



Pleistocene mammal faunas of Calabria (Southern Italy): biochronology and palaeobiogeography

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ABSTRACT - In this paper, current knowledge about Pleistocene mammals of Calabria has been updated, critically discussed, and conformed to the biochronological framework of Italy. Since the palaeogeography obviously influenced the mammal distribution, Pleistocene maps have been included and discussed. In Calabria, the Pleistocene fossil record of mammals is discontinuous in time and space. 15 Local Faunal Assemblages (LFAs) have been selected and located in the biochronological chart of Italy. The most representative LFAs of Calabria, attributed to the Late Pleistocene, seem to be impoverished if compared to those of the rest of Italy. They are made by ubiquitous species of warm-temperate climate. The possible insular phase of Southern Calabria at the beginning of Late Pleistocene (MIS 5) is discussed and rejected on the basis of the palaeogeographical reconstructions and the absence of well documented endemic mammals. The role of Calabria as a dispersal way to Sicily has a consistent relevance in the discussion about evolutionary patterns in island environment. It seems that Calabria acted as a first filter to faunal spreading to Sicily and that the Strait of Messina was a weak sea-barrier in the late Middle Pleistocene and Late Pleistocene.

RIASSUNTO - [I Mammiferi Pleistocenici della Calabria (Italia Meridionale): biocronologia e paleobiogeografia] - Questo lavoro propone un quadro d'insieme delle attuali conoscenze sulle faune a mammiferi del Pleistocene della Calabria, attraverso la selezione dei dati più attendibili ed il loro aggiornamento, descrizione e discussione critica. Si giunge alla selezione di 15 associazioni faunistiche locali (LFAs) ed al loro inserimento nella carta biocronologica d'Italia. Considerato che la diffusione e la distribuzione dei mammiferi sono fortemente influenzate dalla paleogeografia, vengono prodotte le carte relative al Pleistocene. Non ci sono LFA riferibili al Pleistocene iniziale e sono poche quelle riferibili al Pleistocene medio, mentre sono più numerose e più diversificate quelle riferibili al tardo Pleistocene. Le faune del tardo Pleistocene della Calabria risultano impoverite rispetto a quelle coeve del resto d'Italia e sono costituite da specie piuttosto comuni di ambiente temperato-caldo. Le LFAs sembrano non registrare alcuni tratti caratteristici delle associazioni coeve del resto d'Italia. Le condizioni deposizionali indicano una variabilità ambientale più diversificata per il tardo Pleistocene, che peraltro concorda con la paleogeografia, che mostra pianure e coste più estese rispetto ai periodi precedenti. L'isolamento della Calabria meridionale all'inizio del Pleistocene superiore (MIS 5) può essere smentito dalla revisione dei dati, che indicano l'avvenuta chiusura del bacino di Catanzaro e l'assenza di inequivocabili evidenze di mammiferi endemici nel periodo considerato.

Queste considerazioni consentono anche alcune valutazioni sulla diffusione di mammiferi in Sicilia nel corso del Pleistocene. La Calabria sembra aver agito come primo filtro nei confronti delle faune della penisola italiana successivamente passate in Sicilia. La maggior parte delle specie presenti in Calabria nel Pleistocene medio e superiore è passata in Sicilia e sembra che lo Stretto di Messina possa essere stato attraversato più agevolmente e più spesso di quanto non sia stato ritenuto finora, in particolare nella zona della "sella", caratterizzata da fondali relativamente bassi e da una breve distanza delle due coste calabrese e siciliana.

INTRODUCTION

Since 1997, a lot of vertebrate palaeontologists have contributed to a biochronological framework of Plio-Pleistocene mammalian faunas of Italy (Gliozzi et al., 1997; Palombo et al., 2003; Azanza et al., 2004; Palombo, 2004, 2007a; Masini & Sala, 2006; Petronio et al., 2007; Sardella et al., 2006; all with references therein). Some Authors pointed out that the geography of the Italian peninsula, its latitudinal extension, and its complex physiography caused a fragmentation of the territory and the consequent scattering of bioevents in time, as well as the survival of long-persistent taxa in *refugium* areas and/or the evolution of endemites (Palombo, 2004; Sardella et al., 2006). Moreover, these features make difficult the definition of a biochronological framework, as well as its comparison to European one (Azanza et al., 2004; Palombo, 2004).

The main part of the work on biochronology has been focused in Northern and Central Italy, where numerous data have been collected. Recently,

biochronological data have been improved with new evidences from Southern Italy, mainly from Apulia (Petronio et al., 2007). Until now, the southernmost mammal assemblages reported to the biochronological chart of Italy are on the boundary between Calabria and Lucania (Fig. 1, basin of Mercure river; Cavinato et al., 2001).

Mangano (2007) reported an inventory of Pleistocene mammal sites of Calabria, grouped by geochronology and by location in administrative provinces or municipality. Although some inaccuracies occur (Contrada Ianni is in the province of Vibo Valentia, not Catanzaro; Arangea is in the district of Reggio Calabria, not in a distinct municipality; the site of Santo Stefano, Caloi & Palombo, 1989, is not reported), the paper gives a useful list of the taxa present in each site, without any reference to the biochronological chart of Italy.

The aim of this paper is to give a contribution to this shortage, starting from a re-consideration of the literature data about Pleistocene mammalian faunas of Calabria. The reported mammal-bearing sites (Fig. 1)



Fig. 1 - Geographic location of the sites cited in the text.

have been selected by: completeness of stratigraphy and/or absolute dating, richness of species, and reliability of taxonomical attributions. Where necessary, obsolete scientific names are rectified in square brackets. The LFAs has been reported to the biochronological chart of Italy. Because of its bias in mammal distribution, palaeogeographical setting is provided. Moreover, a particular attention has been done to the role of Calabria as a dispersal way to Sicily, having a consistent relevance in the discussion about evolutionary patterns in island environment.

