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THE IMPACT OF THE LATE MIOCENE CLIMATE CHANGE ON LAND MAMMALS: THE CASE STUDY OF CAPO VATICANO - MONTE PORO (VIBO VALENTIA, ITALY)

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ABSTRACT. Late Miocene is characterised by global climatic changes towards cooling and aridification, with a consequent expansion of grasslands and adaptation of mammals to open environments. In Eastern Mediterranean, a peculiar mammal association, the Pikermian fauna, was widespread and dominated by Gomphotheriidae, Rhinocerotidae, Giraffidae, Bovidae, Equidae, Felidae, and Hyaenidae, while Cervidae was remarkably absent. The Pikermian fauna reached its acme at about 7 Ma and rapidly disappeared. During the maximum expansion, Pikermian distinct species were recorded from China to Iberian Peninsula, with some finds in Africa. A new mammal association found in the Late Miocene of the Capo Vaticano – Monte Poro area (Calabria, southern Italy) included some typical Pikermian species with Afro-Arabian ones and coincided with the maximum expansion of the Pikermian Biome. This peculiar mammal association allowed ascribing the fossil assemblage to a third bioprovince in the central Mediterranean, clearly different from the Tusco-Sardinia and the Apulo-Abruzzi and Tyrrhenian bioprovinces, characterised by marked insularity. The Capo Vaticano - Monte Poro area could be connected to North Africa through a land connection between 7.2 and 8 Ma, receiving African mammals and some Pikermian ones, due to the expansion of the association driven by climatic change.

1. Introduction

During Late Miocene, the global climate shifted towards aridification and cooling (Zachos *et al.* 2001; Zachos, Dickens, and Zeebe 2008; Eronen *et al.* 2012; Fortelius *et al.* 2014) probably due to a fall of atmospheric carbon dioxide and a reduction in the amplitude of Earth's obliquity (Brown *et al.* 2022; Qin *et al.* 2022). The climate changes produced effects on terrestrial flora, fauna, and ecosystems, determining a progressive spread of grassland environments accompanied by the adaptation of mammal associations to open habitats (R. L. Bernor 1983; R. L. Bernor 1984; Fortelius *et al.* 1996; Solounias *et al.* 1999; Agustí and Antón 2002). In the Eastern Mediterranean area, in a geographical asset different from nowadays (Fig. 1), a peculiar mammal fauna seems to have recorded the first effects of climate change in a time ranging between 8.3 and 7.0 Ma and in a

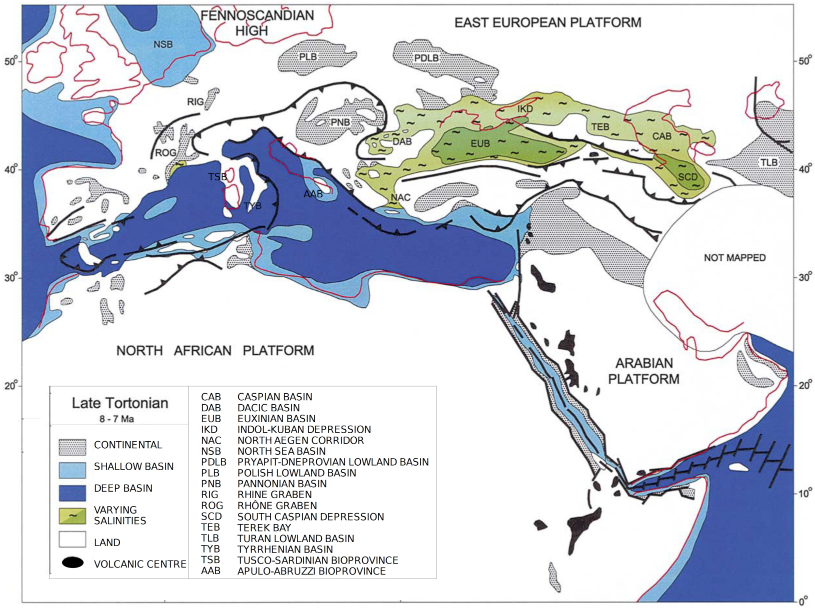

FIGURE 1. Palaeogeography of the Peri-Tethys (modified after (Meulenkamp and Sissingh 2003).

