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ITALIAN FOSSIL CHIROPTERAN ASSEMBLAGES: A PRELIMINARY REPORT

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With 2 figures and 1 table

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Abstract

This work is a preliminary report on Italian fossil chiropteran faunas. During the Paleogene just one sample of Early Oligocene age, pertaining to an extinct species, has been reported. A few findings have been reported from the Neogene. Just one complete assemblage from the Late Miocene site of Brisighella has been examined and has allowed palaeoecological inferences, whilst specimens from Late Miocene localities of Baccinello V0 (Tuscany) and Gargano peninsula (Apulia) need a revision. A Late Pliocene assemblage has been collected in Montagnola Senese (Tuscany) but it still needs a systematic revision.

During the Quaternary and most of all since the Middle Pleistocene the fossil record becomes richer. Some assemblages testify a Mediterranean climate analogous to the present one. The most significant are: the Early Pleistocene ones from Pirro Nord (Apulia) and Ghar Dalam Cave (Malta), the early Middle Pleistocene ones from Slivia (Venezia Giulia) and Spinagallo Cave (Sicily) and the Late Pleistocene ones from Punta Padre Bellu (Sardinia) and Breuil Cave (Latium). In other cases the species represented in the assemblages are typical of colder climate and then they make it possible to infer cooler conditions in Italy during some periods. Good examples in this sense are the Middle Pleistocene assemblage from Vento Cave (Marche) and the Late Pleistocene one from Cittareale Cave (Latium). A distributuion chart of all fossil bats from Italy and Malta is also presented.

Introduction

Nowadays it is quite common to support palaeoenvironmental reconstructions using samples from fossil mammal (especially micromammal) assemblages as palaeoecological and/or palaeoclimatic markers.

Among micromammals bats are really meaningful in this respect but, especially in Italy, although when they are found they are really abundant (especially from Pleistocene sites), they are often lacking. The lack of interest in this group is caused by the bradytelic evolution of these animals that makes them useless for biochronological studies that, in the past decades, have been attracting palaeontologists attention.

Anyway it has to be underlined that bats, because of their peculiar ecological habits are strongly influenced in their distribution by climatic and ecological parameters and this is why they can be considered as good environmental markers. In addition, just because of the low rates of evolution, living species are mostly analogous to fossil ones. Since the present distribution and the climatic context of their life are known it is reasonable to make palaeoclimatic and palaeoecological inferences from studying species pertaining to fossil assemblages. However first of all it is necessary to review chiropteran assemblages and this work represents a preliminary approach to this research project.

Tertiary chiropteran assemblages and their palaeoecological meaning

Just one species of bat is known from Paleogene sediments in Italy: *Archaeopteropus transiens* Meschinelli, 1903. It has been collected in the early Oligocene (MP 21) lignites of Monteviale (Veneto)

Fig.1: Map of main fossiliferous localities of Italy and Malta. 1- Monteviale (Veneto); 2- Baccinello V0 (Tuscany); 3- Brisighella (Romagna); 4- Gargano (Apulia); 5- Montagnola Senese (Tuscany); 6- Pirro Nord (Apulia); 7- Ghar Dalam Cave (Malta); 8- Spinagallo Cave (Sicily); 9- Slivia (Venezia Giulia); 10- Vento Cave (Marche); 11- Punta Padre Bellu (Sardinia); 12- Breuil Cave (Latium); 13- Monte Cucco Cave (Marche); 14- Cittareale Cave (Latium).

(Meschinelli, 1903; Kotsakis et al., 1997) (Figs. 1, 2). It is a large chiropteran classified in its own subfamily, Archaeopteropodinae, and considered by some authors (Russel & Sigé, 1970) to belong to the suborder Microchiroptera and by others (Smith & Storch, 1981) to the suborder Megachiroptera. Unfortunately the original sample has been lost during the Second World War and only some rather good casts are available. *Archaeopteropus* was part of an assemblage that, if considered as a whole, shows a tropical character.

