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THE DEPOSIT OF THE LATE PLEISTOCENE FROM AVETRANA (TARANTO, SOUTHERN ITALY): BIOCRONOLOGY AND PALAEOECOLOGY

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ABSTRACT: C. Petronio, F. Bellardini, M. Arzarello, C. Bedetti, L. Bellucci, A. Cipullo, G. Di Stefano, L. Pandolfi, M. Pavia, M. Petrucci, R. Sardella & L. Salari, *The deposit of the late pleistocene from Avetrana (Taranto, Southern Italy): Biocronology and Palaeoecology*. (IT ISSN 0394-3356, 2008).

The analytical study of the vertebrate assemblage from the Late Pleistocene, found in a karstic cavity (which lays on a calcarenite near Avetrana, Taranto, southern Italy), allows us to reduce the chronological span during which the fossil remains were deposited. In particular, some circumstances allowed the authors to collocate the fauna in a temporal span from 100.000 to 80.000 years (Faunal Unit of Melpignano - PETRONIO *et al.*, 2007). The findings show the occurrence of *Hystrix vinogradovi* (never found in Italy during the central part of the Late Pleistocene), the even more rare presence of *Hippopotamus amphibius* in the same period, the discovery of *Cervus elaphus elaphus*, the archaic morphology of *Dama dama dama*, the dimension of *Bos primigenius*. Finally the finding of an archaic Mousterian tool is also recorded. The analysis of the avifauna and of the mammal fauna allowed us to retrace the habitat of that period.

RIASSUNTO: C. Petronio, F. Bellardini, M. Arzarello, C. Bedetti, L. Bellucci, A. Cipullo, G. Di Stefano, L. Pandolfi, M. Pavia, M. Petrucci, R. Sardella & L. Salari, *Il deposito del Pleistocene superiore di Avetrana (Taranto): biocronologia e paleoecologia*. (IT ISSN 0394-3356, 2008).

Lo studio analitico di un giacimento a vertebrati del Pleistocene superiore rinvenuto in una cavità carsica impostata in una calcarenite nei dintorni di Avetrana (Taranto, Sud Italia) permette di restringere l'intervallo cronologico in cui si sono depositati i resti fossili. In particolare la presenza di *Hystrix vinogradovi*, mai segnalata in Italia nella parte centrale del Pleistocene superiore, la presenza sempre più rara di *Hippopotamus amphibius* nello stesso periodo, la segnalazione di *Cervus elaphus elaphus*, la morfologia arcaica di *Dama dama dama* e le dimensioni di *Bos primigenius* orientano gli autori a collocare la fauna in un intervallo temporale compreso fra 100.000 e 80.000 anni (Unità faunistica di Melpignano, PETRONIO *et al.*, 2007). L'analisi dell'avifauna e della mammalofauna ha infine permesso di ricostruire l'habitat di tale periodo.

Keywords: Vertebrates, Late Pleistocene, Biocronology, Palaeoecology.

Parole chiave: Vertebrati, Pleistocene superiore, Biocronologia, Paleoeccologia.

INTRODUCTION

The Late Pleistocene vertebrate assemblage, object of the present paper, was found in an abandoned quarry near Avetrana, a small town in the eastern area of Taranto, more precisely, in the northern part of the Salento peninsula (Southern Italy). It has already been the topic of an earlier publication (SARDELLA *et al.*, 2005).

The detrital sediments are rich in bone remains, notably of mammals, which are included inside a karstic cavity and which originated during the Pleistocene within rocks attributable to the Plio-Pleistocene formation of the so called "Calcareni di Gravina". The cavity is filled with this material which was carried by alluvial flows, very likely the consequence of numerous exceptional events (which were distinct but chronologically coeval, from a geological point of view).

The "Calcareni di Gravina" is attributed to the Early Pleistocene, it is at least 15 meters thick and composed by a compact yellowish bio-calcareni, rich in molluscs and echinids. It was deposited in a coastal

marine environment, with a temperate climate and shallow waters (CIARANFI *et al.*, 1979).

A preliminary analysis of the avifauna, and chiefly the biocronology of the mammal-fauna found in the cavity (SARDELLA *et al.*, 2005), allowed us to assign a quite large chronological span to the deposition of sediments, although pertaining to the Late Pleistocene. In this paper we consider the detailed analysis of every single taxon, and mainly the evolutive trend of the mammal-fauna, in the pursuit of further reducing this interval of time. We refer particularly to *Bos primigenius* which is by far the most numerous mammal present.

STRATIGRAPHIC NOTES

We can identify 9 layers and 2 pockets (Fig. 1) in the filling of the karstic fissure where the bone remains were discovered. These sediments may be divided into two groups: the upper one fills the main karstic cavity and includes 9 levels; while the lower one forms the layer 0 which fills a network of small basal fissures.

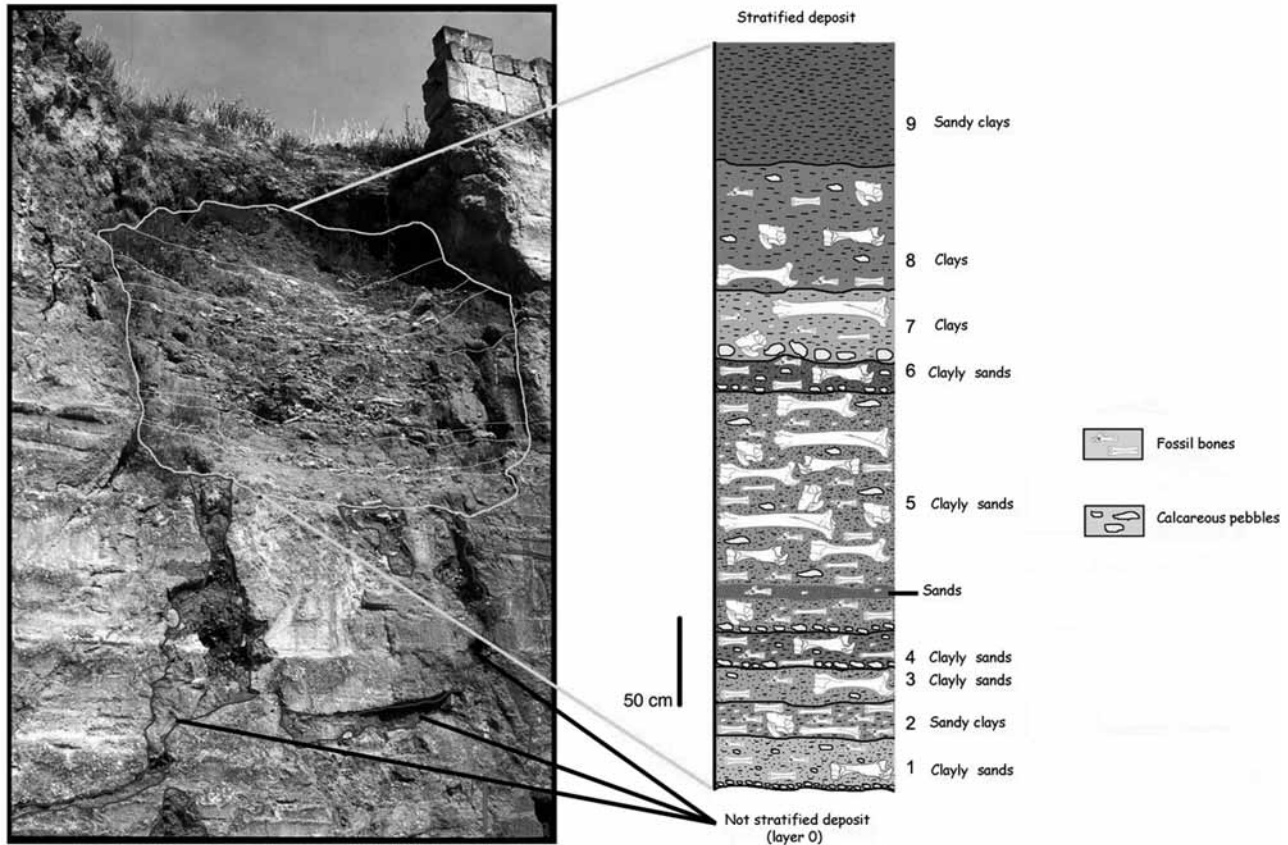


Fig. 1 - Stratigrafical succession of deposit.

Successione stratigrafica del deposito.

