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Orycteropus cf. *gaudryi* (Mammalia, Tubulidentata) from the Late Messinian of the Monticino Quarry (Faenza, Italy)

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ABSTRACT – Aardvark remains from the late Messinian deposits of Monticino Gypsum Quarry (Brisighella, Faenza) are described and referred to Orycteropus *cf.* gaudryi. *These finds represent the westernmost known record of Tubulidentata in the Late Miocene of Eurasia. Although very rare as a fossil,* Orycteropus *was a widespread taxon in the Mio-Pliocene of Eurasia at mediterranean latitudes.*

RIASSUNTO – [*Orycteropus* cf. *gaudryi* (Mammalia, Tubulidentata) dal Messiniano terminale della cava di gesso del Monticino (Faenza, Italia)] – *I resti fossili di oritteropo raccolti nella cava Monticino (Brisighella, Faenza) vengono attribuiti a* Orycteropus *cf.* gaudryi. *Questi reperti rappresentano la segnalazione più occidentale di questa forma in Eurasia durante il Miocene superiore.* Orycteropus, *pur essendo un taxon estremamente raro, ha avuto un areale di distribuzione abbastanza ampio alle latitudini mediterranee durante il Mio-Pliocene.*

FOREWORD

A late Messinian vertebrate fauna (MN 13 mammal zone) has been collected in the fissure fillings of the Monticino Quarry, near Brisighella (Faenza, Central Italy), since 1985 (Costa *et al.*, 1986). The exposed succession is composed, at the base, of a series of tilted gypsum layers with interbedded clays of the early Messinian Gessoso-Solfifera Formation. The gypsum was affected by moderate erosion and by a karst dissolution cycle that took place following the tilting of the strata, not far from the present setting, as is suggested by morphological evidence. The deposits that infill the net of fissures intersecting the gypsum and the depressions ont the upper surface of the gypsum sequence consist of marly-clays, fine-grained conglomerates and sand lenses derived from the Colombacci Formation (grey pelites and variegated marly clays with whitish to yellow thin evaporitic marly limestone; latest Messinian). They contain partially articulated and fragmented skeletons of large mammals, and very abundant micromammal remains. Up to now 29 fossiliferous collecting points have been explored, some of which represent successive sampling of the same fissure that were brought to light by the progress of the quarrying activity. Several taxa have been the object of systematic studies; references and an updated faunal list can be found in Masini & Rook (1993). The Gessoso-Solfifera Formation is unconformably overlain by a thin discontinuous layer of greenish to blackish clay (0 to 1 m thick) that is considered equivalent to the later depositional phases of the Colombacci Formation and is attributed to the Late Messinian. The succession is capped by up to 20 m of Early Pliocene marine gray marly clays (Argille Azzurre Formation) whose base falls in the *Sphaeroidinellopsis* Zone, and which overlie, with apparent conformity, the Colombacci Formation. We refer the reader to Vai (1989) for a more complete discussion of the geological setting of the Romagna Apennine, and to Marabini & Vai (1989) for further details on the geology of the Monticino Quarry.

In the faunal list of Monticino Quarry given by De Giuli *et al.* (1988) *Orycteropus* sp. was reported on the basis of a single molar and a few postcranial bones; some more specimens have been collected since then. These finds are noteworthy as an additional record of a very rare fossil form, and also because they represent the western-most record of Tubulidentata in the late Miocene of Eurasia known to date.

SYSTEMATICS

Order Tubulidentata Huxley, 1872
Family Orycteropodidae Bonaparte, 1850
Genus Orycteropus Geoffroy, 1795
Orycteropus cf. gaudryi Forsyth-Major, 1888
Pl. 1, figs. 1-9

Material – Left M1/ [BRS27/51 (Pl. 1, fig. 1)]; left M3/ [BRS27/50 (Pl. 1, fig. 3)]; right M/2 [BRS5/69 (Pl. 1, fig. 2)]; left and right astragalus [BRS5/141 (Pl.

1, fig. 8); BRS5/142]; left and right calcaneum [BRS5/2; BRS5/58 (Pl. 1, fig. 7)]; four phalanx I, manus [BRS5/81 (Pl. 1, fig. 5); BRS5/214; BRS5/215; BRS4/2]; distal fragment of phalanx I, pes (BRS25/22); two phalanx II [BRS5/216 (Pl. 1, fig. 6); BRS27/22]; right metatarsal I [BRS5/43 (Pl. 1, fig. 4)]; two left trapezia [BRS5bis/5; BRS5/290 (Pl. 1, fig. 9)].

