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BIO-CHRONOLOGY OF PLEISTOCENE VERTEBRATE FAUNAS OF SICILY AND CORRELATION OF VERTEBRATE BEARING DEPOSITS WITH MARINE DEPOSITS

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ABSTRACT
The rich Pleistocene fossil record of Sicily allowed the construction of a fairly detailed bio-chronological frame that is dated by correlation of vertebrate bearing deposits with marine deposits by geochemical and radiometric dating too. Actually, an important category of deposits is representative of transitional and neritic environments, 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. Numerous relationships have been found between the vertebrate bearing deposits and marine deposits, which can be correlated with the $\delta^{18}O$ isotopic record and the main palaeogeographic events in Sicily. At present five Faunal Complexes (F. C.), characterised by the occurrence of different taxa, have been recognised. The two older Faunal Complexes (Monte Pellegrino F.C., *Elephas falconeri* F. C.) include taxa with differently marked endemic features.
Where correlated with marine sediments, the assemblages of the *Elephas falconeri* F. C. are associated with deposits dated early Middle Pleistocene (Comiso, Spinagallo cave, San Vito Lo Capo peninsula).
In the younger F.C'xes (*Elephas mnaidriensis* F.C., S. Teodoro cave-Pianetti F.C., and Castello F. C.) faunal composition is becoming more similar to that of the southern Italian peninsula and denotes that temporary connections with southern Italy occurred. Where correlated with sediment of marine environments, the assemblages of the *E. mnaidriensis* Faunal Complex are associated with deposits dated as late Middle Pleistocene and/or Late Pleistocene (S.Ciro cave, Maddalena peninsula, Contrada Cacaladritta, Cape Peloro, Contrada Fusco, Coste di Gigia, Scodonì, San Vito Lo Capo peninsula). The most likely time interval for the two Faunal Complex seems to be, respectively, from stage 22 to younger not defined oscillations of the oxygen isotope curve (*Elephas falconeri* F.C.) and from early stage 6 to early stage 4 of $\delta^{18}O$ isotopic record (*Elephas mnaidriensis* F. C.).

RIASSUNTO
La ricca documentazione di vertebrati pleistocenici della Sicilia ha permesso la costruzione di una dettagliata scala bio–cronologica, datata mediante correlazioni tra i depositi a vertebrati e depositi marini e mediante datazioni geochimiche e radiometriche. I depositi a vertebrati oltre che in ambiente di grotta, sono contenuti in depositi di ambiente neritico e di transizione, spesso associati ad ambienti palustri e/o salmastri. Frequentemente i resti di vertebrati sono contenuti in depositi limnici relativi ad ambienti di piana costiera a loro volta correlati con depositi francamente marini. Sono stati rinvenuti numerosi rapporti tra depositi a vertebrati e depositi marini correlabili con la curva degli isotopi stabili dell'ossigeno ($\delta^{18}O$) e con i maggiori eventi paleogeografici pleistocenici dell'isola. Sono stati riconosciuti cinque Complesi Faunistici (C.F.) caratterizzati da differenti associazioni faunistiche. I due complessi faunistici più antichi (C. F. di Monte Pellegrino e C. F. a Elephas falconeri*), includono taxa a endemismo di entità differente. I depositi contenenti le associazioni faunistiche del C. F. a* Elephas falconeri *sono correlabili a depositi marini della base del Pleistocene Medio (Comiso, Grotta di Spinagallo, Penisola di San Vito Lo Capo).*
Nei complessi faunistici più recenti (C. F. a Elephas mnaidriensis*, C. F. Grotta di S. Teodoro- Pianetti e C. F. di Castello) la composizione delle associazioni faunistiche diventa sempre più simile a quella dell'Italia peninsulare e indica l'esistenza di connessioni temporanee con l'Italia meridionale. I depositi a vertebrati del C. F. a* E. mnaidriensis *sono correlabili con depositi marini del tardo Pleistocene medio e/o del Pleistocene superiore (Grotta di S.Ciro, Penisola della Maddalena, Contrada Cacaladritta, Capo Peloro, Contrada Fusco, Coste di Gigia, Scodonì, Penisola di San Vito Lo Capo). L'età più probabile per i due complessi faunistici risulta compresa, rispettivamente, dallo stadio 22 a una oscillazione più giovane, attualmente non definibile della curva degli isotopi stabili dell'ossigeno ($\delta^{18}O$) (C. F. a* Elephas falconeri*) e dall'inizio dello stadio 6 all'inizio dello stadio 4 della curva isotopica (C. F. a* Elephas mnaidriensis*).*