In the Italian Miocene the presence of Chiroptera indet. has been signalled from clays of Baccinello V0 (Tuscany - MN11) (Kosakis et al., 1997). Just one Miocene assemblage is known, coming from Monticino Quarry (Brisighella, Romagna) karst fissures. The assemblage is of Late Turolian age (MN13) and it is composed of six species: *Megaderma* cf. *M. mediterraneum* Sigé, 1974, *Rhinolophus* cf. *R. kowalskii* Topál, 1979, *Rhinolophus* sp., *Hipposideros (Syndesmotis)* cf. *H. (S.) vetus* (Lavocat, 1961), *Asellia* cf. *A. mariaetheresae* Mein, 1958 and *Myotis* cf. *M. boyeri* Mein, 1964 (Kotsakis & Masini, 1989). Three species, the two rhinolophids and the vespertilionid, are similar to living forms now inhabiting this same site. On the other hand the remaining three genera, *Megaderma*, *Hipposideros* and *Asellia* now live in tropical and subtropical areas. In particular the presence of *Megaderma* is indicative of minimum temperatures higher than 14-15°C all around the year, while the presence of *Asellia* is indicative of subdesertic conditions (Sigé, 1974). From the species represented here a littoral sandy habitat has been inferred (Kotsakis & Masini, 1989).

Another finding from the Italian Miocene is from Gargano Peninsula (Apulia) from karst fissure fillings characterized by the *Hoplitomeryx* and *Microtia* assemblage and ascribed to the Late Miocene – ?Early Pliocene. Here a single species, not definitely studied yet, has been collected and previously ascribed to the genus *Megaderma* but an attribution to other megadermatid genera is possible (Kotsakis et al., 1997). As in the preceding case the presence of this genus, now inhabiting hot regions, has suggested tropical temperatures in this area.

Another Neogene assemblage is from the Late Pliocene (MN17, Middle Villafranchian Mammal Age or Late Villanyian Micromammal Age, Costa San Giacomo Faunal Unit/Olivola Faunal Unit; Kotsakis et al., 2003) fissure fillings of Montagnola Senese (Tuscany) (Fondi, 1972). It includes four species: *Myotis blythii* (Tomes, 1857), *M.* gr. *schaubi* Kormos, 1934 – *rapax* Heller, 1936, *Myotis* sp. and ? *Tadarida* sp. The fauna needs a systematic revision and it is impossible to infer palaeoecological informations.

Quaternary chiropteran assemblages and their palaeoecological meaning

During the Pleistocene, particularly in the Late Pleistocene, an increase in the Italian fossil record is observed. Among various sites under study at present the most meaningful are Pirro Nord (Gargano, Apulia), Spinagallo Cave (Sicily), Punta Padre Bellu (Alghero, Sardinia), Breuil Cave (Monte Circeo, Latium), Monte Cucco Cave (Perugia, Umbria) and Cittareale Cave (Rieti, Latium). One assemblage from the late Early Pleistocene/earliest Middle Pleistocene from the Ghar Dalam Cave (Malta) is strongly related to Italian faunas.

The oldest chiropteran assemblage is Pirro Nord, ascribed to the early Pleistocene (Late Villafranchian M.A. or Early Biharian Micromammal Age, Pirro F.U.) (Gliozzi et al., 1997). A rich assemblage has been collected from one of the karst fissures in the area. It is