Description and comparisons – The specimens are well preserved. In occlusal outline the M1/ (BRS27/51) is eight-shaped while the M3/ (BRS27/50) is weakly bilobed. The lower M1 (BRS5/69) is bilobed. The molars show the typical wear surface of Tubulidentata; the tubular structure is clearly visible in all specimens.

The astragalus (BRS5/141-142) shows the characteristic morphology typical of the genus, such as the presence of an astragalar foramen and the ball-like navicular articulation. The astragalus and calcaneum are smaller and more slender than those of the living species, *O. afer*.

Metatarsal I (BRS5/43) has, on its proximal end, a large articulation for the trapezium, while the articular facet for Metatarsal II is broken; the diaphysis is slender, as are the phalanges (Pl. 1, figs. 4-5; Tab. 1).

The size and morphology of teeth and postcranial bones of the aardvark from Monticino Gypsum Quarry are fully comparable with the remains of *Orycteropus gaudryi* Forsyth Major 1888 from the Island of Samos (MN 12; Greece), which are stored at the American Museum of Natural History (New York), and which were described by Colbert (1941). The general proportions of the skeleton of *O. gaudryi* are fairly similar to those of the living *Orycteropus afer* Pallas 1766. However, the postcranial bones of this Turolian species from Italy are more slender. With respect to all the known fossil species of the genus, the living *O. afer* is the largest overall and, in particular, has a relatively larger forelimb, which may be indicative of a more developed digging adaptation.

Orycteropus mauritanicus from Oued El Hammam (Vallesian; Algeria) is represented by a fragmentary skull and mandible, and some postcranial bones. Its facial region appears to have been longer relative to the braincase than that of *O. gaudryi*. It is distinctly larger in size with respect to the latter species and to the Monticino specimens, and has a rather narrow astragalus characterized by a neck that is relatively longer than those of other fossil *Orycteropus* in which this bone is known.

Unfortunately, the Monticino material cannot be compared directely with *O. depereti* from Perpignan (MN 15), because the latter is represented only by the type skull. *O. depereti* is comparable in size with *O. mauritanicus*, while it agrees with *O. gaudryi* in rostral length and width, and in the nearly vertical occiput (cf. Patterson, 1978).

Since the most significant diagnostic features of the species mentioned rely on the morphology of skull and mandible, the Monticino aardvark is not unequivocably attributable to anyone of them. However, because of its age and the similarities mentioned, *i.e.* its overall size and the slenderness of its postcranial skeletal elements, we attribute the Monticino material to *Orycteropus* cf. *gaudryi*.