Layer 0 is filled with orange-yellow nonlaminated sandy clays containing small and medium size fossil vertebrate remains. On the other hand, the main cavity is filled with a series of laminated sediments and it is between 4,5 to 5,5 meters thick. It is possible to draw up a list of the most important features of the different layers identified, on the base of the stratigraphic elements observed in the cavity and also on the base of the systematic study carried out on the paleontological contents of the deposits. From the bottom to the top of the karstic cavity the following fossiliferous levels are present:

Layer 0: this level is composed of small irregular fissures which, as already mentioned, are filled by sandy clays rich in small fossil vertebrate remains. Birds are chiefly represented by anterior limb bones belonging to *Perdix perdix*, *Columba livia*, *Athene noctua*, and *Pyrrhocorax graculus*, while Mammals are represented by teeth. In particular, we found remains of *Erinaceus europaeus*, well-preserved mandibles of *Terricola savii*, molars of *Hystrix vinogradovi*, cranial fragments, mandibles and limb bones of *Lepus cf. europaeus* and of *Oryctolagus cuniculus*, and some fragments of *Felis silvestris*.

Layer 1: this level is formed by an uninterrupted stratum of calcareous pebbles and, above it, by a thin deposit (30 cm) constituted by argillaceous sand containing rare clayey pebbles (which are visibly altered) and a few fossil bones of *Bos primigenius*.

Layer 2: the level is formed by a 20 cm thin depo-

sit of sandy clay including numerous bone remains belonging to: *Vulpes vulpes*, *Canis lupus*, *Crocota crocuta*, *Lynx lynx*, *Stephanorhinus hemitoechus*, *Bos primigenius*, *Dama dama dama*, *Cervus elaphus elaphus*, *Hippopotamus amphibius* (Fig. 2, a).

Layer 3: this level is formed by 20 cm of argillaceous sand containing rare calcareous pebbles with only a few bones of *Lepus cf. europaeus*, *Vulpes vulpes*, *Meles meles*, *Canis lupus*, *Bos primigenius*, *Dama dama dama* and *Cervus elaphus elaphus*.

Layer 4: this level is separated from the underlying layer by an erosional surface marked by a stratum containing calcareous pebbles and rare bones; this layer is 20 cm thick and it is formed by sandy clay containing calcareous pebbles and a few remains of *Lepus cf. europaeus*, *Vulpes vulpes*, *Canis lupus*, *Bos primigenius*, *Dama dama dama*, and *Cervus elaphus elaphus*.

Layer 5: this deposit is 140 centimeters thick. It is composed by argillaceous sand containing very numerous bones and rare calcareous pebbles. The level is characterized by a basal stratum with pebbles and bones and by a sandy lens, containing rare fossil remains, which lays 20 centimeters above the base of this deposit. The mammal remains (Fig. 2, b) are represented by *Vulpes vulpes*, *Canis lupus*, *Dama dama dama*, *Cervus elaphus elaphus*, *Crocota crocuta*, *Sus scrofa*, *Lepus cf. europaeus* (at the bottom of the level) and mainly by *Bos primigenius*.

Layer 6: this 20 cm sandy level is above all formed by bone remains (Fig. 2, c) of *Vulpes vulpes*, *Canis lupus*, *Bos primigenius*, *Dama dama dama*, *Cervus elaphus elaphus*, *Sus scrofa*, *Hippopotamus amphibius*, and *Stephanorhinus hemitoechus*. A single Mousterian lithic artefact was also discovered in this layer.

Layer 7: this argillaceous layer which is 40 cm thick, contains numerous bones and large calcareous pebbles, mainly at its base. The species represented (Fig. 2, d) are: *Vulpes vulpes*, *Canis lupus*, *Crocota crocuta*, *Stephanorhinus hemitoechus*, abundant *Bos primigenius*, *Cervus elaphus elaphus*, *Dama dama dama*, and a phalanx of *Megaloceros* sp.

Layer 8: this level is formed by a 75 cm thick argillaceous deposit, separated from the underlying layer by a base which is particularly rich in bones of *Vulpes vulpes*, *Canis lupus*, *Lynx lynx*. We also found a calcaneum belonging to *Panthera spelaea*, *Sus scrofa*, abundant *Bos primigenius*, *Cervus elaphus elaphus*, and *Dama dama dama* (Fig. 2, e).

Layer 9: this 70 cm thick argillaceous level contained very rare bones, which are quite decalcified.

FAUNA ANALYSIS.

Aves

Birds are represented by a few remains, which are extremely fragmented and generally in not good condition. The remains are slightly more frequent at level 0, while they are sporadic in the upper levels.

Falconiformes: Accipitride
Aquila sp.

The discovery of the third phalanx of the first finger shows the presence of a large Accipiter of the genus *Aquila*. Its dimensions are smaller compared to *Aquila chrysaetos* and they are comparable to other European species of this genus, in particular to *A. celia-ca*, *A. nipalensis* and *A. rapax*. It is very difficult to distinguish the posterior phalanxes of the genus *Aquila*, especially if we deal with only one sample (LOUCHART *et al.*, 2005). Therefore, we prefer to attribute the phalanx found to *Aquila* sp.

Galliformes: Phasianidae
Perdix perdix (Linnaeus, 1758)

The presence of this species is seen in one single fragment of the proximal part of the humerus, in one pneumatic fossa, and in the incisura capitis, which is typical of *Perdix perdix*.

Gruiformes: Otidae
Otis tarda Linnaeus, 1758

One complete right ulna os carpi shows the presence of this big Gruiformes. Its morphological features and its large dimension allow us to refer at *Otis tarda* instead of genus *Grus*.

Columbiformes: Columbidae
Columba livia Gmelin, 1789

This is the most frequent taxon found in the Avetrana assemblage. It was found at every level. In

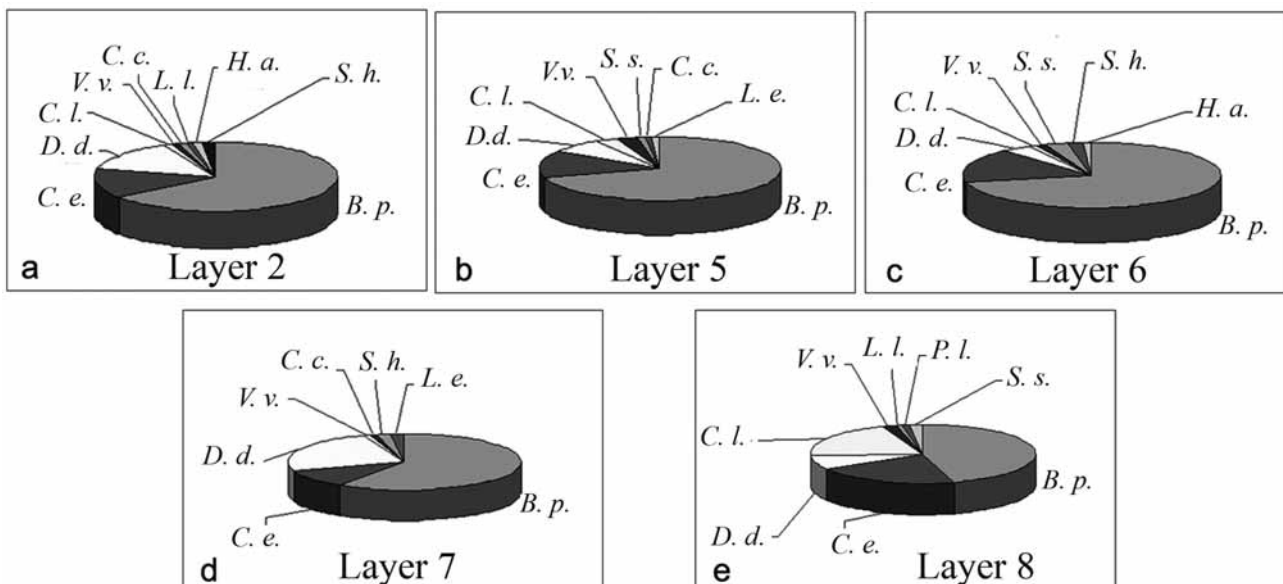


Fig. 2 - Graphic of Taxa percentage for layers.

B. p. = *Bos primigenius*; C. c. = *Crocota crocuta*; C. e. = *Cervus elaphus elaphus*; C. l. = *Canis lupus*; D. d. = *Dama dama dama*; H. a. = *Hippopotamus amphibius*; L. e. = *Lepus cf. europaeus*; L. l. = *Lynx lynx*; P. l. = *Panthera leo*; S. h. = *Stephanorhinus hemitoechus*; S. s. = *Sus scrofa*; V. v. = *Vulpes vulpes*.

Percentuale dei taxa nei singoli livelli.

B. p. = *Bos primigenius*; C. c. = *Crocota crocuta*; C. e. = *Cervus elaphus elaphus*; C. l. = *Canis lupus*; D. d. = *Dama dama dama*; H. a. = *Hippopotamus amphibius*; L. e. = *Lepus cf. europaeus*; L. l. = *Lynx lynx*; P. l. = *Panthera leo*; S. h. = *Stephanorhinus hemitoechus*; S. s. = *Sus scrofa*; V. v. = *Vulpes vulpes*.

particular, we found several elements of the post-cranial skeleton which show all the typical features of the Columbidae family. The dimension of the remains and their morphological features allow us to ascribe them to *Columba livia*.