Keywords: Pleistocene vertebrates, Quaternary, Sicily.

Parole chiave: Vertebrati pleistocenici, Quaternario, Sicilia.

1. INTRODUCTION

Up to 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.

Chronological arrangements of the various Pleistocene mammal assemblages of Sicily were 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 descendant of *Elephas antiquus* (Accordi, 1963; Accordi, 1965; Accordi & Colacicchi, 1962; Ambrosetti *et al*., 1980). Vaufrey (1929) was inclined to assume a post-Tyrrhenian age for all the vertebrate faunas. Since the studies of Accordi (1957; 1963; 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). Nevertheless, Scinà (1831), Vaufrey (1929), Accordi & Colacicchi (1962) and Accordi (1963; 1965)

provide interesting observations concerning the relationship between vertebrate-bearing deposits and littoral marine deposits.

Since 1985, a new synthesis has incorporated new stratigraphic and aminostratigraphic data (Belluomini & Bada, 1985; Bada *et al.*, 1991; Burgio & Cani, 1988; Bonfiglio, 1987; Bonfiglio, 1992 a; Bonfiglio, 1992 b; Bonfiglio & Burgio, 1992; Bonfiglio & Insacco, 1992). Taphonomic data show that Pleistocene vertebrates were distributed in both cave environments and broad, open environments (Bonfiglio, 1987;1992 a; 1992 b; 1995; Bonfiglio *et al*., 1996; Chilardi & Gilotti, 1996a) and numerous relationships have been found between the vertebrate bearing deposits and terraced marine deposits, which can be correlated with the $\delta^{18}O$ isotopic record and the main palaeogeographic events in Sicily (Agnesi *et al*., 1997; Bonfiglio, 1991; Bonfiglio *et al*., 2000; Bonfiglio *et al*., 2002; Di Maggio *et al*., 1999).

New data concern essentially the number and composition of the Pleistocene faunal complexes and stratigraphical, environmental, taphonomic, chronological and palaeogeobiographical characters of the vertebrate-bearing deposits.

2. FAUNAL COMPLEXES AND PALAEOGEOGRAPHY

The Pleistocene vertebrate assemblages of Sicily can be arranged into 5 phases or Faunal Complexes (F.C.), spanning from the Early Pleistocene to the Late Glacial (Bonfiglio et al., 2000; Bonfiglio *et al*., 2001; Bonfiglio *et al*., 2002).

The oldest Quaternary Faunal Complex (Monte Pellegrino F. C.) is documented only in the very restricted geographic area of Monte Pellegrino, close to the town of Palermo, where fossils are contained in small residual deposits of karst fissure. According to Burgio & Fiore (1997) the poorly diversified fauna is late Villafranchian in age. 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, 1974; Azzaroli & 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. in press).

The younger *Elephas falconeri* 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 *Crocidura, Lutra, Leithia, Maltamys*, a giant tortoise, and a rich typical endemic avifauna (Pavia, 1999; Pavia, 2000).

Neither the ancestor nor the geographic provenance of *E. falconeri* has been determined unequivocally and its possible origin from European *Elephas antiquus* stock, or from a north African species is still a matter of discussion (Bonfiglio & Piperno, 1996).

Moreover, the composition of this faunal complex also 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*., in press).

