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Lands and endemic mammals in the Late Miocene of Italy: Constrains for paleogeographic outlines of Tyrrhenian area

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Abstract

The Pre-Messinian land mammal localities of Italy contribute substantial information for reconstructing the complex history of the land masses of the central Mediterranean. At the present state of knowledge the available paleogeographic maps do not have the adequate time resolution for providing an effective picture of the evolution of the physiographic and of the oceanographic characteristics of the area. This can only be accomplished through detailed comparative analyses of the geology and of the land and marine faunas in the course of the Miocene. The Pre-Messinian Late Miocene land mammals localities of Italy document the existence of three distinct bioprovinces. Two of the latter are characterised by faunas with manifestly endemic features, thus attesting to the occurrence of isolated emerged areas. One of these areas is called the Abruzzi–Apulia paleobioprovince; it was located on the Adriatic side of Apennines. The other one is the so-called Tusco–Sardinian paleobioprovince and was located in the peri-Tyrrhenian side of Italy. A third bioprovince, testified by sites in Calabria and Sicily, is characterised by non-endemized mammals, counterparts of which were identified in North Africa and Europe. This area was therefore, at least in part, a northern extension of the Late Miocene Mediterranean border of the African plate. These three areas belong to completely different tectonic domains and kept separated for a considerable time span and each one has a peculiar biogeographic and tectonic history.

Keywords: Fossil mammals; Endemism; Palaeogeography; Late Miocene; Italy

1. Introduction

Two national research projects coordinated at the Earth Sciences Department of the University of Florence and granted by the Italian Ministery for University and Scientific Research (MURST Cofin 1999 and 2001), perfectly fit the EEDEN program objectives, specially for what concerns paleogeography during the Vallesian and Turolian Land Mammal Ages.

There is an obvious continuum in the paleogeographic changes that, from a tethidean geography, led to the present day Mediterranean physiography, thus the story reported here could be referred to a unique span covering the Vallesian, Turolian and Early Ruscinian Land Mammal Ages, from 12 to 4 Ma approximately.

The available paleogeographic maps of the Mediterranean area, although derived from huge efforts of interdisciplinary syntheses (Dercourt et al., 1986; Rögl, 1999a,b; Dercourt et al., 2000; Meulenkamp and Sissingh, 2001; Rögl, 2001) do not have the adequate temporal and geographical resolution for providing an effective picture of the physiographic and oceanographic

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evolution of a "small" and geologically complicated area such as the central Mediterranean.

We offer here an outline of the evidence and constraints provided by land mammals during the Late Miocene of Italy for reconstructing the Central Mediterranean paleogeographic scenario. A major emphasis will be placed on the Tyrrhenian area, where the substantial available data permit a detailed reconstruction of the changing paleogeography.

The Late Miocene land mammals localities of Italy document the existence of three distinct bioprovinces (Torre et al., 2000; Rook et al., 2000a). The latter two are characterised by vertebrate faunas with manifestly endemic features, thus attesting to the occurrence of isolated emerged areas. One of these areas is called the Abruzzi–Apulia paleobioprovince; it was located on the Adriatic side of Apennines. The second one is the so-called Tusco–Sardinian paleobioprovince and was located in the peri-Tyrrhenian side of Italy. The third paleobioprovince, testified by sites in Calabria and Sicily, is characterised by non-endemized mammals, counterparts of which were identified in North Africa. This area was therefore a northern extension of the Late Miocene Mediterranean border of the African plate.

2. The Italian lands from 12 to 8.5 Ma

2.1. Apulo–Abruzzi area

By this time the Apulo–Abruzzi area was already defined and inhabited by its endemic fauna, the land vertebrates found in Lower Tortonian lagoonal calcarenites at Scontrone (Fig. 1) at the southern border of the Abruzzi National Park (Rustioni et al., 1993). At this site, the artiodactyls are by far the dominant faunal component. Eight different morphotypes have been identified, most of which relate to Hoplithomerycidae, an endemic taxon previously known from the Late Miocene "Terre Rosse" faunal complex of Garagano (Leinders, 1983; Mazza and Rustioni, 1996). These taxa have no correspondence with any other presently known artiodactyls (Mazza and Rustioni, 1996, 2000). Though distinct in dental characters and proportion, these animals show a marked morphologic resemblance in the postcranial skeleton and bear plesiomorphic traits typical of pre-Pecora representatives. It has been hypothesized that they possibly are hangovers of some primitive Paleogene ruminant stock that colonized the Abruzzo–Apulian area before the appearance of the bovidae, cervidae and giraffidae lineages (Mazza and Rustioni, 1996, 2000).

