

LATE GLACIAL AND HOLOCENE CLIMATIC OSCILLATIONS INFERRED FROM THE VARIATIONS IN THE MICROMAMMAL ASSOCIATIONS AT GROTTA DELLA SERRATURA (MARINA DI CAMEROTA, SALERNO, S ITALY)

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RIASSUNTO - *Oscillazioni climatiche tardoglaciali e oloceniche desunte dalle variazioni nelle associazioni a micromammiferi della Grotta della Serratura (Marina di Camerota, Salerno, Sud Italia)* - Il Quaternario Italian Journal of Quaternary Sciences, 9(2), 1996, 561-566 - La Grotta della Serratura contiene un deposito che data dal Pleniglaciale superiore all'Olocene antico. Gli studi paleoclimatici qui presentati si riferiscono ad una trincea del fondo grotta dove la serie, di 230 cm, comprende livelli con industrie del Paleolitico superiore, del Mesolitico e del Neolitico. Lo studio dettagliato dei micromammiferi della sequenza stratigrafica continua dal Tardoglaciale all'Olocene antico, che è stata ben datata con il ¹⁴C su carboni vegetali, ha fornito una serie di dati che documenta le fasi climatiche esattamente corrispondenti alle cinque zone polliniche dell'Europa medio-boreale, dal Bølling al Preboreale.

ABSTRACT - *Late Glacial and Holocene climatic oscillations inferred from the variations in the micromammal associations at Grotta della Serratura (Marina di Camerota, Salerno, South Italy)* - Il Quaternario Italian Journal of Quaternary Sciences, 9(2), 1996, 561-566 - Grotta della Serratura contains a deposit which dates to the 2nd Würm Pleniglacial, Late Glacial and early Holocene. The paleoclimatic studies presented here refer to the trench at the rear of the cave where the stratigraphic series includes 230 cm of upper Paleolithic Mesolithic and Neolithic levels. Detailed studies on the micromammal fauna of the Late Glacial and early Holocene continuous stratigraphic sequence, which has been dated with the radiocarbon method, yielded a set of data which inform on the climatic phases that correspond exactly with five pollen zones of central Europe, from the Bølling to the Preboreal.

Key words: Paleoclimatology, micromammals, late Glacial-early Holocene, radiometric chronology, South Italy

Parole chiave: Paleoclimatologia, micromammiferi, Tardiglaciale -Olocene antico, datazioni radiometriche, Sud Italia

1. INTRODUCTION - THE SITE

Grotta della Serratura is located on the eastern side of the village of Marina di Camerota (near Salerno), and open on a rock wall of the promontory which confines the Lentiscella beach. It is a large cave about 60 m long and up to 10 m wide, which developed along a large fault. Its current morphology is the result of karstic processes, of collapse episodes affecting the rock walls and the cave itself, of water circulation inside the cave and of changes in sea-level which caused cave flooding at various times.

The archaeological deposit is now heavily eroded, although thick lenses at the cave entrance, in a wide ravine in the entrance area and in particular in the back of the cave have been preserved.

The initial research (1984-1994) was dedicated to the excavation of the deposits in the back of the cave. At present, excavations have been extended into the entrance area.

Stratigraphy, as shown in a trench in the back of the cave (Fig. 1), includes a 2 m thick series, in which an Upper Palaeolithic sequence was found. The radiometric chronology shows an archaic phase at the base, some episodes of the 2nd Würm Pleniglacial, a continuous Late Glacial and Early Holocene sequence and finally some phases of the Neolithic, which date to the end of the 6th millennium B.P.

The original morphology of the archaeological

deposit, which was subsequently eroded by sea water and by cave waters, was that of a dune at least ten metres high at the entrance, as documented by residual lenses outcropping on the cave walls. The deposit at the back of the cave preserves the morphology of the lee side of the dune, and is very steep towards the interior.