The subsequent *Elephas mnaidriensis* Faunal Complex is almost completely renewed in 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 herbivores (bison, auroch, fallow deer, red deer, hippo) are moderately modified in respect to the congeneric or conspecific taxa from the Italian mainland and the endemic nature of the fauna is apparent mainly from the modest reduction in size (Abbazzi *et al*, 2001; Bonfiglio *et al*., 2002).

The small mammals, are represented by survivors from the *E. falconeri* F. C. (*Leithia, Maltamys* and *Crocidura esuae*; Kotsakis, 1996b, Di Maggio *et al*., 1999, Petruso, 2001; Petruso, in progress; Masini *et al*., in press). One endemic species of bird, *Cygnus falconeri* occurs, while the endemic species of the previous F. C. became extinct, except *Grus melitensis* whose persistence is, however, questionable (Pavia, 2000; 2001).

Amino-acid racemization dating yielded an age of 455 ± 90 Ky for *Elephas falconeri* from the Spinagallo and Luparello cave deposits while an age of 200 ± 40Ky has been assigned to the *Elephas mnaidriensis* F. C. by Bada *et al.* (1991). ESR dating for teeth enamel of *Elephas mnaidriensis* and *Hippopotamus pentlandi* from Contrada Fusco (Rhodes, 1996) provided an age ranging between 146.8 ± 28.7 and 88.2 ± 19.5 Ky.

The fourth Pleistocene Faunal Complex (San Teodoro Cave - Pianetti F. C.) dates to the last glacial cycle. The faunal history of this period is characterised by extinction events (hippopotamus, endemic dormice and *Crocidura 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*, *Crocidura* cf. *sicula, Apodemus* cf. *sylvaticus*, *Erinaceus europaeus*) (Bonfiglio *et al* 1997; Bonfiglio *et al.* 2001, Petruso, in progress). Almost all of the large mammals belonging to this F. C. seem to be inherited from *Elephas mnaidriensis* F. C.. Endemic species of avifauna are lacking (Pavia, 2000).

Finally, the Late Glacial assemblages of the Castello Faunal Complex show a dramatic decrease in diversity, missing all endemic large mammals still occurring in the S. Teodoro cave-Pianetti F. C. Late glacial faunas, which are similar to continental ones, are associated to lithic artifacts and cultural evidences of late Upper Palaeolithic (Kotsakis, 1979; Bonfiglio & Piperno, 1996).

From the oldest to the youngest, the Sicilian faunal complexes show a decreasing degree of endemism and a composition more and more similar to that of the southern Italian peninsula .

The geographic and stratigraphic distribution greatly varies in space and time (younger sites are much more numerous). Such distribution pattern is typical in regions in which tectonic activity is very intense and is probably due to the different extension in time of the emerged areas, which implies sharp lateral variations of the depositional environments.

The active extensional tectonic regime affecting Sicily from the Early Pleistocene onwards resulted in the collapse of peripheral zones and lead to the creation of a series of deep marine basins which occupied large areas around and between two emerged blocks (North and South eastern areas, respectively). These two

islands were of small extension as well as the related depositional environments. In fact, the number of the deposits containing the two oldest faunal complexes (M. Pellegrino and *Elephas falconeri* F.C.), which are early and early-middle Pleistocene in age, is very low. Conversely, the vertebrate bearing deposits of the late-middle and early-late Pleistocene assemblages (*Elephas mnaidriensis* faunal complex) are very numerous, are contained in deposits of different environments and have a wide distribution all over the island (Bonfiglio *et al.*, 2002 with bibliography).

From the beginning of the Middle Pleistocene onwards the evolution of Sicily was characterised by a generalised uplift which led to the emersion of the previous deep marine basins and the island reached almost the present extension, being also bordered by a crown of coastal plains. For that reason, a large amount of the mammalian fossils of the *Elephas mnaidriensis* F.C. are from upraised remnants of coastal plains as well as from caves and fissures.

