

NOTA BREVE

REMARKS ON THE STRATIGRAPHY AND BIOCHRONOLOGY OF THE LATE PLEISTOCENE DEPOSIT OF INGARANO (APULIA, SOUTHERN ITALY)

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Riassunto. Ulteriori considerazioni sulla stratigrafia del deposito di Ingarano (Foggia) consentono di ipotizzare la presenza di tre associazioni faunistiche riferibili ad un intervallo ben definito del Pleistocene Superiore. La associazione più antica (**Ingarano a**) può essere riferita allo stadio 4 delle paleotemperature, quelle più recenti rispettivamente allo stadio 3 (**Ingarano b**) e allo stadio 2 (**Ingarano c**). I dati faunistici si accordano con l'alternanza delle diverse condizioni climatiche nel corso del Pleistocene Superiore.

Abstract. New field data on the Late Pleistocene deposit of Ingarano (Foggia) allow us to hypothesise the occurrence of three faunal assemblages (**Ingarano a, b, c**) respectively referable to isotopic stages 4, 3 and 2 of the palaeotemperature scale. The palaeontological data match with the alternating palaeoclimatical conditions during Late Pleistocene times.

Introduction.

The Late Pleistocene karst cave deposit of Ingarano is exposed at 270 m a.s.l. along the railway of Gargano, near Apricena (Foggia, Southern Italy).

The first studies started in the second half of '80ties, but only since 1992 the complete stratigraphical succession has been exposed by quarry works. These activities and the previous quarry works partially disturbed or hid the stratigraphy of the cave succession, which appears chaotic. From this succession a rich vertebrate fauna and some lithic tools have been recorded and described (Capasso Barbato et al., 1992; Petronio et al., 1996).

The study of the fossils allow us to point out two possible biochronological hypothesis: a single or some distinct faunal assemblages. In order to test these two hypothesis and to point out a more detailed stratigraphy of the cave succession new geological field surveys have been carried out in the area. The vertebrate fauna has been considered following the updated biochronological framework for the late Aurelian Mammal Age (Gliozzi et al., 1997). These new researches allow us to point out a more detailed stratigraphy and biochronology for the

locality of Ingarano, with the definition of three distinct faunal assemblages and the general lines of the paleoecological evolution of the area.

Stratigraphical framework.

Two fossiliferous deposits can be identified (Fig. 1): 1) a sandy-clays deposit (**b**), including very big calcareous blocks, which is exposed in external position to the cave deposit; 2) a succession of 12 m, which testifies

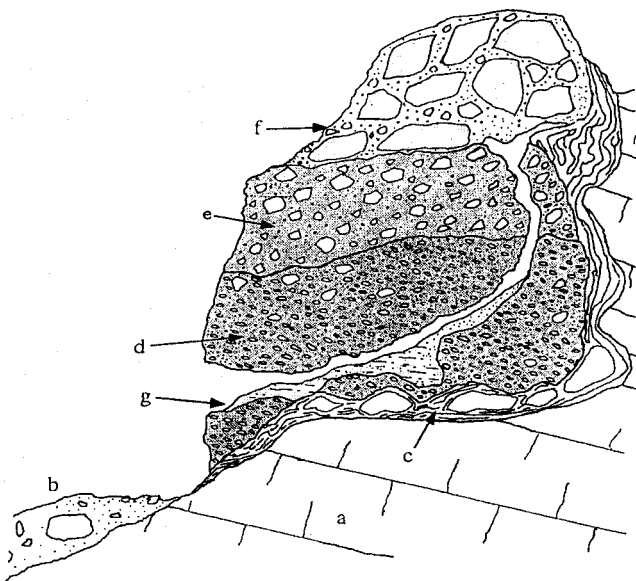


Fig. 1 - Stratigraphical sketch of the Late Pleistocene fossiliferous deposit of Ingarano (Foggia, Southern Italy): a) calcareous bedrock (Calcari di Sannicandro Fm.); b) silty-clays with calcareous blocks; c) alabastrine and encrusted phosphatic layer; d) conglomerate with round and flattened calcareous pebbles of small size (less than one cm) with silty reddish matrix; e) conglomerate with calcarenitic large sized pebbles (1 m length), cemented by a calcareous matrix; f) conglomerate with calcareous pebbles scarcely rounded (sized more than 10 cm), cemented, with a prevalently calcareous matrix; g) incoherent silty sediment.