space defined as the Greco-Iranian Bioprovince (Bonis, Bouvrain, and Geraads 1979). The so-called Pikermian fauna (after the site of Pikermi, near Athens, Greece) was dominated by Gomphotheriidae, Rhinocerotidae, Giraffidae, Bovidae, Equidae, Felidae, and Hyaenidae, while Cervidae was remarkably absent (R. L. Bernor *et al.* 1979; R. L. Bernor 1983; R. L. Bernor 1984; Fortelius *et al.* 1996; Solounias *et al.* 1999; Agustí and Antón 2002)

The first mammal adaptations to open environments were cursoriality and hypsodonty (high-crowned teeth) (R. Bernor *et al.* 1996; R. L. Bernor, Semprebon, and Damuth 2014). Hypsodonty is an indirect climate indicator because an increasing teeth crown height enforces the molar as an adaptation to abrasion produced by grasses and mineral grains in arid environments (Janis 1995). Therefore, a prevalent percentage of grazers is expected in arid environments. The environment where the Pikermian fauna lived has been initially attributed to a savanna, later to a mosaic landscape (Solounias *et al.* 1999). However, the biome associated to the Pikermian fauna has been better defined through the study of palaeodietary habits of large herbivores. The application of the mesowear method (Fortelius *et al.* 2002) consisted in quantifying the wear of herbivores' molars and attributing a dietary category (grazer, browser, mixed feeder). The Pikermian faunas included mainly mixed feeders, subordinately grazers (herbivores feeding grass for 99% of their diet), and browsers (feeding on grass less than 10% of their diet) (Solounias, Rivals, and Semprebon 2010). The environment might have included leaves and grass. About 2/3 of the fauna from Samos and Pikermi (both sites referred to the Pikermian biome) was represented by grazers and mixed feeders, enabling to hypothesise a consistent occurrence of trees, bushes, and shrubs (Solounias, Rivals, and Semprebon 2010). Twelve species of equids, some bovids, and

FIGURE 2. Landscape at Kanha National Park, Madhya Pradesh, India. Author: Honza Soukup, 2008. License: Creative Commons. Source: Wikicommons.

some giraffids have been considered grazers, compatible with feeding C3 grasses typical of woodlands (Solounias, Rivals, and Semprebon 2010). A contemporaneous example of the Pikermian environments (in particular those of Samos and Pikermi) was recognised in the Kanha Park in India (Figure 2), where dense forests prevailed in wet areas, alternated with small trees and grasses in more arid regions (Solounias, Rivals, and Semprebon 2010).

The environmental reconstructions allowed to identify the Pikermian Biome as a sclerophyllous evergreen woodland alternating with grassy meadows inhabited by an uniform mammal fauna mainly spread in the Greco-Iranian Bioprovince (Eronen *et al.* 2009; Solounias, Rivals, and Semprebon 2010). The fauna's uniformity suggested considering it as a chronofauna (Olson 1952). Kostopoulos (2009) questioned the uniformity of the fauna, highlighting differences in species diversity and biochronology of different sites. On the other hand, Mirzaie Ataabadi *et al.* (2013) applied the GFRI (Genus-level Faunal Resemblance Indices) to several sites, obtaining a resemblance degree higher than 50%. The Pikermian Biome appeared about 8.7 Ma ago and had its acme at about 7 Ma. Later, the biome disappeared at 5.3 Ma, probably for the increasing seasonality and climatic changes related to oceanic water circulation in the Northern Atlantic (Eronen *et al.* 2009; Kostopoulos 2009; Solounias, Rivals, and Semprebon 2010). Pikermian species are also reported out of the Greco Iranian Bioprovince, spanning from China to Spain, with scanty finds in Africa (Kurtén 1952; Eronen *et al.* 2009; Casanovas-Vilar *et al.* 2010; Bibi 2011). A different association of mammals was distributed in the Afro-Arabian area since 8 Ma ago. The two most representative sites are in the Baynunah Formation (Al Gharbia region, Abu Dhabi Emirate, United Arab Emirates), dated from 8.2 to 5.3 Ma ago (Whybrow and Hill 1999; Bibi *et al.* 2012, 2013), and at As Sahabi in Libya, dated around 6.7 Ma ago (R. L. Bernor and Rook 2008). Sites of Abu Dhabi released a rich mammal fauna, including