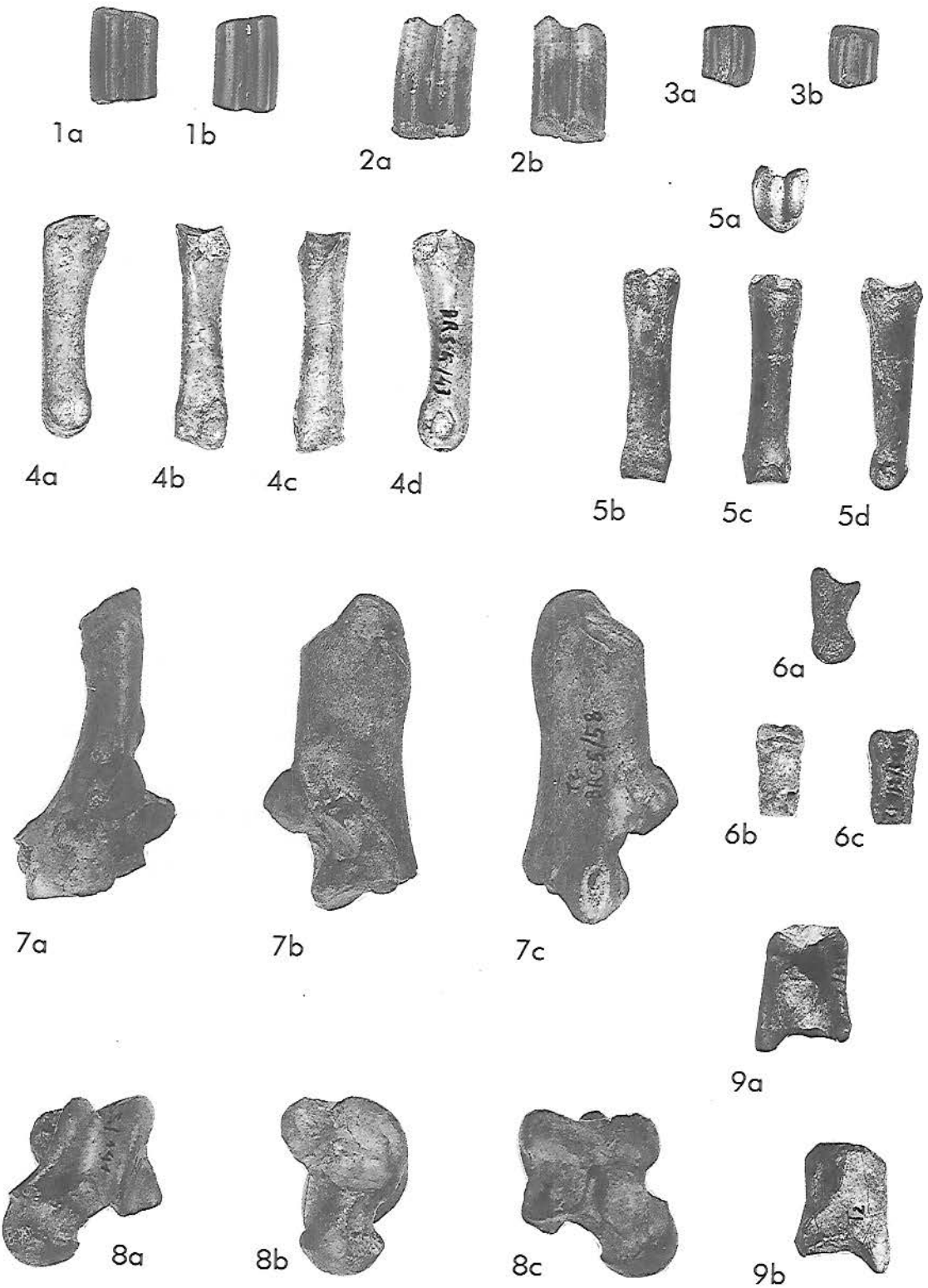
Discussion – The extant aardvark is the representative of a family that is now restricted to the single species *Orycteropus afer*, which inhabits Africa south of the Sahara. However, more diversified representatives of the Orycteropodidae were widespread in Africa, and dispersed northwards and eastwards in Mio-Pliocene times. Aardvarks have also been recorded from middle Miocene to Pliocene deposits of Europe, Caucasus, Asia Minor and Pakistan.

Following the systematic revision of the family

EXPLANATION OF PLATE 1

Figs. 1-9 - *Orycteropus* cf. *gaudryi* from Monticino Gypsum Quarry.
1) Left M1/ BRS27/51 - a) labial, b) lingual views;
2) right M/2 BRS5/6 - a) labial, b) lingual views;
3) left M3/ BRS27/50 - a) labial, b) lingual views;
4) right metatarsal BRS5/43 - a) medial, b) palmar, c) dorsal, d) lateral views;
5) phalanx I manus BRS5/81 - a) proximal, b) palmar, c) dorsal, d) lateral views;
6) phalanx II BRS5/216 - a) lateral, b) dorsal, c) palmar views;
7) right calcaneum BRS5/58 - a) dorsal, b) medial, c) lateral views;
8) left astragalus BRS5/141 - a) dorsal, b) medial, c) plantar views;
9) left trapezium BRS5/290 - a) medial, b) lateral views.

All figures in natural size.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	Heigth	Breadth	
Astragalus			
Orycteropus mauritanicus	30.4	27.5	Arambourg 1959
Orycteropus gaudryi	27.2	25.3	AMNH 22762
Orycteropus cf. *gaudryi*	27.6	23.7	BRS 5/141
Orycteropus cf. *gaudryi*	27.3	----	BRS 5/142
Calcaneum			
Orycteropus mauritanicus	60.5	30.0	Arambourg 1959
Orycteropus gaudryi	57.0	*29.3	AMNH 22762
Orycteropus cf. *gaudryi*	57.8	26.5	BRS 5/2
Orycteropus cf. *gaudryi*	57.7	26.9	BRS 5/58
Trapezium			
Orycteropus gaudryi	21.6	17.1	AMNH 22762
Orycteropus cf. *gaudryi*	18.6	15.4	BRS 5/5
Orycteropus cf. *gaudryi*	20.9	15.8	BRS 5/290

