7340±180 BP (GXO-772), while the earliest appearance of pottery occurs in a flint context at 7670±120 BP (GXO-771). The Late Mesolithic flint industry from this site is very unique, since, contrary to what was observed by the excavator, it does not contain any typical microliths of geometric shape (Adam, 1999). The stratigraphy of Konispol is much thicker and more complicated (Schuldenrein, 1998), ranging from the Upper Palaeolithic to the Late Bronze Age (Harrold *et al.*, 1999). Here, the Late Mesolithic has been dated between 7630±140 BP (Beta-67804) and 7410±80 BP (Beta-79999), while the Early Neolithic Impressed Ware makes its appearance between 7060±10 BP (Beta-56415) and 6800±140 BP (Beta-56416). The earliest dated charcoal sample from a deposit "too scanty for cultural attribution" below the Late Mesolithic layer gave a result of 8900±180 BP (Beta-80001) (Harrold *et al.*, 1999: 367).

Of great interest are also two Montenegro caves where excavations were carried out respectively in the 1950s and in the 1970s: Crvena Stijena (Benac and Brodar, 1958) and Odmu (Srelović, 1974; Kozłowski *et al.*, 1994). The undated stratigraphy of Crvena Stijena is 9.30 m thick, with occupation layers ranging from the Bronze Age (layer I) to the Middle Palaeolithic (layer XII). Layer III produced evidence of Impressed Ware (also *Cardium*) Early Neolithic pottery, while layer IVa yielded a typical Castelnuvian Late Mesolithic assemblage. Contrary to that of Crvena Stijena, the Odmu sequence was accurately dated. Five radiocarbon dates are listed by Kozłowski *et al.* (1994: 54) for the Mesolithic levels and seven for the Early Neolithic layer II (a and b). The radiocarbon dates published by Müller (1994: 348, 351 and 352) are rather different. This author attributes five dates to the Late Palaeolithic/Mesolithic layer Ia (between SI-2225: 10,045±85 BP and SI-2227: 7080±85 BP), five to the Castelnuvian layer Ib (between Z-412: 8686±130 BP and Z-457: 7030±160 BP) and two to the Impressed Ware and Starčevo Culture layer II (SI-2217: 6985±100 BP and SI-2219: 6955±100 BP). Other dates have been published by Marković (1985: 44) for the upper Neolithic and post-Neolithic layers. Even though the radiocarbon chronology of this cave is rather confusing, the Castelnuvian layer Ib, is followed by the Starčevo/Impressed Ware layer IIa (Marković, 1985: 35). The lithic assemblage from this cave is also unique since it "is striking for its surprising stability, over the time span of ca 1500 radiocarbon years in

respect of stone working technology (cores, blades) and morphology of retouched tools as well the quantitative structure of major tool classes" (Kozłowski *et al.*, 1994: 61). The almost complete absence of Early Neolithic typical tools is rather surprising, especially if one considers that Neolithic long blades they are rather common to the Impressed Ware layers of the neighbouring cave of Crvena Stijena (Benac and Brodar, 1958: tabla VII/1-3) and to the Impressed Ware layers of Hateljska pećina in Herzegovina (Marjanović, 2000: T. 1).

3.2 SOUTHERN ITALY

The only available radiocarbon dated sequences are those of Cave Scaloria in Apulia and of Grotta della Madonna in north-western Calabria. The first example is undoubtedly not the best, given that the stratigraphic position of the samples taken for dating and the profiles of the cave have never been published. A few other caves have radiocarbon dated sequences, namely those of Grotta delle Mura (Calattini, 1996), and Grotta Latronico (Cipolloni *et al.*, 1999). Grotta delle Mura yielded a Sauveterrian layer dated to 8290±50 BP (Ute-1417) and 8240±120 BP (Ute-780), beneath a so far undated Impressed Ware layer (Calattini and Greco, 2000). Grotta Latronico, on the contrary, yielded a Castelnuvian sequence, dated between 7800±90 BP (R-449) and 7400±90 BP (R-447), beneath an undated Impressed Ware layer. Other problems related to the chronology of the Mesolithic-Neolithic sites of southern Italy have already been treated by Pluciennik (1997).