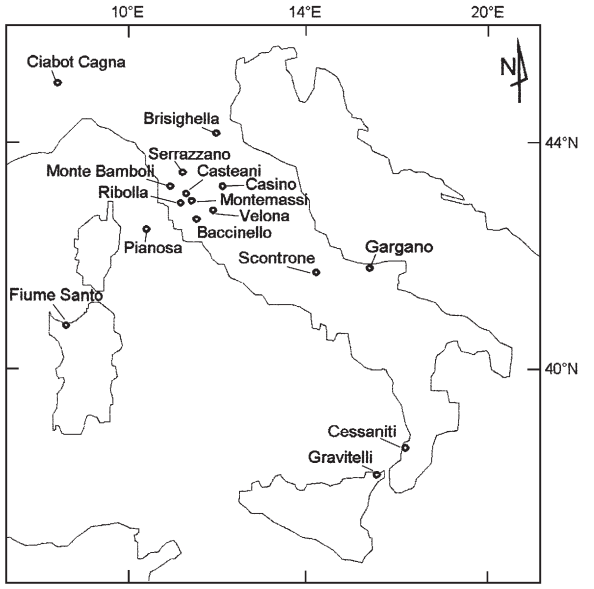

Fig. 1. The schematic map of Italy showing the location of Late Miocene mammal localities quoted in the text.

2.2. Tusco–Sardina area

The Late Miocene faunal succession of the Tusco–Sardinia area has been known for a long time in the literature. The best faunal succession for the history of this paleobioprovince is provided by the geologic record of the Baccinello–Cinigiano basin (BCB) in the Grosseto district (Figs. 1 and 2).

The succession of faunal assemblages in the BCB allows some considerations regarding the paleobiogeographic evolution not only of the limited area, but of the whole Tyrrhenian region during the Late Miocene times (Lorenz, 1968; Benvenuti et al., 1995, 2001). Three successive faunal assemblages recovered from the BCB all belong to an endemic faunal complex (defined as "*Oreopithecus* Zone Faunas [OZF]" in Bernor et al., 2001) different from coeval mammal faunas either from European or African continental realms, although the phylogenetic affinities of these mammals are predominantly with species from the European continent. In addition to the Tuscan localities, an "OZF" assemblage, including the primate *Oreopithecus*, the antelope *Maremmia* and the suid *Eumaiochoerus*, was recently collected in Miocene sediments at Fiume Santo (Fig. 1), in Northern Sardinia (Cordy and Ginesu, 1994; Cordy et al., 1996), thus enlarging the domain of the paleobioprovince (Rook et al., 1999; Bernor et al., 2001). All these faunal assemblages testify to the existence in the Tyrrhenian area of a land (or a complex of large islands) colonized by taxa from continental