During the late Pleistocene a strong uplift accompanied by the contemporaneous sea water low-standing led to the disappearance of humid environments of coastal plains. As a matter of fact the deposits of the youngest faunal Complex ("S. Teodoro cave-Pianetti" and "Castello" F. C.) are numerous, but they are limited to caves and fissures. The faunal composition of this complex is consistent with the disappearance of humid environments (coastal plains with lagoons or swamps) and the laying down of dry conditions.

3. CORRELATION OF FAUNAL COMPLEXES WITH MARINE SEDIMENTS

Most of the mammalian fossils of Sicily are found in caves and fissures - rather common in the carbonate mountain ranges of Northern Sicily and in the Hyblean plateau. Another important category of deposits is representative of transitional and neritic environments, 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 (Fig. 1).

The assemblages of the Monte Pellegrino F.C. and those of S. Teodoro Cave - Pianetti and Castello

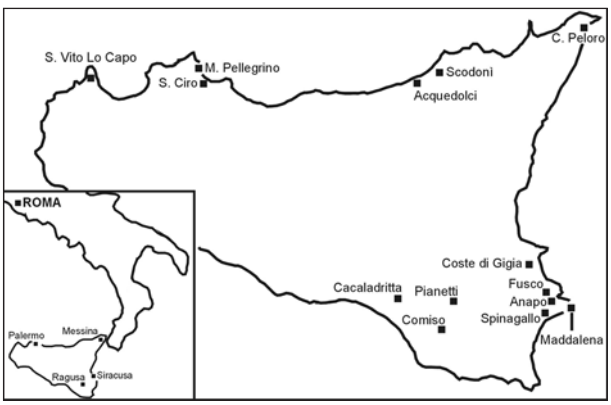

Fig. 1 - Location of the vertebrate-bearing deposits correlated with marine deposits in Sicily quoted in the text.

F.C.'xes are contained in caves and fissure-filling deposits and they have no relationship with marine deposits.

The assemblages of the *Elephas falconeri* and of the *Elephas mnaidriensis* F.C. 'xes are contained in cave deposits correlated with marine deposits, as well as in coastal plain and/or in marine littoral deposits (littoral marine sands, deltaic marine clay sands, deltaic marine gravels and sands) and in continental deposits overlying abrasion platforms.

In the different environments the biodiversity, the preservation conditions and the concentration of the skeletal remains are very diverse.

3.1 *Elephas falconeri* F.C. assemblages correlated with marine sediments

At Comiso a regressive marine sequence begins with Early Pleistocene marine deposits and ends at the top with sands of brackish environment which, in turn, pass to deposits of limnic environment underlying Middle Pleistocene marine sands (Conti *et al.*, 1980; Carbone *et al.*, 1982). In the different levels of the limnic deposits skeletal elements of *Elephas falconeri, Leithia melitensis*, bats, fishes, birds, reptiles (*Lacerta* sp., *Testudo* sp., *Emys orbicularis, Geochelone* sp.) are contained (Bonfiglio & Insacco, 1992).

The continental limnic succession at Comiso, made up by palaesols, lacustrine and aeolian deposits, constitutes the evidence of the first connection of the Hyblean Plateau to the Sicilian mainland in the Pleistocene. This connection occurred after the deposition all around the plateau of the Plio-Pleistocene marine deposits, which end with clays and sands of the latest Early Pleistocene (Di Geronimo *et al.*, 1979; Conti *et al.* 1980). The limnic deposits contain the first occurrence of the *Elephas falconeri* faunal complex (Bonfiglio & Insacco, 1992). The terrestrial gastropods from the limnical deposits of Comiso, indicating wet and cool environment, were attributed by Esu & Girotti (1991) to the earliest Middle Pleistocene.

At Spinagallo cave, the lower vertebrate deposits containing abundant remains of *Elephas falconeri* associated with *Leithia melitensis, Maltamys* gr. *gollcheri-wiedincitensis, Crocidura esuae, Testudo hermanni* overlie early Middle Pleistocene littoral calcarenites (Accordi & Colacicchi, 1962; Petronio, 1970; Kotsakis, 1977; 1986; Kotsakis & Petronio, 1981; Di Grande & Raimondo, 1984; Bonfiglio, 1992 b; Petruso, in progress).