Hippopotamidae, Bovidae, Giraffidae, Suidae, Mustelidae, Felidae, Hyenidae, Equidae, Rhinocerontidae, Deinotheridae, Elephantidae Gomphotheridae, Cercopithecidae, Midae, Dipodidae, Thryonomidae, Sciuridae, and Soricidae (Bibi *et al.* 2013). In some sites of the region, carbonates deposited in marine and in brackish environments preserve the fossil footprints of proboscideans (*Stegotetrabelodon syrticus*) and ungulates. The palaeoenvironment at Al Gharbia was arid but crossed by a river system, probably near a marine gulf, as indicated by the record of sawfish which occasionally may have gone upriver. The plain of the late Miocene Al Gharbia can be assimilated to the modern desertic areas crossed by the Nile, while a late Miocene analogue is As Sahabi, where a river system was present (Bibi *et al.* 2013). Several mammal assemblages relatable to Afro-Arabian biomes come from the As Sahabi formation, in the Sirt Basin of Libya, including rodents (Sciuridae, Ctenodactylidae, Cricetidae, and Muridae), carnivores (Hyaenidae, Ursidae, Viverridae, Felidae and rare Canidae), proboscideans (Elephantidae represented by Stegotetrabelodon syrticus, Amebelodontidae, Gomphoteridae)and ungulates (Equidae, Anthracotheriidae, Suidae, Hippopotamidae, Giraffidae and Bovidae). Among marine vertebrates is remarkable the presence of *Metaxytherium serresii.* The sites are dated from 6.8 to 5.3 Ma (R. L. Bernor and Rook 2008; Boaz *et al.* 2008). Boaz (2009) provided a vivid reconstruction of the paleoenvironment of the river system: "*It is called the Eo-Sahabi River. The river was surrounded by many wild animals. Chattering birds, monkeys clambering in trees, and hippos basking in the sun lived along the river. On the open plains extending inland, there were herds of antelopes and three-toed horses, hyenas, sabertooth cats, pigs, and many other species*". Since 2003, a new Late Miocene mammal association was described in the area of Capo Vaticano - Monte Poro in southern Calabria (Southern Italy), including Pikermian and Afro-Arabian species, mainly found in the site of Cessaniti – Cava Gentile (Ferretti, Rook, and Torre 2003; Marra *et al.* 2011, 2017, Figure 4). The palaeogeographic reconstruction is still uncertain (Fig. 1), due to the complex geological and structural framework, but the mammal assemblage could be indicative of a land connection with North Africa. However, the exact position and extension of the Capo Vaticano – Monte Poro land in the Late Miocene is still unknown and its possible occurence area is indicated in Fig. 1. The Calabrian fauna did not contain endemic taxa, and relationships with the Tusco-Sardinian (TSB in Fig. 1) and Apulo-Abruzzi (AAB in Fig. 1) bioprovinces could be excluded, being these latter characterised by strongly endemic species and impoverished mammal associations due to a long persistence of insular conditions (Marra *et al.* 2017; Marra 2019). The insular conditions are not reported in Figure 1, where the two bioprovinces, TSB and AAP, appear connected, but are widely accepted based on the endemism of species. The Capo Vaticano - Monte Poro assemblage may be interpreted as a new bioprovince in the central Mediterranean (Marra *et al.* 2017; Marra 2019; Pandolfi *et al.* 2019). However, its possible relationships with the mammal assemblage from Gravitelli (Messina, Sicily) need further considerations and insights (Marra *et al.* 2017; Marra 2019; Iannucci 2024).

2. The land mammals of the Capo Vaticano - Monte Poro bioprovince

Upper Miocene successions widely outcrop in the Capo Vaticano - Monte Poro area (Vibo Valentia). The following four informal units and environments were recognised, from

FIGURE 3. The geographical position of the Capo Vaticano – Monte Poro area and related most relevant fossil sites.

bottom to top (Nicotera 1959; Gramigna *et al.* 2008; Caracciolo *et al.* 2013; Marra *et al.* 2017)

- Unit 1
  - subunit a (proximal depositional area) - Paralic dark clayish sandstones with *Ostrea* and *Cerithium*, alternating with coarse sandstones, attributed to lagoonal and flood–tidal–deltaic deposits;
  - subunit b (distal depositional area) - sandstones deposited in shallow waters;

  Transgressive ravinement surface
- Unit 2 - *"Clypeaster sandstones"*, attributed to shallow marine environment;
- Unit 3 - *"Heterostegina yellow sandstones"*, deposited in marine conditions;
- Unit 4 - *"Orbulina marls"*, deposited in a hemipelagic environment.