	Lt	Dp	Bp	Dd	Bd	
Metatarsal I						
Orycteropus gaudryi	35.0	10.9	9.9	10.4	10.5	AMNH 22762
Orycteropus cf. *gaudryi*	32.0	10.7	*8.6	8.1	8.1	BRS 5/43
Phalanx I (manus)						
Orycteropus cf. *gaudryi*	35.1	10.5	9.1	6.2	8.1	BRS 5/81
Orycteropus cf. *gaudryi*	29.8	10.7	8.5	6.3	7.9	BRS 5/214
Orycteropus cf. *gaudryi*	27.4	9.8	8.2	6.6	7.5	BRS 5/215
Orycteropus cf. *gaudryi*	27.5	10.0	8.2	6.5	7.4	BRS 4/2

Tab. 1 - Measurements, in millimetres, of postcranial skeleton elements in some fossil *Orycteropus* species (* = inferred value; Lt = Greatest Length; Dp = Depth of proximal end; Bp = Breadth of proximal end; Dd = Depth of distal end; Bd = Breadth of distal end).

made by Patterson (1975), three fossil genera belong in the Orycteropodidae, in addition to the extant *Orycteropus: Myorycteropus* MacInnes (1956), from the Early Miocene of Kenya and Uganda (*M. africanus*); *Leptorycteropus* Patterson (1975), from the Late Pliocene of Kenya (*L. guilielmi*); *Plesiorycteropus* Filhol (1895), an endemic genus from the Holocene of Madagascar (*P. madagascariensis*).

According to the view of Patterson (1975), only six species can be placed with confidence in the genus *Orycteropus* Geoffroy (1795), in addition to the living *O. afer*:

Orycteropus mauritanicus, Vallesian from Oued El Hammam, Algeria (Arambourg 1951, 1959).

Orycteropus gaudryi, Turolian, from Maragha (MN 11), Iran (Forsyth Major, 1893; Campbell *et al.*, 1980), from Samos (MN 12), Greece (Forsyth Major, 1888; Andrews, 1896; Lewis, 1938; Colbert, 1941), from Tiraspol (MN 13), Moldavia (Pavlova, 1915), and from Monticino Quarry (MN 13), Italy (De Giuli *et al.*, 1988; this paper).

Orycteropus depereti, Ruscinian from Perpignan (MN 15), France (Helbing 1933).

Orycteropus pottieri, Late Pliocene, from Turkey (Ozansoy 1965).

Orycteropus sp., Late Pliocene, from Laetoli, Tanzania (Dietrich, 1942).

Orycteropus crassidens, Late Pleistocene, from Kenya (MacInnes, 1956).

In addition, a number of other fossil forms have been referred to the genus *Orycteropus* (Tab. 2). Most of these references are based solely on isolated teeth, maxillary, mandibular and postcranial fragments and, following Patterson's view (1978), their generic attribution is to be accepted with reservations, as they may well belong to different genera of the same family.

Given these evidences, it appears that representatives of the aardvark family underwent a first dispersal at least in the Middle Miocene (N. Africa, Turkey, Pakistan). The first occurrence of the genus *Orycteropus*, as seen above, is in the Vallesian of Oued El Hammam (Algeria), with the species *O. mauritanicus*. At the end of the Miocene this genus dispersed into Asia Minor and Europe. At present taxonomic evidence is not sufficient to indicate if the more or less coeval finds from the Siwaliks (Colbert, 1933; Lewis, 1938; Patterson, 1975, 1978; Pickford, 1978) result from this late dispersal event, or if they represent a parallel product of the previous dispersal.

Remarks – Aardvarks have a heavily built skeleton with limbs that are specialized for digging. The cheek teeth are large and unique among mammals, in that they are composed of numerous fused hexagonal columns of dentine that appear as tubes on the base of the tooth. Aardvarks have neither incisors nor canines, nor do they have enamel on any of the teeth. The high abrasion rate due to the absence of enamel is compensated for by the continuous growth of the cheek teeth.

Aardvarks are of special phylogenetic interest. Almost certainly African in origin, they are clearly distinct phylogenetically from the other mammalian groups that are highly committed to feeding on ants, such as the myrmecophagid Xenarthra and the pangolins (Pholidota). The pattern of enamel loss of the aardvarks resembles that of the Edentata, but there is controversy regarding their ultimate ancestry. Most recent authors have allied them closely with condylarths, but the highly specialized tooth morphology precludes the specific comparison of the teeth, which are the basis for the recognition of the condylarth families (Patterson, 1978).