Strigiformes: Strigidae
Athene noctua (Scopoli, 1769)

The discovery of a only proximal portion of right tibiotarsus allows us to recognize the presence of *Athene noctua* in the fossil assemblage of Avetrana. The general features correspond with that of the Strigidae family. The dimension and the morphology demonstrate that we are dealing with *Athene noctua*, following the descriptions of PAVIA & MOURER-CHAUVIRÉ (2002).

Passeriformes: Corvidae
Pyrrhocorax graculus (Linnaeus, 1766)

This species is the second species with the most remains found, after *Columba livia*. It is present in several levels, but it is more frequent at level 0. The dimensions and morphology of the remains correspond with that indicated by TOMEK & BOCHENSKY (2000).

Pyrrhocorax pyrrhocorax (Linnaeus, 1758)

We found a left almost complete humerus of Corvidae which shows the stocky structure of the genus *Pyrrhocorax*. However, the dimensions are clearly greater compared with that of *Pyrrhocorax graculus*, allowing us to ascribe these remains to *P. pyrrhocorax*, according with Tomek & Bochnesky (2000).

Mammalia (Fig. 3)

Insectivora: Erinaceidae
Erinaceus europaeus Linnaeus, 1758

The presence of this species is demonstrated by the finding of two molars, one M² and one M³, whose dimensions and morphological features allow us to identify the systematics attribution.

Rodentia: Arvicolidae
Terricola savii (de Sélis Longchamps, 1838)

We identified 7 well-preserved mandibles of this species along with several isolated teeth, among them there are numerous M₁. This material is attributed to the species on the basis of morphology and dimensions of M₁.

Hystricidae
Hystrix vinogradovi
Argyropulo, 1941

A porcupine form, visibly smaller than the modern *Hystrix cristata*, is evidenced by the

discovery of some teeth, one M¹, two M² and one M³. The morphology of the dental structure (Fig. 4, 4) seems to be simpler than that of the modern *Hystrix cristata*, a species imported in Italy during the Roman Age (PETRONIO et al., 2005). *Hystrix vinogradovi* is different from the other European Hystricidae, both from the fossil *Hystrix refossa* and from the actual *Hystrix cristata*, for its smaller dimension. According to WEERS (2005), who hypothesizes that *Hystrix vinogradovi* can be synonymous with both the fossil and living *Hystrix (Acanthion) brachyura* (from south-eastern Asia), this species has been present in the occidental Euro-Asian region since the Early Pleistocene (Hungary - JÁNOSSI, 1972) to the Late Pleistocene (France - SCHWEITZER, 2002). However, *Hystrix vinogradovi*, in addition to the localities mentioned by WEERS (2005), has been cited in Europe also in the TG 10-11 strata, referred to OIS 10 in the "Trinchera del Ferrocarril", in the Sierra of Atapuerca, in Spain (MADE et al., 2003); as well as in the late travertine stones referred to the Eemian Age (OIS 5), in Burgtonna (Germany - KOLFSCHOTEN, 2000) and in the strata referred to Mikulino Interglacial (Eemian, OIS 5) of the Makhnevskaya cave in the Urals Mounts (Russia - KOSINTSEV, 2007). *Hystrix vinogradovi* was found in Italy in the ossiferous breccia of "Monte del Croc", in the Piedmont region, deriving from the Middle Pleistocene, and in the site of "Montignoso", in Tuscany, deriving from the Middle-Late Pleistocene (KOTSAKIS et al., 2003).

Lagomorpha: Leporidae
Lepus cf. europaeus

We found numerous remains of this taxon, among them there are several limb bones, skull fragments, and some mandible fragments. The morphological and biometrical features of these remains are referable to the

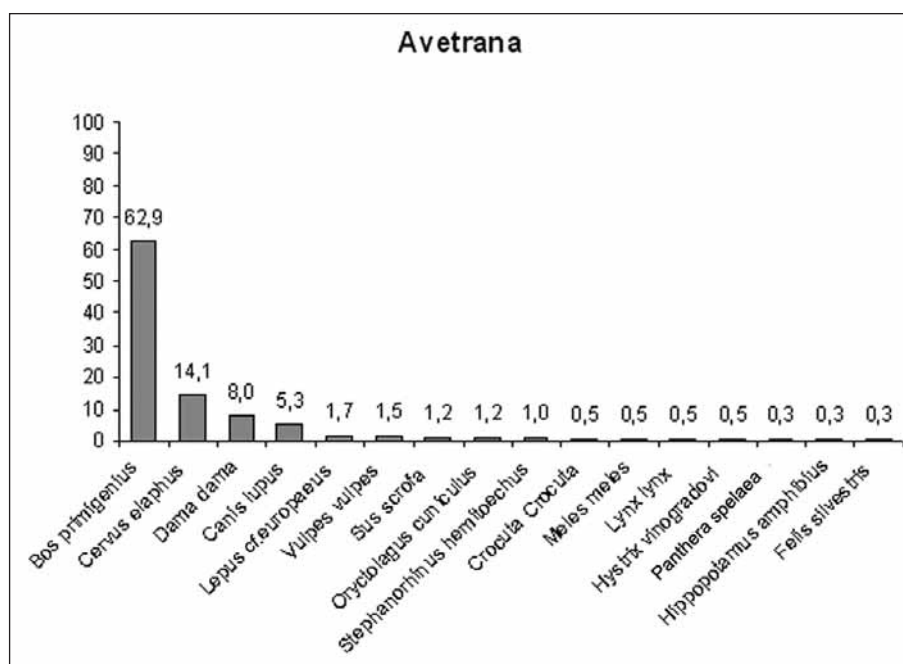


Fig. 3 - Percentage of Taxa in Avetrana Mammal fauna.
Percentuale dei Taxa nella mammalofauna di Avetrana.

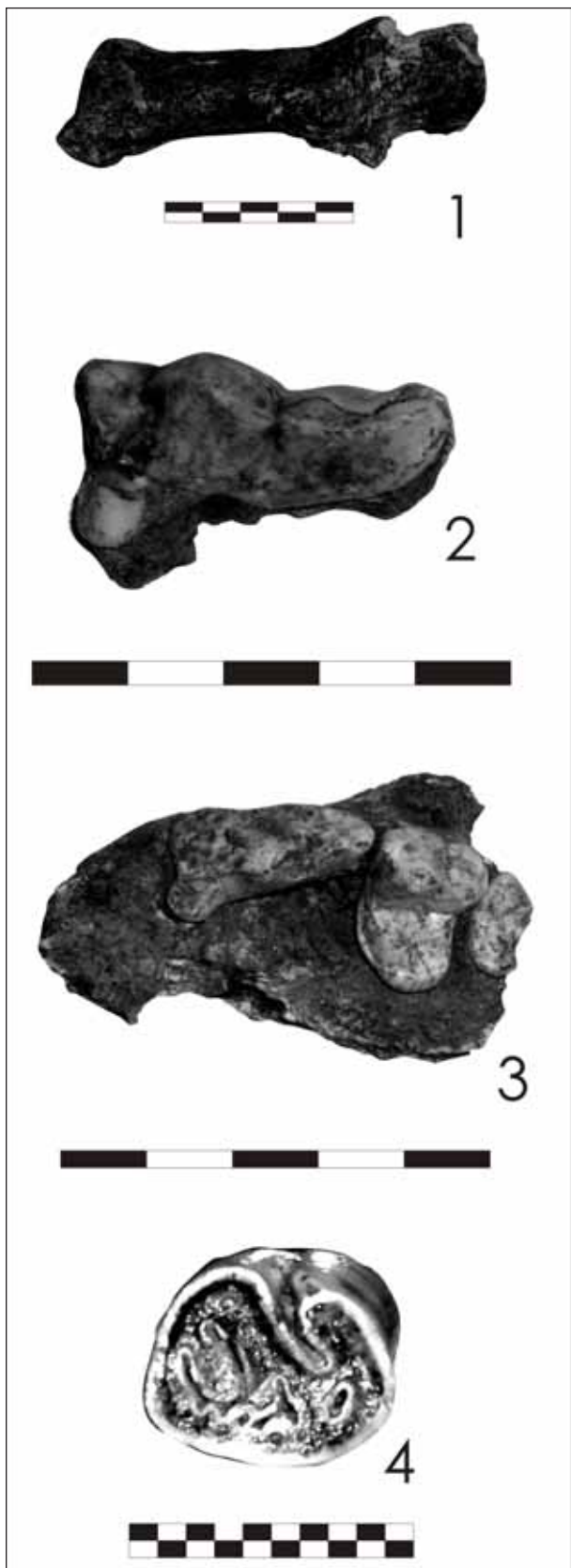


Fig. 4 - *Panthera spelaea*: 1, calcaneum. *Crocota crocuta*: 2, carnassial. *Canis lupus*: 3, maxillary fragment. *Hystrix vinogradovi*: 4, upper molar.