The limnical deposits at Comiso may correspond to the beginning of the "Roman regression" (Ruggieri *et al.*, 1975) that roughly correlates with stage 22 of $\delta^{18}O$ isotopic record, while the *E. falconeri* bearing deposits at Spinagallo cave may correspond to younger oscillations of the oxygen isotope curve.

At San Vito lo Capo Peninsula several littoral and continental mammal bearing deposits are present and related to a well preserved marine terrace sequence Early to Late Pleistocene in age. The terrace succession, composed of seven orders of abrasion surfaces, has been studied in detail by some authors (Antonioli *et al.*, 1998a, b; Di Maggio *et al.*, 1999) that proposed a correlation with IOS succession. Di Maggio *et al.* (1999) analysed the vertebrate deposits and their stratigraphic relationships to such terrace sequence. From the Middle to the Late Pleistocene a tectonic activity affected the

area moderately dislocating the ancient shorelines.

Mammal remains of the *Elephas falconeri* F. C. have been found in morphological traps (caves and wave cut notches) in the Piana di Sopra area, where the terrace sequence is fairly complete and the ancient shoreline remains are quite well preserved. *Elephas falconeri* and *Leithia melitensis* remains occur in paleosols deposits overlying a coastal conglomerate preserved in an ancient wave cut notch at 45 m a.s.l. (Semaforo site). A dental remain of *Elephas falconeri* has been found within a beach conglomerate resting on the floor of a marine cave opened at about 72 m a.s.l in the palaeocliff bordering the southern side of Piana di Sopra (Isolidda 2 site). According to the reconstruction of the palaeogeographic evolution of the area Di Maggio *et al.* (1999) referred both mammal deposits to the second order terrace. Even though the correlation with the IOS record is affected by some uncertainties, this terrace can be confidently related to one of the stages comprised between IOS 15 and IOS 11.

The biocronological events that mark the end of *Elephas falconeri* F. C. are still poorly defined. The extinction of *E. falconeri* might be the result of predation consequent to the dispersal of the large carnivores of the succeeding *Elephas mnaidriensis* faunal complex.

3.2 *Elephas mnaidriensis* F.C. assemblages correlated with marine sediments

The most important recent finding of vertebrate bearing deposits containing faunal remains of the *Elephas mnaidriensis* F.C. is that of Contrada Fusco, located south to the hill of Neapolis, to the west of Syracuse, where a very rich faunal assemblage (an elephant of little reduced size, *Elephas mnaidriensis, Hippopotamus pentlandi, Ursus cf. arctos, Crocuta crocuta spelaea, Lutra trinacriae, Leithia melitensis, Maltamys wiedincitensis, Crocidura esuae, Emys orbicularis, Testudo* cfr. *hermanni, Lacerta siculomelitensis, Natrix* sp.) comes from a stratigraphic sequence cropping in three low hills (respectively, eastern sector, Tor di Conte and western sector), separated by fluvial incisions. The coastal plain deposits overlie Early Pleistocene bathyal clays and underlie Tyrrhenian calcarenites (Chilardi & Gilotti, 1996 a; 1996 b; Chilardi, 1996 a; Kotsakis, 1996 a; 1996 b; Cassoli & Tagliacozzo, 1996 a; 1996 b).

The stratigraphic section (Chilardi & Gilotti, 1996 a, fig. 1, p. 26) includes six sedimentary units (L1, All, C3, C4, L2, L3) interbedded between the marine substrate, Early Pleistocene in age, and overlying littoral calcarenites attributed by Di Grande & Raimondo (1974) to the Thyrrhenian. According to Chilardi & Gilotti (1996 a) the deposition of continental silts (L1), containing scarce vertebrate remains, and fluvial conglomerates (All), containing numerous skeletal elements of large mammals, is followed by a marine ingression, which lead to the deposition of marine biocalcarenites of shallow water environment (C3) eteropic of gravels and sands of back-shore environment (C4). The overlying silts of marsh environments (L2) are attributed to a marine regression to which a successive marine ingression follows, represented by brackish lagoons (L3).

