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The Italian record of latest Miocene continental vertebrates

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ABSTRACT - The present paper provides an overview on the latest Miocene Italian continental vertebrate fossil record, with special emphasis on the faunal turnovers and their paleogeographic significance. The Italian Miocene fossil record of terrestrial vertebrates is relatively poor. It increases only with the latest Miocene. The pre-Messinian Late Miocene land vertebrate localities of Italy belong to three distinct bioprovinces. Two of them are characterised by faunas with manifestly endemic features, attesting to the occurrence of isolated emerged areas (the Abruzzi-Apulia and the Tusco-Sardinian paleobioprovinces). The third paleobioprovince is testified by sites in Calabria and Sicily and is characterised by non-endemized mammals, counterparts of which were identified both in North Africa and Europe. By the Messinian, the Italian continental vertebrate record shows that the region underwent a major paleobiogeographic reorganization.

RIASSUNTO - [I vertebrati continentali del tardo Miocene in Italia] - *Questo lavoro presenta una sintesi del record fossile dei vertebrati continentali del Miocene superiore d'Italia. Il record fossile dei vertebrati continentali durante il Miocene in Italia è relativamente scarso ed aumenta di importanza solamente nel Miocene terminale. Le località a vertebrati del Miocene superiore pre-Messiniano identificano l'esistenza di tre bioprovincie distinte; due hanno caratteri endemici ed attestano la presenza di aree emerse isolate dal resto delle masse continentali (rispettivamente le bioprovincie Apulo-Abruzzese e quella Tosco-Sarda). La terza bioprovincia è identificata grazie a siti fossiliferi della Calabria e della Sicilia ed è caratterizzata dalla presenza di mammiferi non-endemici di affinità sia nordafricana che europea.*

Nelle località della bioprovincia Apulo-Abruzzese gli artiodattili sono ampiamente rappresentati, e documentano l'esistenza di diversi morfotipi, tutti riconducibili agli hoplitomerycidi, una peculiare famiglia che mostra una combinazione di caratteri tipici dei cervidi, giraffidi e dei bovidi, unitamente a caratteri del tutto autoapomorfi. Le caratteristiche di questi artiodattili indicano l'esistenza di accessi dal continente europeo attraverso connessioni con forte effetto filtrante, permettendo il passaggio di pochi ceppi animali, i quali, una volta stanziati nella variegata area apulo-abruzzese, si endemizzarono, dando vita ad una varietà di forme diverse, ma strettamente imparentate fra loro.

Le località a vertebrati del Miocene superiore della paleobioprovincia Tosco-Sarda sono note per la presenza del primate ominoide endemico Oreopithecus bambolii. *Le caratteristiche peculiari di questo ominide lo hanno posto al centro dell'attenzione della comunità scientifica sia per le sue affinità tassonomiche sia per le interpretazioni sui suoi adattamenti locomotori e funzionali.*

Nel Messiniano il panorama cambia profondamente; la penisola italiana prende forma, e le biocomunità terrestri del Tortoniano scompaiono sostituite da associazioni di specie del continente europeo. Il Messiniano è un momento di profonda riorganizzazione nella paleogeografia dell'area tirrenica. Dal punto di vista delle faune continentali questo intervallo di tempo è caratterizzato da un turnover totale. Le nuove comunità hanno lasciato testimonianze in Piemonte, Toscana e in Romagna. Sebbene ridotta, permane la provincia Apulo-abruzzese, con l'area garganica e le Murge rimaste ancora separate dal neo-Appennino, mantenendo così la fauna endemica del tempo precedente ma arricchita dall'arrivo di alcuni micromammiferi che subito sono andati incontro a processi di endemizzazione.

FOREWORD

The Late Miocene land mammals localities of Italy document the existence of three distinct bioprovinces (Torre et al., 2000; Rook et al., 2006b). Two of them are characterised by vertebrate faunas with strongly endemic features, attesting to the occurrence of isolated emerged areas. One is the so-called Abruzzi-Apulia paleobioprovince and 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 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, at least in part, a northern extension of the Late Miocene Mediterranean border of the African plate.

THE LATE MIOCENE APULO-ABRUZZI AREA

The Apulo-Abruzzi bioprovince is first documented by the land vertebrate endemic fauna from the Early Tortonian of Scontrone at the southern border of the Abruzzi National Park (Rustioni et al., 1993). At this site, the artiodactyls are 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 Gargano (Leinders, 1983). These taxa have no correspondence with any other presently known artiodactyls; 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 (Mazza & Rustioni, 1996).

