



Field Trip Guide Book - B07

Florence - Italy
August 20-28, 2004

Volume n° 1 - from PR01 to B15

**32nd INTERNATIONAL
GEOLOGICAL CONGRESS**

**QUATERNARY EUSTATIC
FLUCTUATIONS AND
BIOCHRONOLOGY OF
VERTEBRATE-BEARING
DEPOSITS CORRELATED WITH
MARINE TERRACES IN SICILY**



Leader: L. Bonfiglio

Associate Leaders:

V. Agnesi, F. Masini, C. Di Maggio

Pre-Congress

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The scientific content of this guide is under the total responsibility of the Authors

Published by:

**APAT – Italian Agency for the Environmental Protection and Technical Services - Via Vitaliano
Brancati, 48 - 00144 Roma - Italy**



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Acknowledgments:

**The 32nd IGC Organizing Committee is grateful to Roberto Pompili and Elisa Brustia (APAT, Roma)
for their collaboration in editing.**

Graphic project:

Full snc - Firenze

Layout and press:

Lito Terrazzi srl - Firenze

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Front Cover:

In the square, the Pizzo Castellaro carbonatic massif cut by marine terraces at Acquadolci. The painting shows a reconstruction of the landscape about 200.000 years ago.

Leader: L. Bonfiglio

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Itinerary for Excursion B07

DAY 1

The B07 Tour will meet at Catania Airport at 10:00 am on Monday 16th August. The meeting point is in the "Arrivals" hall (look out for people holding up "B07 Excursion" signs; they will direct you to a bus). We will leave for Siracuse, visiting the "Paolo Orsi" Archaeological Museum. Lunch at Siracuse before going on to Spinagallo Cave. Overnight stay at Taormina.

DAY 2

Full day excursion to Taormina and Acquedolci - S. Teodoro cave. Overnight stay at Palermo.

DAY 3

Full day excursion to Monte Pellegrino and Alcamo. Overnight stay at San Vito Lo Capo.

DAY 4

Full day excursion to the neighbourhood of San Vito Lo Capo. In the afternoon transfer by bus to Palermo Airport.

Sicily is the largest island in the Mediterranean, very well known all over the world for its beautiful landscapes, its very complex geological framework and its huge palaeontological heritage, preserved in the numerous cave deposits.

Five Pleistocene vertebrate complexes have recently been recognized on the island, differing as to composition and degree of endemism. Each complex corresponds to different dispersal events, of various provenance (African and/or European), and has been controlled by filtering barriers of varying intensities.

Variation in palaeogeography caused by tectonics and glacial and eustatic marine cycles have controlled the processes and timing of Middle Pleistocene and Late Pleistocene vertebrate faunal dispersion in Sicily, through temporary connections via the Straits of Messina and the Catanzaro isthmus (Southern Calabria). The field trip will illustrate the palaeontological and geomorphological evidence of variations in the palaeogeography of Sicily during the Pleistocene. At Acquedolci (North Eastern Sicily), where the very large S. Teodoro cave is also located, thousands of remains of the endemic hippo *Hippopotamus pentlandi*, associated with a few remains of other taxa, are displayed in the excavation trenches within a lacustrine deposit. Late Pleistocene deposits will also be seen in the excavation trenches in the S. Teodoro cave.

Quaternary terraces in North Eastern and Western Sicily constitute very spectacular landscapes.

Introduction

Geological framework of Sicily and the Pleistocene land vertebrate-bearing deposits

L. Bonfiglio

The remains of Pleistocene land vertebrates in Sicily, although traditionally associated with caves, in fact occur in a variety of different environments, which reflect the diverse palaeogeographic conditions of the early, middle and late Pleistocene. The uneven distribution of fossil sites in different parts of the island is also determined by the associated diversity of lithologies.

Sicily consists essentially of three structural units, which have come to occupy their current position as a result of the convergent tectonics accompanying the collision between the European and African plates in the period from the early Miocene to the early Pliocene (Catalano and D'Argenio 1982). Of the three structural units, the Hyblean carbonate plateau, which acted as a foreland region, occupies the southeast of the island; the central and the central western regions consist mainly of terrigenous sediments, while to the North there is a succession of tectonic units with varying palaeogeographic settings and rock associations, although carbonate deposits are prevalent in the western area (Mountains of Palermo) while metamorphic rocks and terrigenous sediments predominate in the eastern zone (Nebrodi and Peloritani mountains).

The establishment of an extensional tectonic regime affecting Sicily from the early Pliocene onward resulted in the collapse of peripheral zones of the island and led to the creation of a series of deep marine basins occupying large areas around and between the two emerged blocks (North and South eastern areas, respectively) (Figure 1.1). (Bonfiglio and Piperno 1996). A continental limnic succession at Comiso made up of paleosols, lacustrine and aeolian deposits, constitutes the evidence of the first connection of the Hyblean Plateau with the northern sector of Sicily in the early Middle Pleistocene. From the beginning of the Middle Pleistocene onward, the evolution of Sicily was characterised by an uplifting tendency which led, in the late middle Pleistocene, to the emersion of the previous deep marine basins and to the establishment of a palaeogeography very similar to the present one. The island almost reached its present extension, being also bordered by a crown of coastal plains (Bonfiglio et al. 2002). In the late Pleistocene



Figure 1.1 - Geographic outline of Sicily in the Lower Pleistocene (thick line) and extension of the known Eutyrrhenian shorelines (broken line). (From Bonfiglio and Piperno 1996, modified)

the interaction of neotectonic with eustatic marine cycles generated a series of marine terraces covered by littoral deposits or coastal plains, while creating a series of caves following ancient cliff-lines in areas with a limestone basement. The extent of uplift varied in the different areas, as indicated by the maximum elevations of Eutyrrhenian terrace deposits with *Strombus bubonius*, found at about 30 metres above the present sea level in the Hyblean Plateau and in the

Palermo hills, and at 104 metres in the Peloritani (Di Grande and Raimondo 1984; Bonfiglio and Violanti 1984). From the late Middle Pleistocene onward, the establishment of an intermittent filter barrier in the area of the Messina Straits probably controlled the processes and timing of the Late Middle Pleistocene-Late Glacial vertebrate faunal dispersion in Sicily.

Pleistocene land vertebrates of Sicily

L. Bonfiglio, G. Mangano, F. Masini, M. Pavia, D. Petruso

The rich palaeontological heritage of Pleistocene land vertebrates in Sicily indicates that different faunal complexes inhabited the island over time. Until 1985, most of the known Pleistocene vertebrate remains of Sicily came from cave deposits and little was known about the palaeoenvironmental conditions of the vertebrate-bearing deposits. Most of the older studies on Quaternary vertebrates in Sicily have focused on evolutionary and taxonomic aspects (Vaufrey 1929; Accordi and Colacicchi 1962; Ambrosetti 1968; Brugal 1987) with the aim of identifying the continental species from which the Sicilian ones derived.

Chronological arrangements of the various Pleistocene mammal assemblages of Sicily were

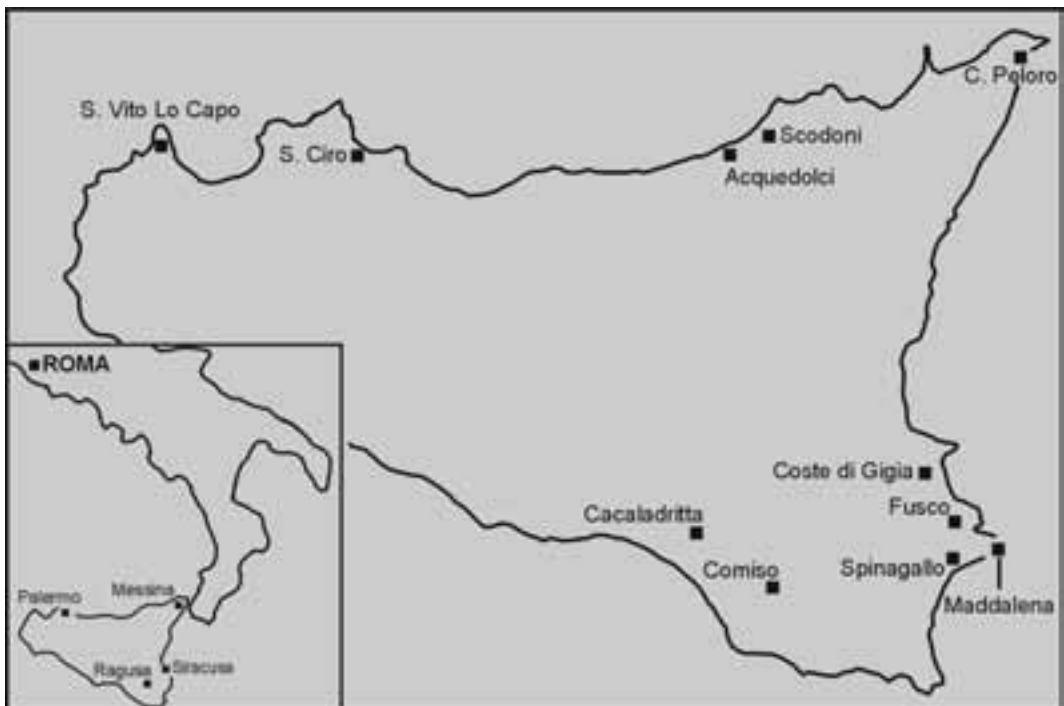


Figure 2.1 - Location of the Pleistocene vertebrate-bearing deposits correlated with marine deposits in Sicily. (From Bonfiglio et al. 2003)

Monte Pellegrino F.C.	<i>Elephas falconeri</i> F.C.	<i>Elephas mnaidriensis</i> F.C.	Grotta S. Teodoro - Pianetti F.C.	Castello F.C.
<i>Mustelercia arzilla</i>	<i>Vulpes</i> sp. <i>Lutra trinacriae</i>	<i>Panthera leo</i> <i>Crocota crocuta</i> cf. <i>spelaea</i> <i>Canis lupus</i> <i>Lutra trinacriae</i> <i>Ursus</i> cf. <i>arctos</i>	<i>Crocota crocuta</i> cf. <i>spelaea</i> <i>Canis</i> cf. <i>lupus</i> <i>Vulpes vulpes</i> <i>Ursus</i> cf. <i>arctos</i>	<i>Canis lupus</i> <i>Vulpes vulpes</i>
<i>Asoriculus burgioi</i> <i>Apodemus maximus</i> <i>Leithia</i> sp. <i>Maltamys</i> cf. <i>gollcheri</i> <i>Pellegrinia panormensis</i> <i>Hypogagus</i> sp.	<i>Elephas falconeri</i> <i>Crocidura esuae</i> <i>Leithia cartei</i> <i>Leithia melitensis</i> <i>Maltamys gollcheri</i> Bats, several species	<i>Elephas mnaidriensis</i> <i>Sus scrofa</i> <i>Hippopotamus pentlandi</i> <i>Cervus elaphus siciliae</i> <i>Dama carburangelensis</i> <i>Bos primigenius siciliae</i> <i>Bison priscus siciliae</i>	<i>Elephas mnaidriensis</i> <i>Sus scrofa</i> <i>Equus hydruntinus</i> <i>Cervus elaphus siciliae</i> <i>Bos primigenius siciliae</i>	<i>Equus caballus</i> <i>Equus hydruntinus</i> <i>Sus scrofa</i> <i>Cervus elaphus</i> <i>Bos primigenius</i>
<i>Testudo graeca</i>	Birds <i>Emys orbicularis</i> <i>Testudo hermanni</i> <i>Geochelone</i> sp. <i>Lacerta siculomelitensis</i> <i>Lacerta viridis</i> <i>Lacerta</i> sp. <i>Coluber</i> cf. <i>viridiflavus</i> <i>Natrix</i> sp.	<i>Erinaceus europaeus</i> <i>Crocidura</i> aff. <i>esuae</i> <i>Leithia</i> cf. <i>melitensis</i> <i>Maltamys</i> cf. <i>wiendincitensis</i>	<i>Erinaceus</i> cf. <i>europaeus</i> <i>Crocidura</i> cf. <i>sicula</i> <i>Apodemus</i> cf. <i>silvaticus</i> <i>Microtus (Terricola)</i> ex gr. <i>savii</i> Chiroptera	<i>Erinaceus europaeus</i> <i>Crocidura</i> cf. <i>sicula</i> <i>Microtus (Terricola)</i> ex gr. <i>savii</i> <i>Apodemus</i> sp. <i>Lepus europaeus</i>
	<i>Discoglossus</i> cf. <i>pictus</i> <i>Bufo</i> cf. <i>viridis</i> <i>Hyla</i> sp.	Birds <i>Emys orbicularis</i> <i>Testudo hermanni</i> <i>Lacerta siculomelitensis</i> <i>Discoglossus</i> cf. <i>pictus</i>	Birds <i>Podarcis</i> sp. Gekkonidae <i>Testudo</i> sp. Anura <i>Hyla</i> gr. <i>H. arborea</i> <i>Rana</i> sp. <i>Bufo</i> cf. <i>viridis</i>	Birds

Table 2.1 - Composition of Quaternary Faunal Complexes of Sicily. (From Bonfiglio et al. 2002, modified)

based on the assumption of the phyletic derivation of the dwarf elephant *Elephas falconeri* from the middle sized *Elephas mnaidriensis*, which was in turn considered a direct descendent of *Elephas antiquus*. Vaufrey (1929) was inclined to assume a post-Tyrrhenian age for all the vertebrate faunas. Following the studies of Accordi (1965) it was thought that most of the size reduction of elephants in Sicily took place during the period preceding the Tyrrhenian. The smallest species (*Elephas falconeri*) was considered to be limited to the early Würm period and to have evolved as a consequence of environmental stress linked to the Würmian climatic cooling (Ambrosetti 1968; Kotsakis 1979). Stratigraphic and taphonomic features have generally been disregarded, although the first valuable scientific paper dealing with the excavations of the *Hippopotamus pentlandi*-bearing deposits of the S. Ciro cave (Palermo), carried out by Abbot Scinà (1831), contains many interesting observations on the relationship between the vertebrate-bearing deposits and the underlying marine sands which extend inside and outside the cave. Vaufrey (1929), Accordi and Colacicchi (1962) and Accordi (1965) also provide interesting remarks regarding the relationship between vertebrate-bearing deposits and marine deposits. Since 1985, a new synthesis has incorporated further stratigraphic and aminostratigraphic data (Belluomini

and Bada 1985; Bada et al. 1991; Burgio and Cani 1988; Bonfiglio 1987; 1991; 1992 a; 1992 b; 1995; Bonfiglio and Burgio 1992; Bonfiglio and Insacco 1992; Chilardi and Gilotti in Basile and Chilardi 1996; Bonfiglio et al. 1993, 1996; 2000; 2002; Di Maggio et al. 1999). Taphonomic data show that Pleistocene vertebrates were distributed in both cave environments and broad, open environments and numerous relationships have been found between the vertebrate bearing deposits and terraced marine deposits, which can be correlated with the $\delta^{18}\text{O}$ isotopic record and the main palaeogeographic events in Sicily (Figure 2.1).

The new data essentially concerns the following aspects:

- a-Number and composition of the Pleistocene faunal complexes
- b-Stratigraphic, environmental and taphonomic data
- c-Chronological data
- d-Geographic distribution of vertebrate bearing deposits and palaeogeography.

a - Number and composition of Pleistocene Faunal Complexes (F.C.) (Tab. 2.1; 2. 2)

The Pleistocene vertebrate assemblages of Sicily can be arranged into 5 phases or Faunal Complexes (F.C.), occurring from the early Pleistocene to the Late Glacial (Bonfiglio et al. 2001; 2002).