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Fig. 2 - Ingarano (Foggia, Southern Italy). Layer b: 1) *Stephanorhinus hemitoechus*: fragmentary maxillary bones with teeth (occlusal view); 2 and 3) *Coelodonta antiquitatis*: fragmentary humerus (posterior and anterior view). All the figures are approximately 45% natural size.

chemical analysis with the $^{230}\text{Th}/^{234}\text{U}$ method on different samples of the speleothem gave an age of 40.000 ± 2.000 for the phosphatic concretion due to the guano of the birds which lived in the area, while the speleothem stopped its growing at about 58.000 ± 2.000 (Petronio et al. 1996). From layer c come the vertebrate bones representing several taxa: Aves - *Aquila chrysaetos*, *Columba livia*, *Pyrrhocorax graculus*; Mammalia - *Cervus elaphus*, *Dama dama dama*, *Lynx lynx*, *Canis lupus*, *Canis ex gr. arnensis-mosbachensis*, *Vulpes vulpes*, *Martes sp.*, *Mustela nivalis*.

Above layer c a conglomerate with round and flattened calcareous pebbles of small size (less than one cm), with silty reddish matrix, poorly cemented is exposed (d). This conglomerate gradually evolves upwards into another conglomerate with calcareous scarcely rounded pebbles of larger size (more than 10 cm), more cemented, with a prevalently calcareous matrix (e). A great number of fossil bones (represented often by some isolated remains) comes from these two layers: *Equus hydruntinus*, *Bos*

different phases of the filling of an ancient cave, today destroyed by the quarry works.

The sandy-clays sediments (b) are in unclear stratigraphical relationship with the cave succession and contain remains of several fossil mammals: *Stephanorhinus hemitoechus*, *Coelodonta antiquitatis*, *Hippopotamus amphibius*, *Elephas antiquus*, *Panthera spelaea*, *Vulpes vulpes*, *Apodemus sylvaticus*.

The Calcare di Sannicandro (a) constitutes the bed rock of the cave, in which an intense karst activity formed stalagmites and a thick alabastine layer. These layers are encrusted with phosphatic material (c). A geo-

primigenius, *Cervus elaphus*, *Capreolus capreolus*, *Rupicapra sp.*, *Felis silvestris*, *Lynx lynx*, *Panthera pardus*, *Crocota crocuta*, *Canis lupus*, *Canis ex gr. arnensis-mosbachensis*, *Vulpes vulpes*, *Ursus arctos*.

At the top of the succession, with a thickness of almost 3 m, a conglomerate with calcarenitic large sized boulders (1 m length), cemented by a calcareous matrix (f), is exposed, testifying the phase of closing of the cave, when the vault fell down.

The passage between the layers e and f is characterised by a different inclination of the deposits; twelve lithic implements of Levallois technique comes from the



Fig. 3 - Ingarano (Foggia, Southern Italy). Layer c: 1) *Lynx lynx* - skull (at the top) (palatal view); emimandible (at the bottom) (labial view). All the figures are approximately 70% natural size.

top of layer e and their state of preservation allow to hypothesise a very low degree of transportation (Petronio et al., 1996).

Some small galleries, probably connected together, exist into the levels d and e. They are partially filled with a silty incoherent sediment (g), with several fossil bones of micromammals and birds (Petronio et al., 1996). Some bones of mammals and birds are partially covered by phosphatic encrustation and for this reason are clearly coming from layer c.