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Shortly after the Scontrone document, the Abruzzi portion of this bioprovince was apparently involved in the orogenetic disruptions which caused the uplift of the central and southern part of the Apennine Mts. Being still part of the foreland, the Gargano-Murge portion was maintained as a structural high which remained emerged until the Early Pliocene, allowing the survival of its typical endemic elements (Abbazzi et al., 1996, and bibliography therein). *Deinogalerix* and *Mikrotia* are the most significant components of the Gargano endemic assemblages (Freudenthal, 1971, 2006; Abbazzi et al., 1993). A peculiar occurrence is the recently identification of the African genus *Crocodylus* in the endemic complex of Gargano "Terre Rosse" assemblages (Delfino et al., 2007).

Since murids are not known before the early Tortonian, the *Mikrotia* ancestor cannot have possibly reached the Apulian area earlier. Given that the most primitive known *Mikrotia* specimens from Gargano are already endemic (hypsodont cheek teeth, high number 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-Murge area possibly occurred during the Messinian. This seems consistent with the fact that the highly endemic *Mikrotia* is associated with the non-endemic *Apodemus* and *Eliomys*, two genera unknown in pre-Messinian deposits of Europe (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 (De Giuli et al., 1987a, b). 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.

THE LATEST MIOCENE TUSCO-SARDINAN AREA

The Late Miocene faunal succession of the Tusco-Sardinian area has been known for a long time in the literature (cfr. Rook et al., 1999). The best faunal succession for the history of this paleobioprovince is provided by the geologic record of the Baccinello-Cinigiano basin in the Grosseto district. The succession of faunal assemblages in this basin has been the basis for hypotheses on the paleobiogeographic evolution not only of this limited area, but of the whole Tyrrhenian region during the Late Miocene times (Benvenuti et al., 1995, 2001). Three successive faunal assemblages recovered from the Baccinello-Cinigiano basin 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. 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*, is recorded in latest Miocene sediments at Fiume Santo, in Northern Sardinia (Cordy & Ginesu, 1994; Rook et al., 2006a; Abbazzi et al., 2008). All of 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 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 Baccinello-Cinigiano basin occurred during the Tortonian when differential subsidence was affecting a wide area between the SW Alps and the Northern Apennines.

A tephra layer within the Baccinello-Cinigiano succession has provided a crucial opportunity to improve the chronology of the *O. bambolii* bearing sediments (Rook et al., 2000). 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 biochronologically based estimates. *Oreopithecus bambolii* is one of the few European hominoid who survived the Vallesian-Turolian boundary for long (Rook et al., 2000; Bernor et al., 2004). 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 (like *Eumaiochoerus etruscus* or *Parapodemus* sp.) 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 (Rook et al., 2006a; Abbazzi et al., 2008).

THE LATEST MIOCENE OF CALABRIA-SICILY AREA

Evidence for a connection of the Calabria-Peloritan arch with North Africa is represented by a *Stegotetrabelodon syrticus* mandible (Ferretti et al., 2003) found in the upper Tortonian-lower Messinian *Clypeaster*-rich sands outcropping at Cessaniti, near Vibo Valentia in Calabria (Ogniben, 1973; Papazzoni & Sirotti, 1999). In addition to a number of sirenian remains attributable to the genus *Metaxytherium* (Carone & Domning, 2007), other mammal specimens have been recovered from the outcrops of the Cessaniti-Zungri basin. These, still unpublished, include a tragocerine bovid, a fragmentary skull of "*Diceros*" *primaevus*, a medium sized giraffe tentatively referred to *Samotherium*? sp., and a single isolated tooth of a hexaprotodont hippopotamid. 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 (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 Gravitelli fossils were destroyed during the 1911 Messina earthquake, and information on this fauna can only be drawn from descriptions and illustrations offered by Seguenza (1902, 1907). Casts of the suid from Gravitelli have recently been found in the collections of the University of Florence Natural History Museum (Geology and Palaeontology section). These allow a secure attribution of the Gravitelli suid to the genus *Propotamochoerus*, and hence a European affinity for at least this taxon (Gallai & Rook, 2006).

THE MESSINIAN CONTINENTAL VERTEBRATES OF ITALY

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 Baccinello-Cinigiano Basin disappeared and were replaced by a new faunal assemblage (Baccinello V3) including continental taxa with clear European affinities (Hürzeler & Engesser, 1976; Rook et al., 1991; Rook, 1999; Abbazzi, 2001; Rook & Martínez-Navarro, 2004). The V3 assemblage points to renewed and definitive paleobiogeographical connection with Europe. A peculiar characteristic of this turnover is in the different pattern shown by mammals and herpetofauna (chelonians). The latter assemblage, in fact, does not show the same turnover pattern of mammalian genera, but persists across the faunal assemblages (Chesi et al., in press).