Panthera spelaea: 1, calcagno. *Crocota crocuta*: 2, ferino. *Canis lupus*: 3, frammento di mascellare. *Hystrix vinogradovi*: 4, molare superiore.

common hare (*Lepus europaeus* Pallas, 1778), such as already described by MILLER (1912), OGNEV (1935) and IACOANGELI (1996). As a matter of fact, recently the Italian hare *Lepus corsicanus* (DE WINTON 1898) has been considered as a valid species. Nowadays, this taxon lives in Central, Southern Italy and Sicily (TROCCHI & RIGA, 2002). For this reason, it seems reasonable to refer the hare fossil remains of Avetrana to *Lepus* cf. *europaeus*, and only further osteometric studies will enable to clear its taxonomic position.

Oryctolagus cuniculus (Linnaeus, 1758)

Only a few fragments of limb bones and some sporadic teeth can be ascribed to this species. The dimensions and the morphological features of the teeth are typical of the wild rabbit features.

Carnivora: Canidae

Canis lupus Linnaeus, 1758

Canis lupus is the best representative carnivorous of the Avetrana site, both for the frequency and the abundance of its remains. Various skeletal elements of this predator (almost all of which from layer 8) were found (Fig. 2, e).

We specifically identified teeth and phalanges. Complete long bones are absent, while we found quite numerous fragments of the articular epiphyses. Almost all the remains were attributed to adult of large size, from the dental wear and the fusion of the articular epiphyses. There was only a mandibular fragment attributable to a young individual.

The better preserved elements are some maxillary fragments (Fig. 4, 3), numerous carnassial teeth, and first maxillary molars with well-preserved main cusps, inferior canine and carnassial teeth and mandible fragments. The other remains found are distal epiphyses of humerus, some first phalanges, fragmented distal epiphyses of femur and tibia, one almost complete astragalus, distal epiphyses of metacarpus and metatarsus.

Vulpes vulpes (Linnaeus, 1758)

Vulpes vulpes remains are relatively scarce, but they are present in all the layers. These remains are essentially constituted of teeth (one complete canine tooth with its root, and three first maxillary molars); other remains are constituted by a distal epiphysis of tibia, one fragmented distal epiphysis of femur which is very damaged, and by an complete distal epiphysis of humerus. The dimensions and the morphological features are always compatible with that of the species.

Mustelidae

Meles meles (Linnaeus, 1758)

Remains referable to this small carnivorous were found in layer 3. They are exclusively composed by maxillary bones, some of which still retain well-preserved teeth. We discovered a maxillary bone with undamaged P⁴ and M¹ (the wear of the dental cusps is quite pronounced, and indicates an adult age), a left maxillary bone with the alveoli of the three incisors, the canine and the first two premolars, and a fragment of the right zygomatic bone. All these skeletal remains are probably referable to the same specimen.

Hyaenidae

Crocota crocuta (Erxleben, 1777)

The presence in the deposit of this great predator is found in several layers, always through the discovery of teeth, among which an upper carnassial (found in layer 5) is particularly revealing. The carnassial (Fig. 4, 2) is complete and very well-preserved, it is stout and well-developed. It definitely belongs to an adult subject with the typical features of *Crocota*. In fact, the protocone is inclined forward, the parastylus is small, well-developed and laterally slightly worn, the paracone along with the metacone are significantly long. The crown wear is mostly concentrated on the side of the tongue of cusps.

Felidae

Lynx lynx (Linnaeus, 1758)

Very rare fragments of long limb bones, along with a premolar tooth can be ascribed to this felid.

Felis silvestris Schreber, 1777

We found only a lower premolar, one first phalanx and some fragmented limb bones referable to this species.

Panthera spelaea (Goldfuss, 1810)

In the faunal assemblage the presence of this species is evidenced by the discovery from layer 8 of a fragmented calcaneum (Fig. 4, 1) and of a proximal portion of the third metatarsal bone which is particularly stout. On the calcaneum the lion's typical irregular protuberance is well noticeable; the distal portion is more fragmented, lacking in a part of the articular portion of the tarsal elements, and in the *sustentaculum tali* area. Only the internal part of the tendinous splint is present alongside the lateral margin, due to the lack of the part which overhangs the *sustentaculum tali*. Along the dorsal margin the peculiar coracoid process and the relative articular surface and the astragalus are well-preserved, as well as the underlying system of depressions which originates from the calcaneal sulcus separating the different articular facets.

Perissodactyla: Rhinocerotidae

Stephanorhinus hemitoechus (Falconer, 1868)

The only representative of Perissodactyla at Avetrana is this medium-large bicorn rhinoceros. It was recognized from the discovery of three teeth: one third lower fragmented molar (Fig. 5, 2), one lower premolar (Fig. 5, 1) and one well-preserved superior deciduous premolar.

The roots of the third lower fragmented molar are almost completely missing; part of the wall at the level of the neck is fractured and the lingual portion of the crown is absent, or visibly damaged. The tooth, with its typical double-C shape, which is peculiar for the lower molar of *Stephanorhinus*, presents a stout, well-developed wall. The enamel is only partially worn, merely at the summit portion, especially on the labial side of the crown. This molar, along with the inferior premolar, presents a wrinkled, rough surface due to the presence of a dense system of stripes and protuberances. This feature is peculiar of the *Stephanorhinus hemitoechus*

(GUERIN, 1980; LACOMBAT, 2005; BILLIA and PETRONIO, 2007) and it is useful to distinguish this species from *Stephanorhinus kirchbergensis*.

The second superior premolar belongs to a young adult individual (from the state of the crown wear). The roots are present, even if lacking in their apices, the neck is well visible and complete, alongside all the tooth perimeter. The crown is essentially intact, basically worn only in its central part.

Stephanorhinus sp.

A juvenile calcaneum, whose top is missing, along with a second quite fragmented metatarsal bone, with

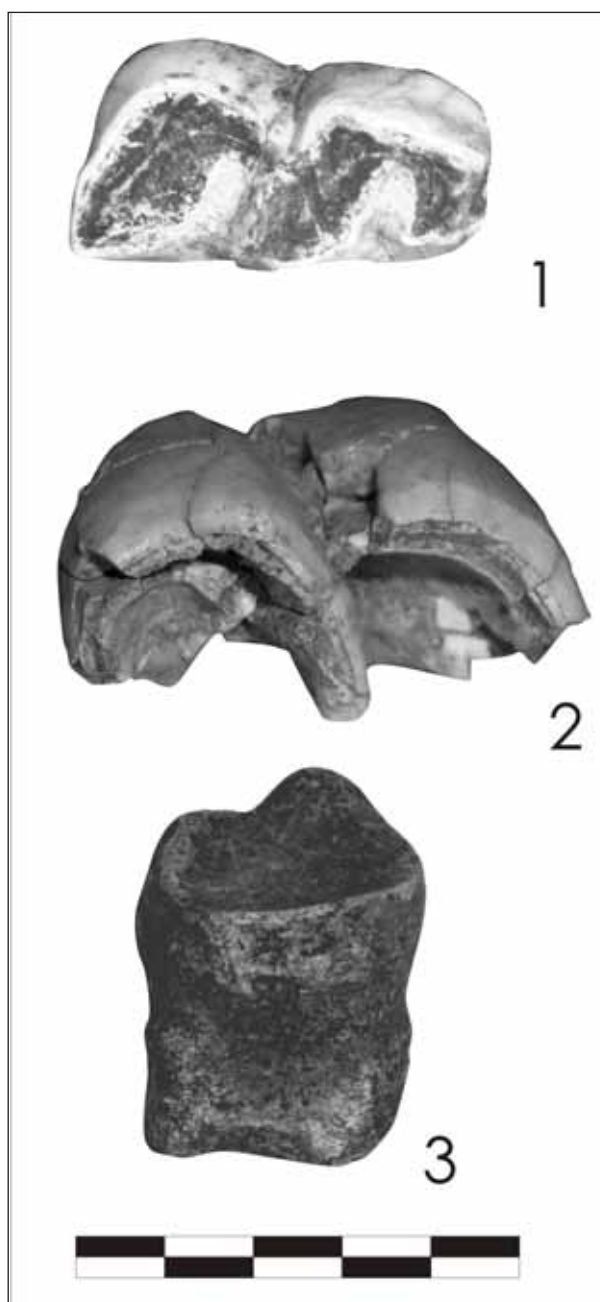


Fig. 5 - *Stephanorhinus hemitoechus*: 1, lower premolar, 2, lower molar. *Hippopotamus amphibius*: 3, second phalanx.