Monte Pellegrino F.C.. This is the oldest Quaternary fossil record so far known (late Villafranchian, Burgio

<i>Elephas falconeri</i> F.C.	<i>Elephas manidriensis</i> F.C.	Grotta S. Teodoro - Pianetti F.C.	Castello F.C.
<i>Geronticus eremita</i>	<i>Tachybaptus ruficollis</i>	<i>Branta</i> sp.	<i>Calonectris diomedea</i>
<i>Cygnus</i> cfr. <i>C. cygnus</i>	<i>Podiceps cristatus</i>	<i>Falco columbarius</i>	<i>Puffinus yelkouan</i>
<i>Cygnus equitum</i> (E)	<i>Podiceps auritus</i>	<i>Falco tinnunculus</i>	<i>Podiceps cristatus</i>
<i>Anser erythropus</i>	<i>Phalacrocorax carbo</i>	<i>Coturnix coturnix</i>	<i>Phalacrocorax aristotelis</i>
<i>Branta</i> cfr. <i>B. ruficollis</i>	<i>Pelecanus crispus</i>	<i>Alectoris graeca</i>	<i>Anser erythropus</i> ?
<i>Anas crecca/querquedula</i>	<i>Ixobrychus minutus</i>	<i>Vanellus vanellus</i>	<i>Anser fabalis</i> ?
<i>Anas penelope</i>	<i>Botaurus stellaris</i>	<i>Pluvialis</i> cf. <i>P. apricaria</i>	<i>Branta leucopsis</i> ?
<i>Marmaronetta angustirostris</i>	<i>Egretta garzetta</i>	<i>Scolopax rusticola</i>	<i>Falco tinnunculus</i>
<i>Accipiter gentilis</i>	<i>Ardea cinerea</i>	<i>Columba livia / oenas</i>	<i>Falco naumanni</i>
<i>Accipiter nisus</i>	<i>Plegadis falcinellus</i>	Hirundinidae indet.	<i>Alectoris graeca</i>
<i>Falco tinnunculus</i>	<i>Cygnus falconeri</i> (E)	<i>Turdus</i> sp.	<i>Rallus aquaticus</i>
<i>Falco subbuteo</i>	<i>Anser anser</i>	<i>Pyrrhocorax pyrrhocorax</i>	<i>Crex crex</i>
<i>Falco eleonorae</i>	<i>Anser fabalis</i>	<i>Pyrrhocorax graculus</i>	<i>Tetrax tetrax</i>
<i>Falco columbarius</i>	<i>Anser albifrons</i>	Passeriformes indet	<i>Columba livia</i>
<i>Coturnix coturnix</i>	<i>Anas platyrhynchos</i>		<i>Columba palumbus</i>
<i>Rallus aquaticus</i>	<i>Anas acuta</i>		<i>Cuculus canorus</i>
<i>Fulica atra</i>	<i>Anas strepera</i>		<i>Athene noctua</i>
<i>Grus grus</i>	<i>Anas querquedula</i>		<i>Asio otus</i>
<i>Grus meliensis</i> (E)	<i>Anas crecca</i>		<i>Strix aluco</i>
<i>Tetrax tetrax</i>	<i>Aythya fuligula</i>		<i>Apus apus/pallidus</i>
<i>Recurvirostra avosetta</i>	<i>Mergus merganser</i>		<i>Picus viridis</i>
<i>Scolopax rusticola</i>	<i>Oxyura leucocephala</i>		<i>Hirundo daurica/rustica</i>
<i>Limosa limosa/lapponica</i>	<i>Pandion halietus</i>		<i>Garrulus glandarius</i>
<i>Larus minutus</i>	<i>Gyps meliensis</i> (†)		<i>Pyrrhocorax pyrrhocorax</i>
<i>Larus ridibundus</i>	<i>Aquila heliaca</i>		<i>Pyrrhocorax graculus</i>
<i>Pterocles alchata</i>	<i>Accipiter gentilis</i>		<i>Corvus monedula</i>
<i>Columba livia/oenas</i>	<i>Accipiter nisus</i>		<i>Corvus corone</i>
<i>Columba palumbus</i>	<i>Falco tinnunculus</i>		<i>Corvus corax</i>
<i>Streptopelia turtur</i>	<i>Falco columbarius</i>		<i>Sturnus unicolor/vulgaris</i>
<i>Tyto n. sp.</i> (E)	<i>Coturnix coturnix</i>		<i>Sturnus roseus</i>
<i>Onus scops</i>	<i>Fulica atra</i>		<i>Carduelis chloris</i>
<i>Athene trinacriae</i>	<i>Grus grus</i>		<i>Emberiza sp.</i>
<i>Asio otus</i>	<i>Otis tetrax</i>		Passeriformes indet
cfr. <i>Surnia ulula</i>	<i>Otis tarda</i>		
<i>Caprimulgus</i> cfr. <i>C. europaeus</i>	<i>Scolopax rusticola</i>		
<i>Apus apus/pallidus</i>	<i>Numenius phaeopus</i>		
<i>Tacymartus melba</i>	<i>Pterocles orientalis</i>		
<i>Dendrocopos leucotos</i>	<i>Columba palumbus</i>		
<i>Picus viridis</i>	<i>Columba oenas</i>		
<i>Calandrella brachydactyla</i>	<i>Bubo bubo</i>		
<i>Lullula arborea</i>	<i>Strix aluco</i>		
<i>Hirundo daurica/rustica</i>	<i>Athene noctua</i>		
<i>Anthus sp.</i>	<i>Asio otus</i>		
<i>Prunella modularis</i>	<i>Tacymartus melba</i>		
<i>Eriothacus rubecula</i>	<i>Coracias garrulus</i>		
<i>Oenanthe</i> cfr. <i>O. hispanica</i>	<i>Picus viridis</i>		
<i>Monticola solitarius</i>	<i>Hirundo daurica/rustica</i>		
<i>Turdus sp.</i>	<i>Anthus sp.</i>		
<i>Sylvia sp.</i>	<i>Eriothacus rubecula</i>		
<i>Phylloscopus sibilatrix/collybita</i>	<i>Turdus viscivorus</i>		
<i>Lanius senator</i>	<i>Turdus merula</i>		
<i>Pica pica</i>	<i>Sylvia sp.</i>		
<i>Pyrrhocorax graculus</i>	<i>Pica pica</i>		
<i>Pyrrhocorax pyrrhocorax</i>	<i>Pyrrhocorax pyrrhocorax</i>		
<i>Corvus monedula</i>	<i>Corvus corone</i>		
<i>Corvus corax</i>	<i>Sturnus unicolor/vulgaris</i>		
<i>Corvidae n. sp.</i> (E)	<i>Fringilla coelebs</i>		
<i>Sturnus vulgaris/unicolor</i>			
<i>Petronia petronia</i>			
<i>Fringilla coelebs/montifringilla</i>			
<i>Serinus sp.</i>			
<i>Carduelis chloris</i>			
<i>Carduelis sp.</i>			
<i>Pyrrhula pyrrhula</i>			
<i>Coccothraustes coccothraustes</i>			
<i>Emberiza sp.</i>			

Table 2.2 - Composition of Quaternary avifauna of Sicily: (E) indicates the endemic species of the Siculo-Maltese archipelago; (†) indicates extinct species. (From Bonfiglio et al. 2002)

and Fiore 1997) and it is documented only in the very restricted geographic area of Monte Pellegrino, close to the town of Palermo. The poorly diversified fauna includes species of the genera *Hypolagus*, *Mustelercta*, *Leithia*, *Asoriculus*, *Pellegrinia*, *Apodemus*.

The composition of the Monte Pellegrino fauna - unique for the Mediterranean islands - suggests it may have been derived in part from an older, not locally known, population phase (Messinian age ? Azzaroli and Guazzone 1979) and partially from younger dispersals from Europe. The different degree of endemism and the different geographical affinity of the taxa, indicate a polyphasic origin (Masini et al. 2002).

Elephas falconeri F. C. This Faunal Complex is even poorer than the preceding one in mammalian biodiversity. The poorly diversified fauna includes, besides the pigmy elephant, members of the genera *Crociodura*, *Lutra*, *Leithia*, *Maltamys*, a giant tortoise, and a rich typical endemic avifauna (Pavia 1999; Pavia & Mourer-Chauviré 2002).

The shrew *Crociodura esuae* is an endemic species, of uncertain bio-geographic affinity (Kotsakis 1986). Large mammals include the pigmy elephant *Elephas falconeri*, greatly reduced in size, and a member of the *Lutrinae* (genus *Lutra*). Neither the ancestor nor the geographic provenance of *E. falconeri* has been determined unequivocally. Even though its derivation from a Paleoloxodontine elephant is accepted by several authors, its possible origin from European *Elephas antiquus* stock, or from a north African species, is still a matter for discussion. Moreover, also the composition of this faunal complex reveals a polyphasic origin; some taxa are relics from the preceding phase and others are 'newcomers' that probably entered the island through a strongly filtering barrier (Masini et al. 2002).

Elephas mnaidriensis F. C.: The large mammal assemblage of this Faunal Complex is completely renewed with respect to the preceding F. C. The pigmy *E. falconeri* is extinct, while the faunal composition is more balanced and includes top predators such as the lion and the spotted 'cave' hyena. The faunal composition is quite similar to that found in the southern Italian peninsula, and the continental forerunner of most of these taxa has been fairly accurately identified. The only significant absence is that of perissodactyls (rhinos and horses). The herbivorous taxa (bison, aurochs, fallow deer, red deer, hippo) are moderately modified with respect to the cogenetic or conspecific taxa from the Italian mainland and the endemic nature of the fauna is

apparent mainly from the modest reduction in size. *E. mnaidriensis* is a smaller, but not extremely modified, descendant of *Elephas antiquus*. The red deer *Cervus elaphus siciliae* is slightly reduced in size (about 20%). *Dama carburangelensis* (previously identified as *Megaceroides carburangelensis*) is probably derived from fallow deer populations (*Dama dama tiberina*) widespread in central and southern Italy during the late Middle Pleistocene (Abbazzi et al. 2001).

A peculiarity of this fauna is the very low diversity of small mammals, which are represented only by survivors from the *E. falconeri* F. C. (*Leithia*, *Maltamys* and *Crociodura esuae*; Petruso D. 2002, unpublished PhD dissertation). Knowledge of the composition of the avifauna is still incomplete (Pavia M. 2001, unpublished PhD dissertation). One endemic species of birds, *Cygnus falconeri* occurs. Typical continental taxa (i. e. Galliforms) are still lacking. On the whole the avifauna assemblages are partially renewed like the mammal fauna.

The San Teodoro Cave - Pianetti - F. C. dates back to the last glacial cycle. The faunal history of this period is characterized by extinction events (hippopotamus, endemic dormice and *Crociodura esuae*), and by the dispersal of equids (*Equus hydruntinus*) and of mainland small mammals, which are represented by taxa still occurring in Sicily (*Microtus (Terricola) ex gr. savii*, *Crociodura cf. sicula*, *Apodemus cf. sylvaticus*, *Erinaceus europaeus*) (Bonfiglio et al. 1997; 2001). Almost all the large mammals belonging to this F. C. seem to be descended from *Elephas mnaidriensis* F. C. Endemic species of avifauna are lacking, while the strictly continental *Alectoris graeca* occurs.

Castello F. C. Finally, the Late Glacial associations show a dramatic decrease in diversity, missing all endemic large mammals still occurring in the S. Teodoro Cave - Pianetti F. C. Late glacial fauna, which are similar to continental ones, are associated to lithic industries and cultural evidences of Epigravettian culture (Upper Palaeolithic) and, following some authors (Kotsakis 1979), include taxa present in one (*Equus hydruntinus*) or both (*Sus scrofa*) previous faunal complexes.

b - Stratigraphic, environmental and taphonomic data

The assemblages of the Monte Pellegrino F.C. and those of the S. Teodoro Cave - Pianetti and Castello F.C. are contained in caves and fissure-filling deposits which have no direct relationship with marine deposits.

The assemblages of the *Elephas falconeri* and of the *Elephas mnaidriensis* F.C. are contained in cave and in fissure-filling deposits as well as in coastal plain and/or in ancient shorelines, beach deposits and marine terraces, frequently associated with a lagoon or swamp. Limnic deposits related to small freshwater basins also occur, often in relation to coastal and fully marine deposits (Figure 2.1).

The biodiversity, the preservation conditions and the concentration of the skeletal remains vary greatly according to the different environments.

Littoral marine sands - In the late Middle Pleistocene sandy gravel outside the S. Ciro cave, the rare hippopotamus and elephant remains (molars, limbs) are disarticulated, encrusted by serpulid polychaetes worms and associated with a rich marine fauna of littoral euryhaline environment (Galletti and Scaletta 1991). An isolated scapula of *Elephas mnaidriensis* comes from Thyrrenian marine deposits at the Maddalena peninsula (Siracusa) (Accordi 1965; Di Grande and Raimondo 1984).

Deltaic marine clay sands - At Contrada Cacaladritta (south eastern Sicily) rare skeletal remains of hippopotamus, elephant, aurochs are concentrated in deltaic Middle Pleistocene clay sands with *Ostrea edulis* (Bonfiglio and al. 1996).

Deltaic marine gravels and sands - Disarticulated, fragmented, worn and mechanically selected remains of elephant, hippopotamus, red deer, bear, tortoise are contained in the deltaic marine gravel and sandy deposits underlying Thyrrenian sands with *Strombus bubonius* at Cape Peloro. Serpulids encrust some skeletal elements (Bonfiglio and Berdar 1979; Bonfiglio and Violanti 1984).

Fluvial and lacustrine coastal plain deposits - The continental limnic succession at Comiso contains the first occurrence of the *Elephas falconeri* F. C. (Bonfiglio and Insacco 1992).

The gravel, sandy and silty deposits of the coastal plain environment of Contrada Fusco, near Syracuse, contain almost all the vertebrate taxa of the *Elephas mnaidriensis* Faunal Complex. The coastal plain deposits overlie Early Pleistocene bathyal clays and underlie Thyrrenian calcarenites (Cassoli and Tagliacozzo, Chilardi, Chilardi and Gilotti, Kotsakis, in Basile and Chilardi 1996; Pavia M. 2001, unpublished PhD dissertation).

The silty, laminated lacustrine deposits at Acquadolci (Day 2, Stop 2.2) belong to the coastal plain environment.

Cave deposits correlated with marine deposits - The vertebrate assemblage containing abundant remains

of *Hippopotamus pentlandi* associated with rare remains of *Elephas mnaidriensis*, *Cervus siciliae*, *Dama carburangelensis*, *Bos primigenius siciliae*, *Canis lupus*, *Ursus* cfr. *arctos*, *Crocota spelaea* of the S. Ciro cave, overlie middle Pleistocene marine sands (Scinà 1831; Fabiani 1928).

At Spinagallo cave (Day 1, Stop. 1.2) the lower vertebrate deposits overlie Middle Pleistocene littoral calcarenites (Accordi and Colacicchi 1962; Di Grande and Raimondo 1984; Bonfiglio 1992 a)

Vertebrate-bearing deposits overlying marine terraces - At the San Vito Lo Capo peninsula (Day 4) mammal remains of the *Elephas falconeri* F.C. and of the *Elephas mnaidriensis* F.C. overlie marine terraces correlated with the IOS 11-15 and with the IOS 5a or 5e respectively (Di Maggio et al. 1999). In eastern Sicily, vertebrate bearing deposits overlie the large Tyrrhenian abrasion platforms extending from Taormina to Cape Peloro to Acquadolci, between 80 and 105 m a.s.l. (Bonfiglio 1987; Bonfiglio 1992 b).

Karst fissure - In this environment the bones were accumulated in different ways. Taphonomic characters in the different sites suggest that detritus and bones scattered on the surface filled the cavity by the action of gravity and/or washing, or that surface opening of the fissure may have acted as a trap for living animals.

c - Chronological data

Where correlated with marine sediments, the assemblages of the *Elephas falconeri* F. C. are associated with deposits belonging to the early middle Pleistocene. The limnic deposits at Comiso may correspond to the beginning of the "Roman regression" (Ruggieri and al. 1976) that roughly correlates with stage 22 of $\delta^{18}\text{O}$ isotopic record, while the *E. falconeri* bearing deposits at Spinagallo cave may correspond to younger oscillations of the oxygen isotope curve.

Amino-acid racemization dating yielded an age of 455 ± 90 Ky for *Elephas falconeri* from the Spinagallo and Luparello cave deposits (Bada and al. 1991). The most likely time interval for this Faunal Complex seems to be from stage 22 to a still not precisely defined oscillation of the oxygen isotope curve, not younger than IOS6.

Where correlated with the sediment of littoral environments, the assemblages of the *E. mnaidriensis* F. C. are associated with deposits dated late Middle Pleistocene and/or Upper Pleistocene (Bonfiglio and Burgio 1992; Bonfiglio et al. 1996). Bada et al. (1991) assigned an age of 200 ± 40 Ky to this faunal complex.

ESR dating for teeth enamel of *Elephas mnaidriensis* and *Hippopotamus pentlandi* from Contrada Fusco provided an age ranging between 146.8 ± 28.7 and 88.2 ± 19.5 Ky (Rhodes 1996).

d - Geographic distribution of vertebrate bearing deposits and palaeogeography.

Fossil documentation of Quaternary mammalian populations in Sicily is not evenly distributed in time and space. A trend is evident towards a richer fossil record from the Early Pleistocene to the Late Glacial, the latter fossils being most widespread. The geographic distribution could be related to taphonomical factors and to effective differences in paleogeography in the insular system (Bonfiglio and Burgio 1992), while the reason why the number of sites and stratigraphic levels varies so greatly with respect to time (younger sites are much more numerous) has never been investigated. This pattern, widespread in regions in which tectonic activity is very intense, is probably due to the destruction of older deposits by intense erosion (Masini et al. 2002).