The taxa surely coming from layer g are: Aves - *Aquila chrysaetos*, *Falco peregrinus*, *Falco tinnunculus*, *Alectoris graeca*, *Circus* nov. sp., *Perdix perdix*, *Columba livia*, *Nyctea scandiaca*, *Pyrrhocorax graculus*, *Pyrrhocorax* sp., *Corvus corax*, *Corvus monedula*; Mammalia - *Erinaceus europaeus*, *Myothis blythi*, *Oryctolagus cuniculus*, *Lepus europaeus*, Arvicolidae indet., *Microtus (Terricola)* sp., *Microtus* ex gr. *arvalis-agrestis*, *Apodemus sylvaticus*, *Eliomys quercinus*.

Fauna.

Layer b.

The fauna assemblage coming from the sandy-clays sediments is characterised by the presence of the "warm" species *Stephanorhinus hemitoechus* and the "cold" *Coelodonta antiquitatis*.

Stephanorhinus hemitoechus is represented by skull fragments with a complete series of teeth - Fig. 2.1-, a complete tibia and other parts of limb bones, probably belonging to the same juvenile specimen. Even if it is a juvenile specimen some dental features allow a quite sure taxonomical determination. Premolars and molars show the peculiar undulate profile of the ectoloph and the tendency to develop quite ipsodont teeth. These characters are typically of *Stephanorhinus hemitoechus* and are shared with the "etruscoid" forms.

Coelodonta antiquitatis is represented by a fragmentary upper tooth (Capasso Barbato et al. 1992), a partial humerus (fig 2.2, 2.3), carpal bones and some metacarpal in anatomical connection, radius and tibia). The fauna is completed by *Hippopotamus amphibius* (a fragmentary molar and a proximal epiphysis of a femur); *Elephas antiquus* (a fragment of a molar), *Panthera spelaea* (part of a very large sized tibia), *Vulpes vulpes* (some limb bones) and *Apodemus sylvaticus* (a complete emimandible).

Cave succession.

Layer c.

Bird remains are represented by several limb bones, with *Pyrrhocorax graculus* the most common species. Among mammals, the boreal lynx is the best represented taxon with skull fragments, mandibles and limb bones referable to almost five specimen (Fig. 3). A study still in progress is evidencing some peculiarities of these lynxes. The skulls are comparable in size to the actual Scandinavian *Lynx lynx*, but show proportionally less developed teeth, intermediate in size between the northern lynxes and the Pleistocene samples of *Lynx pardina spelaea* (Werdelin 1981).

Canids and mustelids are quite common in this layer. The occurrence of *Canis lupus* is testified by several limb bones, while also a small wolf-like dog occurs. The presence of a middle sized canid in Late Pleistocene deposits from Southern Italy have been considered as a persistence of a taxon of Galerian origin (Di Stefano et al., 1992; Capasso Barbato & Gliozzi, 1996). The systematic position of this dog is still unclear. The Mediterranean Galerian deposits are characterised by the occurrence of *Canis* aff. *arnensis* (Rook & Torre 1996)

Discussion.

In the first study on this deposit (Capasso Barbato et al., 1992), the presence of two distinct faunal assemblages, respectively referred to the stage 4 of the isotopic scale (the fauna with "pachyderms") and to the stage 2



Fig. 5 - Ingarano (Foggia, Southern Italy). Layer **d**: *Ursus arctos* - skull and mandible (approximately 45% natural size).

(in particular the avifauna, with the “cold” taxon *Nyctea scandiaca*), have been hypothesised.

In a further work, (Petronio et al., 1996) the hypothesis of a single faunal assemblage, referred to the isotopic stage 3, was considered as more probable for the coexistence of “cold” and “warm” taxa. New field data allow us to test these different hypothesis showing a more articulated stratigraphical framework outlined in this paper.

At the present time, there is no evidence of direct stratigraphical relationships with the cave succession for deposit **b**, with the “pachyderm” remains. No fragments of “pachyderms” come from the other layers. The layer **b** may probably be older than the cave succession. The coexistence of two species of rhinos, ecologically distinct, of the hippo and of the forest elephant may be explained, if we consider the faunal assemblage coming from the layer **b** as homogeneous, referring it to the isotopic stage 4 (Ingarano **a**, Fig. 6).