Stephanorhinus hemitoechus: 1, premolare inferiore, 2, molare inferiore. *Hippopotamus amphibius*: 3, seconda falange.

the only proximal epiphysis, can be referable to this genus. The juvenile calcaneum was discovered at layer 6 and is in good condition, except for its upper side which is absent because of the non-fusion with the central body. The articular surfaces, along with the other tarsal bones, are all complete and evident, the whole body appears complete, presenting only limited damaging.

Artiodactyla: Hippopotamidae
Hippopotamus amphibius Linnaeus, 1758

A fragmented diaphysis of the right humerus and a second phalanx (Fig. 5, 3) are the only elements which testify to the presence of *Hippopotamus* in the Avetrana faunal assemblage.

The fragmented humerus is particularly interesting; the fracture is at the level of the deltoid protuberance, the proximal portion is absent, while the epicondylar crest seems to be well-developed. We can note some traces of fractures at the base of this bone, mainly at the superior part of the epitrochlea. In fact we discovered some possible fractures which, maybe, were provoked in order to extract the medulla from this long bone.

The remarkable stoutness of the two bones which were found, along with their morphological features, leads us to believe they pertain to this species, after the comparison with analogous long bones deriving from Middle Pleistocene sites.

Suidae
Sus scrofa Linnaeus, 1758

This species is represented by a few remains, only from layer 5, 6 and 8. These remains are all in a good condition of preservation and are referable to adult subjects. They are especially teeth, among them there are two male upper canine teeth, and three right molars still found in an anatomical connection. The molar characteristic mammillary tuberosities, which allowed us to easily identify this species, are well visible and present the evidence of protracted wear, chiefly in the first molar.

Other two remains, from layer 8, are a fragmented second phalanx and a fragment of the distal epiphysis of the third, or fourth, metapodial bone.

Cervidae
Dama dama dama (Linnaeus, 1758)

The presence of this cervid in the deposit is demonstrated by the find of several skeletal elements. We found in particular teeth, phalanxes, and long bone fragments, mainly metapodial bones and articular epiphyses. We did not find complete long bones, while many elements have to be ascribed to young subjects, because of their dimensions and the state of the epiphyseal fusion.

The number of teeth is considerable. Some of them still adhere to the maxillary and mandibular bones.

From a general point of view, all the teeth are well-preserved, except for some elements which are fragmented or covered with calcareous concretions. Both the enamel folds, and the infundibula among the

cusps, which are indispensable for the identification of this species and to distinguish *Dama dama dama* from *Cervus elaphus*, are evident. The fourth lower premolar is slightly molarized and the anterior molar cingula are well pronounced, including the M3 cingula (Fig. 6, 4) where the posterior cingulum is also visible. These features allow us to deduce the primitiveness of this fallow deer compared to the last shapes found in various peninsula deposits.

Among the long bones, a fragmented femur, some metacarpal diaphyses, an almost complete metacarpus, a distal epiphysis of the left humerus, two young distal epiphyses of radii, and some phalanxes, are of particular interest.

Cervus elaphus elaphus Linnaeus, 1758

The presence of red deer is constant, at every stratigraphic layer. This species is the best representative after *Bos primigenius*; only in layer 2 and 7 red deer seems to be more copious.

Most of the remains are teeth (Fig. 6, 5), some of which are deciduous, and phalanxes. Complete long bones are absent, while the epiphyses and the fragments of articular portions are numerous. Some elements are referable to young individuals. The remains of antlers have quite evident grooves. They are essentially some fragments of the basal portions, with brow tine, bez tine and trez tine, this latter is close to the other two tines. This morphological characteristic allows us to ascribe these remains to a modern form of red deer.

Megaloceros sp.

We found a few remains of this genus at layer 7, among them there is a first phalanx which clearly presents the morphology of a cervid of large dimension.

Bovidae
Bos primigenius Bojanus, 1827

This bovid is the best represented species in the site of Avetrana. Its bones are all of large dimension and were found at all the stratigraphic layers, where they represent the most frequent and numerous specimens.

The largest part of the remains is composed of long bones, vertebrae, ribs, phalanxes and teeth (Fig. 6, 1-2-3). Except for a limited number of elements, which are referable to young subjects, almost the whole of the bones is attributable to adult and sub-adult specimens, in which the epiphyses are already completely knitted.

As for the cranial elements, a lot of fragmented hemi-mandibles and frontal bones with horns (Fig. 7) were discovered, among which some are ascribable to young subjects. The maxillary bones were very rarely found, often they are fragmented and frequently only constituted by the alveolar portions of the teeth. The teeth are the most recurrent remains. On the whole they are in very good condition and mostly belong to adult individuals.

The best preserved bones are represented by complete skeletal elements of long bones: one of which is a tibia, some are radii, there are numerous metacarpi (some are definitely stout and therefore ascribable to male individuals), there are several metatarsi, many car-



Fig. 6 - *Bos primigenius*: 1, mandibula; 2, metacarpus; 3, metatarsus. *Dama dama dama*: 4, lower molar. *Cervus elaphus elaphus*: 5, lower molar.

Bos primigenius: 1, mandibola; 2, metacarpo; 3, metatarso. *Dama dama dama*: 4, molare inferiore. *Cervus elaphus elaphus*: 5, molare inferiore.

pal and tarsal remains and very copious first, second and third phalanxes (numerous are still in an anatomical connection).

Lithic artefact

The raw material used of this single lithic artefact (Fig. 8) is a very homogeneous good quality flint, probably coming from a local collecting.

From a typological point of view, it is a *déjeté* side-scraper; the blank is a distal fragment of flake. The fracture seems to be contemporaneous to the debitage

and the retouch was done directly on the fragmented flake. From the fracture, on the dorsal face, an irregular retouch was done, this one seems to be correlated to the prehension of the tool because it is more evident in correspondence of more prominent arris. The retouch was made by direct percussion with hard hammer and it is direct, continuous, convex, short, semi-abrupt and scaled.

All those characteristics suggest an attribution of the artefact to the Mousterian.

DISCUSSION

The areal and vertical discontinuity of the continental sediments deposited in a karstic cavity, reduce the possibility of finding a correlation between deposits which are relatively close and, a fortiori, between deposits which lie in different regions. A way to partially resolve this problem is to leave the sediments aside and, through bio-chronology, and by means of the Faunal Units, to connect the bio-events (considered coeval) of one region.

In this perspective, according to GLIOZZI et al., 1997, during the Aurelian Age, the most recent Mammal Age, there are only two Faunal Units, Torre in Pietra and Vitinia. A series of reasons persuaded these authors not to consider further Faunal Units valid from the Italian peninsula coming from the last one hundred thousand years, when temperatures began to decrease (reaching the minimum in the early Last Glacial), and especially in the late Last Glacial (Stage 2 O.I.S.). The most important among these reasons (GLIOZZI et al., 1997) was the fact that, due to the differentiation of the micro-climates, none of the Faunal Units from this time could be considered as a representative of the biosystems which were present in all the area.

However, according to PETRONIO et al., 2007, a detailed and analytical study of the faunal appearance and disappearance during the Late Pleistocene, may help us to surpass this opinion and to understand whether particular environmental circumstances were really present in the Last Glacial, or if, on the other hand, considering the increasing closeness of the events, we have to take a different methodological approach. In fact, we must remember that as we near the latter part of the Pleistocene, apart from the open

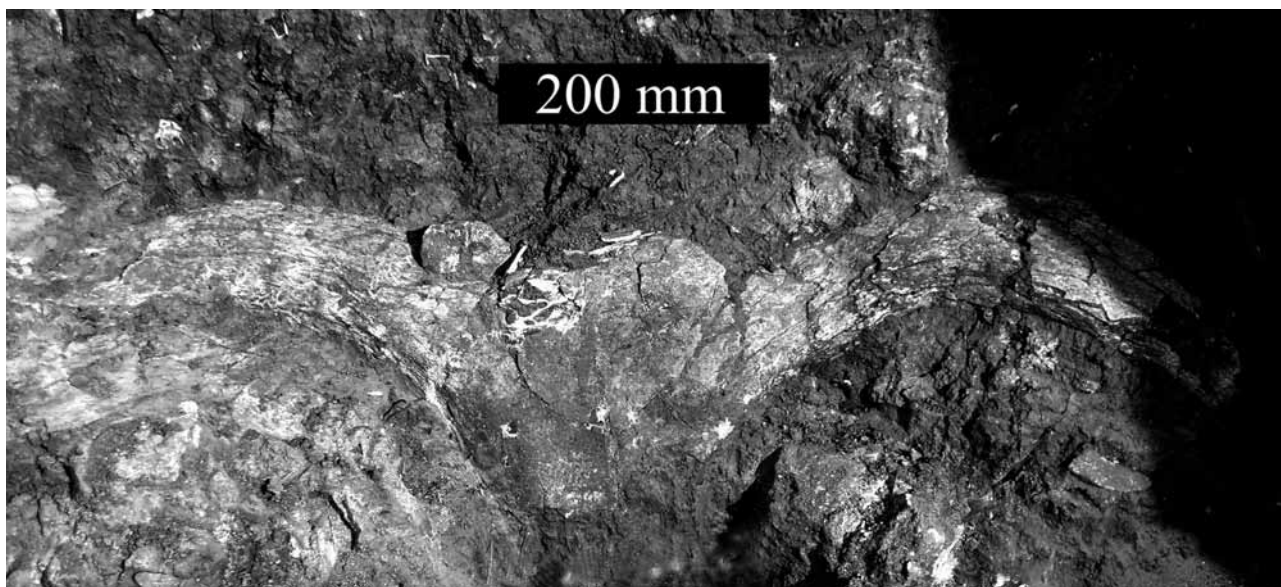


Fig. 7 - *Bos primigenius*: cranial remains in the karstic cavity.