The European fauna penetrated into the northern Apennine throughout Piedmont and Romagna (Ciabot Cagna and Brisighella faunal assemblages; De Giuli et al., 1988; Cavallo et al., 1993; Rook & Delfino, 2004) and dispersed down to southern Tuscany as testified by the findings from Fine Valley, Casino, Velona and Baccinello V3 (Kotsakis et al., 1997; Rook & Ghetti, 1997; Benvenuti et al., 2001; Ghetti et al., 2002; Rook et al., 2005; Abbazzi et al., in press). 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 (Martini & Sagri, 1993). 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.

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 strongly endemic features, supporting paleogeographic models where these are seen as being isolated, emerged terrestrial 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 bioprovince, represented by sites in Calabria and Sicily, is characterised by non-endemic mammal faunas, 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 earlier times of the Italian continental Neogene record.

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REFERENCES

Abbazzi L. (2001). Cervidae and Moschidae (Mammalia, Artiodactyla) from the Baccinello V3 faunal assemblage (Late Miocene, Late Turolian, Grosseto, Central Italy). *Rivista Italiana di Paleontologia e Stratigrafia*, 107: 10-123.

Abbazzi L., Benvenuti M., Boschian G., Dominici S., Masini F., Mezzabotta C., Piccini L., Rook L., Valleri G. & Torre D. (1996). Revision of the Neogene and Pleistocene of the Gargano region (Apulia, Italy). The marine and continental successions and the mammal faunal assemblages in an area between Apricena and Poggio Imperiale (Foggia). *Memorie della Società Geologica Italiana*, 51: 383-402.

Abbazzi L., Benvenuti M., Ceci M.E., Esu D., Faranda C., Rook L. & Tangocci F. (in press). The Mio-Pliocene transition in the SE Valdelsa Basin (Central Italy): interference between tectonism and sea-level rise on palaeoenvironmental change. *Geodiversitas*.

Abbazzi L., Delfino M., Gallai G., Trebini L. & Rook L. (2008). New data on the vertebrate assemblage of Fiume Santo (North-west Sardinia, Italy), and overview on the Late Miocene Tusco-sardinian palaeobioprovince. *Palaeontology*, 51: 425-451.

Abbazzi L., Masini F. & Torre D. (1993). Evolutionary patterns in the first lower molar of the endemic murid *Microtia*. *Quaternary International*, 19: 63-70.

Benvenuti M., Bertini A. & Rook L. (1995). Facies analysis, vertebrate paleontology and palynology in the Late Miocene Baccinello-Cinigiano basin (Southern Tuscany). *Memorie della Società Geologica Italiana*, 48: 415-423.

Benvenuti M., Papini M. & Rook L. (2001). Mammal biochronology, UBSU and paleoenvironment evolution in a post-collisional basin: evidence from the Late Miocene Baccinello-Cinigiano basin in southern Tuscany, Italy. *Bollettino della Società Geologica Italiana*, 120: 97-118.

Bernor R.L., Fortelius M. & Rook L. (2001). Evolutionary biogeography and paleoecology of the "*Oreopithecus bambolii* Faunal Zone" (Late Miocene, Tusco-Sardinian Province). *Bollettino della Società Paleontologica Italiana*, 40: 139-148.

Bernor R.L., Kordos L., Rook L., Agustí J., Andrews P., Armour-Chelou M., Begun D., Cameron D., Daxner-Höck G., De Bonis

L., Ekart G., Feijfar O., Fessah N., Fortelius M., Franzen J., Gasparik M., Gentry A., Heissig K., Herniak G., Kaiser T., Koufos G.D., Krolopp E., Janossy D., Llenas M., Meszáros L., Muller P., Renne P., Roček Z., Sen S., Scott R., Szindlar Z., Theobald G., Topal G., Werdelin L., Ungar P. & Ziegler R. (2004). Recent Advances on Multidisciplinary Research at Rudabánya Late Miocene (MN9), Hungary: a compendium. *Palaeontographia Italica*, 89: 3-36.

Carone G. & Domning D.P. (2007). *Metaxytherium serresii* (Mammalia: Sirenia): new pre-Pliocene record, and implications for Mediterranean paleoecology before and after the Messinian Salinity Crisis. *Bollettino della Società Paleontologica Italiana*, 46 (1): 55-92.