In this paper, the terms “Calabrian” and “Sicilian” are used in a geographical, not stratigraphical, significance.

BIOCHRONOLOGY

Gliozzi et al. (1997) elaborated four range charts of large and small mammals, molluscs and continental ostracods, for Plio-Pleistocene of peninsular Italy, providing a biochronological framework. Palombo (2004, 2007a), Palombo et al. (2004), Masini & Sala (2007), Palombo & Sardella (2007), and Petronio et al. (2007), suggested modifications.

The Authors considered several Local Faunal Assemblages (LFAs, intended as lists of species collected in a deposit or in correlated deposits from the same locality) and defined Faunal Units (FU, synonymous of Faunal Complexes, FC), based for all the large mammal species from coeval LFAs selected as typical associations. Successive Faunal Units cannot be separated by boundaries (Gliozzi et al., 1997) and can be intended as non-overlapping and “ecologically adjusted groups of animals with specific geographic limit and geographic range” (Palombo, 2004, with references therein). According to Palombo (2004) and Palombo & Sardella (2007), “the definition of FUs is based on the bioevents, such as the first appearance of one or more taxa, and/or the possible disappearance of others, on the evolutionary stage displayed by taxa belonging to a well-established phyletic lineage or on typical taxa associations”.

Faunal Units (FUs) have been further grouped into a number of Land Mammal Ages (LMAs), defined as

relatively short intervals of geologic time that can be recognized and distinguished from earlier and later units (in a given region and province) by a characterising assemblage of mammals (cf. Palombo, 2004; Palombo & Sardella, 2007, for a discussion).

At the state of art, Plio-Pleistocene of Italy includes three LMAs (Villafranchian, Galerian, and Aurelian) defined accordingly to the above reported method. The definition of FU is sometimes debated amongst different Authors. The current biochronological chart of Italy is a continuous “work in progress”, improved by new findings and new theoretical integrations (see, for instance, Palombo & Sardella, 2007).

Pleistocene LFAs of Calabria

No records are known from the Lower Pleistocene. From the Middle Pleistocene several mammal associations have been recorded from the Mercure basin, located on the boundary between Calabria and Lucania. *Elephas antiquus* and *Hippopotamus amphibius* have been reported respectively by De Angelis d’Ossat (1895) at Laino di Borgo (Cosenza) and by Airaghi (1922) in the Calabrian side of the basin. New findings in the Mercure basin are in the regional territory of Lucania, but they are significant in the understanding of Calabrian faunas. *E. antiquus*, *Stephanorhinus hundsheimensis* and *H. amphibius* have been excavated at Calorie (near Rotonda, Potenza; Cavinato et al., 2001) and *Megaceroides* ex gr. *M. verticornis* [recte *Praemegaceros* cf. *P. verticornis*], *Dama* cf. *D. clactoniana* and *Bison* sp. came from a correlated level at Fornaci-Fondo Pagano (Castelluccio Inferiore, Potenza; Cavinato et al., 2001). These LFAs are attributable to the middle Galerian (Cavinato et al., 2001). Another association, late Aurelian in age, has been recovered at Fornaci-Fondo Pagano (Castelluccio Inferiore, Potenza), and includes: *Dama dama*, *Cervus elaphus*, and *Equus hydruntinus* (Cavinato et al., 2001).

Caloi & Palombo (1989) reported an early Aurelian LFA from a marine terrace quoted 130-70 m a.s.l. at Santo Stefano (Praia a Mare, Cosenza): *Ursus* sp., *Equus caballus* ssp. [recte *E. ferus*], Rhinocerotidae gen. et sp. indet., *Cervus elaphus*, ?*Cervus* (*Dama*), Capridae (? *Capra ibex*), Bovidae (*Bos/Bison*).

The Local Faunal Assemblage of Bovetto (Reggio Calabria) includes remains of cervid, elephant, and hippopotamus (Bonfiglio, 1978; Marra, 2000; Abbazzi et al., 2001). Cervid’s remains (an incomplete cranium and a fragment of a left maxillar bone) collected in the neighbouring of “Fornace Neri” have been attributed by Bonfiglio (1978) to “*Megaceros* (*Megaceroides*) *calabriae*”, a new species of dwarf megacerine, related to a supposed geographic isolation of Southern Calabria during the “Tyrrhenian cycle” (MIS 5). The revision provided by Abbazzi et al. (2001) attributed the cervid to *Dama dama* cf. *tiberina*, a subspecies widely spread in Europe during MIS 8 and MIS 7 (Petronio et al., 2007), already present in Italy since MIS 9 according to Palombo et al. (2004) and apparently absent since MIS 5 (Palombo, 2004, 2007a; Petronio et al., 2007).

At Bovetto, the fallow deer remains come from grey sands inter-bedded to cross bedding sands containing

Loripes, *Tellina* and *Cerithium* in the level 6a (Bonfiglio, 1972; 1978). Levels from 5 to 7 (from the bottom to the top) have been attributed to a marine Tyrrhenian series (MIS 5). The level 6a underlies a conglomerate with rare molluscs (6b), which is overlaid by a level of brown sands containing *Strombus bubonius* (6c), attributable to the MIS 5e (*Eutirreniano* in Bonfiglio, 1972) and dated 124,000 yr B.P. by AAR (Hearty et al., 1986). Bonfiglio et al. (2002) correlated the fallow deer-bearing level to the end of the Middle Pleistocene, also according to the neotectonic study provided by Sauret (1980).

Also remains of *Hippopotamus* ex gr. *H. amphibius* have been recovered at Bovetto: one atlas, one distal epiphysis of left humerus, and one right femur (Marra, 2000). Remains were collected by an amateur without stratigraphical data. Elephant remains coming from Bovetto (level 6a; Bonfiglio, 1972, 1978) are still unpublished (Bonfiglio & Berdar, 1986).