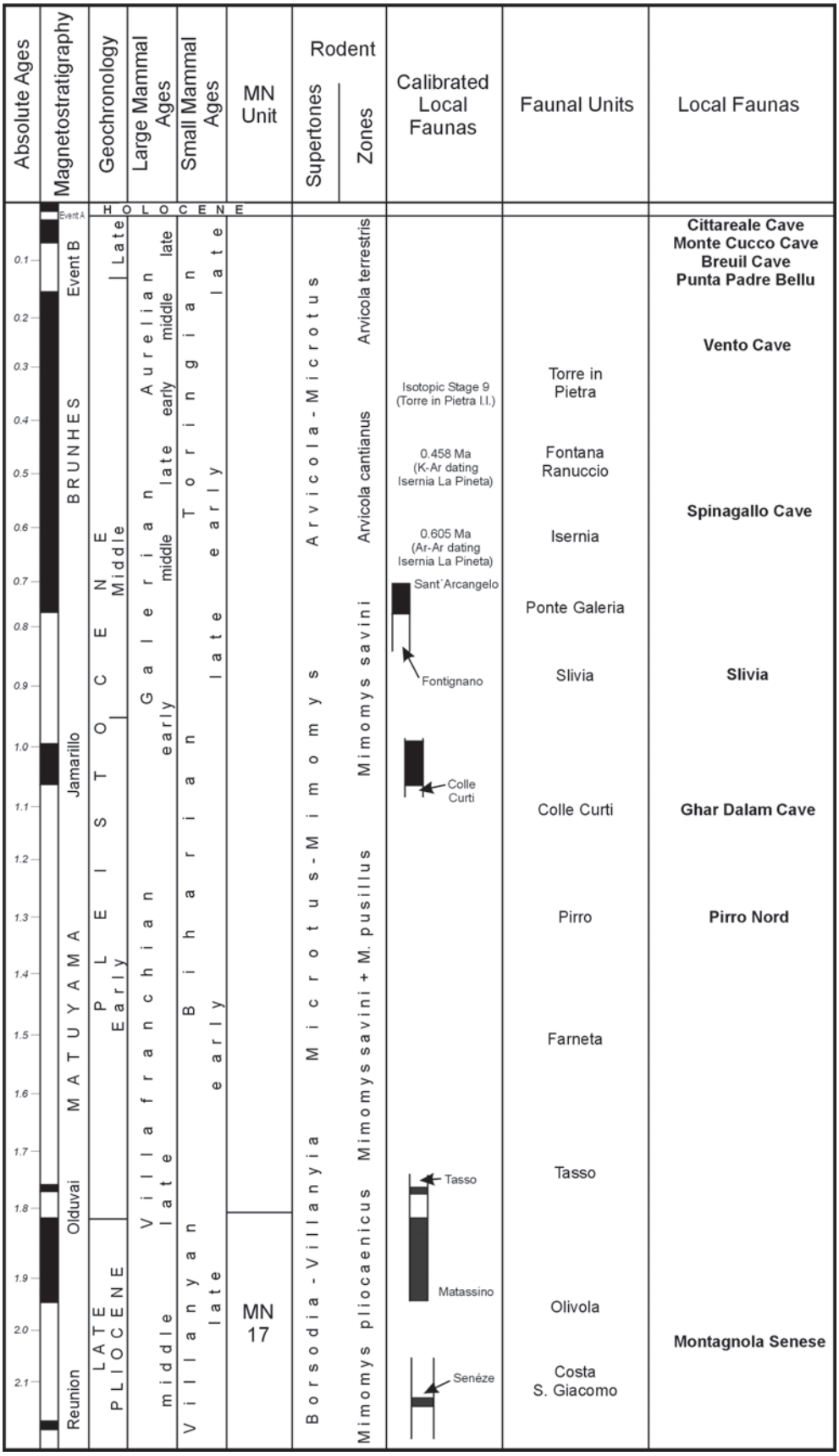

Fig. 2: Biochronological scheme of localities bearing fossil bats of Italy and Malta.