Cavallo O., Sen S., Rage J.C. & Gaudant J. (1993). Vertébrés messiniens du Faciès à Congéries de Ciabòt Cagna, Corneliano d'Alba (Piémont, Italie). *Rivista Piemontese di Storia Naturale*, 14: 3-22.

Chesi F., Delfino M. & Rook L. (in press). Late Miocene *Mauremys* (Testudines, Geoemydidae) from Tuscany (Italy): evidence of terrapin persistence after a mammal turnover. *Journal of Paleontology.*

Cordy J.M. & Ginesu S. (1994). Fiume Santo (Sassari, Sardeigne, Italie): un nouveau gisement à Orèopithèque (Orepithecidae, Primates, Mammalia). *Comptes Rendus de l'Académie des Sciences de Paris*, sér. II, 318: 679-704.

De Giuli C., Masini F., Torre D., Benericetti A., Costa G.P., Fosella M. & Sami M. (1988). The mammal fauna of the Monticino quarry. *In* De Giuli C. & Vai G.B. (eds.), Guide Book of the Workshop "Continental Faunas at the Mio-Pliocene Boundary", Faenza: 65-69.

De Giuli C., Masini F., Torre D. & Valleri G. (1987a). Mammal migrations events in the emerged areas of the Apulian platform during the Neogene. *Giornale di Geologia*, ser. 3, 48 (1/2): 145-162.

De Giuli C., Masini F. & Valleri G. (1987b). Paleogeographic evolution of the Adriatic area since Oligocene to Pleistocene. *Rivista Italiana di Paleontologia e Stratigrafia*, 93: 109-126.

Delfino M., Böhme M. & Rook L. (2007). First European evidence for transcontinental dispersal of *Crocodylus* (late Neogene of Southern Italy). *Zoological Journal of the Linnean Society of London*, 149: 293-307.

Engesser B. (1989). The Late Tertiary small mammals of the Maremma region (Tuscany, Italy): II Part. Muridae and Cricetidae (Rodentia, Mammalia). *Bollettino della Società Paleontologica Italiana*, 29: 227-252.

Ferretti M.P., Rook L. & Torre D. (2003). *Stegotetrabelodon* cf. *syrticus* (Proboscidea, Elephantidae) from the Upper Miocene of Cessaniti (Calabria, southern Italy) and its bearing on Late Miocene paleogeography of central Mediterranean. *Journal of Vertebrate Paleontology*, 23: 659-666.

Foresi L., Pascucci V. & Sandrelli F. (1997). Sedimentary and ichnofacies analysis of the epiligurian Ponsano Sandstone (northern Apennine, Tuscany, Italy). *Giornale di Geologia*, 59: 301-314.

Freudenthal M. (1971). Neogene vertebrates from the Gargano peninsula, Italy. *Scripta Geologica*, 3: 1-10.

Freudenthal M. (2006). *Mikrotia* nomen novum for *Microtia* Freudenthal 1976 (Mammalia, Rodentia). *Journal of Vertebrate Paleontology*, 26 (3): 784.

Gallai G. & Rook L. (2006). *Propotamochoerus* sp. (Suidae, Mammalia) from the Late Miocene of Gravitelli (Messina, Sicily, Italy) rediscovered. *Rivista Italiana di Paleontologia e Stratigrafia*, 112: 317-321.

Ghetti P., Anadón P., Bertini A., Esu D., Gliozzi E., Rook L. & Soulié-Marsche I. (2002). The early Messinian Velona basin (Siena, central Italy): palaeoenvironmental and palaeobiogeographical reconstructions. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 187: 1-33.

Hürzeler J. & Engesser B. (1976). Les faunes de mammifères néogènes du Bassin de Baccinello (Grosseto, Italie). *Comptes Rendus de l'Academie des Sciences de Paris*, sér. II, 283: 333-336.

Kotsakis T., Barisone G. & Rook L. (1997). Mammalian biochronology in an insular domain: the Italian Tertiary faunas. *Mémoires et Travaux de l'Institut de Montpellier de l'École Pratique des Hautes Études*, 21: 431-441.

Leinders J. (1983). Hoplitomericidae fam. Nov. (Ruminantia, Mammalia) from Neogene fissure fillings in Gargano (Italy): Part 1. The cranial osteology of *Hoplitomerix* gen. nov. and a discussion on the classification of pecoran families. *Scripta Geologica*, 70: 1-68.