The two oldest F. C. (Monte Pellegrino and *E. falconeri* F.C.) characterized by strongly endemic faunal assemblages, denote the occurrence of an insular system made up of small geographically isolated islands, with very difficult and sporadic connections with the mainland. Palaeogeographic data does not provide information on the route followed by dispersals for the Monte Pellegrino F.C. According to Bonfiglio and Piperno (1996) the distribution of the *E. falconeri* assemblages in south-eastern and western Sicily and the scattered traces of Lower Palaeolithic artefacts in the Hyblean Plateau and along the area linking it to western Sicily, suggest that the dispersal events of humans and of some faunal elements might have followed the same route. According to the latter authors the hypothesis of an African provenance for both *E. falconeri* and human populations through the Sicilian-Tunisian isthmus during the Early Pleistocene should at least merit a fresh and more detailed re-consideration (see Alimen 1975; Kelling and Stanley 1972; Vaufrey 1929).

The vertebrate-bearing deposits of the late-middle and early-late Pleistocene assemblages (*Elephas mnaidriensis* F. C.) are very numerous, contained in the upraised remnants of coastal plains as well as in caves and fissures and have a wide distribution all over the island.

During the late Pleistocene a strong uplift, accompanied by the contemporaneous sea water low-stand led to the disappearance of the humid

Field itinerary

DAY 1

Stop 1.1:

The "Paolo Orsi" Museum

C. Ciurcina

The Museum is located near the Neapolis archaeological area, within the grounds of a famous estate, the Villa Landolina. The estate also contains important ancient remains, such as parts of the archaic Greek necropolis, stretches of the Hellenistic road system, pagan hypogea and Christian catacombs. The estate was acquired in the 1960's expressly for the construction of the new Archaeological Museum. More space was needed to display all the finds from excavations carried out by the Superintendence for Antiquities of Syracuse which, until 1987, was also responsible for all of eastern Sicily from the times of the great archaeologist Paolo Orsi, after whom the Museum is named. The unusual structure of the museum consists of an articulated system of three parts on three levels; these in turn are organized around a central hall. The exhibition layout was conceived as a continuous and flexible space rather than traditionally distinct rooms. The central hall houses an auditorium for didactic audiovisual presentations keyed to the museum visit. Laboratory and storage space (ca. 3.000 sq. meters) are found on the lowest floor.

The museum, which covers a total of 9,000 square meters, was planned by Giuseppe Voza according to the most modern criteria for museum design. The second level covers the periods from Prehistoric to Classical, with the presentation of the stratigraphic sequence of Syracuse through the medieval and, environments of the coastal plains. As a matter of fact the deposits of the youngest F. C. ("S. Teodoro cave-Pianetti", "Castello") are numerous, but they are limited to the caves. The faunal composition of these complexes is consistent with the disappearance of the humid environments (coastal plains with lagoons or swamps) replaced by dry conditions.

The three dispersals documented in Sicily from the late Middle Pleistocene to the Late Pleistocene prove the possibility of a connection existing between the island and the continent through the Straits of Messina area.

The studies still in progress could enhance our knowledge on how and to what extent "discontinuous" insularity conditions interact with

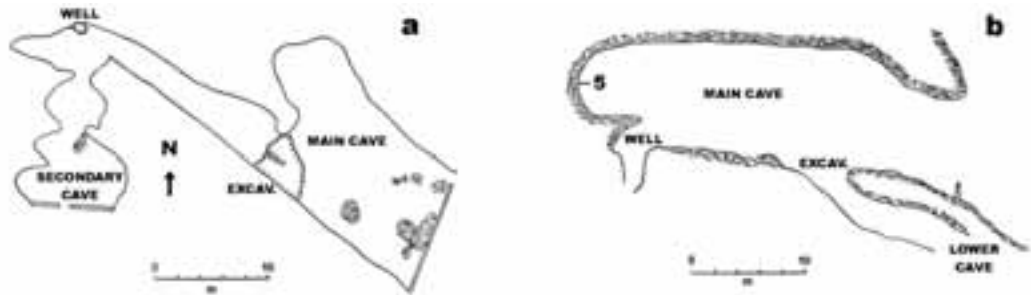


Figure 4.1 - Plan (a) and longitudinal section (b) of the Spinagallo caves and location of excavations; 5: bone breccia encrusting the walls of the main cave. (From Accordi et al. 1959)

climatic and environmental changes in determining the faunal changes of Sicily during the last phases of the Pleistocene.

modern period. The over 18,000 objects are presented in terms of their documentary value rather than in a predetermined hierarchy of artefact importance.

Section A contains the documentation for the Sicilian prehistoric and proto-historic periods. This section is preceded by a sector illustrating the geomorphological pattern of the Mediterranean and the paleogeography of the Hyblean region. Fossil

samples and stone tools linked to the stratigraphic sequence presented in the didactic panels are also included in the display. The Quaternary fauna of Sicily and the phenomena of dwarfism and gigantism found in the island environment, are demonstrated in the Pleistocene faunal remains in the plaster casts of two dwarf elephants. These, with the Upper Palaeolithic and Mesolithic stone tools, document the most important deposits found in Eastern Sicily (Spinagallo, S. Teodoro, Corruggi, Giovanna caves, Fontana Nuova, Canicattini Bagni, etc.).

Section B is dedicated to the Greek colonies and to

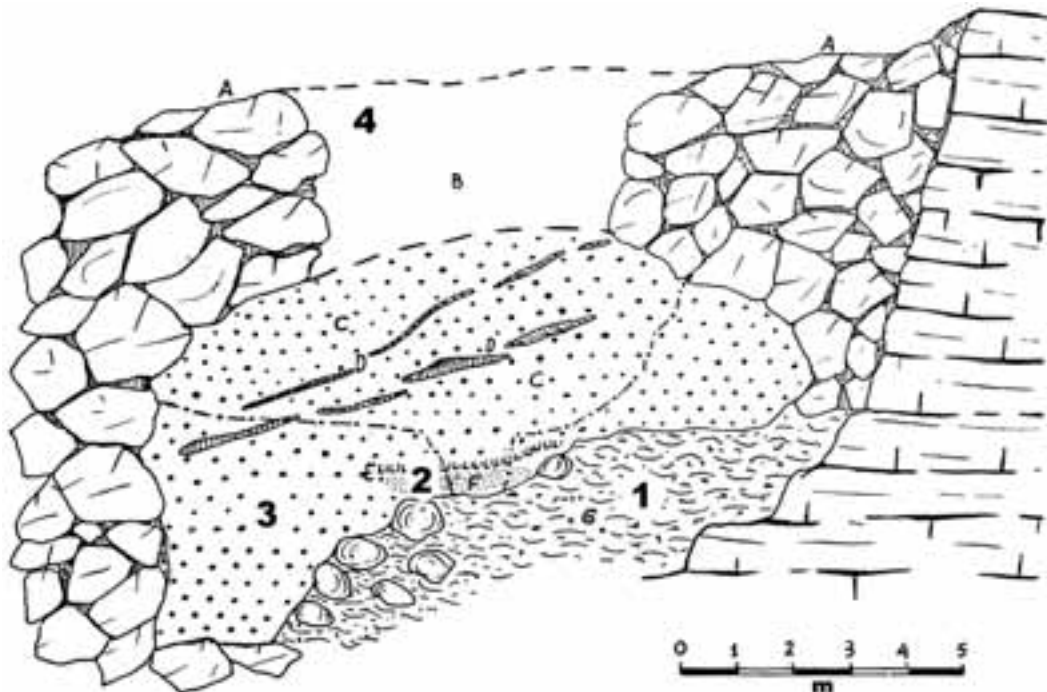


Figure 4.2 - Longitudinal section through the Spinagallo lower cave; A, floor of the main cave; B, roof of collapsed and cemented blocks. For numbers see the text. (From Accordi and Colacicchi 1962, modified)

Syracuse. The Ionic Greek colonial foundations are exemplified by Naxos (the oldest, in 734 B. C.), Mylai-Milazzo, Zancle-Messina, Catania and Lentini, as well as by a selection of the most important proto-Corinthian, Attic, Euboean and the best-represented East Greek ceramic productions.

Section C offers evidence of the subcolonies of Syracuse, the Hellenized centres, the colonies of Gela and Agrigento.

At the beginning of the prehistoric section the location of the various cultures is indicated by differently coloured points of light in a diorama of a satellite photograph of Eastern Sicily.

Stop 1.2:

The Spinagallo caves

L. Bonfiglio, G. Mangano

The stratigraphy of the three Spinagallo caves, on the south-western border of the Hyblean Plateau, has been described by Accordi and Colacicchi (1962). Almost all the taxa of the *Elephas falconeri* F. C. studied come from this cave (Kotsakis 1977, 1986; Kotsakis

and Petronio 1981; Petronio 1970; Pavia 1999) from which hundreds of bones of the pygmy elephant have also been collected.

The caves occur in the upper part of a high cliff, inside Miocene limestone, with bases at the height of 130 m (upper cave), 120 m (main cave) and 116 m (lower cavity), respectively (Figure 4.1); the two highest ones open onto the surface of the cliff. Only the main cave and the lower hypogean cavity have been investigated. The stratigraphic diagram proposed by the Authors is heavily conditioned by the old ideas, proposed by Vauffrey (1929), on the chronological succession of pygmy elephants in Sicily. According to the Authors, the main stratigraphic elements at Spinagallo, starting from the bottom of the lower cavity, are (Figure 4.2):

- 1- Middle Pleistocene calcarenite ("panchina"), which occupies the bottom of the cavity; a wavecut notch and Lithodomes holes occur on the inside wall, consisting of Miocene limestone.
- 2 - Dark red clays with remains of Chiroptera.
- 3 - Unstratified sands and reddish soil containing:

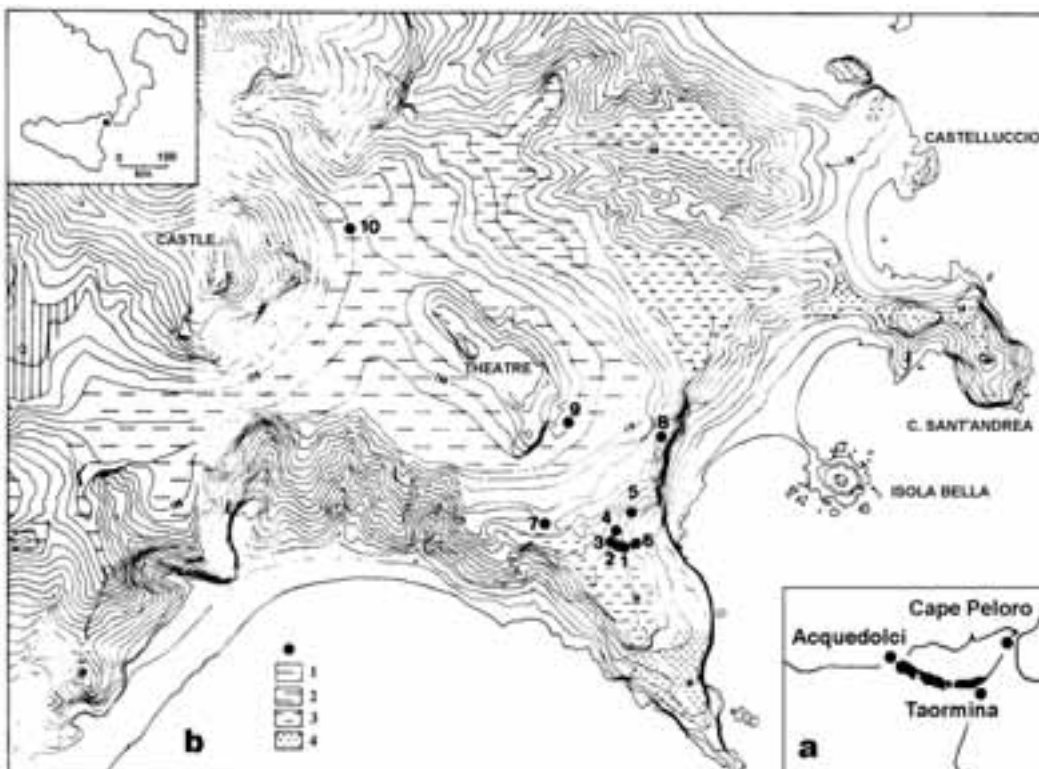


Figure 5.1 - Extension of the carbonatic Longi Taormina nappe (black in a) and topography of the Taormina area (b): numbered black circle: caves; 1-4: terraces extending between 220-180 m a.s.l. (1), 140-160 (2); 130-60 (3), 25-30 (4), respectively. (From Bonfiglio 1982, modified).

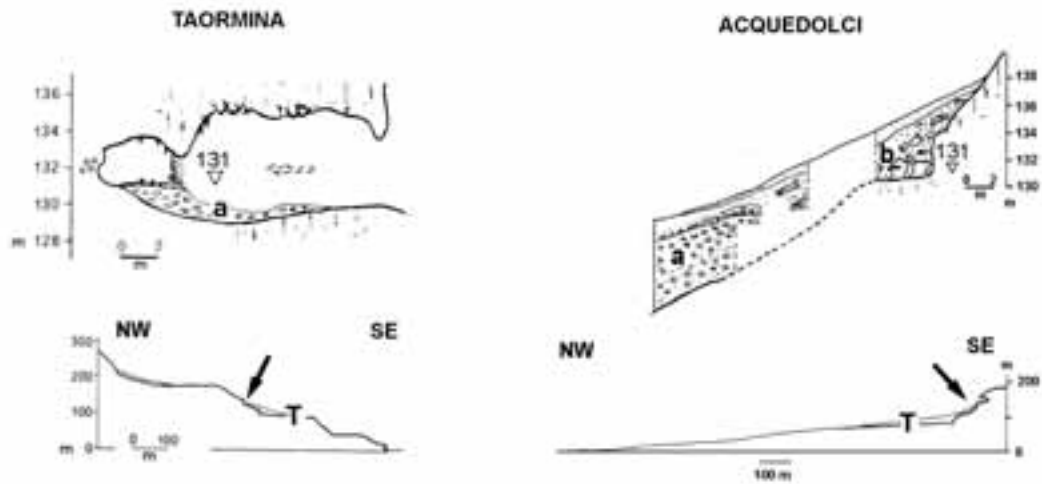


Figure 5.2 - Extension of the Tyrrhenian abrasion platform (T) and structure of the inner margin of the terrace located between 130 and 60 m a.s.l. at Taormina and Acquedolci; a, littoral gravels; b, palaeosol and lacustrine deposits at Acquedolci. (From Bonfiglio 1991, modified).

Elephas melitensis, *E. falconeri*, a dwarf fox, *Leithia melitensis*, *L. cartei*, Insectivora, Chiroptera, Amphibia, Reptilia, Aves.

4 – A breccia cemented by stalagmite sets up the ceiling of the hypogean cavity and the floor of the main cave.

5 – Bone breccia containing remains of *Hippopotamus pentlandi* and of deer, crusts on the walls of the main cavity (Figure 4.1 b).

Ambrosetti (1968), who tried to give a more straightforward reconstruction of the events, was unable to overcome the need to consider the bone breccia (5) older than the deposits with remains of pygmy elephant, which he attributed to the species *E. falconeri*, showing that *E. melitensis* is the masculine morphotype of *E. falconeri*.

According to Bonfiglio (1992 a) the succession of events at Spinagallo caves are: excavation of the caves by karst phenomena, by far preceding the early middle Pleistocene transgression which modelled the cliff, exposed the hypogean caves, and deposited the “panchina”, producing the notch and the lithodome holes in the inner wall of the lower cave. The following steps all belong to a continental environment that underwent variable morphoclimatic conditions. After subaerial alteration (dark-red clays), sands were accumulated, with remains of the vertebrates living on the Plateau, probably through fissures or swallows which have since disappeared or have not yet been located.

After the deposit of the sterile breccia (4), deposition

of the main cavity breccia (5) occurred. The removal of the highest filling levels, with the preservation of residual crusts on the walls, is a phenomenon common to most Sicilian caves. In the fossil bird assemblage found in the lower cavity, *Athene trinacriae* and *Tyto* n. sp. (Strigiforms) have endemic characteristics. *Tyto* has evolved towards gigantism, reaching dimensions slightly smaller than the modern *Bubo bubo*. It is considered the main accumulator of small and medium size vertebrate remains in the Spinagallo cave and in other karst cavities of the “*E. falconeri* F.C.” (Pavia in press; Pavia and Mourer-Chauvireé 2002).

