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THE GENUS *URSUS* IN EURASIA: DISPERSAL EVENTS AND STRATIGRAPHICAL SIGNIFICANCE

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Key-words: Ursus, Plio-Pleistocene, Eurasia.

Riassunto. Sulla base dei risultati di precedenti studi condotti dagli stessi autori vengono riconosciuti cinque gruppi principali di orsi: *Ursus* gr. *minimus* - *thibetanus* (orsi neri), *Ursus* gr. *etruscus* (orsi etruschi), *Ursus* gr. *arctos* (orsi bruni), *Ursus* gr. *deningeri* - *spelaeus* (orsi delle caverne) e *Ursus* gr. *maritimus* (orsi bianchi). Gli orsi neri sembrano essere scomparsi dall'Europa durante il Pliocene superiore, immigrarono nuovamente in Europa all'inizio del Pleistocene medio e scomparvero definitivamente dall'Europa all'inizio del Pleistocene superiore.

Gli orsi etruschi sono presenti più o meno contemporaneamente nelle aree meridionali dell'Europa e dell'Asia nel corso del Pliocene superiore. La linea asiatica sembra scomparire alla fine di questo periodo, mentre il ceppo europeo sopravvisse, dando origine, nel corso del Pleistocene inferiore, ai rappresentanti più evoluti. Gli orsi bruni si sono probabilmente originati in Asia. Questo gruppo si diffuse ampiamente nella regione oloartica differenziandosi in un gran numero di varietà e presumibilmente raggiunse l'Europa alla fine del Pleistocene inferiore. L'arrivo degli orsi bruni in Europa è un evento significativo, che all'incirca coincise con il grande rinnovamento faunistico del passaggio Pleistocene inferiore-Pleistocene medio. Gli orsi bruni soppiantarono gli orsi etruschi, tipici dei contesti faunistici villafranchiani, e dettero origine alla linea degli orsi delle caverne. Gli orsi delle caverne ebbero grande successo in Europa nel Pleistocene medio e superiore e scomparvero alla fine dell'ultima glaciazione quaternaria o nel corso del primo Olocene. Gli orsi bianchi sono forse derivati da popolazioni di orsi bruni dell'Eurasia settentrionale durante il Pleistocene superiore.

Abstract. On the basis of the results of former studies by the present authors five main groups of bears are recognized: *Ursus* gr. *minimus* - *thibetanus* (black bears), *Ursus* gr. *etruscus* (etruscan bears), *Ursus* gr. *arctos* (brown bears), *Ursus* gr. *deningeri* - *spelaeus* (cave bears) and *Ursus* gr. *maritimus* (white bears). Black bears seem to have disappeared from Europe during the Late Pliocene, immigrated again at the beginning of the Middle Pleistocene, and definitively died out in Europe at the beginning of the Late Pleistocene. Etruscan bears occur more or less contemporaneously in the southern areas of Europe and Asia during the Late Pliocene. The Asian branch apparently became extinct at the end of this period, while the European stock survived, giving rise to more advanced representatives during the Early Pleistocene. Brown bears seem to

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have originated in Asia. This group dispersed widely in holoarctic areas diversifying into a great number of varieties. They reached Europe presumably at the very end of the Early Pleistocene. The arrival of brown bears in Europe is a crucial event, which approximately coincides with the great faunal turnover which marks the Early-Middle Pleistocene transition. Brown bears replaced the etruscan bears, typical of the Villafranchian faunal assemblages, and gave rise to the cave bear line. Cave bears were very successful in Europe during the Middle and Late Pleistocene and disappeared at the end of the last glaciation or even at the very beginning of the Holocene. White bears presumably originated from northern Eurasian brown bear populations during the Late Pleistocene.

Introduction.

The present paper is based on the results of two recent studies on fossil and extant Eurasian bears (Mazza & Rustioni, a,b, in press). In the first, *Ursus etruscus* Cuvier, 1823 was thoroughly redescribed. Of the specimens originally reported by Cuvier (1812, 1823) and Ristori (1897), one, IGF 905, was designated as the lectotype of the species by Berzi (1965). These specimens were supplemented by several others which altogether provided a satisfactory picture of the species. Etruscan bears most probably derived from Pliocene Eurasian black bears. During their history they show a progressive change. We named the oldest representatives, from Saint-Vallier (central France), Kuruksay (Tadjikistan), and La Puebla de Valverde (southeastern Spain), *Ursus* aff. *etruscus*. They are distinct from the latest Pliocene and Early Pleistocene specimens from Tegelen (The Netherlands), Olivola (Magra Valley, central Italy), Upper Valdarno (Florence-Arezzo, central Italy), Crostolo-Modolena (Reggio Emilia, central Italy) and Pietrafitta (Perugia, central Italy), all referred to *Ursus etruscus*, in the proportions of the skull and in the characteristics of their dentitions. The late Early Pleistocene etruscan bears apparently reached a high grade of evolution. *Ursus* aff. *etruscus* dispersed in Europe and Asia, while *U. etruscus* was restricted to Europe.