Further north, in the Fucino basin, the only dated long sequence is that of Grotta Continenza, whose Mesolithic Sauveterrian levels, above the final Epigravettian horizon, radiocarbon dated to 10,230±110 BP (R-558: spit 34) and 10,280±110 BP (R-557: spit 32), cover a time-span between 9680±100 BP (R-557: spit 28) and 9490±100 BP (R-552: spit 25) (Bevilacqua, 1994). The Early Neolithic Impressed Ware layer above gave three dates, all from charcoal, falling between 6590±75 BP (R-1411) and 6170±75 BP (R-1410) (Improta and Pessina, 1998: 111).

3.3 SICILY AND SARDINIA

Very little is known of the Mesolithic period in Sicily (Leighton, 1999: 30). The only radiocarbon dated Sicilian sequence is that of the Grotta dell'Uzzo (fig. 8). Other Mesolithic dates have been obtained from the Grotta della Molara and from the rock-shelter of Perriere Sottano, which both produced results attributable to the Boreal and Late Boreal periods (Natoli, 2000: 524).

Our knowledge of the beginning of the Holocene in Sardinia is even worse, given that the only excavated sequence, where occupation layers of this period are attested, is that of Grotta Corbeddu (fig. 14). The only parallels can be extended to the Mesolithic-Neolithic sequences recently excavated in Corsica (Weiss, 2000) where the sites of Curacchiaghju and Araguina Sennola have produced Mesolithic dates that fall into the middle of the ninth millennium BP (de Lanfranchi, 2000: 43), while the Early Neolithic Impressed Ware Culture has been dated to 7700±150 BP (Gif-1851) at Basi and between 7600±150 BP (Gif-1962) and 7300±160 BP (Gif-796) at Curacchiaghju (de Lanfranchi, 2000: 44). Nevertheless two controversial dates come from the "pre-Neolithic" burial of Pietracorbara dated between the beginning of the eighth and the beginning of the seventh millennium BP.

3.4 THE TRIESTE KARST

Apart from the Edera Cave, the only radiocarbon dated sequence of the Trieste Karst is that of Grotta Benussi (BROGLIO, 1971), whose Mesolithic series comprises Late Sauveterrian and Castelnovian levels dated between 8650 ± 70 BP (R-1045A) and 7050 ± 60 BP (R-1043) (ALESSIO *et al.*, 1983: 251). According to MONTAGNARI KOKELJ (1993: 74) the Trieste Karst cave sites that produced evidence of both Mesolithic and Neolithic occupation are only six, none of which has been carbon-dated.

The best dated sequence of the neighbouring Istria karstic region is that of Pupicina peč that was inhabited from the very end of the Pleistocene (Z-2574: $10,610 \pm 200$ BP) to the Mesolithic Boreal period (Z-2635: 8708 ± 170 BP), while the earliest Neolithic date available from this cave is of 6600 ± 240 BP (Z-2575) (MIRACLE, 1997: 49).

3.5 LIGURIA

The situation of the Ligurian cave sequences has already been described in detail by BIAGI *et al.* (1989: 538; 1993: 54). New observations made by MAGGI (1999) on the distribution of the Mesolithic-Neolithic sites in the region and on new controversial Boreal dates obtained from the cave sequence of the Arma dello Stefanin, in western Liguria, do not change the general picture previously drawn.

3.6 THE ADIGE VALLEY

Three radiocarbon dated long sequences have been excavated in the Trento Basin: Romagnano III, Pradestel and Vatte di Zambana (ALESSIO *et al.*, 1983: 247-249). They allow one to follow the development of the Mesolithic cultures from the Preboreal to the Atlantic climatic period. Apart from Romagnano, the rock-shelter of Pradestel produced four radiocarbon dates that cover a time-span from the beginning of the Boreal period (R-1151: 9320 ± 50 BP; layers L8-L7) to the beginning of the Atlantic (R-1148: 6870 ± 50 BP; layers D3-D1). Unfortunately both oldest and the more recent anthropogenic layers of this sequence have not been radiocarbon dated. The topmost layer A yielded a small lithic assemblage of Castelnovian type and a few potsherds attributed to the Early Neolithic Gaban Group.