DAY 2

Stop 2.1:

Taormina Pleistocene terraces and caves

L. Bonfiglio

A Mesozoic carbonatic massif crops in the Taormina area, belonging to the Longi Taormina nappe, the lowermost tectonic unit of the Peloritani chain. The Longi Taormina nappe extends from South East (Taormina) to North West (Acquedolci) (Figure 5.1, a) and underlies the metamorphic rocks which mainly constitute the substrate of the Peloritani chain. In North Eastern Sicily several Pleistocene marine terraces have been recognized; these originated from the interaction between Pleistocene uplift of the region and eustatic changes in the sea level. They range from 600 m a.s.l. (the oldest one) to 25-30 m (the youngest one) (Hugonie 1982). The widest

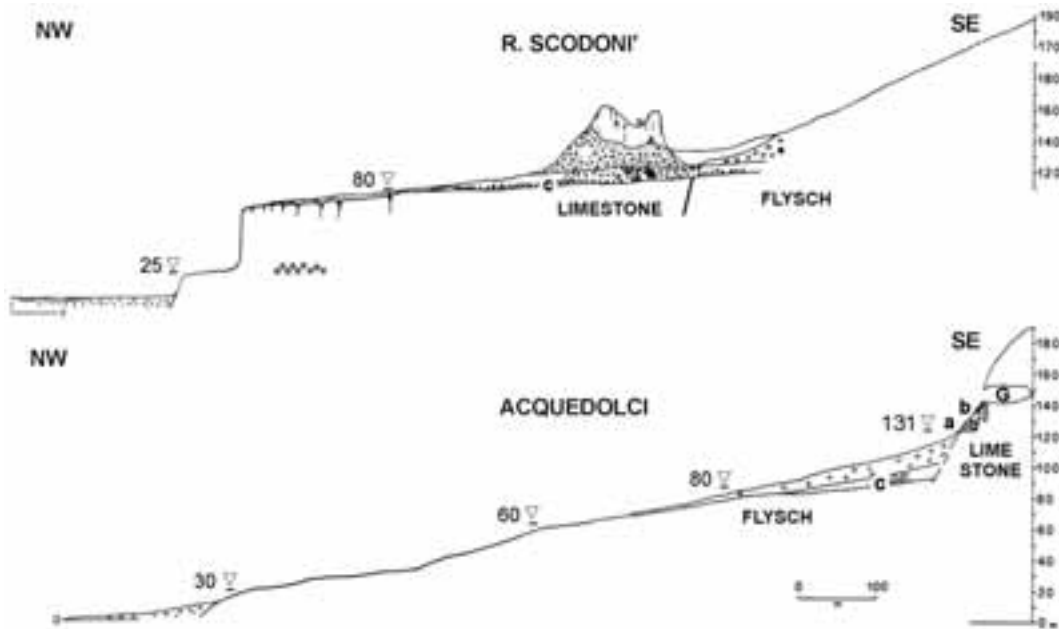


Figure 6.1 - Location of the lacustrine deposits (b) overlying the littoral deposits (a) at the inner margin of the terrace extending between 130 and 60 m a.s.l. at Acquedolci, and of the fossiliferous deposits (c) overlying the Tyrrhenian abrasion platform at Acquedolci and Scodoni; G: the S. Teodoro cave. (From Bonfiglio 1987, modified)

terrace is located between the altitudes of 130 and 60 m a.s.l. and includes an abrasion platform underlying Eutyrrhenian marine sediments with *Strombus bubonius* which have been recognised at Cape Peloro, North of Messina (Bonfiglio and Violanti 1984). It is only on the carbonatic substrate of Taormina and the Acquedolci area, on the inner edge of the terrace and underneath the continental deposits, that evidence (waterline ridge, lithodome holes, abrasion platform) still remains of a shoreline older than the Eutyrrhenian abrasion platform.

Evidence of Pleistocene evolution of the Taormina area was collected by several authors between 1884 and 1936 and has been summarized by Bonfiglio (1981). On the carbonatic substrate marine terraces and littoral deposits, Lithodomus holes, wavecut notches, caves and continental deposits have been recognized at different heights a.s.l. (Figure 5.1, b). Most of them have been destroyed by the expansion of the town. The best preserved terraces extend between 220-180, 140-160, 130-60 and 25-30 m a.s.l., respectively. Mammal remains (*Hippopotamus pentlandi*, *Elephas mnaidriensis*, *Cervus elaphus siciliae*) come from littoral fossiliferous gravels of the 220-180 and 140-160 terraces. The thin littoral covering of the 130-60 terrace is overlain by pyroclastites which most

probably come from the Etna volcano. Remains of elephant, hippo and deer also come from caves n° 3, 8, 10 (Figure 5.1, b). A littoral conglomerate and a wavecut notch, perforated by lithodomus holes and encrusted by Vermetids, may be seen inside cave n° 7, which also contains relics of an Upper Palaeolithic soil with feeding remains (mammal bones) and associated stone artefacts.

The beautiful Greek theatre will also be visited.

Stop 2.2:

Acquedolci lacustrine deposits

L. Bonfiglio, G. Mangano

The excavation of the Acquedolci deposits has contributed significantly towards a better understanding of the taphonomic conditions of *Hippopotamus pentlandi* deposits in Sicily. Acquedolci is located on the Tyrrhenian Sea, on the northern flank of the Nebrodi range, where carbonatic outcrops of the Longi Taormina nappe overlie the Monte Soro Flysch tectonic unit.

Carbonatic outcrops are limited by vertical cliffs of tectonic origin and cut by numerous marine terraces. The widest terrace is located between the altitudes of 130 and 60 m a.s.l.; an older terrace is located at the altitude of 200-180 m a.s.l. and a younger one is

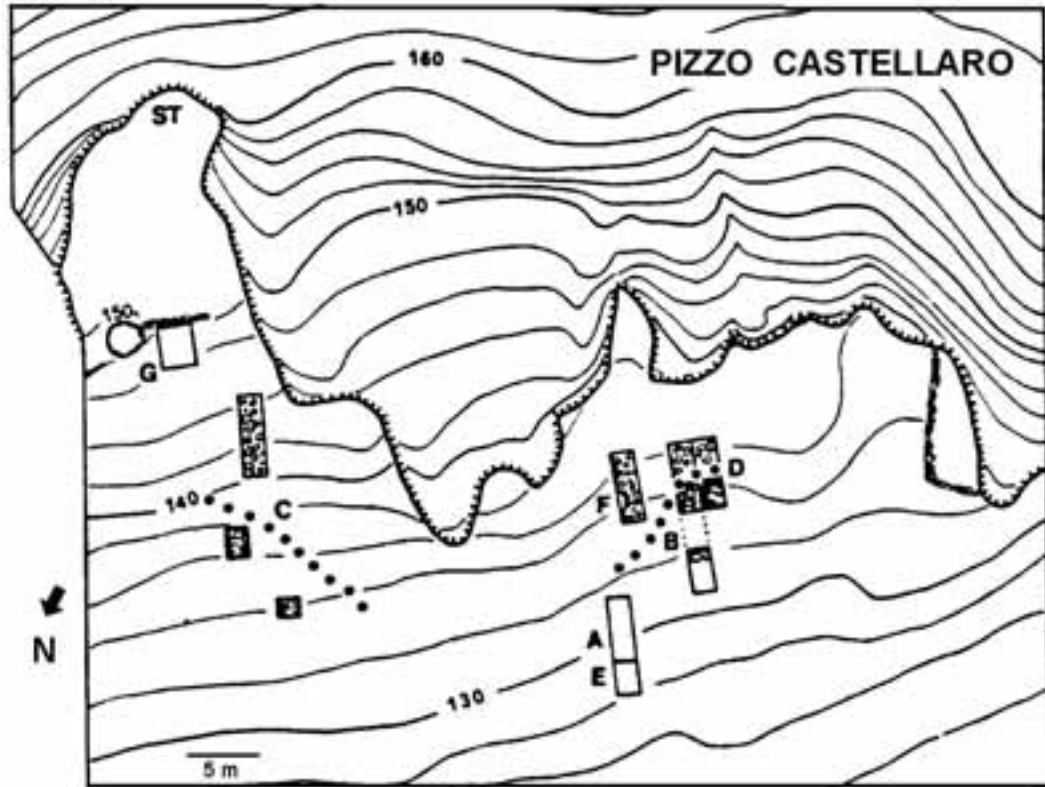


Figure 6.2 - Location of the excavation trenches at Acquedolci (A-G); ST: the S. Teodoro cave; dark circles show the separation of the coarse detritus (near the cliffs) and the silty portion of the lacustrine deposits; height: meters above sea level. (From Bonfiglio 1995, modified)

found at the altitude of 30-25 m a.s.l. The lacustrine deposits lie in the steep slope between the Northern high vertical cliffs of the Pizzo Castellaro carbonatic massif and the widest terrace extending northward. The S. Teodoro cave is situated on the vertical cliffs. The gravels and silty laminated lacustrine deposits with vertebrate remains overlie beach gravels and a wave-cut platform located at 131 m a.s.l. The vertebrate bearing deposits, the abrasion platform and the beach gravels are in turn cut by the younger Tyrrhenian abrasion platform which in this area presents its inner margin at an altitude of 105 m a.s.l. (Bonfiglio 1992 b).

Remains of hippo and deer come from a drilling site located north of the lacustrine deposits, which reached the Tyrrhenian abrasion platform below the continental sterile covering. At Rocca Scodoni, East of Acquedolci, a similar faunal assemblage overlies the Tyrrhenian abrasion platform (Figure 6.1).

Extensive stratigraphic investigations and excavations carried out during the years 1982 -1987 brought to light

late Middle Pleistocene lacustrine deposits containing thousands of Pleistocene vertebrate remains. The widely prevailing bones of *Hippopotamus pentlandi*, the endemic Sicilian hippo, are associated with scarce and fragmentary bones of *Cervus elaphus siciliae*, *Ursus cf. arctos*, *Canis lupus*, *Testudo cf. hermanni*, which are scattered through the entire depth of the lacustrine deposit (Bonfiglio 1992 b; 1995). One specimen of *Lithodomus* sp. has been collected; it had fallen from the limestone cliffs, which are burrowed by lithodome holes. The lacustrine deposit was originally at least 14 m thick.

Seven trenches have been excavated, extending over 104 m² (Figure 6.2) Detailed excavations and mapping of the Acquedolci deposits have shown that they are the site of an ancient lacustrine basin located on a coastal plain extending at the base of steep limestone cliffs. Taphonomic characters suggest an autochthonous bone assemblage.

The insight obtained on how Acquedolci bone deposits formed has implications for the study of

environmental deposition of Pleistocene mammal-bearing deposits in Sicily. Palaeontological, stratigraphic and sedimentological evidence suggests an unusual depositional environment in which a slope talus was accumulating on the edge of a lacustrine basin over a relatively large interval of time. The isolated remains of terrestrial animals, such as cervid, ursid, canid, may reflect animals which died close to the ancient lacustrine basin. Due to the spectacular abundance of fossil bones in the lacustrine deposit at Acquadolci, in the richest areas (trenches B, D, the bottom of trench F) they have been preserved in situ, in order to organize a field Museum.

Lithological characters

The following sedimentation units have been recognized, from bottom to top (Figure 6.3; 6.4):

- a - sterile beach gravels made up of sandstone and quartzarenite from the Monte Soro Flysch and subordinate fragments from the carbonatic substrate. A wave-cut platform is preserved on the bottom of trench F overlain by flattish pebbles and limestone boulders which show flat upper surfaces.
- b- gently sloping subaerial surface, having a detritic

cover containing scarce and fragmentary vertebrate remains (*Hyppopotamus pentlandi*, *Cervus elaphus siciliae*).

c – lenticular greenish-black shales, containing scarce vertebrate remains (*Hyppopotamus pentlandi*, *Cervus elaphus siciliae*, *Testudo* cfr. *hermanni*).

d – slope deposits consisting of graded coarse rounded quartzarenite pebbles and carbonatic angular fragments. The pebbles range from very coarse (1 m) to sand size and come from the sedimentary cover of the older terrace. Scarce vertebrate remains have been found.

e – *Hippopotamus pentlandi* bearing a lacustrine deposit which includes a coarse detritic (e2) and a silty (e1) portion). Sandstone and quartzarenite round pebbles are strongly prevailing near the cliffs while the northward extending part of the lacustrine deposit, mostly destroyed by erosion, consists mainly of silty sediments composed of thin laminated layers. The lithological characteristics are those of a lacustrine basin located at the base of a steep slope, where coarse gravels are not brought by a river or produced from the abrasion of the coast, but are the



Figure 6.3 - SE-NW (a) and E-W (b) sections of trenches B and D; A, B, squares (side 1 m); height: meters above sea level. For letters, see the text. (From Bonfiglio 1992 b, modified)

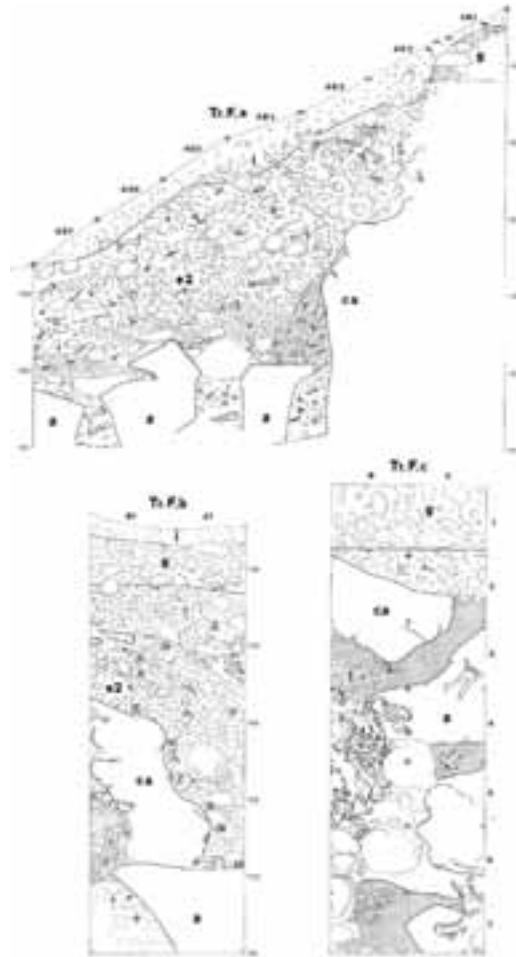


Figure 6.4 - SE-NW (a) and E-W (b) sections and plan (c) of trench F; ca: carbonatic substrate; a: carbonatic blocks of the abrasion platform; AB, squares (side 1 m); height above sea level. For letters, see the text. (From Bonfiglio 1992 b, modified)

product of slope deposition. Characteristic features of talus sedimentation are absent, such as grain size increasing towards the lower parts and absence or scarcity of clay matrix. The aquatic environment has prevented the pebbles and fragments from being selected by gravity. The silty laminated sediments, together with the strongly prevailing hippo remains, are also evidence of an aquatic environment. The high frequency of hippo remains argues against floods as the mechanism of accumulation, since flood waters would be expected to act as a transport agent not selective with respect to taxonomic identity. The abundance of the silty and clayey matrix in the coarser part of the deposit and the fossil bones setting

are evidence of a low energy environment and/or stagnant water.

Units f, g, h, i provide evidence for recognizing the drying-up of the lacustrine deposits in a later period and their cutting by the subsequent Eutyrrhenian marine cycle, up to the establishment of the present morphological conditions.

Taphonomic features

A study of the taphonomic parameters (*sensu* Badgley and Beherensmeyer 1980; Badgley 1986) such as spatial distribution of the fossils within the bone beds, degree of skeletal articulation, orientation of the fossil material at the site, bone modification features and skeletal part composition, provides a means to determine the biological and sedimentological processes that influenced the formation and preservation of the bone-bearing deposits.

Spatial distribution

In the lacustrine deposit at Acquedolci, fossil bones are distributed throughout the entire layer. In the gravel portion, bones can be found lying in the spaces between pebbles and limestone fragments. The greatest concentrations of bones are found in the silty portion, where they are clustered and densely piled. Bones range in size from complete metapodials and podials to complete but fragmented limbs, scapulae, pelvises, skulls, jaws. Sizes vary in both facies. Adult specimens are found together with juvenile and less frequent infantile remains. Less dense elements, such as vertebrae, ribs, are together with heavy bones, such as skull, jaw, scapula, pelvis. Though extremely concentrated, the fossil bones at Acquedolci were not accumulated by mass deaths; the setting of the associated species bones argues against mass deaths, since mass deaths would be expected to involve all the species present at the time in the same way. The density of the bone deposit suggests that the bones accumulated over a relatively large interval of time.

Skeletal articulation.

The high density of fossil bones belonging to the same species (*Hyppopotamus pentlandi*) prevents a reliable identification of complete articulated skeletons. Partially articulated skeletal elements have been recognized, representing the partial remains of single individuals, as inferred from either the presence of articulated material or the close fit of adjacent body parts having the same size, such as: an axe and several cervical vertebrae lying nearby a skull; ranges of lumbar vertebrae lying in succession. In a complete skull belonging to an adult individual, found lying near a jaw, the degree of wear of the upper and lower molars suggests that the skull and jaw belong

to the same individual. A complete palato-maxillary arch underlies an overturned mandibular arch. A right femur lies parallel and close to a left one of the same size. A complete pelvis was found with the pairs of ischium and ilium lying preserved on both sides of the pubic symphysis. Numerous juvenile metapodials, such as a juvenile femur, are in anatomical connection with their not yet joined distal epiphysis. The ischium and the ilium of numerous juvenile pelvises are articulated but not joined. A set of infantile skeletal elements (jaw, molars, radius-ulna, tibia, femur, fragments of skull) come from the fissure between two boulders lying upon the wave-cut platform. This pattern can be derived within a lacustrine deposit from bloated carcasses floating for sometime after death and partially disarticulated by biological processes before their entrapment within the silty and/or the detrital bottom. The bone assemblage represents bones that were added to the deposit as skeletal "sets".