In our view, the latest etruscan bears had progressed too far to be the ancestors of brown and cave bears. In the light of this new view of *U. etruscus*, the necessity was felt to reconsider the phylogeny of the Plio-Pleistocene Eurasian bears. This was the aim of the second investigation (Mazza & Rustioni, b, in press). In this further research, most of the fossil and extant Eurasian bears were united into five main groups, the group of *Ursus minimus* - *thibetanus* (black bears), the group of *Ursus etruscus* (etruscan bears), the group of *Ursus arctos* (brown bears), the group of *Ursus deningeri* - *spelaeus* (cave bears) and the group of *Ursus maritimus* (white bears).

As opposed to the group of *Ursus etruscus*, that of *Ursus arctos* Linnaeus, 1758 is highly polymorphic and capable to adapt to extremely different environmental conditions. The great plasticity of brown bears denotes the primitiveness of their genetic pools. Moreover, some anatomical features, such as the different proportions of the skull, mandible and of the back teeth (P4-M2/3), exclude a possible relation with advanced etruscan bears. The writers also exclude that brown bears derived from *Ursus* aff. *etruscus*, since the latter is quite distinct from the oldest specimens which may possibly be referred to the brown bear group. Brown bears are more likely derived

from primitive Asian black bears.

The first cave bears show clear *arctos* affinities, to a point where in several cases researchers have reported the occurrence of *arctos-deningeri, arctos-spelaeus* or *deningeri*-like specimens. In our opinion, there is far closer resemblace between cave and brown bears than there is between cave and etruscan bears, especially late representatives of the latter.

As for white bears, the writers agree with Kurtén (1964), who supposed that *U. maritimus* likely derived from *U. arctos*. The evolution of white bears was so rapid and so recent that only subfossils are known.

An aspect that was cursorily considered in the two previous studies by the authors is the stratigraphical distribution and the biochronology of Plio-Pleistocene Eurasian bears, and the relation between the most significant steps of bear evolution and the main bioevents. The present paper proposes to analyze this subject.

Timing bear evolution.

According to Maier von Mayerfels (1929), Erdbrink (1953) and Kurtén (1968), the genus *Ursus* Linnaeus, 1758 derived from *Ursavus* Schlosser 1899. Remains of the oldest representatives of *Ursus*, *U. böckhi*, were found at Baróth-Köpecz, North of Brasov, in Transylvania. They were described and figured by Schlosser (1899) and Maier von Mayerfels (1929). Schlosser dated the Baróth-Köpecz deposits to the lower Pontian. Erdbrink (1953) argued that since the faunal assemblage from Baróth-Köpecz cited by Schlosser (1899) includes *Hipparion*, *Tapirus priscus*, *Rhinoceros*, *Cervus* sp., *Mastodon arvernensis* and *Parailurus anglicus*, it should be correlated with Pikermi (Greece) and therefore dated to the Middle Pliocene. On the basis of up-to-date studies (Mein, 1990; Bernor et al., 1990; Bonifay, 1990; Rustioni, in press), *Hipparion* characterises Early Vallesian (MN9) to Middle Villafranchian (MN17) faunal assemblages, *Tapirus priscus* only Vallesian faunas and *Anancus arvernensis* Ruscinian (MN15) to Middle (MN17)-early Late Villafranchian assemblages. The co-occurrence of these species, especially of *Tapirus priscus* and *Anancus arvernensis*, raises some doubt; the specimens most probably come from different stratigraphic levels, or were incorrectly identified.