In particular the chronology of this fauna is defined by the occurrence of *Coelodonta antiquitatis*, which was widespread in Italy in Late Pleistocene since the isotopic stage 4, while the other large mammals are frequent in the isotopic stage 5 and survive until the isotopic stage 3 (Late Aurelian Mammal Age, Gliozzi et al., 1997). However the coexistence of *Coelodonta* and *Stephanorhinus*, even if rare, has been recorded in some European localities as Achenheim (Alsace, France) and Balauzière (France) (in Guerin, 1980, with bibliography). The occurrence of the woolly rhino, in association with

the other pachyderms, which show a wider ecological significance, may testify the beginning of the climatic deterioration referred to the isotopic stage 4.

Considering the cave succession, the geochemical analysis with the $^{230}\text{Th}/^{234}\text{U}$ method of the phosphatic encrustation gave an absolute age of 40.000 \pm 2.000 (Petronio et al., 1996), in consequence this is the age of the fossil bones coming from level **c**. For this reason it is possible to refer the faunal assemblage to the isotopic stage 3 (see Gliozzi et al., 1997). Also the vertebrate fauna coming from the layers **d** and **e** can be referred to the isotopic stage 3, but it testifies the

progressive change toward more temperate-cold climatic conditions (relative abundance of *Cervus elaphus*, occurrence of *Equus hydruntinus* and *Rupicapra* sp.).

The medium sized dog, even if rare, coexists with the wolf in layer **c**, while doesn't occur in layers **d** and **e**, where there is the predominance of *Canis lupus*. A similar tendency seems to be present in the Grotta Romanelli succession with the *Canis* ex gr. “*arnensis-mosbachensis*” more frequent than wolf in “terre rosse” and very rare in the younger “terre brune” with the predominance of *Canis lupus* (Tagliacozzo, personal comm.).

As a matter of fact, the maintenance of delicate anatomical structures as nasal coanes (*Vulpes vulpes*, *Canis lupus*, *Felis silvestris* from layer **d** and **e**) and encephalic casts (*Lynx lynx* from layer **c**), besides some examples of fossil bones in anatomical connection (*Ursus arctos* from layer **d**), suggest a low degree of transportation for the fossils and a quite high degree of the sedimentation ratio.

Also the study of the lithic implements coming from the top of level **e** match with both the deposition setting than with the chronological considerations (the Levallois technique is not used after approximately 35-37.000 B. P.) (Petronio et al., 1996). The fossils coming from layers **c**, **d** and **e** may be included in the faunal assemblage Ingarano **b** (Fig. 6).

The fauna coming from **g** (Ingarano **c**) is younger than the other faunal assemblages, probably referable to the isotopic stage 2, with cold climatic conditions testified by the predominance of the snow-owl.