The only possible evidence against an African origin of the Tubulidentata are some remains from the Quercy Phosphorites (France). Those specimens (a humerus, a tibia and an incomplete dorsal portion of a skull) were first referred to Tubulidentata by Filhol (1894) and have been then compared with Pholidota or regarded as indeterminate (Simpson, 1931; Emry, 1970; Patterson, 1975). Recently, the skull fragment was again tentativelly referred to the Tubulidentata by Thewissen (1985).

	Locality	Material	References
Early Miocene			
Orycteropus (?) *minutus*	Songhor, Rusinga and Mfwangano (Kenya)	Isolated molars, autopodium bones	Pickford, 1975
Middle Miocene			
Orycteropus (?) sp.	Pasalar (Turkey; MN 6)	Two isolated teeth, phalanx, metacarpal	Fortelius, 1990
Orycteropus (?) sp. (small)	Chinji (Pakistan)	Two fragmentary mandibular rami, postcranial bones	Pickford, 1978
Orycteropus (?) *chemeldoi*	Fort Ternan (Kenya)	Two phalanges	Pickford, 1975
Orycteropus (?) *chemeldoi*	Ngorora Fmt. (Member B) (Kenya)	Mandibular ramus (fragment), isolated teeth, associated bones of a left manus	Pickford, 1975
Orycteropus (?) sp.	Belomechetskaya (Caucasus)	Mandibular ramus (fragment)	Gabounia, 1956
Late Miocene			
Orycteropus (?) sp. (large)	Lukeino (Kenya)	A fragmentary left talus	Pickford, 1975
Orycteropus (?) sp. (tiny)	Lukeino (Kenya)	Phalanx (proximal fragment)	Pickford, 1975
Orycteropus (?) browni [=*O. pilgrimi*?]	Nagri and Dhok Pathan (Pakistan)	Maxillary fragment with M2-M3, M2/, fragmentary skull including posterior portion of the palate and part of the ascending ramus, fragmentary mandibular ramus, metacarpal	Colbert, 1933; Lewis, 1938; Pickford, 1978
Early Pliocene			
Orycteropus (?) sp.	Makapan (S. Africa)	Mandibular ramus (fragment), M1/	Kitching, 1963

Tab. 2 - Fossils referred in the literature to the genus *Orycteropus* whose generic attribution has to be regarded with reserve (according to Patterson, 1975).

Tubulodon taylori, from the Eocene of Wyoming, was described by Jepsen (1932) as a Tubulidentata. However, following Simpson (1959), it is now accepted as a palaeanodont.

The survival of aardvarks is linked to the presence of soft soils. This characteristic is very important, because they dig burrows either for food, or as temporary shelters or permanent residence; they are nocturnal, and sleep in their burrows during the day. Living *Orycteropus* seem to favour arid environments, although they cannot tolerate completely arid conditions and they occurs in forest too (Kingdon, 1971; Shoshani *et al.*, 1988). The Ethiopian and Cape sub-species of Africa are in fact separated only by the barrier of the intermediate humid regions. The range of *Orycteropus afer* possibly also extended to North Africa during historical times (Shoshani *et al.*, 1988). *Orycteropus* feeds primarily on termites, but it is known to intergrate its myrmecophagean diet by eating the fruits of a Cucurbitaceae plant species (*Cucumis humifructus*), which represents an important source of water. It is significant that the range of this plant coincides with the distribution of living aardvarks, and the association between the animal and the plant is so close as to be described as symbiotic (Meeuse, 1963).

CONCLUSIONS

The *Orycteropus* cf. *gaudryi* found in the Monticino Gypsum Quarry is the western-most record of Tubulidentata in the Late Miocene of Eurasia. Although very rare as a fossil, *Orycteropus* was a widespread taxon in the Mio-Pliocene of Eurasia at mediterranean latitudes. The occurrence, in Mio-Pliocene deposits, of this rare form, which is represented by species congeneric with the living aardvark, suggests that environment was most likely to have been arid.

The occurrence of this taxon in the Monticino faunal assemblage does not appear to indicate a direct connection between Italy and the African continent via Sicily during latest Miocene. Instead, as has been shown for the genus *Hystrix* (Masini & Rook, 1993; Montoya, 1993), the fossil distribution of aardvarks in latest Miocene sediments (North Africa, Egean region, Caucasus and Iran) suggests a dispersal of this taxon through eastern pathways. Furthermore, the Monticino mammal fauna contains no elements indicative of direct migrations from North Africa. It is, on the contrary, characterized by the presence of taxa with Egean or eastern provenance (e.g. *Samotragus, Centralomys, Trischizolagus*) or with strong european affinities (e.g. *Stephanomys*).

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