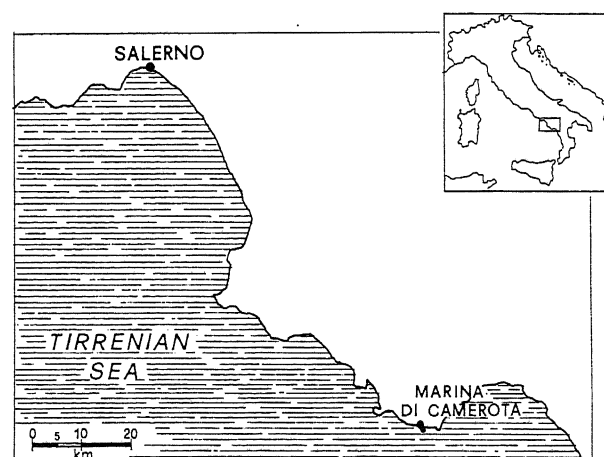


Fig. 1 - Location of Marina di Camerota (Salerno, Italy).
Ubicazione di Marina di Camerota (Salerno, Italia)

2. THE CULTURAL SEQUENCE AND RADIOMETRIC CHRONOLOGY

Holocene deposits have only been found in successions preserved in the back of the cave. Studies on these deposits have already been published in detail and further information can be found in Martini (1993). The present paper presents a first revision of the micromammal collections and their paleoclimatic significance.

At the top of a series which is referable to the Late Glacial (which we will refer to later) the Holocene succession includes – from a cultural point of view – a Sauveterrian horizon (str. 7-6), an undifferentiated Epi-palaeolithic horizon (str. 5-4) and, at the very top of the stratigraphic sequence, some phases of Neolithic reoccupation (str. 3-1).

All uncalibrated radiometric dates were obtained from charcoal. The dates for the Holocene succession are shown in Table 1. For str. 3-2 there are seven dates, of which only those between 6700±170 BP (UtC-749, str. 3) and 6300±130 BP (str. 2) are consistent with the archaeological findings.

The undifferentiated Epipalaeolithic horizon spans the first quarter of the 10th millennium. The Sauveterrian horizon is chronologically continuous, which indicates that the two industrial facies were coeval. The underlying Pleistocene series rests on a thick flowstone layer (str. 15) and includes, from the base upwards, some partially cemented anthropic levels, in which scarce artifacts and large mammal remains were found. On the basis of uncalibrated radiometric dates these seem to date to a period between the archaic Upper Palaeolithic and the 2nd Würm Pleniglacial (str. 14-11). However, the poor archaeological evidence does not permit a more precise cultural definition.

An Evolved Epigravettian horizon follows, which is found at various occupation levels (str. 10 F-10 A). The

Table 1 - Grotta della Serratura. Radiometric dates from charcoal of the Upper- and Epi-Palaeolithic horizons.

Grotta della Serratura. Età radiometriche ottenute su carboni degli orizzonti dell'Epi-Paleolitico e del Paleolitico superiore.

str. 4	UtC-750	10,000±200	bp	
str. 5	UtC-751	9,790±170	bp	
	Bln-3568	9,720±60	bp	
str. 6	Bln-3569	9,620±60	bp	
	UtC-752	9,770±140	bp	
str. 7	Bln-3570	9,870±70	bp	
	UtC-753	10,230±130	bp	
str. 8A	UtC-754	10,000±130	bp	
str. 8B	UtC-755	10,270±140	bp	
	Bln-3571	10,220±60	bp	8270±60 bc
str. 8C	UtC-1418	11,290±90	bp	
str. 8E	UtC-1420	11,490±60	bp	
str. 8F	UtC-1463	11,460±80	bp	
str. 8FI	Beta-63289	11,240±90	bp	
str. 8FII	Beta-63290	12,100±100	bp	
str. 8FIII	Beta-63291	11,880±120	bp	
str. 8G	Beta-63292	12,060±90	bp	
str. 9	Beta-63293	13,100±120	bp	
str. 10A	Beta-63294	15,350±200	bp	
str. 10C	UtC-1421	15,700(110)	bp	
str. 11	Beta-88907	24,380±1530	bp	
str. 12	Beta-88908	29,020±2650	bp	

radiometric dates are coherent with archaeological data.