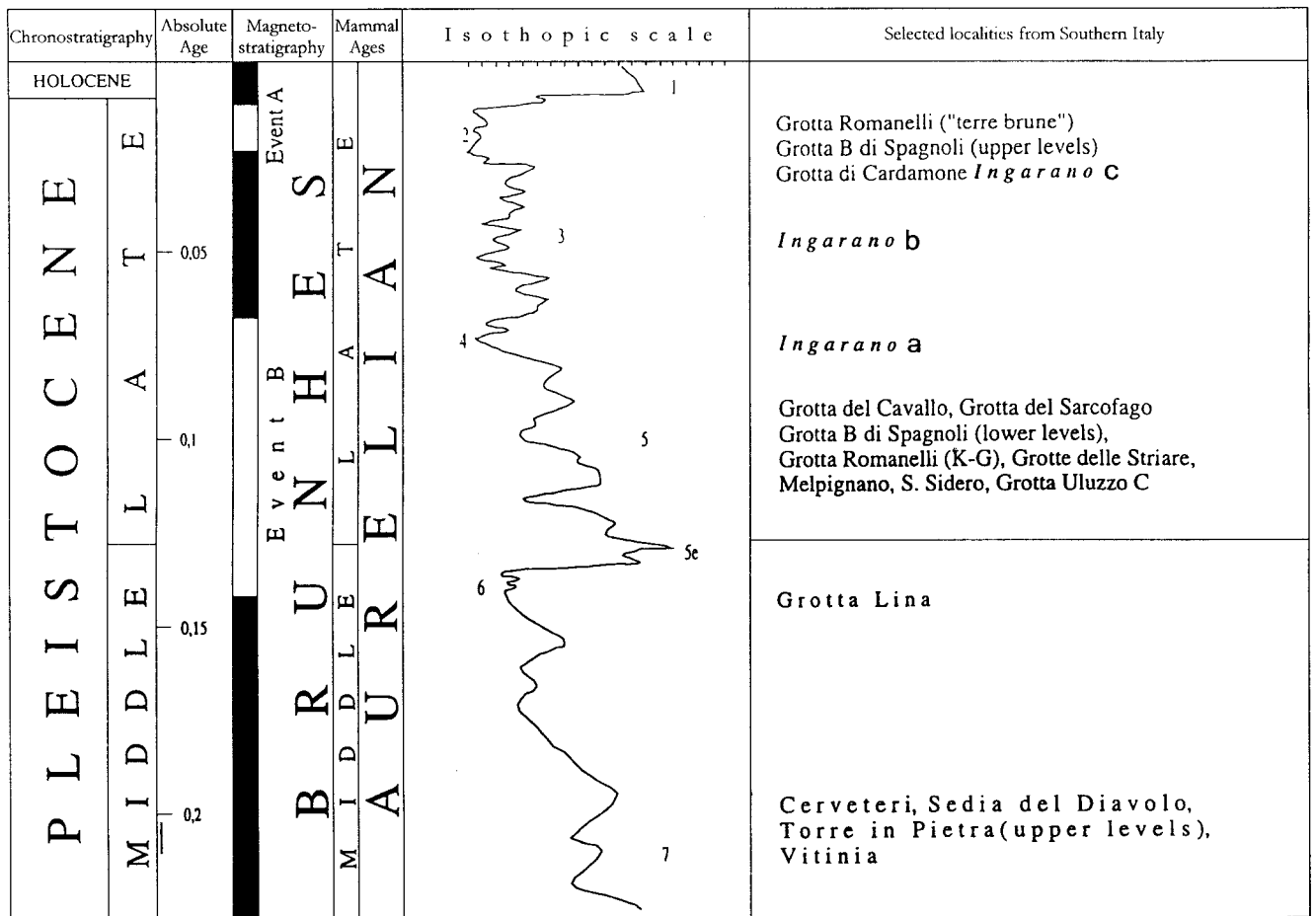


Fig. 6 - Revised chronological framework of Ingarano faunal assemblages in comparison with some late Middle and Late Pleistocene selected localities from Southern Italy (from Petronio et al. 1996, modified).

Palaeoecological notes.

From the fossiliferous deposit of Ingarano have been identified three faunal assemblages (a, b, c) referable to the late Aurelian mammal age.

The study of the assemblages allow us to stress some considerations about the palaeoenvironmental evolution of the area. The fauna with *Coelodonta* and *Stephanorhinus* (**Ingarano a**) is probably to refer to the beginning of the climatic deterioration occurred in isotopic stage 4. The presence of these two genera of rhinos testifies the existence of plains and open areas.

The fauna **Ingarano b** is characterised by the occurrence of the modern subspecies of the fallow deer in layer c, which may be referred to warm-temperate climatic conditions. The fauna of the layers d and e testify instead the changing of the climate (occurrence of *Equus hydruntinus* and *Rupicapra* sp.), with the development of more temperate-cold conditions and the reduction of the forested areas. The coldest phase, related to the last Pleniglacial (isotopic stage 2), is testified by the fauna **Ingarano c**, characterised by the abundance of the snow-owl *Nyctea scandiaca*, which today is widespread in Northern latitudes and is specialised in preying lemmings.

Conclusions.