composed of six species: *Rhinolophus ferrumequinum* (Schreber, 1774), *R. birzebbugensis* Storch, 1974, *Myotis blythii*, *M. capaccinii* (Bonaparte, 1837), *Miniopterus schreibersi* (Kuhl, 1819) and *Miniopterus* n. sp. (Masini et al., 1996; Tata, 2003). Among them the living species *R. ferrumequinum*, *M. blythii*, *M. capaccinii* and *M. schreibersi* are present in Europe in the central and southern part of the continent (except for *R. ferrumequinum* that extends to more northern latitudes). The remaining two species *R. birzebbugensis* and *Miniopterus* n. sp. cannot be considered as strong palaeoclimatic markers since the rhinolophid is known as a fossil only from a few localities (Malta, Bulgaria and probably Spain) (Storch, 1974; Popov, 2004; Tata & Kotsakis, in prep.) while the miniopterid has been collected here for the first time. Considered as a whole the assemblage has a strong Mediterranean character. A different assemblage including three species has been collected from another fissure filling in the same area (De Giuli & Torre, 1984): *Rhinolophus* gr. *R. euryale* Blasius, 1853, *Myotis* cf. *M. blythii* and *Myotis* sp. (small size). From a climatic point of view the assemblage does not differ from the previous one.

Close in age to the previous assemblage is that collected in the Ghar Dalam Cave (strata with *Leithia cartei*; Storch, 1974) including ten species: *Rhinolophus hipposideros* (Bechstein, 1800), *R. birzebbugensis*, *R. blasii* Peters, 1866, *Myotis exilis* Heller, 1936, *M. bechsteini robustus* Topál, 1963, *M. ghardalamensis* Storch, 1974, *M. capaccinii*, *Eptesicus praeglacialis* Kormos, 1930, *Pipistrellus pipistrellus* (Schreber, 1774) and *Miniopterus schreibersi*. The assemblage shows a Mediterranean character with forested and open habitats and the presence of fresh water.

Also the assemblage from the Spinagallo Cave, ascribed to the early Middle Pleistocene (*Elephas falconeri* Faunal Complex) (Bonfiglio et al., 2003) is quite rich including ten species: *R. ferrumequinum*, *R. hipposideros*, *R. mehelyi* Matschie, 1901, *R.* cf. *R. blasii*, *Myotis mystacinus* (Leisler in Kuhl, 1819), *M. bechsteini* (Leisler in Kuhl, 1819), *M. capaccinii*, *Eptesicus serotinus* (Schreber, 1774), *Barbastella barbastellus* (Schreber, 1774) and *M. schreibersi* (cfr. Kotsakis & Petronio, 1980). Very probably the new species of *Miniopterus* collected in Pirro Nord is also present in the Spinagallo Cave assemblage.

The species are derived from two different strata; in the lower one only three species are represented: *M. schreibersi*, *R. ferrumequinum* and *M. capaccinii*, the first being decisely dominant. In the higher stratum all the species, except *M. capaccinii*, are represented. *M. schreibersi* is always dominant although less numerous than in the lower stratum. On the whole the assemblage has a Mediterranean character although forms such as *M. mystacinus* and *B. barbastellus* usually have a more northern distribution. All but one species are still living in Sicily, *M. bechsteini* and *B. barbastellus* are less widespread then the others (Kotsakis & Petronio, 1980). *R. blasii* has a recent eastern Mediterranean distribution and is present in the easternmost province of Italy near the Italian-Slovenian boundary (Lanza & Agnelli, 1999). Palaeoecological conditions similar to those of Ghar Dalam can be inferred.

At several fossil localities a small number of bat species has been collected; usually the specimens represented there belong to recent species now living in the same areas. A good example is the early Middle Pleistocene (Early Galerian M.A., Slivia F.U.) assemblage collected in Slivia karst fissure (Trieste, Venezia Giulia) where two species have been recognized: *Rhinolophus ferrumequinum* and *Miniopterus schreibersi* (cfr. Ambrosetti et al., 1979). In other cases some elements indicating colder conditions have been recognized in mammal assemblages as for example in the late Middle Pleistocene (Early Aurelian M.A.) deposit from Vento Cave (Ancona, Marche), where two species are found: *Rhinolophus ferrumequinum* and *Myotis dasycneme* (Boie, 1825) (Esu et al., 1990). Among them particularly significant in this respect is the presence of *M. dasycneme*, typical of cold conditions, known at present by just one erratic individual in the north-eastern part of the Italian peninsula .