The Late Glacial series is the most detailed, and interesting both from the point of view of the palaeoclimatic reconstruction as well as of the cultural sequence. After a depositional gap which separates str. 10A from the overlying str. 9, a sequence begins which can be ascribed to the Final Epigravettian. This includes the last three thousand years before the beginning of the Holocene in a deposit which is about one metre thick.

Levels 8 C-D indicate an advanced phase of the Final Epigravettian (Martini, 1993), which is in agreement with radiometric dates, and can be correlated with the cultural scheme generally accepted for the lower Tyrrhenian coastal area (subphase 3 of Bietti *et al.*, 1983).

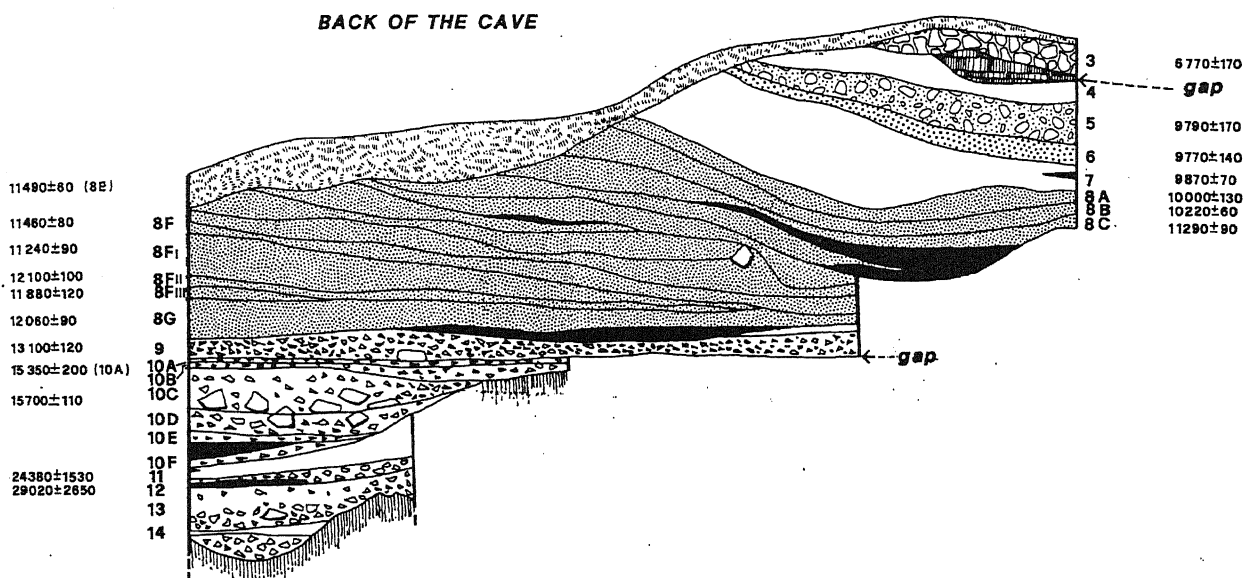


Fig. 2 - Grotta della Serratura: stratigraphy of the trench at the back of the cave with the corresponding ¹⁴C dates. *Grotta della Serratura; stratigrafia della trincea a fondo grotta con le corrispondenti datazioni al ¹⁴C.*