At Contrada Ianni (Nicotera, Vibo Valentia), a fossil mammal assemblage was recovered in coastal plain deposits attributed to the Upper Pleistocene ("Unità C" in Bonfiglio et al., 1986). Nowadays, the "Unità C" is almost destroyed by quarry works. It was overlying a unit of coastal environment, having *S. bubonius* at the basis ("Unità B" in Bonfiglio et al., 1986). Remains of *Megaceros* cf. *calabriae* [recte *Dama dama* cf. *tiberina*] and *Elephas* cf. *antiquus* have been recovered from the level 4b of the Unit C, which was overlaid by whitish marls with *Cerastoderma* sp., probably related to a small event of marine transgression (Bonfiglio et al., 1986). The overlying aeolian sands (level 6) consist of alternated reddish coarse-grained levels containing *Homo sapiens neanderthalensis* (fragment of parietal bone belonging to a child, 2-4 years old), *Elephas antiquus*, *Dicerorhinus* [recte *Stephanorhinus*] sp., *Hippopotamus* sp., *Bos primigenius*, and *Crocota* sp. (Bonfiglio et al., 1986). The recovered lithic artifacts do not show diagnostic features (Bonfiglio et al., 1986).

The Local Faunal Assemblage of Archi (Reggio Calabria), as reported by Ascenzi & Segre (1971), comprises *Homo neanderthalensis*, *Palaeoloxodon antiquus* [recte *Elephas (Palaeoloxodon) antiquus*], *Dicerorhinus mercki* [recte *Stephanorhinus kirchbergensis*], *Hippopotamus* sp., *Cervus elaphus*, *Megaceros* [recte *Megaloceros*] sp., *Bos primigenius*. The mammals come from level C3 of the stratigraphic Complex C, attributed to Tyrrhenian (Ascenzi & Segre, 1971).

The underlying level C2 consists in gently inclined lenses of sands and sandy gravels with scattered marine shells, with the probable presence of reworked *S. bubonius*, which in the opinion of Ascenzi & Segre (1971) could be attributable to MIS 5e or later. The few elephant remains recovered in C2 were attributed to a small sized *Elephas* cf. *antiquus* by Bonfiglio & Berdar (1986). The overlying level C3 consists in gravel and sands of fluvial deposition (Ascenzi & Segre, 1971). Among the recovered taxa, only *H. neanderthalensis* and *E. antiquus* (Ascenzi & Segre, 1971; Bonfiglio & Berdar, 1986) have been studied, while the other species have been determined only.

A third lower molar of *Equus hydruntinus* and two teeth of a large bovid (*Bos* vel *Bison*) have been

recovered at Le Castella (Calabria), in the deposit of a marine terrace located in the Crotone-Capo Spartivento basin and attributed to MIS 5c (Marra & Bellomo, 2008; Marra, 2009).

The LFA from Grotta dello Scoglio di Giovanni (Cirella, Cosenza) comprises: *Ursus* sp., *Elephas* sp., *Equus* sp., *Stephanorhinus* sp., *Bos* sp., *Lepus* sp. (Cremonesi, 1987; Leone, 1967; Topa, 1933). In different excavations in the caves at Torre Talao (Scalea, Cosenza) the following taxa have been recovered: *Panthera leo* [recte *Panthera spelaea*], *Crocota crocuta spelaea*, *Ursus spelaeus*, *Elephas antiquus*, *Equus caballus* [recte *Equus ferus*], *Stephanorhinus kirchbergensis*, *Sus scrofa*, *Hippopotamus amphibius*, *Cervus elaphus*, *Dama dama*, *Bos primigenius*, *Bison priscus* (Bulgarelli, 1972; De Fiore, 1937; Del Campana, 1914; De Lorenzo & D'Erasmus, 1932; Leone, 1967; Lovisato, 1879; Mochi, 1912; Patroni, 1897; Topa, 1927).

In both localities, mammal's remains had associated with lithic artifacts attributable to Mousterian typologies, indicating the presence of *Homo neanderthalensis*.

A rich small mammal association comes from a fissure deposits at Serra Vingiolo (Praia a Mare, Cosenza): *Sorex araneus*, *S. minutus*, *Glis glis*, *Eliomys quercinus*, *Muscardinus avellanarius*, *Clethrionomys glareolus*, *Arvicola terrestris*, *Microtus (Microtus) arvalis*, *M. (M.) agrestis*, *M. (Terricola) savii*, *Apodemus (Sylvaemus) sylvaticus* (Capasso Barbato & Gliozzi, 2001). The LFA can be attributed to the end of MIS 3 (Capasso Barbato & Gliozzi, 2001).

Grotta di Torre Nave (Scalea, Cosenza) released deposits from Middle to Upper Palaeolithic (Bulgarelli, 1972; Cremonesi, 1987). In the Middle Palaeolithic deposits, probably related to the MIS 3, Mousterian artifacts were associated with: *Felis silvestris*, *Crocota crocuta spelaea*, *Vulpes vulpes*, *Mustela nivalis minor*, *Ursus* sp., *Sus scrofa*, *Cervus elaphus*, *Capreolus capreolus*, *Capra ibex*, *Rupicapra rupicapra*, *Bos primigenius*, *Sciurus vulgaris*, *Arvicola terrestris*, ?*Arvicola* sp., *Glis glis italicus*, *Eliomys quercinus*, *Muscardinus avellanarius*, *Lepus* sp., *Erinaceus europaeus*, *Talpa europaea*, *T. caeca*, Chiroptera indet. Cervoids and mountain species prevail among mammals, while birds include also dry prairie forms (Bulgarelli, 1972; Cremonesi, 1987).