The time of appearance of *Ursus* may perhaps be inferred indirectly. Since the first traces of Pliocene Eurasian black bears, which are derived from *U. boeckhi* (Erdbrink, 1953), are known from the Early Ruscinian levels of Montpellier, the bear of Baróth-Köpecz should not be younger than the Early Pliocene. Black bears are represented in several other localities of France (Roussillon and Auvergne) and Italy (Arondelli (?), Gaville, Ponzano Magra). They are also reported from East Anglia, but this occurrence is uncertain. In Asia, Pliocene black bears are represented in India, at Nerbudda and Godávarí, and in China, at Huai-Yü and Yushê- Shansi (*Ursus namadicus* Falconer & Cautley, 1849; see also Erdbrink, 1953). The last occurrence of Pliocene black bears in Europe is problematic. Depéret et al. (1923) reported the occurrence of

U. arvernensis (syn.: *U. minimus)* from Chagny. Chaline and Michaux (1969) studied the micromammals of this site, distinguishing two horizons, a Late Villafranchian-Galerian one, called Chagny I, and an Early-Middle Villafranchian one, called Chagny II. The bear remains presumably come from Chagny II, but they were collected in earlier times, without a precise record. Therefore, Les Etouaires and Gaville represent the last ascertained occurrences of Pliocene black bears in Europe; the sites are referred to the Triversa faunal unit (f.u. - according to the Mammal Age scale).

The transition from the Triversa to the Montopoli f.u. is marked by a drastic faunal turnover, following the intense worldwide climatic deterioration at about 3.0 - 2.5 MA (Elephant - *Equus* event: Lindsay et al., 1980; Azzaroli, 1983). The arrival of elephant, *Equus*, *Eucladoceros* deer, and the disappearance of *Mammut borsoni, Sus minor, Tapirus arvernensis,* and of the black bears, indicate a strong change to more open, parkland environmental conditions. This event is correlated with the Acquatra-

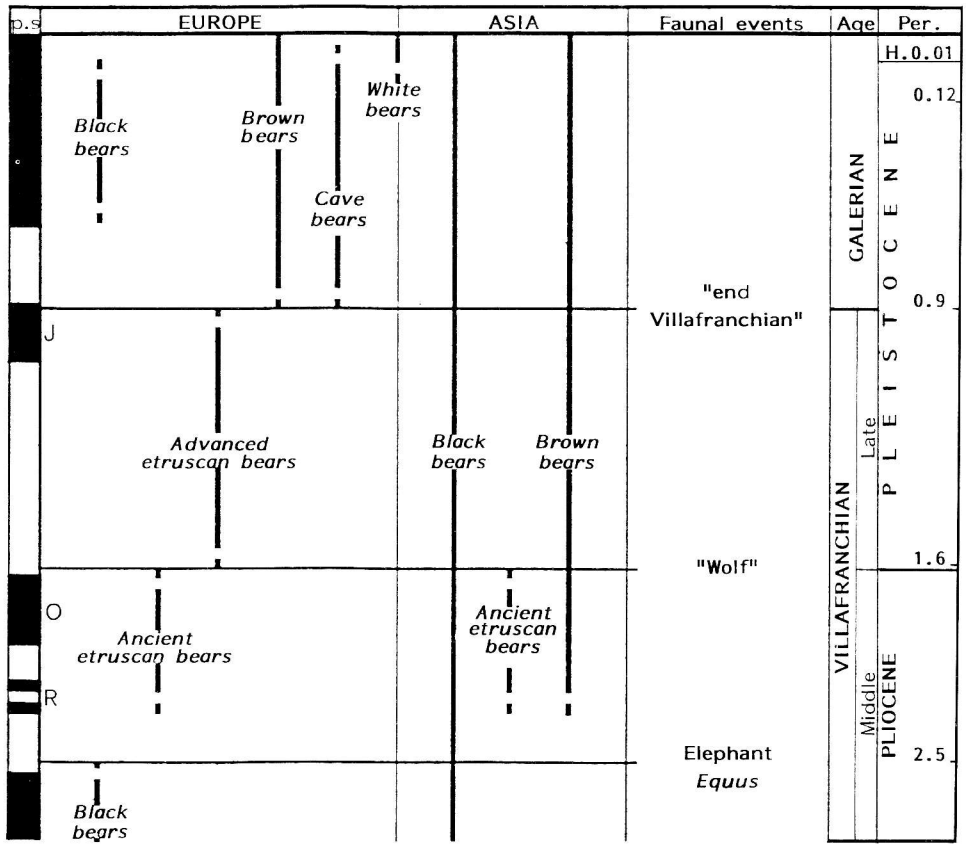

Fig. 1 - Scheme of the stratigraphical distribution of Eurasian bears. Scale of the main paleomagnetic events and episodes, on the left (R = Réunion; O = Olduvai; J = Jaramillo); scale of the Mammal Ages, on the right.

versan erosional phase (Blanc et al., 1953; Azzaroli et al., 1988). The Montopoli f.u. is correlated with the Pretiglian of the Dutch pollen scale (Azzaroli et al., 1988). Bears are apparently missing in Europe during this interval.