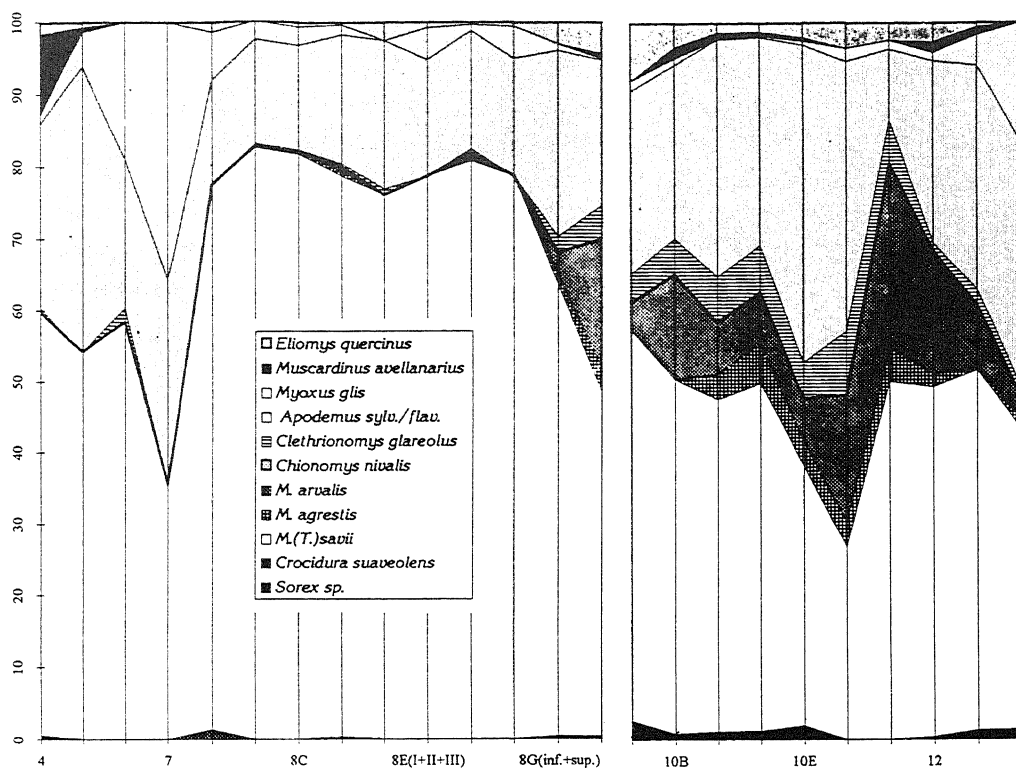


Fig. 3 - Variations in micromammal percentages in the stratigraphic sequence of Grotta della Serratura.

Variazioni nelle percentuali dei micromammiferi nella sequenza stratigrafica della Grotta della Serratura.

Str. 8 A-B, which overlies the previous strata, shows evidence of a further development of the previous subphase, with an increase in microlithic and hypermicrolithic armatures. This horizon has been interpreted (Martini, 1993) as a transitional phase between the Final Epigravettian (subphase 4-5 of Bietti *et al.*, 1983) and the Sauveterrian of levels 7-6. The physiognomy of the assemblage is indicative of a Late Pleistocene culture, with an Epigravettian style which is distinguished by a particular technique oriented towards the production of armatures, which is clearly Sauveterrian. It has not been possible to separate levels 8B and 8A from the available material because single levels do not contain a high enough number of artifacts. The micromammal component was more indicative from the point of view of the levels separation.

In conclusion, the archaeological data indicate that levels 8A-B represent the last phase of the Late Glacial, whereas levels 7-6 belong to the early Holocene, since the artifacts can be ascribed to the Sauveterrian facies of the Mesolithic.

3. THE MICROMAMMAL FAUNA: PALAEO-ECOLOGICAL AND BIOCHRONOLOGICAL CONSIDERATIONS

The study of the very rich microfauna from the Pleistocene levels and the revision of the fauna from levels 7-4 gave information which allow for considerations on the climatic changes which took place in the Late Glacial and Early Holocene, and which are in agreement with the scenarios reconstructed through other disciplines (for instance: Bard *et al.*, 1987; Johnsen *et al.*, 1992; Paterne *et al.*, 1986; Turner & Hannon, 1988).

The use of micromammals for palaeoclimatic reconstructions is especially effective if there is abundant material in each level and if the series in which the bones are found, is continuous. When interpreting the data, it is necessary to take into account the variations in the percentages of faunal associations from one level to the next, rather than the faunal associations found in each level, because these may partly depend on the selection which owls carry out when hunting, as these birds are responsible for the accumulation of micromammal bones in caves. If the selection process governed by predators repeatedly occurred – as it is possible –, one can obtain data which overcome the interpretation errors caused by this selection process. Although micromammal associations are related to the raptors hunting range, variations in their percentages yield data on environmental changes, which are, in turn, linked to climatic changes.