Orientation of fossils

The distribution and the degree of fossil orientation provide constraints for evaluating whether bones were accumulated by the current (Woorhies 1969; Macdonald and Jefferson 1985). At Acquedolci, four different orientation patterns can be recognized, deriving from different bottom conditions. In the silty portion, long bones show random orientations and lie horizontally, as also observed for flat bones (scapulae). In the gravel portion, the bones fill the spaces between the boulders and their orientation is conditioned by the size and shape of the available space. In the gravel portion near the limestone substrate (trench F), the larger bones have a pericline orientation, which is also shown by the boulders lying on the steep slope of the substrate. The bones lying on the flat top of boulders at the bottom of trench F are horizontal.

Bone modification

Due to the falling of pebbles and limestone fragments from the steep cliffs next to the basin, the bones exhibit a network of fractures. There is also some deformation deriving from the compression of the overlying pebbles and limestone fragments. Most of the shorter bones, such as carpals, tarsals, metapodials, are not fractured. A set of bones lying on the substrate, at the bottom of trench F, has been cut by a large overplunging limestone fragment. A network of millimetric fractures have been recognized in bones lying on the limestone substrate, where heavy processes of mineralization have also been recognized. Whole bones or those with small fractures come only from the fissures between the limestone boulders overlying the wave-cut platform at

the bottom of trench F.

Some complete ribs come from these fissures, while elsewhere they are always fragmented, as well as the only complete metapodial of *Cervus elaphus siciliae*. The vast majority of the bones show that they were not exposed subaerially, since their surface shows no cracking or flaking. None of the Acquedolci bones shows any rounding due to abrasion. The lack of abrasion on the semi-aquatic *Hyppopotamus pentlandi* remains is the result of the absence of transportation; the lack of abrasion of the associated species may be explained by the hypothesis that they come as fragments from animals living in the area.

Skeletal part composition

Skeletal part frequency has been considered a potential indicator of the accumulation history of bone assemblage (Woorhies 1969; Behrensmeyer and Dechant Boaz 1980). Since the skulls were greatly fragmented, the better-preserved palato-maxillary arches have been counted. Almost all the podials have already been identified and counted. For limbs, metapodials and phalanges, complete specimens have been counted, plus the number of either proximal or distal ends, according to the larger number. Juvenile and infantile remains represent approximately 8-10% of the whole. The fossil bone composition is similar to the proportions of a whole hippo skeleton. This pattern suggests that no significant transformation of skeletal proportion occurred before burial.

Stop 2.3:

S. Teodoro cave

L. Bonfiglio, G. Mangano, F. Masini, M. Pavia, D. Petruso, U. Spigo.

The San Teodoro Cave is a landmark for the study of Upper Palaeolithic culture in Sicily, not least because of the great scientific prestige of the researchers who have been carrying out excavations and studies since the second half of the XIXth century (Anca, Vaufrey, Maviglia, Graziosi). This cave, very impressive for its huge dimensions (about 60 m long, 20 m wide and up to 20 m high), opens out in Jurassic limestone, has a relatively small entrance and a total surface of more than 1,000 m² (Figure 7.1 a).

In previous excavations the Authors distinguished an upper Late Glacial sedimentary unit, containing human feeding remains (mammal bones) associated with late Upper Palaeolithic (Epigravettian) stone artefacts, and a lower sedimentary unit (unit B in this paper) containing late Pleistocene endemic mammal remains (Figure 7.1 b) (Anca 1860; Vaufrey 1929; Graziosi 1947; Graziosi and Maviglia 1946). Within

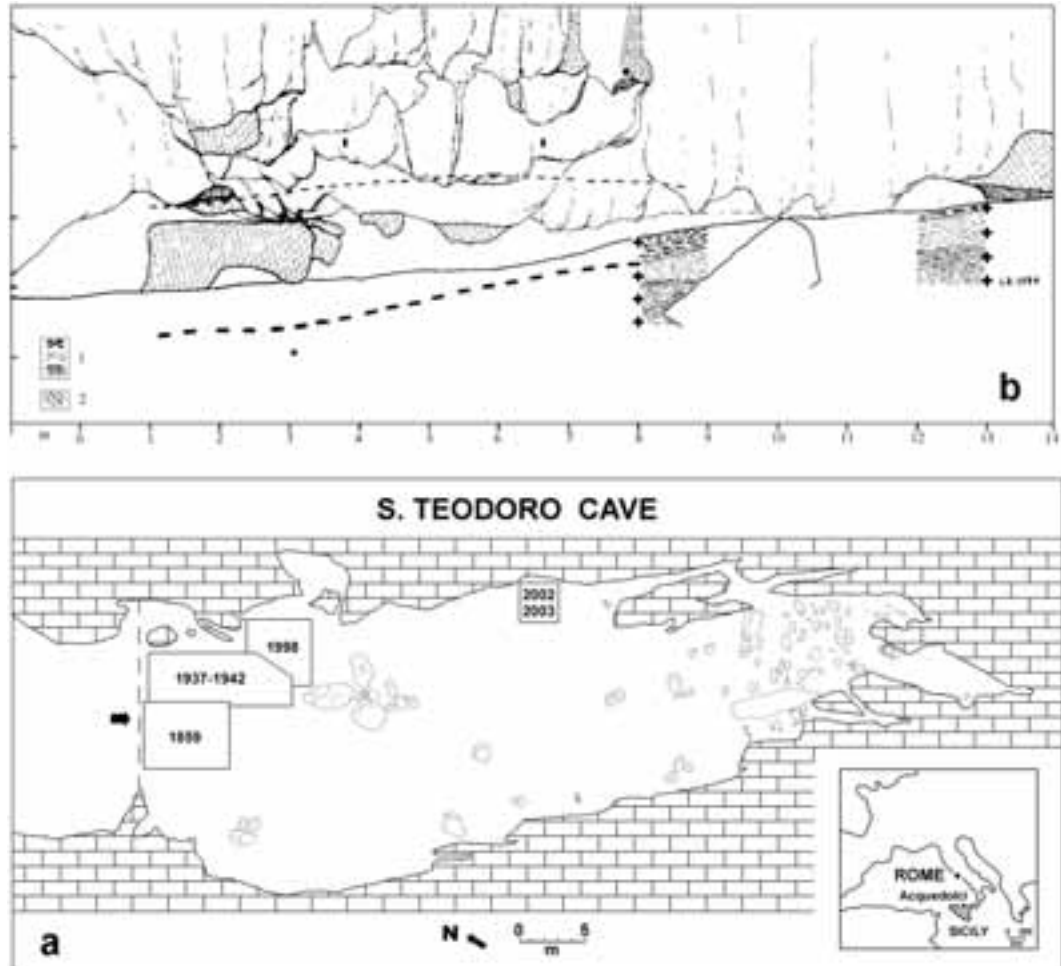


Figure 7.1 - The S. Teodoro Cave: Plan (a) where the excavation trenches are indicated and stratigraphic diagram (b). 1: unit B in the 1998 trench; 2: Remains of prehistoric bone breccias encrusting the walls; broken line, profile of the cave floor in 1942; thick broken lines: red ochre level, reconstructed by L. Bonfiglio. (From Bonfiglio et al. 2001, modified)

the prehistoric deposit, two successive cultural phases have been identified (Vigliardi 1968), which are also recognised in other Sicilian prehistoric sites where they have been dated from 14,000 to 11,000 y BP. (Radiocarbon dating, Martini 1997).

The great importance and interest of the San Teodoro Cave is also and mainly due to the presence of the first, and so far still unique, Palaeolithic burial-grounds of Sicily, which have been referred to by the authors as the oldest anthropic frequentation phase of the cave. The skulls and the exceptionally complete and well-preserved articulated skeletons of at least seven humans have been recovered, buried in the clayey sands and gravels of the lower stratigraphic

unit. (Graziosi 1947; Fabbri 1993).

Even though the San Teodoro Cave has been the object of intense episodes of human frequentation ranging from the upper Palaeolithic to the present, it still preserves a considerable part of the older, not anthropic, deposits containing Pleistocene mammals. After its discovery and first excavations by Anca (1860), and the trial pits by Vaufray (1929), the successive excavations were aimed exclusively at the recovery of human skeletons. New excavations were carried out during 1998, 2002 and 2003, devoted to the reconstruction of the stratigraphy of cave deposits and to deeper research into the faunal assemblages. Since only scattered relics of anthropic Epigravettian

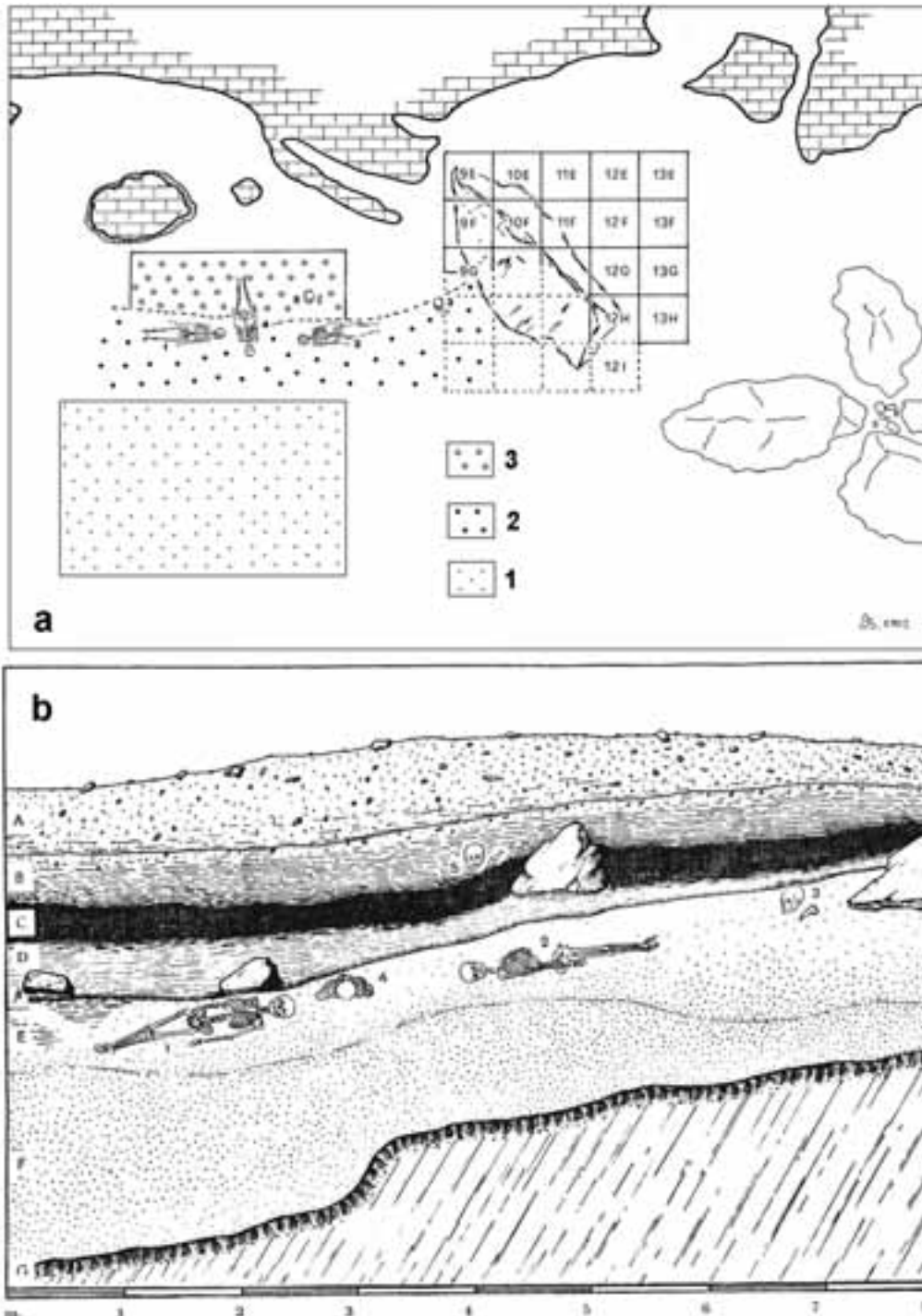


Figure 7.2 - The S. Teodoro cave: arrangement of Late Palaeolithic burial-grounds according to Graziosi (1947, Figure 1) (b) and position of the burial-grounds with regard to 1859 (1), 1937 (2), 1942 (3) and 1998 trenches (reconstructed by L. Bonfiglio). The large boulder inside the 1998 trench is seen on the right side of Figure 1 by Graziosi (1947).

soil had been preserved to date, the new trenches have been excavated mainly in older deposits. The results of the recent excavations offer new contributions concerning the history of Pleistocene mammal populations of the island and provide original taphonomic aspects (Bonfiglio et al. 1999).

Methods

A grid of squares (1m x 1m) identified by surface co-ordinates (numbers and cap. letters) have been superimposed on the cave floor, starting from the entrance and proceeding towards the inner part of the cave. The letters start from M, indicating the squares immediately eastward of the major axis set at the centre of the cave. Two excavation trenches were located on the eastern side of the cave. The 1998 trench was located on a square surface of 25 m² (co-ordinates 9 to 13 and E to I) and partially included the area excavated by Graziosi and Maviglia, refilled by

the same authors with sediments resulting from the dig. (Fig 7. 1 a). The 2002/2003 trench was located on the eastern side of the cave on a square surface of 9 m² (co-ordinates 30 to 32 and A to C). The 2003 excavations are still in progress.

The depth co-ordinate, reported for cuts and significant specimens, starts from a landmark (quote '0') marked on the eastern side wall of the cave. Each square of surface has been deepened by cuts of about 10 cm. The material extracted is therefore identified according to surface (square) and depth (cut) co-ordinates. All the sediments resulting from cut units was first dry-sieved and then screen washed on a 2 mm mesh. Sediment samples for pollen, lithological and micromorphological analysis were also collected.

Finally, reworked sediment extracted from the Graziosi and Maviglia trench was also sieved,

Species	Lower unit			Upper unit			Unit B
	Anca 1859	Graziosi 1947	Vaufrey 1929	Anca 1859	Graziosi 1947	Vaufrey 1929	Excavations 1998-2003
<i>Crocota crocuta spelaea</i>	X	X	X				X
<i>Canis lupus</i>							X
<i>Vulpes vulpes</i>			X			X	X
<i>Elephas mnaidriensis</i>	X	X	X				X
<i>Cervus elaphus siciliae</i>	X	X	X				X
<i>Bos primigenius siciliae</i>	X						X
<i>Sus scrofa</i>	X			X	X	X	X
<i>Equus asinus hydruntinus</i>		X		X	X	X	X
<i>Bos primigenius</i>					X	X	
<i>Cervus elaphus</i>				X	X	X	
<i>Erinaceus cf. europeus</i>							X
<i>Apodemus cf. silvaticus</i>							X
<i>Microtus (Terricola) ex gr. savii</i>							X
<i>Crocidura cf. sicula</i>							X
Rodents	X						
Chiroptera							X
<i>Columbia livia /oenas</i>							X
<i>Falco columbarius</i>							X
<i>Falco tinnunculus</i>							X
<i>Pyrrhocorax graculus</i>							X
<i>Pyrrhocorax pyrrhocorax</i>							X
Caradriiformes							X
Corvidae							X
Passeriformes.							X
<i>Hyla gr. H. arborea</i>							X
<i>Rana sp.</i>							X
<i>Bufo viridis</i>							X
<i>Podarcis sp.</i>							
Gekkonidae							X
<i>Testudo sp.</i>							X
Anura							X
Amphibians	X						

Table 7.1 - The S. Teodoro cave: faunal composition of upper and lower units according to previous excavations, compared with 1998 results. (From Bonfiglio et al. 2001, modified)

since the very abundant skeletal remains and stone artefacts left by these authors during their work, even though the indications of their stratigraphic position have been lost, still maintain their value as historic documentation.

Stratigraphic and faunistic data

In the 1998 excavation trench a large limestone boulder, with a flat upper surface and NE-SW elongation, made it possible to separate the part of the deposit *in situ* from that already involved in previous excavations (Figure 7.2 a). This boulder was clearly reported also in Graziosi's stratigraphic section (1947) (Figure 7.2 b). At the intersection between the 1998 northern wall with the eastern limit of the Graziosi excavations, a section of the red ochre level which covered the burials, an exclusive peculiarity of Palaeolithic burial ritual at S. Teodoro, was exposed. In some squares only (9 F, 9 G and 13 H) relics of the archaeological layers were present. The 1998 excavations involved the sediments of the lower (pre-Late Glacial) unit, to a total depth of about 1.50 m.

Lithology and fossil content is fairly uniform along all the investigated depth. The sediment is prevalently clayey sand, yellowish in the upper 50-60 cm and then grey-greenish in the deeper part of the deposit.