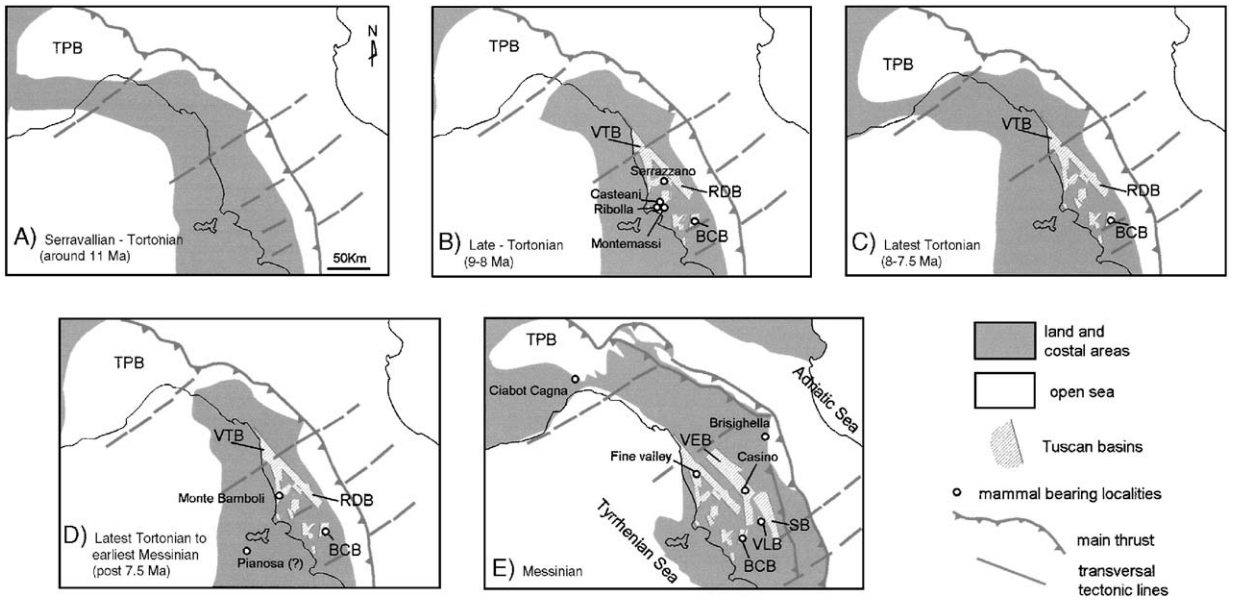

Fig. 2. The paleogeographic evolution of the northern peri-Tyrrhenian area (Corsica and Sardinia not included) from the earliest Tortonian to the Messinian. BCB: Baccinello–Cinigiano basin; RDB: Radicondoli basin; SB: Siena basin; TPB: Terziario–Piemontese basin; VEB: Val d'Elsa basin; VLB: Velona basin; VTB: Volterra basin. Three main phases of peopling of the Tusco–Sardinia area are identified. Around the Serravallian–Tortonian transition (A) the endemic peopling of the so-called V0 and V1 endemic faunal assemblage of the BCB (B) were established. During latest Tortonian (C) a new temporary connection with the European mainland allowed the entrance of new taxa that characterized the so-called V2 endemic assemblages in the BCB (D); the same taxa are also present at Fiume Santo (northern Sardinia) attesting thus the connection at that time with the Corsica–Sardinia massif. By the Messinian the connection with the European mainland was defined, the endemic paleobioprovince vanished and taxa with continental European affinities were widespread in several localities (E). The opening of the Tyrrhenian sea separated at that time the Corsica–Sardinia massif from the Italian mainland. Modified from Benvenuti et al. (2001). Tectono-sedimentary outline from Boccaletti et al. (1990) and Martini and Sagri (1993).

Europe at the beginning of the Late Miocene (Early Tortonian).

On the grounds of the regional geological setting (the Late Serravallian–Early Tortonian age of the Arenarie di Ponsano, shallow marine sandstones deposited in small satellite basins formed in southern Tuscany, Foresi et al., 1997) the origin of the Tuscan lands cannot be older than Late Miocene times and the occurrence at Baccinello of taxa such as the murid *Huerzelerimys* and the primate *Oreopithecus bambolii* testifies to the Late Miocene dispersal phases from Europe (Engesser, 1989; Rook et al., 1996). It is likely that the activation of the BCB occurred during the Tortonian when differential subsidence was affecting a wide area between the SW Alps and the Northern Apennines (Fig. 2A and B).

A recently discovered tephra layer within the BCB succession provide a crucial opportunity to improve the chronology of the *O. bambolii* bearing sediments (Rook et al., 2000b). The 7.55±0.03 Ma age of this ash represents a younger age for *Oreopithecus* in V2 faunal assemblages than previously estimated on the basis of biochronologic constraints. *O. bambolii* is therefore the only European hominoid who survived the Vallesian–Turolian boundary for long (Rook et al., 2000b). A novelty element within the evolution of the structure of these endemic mammal communities is the occurrence in the assemblage V2 of taxa absent in the previous assemblages and testifying to the dispersal of new immigrants from Europe within this paleobiogeographic domain. The occurrence of the suid *Eumaiochoerus* in the Sardinian locality (Fiume Santo) is a clear signal that at the time of the dispersal of this taxon within the area, the Tyrrhenian sea was not fully separating the Corso–Sardinian massif from southern Tuscany (Kotsakis et al., 1997) (Fig. 2C and D).