However, carefully looking to fig. 1, p. 26 in Chilardi & Gilotti (1996 a) and to the palaeontological and taphonomical characteristics of the deposits, the six sedimentary units probably represent the different sedimentary facies of a late Middle Pleistocene coastal plain which gradually became subsiding before the deposition of Tyrrhenian calcarenites.

At Contrada Fusco together with the remains of *Elephas mnaidriensis*, remains of a larger elephant (*Elephas* sp.) have been collected (Chilardi, 1997) which may represent the first arrival of continental species not yet reduced in size of the *Elephas mnaidriensis* F.C.

The “paleosoil” containing remains of *Elephas mnaidriensis* (Accordi, 1963; 1965) underlying Tyrrhenian calcarenites at Maddalena Peninsula (Castelluccio Lighthouse) probably belong to the same coastal plain which extended south of the hill of Neapolis. Actually several fossil remains have been signalled by De Gregorio (1924-25) south of C.da Fusco in the the Anapo river valley where Pleistocene alluvial conglomerates underlie Tyrrhenian calcarenites (Chilardi, 1996 b). An isolated scapula of *Elephas mnaidriensis* comes from Thyrrhenian marine deposits at Maddalena peninsula (Accordi, 1963). According to Di Grande & Raimondo (1984) the present highest altitude of the Thyrrhenian “ calcarenites of Targia ” in the area of Neapolis-Maddalena Peninsula is about 25 m.

North to Contrada Fusco, at Coste di Gigia, the red clays containing *Hippopotamus pentlandi* and *Elephas mnaidriensis* overlie late Middle Pleistocene littoral gravels and calcarenites and a small wave-cut platform relative to a shore line located at 40 m a.s.l. Calcarenites and abrasion platform are cut by the younger Tyrrhenian abrasion platform which presents its inner margin at the altitude of 34 m a.s.l. Again the faunal assemblage of the *Elephas mnaidriensis* F.C. is late Middle Pleistocene in age (Bonfiglio, 1992 b).

The different position of Tyrrhenian calcarenites in respect to mammal bearing deposits at Coste di Gigia and at Contrada Fusco is due to the location of the two sites in areas with different uplift rate, respectively the Priolo depression and the Floridia Graben (Di Geronimo *et al.*, 1980; Carbone *et al.*, 1982).

In the Late 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 containing gastropods, bivalves, ostracods, foraminifera, of littoral euryhaline environment (Galletti & Scaletta, 1991).

At S. Ciro cave the vertebrate assemblage contains abundant remains of *Hippopotamus pentlandi* associated with rare remains of *Elephas mnaidriensis, Cervus siciliae, Dama carburangelensis, Bos primigenius siciliae, Canis lupus, Ursus* cfr. *arctos, Crocuta spelaea* (Scinà, 1831; Fabiani, 1928). The marine sands and the wave cut notch with *Lithodomus* holes, brought to light by Scinà (1831) at the bottom of the cave deposits, probably have a Middle Pleistocene age.

At Contrada Cacaladritta rare skeletal remains of *Hippopotamus pentlandi*, *Elephas* cf. *mnaidriensis* and *Bos primigenius siciliae* are concentrated in deltaic clayey sands with *Ostrea edulis* that underlie gravelly, sandy and calcareous continental deposits with fresh water mollusks. The two units constitute the uppermost Middle Pleistocene portion of a regressive marine sequence, which begins with Early Pleistocene clays of bathyal environment (Bonfiglio *et al.*, 1996, with biblio-

graphy).