Vatte di Zambana is the first Mesolithic rock-shelter discovered in the Adige Valley in 1969. Nine radiocarbon dates, from 8000 ± 110 BP (R-491) to 7250 ± 110 BP (R-487) help follow the development of the Late Boreal-Early Atlantic occupation of the site which yielded a rather poor lithic assemblage, compared to those of the two above-mentioned sites (BROGLIO, 1971).

4. CONCLUSIONS

The radiocarbon dated long sequences described in this paper contribute very little toward a better knowledge of the problem of the Mesolithic-Neolithic transition is very little for various reasons that will be discussed region by region.

4.1 GREECE AND THE IONIAN AND ADRIATIC COASTS

The sedimentary problems concerning the Mesolithic-Neolithic sequences of Cyclope

and Theopetra Caves have already been described in Paragraphs 2.1 and 2.2; whilst the problem of the cultural "continuity" of the Franchthi Cave through this period has been widely discussed by PERLES (1999: 317). The stratigraphy of the Klisoura Cave, from which both Sauveterrian and Castelnovian Mesolithic, though no Early Neolithic, assemblages have been collected, is unfortunately almost undated, at least as regards the period under discussion (KOUMOUZELIS *et al.*, 1996: 146). Also the stratigraphy of the Konispol Cave is not without problems especially as concerns the Late Mesolithic and Early Neolithic deposits of layer 6 and its "penecontemporaneous" subunits, which SCHULDENREIN (1998: 508) mainly attributes to "reworked laminar to massive strata of colluvium, scree, and anthropogenic fines" and to "peak karstic activities during the Early Holocene". The correlation of depositional sequences of his fig. 9 (SCHULDENREIN, 1998: 522) stresses the geoarchaeological fragmentary parallels between the sediments of this cave and that of Franchthi.

The undated Montenegro cave of Crvena Stijena represents another problem. Of the 9.30 m sequence of Crvena Stijena (BENAC and BRODAR, 1958), the Mesolithic layers IVb and IVa, occupy at least 1.50 m of deposit, while the Early Neolithic Impressed Ware layer III, some 40 cm. Contrary to Crvena Stijena, many radiocarbon dates have been obtained from the Odmut Cave sequence, whose Final Palaeolithic-Mesolithic layer Ia is some 1.20 m thick, the Late Mesolithic layer Ib some 20-25 cm, the Early Neolithic (Starčevo) layer IIa some 30-40 cm and the Adriatic Impressed Ware layer IIb some 25-30 cm (MARKOVIĆ, 1985: 35). Other Mesolithic rock-shelter sites are known in Montenegro, though their sequences do not include Neolithic occupation layers (MIHAILOVIĆ and DIMITRIJEVIĆ, 1999). The most important of these is that of Medena Stijena. Layer IV of this site produced a Late Mesolithic assemblage comparable to those of the above-mentioned caves of Crvena Stijena and Odmut (MIHAILOVIĆ, 1996).

4.2 SOUTHERN ITALY

The number of radiocarbon-dated sequences from this region is very limited and of uncertain reliability, at least as regards the Scaloria Cave. Also the radiocarbon dates of the Grotta della Madonna are sometimes confusing at least for the lower part of the sequence. The other stratigraphic series mentioned in this paper have not been enough systematically sampled for radiocarbon chronology, to be taken into consideration for the purposes of this paper.

4.3 SICILY AND SARDINIA

The only detailed radiocarbon dated sequence of Sicily is that of Grotta dell'Uzzo, although its stratigraphy shows a clear sedimentary discrepancy between the transitional Meso-Neolithic layer (some 1 m thick) and the Early Neolithic deposit above (1 m thick). Even though the earliest Neolithic occupation of the cave has not been dated, according to TAGLIACOZZO (1993: 17), the two dates available for the Early Neolithic (P-2733 and UD-165) are the earliest so far available for the neolithisation of the island (LEIGHTON, 1999: 271).