The evolution of the mammal faunas provides evidence of regional significance for paleogeographic reconstructions (Fig. 2 A–E). The mid-Late Tortonian isolation of the Tusco–Sardinian paleobiogeographic province from Europe, recorded in the V0–V2 assemblages of the BCB, can be only be referred to a temporary interruption in the NW connection (Maritime Alps) with Europe. Possible evidence of the closure of a pathway for mammal dispersal can be found in the Upper Miocene lithostratigraphy of the Tertiary Piedmont Basin (TPB), an episutural basin activated from

the Late Eocene just between the south-western Alps and the northern Apennine (Ghibaudo et al., 1985; Benvenuti et al., 2001). The Tortonian is here represented by outer shelf sands and pelites (S. Agata Fossili Marls) thus recording a wide progressive transgression over the basin. Ghibaudo et al. (1985) referred such a transgression to fast tectonic subsidence related to sin-sedimentary faulting in the basin. This tectonically-induced transgression could have interrupted the dispersal of mammals from Europe possibly established since the end of the Serravallian, as suggested by shallow marine deposits in the TPB which record a significant shallowing in the basin (Ghibaudo et al., 1985). The history of the endemic faunal complexes of the BCB reveals a temporary reopening of that pathway witnessed in the V2 assemblage by the occurrence of *Eumaiochoerus* and *Parapodemus*. In the TPB this event could be evidenced by resedimented gravels in the lower part of the S. Agata Fossili Marls. Such coarser deposits rest unconformably on the inner shelf sands and silts and contain reworked coeval shallow marine fossils and sediments (Ghibaudo et al., 1985). Despite their limited occurrence, the gravely deposits could record an important, infra-Tortonian, reorganization of the basin through localized uplift and shallowing of the marine environment allowing a new, short-lasting, access of mammals from SW Europe (Fig. 2C). Direct evidence of this faunal dispersal phase could be represented by an isolated find of a giraffid tooth from an unregistered locality in the surrounding of La Morra (Alba, CN) in the TPB. A cast of this specimen (collected by an amateur in the '70s) is kept in the collections of the University of Florence Natural History Museum (Geology and Palaeontology section, with inventory number IGF 15869).

3. The Italian lands from 7 to 4 Ma

3.1. Apulo–Abruzzi area

Shortly after the Scontrone document, the Abruzzo portion of this paleobioprovince was apparently involved in the orogenetic disruptions which caused the edification of the central and southern part of the Apennine. Being still part of the foreland, the Gargano–Murgie portion was practically a structural high which remained emerged until the Early Pliocene, thus allowing the survival of its typical endemic elements (Abbazzi et al., 1996, and bibliography therein).

Deinogalerix and *Microtia* are, by far, the most significant components of the Gargano endemic assemblages (Freudenthal, 1971; Abbazzi et al., 1993). Since murids are not known before the Early Tortonian, the *Microtia* ancestor cannot have possibly reached the Apulian area earlier. Given that the most primitive known *Microtia* specimens from Gargano are already quite endemized (hypsodont cheek teeth, high numer of dental lophs etc.) it is presumed that a great deal of their initial evolution was lost to the record (Abbazzi et al., 1993). A second Late Miocene micromammal entrance into the Gargano–Murgie area possibly occurred during the Messinian. This seems consistent with the fact that the highly endemic *Microtia* is associated with the non-endemic *Apodemus* and *Eliomys*, two genera unknown in Pre-Messinian times (Abbazzi et al., 1996).

The Pliocene marine ingression did not completely cover the Apulia area, although there are no further documents of the persistence of residual endemic terrestrial communities. Perhaps the extreme reduction of the areas in combination with the Pliocene climatic and environmental alterations doomed this peculiar faunal complex to a rapid extinction.