Disarticulated, fragmented, worn and mechanically selected remains of elephant (*Elephas mnaidriensis*), hippopotamus (*Hippopotamus pentlandi*), red deer (*Cervus elaphus siciliae*), bear (*Ursus* cf. *arctos*), tortoise (*Testudo* cf. *hermanni*) are contained in the deltaic marine gravel and sandy deposits underlying Thyrrhenian sands with *Strombus bubonius* at Cape Peloro. Serpulids encrust some skeletal elements (Bonfiglio & Berdar, 1979; Bonfiglio & Violanti, 1986; Marra, 2001).

At Acquedolci gravels and silty laminated lacustrine deposits overlie a wave-cut platform and beach gravels relative to a shore line located at 130 m a.s.l and contain very abundant skeletal elements of the endemic hippo *Hippopotamus pentlandi* associated with scarce remains of *Cervus elaphus siciliae, Ursus* cfr. *arctos, Canis lupus, Elephas mnaidriensis, Testudo* cfr. *hermanni*, birds.

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 the altitude of 105 m a.s.l. (Bonfiglio, 1992 a; Bonfiglio, 1995).

At Scodonì, east to Acquedolci, fluvial gravels containing abundant remains of *Hippopotamus pentlandi* associated with scarce remains of *Ursus* cfr. *arctos,* overlie the large Tyrrhenian abrasion platforms extended between 80 and 105 m a.s.l. (Bonfiglio, 1987)

At San Vito lo Capo Peninsula, Eutyrrhenian deposits and/or abrasion platforms are well represented and continuously distributed at a height comprised between 0 and 18 m a.s.l. (sixth order terrace). Within such deposits a rich "Senegalese" fauna including *Strombus bubonius* and *Patella ferruginea* locally occurs. At Seno dell'Arena site scant remains of *Dama carburangelensis* are encrusted above the Eutyrrhenian abrasion surface at 10 m a.s.l. At Caletta Cofano remains of *Elephas mnaidriensis, Bos primigenius* and *Crocuta crocuta* occur at about 1-2 m a.s.l. within a continental succession composed by paleosol sediments alternated to stone lines overlying marine calcarenites. The abrasion surface, on which the continental deposit lies, is correlated with IOS 5a or 5c (Di Maggio *et al.,* 1999).

All these data represent the evidence that the first occurrence of the *Elephas mnaidriensis* F.C. in the island is late Middle Pleistocene in age and that this elephant survived the Eutyrrhenian interglacial. Stratigraphical correlations at Acquedolci, S. Ciro cave, Coste di Gigia show that the *E. mnaidriensis* assemblages are found in late Middle Pleistocene terraced deposits overlying a shoreline which probably corresponds to IOS 7 (Bonfiglio, 1991).

Chronostratigraphical data concerning the last occurrences of the taxa of this faunal complex are still poorly defined, but significant evidence come from S. Teodoro cave and Contrada Pianetti. At these sites the highly diversified assemblage of vertebrates (elephant, horse, wild ox, deer, wild boar, hyena, fox, mice, ground vole, shrew, hedgehog, bats, birds, reptiles) invertebrates and vegetal remains lacks hippopotamus, endemic dormice and *Crocidura esuae*. The assemblage of small mammals is completely renewed in respect to that of the *E. mnaidriensis* faunal complex, and includes not endemic taxa such as *Microtus (Terricola)* ex gr. *savii*, *Apodemus, Erinaceus* and *Crocidura* cf. *sicula* (Bonfiglio *et al*., 1997; Bonfiglio *et al*., 2001). The association of the elephant (*Elephas mnaidriensis*) with the equid (*Equus hydruntinus*), which were previously thought to represent the typical taxa of two different faunal complexes (the endemic *Elephas mnaidriensis* faunal complex and the younger, not endemic, Castello Faunal complex), evidences a longer survival of the elephant and the associated taxa in Sicily. The combined occurrence of taxa up to now considered as typical, or exclusive, of two contiguous faunal complexes (*Elephas mnaidriensis* and Castello F.C.'s) can be explained by the occurrence of a dispersal event posterior to IOS 5e. Geochemical and radiometric dating are not available and the deposits of the large S.Teodoro cave are still to be more extensively investigated.