The overlying deposits, Upper Palaeolithic in age, were partially preserved. Lithic artifacts and coals had associated with *Bos primigenius*, *Cervus elaphus*, *Capreolus capreolus*, and *Capra ibex* (Bulgarelli, 1972). These remains are dated late Glacial as well as those from "Grotta della Madonna" (Praia a Mare, Cosenza), whose deposits extended from Upper Palaeolithic to historical ages: *Bos primigenius*, *Cervus elaphus*, *Capreolus capreolus*, *Capra ibex*, *Sus scrofa*, *Canis lupus*, *Panthera leo* [recte *P. spelaea*], *Lepus* sp., micromammals indet. (Lovisato, 1879; Cardini, 1972; Guidi & Piperno, 1992).

"Grotta del Romito", at Papasidero (Cosenza), is well known for its rock engravings representing large bovids. Its deposits cover a large time-span, from Upper Palaeolithic to historical ages. The LFA referred to Upper Palaeolithic is made by: *Sus scrofa*, *Capra ibex*, *Rupicapra* cf. *pyrenaica*, Caprinae indet., *Cervus*

elaphus, *Capreolus capreolus*, *Lepus* sp., *Canis lupus*, *Vulpes vulpes*, *Meles meles*, *Felis silvestris* (Boscato et al., 1998; Graziosi, 1963, 1964, 1965; Guidi & Piperno, 1992).

Other findings are too poor and sporadic to be taken into account.

PALAEOBIOGEOGRAPHY

The palaeogeography of Calabria during the Pleistocene can help to understand the ways of dispersion of land mammals in the southernmost area of the Italian peninsula, and then to Sicily.

Calabria is characterized by a complex geography, being made by majestic mountains and narrow inner and coastal plains. In the past, the extension of plains was probably smaller than nowadays.

In the late Pliocene-Early Pleistocene, Calabria was divided into three islands (Serre, Aspromonte, and Capo Vaticano) by sea straits. In the Crati basin, a very thick Pliocene-Pleistocene sedimentary succession was depositing (Spina & Schiattarella, 2006). The marine basins of Monte Torre and Catanzaro were connecting the Tyrrhenian and Ionian seas, while the marine basins of Mesima and Gioia Tauro were isolating Cape Vaticano (Barrier et al., 1993; Bouillot, 1998; Fabbri et al., 1980; Selli et al., 1977). Southward, the Messina Strait persisted as a sea strait for all the Quaternary, between Calabria and Sicily (Barrier, 1987; Di Geronimo, 1987).

In the Early Pleistocene, Mt. Torre sea-strait was closing, and a lagoon have had place, in connection with the marine basin of Locri (Fig. 2A). A portion of Cape Vaticano tilted under the sea level (Barrier et al., 1993). At that time, the sea strait of Catanzaro was very narrow and definitely closed in the Middle Pleistocene (Bouillot, 1998), while the Messina Strait was wider than today (Mercier et al., 1987). There are no fossil records of mammals during the Early Pleistocene in Calabria, when the region was an archipelago, probably not favourable to dispersals. Late Pliocene - Early Pleistocene fauna of Sicily ("Monte Pellegrino" Faunal Complex) had made by some species derived from North African taxa, which should imply a connection to Africa (Bonfiglio et al., 2001, 2002; Marra, 2005; Masini et al., 2008). However, the FC is based on a single LFA coming from a karst cavity with an unclear depositional setting and is considered highly dubitative (Marra, 2005).

During the Middle Pleistocene the sea strait of Catanzaro had closed definitely (Bouillot, 1998), while the Strait of Messina was a little narrower than before and attained its present wideness at the end of the Late Pleistocene (Mercier et al., 1987). Sicily consisted of two islands (Agnesi et al., 1997).

In the Middle Pleistocene a general uplift interested the whole Calabria, which progressively attained its present shape (Figs. 2A-C). Coastal areas were subjected to variations as a consequence of tectonic uplift and of oscillations of the sea level due to the glacial/interglacial periods. The emersion of marine basins and of the Etna Volcano gave to the Sicily a geography similar to the present one (Agnesi et al., 1997).

The partial emersion of coastal plains and the establishment of land connections between Southern and Northern Calabria probably allowed the spreading of mammals during the Middle Pleistocene. Only two LFAs are recorded from the early Middle Pleistocene, Mercure A and Santo Stefano, located in Northern Calabria. The Mercure A LFA has been recovered in lacustrine deposits, while the Santo Stefano LFA has been recovered in a marine terrace.

In Sicily, during the early Middle Pleistocene, the strong impoverishment, the marked endemism, and the high dispersal ability of the mammal fauna (*Elephas falconeri* Faunal Complex) could be related to a troublesome dispersal through the Messina Strait by swimming (elephant and otter) or by passive transport on natural floating (small mammals) (Bonfiglio et al., 2001, 2002; Marra, 2005; Masini et al., 2008).

The fossil records of the latest Middle Pleistocene (Bovetto and Morrocu) and of the Late Pleistocene (Archi, Iannì, Le Castella, Torre Talao, Scoglio San Giovanni, Torre Nave, Grotta del Romito, Grotta della Madonna, Mercure B, Serra Vingiolo) are richer than before and distributed from the North to the South of Calabria. Local faunal assemblages have been recovered in different depositional settings: marine littoral (Bovetto, Morrocu), fluvial (Archi, Mercure B), coastal plain deposits (Iannì), cave deposits (Grotta di Torre Nave, caves of Torre Talao, Grotta della Madonna, Grotta del Romito), fissure fillings (Serra Vingiolo). The differentiation of depositional settings is coherent with palaeogeographic changes, indicating an extension of inner and coastal plains larger than in the early Middle Pleistocene (Figs. 2 C-D).