Vertebrate remains are scattered within all the excavated levels. Skeleton remains of large mammals are fragmented and not articulated. The material resulting from washed samples of sediment consists of a large number of mammal bones and hyena coprolite fragments, small vertebrates (rodents, insectivores, bats, birds, amphibians and reptiles), small gastropods and seeds. Tab 7.1 gives the list of the taxa collected from unit B, and taxa which have been listed in the stratigraphic description of previous papers.

Taphonomy and Biochronology

The 1998-2002 research in the San Teodoro Cave has supplied new data regarding the taphonomy and biochronology of Quaternary mammals in Sicily.

The abundant and varying evidence of cave frequentation by spotted hyena populations is at present the most prominent taphonomic feature of this deposit. This evidence consists in the occurrence of several *Crocota* skeletal elements (skull, teeth, limb bones), an impressive quantity of coprolites, and in ubiquitous traces of crushing, gnawing, chewing and digestion that have been detected in almost all the large mammal remains (Marra and Bonfiglio 2002). In the bone assemblage of the San Teodoro cave, large mammal skeletal elements were accumulated by *Crocota crocuta spelaea*, which damaged the main part of the bones. The unusual taphonomic features

related to hyena frequentation during the deposition of Unit B are more or less identical to those associated with continental African and European cave deposits. These taphonomic features are at present a novelty for insular environments and apparently reinforce the scant insular character of ecological conditions related to this new faunal complex. The most important issue concerning the fauna is the occurrence of non-endemic micromammals and of *Equus hydruntinus* associated with endemic large mammal taxa, survivors of the *E. mnaidriensis* F.C. The fossorial habits of the savii vole strongly suggest that its dispersal across the Messina Straits occurred through an emerged land bridge, probably during a low stand stage. Pollen from coprolites depicts a glacial landscape that included steppes of Poaceae, *Artemisia*, *Ephedra*, Chenopodiaceae, *Asteraceae*, *Pinus*, *Cupressaceae*. Lower percentages of pollen of mesophilous taxa (*Quercus*, *Betula*, *Abies*, *Alnus*, *Pistacia*, among others) suggest the existence of nearby refugia of temperate and Mediterranean vegetation (Yll et al. in press). The assemblages of the "S. Teodoro cave - Pianetti" F. C., have not yet been dated radiometrically. The most likely time interval for this Faunal Complex seems to be from early IOS4 to IOS2.

DAY 3

Stop 3.1:

Monte Pellegrino

V. Agnesi, C. Conoscenti, C. Di Patti

Geological and Geomorphological setting

Monte Pellegrino is an isolated relief and forms part of the Palermo Mountains. It is made up of a carbonatic rock succession (upper Trias – Eocene), belonging to three different stratigraphic series (Montanari 1965) referable to a platform palaeogeographic domain. These deposits are deformed and faulted due to the Neogenic orogenic phases and to the Plio – Pleistocene tectonic events that involved the whole complex of the Monti di Palermo.

The geomorphological setting of Mount Pellegrino consists of structural forms, originating from surface waters, karstic, and coastal, and other forms produced by slope and planation processes (Figure 8.1).

Structural control had a primary role in the morphological evolution of Monte Pellegrino, influencing the genesis of the different forms either in a direct way, due to tectonic movements, or in an indirect way, due to selective erosion. The tectonic forms are represented by several degraded fault scarps

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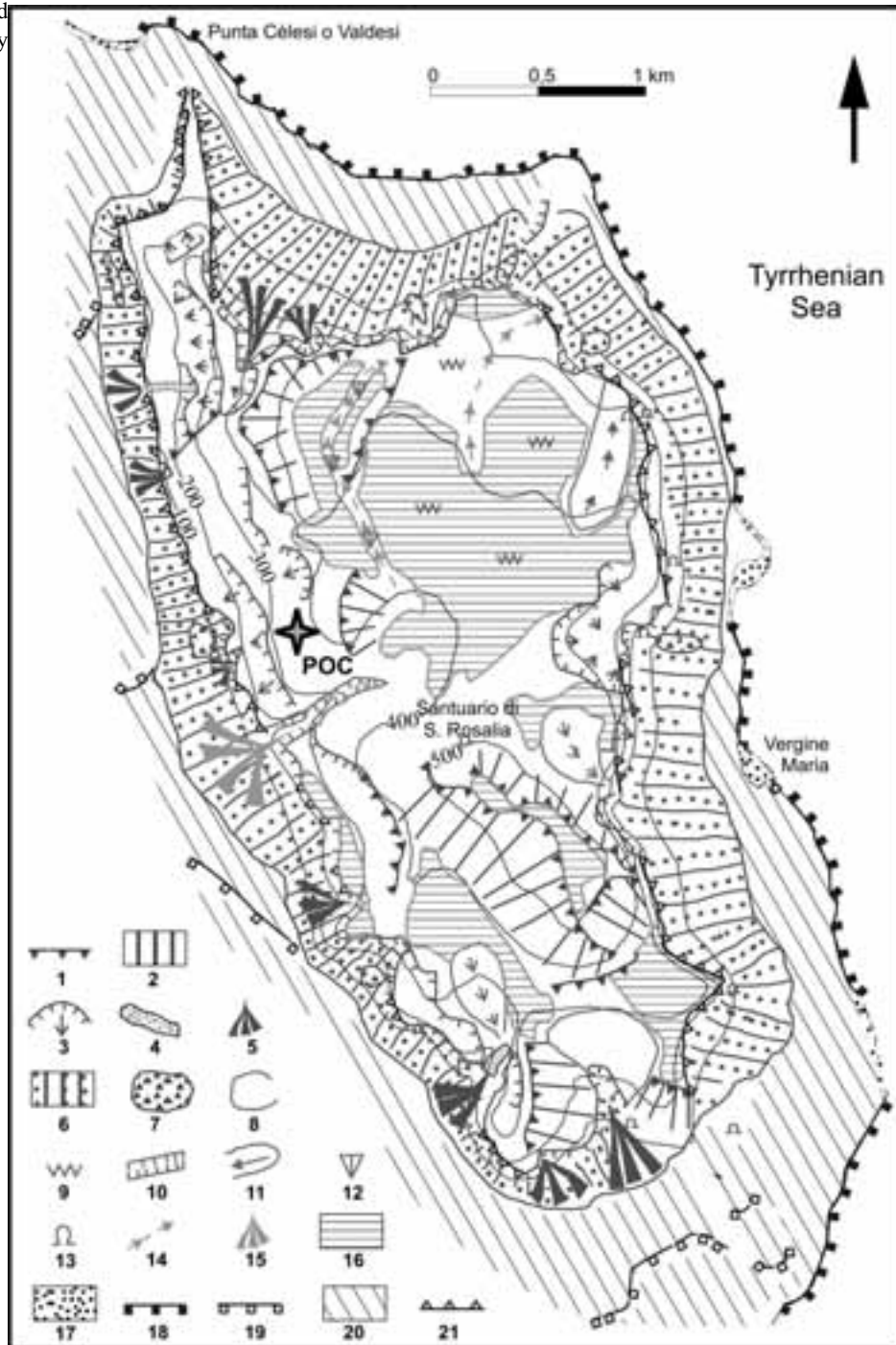


Figure 8.1 - Geomorphological map of Monte Pellegrino. 1) scarp edge or fault step, 2) fault slope, 3) fall niche, 4) debris flow, 5) debris cone, 6) debris talus, 7) landslide debris, 8) open doline, 9) karren, 10) fluvio-karst canyon, 11) dead valley evolved to open doline, 12) swallow hole, 13) karst cave, 14) dead valley, 15) alluvial fan, 16) sub-horizontal surface, 17) actual beach, 18) active marine scarp, 19) inactive marine scarp, 20) marine-cut terrace, 21) inactive sea cliff.

ancient sea-cliffs, structurally controlled, that border the relief and have retreated in respect to their former positions.

The morphologies originating from surface runoff waters are mainly valleys and relict riverbeds. Nowadays the surface washout waters are responsible for the removal of the eluvial covers and of the slope deposits outcropping along the flanks or in the mountain-top areas. Among the forms influenced by the surface runoff waters the Valle del Porco canyon can be noted, produced by a combination of fluvial and karstic processes.

The epigeic karstic forms are represented by open dolines and karren. The main hypogean forms are represented by caves and sinkholes.

The coastal processes played a role of great importance in the evolution of the peripheral areas, deeply influencing the present morphology of the relief edges. Owing to the emersion of the fault planes, responsible for the configuration of the Monte Pellegrino structural high, were reworked by the erosion of the Pleistocene sea that formed sea cliffs affected by parallel regressions. Moreover three orders of marine terraces are present, represented by abrasion surfaces separated by moderate erosion scarps. The ancient sea cliffs have been modified by rock falls and by weathering processes; the rock falls led to the creation of wide semi-circular niches, commonly set up in the intersection of faults or fracture systems with sub-vertical scarps; the weathering processes, aided by the mechanical decomposition of the rocks, gave rise to the formation of talus slopes and debris cones. The sub-plain surfaces of the top areas, presenting similarities with those present in the Apennine chain and indicated as "sub-horizontal surfaces" by Di Maggio (2000), are clearly forms of erosion due to continental phases. The planation processes that shaped such morphologies probably acted during standing phases of the erosion base level. In the Monte Pellegrino area, the sub-horizontal surfaces form a regular altimetric succession produced by the combination of areal erosion and the relative lowering of the erosion base level. The erosion processes, primed by the definitive emersion of the relief during the Early Pleistocene, led to the gradual dismantling of the Neogenic terrigenous deposits that had formerly covered the carbonatic substrata. The hydrographical system, which had originally developed on the clayey deposits, today completely eroded, is now superimposed on the carbonatic rocks as a consequence of the lowering of the base level. This gradual drop produced the sub-horizontal



Figure 8.2 - View of the POC (*Pellegrino occidentale*) site.

surfaces sequence. During these phases and the high stand periods, the marine erosion processes cut the coastal areas forming a succession of marine terraces (Lucido 1992).

Monte Pellegrino fossil vertebrates

In 1886, the Marquis Antonio De Gregorio discovered a vertebrate-bearing deposit on the top of Mount Pellegrino, containing a fossil fauna different from those yet known in Sicily and in the Mediterranean area. De Gregorio (1886) gave the following list of the taxa:

Pellegrinia panormensis, De Gregorio
Mustela arzilla, De Gregorio
Lepus (Oryctolagus) cuniculus Linnaeus
Mus piletus De Gregorio
Lacerta viridis Linnaeus

In 1925, after the finding of new specimens, De Gregorio revised the faunal assemblage of Mount Pellegrino, giving the following list:

Pellegrinia panormensis De Gregorio
Mustela (Mustelercta) arzilla De Gregorio
Lepus n. sp.
Myoxus melitensis Adams (var. *piletus*)

At present the following taxa have been recognized in the faunal assemblage of Mount Pellegrino (Di Patti and Fiore 1998):

Mustelercta arzilla (De Gregorio, 1886)
Pellegrinia panormensis De Gregorio 1886
Hypolagus sp.
Eliomys (Maltamys) cfr. *gollcheri* (De Bruijn, 1966)
Apodemus maximus Thaler, 1972
Lacerta viridis Linneo, 1758
Asoriculus burgioi, Masini & Sarà, 1998
Testudo graeca ???

The fossiliferous site found on the top of Monte Pellegrino was completely removed by De Gregorio during the period between 1886 and 1925. In 1972

Thaler signaled a new fossiliferous site on the western side of Mount Pellegrino, which contained new taxa, such as *Leithia* n. sp. and *Apodemus maximus* Thaler. In recent years a new deposit, containing very scant fossil remains, has been discovered on the western flank of the mountain named the “Pellegrino falde” and “POC” (“Pellegrino occidentale”; Figure 8.2). This new site probably represents the only preserved evidence of the Monte Pellegrino Pleistocene faunal assemblage. For its great scientific interest this site is being proposed as a “palaeontological site” by the Department of Geology and Geodesy of Palermo University. The Monte Pellegrino faunal assemblage is the oldest Quaternary fossil record of Sicily known so far and is documented only in the very restricted geographic area of Monte Pellegrino, close to the town of Palermo. The faunal assemblage was recovered from soil deposits infilling karst fissures.

The taxa of the Monte Pellegrino faunal complex have been considered indicative of a Late Pliocene - Early Pleistocene age by Thaler (1972), although Burgio and Fiore (1997) considered it to be Early Pleistocene (late Villafranchian).

The poorly diversified fauna includes species with different degrees of endemism and of different geographic affinity, indicating a polyphasic origin. Since the first report by Thaler (1972) some of the taxa have been revised more recently, but our knowledge of this very peculiar and intriguing faunal assemblage is still not exhaustive.

Mustelercta arzilla is one of the two mustelids contained in the Sicilian Pleistocene faunas. The other, *Lutra trinacrie*, is an otter recovered from the Poggio Schinaldo cave (Cinisi – Palermo) and at Contrada Fusco (Syracuse), and belongs to the *Elephas mnaidriensis* faunal assemblage. The specimen of *Mustelercta arzilla* collected by De Gregorio comes from the deposit located at the top of Mount Pellegrino and is the size of a big marten. Recent studies based on comparisons among the closest fossil mustelids brought Burgio and Fiore (1997) to consider valid the genus *Musterlecta* proposed by De Gregorio (1925), supporting the priority of this generic name instead of the fossil genus *Pannonictis* proposed by Kormos (1931). *Musterlecta* was diffused in the whole of Europe during the Plio – Pleistocene and also occurs in central Italy in deposits dated Lower Pleistocene.

Hypolagus sp. was described only by Thaler (1972) who, owing to a lack of sufficient finds, attributes the specimen from Mount Pellegrino to the genus *Hypolagus*, widespread in all of Europe during the Villafranchian. The subsequent discovery in the

“POC” deposit of several remains, such as many mandibles with teeth and, especially, a skull, which probably represents the only known skull of this genus, will certainly lead to a specific determination. At present, only the generic attribution given by Thaler



Figure 8.3 - Skull and mandible of *Pellegrinia panormensis*.

can be confirmed and it can be hypothesised that the Monte Pellegrino specimen is on the evolutionary line of the European forms *Hypolagus beremendensis* and *H. brachygnatus*, both of Hungarian origin and also found in some Italian localities.

Asoriculus burgioi. This shrew is about twice as large as the *Asoriculus* representatives from the mainland but, apart from this, is not very different from them (Masini and Sarà 1998). *Asoriculus* is well documented in Europe from the early Pliocene, and it has also been found recently in northern Africa, in upper Pliocene - lower Pleistocene deposits (Geraads 1995; Rzebik-Kowalska 1988). This find complicates the palaeobiogeographical picture, making any hypothesis of its geographic provenance more uncertain.

The endemic dormouse *Leithia* nov. sp. was quoted by Thaler (1972), but this taxon has not been studied in detail. There is, however, a certain consensus in literature, regarding it as one of the direct precursors of the better known and better described *Leithia* and *Maltamys* from the middle to late Pleistocene of Sicily and Malta (Zammit Maempel and De Bruijn 1982). These forms have been assigned to the tribe *Eliomyini* and, according to some authors, are the direct offspring of a taxon, no better identified than *Eliomys* sp. (Daams and De Bruijn 1995). These authors considered *Leithia* and *Maltamys* as relics of a scarcely known older (Messinian) population phase which remained isolated in the Sicilian Maltese archipelago for the entire Pliocene and most of the

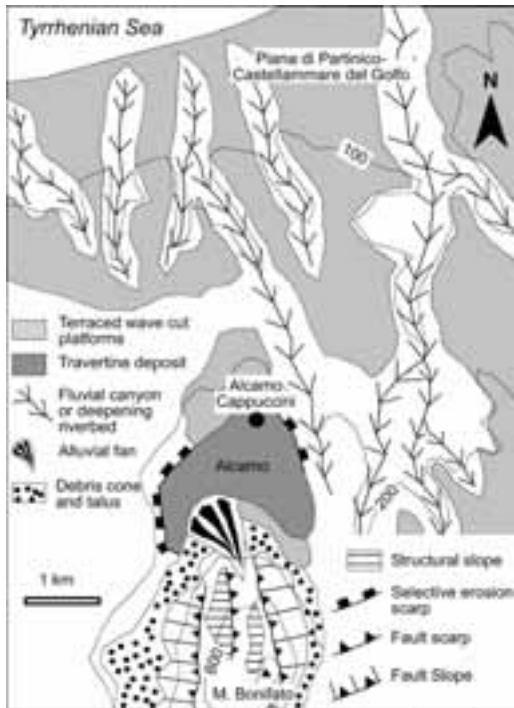


Figure 9.1 - Geomorphological sketch of Alcamo area.

Quaternary. *Maltamys* sp. is the only taxon occurring also in the younger Faunal Complexes of Sicily. It is the smallest dormouse recovered from the Siculo-Maltese archipelago. According to Petruso D. (2002, unpublished dissertation) the morphology of teeth and mandible of the specimen from Mount Pellegrino are to be attributed to the most primitive form of the genus.