The most likely time interval for this faunal complex is from early IOS 6 to early IOS 4.

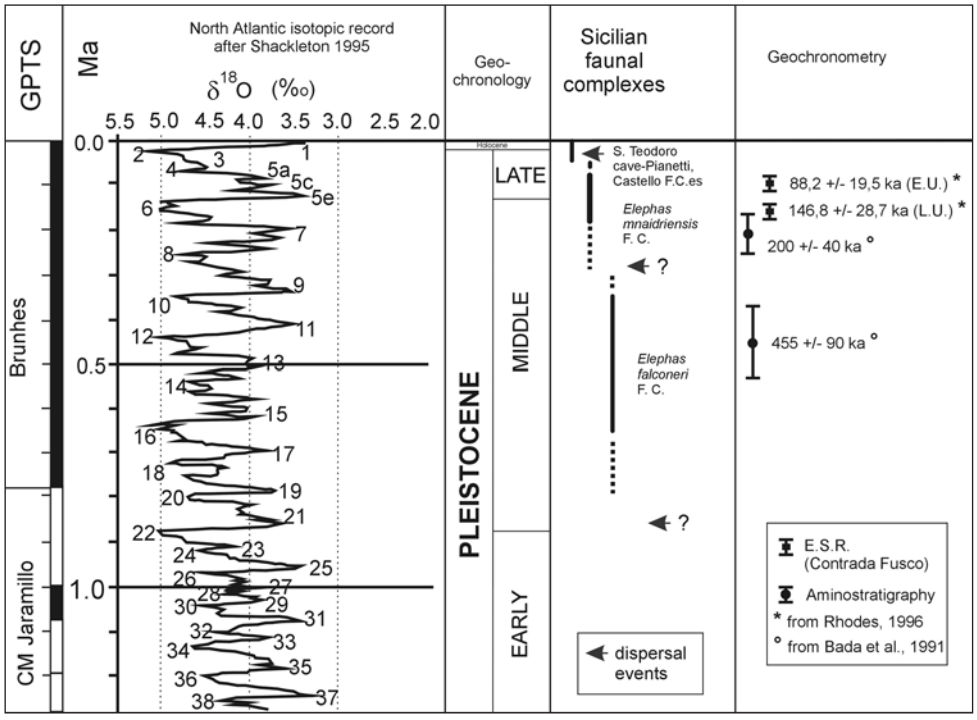

Fig. 2 – Chronological correlation frame of the vertebrate-bearing deposits with marine deposits in Sicily (From Di Maggio *et al.*, modified).

4. CONCLUSION

In Sicily numerous relationships have been found between the faunal assemblages of two Faunal Complexes (*Elephas falconeri* F.C. and *Elephas mnaidriensis* F. C.) and marine deposits, which can be correlated with the $\delta^{18}O$ isotopic record and the main palaeogeographic events in Sicily (Fig. 2). Vertebrate are contained in deposits of transitional and neritic environments, 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.

Where correlated with marine sediments, the assemblages of the *Elephas falconeri* F. C. are associated with deposits dated early Middle Pleistocene (Comiso, Spinagallo cave, San Vito Lo Capo peninsula) while the assemblages of the *E. mnaidriensis* Faunal Complex are associated with deposits dated as late Middle Pleistocene and/or Late Pleistocene (Acquedolci, S.Ciro cave, Maddalena peninsula, Cape Peloro, Contrada Fusco, Coste di Gigia, Scodonì, San Vito Lo Capo peninsula).

The most likely time interval for the two Faunal Complex seems to be, respectively, from stage 22 to younger not defined oscillations of the oxygen isotope curve (*Elephas falconeri* F.C.) and from early stage 6 to early stage 4 of $\delta^{18}O$ isotopic record (*Elephas mnaidriensis* F. C.).

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