In Sicily, an almost complete renewal of the large mammal fauna (small mammals excepted) occurred during the late Middle Pleistocene - early Late Pleistocene ("*Elephas mnaidriensis* FC"; Bonfiglio et al., 2002; Marra, 2005; Palombo 2007b; Masini et al., 2008). The observed increasing biodiversity, the moderate endemism of the herbivores, and the presence of non-endemic carnivores (with top predators among them) have been related to an easier dispersal through the Strait of Messina (Figs. 2 D-E; Bonfiglio et al., 2002; Marra, 2005; Palombo 2007b; Masini et al., 2008). The dispersal could be related to several events occurred during the stadial oscillations in late Middle Pleistocene (MIS 10, MIS 8, and MIS 6, according to Palombo, 2007b) or to a single event occurred 0.3 Ma (MIS 8, according to Masini et al., 2008, with reference therein). The combination of both tectonic uplift of Calabria and Sicily and lowstand phases of the sea level probably reduced the relative distance between the two coastlines of the Messina Strait.

During the Last Interglacial (Grotta San Teodoro-Pianetti FC), some species became extinct and the arrivals of *E. hydruntinus* and of a renewed stock of small mammals preceded the latest Pleistocene fauna ("Castello" FC, MIS 2), characterized by an impoverished continental fauna, without endemites and with humans (Bonfiglio et al., 2001, 2002; Marra, 2005, 2008; Masini et al., 2008). Mammals probably crossed a partially or fully emerged land connection (Bonfiglio et al., 2002; Marra, 2005; Masini et al., 2008, with references therein).

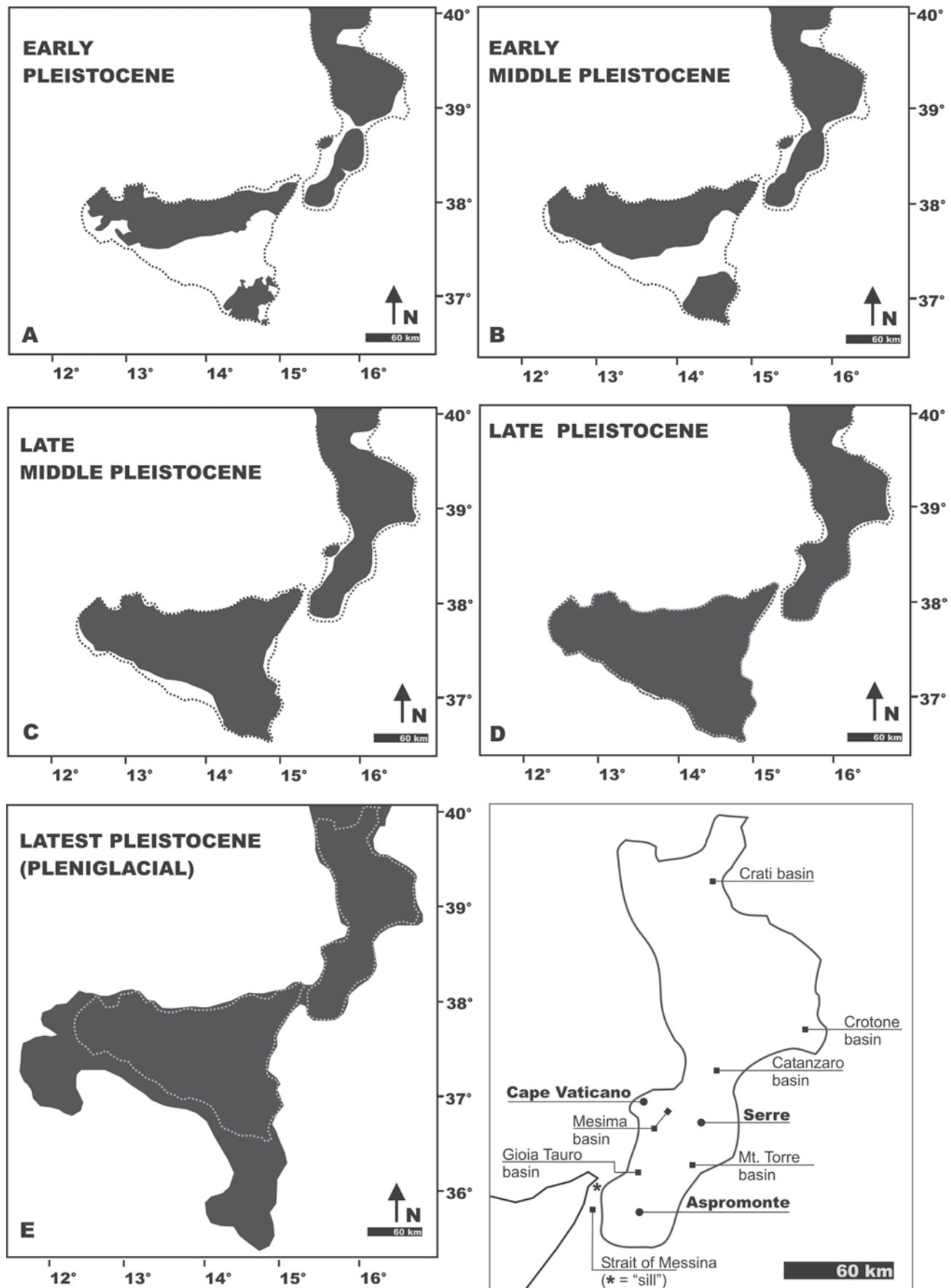


Fig. 2 - Pleistocene palaeogeography of Calabria and Sicily (according to the references cited in the text and Critelli & Le Pera, 1999).

The role of the Strait of Messina in the faunal dispersal is very important and highly debated by a palaeogeographical point of view. According to Barrier (1987), Di Geronimo (1987), Montenat et al. (1987), and Mercier et al. (1987), the Strait always persisted during Quaternary, though with consistent reductions in deepness and wideness during the lowstand phases. On the other hand, vertebrate palaeontologists proposed the occurrence of a land bridge to explain the mammal dispersal events to Sicily, at least the late Middle Pleistocene and the Late Pleistocene-Holocene ones (Bonfiglio & Kotsakis, 1987; Bonfiglio et al., 2001, 2002; Masini et al., 2008). Lambeck et al. (2004) proposed a palaeogeographic reconstruction where the Strait was emerged 20,000 yr. BP (Fig. 2 E).