In Sardinia, the Grotta Corbeddu sequence, described in Paragraph 2.6, has other problems of interpretation at least as regards hall 2, layer 1, whose earliest level 1b has been dated to 8040 ± 180 BP (Uc-22). So far, this the oldest date available for the (pottery) Neo-

lithic of this part of the Mediterranean, including the Early Neolithic dates currently available for the earliest Neolithic of Corsica (DE LANFRANCHE, 2000: 44). According to PLUCIENNIK (1997: 132), this date should be taken with caution also because its stratigraphic position is above Utc-301 (7860±130 BP), which dates the upper part of the Mesolithic layer 2 in hall 2 (SONDAAR *et al.*, 1988: 219).

4.4 THE TRIESTE KARST

The Edera Cave is the only detailed Mesolithic-Neolithic carbon-dated sequence of the region. The occupation of the cave took place mainly during the Boreal period, while a hearth documents the last Mesolithic communities, just before the advent of the Neolithic Vlaška Group people. Even though rarely carbon-dated, the Mesolithic sequences of the Trieste Karst mainly regard Boreal occupations, while the pre-Boreal and the Early Atlantic periods are much lesser represented (MONTAGNARI KOKELJ, 1993: 73). According to the few data available from recent excavations, the situation of the Istrian Karst might be rather similar, given that Late Mesolithic layers are not so far attested from the available sequences (MIRACLE, 1997; MIRACLE *et al.*, 2001).

4.5 LIGURIA

Regarding Liguria, "it has been already noticed that the most complete cave sequences show no traces of occupation during the entire Mesolithic period" (BIAGI *et al.*, 1993: 54). New Boreal dates have recently published by MAGGI (1999) for the Arma dello Stefanin uppermost layers of the Final Epigravettian sequence. The same author hypothesizes the hardly tenable question of the cultural background of the Val Pennavaira ibex hunters who, according to him, still had a Final Epigravettian way of life in Boreal times.

4.6 THE ADIGE VALLEY

Even though some of the most "complete" Mesolithic sequence of southern Europe are known in the Adige Valley, it must be said that the stratigraphy of Pradestel is very detailed as it is that of Vatte di Zambana, even though this latter represents a rather short period of occupation. The Romagnano stratigraphy is much more problematic especially as regards the upper Mesolithic, Castelnovian layers that have been excavated in 10 cm spits because of the hardness of the quite homogeneous sediments of layers AB and AA. An even more complex situation is that of Riparo Gaban, whose "disturbance of the deposits, caused by both natural and anthropic factors, makes the study of the assemblages from this key site rather problematic" (BIAGI, 2001).

To sum up, the radiocarbon evidence for the Mesolithic-Neolithic transition of the long sequences taken into consideration for this paper is very poor. Where it is represented it often shows evident gaps in its seriation that might be caused 1) by sedimentary problems, 2) by lack of anthropisation during the key period between the (end of the) Mesolithic and/or the beginning of the Neolithic, or 3) by the scarcity or inaccuracy of the radiocarbon dates (fig. 24). It must be stressed that there is not one single "continuous" sequence without problems, or without data that can be interpreted (or that have been interpreted) in a controversial way. Other problems regard the sampling method employed for the radiocarbon da-