The succession exposed at the Cessaniti - Cava Gentile quarry recorded a marine transgression following more or less the modern coastline. During the deposition of Unit 1, a lagoonal environment formed at Cessaniti - Gentile quarry (subunit a), while a shallow sea formed in the area (subunit b). The most representative succession of Unit 2 released the main part of mammal fossils (Figure 4) (Guido *et al.* 2011). Soils and fluvial deposits in this unit (FL1 to FL3) indicated temporary falls in sea level, probably due to tectonic control (Marra *et al.* 2017). Unit 1 was correlated to a layer attributed to the normal Chron C4An (8.1–7.5 Ma), whereas the calcareous nannofossil assemblages present in the marls of Unit

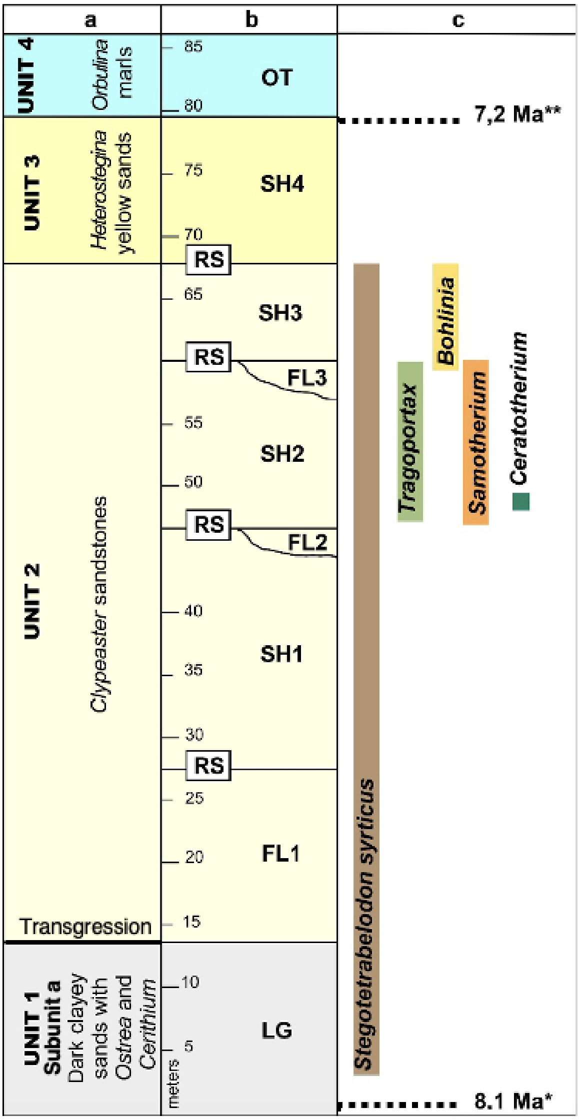

FIGURE 4. Stratigraphy of the Cessaniti - Cava Gentile quarry succession (Cessaniti): a) informal stratigraphy; b) stratigraphy according to Marra *et al.* (2017); c) land mammal taxa. Acronyms and symbols: LG: Lagoonal deposits, FL: fluvial deposits, SH: shoreface deposits, OT offshore transition; RS, Ravinement Surface; * dating for the attribution of LG to the Chron C4An; ** dating for the attribution of OT to the nannoplankton zone CNM17.

4 indicated a biozone (CNM17) attributed to the Tortonian/Messinian boundary, dated 7.2 Ma (Marra *et al.* 2017).

FIGURE 5. Graphic composition illustrating the land mammal assemblage in the landscape of the Cessaniti – Gentile quarry.

The main part of the fossil record found at Cessaniti was collected during quarry activities at Cava Gentile and exhibited in local Museums (Marra, Sudano, and Guido 2022; Marra 2023; Marra, Somma, and Guido 2023; Somma *et al.* 2023)

Land mammals released by Unit 2 were mainly collected and subordinately in correlatable sites (*i.e.* Zungri, Figure 3). The studied land mammal assemblage included *Stegotetrabelodon syrticus; Samotherium* cf. *boissieri; Bohlinia attica*; *Tragoportax* cf. *rugosifrons, Ceratotherium' advenientis*; an undetermined Antracotherid, an undetermined Hipparionine and a small bovid (Ferretti, Rook, and Torre 2003; Marra *et al.* 2011, 2017; Marra 2018, 2019, 2025) (Figure 5). Unit 2 also released a high number of fossils of the Sirenian *Metaxytherium serresii* and rare Cetaceans (Odontocetes: Physiteroidea indet.; Mysticetes: *Heterocetus* cf. *guiscardii*; Carone and Domning (2007), Carone, Domning, and Marra (2013), and Marra, Carone, Bianucci, *et al.* (2016)).