The “Fossil Island” of Calabria

A “Tyrrhenian” island of Calabria south to Catanzaro has been supposed on the basis of the presence of a dwarf megacerine at Bovetto (Bonfiglio, 1978; Azzaroli, 1982; Bonfiglio & Berdar, 1986) and of a small-sized elephant at Archi (Bonfiglio & Berdar, 1986; Abbazzi et al., 2001).

Abbazzi et al. (2001) excluded an insular phase at the end of MIS 6 - beginning of MIS 5, as a consequence of the revised attribution of the cervids’ remains (previously attributed to *Megaceros (Megaceroideus) calabriae*, an endemic form) to *Dama dama* cf. *tiberina*. The same Authors considered possible a later insular phase (maybe Tyrrhenian, MIS 5) proved by the occurrence of a small-sized elephant from the Unit C2 at Archi, according to Bonfiglio & Berdar (1986).

However, the elephant bones (a last thorax vertebra, a rib, and a humerus proximal epiphysis) are very fragmentary and are not particularly significant in the evaluation of body size. The most significant remain is the proximal epiphysis of humerus, whose preservation

status allowed only four measurements (Bonfiglio & Berdar, 1986; Tab. 1).

The comparison of three of these measurements to an updated data set (Tab. 1) shows they are within the variability of *Elephas (Palaeoloxodon) antiquus* and comparable to the female specimen from Crumstadt (Deutschland; Kroll, 1991). Moreover, Bonfiglio & Berdar (1986) considered the specimens from Archi C2 comparable to the Sicilian fossils from Viale Libertà (Palermo, Sicily; Aguirre, 1968-69). These latter specimens are still objects of debate, because their size is larger than those of the Sicilian endemic species (*E. (Palaeoloxodon) falconeri* and *Elephas (Palaeoloxodon) mnaidriensis*), but smaller than continental ones (Palombo & Ferretti, 2005). They should have been the forerunners of *E. (Palaeoloxodon) mnaidriensis* arrived in Sicily about 0.4 Ma (MIS 11-12; Bada et al., 1991; Palombo & Ferretti, 2005), before the Tyrrhenian. Large sized elephants have been recovered also at Contrada Fusco (Siracusa) and Grotta Za’ Minica (Palermo) associated with *E. (Palaeoloxodon) mnaidriensis*. The ESR age (88-134 ka) could indicate new migrations of elephants from mainland, later than the Via Libertà event (Rhodes, 1996; Palombo & Ferretti, 2005; Palombo 2007b).

The other specimen reduced in size reported by Bonfiglio & Berdar (1986) was a femur from the Vialli’s collection, stored at the Dept. of Earth Sciences of the University of Florence and labelled “Archi”, without any other information. Bonfiglio & Berdar (1986) discussed the possible provenance on the basis of the preservation status, and tentatively attributed some elephants’ remains of the collection (one femur, two molars, one lunatum, one cuboid and one humerus’ head) to the Unit C of Archi.

HUMERUS				FEMUR					
Site	DAP	DAPh	DT	Site	GL	Dh	Dts	Dtdist	DAPdist
Archi C2NUM.53	260	200	237	Archi (coll. Vialli)	790	127	127	170	160
Riano, Viterbo	325	290		Fontana Campanile, Viterbo	1450	242	242	277	
Monte Sacro, Rome		280		Grotte S. Stefano, Viterbo	1370	200	192	247	
Grotte S. Stefano, Viterbo		320		Riano, Rome	1290		155	283	303
Via Libertà, Palermo, 1		200		Luparello I, Sicily	556	87	59	108	
Via Libertà, Palermo, 2		130		Puntali, Sicily	781	114	83	160	
Avely, Essex (UK)		236		Upnor (UK)	1545	214			
Grobern (D)	366		321	Crumstad (D)	1040	155	116	208	206
Crumstadt (D)	235	213	270	Grobern (D)	1402	224	173	308	307
Kiesacker (D)	356	295	417						

Tab. 1 - Measurements of *Elephas (Palaeoloxodon) antiquus* from Archi compared to Italian and European specimens. Measurements’ abbreviations: DAPprox - Antero-Posterior Diameter of the proximal epiphysis; DAPh - Antero-Posterior Diameter of the head; Dtprox - Transverse Diameter of the proximal epiphysis; GL - Greatest Length; Dh - Diameter of the head (max); DTs - Transverse Diameter of the shaft; DTdist - Transverse Diameter of the distal epiphysis; DAPdist - Antero-Posterior Diameter of the distal epiphysis. References: Archi C2, Archi (coll. Vialli), Via Libertà (Palermo) 1, Luparello I°, and Puntali: Bonfiglio & Berdar (1986); Riano: Maccagno (1962); Monte Sacro (Rome), Grotte S. Stefano (Viterbo), Via Libertà (Palermo) 2, Avely (Essex, UK): Ferretti (1998); Grobern, Crumstad and Kiesacker (D): Kroll (1991); Fontana Campanile, Viterbo: Trevisan (1948); Upnor (UK): Andrews & Cooper (1928).