The presence of *Pellegrinia panormensis* in the Monte Pellegrino assemblage is enigmatic (Figure 8.3). This rodent was described by Thaler (1972) as a strongly endemic form belonging to Ctenodactylids, a rodent family that nowadays has an exclusively African distribution (Jager 1971). Ctenodactylids probably originated in Asia in the Oligocene; the oldest African representative of the family dates back to the middle Miocene (Locality Beni Mellal). Ctenodactylids are also known from Sardinian deposits of lower Miocene age. According to Thaler *Pellegrinia* has derived the characteristics of the African stock of Ctenodactylids, thus indicating a dispersal from that region. Again, a Late Miocene (Messinian) age has been cited for this dispersal.

The information derived from the poorly studied *Apodemus maximus* is limited to the observation that this mouse is more than twice as large as the

living *Apodemus sylvaticus*. The size increase, comparable to that observed in *Asoriculus*, indicates that this taxon underwent a certain amount of differentiation in insular conditions. *A. maximus* can be morphologically related to the living species *A. mystacinus* and to the genus *Rhagapodemus* which are in turn on the evolutionary line of the large sized species widespread in all Europe during the Pliocene. The composition of the Monte Pellegrino fauna - unique for the Mediterranean islands - suggests it may have been derived in part from an older, not locally known, population phase (Messinian age ?; Azzaroli and Guazzone 1979) and partially from younger dispersals from Europe.

Stop 3.2:

Alcamo Cappuccini

V. Agnesi, C. Di Maggio, C. Di Patti

Geological and Geomorphological Setting

Alcamo is located at the foot of Monte Bonifato on the northern flank, an isolated carbonatic relief that reaches the height of 825 m a.s.l.

The built up area is developed on a slightly sloping plateau which extends for more than 2 km², between the heights of 200 and 300 m a.s.l., connected with the hilly or sub-horizontal areas of Piana di Partinico and Castellammare del Golfo.

The geological setting consists of a pile of tectonic units folded and thrust, deriving from the Neogenic deformation of carbonatic and pelagic rock successions dated upper Trias - Tortonian, and by terrigenous covers of Tortonian - lower Pliocene (Catalano and Lo Cicero 1998). A thick wedge of Quaternary deposits, either marine (conglomerates, arenaries and clays) or continental (aeolian, fluvial and colluvial deposits) lay, on the Tertiary - Mesozoic rocks at a maximum thickness of about ten meters (Mauz and Renda 1991).

The geomorphological setting of the area is characterized by relief forms referable to coastal, tectonic and morphoselective processes as well as surface run-off waters and gravity (Figure 9.1).

The most significant morphological element is the marine abrasion platform constituting the sub - plain area on which the town of Alcamo is built. It is a slightly north immersing planate, whose origin is due to the abrasive action of the Pleistocene sea that, in the past, stationed at relatively higher levels than the present ones; this sea slowly produced a sub - plain surface, cut here on the Tertiary - Mesozoic substrata, and at the same time gave origin to conglomeratic and arenitic deposits of neritic and beach environment.



Figure 9.2 - Alcamo Cappuccini: karst fissure open in the travertine.

The inner edge of the terrace is buried under a pack of talus debris; however, its height can be hypothesized as about 350 m a.s.l. The abrasion platform is obviously older than the travertine deposits, to which Bada et al. (1991), on the basis of aminostratigraphic data, attribute an age of about 500,000 years b.p.

The surrounding hilly areas are characterized by a landscape of moderate rounded reliefs with non-uniform and slightly inclined slopes, cut by frequent rivers, subject to intense washout processes and disrupted by several landslide movements. The first one of these processes is certainly posterior to the gradual withdrawal of the sea from these areas and subsequent to the phases of sea level high stand (early Pleistocene – late Pleistocene).

This erosive action may be responsible for the partial or total dismantling of the ancient coastal forms and for the present geomorphological setting of the examined areas.

Nowadays only the ancient sea platform at the town of Alcamo is preserved, together with the more recent and extended terraced areas located at lower heights along the coastal sectors, referable to isotopic stages 5, 7 and 9. A gradual uplift tendency of the area was



Figure 9.3 - Travertine cast of brain of E. falconeri from Alcamo.

estimated with rates between 0.14 and 0.25 m/ky (Mauz et al. 1997).

Several small trough-shaped valleys can be pointed out among the landforms of the hilly sectors, as well as frequent canyons, deepening riverbeds, landslide bodies and also a few patches of erosional glacia on soft rocks.

The northern Monte Bonifato flank is characterized by landforms influenced mainly by the structure. In this sector, due to the presence of highly conservative carbonatic rocks, either tectonic forms are preserved, such as wide fault scarps and slopes (Hugonie 1982), or forms due to morphoselection, such as structural slopes.

The edges of the travertine table and of the more cemented underlying arenitic - conglomeratic deposits are affected by selective erosion scarps, a few meters high. These scarps are caused by the superimposition of relatively “hard” rocks (travertines) on “softer” rocks (clays).

Moreover, along the slopes of Monte Bonifato

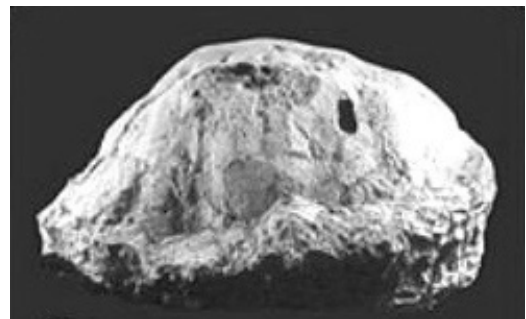


Figure 9.4 - Giant terrestrial tortoise from Alcamo: inner cast of the carapace.

talus, debris cones and alluvial fans are present, due respectively to gravitative processes like debris falls or rock falls and to mass movements.

Alcamo fossil vertebrates

The exploitation of travertine quarries at Alcamo can be dated back to the XIV century, as testified by its historic buildings. From the beginning of the extractive activity, several casts of fossil mammals were collected from the travertine and utilised by quarrymen as gifts and ornamental objects. Around the nineteen-seventies these casts were recognized as fossils, giving the site an important scientific significance. Meanwhile, however, most of the fossils were destroyed during the centuries-old quarry activity.

From 1928 onward Ramiro Fabiani, the director of the Geological Museum of Palermo University, collected fossil remains coming from the Alcamo travertines, especially from the area known as Contrada Fontana della Pietra.

A collection was formed through periodical investigations of great scientific value both for the importance of the finds and for their fossilisation conditions.

In Contrada Alcamo Cappuccini (Figure 9.2) Burgio and Cani (1988) found the first stratigraphic data, which contradicted the previous ideas on the chronological succession of elephants in Sicily and assigned an age to *Elephas falconeri* superior to that of *E. mnaidriensis*.

As a matter of fact, the faunal assemblage contained in the travertine formation belongs to the *Elephas falconeri* Faunal Complex, while the fossils coming from "red soils", which infill some karst fissures open in the travertine (Figure 9.2), belong to the *Elephas mnaidriensis* F.C.

The faunal assemblage collected from Alcamo travertine contains, beside the pygmy elephant, remains of the giant dormouse *Leithia melitensis*, and a giant terrestrial tortoise (Testudininei indet., Delfino M. 2001, unpublished PhD dissertation) and the gastropod *Helix mazzulli*.

Skeletal elements of *E. falconeri* represent nearly the entire skeleton; two brain casts have also been recovered, one of which inside its skull. The encephalic convolutions formed by the travertine are enhanced by a white patina (Figure 9.3).

The giant terrestrial tortoise is represented by an almost complete interior mould, fragments of the plastron, limb bones and several hundred eggs

(Figure 9.4).

Several vegetal remains (branches, trunks, pinecones and needles) also come from the Alcamo travertines.

At Contrada Cappuccini, a wide fissure contains remains of *Elephas mnaidriensis*, *Hippopotamus pentlandi*, *Cervus elaphus siciliae*, *Bos primigenius siciliae* and of the endemic dormouse (*Maltamys wiedincitensis*).

DAY 4

Capo San Vito Peninsula (Stops 4.1 – 4.4)

F. Masini, D. Petruso, C. Di Maggio

Capo San Vito Peninsula, the northernmost sector of the Trapani Mountains, has long been involved in geological, geomorphological and palaeontological research.

The earliest studies (Fabiani and Trevisan 1940) gave generic geological information about the area; it was only from 1970 that the peninsula was investigated in more detail (Broquet and Mascle 1972; Giunta and Liguori 1972; Catalano and D'Argenio 1982; Abate et al. 1991). Over the last decades, geomorphological and palaeontological investigations have been carried out and are still in progress. In particular, morpho-evolutionary models related to gravitative slope processes (Agnesi et al. 1995) and to Pleistocene coastal dynamics have been proposed (Antonioli et al. 1998a, 1998b; Di Maggio et al. 1999). Mauz et al. (1997), who studied the upper – middle Pleistocene deposits of the Castellammare del Golfo area and the Capo San Vito Peninsula, added palaeontological and stratigraphic data (figs. 10.1, 10.2). Eventually, analysis of the different continental deposits and the results of an excavation carried out on the "K22" fossiliferous site, made it possible to recognise the presence of fossil mammal assemblages belonging to the main Sicilian Faunal Complexes. On the basis of this data a correlation of such deposits was proposed, the marine terraces with the North Atlantic $\delta^{18}\text{O}$ isotope variation curve (Di Maggio et al. 1999; Figure 10.3).

The purpose of the excursion is to highlight the complex relations among the eustatic fluctuations, neotectonic and quaternary deposits, in order to propose a model of palaeogeographic reconstruction. Particular attention has been focused on the Piana di Sopra and Piana di Castelluzzo areas, which represent important sectors for the presence of well-preserved quaternary deposits with fossil vertebrates, marine terrace succession and much evidence of neotectonic activity.

Geological features

The Capo San Vito Peninsula Mountains, forming the north-westernmost sector of the Sicilian chain, are formed by the overlapping of different tectonic units overthrust with eastern and south-eastern vergence.

Such units mostly consist of carbonatic or carbonatic – pelagic rock successions dated upper Triassic – middle Miocene. A Miocene orogenic phase stacked such units and a disjunctive and transcurrent tectonic dissected them during the late Pliocene – early

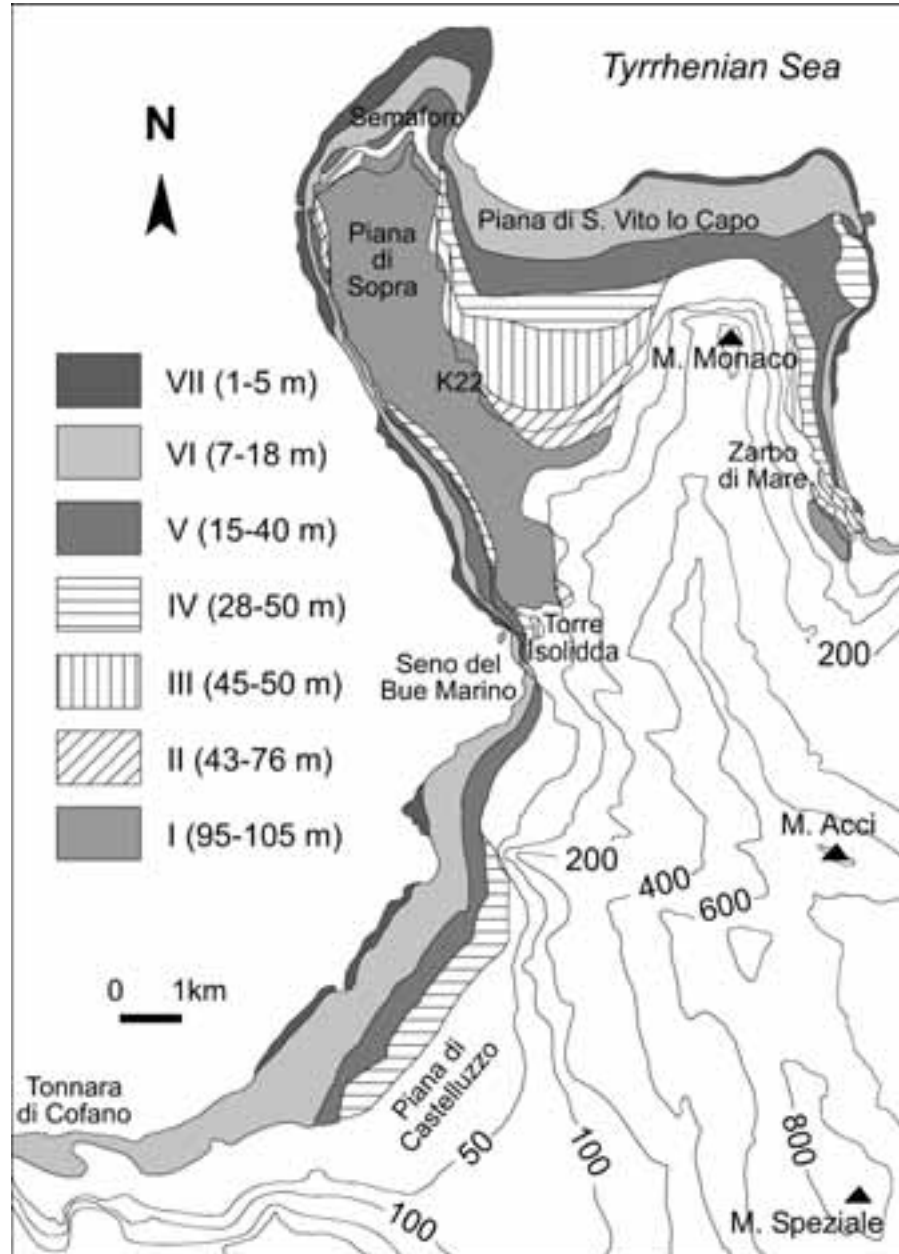


Figure 10.1 - Distribution of marine terraces in the northern extremity of the San Vito Lo Capo Peninsula and in the Piana di Castelluzzo, trip itinerary and location of stops. The heights of the inner edge of the various order terraces are reported in the legend (modified from Di Maggio et al. 1999).

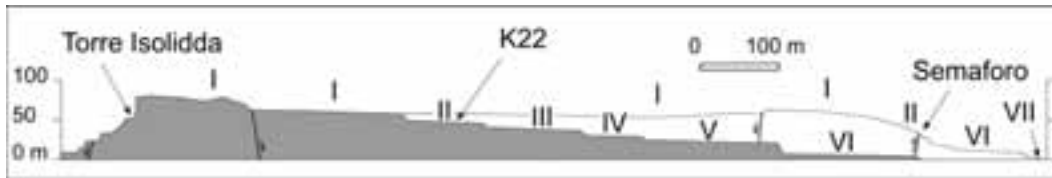


Figure 10.2 - Schematic section of the terraced succession of Piana di Sopra (white) and Piana di San Vito lo Capo (grey) areas. Modified from Di Maggio et al. 1999.

Pleistocene (Oldow et al. 1990; D'Angelo et al. 1997).

In particular, in the Piana di Sopra area, in the north-western sector of the Capo San Vito Peninsula (Figure 10.1), the Mesozoic – Tertiary substrate consists, from bottom to top, of calcilutites and nodular marly calcisiltites with ammonites (Dogger – Malm), calcilutites and marly calcisiltites with chert (Titonic - lower Cretaceous), calcirudites and corallgal calcisiltites (lower Cretaceous – upper Cretaceous), calcilutites and marls (Scaglia) interspersed by thin lens of carbonates (upper Cretaceous – Eocene).

Piana di Castelluzzo, on the eastern edge of the Peninsula (Figure 10.1), is made up of yellowish bioclastic calcarenites, mostly of neritic environment, bearing a rich invertebrata fauna (bivalves, gastropods, bryozoans, hexacorals, ostracods and macroforaminifera). Rocks with similar characteristics, outcropping commonly along the coastal areas of north-western Sicily, are generally attributed to the Early Pleistocene (Mauz and Renda 1991).

In the Capo San Vito Peninsula and, particularly, in the Piana di Sopra and Piana di Castelluzzo areas middle and upper Pleistocene deposits are often preserved inside karstic cavities, marine caves and wave cut notches. The deposits are mainly made up of badly stratified beach conglomerates decimetres thick, locally bearing marine invertebrates and occasionally mammals. Such sediments are followed by conglomerates, breccias, paleosols, aeolian sediments and more recent colluvial deposits, often containing vertebrates and pulmonate mollusc remains, that can be referred to different depositional cycles.

Geomorphological setting

The western and northern coastal areas in the Capo San Vito Peninsula consist of extensive marine abrasion surfaces located at various heights and separated by cliffs. The geomorphological setting is the result of Quaternary coastal morphogenesis that, due to the marine level fluctuations determined either by eustatic

variations or by tectonic movements, is responsible for the formation of different orders of marine terraces (Ulzega 1989; Antonioli et al. 1998a).