Martini I.P. & Sagri M. (1993). Tectono-sedimentary characteristics of Late Miocene-Quaternary extensional basins of the Northern Apennines, Italy. *Earth Science Review*, 34: 197-233.

Mazza P. & Rustioni M. (1996). The Turolian fossil artiodactyls from Scontrone (Abruzzi, Central Italy). *Bollettino della Società Paleontologica Italiana*, 35: 93-106.

Ogniben L. (1973). Schema geologico della Calabria in base ai dati odierni. *Geologica Romana*, 12: 243-585.

Papazzoni C.A. & Sirotti A. (1999). *Heterostegina papyracea* Seguenza, 1880 from the upper Miocene of Cessaniti (Vibo Valentia, Calabria, southern Italy). *Bollettino della Società Paleontologica Italiana*, 38: 15-21.

Rook L. (1999). Late Turolian *Mesopithecus* (Mammalia, Primates, Colobinae) from Italy. *Journal of Human Evolution*, 36: 535-547.

Rook L., Abbazzi L. & Delfino M. (2005). Il Miocene: Le associazioni a vertebrati continentali del Messiniano. *In* Bonfiglio L. (ed.), Paleontologia dei vertebrati in Italia: evoluzione biologica, significato ambientale e paleogeografia. *Memorie del Museo Civico di Storia Naturale di Verona, ser. 2, Sezione Scienze della Terra*, 6: 163-165.

Rook L., Abbazzi L., Delfino M., Gallai G. & Trebini L. (2006a). Il giacimento paleontologico di Fiume Santo. Stato delle ricerche e prospettive a dieci anni dalla scoperta. *Sardinia Corsica et Baleares Antiqvae - International Journal*, 4: 9-17.

Rook L., Abbazzi L. & Engesser B. (1999). An overview on the Italian Miocene land mammal faunas. *In* Agustí J., Rook L. & Andrews P. (eds.), The Evolution of Neogene Terrestrial Ecosystems in Europe. Cambridge University Press: 191-204.

Rook L. & Delfino M. (2004). I vertebrati fossili di Brisighella nel quadro dei popolamenti continentali del Mediterraneo durante il Neogene. *Ravenna Studi e Ricerche*, 10/1(2003): 179-207.

Rook L., Ficcarelli G. & Torre D. (1991). Messinian carnivores from Italy, *Bollettino della Società Paleontologica Italiana*, 30: 7-22.

Rook L., Gallai G. & Torre D. (2006b). Lands and endemic mammals in the Late Miocene of Italy: constrains for paleogeographic outlines of Tyrrhenian area. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 238: 263-269.

Rook L. & Ghetti P. (1997). Il bacino neogenico della Velona (Toscana, Italia): stratigrafia e primi ritrovamenti di vertebrati fossili. *Bollettino della Società Geologica Italiana*, 116: 335-346.

Rook L., Harrison T. & Engesser B. (1996). The taxonomic status and biochronological implications of new finds of *Oreopithecus* from Baccinello. *Journal of Human Evolution*, 30: 3-27.

Rook L. & Martínez Navarro B. (2004). *Viverra howelli* n. sp., a new viverrid (Carnivora, Mammalia) from the Baccinello-Cinigiano basin (latest Miocene, Italy). *Rivista Italiana Paleontologia e Stratigrafia*, 110: 719-723.

Rook L., Renne P., Benvenuti M. & Papini M. (2000). Geochronology of *Oreopithecus*-bearing succession at Baccinello (Italy) and the extinction pattern of European Miocene hominoids. *Journal of Human Evolution*, 39: 577-582.

Rustioni M., Mazza P., Azzaroli A., Boscagli G., Cozzini F., Di Vito E., Masseti M. & Pisanò A. (1993). Miocene vertebrate remains from Scontrone, National Park of Abruzzi, central Italy. *Rendiconti Lincei Scienze Fisiche e Naturali*, ser. 9, 3: 227-237.

Seguenza L. (1902). I vertebrati fossili della provincia di Messina: Parte II. Mammiferi e geologia del piano Pontico. *Bollettino della Società Geologica Italiana*, 21: 115-172.

Seguenza L. (1907). Nuovi resti di mammiferi fossili di Gravitelli presso Messina. *Bollettino della Società Geologica Italiana*, 26: 7-119.

Torre D., Abbazzi L., Delfino M., Fanfani F., Ferretti M.P., Ficcarelli G., Mazza P., Rustioni M. & Rook L. (2000). Mammal palaeobioprovinces in the Italian Miocene. 11th RCMNS Congress. Abstract book: 43, Fez.

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