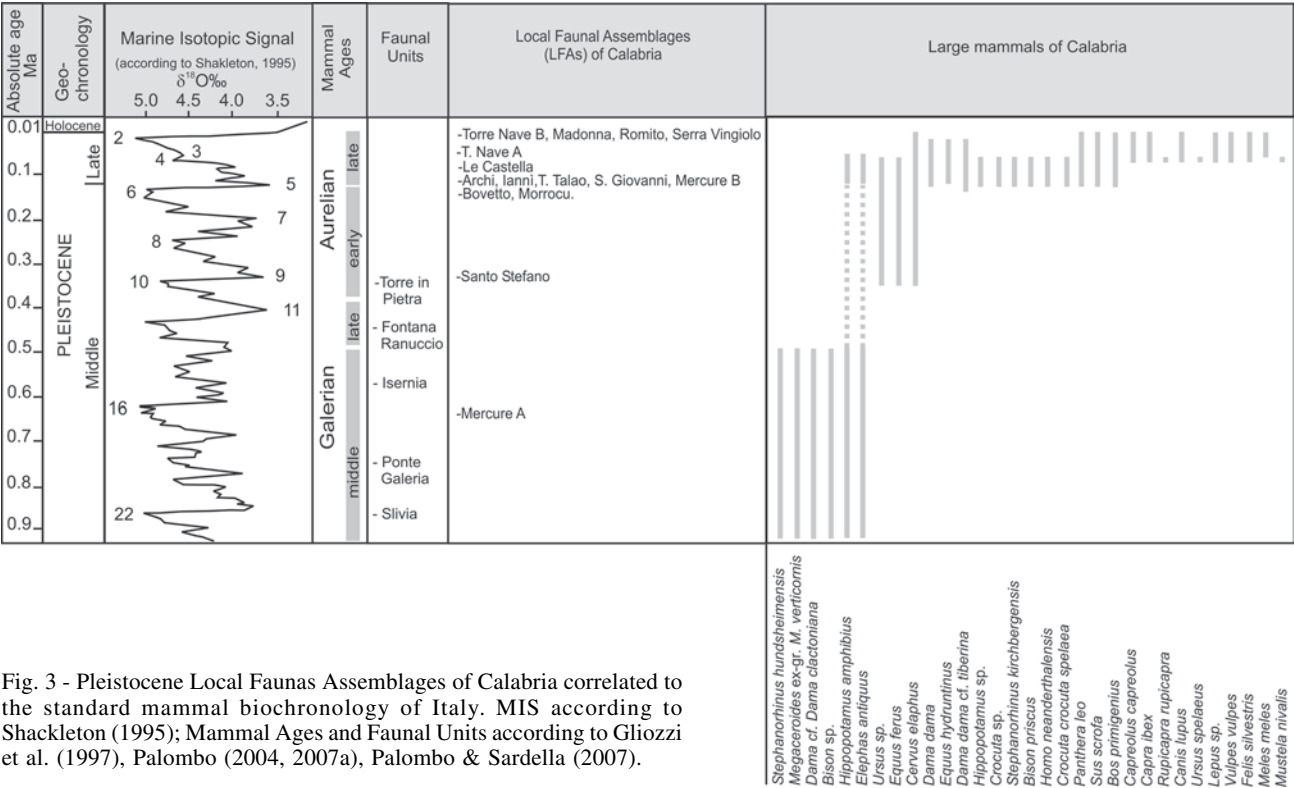


Fig. 3 - Pleistocene Local Faunas Assemblages of Calabria correlated to the standard mammal biochronology of Italy. MIS according to Shackleton (1995); Mammal Ages and Faunal Units according to Gliozzi et al. (1997), Palombo (2004, 2007a), Palombo & Sardella (2007).

Unfortunately, the access to the Vialli's collection for a revision has not been possible. The measurements of the femur provided by Bonfiglio & Berdar (1986) and here compared to an updated dataset fall within the variability of Sicilian specimens (Tab. 1). If the femur really comes from Archi, and in particular from the Unit C, it would indicate the unusual condition of coexistence of *E. antiquus* with a strongly endemic elephant. Lacking unequivocal data, the presence of an endemic elephant is highly dubitative.

Moreover, the sea strait of Catanzaro was already very narrow in the Early Pleistocene and its wideness was progressively reducing until its definitive closing in the course of Middle Pleistocene (Figs. 2 A-C; Bouillot, 1998).

So, it seems plausible that in the late Middle and Late Pleistocene there was not a sea barrier isolating southern Calabria.

DISCUSSION

The place of the LFAs of Calabria in the biochronological chart of Italy

In Calabria, the Pleistocene fossil record of mammals is discontinuous in time and space. The most representative LFAs have been attributed to the Late Pleistocene, corresponding to the late Aurelian in the biochronological chart of Italy by Gliozzi et al. (1997) (Fig. 3). No characteristic FUs have been designated for the late Aurelian by Gliozzi et al. (1997), because no peculiar associations of characteristic taxa had been detected. Only for palaeoecological purpose Palombo (2007a) grouped the late Aurelian faunal assemblages

into two Faunal Complexes informally named "Last Interglacial" (MIS 5) and "Last Glacial" (MIS 4, 3, and 2). However, Petronio et al. (2007) recently proposed two new FUs in the Late Aurelian, both based on LFAs from Apulia: Melpignano FU (MIS 5), marked by the occurrence of modern cervids (*D. dama dama* and *Cervus elaphus elaphus*) and Ingarano FU (MIS 4/3), marked by the occurrence of "cold" mammals (*Coelodonta antiquitatis*, *Mammuthus primigenius*, and *Marmota primigenia*). The latter bioevents have not been recorded in Calabria.

Bovetto "Fornace Neri" LFA can be considered slightly precedent the MIS 5e, both for the stratigraphic evidences and the presence of *Dama dama cf. tiberina*. However, the same fallow deer is probably present at Ianni Unit C, overlying *Strombus bubonius*-bearing levels attributed to MIS 5e. If the tentative attribution of the specimens from Ianni Unit C to the subspecies "*tiberina*" will be confirmed, the taxon can be considered refugee in Calabria after the MIS 5e. Ianni and Archi LFAs are comparable for their mammal associations and for their position over *S. bubonius* -bearing levels. The presence of *Hippopotamus* sp. could indicate an age earlier than MIS 4, when hippopotamuses had already disappeared from Italy. Similarly, the presence of *Hippopotamus amphibius* at Torre Talao allows an upper limit before the MIS 4, while the occurrence of Mousterian artifacts gives a lower limit not earlier than MIS 5, when *H. neanderthalensis* had widespread in Italy (Stiner, 1994; Bruner & Manzi, 2007)

The LFAs attributable to MIS 5 (Ianni, Archi, Le Castella, Grotta dello Scoglio) or slightly anterior (Bovetto) are comparable to other Italian ones, but they are less diversified.