3.2. Tusco–Sardina area

A major reorganization in the paleobiogeography of the Tyrrhenian area occurred during the Messinian. From a faunistic point of view this time interval is characterized by a dramatic change. All the taxa belonging to the endemic faunal complex in BCB disappeared and were replaced by a new faunal assemblage (Baccinello V3) including continental taxa with clear European affinities (Hürzeler and Engesser, 1976; Rook, 1999; Rook et al., 1999; Abbazzi, 2001; Benvenuti et al., 2001; Bernor et al., 2001). The V3 assemblage points to renewed and definitive paleobiogeographical connection with Europe. The northwestern seaway was definitively removed (Fig. 2E) as testified by widespread subaerial erosion documented in the Tertiary Piedmont Basin during the Early Messinian (Ghibaudo et al., 1985). The European fauna penetrated into the northern Apennine throughout Piedmont and Romagna (Ciabot Cagna and Birsighella faunal assemblages; Cavallo et al., 1993; De Giuli et al., 1988) and dispersed down to southern Tuscany as testified by the findings from Fine valley, Casino, Velona and Baccinello V3 (Kotsakis et al., 1997; Rook et al., 1999; Benvenuti et al., 2001). The slopes of the newly emerged Apennines constituted a wide pathway for the dispersal of mammal communities although west to the Mid Tuscan Ridge there were still basins occupied by shallow marine areas with evaporitic deposition.

This faunal change marks the moment when the Corso–Sardinian massif was definitely isolated from

southern Tuscany by the opening of the Tyrrhenian sea and southern Tuscany became fully connected with the newly formed Apennine chain. The passageway from mainland Europe persisted in the Early Pliocene. It was not interrupted by the earliest Pliocene transgression, thus allowing new dispersal of Early Pliocene taxa along the Apennine chain such as the case of the gerbil *Debruijnimys* sp., possibly attested by the recent finding in Val d'Elsa (Rook et al., 2001; Tangocci, 2001).

3.3. Calabria–Sicily area

The first evidence for a connection of the Calabria–Peloritan arch with North Africa is represented by a *Stegotetrabelodon syrticus* mandible found in the Upper Tortonian–Lower Messinian *Clypeaster*-rich sands outcropping at Cessaniti (Fig. 1), near Vibo Valentia in Calabria (Ogniben, 1973; Papazzoni and Sirotti, 1999; Ferretti et al., 2003). New specimens were recently recovered from the outcrops of the Cessaniti–Zungri basin. These are represented by a tragocerine bovid, a fragmentary skull of "*Diceros*" *primaevus*, a middle-sized giraffe tentatively referred to *Samotherium?* sp., and a single isolated tooth of a hexaprotodont ippopotamid. Affinities with North African taxa and the non-endemic character of these faunal elements clearly underscore a direct connection of the area with North Africa (Rook et al., 2000a; Torre et al., 2000). The Cessaniti–Zungri sequence shows possible correlations with the Gravitelli succession (Seguenza, 1902). Unfortunately the latter had to be considered from the literature only since it is no longer accessible. The two successions altogether testify to the existence of a Late Miocene Calabro–Peloritan complex.

The fossil from Gravitelli went missing during the Messina 1911 earthquake, and information on this fauna was drawn only from descriptions by Seguenza (1902, 1907). Casts of the suid from Gravitelli have been recently found in the collections of the University of Florence Natural History Museum (Geology and Palaeontology section). These surely allow to attribute the Gravitelli suid to the genus *Propotamochoerus*, thus evidencing a European affinity (Gallai and Rook, in press).

4. Concluding remarks

The Pre-Messinian Late Miocene land mammals localities of Italy document the existence of three distinct bioprovinces, two of them characterised by faunas with manifestly endemic features, thus attesting to the occurrence of isolated emerged areas. The two endemic areas belong to completely different tectonic domains and have been separated for a considerable time span, each one having its peculiar biogeographic and tectonic history. The third Late Miocene "paleobioprovince", testified by sites in Calabria and Sicily, is characterised by non-endemized mammals, counterparts of which were identified in North Africa and Europe. This area was therefore, at least in part, a northern extension of the Late Miocene Mediterranean border of the North Africa shelf. The documentation of land mammals inhabiting each of these lands, provide constraints on delineating paleogeography and paleogeographic changes during the Late Miocene time interval, with a temporal and spatial resolution not available in the published paleogeographic maps of circum-Mediterranean area.

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