The primitive elephantoid *Stegotetrabelodon syrticus* is the only mammal present both in Unit 1 and Unit 2 (Ferretti, Rook, and Torre 2003; Ferretti *et al.* 2017) *Stegotetrabelodon* is represented by a single worn DP4 coming from the lagoonal unit (Unit 1, subunit a) and one mandible, one incisor, one fragmentary molar, two fragmentary humeri, one right II metacarpal and one incomplete femur, released by the shoreface sandstones (Unit 2, SH1 to SH3). The specimens from Cessaniti show some plesiomorphic characters recognised in the type material from As Sahabi in Libya ((Ferretti, Rook, and Torre 2003; Ferretti *et al.* 2017). Rhinocerontid remains come from SH2 at Gentile quarry and are represented by a fragmentary skull, two fragmentary teeth, and a few postcranial bones. Although initially referred to the genus *Diceros* (Marra *et al.* 2011), the specimens have been attributed to a new species, *'Cerathotherium' advenientis*, having African affinities (Pandolfi *et al.* 2019). The cladistic analysis placed *'Cerathotherium' advenientis* within Rhinocerotina and related it to the African genera *Diceros* and *Ceratotherium* (Pandolfi *et al.* 2019). Two mid-sized giraffids typical of the Pikermian fauna have been recovered at the Cessaniti-Gentile quarry and in the nearby territory of Zungri (Marra *et al.* 2011) (Figure 3). From the unit SH3 of Gentile quarry, an upper toothrow, a distal radius, two astragalii, two cubo-naviculars, and a distal tibia attributable to *Bohlinia attica* (Marra *et al.* 2011, 2017; Marra 2025) were recovered. In addition, layers outcropping at Zungri and correlatable to Unit 2-SH1 (Figure 4) released postcranial elements of *Samotherium* cf. *boissieri* while two metacarpals, two metatarsals and a distal tibia come from the Gentile quarry, SH2 unit). Both species were common in the Greco-Iranian bioprovince and more rarely in Africa. A hemimandible from Gentile quarry is attributable to *Tragoportax* cf. *rugosifrons* (Marra 2018). Postcranials of a boselaphine bovid coming from Unit 2 SH2-FL3 of the Gentile quarry (radius, astragalus and anterior phalanx) and from correlatable layers at Papaglionti (a locality near Cessaniti) (humerus, anterior phalanx, metatarsal, posterior phalanx), are tentatively attributed to *Tragoportax* cf. *rugosifrons* (Marra 2018). However, few remains of a small bovid are still undermined (Marra 2018). An incisor and a femur from Unit 2 SH2 at Cessaniti are still under study and can be attributed to an Anthracotherid rather than a hexaprotodontid hippopotamus, as previously considered (Ferretti, Rook, and Torre 2003; Marra *et al.* 2011, 2017). In addition, a fragmentary humerus attributable to a Hippariorine is still under restoration (Marra 2019).

3. Discussion

The proboscidean *Stegotetrabelodon syrticus* is a mammal usually distributed in the Afro-Arabian area. The finding of this taxon at Cessaniti represents the unique evidence known until now out of this area (Marra *et al.* 2011; Ferretti *et al.* 2017; Marra 2019). The biochronological constraints are very significant. The first three units studied at Cessaniti may be inferred to 8.1 and 7.2 Ma time span (Marra *et al.* 2017). The plesiomorphic characters concerning the type material from As Sahabi (Libya, Africa), dated 6.7 Ma (R. L. Bernor and Rook 2008) seem to confirm an earlier age for the specimens from Cessaniti. Sanders *et al.* (2010), dated 7.5-8 Ma the first appearence of the same species. However, the species was also recorded in the Baynunah Formation (Abu Dhabi, United Arab Emirates) from 8.2 to 5.3 Ma (Whybrow and Hill 1999; Bibi *et al.* 2012, 2013). The dating of Unit 1 in the Chron C4An (8.1–7.5 Ma) is coherent with the biochronological range of *Stegotetrabelodon syrticus*. It is worth noting that the occurrence since Unit 1 indicates a long persistence of the taxon in the area. In the Capo Vaticano - Monte Poro bioprovince, Pikermian guests are represented by Giraffids (Marra *et al.* 2011). *Bohlinia attica* was a species present in the western regions of the Greco-Iranian bioprovince, from the Tortonian to the Messinian (Geraads, Spassov, and Kovachev 2005; Kostopoulos 2009). The presence of *Bohlinia* sp. in the Late Miocene of Chad, Africa, is still dubitable (Geraads, Spassov, and Kovachev 2005). Also, *Samotherium boissieri* was a common species in the Greco-Iranian bioprovince, in some cases associated with *Bohlinia*, between 8.0 and 7.4 Ma. This species is not recorded in Africa, but few remains represent the genus at As Sahabi (Libya), Bou Hanifia (Algeria), and Nakali (Kenya; Figure 6) (Harris, Solounias, and Geraads 2010). The occurrence of two giraffids typical of the Pikermian biome can be the evidence of the expansion through North Africa of this peculiar mammalian community