Di Maggio et al. (1999) identified seven order terraces with an inner edge between the heights of about 95 – 105 m, 43 – 76 m, 45 – 50 m, 28 – 50 (?) m, 15 – 40 m, 7 – 18 m e 1 – 5 m a.s.l. indicated respectively as the I, II, III, IV, V, VI and VII orders, beginning from the highest one (figs. 10.1, 10.2). This terrace succession appears complete and well preserved in the Piana di Cornino, where the different terrace orders are separated by inactive cliffs, and along the north-western coastal areas of the peninsula (Piana di Castelluzzo, Piana di Sopra, Piana di San Vito lo Capo, Zarbo di Mare). The various phases of marine high stand are also recorded by wave-cut notches and marine caves, cut in the inactive cliffs, which are frequently affected by bands of lithodorous holes and filled by marine and/or continental deposits sometimes bearing vertebrate remains.

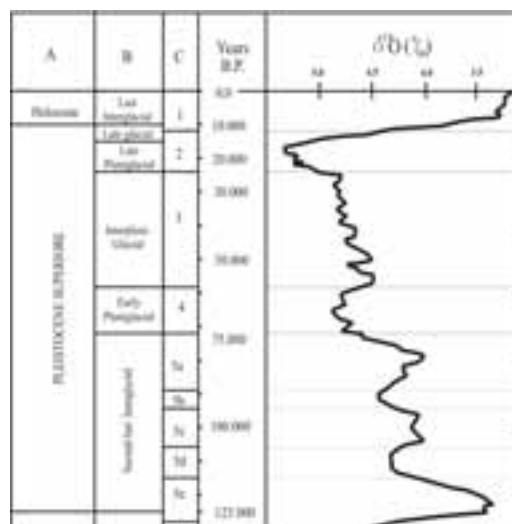


Figure 10.3 - Chronology and Climatic stratigraphy of the interval late Pleistocene – Holocene. A. Chronostratigraphy; B. Climatic stratigraphy; C. Isotopic stages. Modified from Agnesi et al. 1997.

The terrace heights cannot be considered strictly indicative, as a result of the neotectonic activity that produced fault scarps and fragmented the area in sectors characterised by different uplift speed.

Although tectonic disturbance renders the dating of the terraces and related deposits more uncertain, the succession of events can be reconstructed on the basis of stratigraphic and palaeontological data.

The more constraining datum is represented by the presence of a rich warm – temperate “Senegalense” fauna, including *Strombus bubonius* (Mauz et al. 1997), in the deposits overlying the abrasion surfaces of the VI order terrace, which make it possible to attribute this terrace to the Eutyrrhenian (isotopic sub-stage 5e; Figure 10.3). According to the geometric position the VII order terrace can be attributed to the “neotyrrhenian” phase (isotopic sub-stage 5a or 5c; Figure 10.3) and the other terrace orders, locally cut in the Early Pleistocene calcarenites, are instead attributed to different phases of the marine high stand of the late early Pleistocene (?) – middle Pleistocene.

Mammal deposit Biochronology

The Capo San Vito Peninsula is particularly rich in mammal deposits that are mostly preserved in morphological traps (wave-cut notches, marine caves and karst cavities) and sometimes overlay terrace deposits (Di Maggio et al. 1999). The Peninsula mammal assemblages can be attributed to the last four Sicilian Faunal Complexes (see chapter 2) so that they document the continental mammals populating the whole middle Pleistocene and late Pleistocene (Figure 10.4).

The biochronological significance of the Peninsula continental deposits can be inferred considering all the yielded data. An excavation carried out in the last decade on the “K22” fossiliferous site made it possible, for the first time, to recognise the presence, up to that time only hypothesised, of a micromammal association (two dormice and a shrew) together with the characteristic *Elephas mnaidriensis* fauna.

The data related to the mammal assemblages in the deposits of these localities is substantially in agreement with the age reconstruction presented above and, even if with some difficulties, make it possible to confine the age of the terraces within certain limits (Figure 10.4).

Stop 4.1:

“Semaforo”

This fossiliferous site was discovered during

the extraction activity of a quarry that exposed a sedimentary succession disturbed by post-depositional tectonic and located in a wave-cut notch at the height of about 45 – 47 m a.s.l. (figs. 10.1, 10.2). This cavity is cut in a more erosional horizon of marls and marly limestones (“Scaglia”), dated upper Cretaceous – Eocene, that are tectonically interposed between the Cretaceous rudistid limestones (Figure 10.5) and overlay the Titonic cherty limestones.

The Pleistocene succession (Figure 10.5) consists, from bottom to top, of a polygenic conglomerate (a) of offshore environment (0.40 – 0.60 m thick) that passes with marked contact to a pelitic continental horizon (c), well-cemented and red coloured (0.40 – 1 m thick). A thin laminated speleothem (b) outcrops at the base of the horizon of the latter. A gradual passage characterises the contact with a second continental level (d) red coloured (1.5 m thick) and irregularly cemented, containing resorption sacs, rare angular clasts and remains of pulmonate molluscs and mammals such as the dormouse *Leithia* sp. and the elephant *Elephas falconeri*. The mammal assemblage is attributed to the *Elephas falconeri* F. C. dated early middle Pleistocene (Figure 10.4).

Leaving this fossiliferous site we pass through Piana di Sopra, a wide area representing a marine abrasion surface, probably polygenic in origin. This surface outcrops from 53 to 83 m a.s.l. and is referable to the more ancient marine terrace (I order; figs. 10.1, 10.2) of the peninsula dated late lower Pleistocene – early middle Pleistocene (Di Maggio et al. 1999). The uppermost part of the terrace is marked by fault scarps and steps as evidence of Pleistocene tectonic activity. Several notches and marine caves are cut on the ancient wave-cut cliff bordering Piana di Sopra, among which that of the “K22” and Semaforo sites, attributed to more recent phases of marine high stand than that responsible for the genesis of the uppermost terrace (Figure 10.2).

Stop 4.2:

“K 22” Site

The outcrop, represented by a karst cavity filled by 9 m thick sedimentary succession, is exposed in an abandoned quarry. Part of the continental deposit was investigated during an excavation carried out in 1994 by the Geology and Geodesy Department and the G. G. Gemmellaro Museum of Palermo University, under the supervision of the Superintendence of Trapani. The cavity, located at a height of 55 m a.s.l., is close to the eastern edge of the ancient wave-cut cliff, which contours Piana di Sopra (Figure 10.1) and today opens out on the top of this abrasion surface.

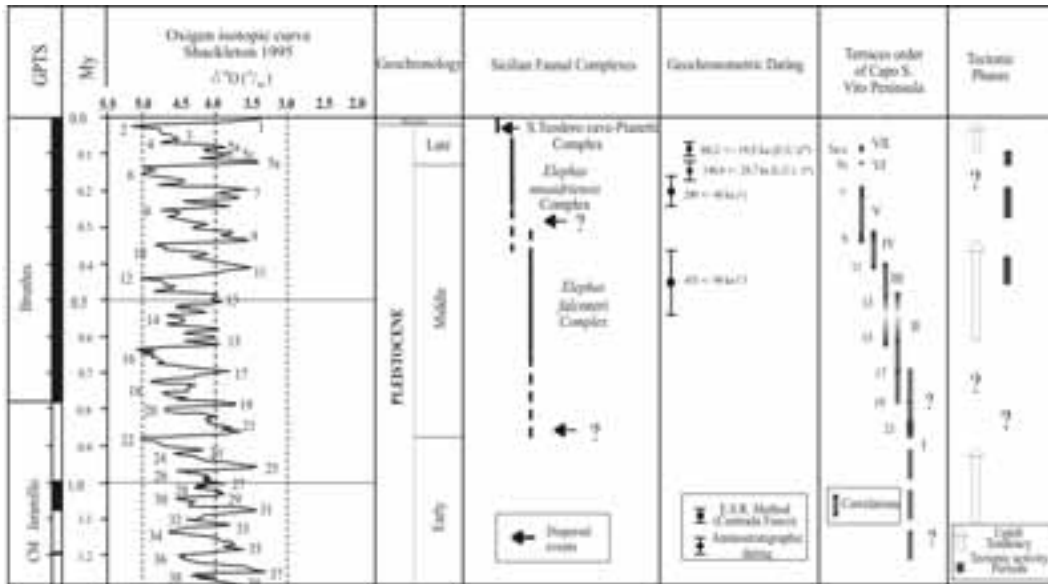


Figure 10.4 - Chronological correlation frame (*) by Rhodes 1996; (°) Bada et al. 1991; Di Maggio et al. 1999.

The cavity, whose lower part is characterised by lithodomous holes, contains a well stratified infilling consisting, from bottom to top, of (Figure 10.6): a thin layer of coarse rounded calcareous sandstone (a) strongly cemented and pinkish coloured, filling up part of the fractures present at the base. It contains heterometric carbonatic clasts, reworked by the sea and bored by clyonid sponges, and rare marine mollusc fragments immersed in a scarce pelitic matrix. A gradual passage characterises the contact with a 0.50 m thick cemented conglomerate (b)

containing heterometric carbonatic clasts, variably rounded, wrapped up in an arenitic pinkish matrix, locally more abundant, and remains of fish bones and marine molluscs (*Spondylus* sp., *Jujubinus* sp.). Both the clasts and the molluscs present *Clyona* boreholes. A flat contact marks the passage to an irregular level (0.30 – 0.40 m thick) of pinkish calcareous sandstone (c) that presents a vacuolated structure. Its rarely centimetric pebbles are immersed in a well-cemented arenitic matrix. An irregular erosional surface and

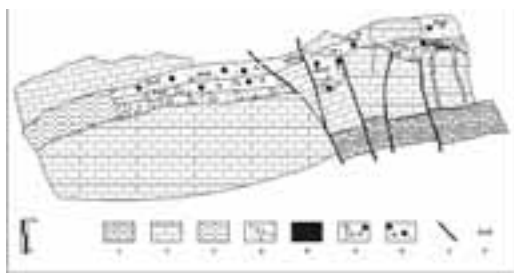


Figure 10.5 - Schematic geological section of the Semaforo locality outcrop. 1. calcilutite with calpionelle (Tithonian - lower Cretaceous); 2. corallgal limestone (lower and upper Cretaceous); 3. calcilutite and calcisiltite with planctonic foraminifera, "Scaglia" (upper Cretaceous - Eocene); A. marine conglomerate (middle Pleistocene); B. speleothem; C. lower continental level (middle Pleistocene); D. upper continental level (middle Pleistocene); 4. fault; 5. fossil vertebrates (modified from Di Maggio et al. 1999).



Figure 10.6 - Schematic section of the K22 locality outcrop. 1. corallgal limestone (lower - upper Cretaceous); A. sandstone; B. lower conglomerate; C. pinkish sandstone; D. upper conglomerate (late middle Pleistocene); E. orange lens (late middle Pleistocene); F. red horizon and petrocalcic level (late middle Pleistocene); G. blocks level (pleniglacial); H. brown level (late glacial - Holocene); 2. reworked material; 3. fault; 4. fossil vertebrates (modified from Di Maggio et al. 1999).

an abrupt change of facies characterise the passage to the following horizon, consisting of a polygenic conglomerate (d), 2 – 2.50 m thick. It is represented by centimetric and decimetric variably rounded grains of carbonatic and marly composition. The base of such a level yields remains of the small-sized hippo *Hippopotamus* cf. *pentlandi*. In the western part, the top of the conglomeratic horizon passes gradually to an orange silty loam level (e) 0.30 m thick, weakly cemented, containing remains of pulmonate molluscs, vertebrates and small mammals (*Crocidura* aff. *esuae*, *Leithia melitensis* - *cartei*, *Maltamys wiedincitensis*). A flat contact marks the passage to a well-cemented clay loam horizon, strongly rubefact (paleosol f), about 0.50 – 0.90 m thick. The horizon is characterised by polyhedral aggregation, abundant coatings, nodules of iron and manganese oxides and nodular carbonate concretions (*poupées*). On the eastern side, the base of the level is more cemented and represents a petrocalcic horizon, about 0.25 m thick. This unit yields remains of pulmonate molluscs, amphibians, reptiles, birds, scant remains of large mammals (*Hippopotamus* cf. *pentlandi* and *Sus* sp.) and abundant remains of small ones (*Crocidura* aff. *esuae*, *Leithia melitensis* - *cartei*, *Maltamys wiedincitensis*). The mammal assemblage recovered from the three latter horizons belongs to the *Elephas mnaidriensis* F. C., dated late middle Pleistocene - late Pleistocene (Figure 10.4). An undulated erosive surface, together with a stone line, marks the passage to the upper level and is indicative of a gap, whose long duration is inferred from the deep renovation of the mammal assemblage of the upper horizons. A block level (g) follows, 0.60 – 0.80 m thick. These heterometric calcareous elements, modelled by exogenous agents, derive from the dismantling of the Piana di Sopra Cretaceous limestone and are immersed in a red brownish pelitic – arenitic matrix characterised by polyhedral aggregation. Abundant remains of pulmonate gastropods and of micromammals are present. The small mammal assemblage, dominated by the vole *Microtus (Terricola)* ex gr. *savii*, also includes the mouse *Apodemus* cf. *sylvaticus* and the shrew *Crocidura* cf. *sicula*, while *Sus scrofa* e *Cervus elaphus siciliae* occur among large mammals. This faunal assemblage belongs to the S. Teodoro cave - Pianetti F. C. and can be attributed, according to the climatic stratigraphy, to the Interpleniglacial (stage 3; figs. 10.3, 10.4). A brown level (h) follows with a sandy - silt loam skeleton (0.60 – 0.70 m thick) that includes heterometric, mainly angular, carbonatic

elements. It contains pulmonate molluscs, small mammals (*Microtus (Terricola)* ex gr. *savii* and *Crocidura* cf. *sicula*) and large mammals (*Vulpes vulpes*, *Sus scrofa* and *Cervus elaphus*). The mammal assemblage is comparable to the Castello F. C., which is attributed, according to the climatic stratigraphy, to the late Pleniglacial – Late glacial (stages 2/1; figs. 10.3, 10.4). The recovery of lithic artefacts, organic matter scraps, *Homo sapiens* remains and abundant marine molluscs (*Patella* sp. and *Trochus* sp.) which may be explained as food remains, are indicative of anthropic frequentation. The typology of the lithic assemblage and the occurrence of obsidian artefacts show that these cultural remains can be ascribed to the late Mesolithic - earliest Neolithic (Tusa S., personal communication), and therefore the level can be attributed to the Pleistocene – Holocene boundary.

Stop 4.3:

Castelluzzo – Tonnara di Cofano

Along the western stretch of the coast of the Capo San Vito Peninsula (Figure 10.1) a continental succession outcrops, at a height of about 2 m a.s.l., in disconformity over a marine deposit cut by a Eutyrrhenian (stage 5e; figs. 10.3, 10.4) marine abrasion surface. The continental sequence at the bottom consists of a strongly cemented red arenitic level (0.70 m thick). It can be considered a petrocalcic horizon that presents a clastic level at the top. Angular shaped calcarenitic grains, reworked and with a sub-horizontal attitude (stone line), form this unit. Scarcely fossiliferous at the base, it is enriched with pulmonate molluscs at the top. It even shows traces of an intense bioturbation due to root apparatus. Above this there is a pelitic horizon, interpretable as a red soil. Within this level there is a lens-shaped petrocalcic horizon containing fossil vertebrates (*Elephas mnaidriensis*, *Bos primigenius*) and pulmonate gastropods. At the top of this sequence a clastic level outcrops, with decimetric elements, have a sub- horizontal attitude (stone line) and are immersed in a reddish silty matrix. The latter level bears abundant mammal remains such as *Elephas mnaidriensis*, the aurochs *Bos primigenius* and the spotted hyena *Crocuta crocuta (Elephas mnaidriensis* F. C.), as well as continental mollusc fragments. The total thickness of the last two horizons is about 0.70 m. The sedimentary succession is closed at the top by a brownish-red soil, 0.60 m thick, that appears sterile.

Stop 4.4:

Seno del Bue Marino

In this locality (Figure 10.1) a marine abrasion surface outcrops attributed to the Eutyrrhenian (stage 5e; figs. 10.3, 10.4), with the height of around 1 and 10 m a.s.l., cut on the marly calcilutite known as "Scaglia" (upper Cretaceous – Eocene). The marine and beach deposits overlaying this surface are composed of calcarenites and conglomerates containing a rich "Senegalense" fauna, among which *Strombus bubonius* and *Patella ferruginea* can be recognised.

Acknowledgments

To the Department of Earth Sciences of Messina University for financial support and to the Department of Geology and Geodesy of Palermo University for sponsorship. To G. Villari, Superintendent of Archaeological and Cultural Heritage of Messina, U. Spigo, responsible for the Archaeological Section of the Messina Superintendence of Archaeological and Cultural Heritage, G. Voza, Superintendent of Archaeological and Cultural Heritage of Siracusa, C. Ciurcina, Director of the "Paolo Orsi" Museum, for scientific and logistic support.

C. Di Patti, G. Mangano, M. Pavia, D. Petruso collaborated in the preparation of the guidebook.

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FIELD TRIP MAP