In the Late Pleistocene the findings are abundant, isolated remains are often reported (Lombardy, Santi, 2000; Sardinia, Abbazzi et al., 2004), but systematic analysis has been conducted only on a few cave deposits.

The assemblage from Punta Padre Bellu, collected in a destroyed cave near Alghero, has been ascribed to the Late Pleistocene and is composed of six species: *R. ferrumequinum*, *R. hipposideros*, *Myotis myotis* (Borkhausen, 1797), *M. capaccinii*, *Nyctalus* cf. *N. lasiopterus* (Schreber, 1780) and *M. schreibersi* (cfr. Kotsakis, 1987). All the species with the exeption of *N. lasiopterus* (that however is quite rare in the peninsula today) are still living in Sardinia suggesting a climatic context similar to the present one.

Bat species	Early Oligocene	Late Miocene	Late Pliocene	Early Pleistocene	Middle Pleistocene	Late Pleistocene	Recent
Archaeopteropus transiens+	X						
Megaderma mediterraneum+		cf.					
Megaderma (*s.l.*) sp.+		X					
Rhinolophus kowalskii+		cf.					
Rhinolophus ferrumequinum				X	X	X	X
Rhinolophus euryale				X		X	X
Rhinolophus birzebbugensis+				X	X		
Rhinolophus mehelyi					X	X	X
Rhinolophus blasii				X	X		X
Rhinolophus hipposideros				X	X	X	X
Rhinolophus sp.+		X					
Hipposideros vetus+		cf.					
Asellia mariaetheresae+		cf.					
Myotis boyeri+		cf.					
Myotis bechsteini					X	X	X
Myotis bechsteini robustus+				X			
Myotis myotis						X	X
Myotis ghardalamensis+				X			
Myotis blythii			?	X	X	X	X
M. nattereri						X	X
Myotis gr. *M. schaubi-M. rapax*+			X				
Myotis emarginatus						X	X
Myotis exilis+				X			
Myotis mystacinus					X		X
Myotis brandti							X
Myotis daubentoni						?	X
Myotis capaccinii				X		X	X
Myotis dasycneme					X	X	X*
Myotis sp.			X	X			
Barbastella barbastellus					X	X	X
Plecotus auritus						X	X
Plecotus austriacus							X
Plecotus sp.					X		
Pipistrellus pipistrellus				X			X
Pipistrellus nathusii							X
Pipistrellus kuhlii							X
Pipistrellus sp.						X	
Hypsugo savii						X	X
Nyctalus leisleri						?	X
Nyctalus noctula						X	X
Nyctalus lasiopterus						cf.	X
Amblyotus nilssonii						X	X
Eptesicus praeglacialis+				X			
Eptesicus serotinus					X	X	X
Vespertilio murinus						X	X
Miniopterus n. sp. +				X	?		
Miniopterus schreibersi				X	X	X	X
Tadarida teniotis						X	X
Tadarida sp.			X				

* It has been reported just one specimen captured in Northern Italy in 1881.

Tab. 1: Distribution chart of fossil bats from Italy and Malta. + = extinct species or subspecies. *Pipistrellus pygmaeus*, *Myotis punicus*, *Plecotus alpinus* and *Plecotus* n. sp. are not included among living species.