The animals that strigiforms seldom catch, because of their large size, are not included in Figure 3, since their presence is often accidental and is usually limited to young individuals. These belong to the genera *Eri-naceus*, *Talpa*, *Arvicola* and *Mustela*, which, with the exception of moles, are cosmopolitan animals and, therefore, of little use in palaeoecological interpretations.

The animals represented on the right hand side of the figure, Gliridae, Muridae and *Clethrionomys*, are all indicators of forested environments, whereas those to the left, which belong to the genera *Microtus* and *Chionomys*, – the latter being present in level 9 only – tend to live in open environments. If percent variations are considered, it can be inferred that the peaks on the right correspond with episodes of forest reduction while those on the left indicate a reduction of the open environments.

In levels 14 to 10A, stratigraphy and radiometric dates have highlighted various hiatuses and this lack of

continuous stratigraphy prevents the interpretation of the changes in faunal associations. However we can hypothesise that these levels represent various moments in the second Pleniglacial when there was a great biodiversity, which indicates the contemporaneous presence of numerous habitats. Probably, both forested and open environments expanded and retreated, thus offering a habitat for many taxa. This agrees with our knowledge about the faunal population of the last glaciation, and in particular that in a mediterranean environment. The most significant climatic element of these levels is, probably, the relatively low temperature.

Level 11 documents a very cold stadial, whereas levels 10F and 10E indicate a quite temperate interstadial. Level 10A, which corresponds with the end of the second Pleniglacial, documents the Angles interstadial of central-northern European pollen zones.

After a marked hiatus between level 10A and 9, stratigraphy, lithic industries and numerous radiometric dates suggest that the following sequence is continuous.

The climatic characteristic indicated by the fauna in levels 9-8A, where there is a predominance of *Microtus (Terricola) savii*, is aridity. This becomes very pronounced from level 10A onwards. The marked increase in *M. (Terricola)* results in a drastically reduced presence of the other voles and also in a decrease of *Apodemus*. However Gliridae are present and indicate that restricted areas of woodland were preserved on the Tyrrhenian coast of Southern Italy, even in this particularly arid phase of the Late Glacial. A further support to arid climatic conditions is given by the appearance of the *Crocidura* genus in levels 8D and 8A.

There, the microfauna indicates the succession of:

- a temperate period (str. 9-8G) referable to the Bølling with a still rich association of individuals from each species;
- a brief episode of climatic deterioration, the apex of which occurs in str. 8F, which is related to the Older Dryas;
- a slightly more temperate period (apex in str. 8E), which can be ascribed to the Allerød interstadial;
- a stadial, which culminates in str. 8B, which is referred to the Younger Dryas.

The radiometric dates (uncalibrated) exactly correspond with the pollen zones as found all over Europe (Bottema, 1991; Boyer-Klein, 1991; Follieri *et al.*, 1988; Kofler, 1994; Pons & Reille, 1988; Reille *et al.*, 1992; Seiwald 1980; Suc & Zagwijn, 1983) and thus these results should not be surprising.

In the following series (str. 7-4), the age determinations and lithic industries of which refer to the Preboreal, *Microtus agrestis* and *M. arvalis* disappear, while an initial peak of *Myoxus glis* followed by an increase of *Apodemus* was observed. The faunal data of these levels (Table 2) were obtained from the literature (Steensma & Hellemans, in Martini, 1993) and have been checked by dr. M. Bon.

It is necessary to point out that very few remains were found in str. 7 and 6 (31 and 53 individuals, respectively), whereas in levels 5 and 4 the number of individuals is higher (278 and 187, respectively).

In the Preboreal series it is possible to observe a

sudden climatic change which took place throughout the northern hemisphere at the end of the Late Glacial. The fauna indicates a marked increase in temperature and, initially, in humidity, which favoured the expansion of woodlands. It is interesting to note the slight reduction in forest forms in level 6, which indicates a slight climatic deterioration that is well known to palynologists because it was recognised in many European pollen spectra, although it was not been named due to the lack of precise age determinations.

4. CONCLUSION

In conclusion the rich micromammal fauna from Grotta della Serratura at Marina di Camerota has documented the climatic oscillations in the middle and recent part of the Late Glacial and the beginning of the early Holocene with great precision.