Bos primigenius: resti craniali nella cavità carsica.

cast deposits such as the ossiferous breccias and the filling of the karstic cavities (i.e. deposit from Avetrana), also the cavern deposits begin to be more numerous (both along the coastlines, and in the internal areas of the peninsula). These caverns were also inhabited by ancient human beings. The abundance of this data allows us to collect more information than in the Middle and Early Pleistocene.

Consequently, the Late Pleistocene, which approximately corresponds to the latter part of the Aurelian Age, may be divided into two parts: the most ancient includes the last Interglacial and the early phase of the Last Glacial period (between ca. 128.000 and 75.000 years), and the second part, spanning the later part of the Last Glacial period between 75.000 and 11.600 years.

The climate interval of the most ancient part is very warm (Stage 5e O.I.S.). A temperate-hot period follows this, alternating with an oceanic climate (5d) which is more rigid and arid (5c) and a greater forest expansion (5b, 5a) with extremely various essences, as we

deduced from the pollinic sequences of "Valle del Castiglione" (Follieri et al., 1989), of "Lagaccione" in the Vulsini Mountains, and of the Vico lake.

Through the relative abundance of mammal remains, deriving from the early Late Pleistocene (Stage 5e O.I.S.), we realize that in this period the environments are more similar to our environment today; and in the meantime, we can note an increasing climatic and environmental, regionalism. Due to this phenomenon of micro-zones of climates and bioenvironments, and through the discovery of the micro-mammiferous and macro-faunal remains, we can recognize in northern Italy several different ambits, the Padano plain, the Piedmont plain, the Montane plain, and finally the Ligurian and the Adriatic versant. Regarding Peninsular Italy, the Apennines separate the Tyrrhenian environment, with a more temperate-humid-hot climate, from the Adriatic environment, which is characterized by a continental-arid-fresh climate.

There are still many taxa belonging to the previous Faunal Units, among the mammal fauna from this period which was discovered in the whole peninsula. We have to recall, among the pachyderms, *Elephas antiquus*, *Mammuthus chosaricus*, *Stephanorhinus hemitoechus* and the increasingly always more rare remains of *Hippopotamus amphibius*, which gradually had replaced *H. antiquus* since the late of the Galerian Age. *Capra ibex*, *Rupicapra rupicapra*, *Marmota marmota*, along with several Felidae and a wolf of large dimension, are very frequent in this period, as well as in the following periods. They obviously were present only in congenial environment, but probably appeared during Stage 6 of the palaeotemperatures. Remains of *Bos primigenius* and *Equus ferus* were also frequent, while we found fewer remains of *Equus hydruntinus*. For example, evidence of the climatic regionalization, which separates the Po region from the rest of the peninsula and from southern Italy, is found in the conspicuous remains of red deer, roe deer, *Bos primigenius*, *Ursus spelaeus*, *Felis silvestris*, *Lynx lynx* and, only

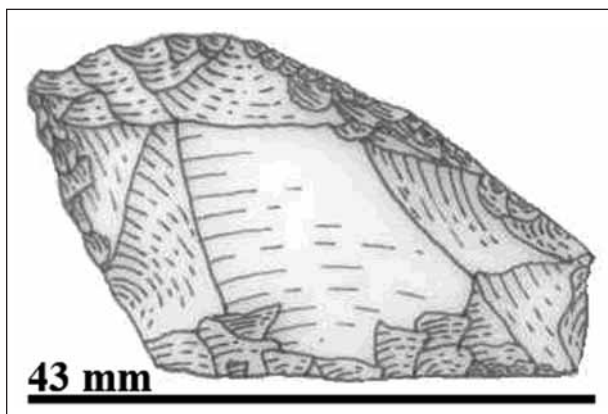


Fig. 8 - Artefact lithic musterian.

Manufatto litico musteriano

in north-eastern Italy, steppe micro-mammals, such as *Microtus (Stenocranius) gregalis*, *Microtus (Palasiinus) oeconomicus* and *Ochotona pusilla* (KOTSAKIS et al., 2003). *Capra ibex*, *Rupicapra rupicapra*, *Equus ferus* and *Equus hydruntinus* become more frequent when the climatic conditions turn out to be colder and less humid. The climatic regionalization is evidenced also by the early, gradual disappearance (in northern Italy, except for Liguria – Balzi Rossi) of the temperate-hot faunal component, which is essentially composed by *Hippopotamus amphibius*, *Elephas antiquus* and *Stephanorhinus hemitoechus*.

However the Cervidae, among the Artiodactyla, present some novelties. Red deer, which was common in all the Italian territories in the Early and Middle Aurelian Age (F. U. Torre in Pietra and Vitinia; GLIOZZI et al., 1997) with local archaic subspecies (*Cervus elaphus rianensis*, *Cervus elaphus aretinus*), is attested by its modern subspecies of *Cervus elaphus elaphus*. The modern fallow deer (*Dama dama dama*), which has multiplied since Stage 5 O.I.S., especially in the more temperate regions of the peninsula, descended from *Dama dama tiberina* (DI STEFANO & PETRONIO, 1998), a form of archaic Mediterranean fallow deer which multiplied in Europe during Stage 8 and 7 O.I.S.

As demonstrated by PETRONIO et al., 2007, it is possible to correlate the fossiliferous deposit of Cava Nuzzo (in the Melpignano area, near Maglie - Lecce, in the southern Salento area (BOLOGNA et al., 1994; DI STEFANO, PhD thesis, 1985) with Stage 5 b-a/4, where both the modern cervines are indicated, even though *Dama dama dama* is mostly present. The faunal data evidence an extensive arboreal cover, alternated with arid and hot open areas, which are populated by a dominant species, *Terricola savii*, and by the wild rabbit (*Oryctolagus cuniculus*). In this deposit, near the St. Sidero area (DE GIULI, 1983), apart from the two cervines, a rich mammal fauna was found, contained inside the karstic “Ventarole” present in the stones of Lecce. Along with the remains of pachyderms, (*Elephas antiquus*, *Stephanorhinus hemitoechus*) there are several specimens of *Crocota crocota* (whose morphological features are very similar to that of *Crocota crocota intermedia*), a form of large dimension of *Equus ferus*, *Equus hydruntinus*, *Bos primigenius* of large dimension, remains of *Bison priscus*, and a rich micro-mammal fauna. The presence of modern cervids, along with this mammal fauna, in the same deposit, allowed the authors (PETRONIO et al., 2007) to establish the new Faunal Unit of Melpignano, and consequently to determine a possible temporal interval which is included between 110.000 and 80.000 years for this Unit.

Also the first reports in Italy of the wholly rhino (*Coelodonta antiquitatis*) and of the Mammoth (*Mammuthus primigenius*) (GLIOZZI et al., 1997) demonstrate the passage from this chronological interval to the gradual climatic recrudescence, which includes the entire Italian peninsula and which characterizes Stage 4 O.I.S.. However, apart from these species deriving from north-eastern and north-central Europe, also some stenoterm taxa proliferate, or taxa that prefer steppe environments, with temperate-cold climates.

The fragmentation of the different faunal assemblages present in the various Italian regions, does not impede us to note the few biological common events

which allow us to define a last temporal interval, Faunal Unit of Ingarano, between 70.000 and 35.000 years BP (Petronio et al., 2007) from a biochronological point of view. This interval is characterized by the first evidences of *Coelodonta antiquitatis*, *Mammuthus primigenius*, and *Marmota marmota*, in Italy.

In the deposit of Ingarano (PETRONIO & SARDELLA, 1998) *Coelodonta antiquitatis* is associated with an extremely rich mammal fauna. In this chaotic grotto deposit, it is possible to distinguish at least two levels. The external level is the most ancient. Here we found, apart from the remains of *Coelodonta*, some remains of *Stephanorhinus hemitoechus*, *Hippopotamus amphibius*, *Elephas antiquus*, *Vulpes vulpes*, *Cervus elaphus elaphus*, and of *Equus hydruntinus*. The second level was the actual deposit of the grotto, here we found, in addition to a notable abundance of large, medium and small size carnivores, a faunal assemblage (PETRONIO & SARDELLA, 1998) evidencing a gradual climatic recrudescence (*Nyctea scandiaca*, *Gulo gulo*, *Rupicapra rupicapra*, etc...).