FIGURE 6. Distribution of *Samotherium boissieri* (black square) and *Samotherium* sp. (black dot) in the Mediterranean area; the red cross indicates the location of Cessaniti.

during the Late Miocene (Solounias *et al.* 1999; Solounias, Rivals, and Semprebon 2010; Marra *et al.* 2011). From a palaeoecological point of view, data from mesowear and anatomy suggested that *Bohlinia attica* and *Samotherium boissieri* were browsers (Solounias et al., 2010). The scanty remains of a mid-sized bovid allowed only a tentative specific attribution to *Tragoportax* cf. *rugosifrons* (Marra 2018). Nevertheless, the presence at Cessaniti is significant, considering the wide distribution of the genus in Eurasia and Africa during Late Miocene (Kostopoulos 2009; Bibi 2011). The ecological niche of *Tragoportax* is comparable to that of the extant *Hippotragus*, a dweller of forest-savannah alternating with open spaces (Spassov and Geraads 2004) *Tragoportax rugosifrons* is considered a grazer (Spassov and Geraads 2004).

Some considerations about the stratigraphic distribution of the Sirenian *Metaxytherium* in the Capo Vaticano - Monte Poro area can help to reconstruct the biochronological framework. Two chronospecies on the lineage of the genus *Metaxytherium* have been recorded in the area (Moncharmont Zei and U 1987; Carone and Domning 2007; Sorbi 2008; Sorbi *et al.* 2012; Carone, Domning, and Marra 2013). The species *M. medium*, considered the ancestor of *M. serresii*, has been recorded at Santa Domenica di Ricadi, in Unit 1 subunit 1b. *M. medium* inhabited the shallow sea (subunit 1b) distally to Cessaniti-Gentile quarry, where a lagoonal environment was present. The derived species, *M. serresii*, is very common in Unit 2 throughout the Capo Vaticano - Monte Poro area. *M. serresi* shows ecophenotypic dwarfism probably due to a dietary adaptation to rhizomes rather than seagrasses consequent to an environmental crisis. At first, the environmental crisis was identified in Messinian Salinity Crisis, being the species spread in Pliocene. Later, the new dating of As Sahabi site, where the species is present at 6.7 Ma (R. L. Bernor and Rook 2008), and the new records at Cessaniti in a stratigraphic position under the Messinian beds, allowed the identification of the environment change as the effect of the Tortonian Salinity Crisis (TSC) occurred 7.8-7.3 Ma (Kouwenhoven, Hilgen, and Van der Zwaan 2003; Carone and Domning 2007; Carone, Domning, and Marra 2013). Moreover, specimens from Cessaniti have some plesiomorphic characters concerning the sample from As Sahabi (Carone and Domning 2007). In the hypothesis that *M. serresii* evolved during the TSC, Unit 2 could have formed in a very short time span, comprised between 7.8 and 7.3 Ma (timing of the TSC) and before the deposition of Unit 3, capped by Unit 4, dated Messinian (7.2 Ma). The impressive thickness of the layers of Unit 2 may have been due to a deposition in a short time under the combined effect of tectonic (uplift possibly testified by the RSs and FL1-3, Fig. 4) and marine transgression. The extent in time and space of this Calabrian bioprovince needs more in-depth studies and geological field surveys. Indeed, the bioprovince had no relationships with the insular bioprovinces of the Tusco-Sardinian and Apulo-Abruzzi and Tyrrhenian areas, characterized by strongly endemic taxa and impoverished faunal association (Marra 2019). The possible relationships with the mammal assemblage from the Sicilian site of Gravitelli (Messina, Sicily) are still pending. The two assemblages have only the genus *Ceratotherium* in common, but have been tentatively considered part of the same bioprovince for the non-endemic character of their faunas and for their proximity (Gallai, Rook, *et al.* 2006; Rook, Gallai, and Torre 2006; Marra *et al.