The excavation of the entrance area in the cave will probably provide a detailed sequence for the Upper Pleniglacial as well, a period which is poorly represented in the area excavated so far and only at the back of the cave. In addition, comparison with the macrofauna, which has not yet been studied, will provide even more detailed data which will be especially useful for understanding the role played by the arid and humid conditions as well as by temperature.

In general, the study of abundant microfauna from continuous sequences can be of great value in palaeoecological interpretations of restricted areas and in documenting complex, frequent and significant climatic changes such as those which occurred during the last 25,000 years.

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CITED BIBLIOGRAPHY

- Bard E., Arnold M., Maurice P., Duprat J., Moyes J. & Duplessy J.C., 1987 - *Retreat velocity of the North Atlantic polar front during the last deglaciation determined by ¹⁴C accelerator mass spectrometry*. Nature, **328**, 791-794, London.
- Bietti A., Martini F. & Tozzi C., 1983 - *L'Epigravettien évolué et final de la zone moyenne et basse tyrrhénienne*. Riv. Sc. Preist., **38**, 319-350, Firenze.
- Bottema S., 1991 - *Développement de la végétation et du climat dans le bassin méditerranéen oriental à la fin du Pléistocène et pendant l'Holocène*. L'Anthropologie, **95**(4), 695-728, Paris.
- Boyer-Klein A., 1988 - *Analyses polliniques au Tardiglaciaire dans le Nord de l'Espagne: au sujet du Dryas I, II, III*. Actas del VI Simposio de Palinología APLE,

- 277-285, Salamanca.
- Follieri M., Magri D. & Sadori L., 1988 - *250.000 years pollen record from Valle di Castiglione (Roma)*. *Pollen et Spores*, **30**, 329-356, Paris.
- Kofler W., 1994 - *Die Vegetationsentwicklung im Spät-paläolithikum und Mesolithikum im Raume Trient*. *Preist. Alpina*, **28**, 83-103, Trento.
- Johnsen S.J., Clausen H.B., Dansgaard W., Fuhrer K., Gundestrup N., Hammer C.U., Iversen P., Jouzel J., Stauffer B. & Steffensen J.P., 1992 - *Irregular glacial interstadials recorded in a new Greenland ice core*. *Nature*, **359** (24 Sept. 1992), 311-313, London.
- Martini F. (editor), 1993 - *Grotta della Serratura a Marina di Camerota. Culture e ambienti dei complessi olocenici*. Garlatti & Rizzai Ed., 376 pp., Firenze.
- Paterne M., Guichard F., Labeyrie J., Gillot P.Y. & Duplessy J.C., 1986 - *Tyrrhenian sea tephrocronology of the oxygen isotope record for the past 60,000 years*. *Marine Geology*, **72**, 259-285, Amsterdam.
- Pons A. & Reille M., 1988 - *The Holocene and Upper Pleistocene pollen record from Padul (Granada, Spain): a new study*. *Palaeogeogr., Palaeoclimat., Palaeoecol.*, **66**, 243-263, Amsterdam.
- Reille M., Pons A. & de Beaulieu J.L., 1992 - *Végétation tardie et postglaciaire, climat et action de l'Homme dans le Massif Central, France*. *Chaiers de Micropaleont.*, n. s., **7**(1-2), 93-106, Paris.
- Seiwald A., 1980 - *Contributions to the vegetational history of Tyrol IV: Natzer Plateau - Villanderer Alm*. *Ber. nat.-med. Ver. Innsbruck*, **67**, 31-72 (in German).
- Suc J.P. & Zagwijn W.H., 1983 - *Plio-Pleistocene correlations between the northwestern Mediterranean region and northwestern Europe according to recent biostratigraphic and paleoclimatic data*. *Boreas*, **12**, 153-166, Oslo.
- Turner C. & Hannon G.E., 1988 - *Vegetational evidence for late Quaternary climatic changes in southwest Europe in relation to the influence of the North Atlantic Ocean*. *Philosoph. Trans. Roy. Soc. of London, B*, **318**, 451-485.

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