Therefore, this is the palaeobiological context of the early Late Pleistocene. The faunal assemblage found in the site of Avetrana, in the opinion of the authors, must be collocated in this period. The biochronologic detailed distribution of the different taxa allows us to draw some conclusions.

1. The presence of *Hystrix vinogradovi* in the faunal assemblage, as already mentioned, represents a first significant element for the biochronological collocation due to the fact that (KOTSAKIS et al., 2003) this rodent becomes extremely rare during the Late Pleistocene. The evidence of its remains is considered extremely dubious, mainly if it is deduced from the dimensional elements, instead of from the morphology of its molars. In fact, there is some evidence of porcupines in the Late Pleistocene, but they are the remains of a discussed stratigraphic position (BARTOLOMEI, 1969; KOTSAKIS et al., 2003). Therefore, the remains of *H. vinogradovi* found among the faunal remains in the site of Avetrana are, at the present time, the most recent discovery in Italy, and the discovery in the most southern part of Europe.
2. Also the report of the remains of hippopotamus becomes even more rare during the Late Pleistocene, limiting the late chronological interval that we must consider for the faunal assemblage of Avetrana. In fact, as already mentioned, among the remains of the entrance to the cave of Ingarano (PETRONIO & SARDELLA, 1998), along with the remains of *Coelodonta antiquitatis*, the last appearance of *Hippopotamus amphibius* is cited. The latter, according to our knowledge today of the first manifestation of the wholly rhinoceros, allows us to link the fossiliferous sediments of Ingarano with Stage 4 of the palaeotemperatures, or near this Stage.
3. The dental structures of the remains of *Dama dama* represent a morphological element which limits the inferior chronological interval of the faunal assemblage from Avetrana. This element indicates a temporal interval which is posterior to the Middle-Late Pleistocene. As already mentioned, the molari- zed premolars, and the cingula which are clearly evident, allow us to lean toward the first archaic forms

of the modern fallow deer. Also the modernness of the structure of the fragments of the antlers of *Cervus elaphus*, cause us to exclude elaphine forms from the Middle Pleistocene.

4. We find in literature that the height of some species decreased from the Middle-Late Pleistocene, to the Late Holocene. This happened, for example, to *Capra ibex* (BAROLOMEI & SALA, 1972), *Vulpes vulpes* (PETRONIO *et al.*, 2006), *Equus ferus* (EISENMANN & DAVID, 2002; CONTI *et al.*, in press) and to *Bos primigenius* (GRIGSON, 1969; CERILLI & PETRONIO, 1998). The morphological structures, and in particular the dimension of *Bos primigenius* found in Avetrana, seem to lead us to believe their biochronological placement is in the early Late Pleistocene. In fact, if we consider the publications of DEGERBØL & FREDSKILD (1970), BRUGAL (1983), GRIGSON (1969) and CERILLI & PETRONIO (1998), concerning the evolutive degree of the different populations of *Bos primigenius* deriving from the European Pleistocene, we can identify a particular evolutive trend. During this trend, the height and stoutness, in particular of the limbs, constantly decreased. However, even though we had a large quantity of measurements of tibiae, humeri, radii, femurs, and especially of phalanges and small bones (i.e. carpi and tarsi), it was not possible to obtain useful indications since we did not have statistical significant samples. We considered in particular the metapodial bones as they are numerous and because of their particular morphofunctional importance, as well. However, in general all of the bones of *Bos primigenius* have decreased dimensions. In fact, from the statistical analysis carried out on the metacarpi and metatarsi of *Bos primigenius* (Fig. 9), a noticeable lowering of its dimension seems to be evident, since the Late Pleistocene. This trend allowed us to identify a common area between the values of the population from Avetrana and the values referable to the populations from the early Late Pleistocene. The scattering charts and the general charts give us some consistent information. In the scattering diagram we asso-

ciate the values of the transversal distal diameters with the max. length (Fig. 9 a). In the general chart we consider the variations of the max. length from the Middle-Late Pleistocene, to the Holocene. In the diagram concerning the metacarpi, we can clearly note two areas. The first one is typical of the Holocene populations. This area is mostly concentrated in the left lower part of the graph and clearly shows us that these populations had a reduced height and that they were not very robust. The second area, which refers to the populations from the Middle-Late Pleistocene to the Late Pleistocene, is mostly concentrated in the central and right side of the graph. This area obviously indicates larger

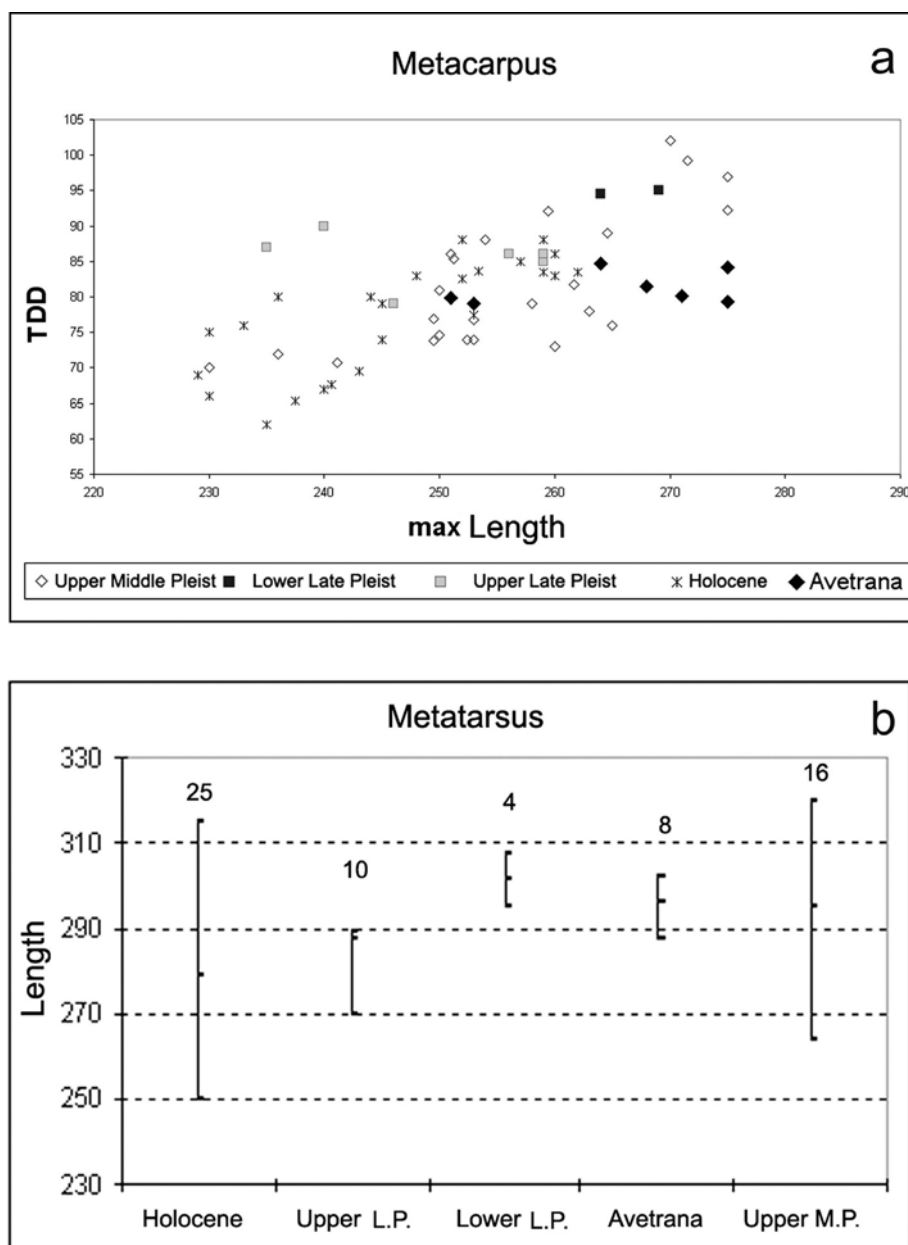


Fig. 9 - *Bos primigenius*: a) scattergram of max length and transversal distal diameter in metacarpus; b) variations of the max. length in metatarsus from the Middle-Late Pleistocene, to the Holocene.

Bos primigenius: a) distribuzione della lunghezza massima e del diametro distale trasverso nei metacarpi; b) variazione della massima lunghezza nel metatarso dal Pleistocene medio superiore all'Olocene.

dimensions and more robust bones. The Avetrana population approximately corresponds to the latter area, even if the subjects of larger dimensions, probably males, are more slim.