The later LFAs, attributed to MIS 3 and MIS 2 (Serra Vingio, Torre Nave, Grotta della Madonna, Grotta del Romito), have a mammal fauna with species widely common in other Italian Apennine and pre-Apennine environments.

Calabria as a dispersal way to Sicily

The “Mercure A” LFA poorly supports with evidences the spreading to Sicily, for its attribution to a “generic” Middle Galerian, as well as for its northern position. The presence of the faunal association in southernmost parts of the region is not sustained by evidences. *Elephas (Palaeoloxodon) antiquus*, the probable ancestor of the Sicilian species *E. (Palaeoloxodon) falconeri* (Palombo & Ferretti, 2005; Palombo, 2007b), is recorded at “Mercure A” (Cavinato et al., 2001). However, *Praemegaceros* cf. *P. verticornis* and *Dama* cf. *D. clactoniana*, species with high dispersability, did not disperse to Sicily.

The poor record of the fossil record does not document the dispersal to Sicily, which had place in the late Middle Pleistocene. On the contrary, the Late Pleistocene fossil record shows a perfect correspondence with Sicilian faunas. The probable ancestors of endemic and not endemic large mammals recorded in Sicily during the Late Pleistocene are present in the Late Pleistocene LFAs of Calabria. All the precursors of the species of the S. Teodoro-Pianetti FC (Late Pleistocene of Sicily) have been recorded in the Santo Stefano LFA, attributable to the early Aurelian (*Ursus* sp. and *Cervus elaphus*, ancestor of *C. elaphus siciliae*) and in the numerous LFAs attributable to the late Aurelian: *Crocota crocuta spelaea*, *Canis lupus*, *Vulpes vulpes*, *Elephas (Palaeoloxodon) antiquus* (ancestor of *E. (Palaeoloxodon) mnaidriensis*), *Sus scrofa*, *Equus hydruntinus*, *Cervus elaphus*, *Dama dama* cf. *tiberina* (ancestor of *Dama carburangelensis*), *Bos primigenius* (ancestor of *B. primigenius siciliae*), *Bison priscus* (ancestor of *B. priscus siciliae*). Because of the main part of mammals belonging to the S. Teodoro-Pianetti FC were already spread in Sicily in the second half of Middle Pleistocene (*E. mnaidriensis* FC), their presence of Calabria at that time can be tentatively supposed. All the mammals of the Castello FC are recorded in Calabria except for *Martes* sp.

It is important to point out that only few species were present in Calabria and not in Sicily: *Praemegaceros* cf. *P. verticornis*, *Stephanorhinus hundsheimensis*, and *Dama* cf. *D. clactoniana* in the early Middle Pleistocene; *Homo neanderthalensis*, *Equus ferus*, *Stephanorhinus kirchbergensis*, *Capreolus capreolus*, *Capra ibex*, *Rupicapra rupicapra*, and *Meles meles* in the Late Pleistocene (Fig. 3).

It seems reasonable that in Sicily biodiversity was slightly lower than in Calabria. The continental species, which did not cross the sea in the Late Pleistocene, were mammals adapted to mountain or prairie environments.

Mammals reached Sicily thanks to their swimming ability, possibility of floating on natural rafts, and/or casual crossing of shallow waters in correspondence of the “sill” of the Messina Strait. The “sill” should be considered a key to understand the sea crossing through the Strait of Messina. Actually, Sicilian coast is 3 km

away from Calabria, in correspondence of the “sill”, an area with a deep and irregular western part (60 to 100 m deep, offshore Ganzirri) and a shallow and smooth (80 to 100 m deep, offshore Punta Pezzo) eastern part (Colantoni, 1987).

Geologists and palaeontologists stated that the sill never emerged and the Strait of Messina has had always a high hydrodynamicity, but they did admit a reduction in depth and width during regressive phases. On the other hand, vertebrate palaeontologists hypothesized an instable land bridge. But what would have occurred if only some parts of the sill had emerged? The Strait would have been open, but land mammals should have cross it by “stepping stones”. These conditions have been not stable, but occasionally should have allowed the dispersal of mammals, especially those having a scarce swimming ability. Moreover, Sicily was not a far island but a land visible to mammal, only few kilometres away from Calabria.

CONCLUSIONS

Although relatively poor, the fossil record of Calabria allowed the selection of 15 LFAs mainly based on large mammals. The LFAs selected in this paper have been described and correlated to the biochronological chart of Italy. At the state of the art, the LFAs seem to indicate a fauna impoverished if compared to those from the rest of Italy. Calabrian LFAs are made by ubiquitous species of warm-temperate climate, excluding the possibility to mark bioevents. The mammal assemblages seem to reveal an increasing environmental diversification in the late Middle Pleistocene and in the Late Pleistocene of Calabria, as also indicated by the palaeogeographical setting. Spreading of mammals has probably been limited by the complex palaeogeography and the long latitudinal extension of Calabria.

The insularity of Calabria South to Catanzaro basin in the MIS 5 should be rejected on the basis of the palaeogeographical reconstructions and the absence of well-documented endemic mammals.

Calabria probably acted as a first filter on faunas spreading to Sicily. By a palaeobiogeographical point of view, the filter seems to have been stronger in the Early and early Middle Pleistocene, weaker in the late Middle Pleistocene and Late Pleistocene.

The mammals found in Calabria in late Middle and Late Pleistocene spread to Sicily, with the exception of few species well adapted to mountain or prairie environments. These data could help understanding the insular processes occurred in the Pleistocene of Sicily, confirming that the Strait of Messina was a weak barrier for the dispersal of land mammals in the late Middle and Late Pleistocene.

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