The analysis of faunal assemblages **Ingarano a**, **b** and **c** allow to implement the knowledge on the late Aurelian mammal faunas (Glozzi et al., 1997). The Late Aurelian, is referable to a time span included between the Eemian and the end of the last Glaciation. No Faunal Units have been defined because the late Aurelian faunas are characterised by the disappearance of large and medium mammals. In the corresponding time span some climatic events occur. These events, in particular in the Adriatic coast, have a great influence in the faunal composition and in the causes of their disappearances. However, another important element to consider is the rule of *Homo neandertalensis* and *Homo sapiens*. Finally, the great amount of data referable to late Aurelian faunas if on the one hand gives the possibility to define a paleoecological framework of the microclimatic and environmental conditions for the different areas of the peninsula, on the other hand do not allow to choose a single fauna to define a Faunal Unit.

For this reason the Ingarano faunal assemblages testify the disappearance of the large "pachyderms" in an earlier moment than 35.000 B.P. (**Ingarano a**), a quite progressive climatic deterioration (**Ingarano b**) corre-

sponding to the isotopic Stage 3, toward the cold phase of the isotopic Stage 2 (Recent Würm) with the disappearance of several taxa of mammals and the abundance of cold taxa as *Nyctea scandiaca*.

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REFERENCES

- Capasso Barbato L., Cassoli P.F., Minieri M.R., Petronio C., Sardella R. & Scarano M. (1992) - Note preliminari sulla fauna pleistocenica di Ingarano (Apricena, Foggia). *Boll. Soc. Paleont. It.*, v. 31, n. 3, pp. 325-334, Modena.
- Capasso Barbato L. & Gliozzi E. (1996) - Biostratigraphical and palaeogeographical implications of the late Middle Pleistocene well balanced fauna from Quisisana-Certosa (Capri, Southern Italy). *Boll. Soc. Paleont. It.*, v. 34, n. 2, pp. 235-261, Modena.
- Di Stefano G., Petronio C., Sardella R., Savelloni V. & Squazzini E. (1992) - Nuove segnalazioni di breccie ossifere nella costa fra Castro Marina e Otranto (Lecce). *Il Quaternario*, v. 5, n. 1, pp. 3-10, Roma.
- Di Stefano G. & Petronio C. (1997) - Origin and evolution of the European fallow deer (Dama, Pleistocene). *N. Jh. Geol. Palaont. Abh.* v. 203, n. 1, pp. 57-75, Stuttgart.
- Gliozzi E., Abbazzi L., Argenti P., Azzaroli A., Caloi L., Capasso Barbato L., Di Stefano G., Ficarelli G., Kotsakis T., Masini F., Mazza P., Mezzabotta C., Palombo M.R., Petronio C., Rook L., Sala B., Sardella R., Zanalda E. & Torre D. (1997) - Biochronology of selected mammals, molluscs and ostracods from the Middle Pliocene to the Late Pleistocene in Italy. The state of the art. *Riv. It. Pal. Strat.*, v. 103, n. 3, pp. 369-388, Milano.
- Guerin C. (1980) - Les Rhinocéros (Mammalia, Perissodactyla) du Miocène terminal au Pleistocène supérieur en Europe occidentale comparaison avec les espèces actuelles. *Docum. Lab. Géol. Lyon*, v. 79, n. 3, pp. 785-1185, Lyon.
- Petronio C., Billia E., Capasso Barbato L., Di Stefano G., Mussi M., Parry S.J., Sardella R. & Voltaggio M. (1996) - The Late Pleistocene fauna of Ingarano (Gargano, Italy): biochronological, paleoecological, paleoethnological and geochronological implications. *Boll. Soc. Paleont. It.*, v. 34, n. 3 (1995), pp. 333-339, Modena.
- Rook L. & Torre D. (1996) - The latest Villafranchian-early Galerian small wolves in the Mediterranean area. *Acta zool. Cracov.*, v. 39, pp. 1-7, Cracovia.
- Werdelin L. (1981) - The evolution of lynxes. *Ann. Zool. Fennici*. v. 18, pp. 37-71, Helsinki.