The rich assemblage from Breuil Cave (Monte Circeo, Latium) collected in two strata (stratum "e" and stratum "d") must be referred to the Late Pleistocene (OIS 3). Among micromammals bats are well represented with five species: *R. ferrumequinum*, *M. myotis*, *Nyctalus noctula* (Schreber, 1774), *M. schreibersi* and *Tadarida teniotis* (Rafinesque, 1814). All these species are present in the lower part of the stratum "e", while only *R. ferrumequinum* is represented in the upper part of the stratum "d" (Kotsakis, 1989). The assemblage derived from stratum "e" is constituted partly by typical Mediterranean species such as *M. schreibersi* and *T. teniotis* (that are more aboundantly represented) and partly by species having a more northern distribution such as *N. noctula*. If this assemblage is considered in the general faunal context it becomes quite clear that its interstadial character denotes a woodland environment with moist areas in the neighbourhood of the cave.

Another Late Pleistocene (OIS 2) chiropteran assemblage is that from the Monte Cucco Cave (Perugia, Umbria) (Capasso Barbato & Kotsakis, 1986), including five species: *R. ferrumequinum*, *M. myotis*, *M. blythii*, *M. bechsteini* and *M. emarginatus* (E. Geoffroy, 1806). The absence of *Miniopterus schreibersi* is interesting because it is a usual component of Italian cave- dwelling faunas. The assemblage does not show any peculiar characteristics that allow palaeoclimatic inferences.

The chiropteran assemblage from Cittareale Cave (Rieti, Latium) is clearly colder and ascribed to the Late Pleistocene (OIS 2, Younger Dryas?); five species are present: *R. ferrumequinum*, *R. hipposideros*, *M. myotis*, *M. bechsteini* and *M. dasycneme* (cfr. Argenti et al., in press). Particularly meaningful in a climatic sense is the presence of *M. dasycneme* that suggests the attribution of the assemblage to a cold interval, presumably to the Younger Dryas period. In addition all the species, with the exeption of *M. myotis* that usually prefers open and slightly wooded terrain, are common in wooded areas suggesting then, for the assemblage, a forested environment with open space and ponds.

Conclusions

Among the recent mammalian faunas of Italy and Malta, Mitchell-Jones et al. (1999) indicate the presence of 28 species of bats. This number has been increased in the last years by new researches: *Pipistrellus pygmaeus* (Leach, 1825) (Russo & Jones, 2000); *Myotis punicus* Felten, 1977 (Castella et al., 2000; Beuneux, 2004); *Plecotus alpinus* Kiefer & Veith, 2001 (Trizio et al., 2003); *Plecotus* n. sp. from Sardinia (Mucedda et al., 2002) have been added in the list of bats of Italy. However for an attribution of Italian fossil material to these species a complete systematic revision is necessary.

The number of Italian Tertiary fossil species is much less; it has been calculated to include 12 species, among them 11 are surely extinct, but also the twelwth, which has been attributed to a living species, needs a systematic revision.

During the Quaternary an increase in the number of species is observed with at least 31 represented; 5 of this number are extinct (*R. birzebbugensis*, *M. ghardalamensis*, *M. exilis*, *E. praeglacialis* and *Miniopterus* n. sp.). A fossil subspecies has also been reported *M. bechsteini robustus*. Another species has to be mentioned pertaining to the genus *Rhinolophus*, *R. botegoi* Regàlia, 1893 described by Regàlia (1893), from fossil remains collected in Colombi Cave (Palmaria Island, Liguria). Its validity seems to be improbable, but in any case the material needs to be revised. In the fossil record of Italian bats the presence of troglophilous species is dominant, whilst non-cave dwelling species are not well represented (see Table 1).

The analysis of the chiropteran assemblages confirms that during the time span between the Miocene and Pleistocene the Italian peninsula has been subjected to a general decrease of temperature. This inference comes from the observation that species typical of tropical and subtropical environments present in the Neogene assemblages are completely lacking from more recent assemblages. It has to be emphasised that in some cases the presence of a single species with peculiar ecological requirements gives clear palaeoecological information whilst in other cases it is the assemblage as a whole (considering the percentage composition of each single species) that allows palaeoecolgical inferences.

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