* 2011, 2017; Marra 2019). However, data from Gravitelli are incomplete. The land mammal assemblage is known in the literature thanks to the research of Luigi Seguenza (Seguenza 1902, 1907), which emphasised similarities of the fauna with Pikermi's and Samo's species. Original fossils studied by Seguenza, unfortunately, went lost during the 1908 earthquake that devasted the city of Messina. Moreover, new research on the original site is not possible nowadays for the occurred intense urbanisation. The faunal assemblage, updated by modern studies carried on museum casts and figures by Seguenza, consisted of: *Mesopithecus* sp., Metailurini indet., *Hyaenictitherium hyaenoides, Plioviverrops orbignyi, Zygolophodon turicensis, Ceratotherium* sp., Bovidae indet., *Hexaprotodon? siculus,* and *Propotamochoerus provincialis* (Kotsakis, Barisone, and Rook 1997; Rook 1999; Van der Made 1999; Gallai, Rook, *et al.* 2006; Rook, Gallai, and Torre 2006; Martino *et al.* 2021; Iannucci 2024). Despite some authors considered an older age, the site has been attributed to the Messinian. Recently, Iannucci (2024) re-considered the stratigraphy provided by Seguenza and tentatively attributed the mammal association to an age older than 7 million years, putting the site closer for age to Cessaniti. The chronological distributions of the identified species do not help in better define the time span (Iannucci 2024). The mammal assemblage of Gravitelli have European affinity with maybe only one African element, the new species *Hexaprotodon? siculus.* Iannucci (2024) excluded that Gravitelli and Cessaniti could have been part of a larger bio-province, for their differences in composition and for the African affinity of the Calabrian assemblage. Certainly, the two assemblages have in common only *Ceratotherium.* However, the Cessaniti assemblage has mixed African and Eurasian affinities, and does include European mammals of the Pikermian biome. The mammal association probably represents a precise time, between 8.1 and 7.2 Ma, when the Greco-Iranian mammals moved westwards through North Africa under climatic control (Marra *et al.* 2011, 2017; Marra 2019). Given that the "European" taxa of Gravitelli also were widespread in East Europe, why not consider the possibility of their spreading westwards through North Africa? The possibility that mammals spread westward to a Calabro-Sicilian land via North Africa in a comparable time span cannot be excluded. The different faunal composition of the two sites can be the result of heterochronic spread or can be affected by climatic conditions that have favoured the expansion of the Pikermian biome recorded at Cessaniti and – earlier or later – of the Gravitelli association. In addition, different environmental conditions could have been occurred in the two sites. Spreading from eastern Europe are not substained by paleogeographical evidence. As is evident, the relationships between Cessaniti and Gravitelli are not clear and need further research.

4. Conclusions

The peculiar composition of the Cessaniti fauna allows ascribing the fossil assemblage to a third bioprovince in the central Mediterranean, clearly different from the Tusco-Sardinia and the Apulo-Abruzzi bioprovinces, characterised by marked insularity. The composition of the Capo Vaticano - Monte Poro bioprovince was related to climate change and complex palaeogeographic and tectonic evolution. In the absence of detailed paleogeographic reconstructions, the Cessaniti fossil assemblage could be a key element in identifying a land continuity with North Africa. Mammals did not evolve endemic characters and were found in a transgressive succession, so isolation and arrival during a sea low stand can be excluded. This could mean that the Capo Vaticano - Monte Poro area was connected to North Africa through a land connection between 8 and 7.2 Ma, receiving African mammals and some Pikermian ones, due to the expansion of the association driven by climatic change. The dietary categories of Giraffids (browsers) and *Tragoportax* (grazers) are consistent with a mosaic environment with wooded areas alternated with an open environment. This reconstruction is also coherent with the presence of *Stegotetrabelodon* and *Ceratotherium*. The possible territorial extension of the Capo Vaticano - Monte Poro bioprovince in Calabria and Sicily is still under study.

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