In the diagram concerning the metatarsi (Fig. 9 b), the data of the minimum, medium and maximum values of the maximum length indicate that since the early Late Pleistocene the aurochs dimensions gradually and clearly decreased. The data of the Avetrana assemblage show a strict analogy to the values which characterize the populations from the early Late Pleistocene, both in the scattering chart (Fig. 8 b), and in the graph regarding length (Fig. 9 b).

CONCLUSION

From the biochronological analysis of the mammal fauna from Avetrana (Fig. 10), we can detect some data which allow us to exclude a chronological interval which expands over the early Late Pleistocene, due to the presence of *Hystrix vinogradovi* and *Hippopotamus amphibius*. On the other hand, the presence of archaic forms of *Dama dama dama* and *Cervus elaphus elaphus* shows (PETRONIO et al., 2007) an age which expands from the first part of Late Pleistocene to the initial phases of Stage 4 O.I.S.. However, also the presence as well of a quite archaic Mousterian manufacture is not in contrast with this faunal assemblage, even if it isn't suf-

ficient to define a chronological interval. Finally, this interval of time can be confirmed, as already shown, by the dimension, in particular of the limbs, of *Bos primigenius*. Taking these factors into consideration, the authors assume that the mammal fauna from Avetrana can be attributed to the F.U. of Melpignano (PETRONIO et al., 2007).

Regarding the genesis of the deposit, the observations made on the structure of the cavity, on the sediments of the filling, the physical status and spatial disposition of the fossil bones suggest that the stratification originated from a series of depositional events, which were independent and exceptional. The fossil bones are usually well preserved, with the exception of those of Layer 9. No clear evidences of human activity and of gnawing by rodents and carnivores have been checked, several bones are fractured. Different part of the skeleton of the ungulates are not equally distributed. These data suggest the main role of sin- and post-depositional physical and chemical factors. Water has been the principle, if not the only one, depositional factor. Moreover, many bones are complete, some of them articulated, without clear signs of transport. Thus, carcasses (in particular those of *Bos primigenius*) were not carried by water for long distances, their disposition being quite chaotic in the deposit. Some intentional fractures can be noticed only on a hippo humerus. That, together with the collection of a single Mousterian

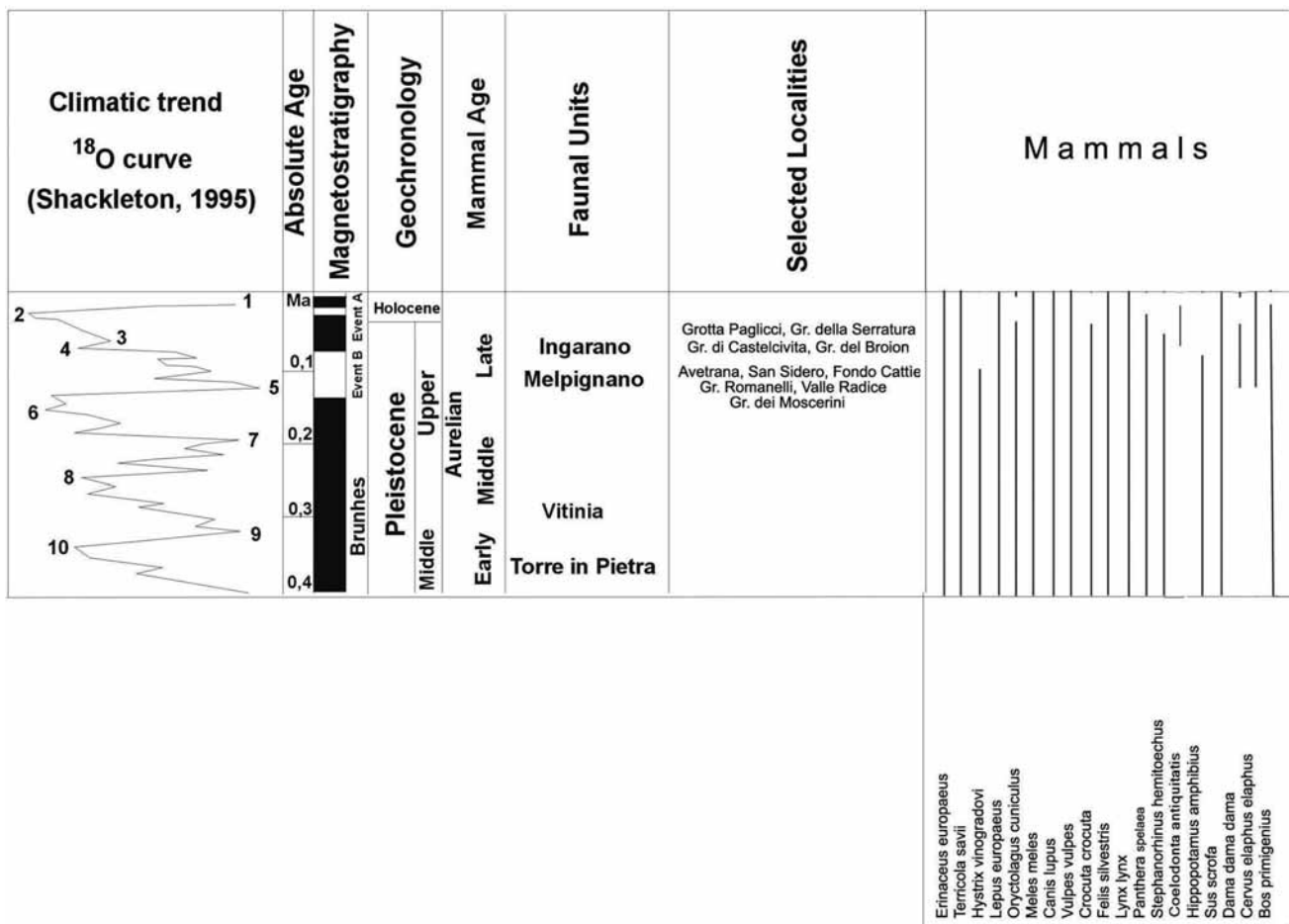


Fig. 10 - Biochronology of Late Pleistocene.
Biocronologia del Pleistocene superiore.

tool, suggest a human frequentation of the area, but without an active role in the deposition. The lower part of the karstic cavity, including the little fissures of level 0, was only filled by debris and by small bones, because it was the only material which could pass through the small karstic microfissures. The actual levels of the main cavity (levels 1-9), underwent a slight modification and remixing on the top. Moreover, due to the lack of evident surfaces of erosion and of palaeosoils, we can not determine any periods of outcrop and exposure. The run-off water and the flood-water, probably due to conspicuous showers or to the overflow of adjacent streams, caused the detrital sediments, the clastoi of various dimensions, and the bones of the vertebrates which the water found along its way, to be carried inside the karstic fissure.

The hypothesis that the fossiliferous deposit was the result of a series of individual events, which occurred close to each other, is corroborated and confirmed by the presence of this faunal assemblage which is coherent from a chronological point of view. The assemblage remains practically unaltered in its general features, aside from the different levels. This is possible only when the time passed from the first and the last event is insignificant from a geological point of view.

Some general considerations on the palaeoenvironmental conditions of the area derive in particular from the presence at level 0 of *Terricola savii*, and of the lagomorphs, which indicate the presence of a temperate environment characterized by large ample spaces. This aspect is also confirmed by the avifauna. In fact, the fossil remains of birds found in Avetrana, even if belonging to a few species, provide us with homogeneous indications from an ecological point of view, allowing us to retrace the Avetrana habitat during the phases of the formation of the fossiliferous deposit. All the species found are linked to an open environment with the presence of rocky outcrops on which it is possible to nidificate. This is mostly suggested by the discovery in the deposit of *Athene noctua*, *Columba livia*, *Pyrrhocorax graculus*, and *P. pyrrhocorax*. The open areas were inhabited by other species (i.e. *Otis tarda* and *Perdix perdix*).

The remains of large and medium dimension are mostly present in the fossil assemblage. We can consequently assume that it was not a predator that caused the deposition of these remains. This detail coincides with the fact that we mostly found remains of cock-of-the-rock species, while the species which are typical of open environments are sporadic, and were carried inside the deposit along with countless mammal remains.

Regarding the faunal assemblage of the large mammals, we can gather general information concerning an environment characterized by an open forest, or by a grassland-park, variously wooded. The great quantity of aurochs, and the presence of deer and fallow deer emphasize an environment characterized by large wooded areas, that are rich in glades, with both ample and open spaces where, presumably, the rhinoceros and the most part of the carnivorous forms (found in the faunal assemblage) lived. The wild pig and hippopotamus were also present, even though they were not copious, suggesting the presence of expanses of water and of an area which was more humid than the actual one.

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