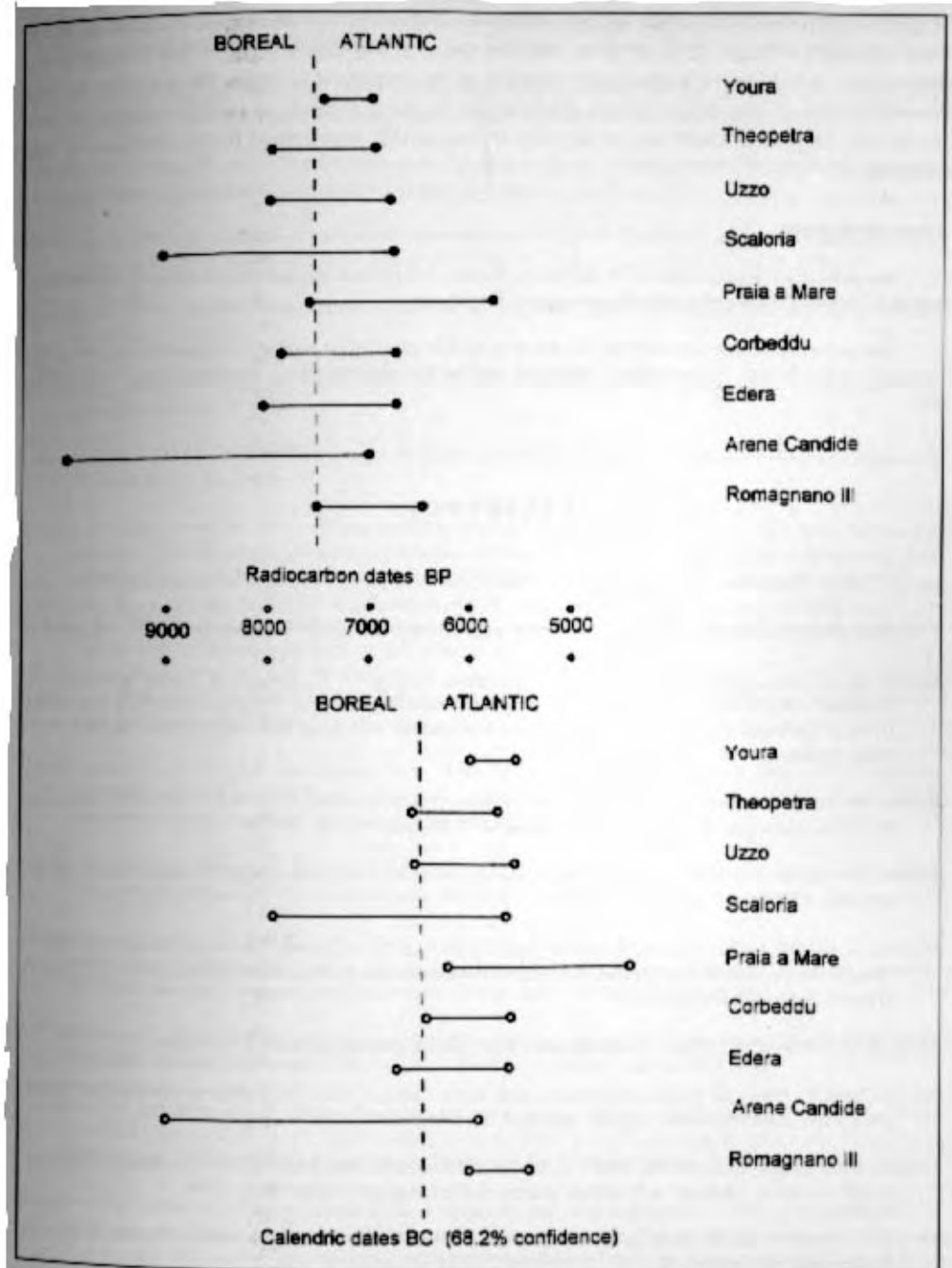


Fig. 24 - Graph of the radiocarbon (top) and calibrated (bottom) time-span during which the caves were uninhabited mainly between the end of the Boreal and the beginning of the Atlantic climatic periods (drawn by P. Biagi).

ting of the sequences that, with the exception of a few cases, too often does not seem to have been accurate enough. It is obvious that the radiocarbon chronology of the stratigraphic sequences is not the only necessary method to be employed to solve the question of the Neolithisation of the study region; nevertheless it can contribute to define whether or not these long-term sites really are, or are not, of reasonable importance for the solution of the problem.

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