Etruscan and brown bears appeared in the Middle Villafranchian. Primitive etruscan bears (*Ursus* aff. *etruscus*) are more or less contemporaneously represented in Europe (Saint-Vallier) and in Asia (Kuruksay); scanty remains which may confidently be referred to a brown bear are known from Nihewan, in China. *Ursus thibetanus* Cuvier, 1823 survived in Asia to the present day. The sudden appearance of etruscan bears in Europe suggests that these forms probably originated in Asia. The Asian branch soon disappeared. Typical etruscan bears (*Ursus etruscus*) arose in Europe at the transition from the Middle to the Late Villafranchian. Their evolution from the primitive representatives was apparently rapid; scanty remains from Tegelen are most probably the first evidence of *U. etruscus. U. etruscus* is well represented at Olivola. The transition from the Saint Vallier to the Olivola faunal units is marked by the "wolf" event (Azzaroli, 1983). The faunal change was more limited than during the elephant-*Equus* event; it is characterized by the disappearance of *Nyctereutes megamastoides, Leptobos* cf. *stenometopon, Gazella borbonica* and *Eucladoceros teguliensis*, and by the massive immigration of *Canis etruscus, Pachycrocuta brevirostris*, and the appearance of *Panthera gombaszoegensis, Leptobos etruscus, Eucladoceros dicranios, Pseudodama nestii* (Azzaroli et al., 1988). The "wolf" event is correlated with the Aullan erosional phase (Arias et al., 1980; Azzaroli, 1991) and corresponds approximately to the end of the Olduvai paleomagnetic episode and to the Eburonian cold phase of the Dutch pollen scale (Azzaroli et al., 1988). *U. etruscus* was the only bear present in Europe during most of the Early Pleistocene. At this time, brown and black bears were radiating in Asia.

Brown bears reached Europe during the crucial phase which marks the transition from the Villafranchian to Galerian, the so-called "end-Villafranchian" event (Azzaroli & Napoleone, 1982; Azzaroli et al., 1988). The oldest evidence of brown bears in Europe seems to be that of Vallonnet, in France (De Lumley et al., 1988). The site is radiometrically dated about 950.000 years by ESR method. Another locality which provided few specimens which may possibly be referred to brown bears is Pirro (Gargano, southern Italy), a site approximately contemporaneous to Vallonnet. However, the sample is still too poor to substantiate this opinion and therefore this bear is provisionally referred to as *Ursus* sp. The spectacular faunal revolution which marks the "end-Villafranchian" event in Europe is characterised by the replacement of the Late Villafranchian mammals by newly born species or by new immigrants from Asia. Brown and black bears belong to the latter.

The "end-Villafranchian" event approximately corresponds to the Cassian erosional phase and may be correlated with an interval that encompasses the Jaramillo episode and the transition to the Matuyama and Brunhes epochs of the paleomagnetic scale. Galerian faunas were more cold-resistant than Villafranchian faunas. Among bears, the more specialized, southerly dispersed etruscan bears were displaced by the

comparatively more primitive and more ubiquitarian brown bears.

The brown bear populations which radiated in Europe rapidly diversified during the Middle-Late Pleistocene, giving rise to a typical *arctos* branch and to a cave bear branch. Cave bears were very successful in Europe; the last representatives were found in the Caucasus and are dated to the earliest Holocene (Verestchaguine, 1959).

Black bears apparently re-immigrated in Europe during the "end-Villafranchian" event. The oldest ascertained record is that from the Galerian levels of Mosbach (central Germany) (*U. arvernensis* of von Reichenau, 1906). Black bears are slightly represented in the Pleistocene of Europe. They are still present during the late Middle-early Late Pleistocene in the Elba island, together with *U. spelaeus*, as testified by the findings from Grotta di Reale, Porto Azzurro (Rustioni & Mazza, in press); Del Campana (1909/1910) reported on the small-sized bears of the Elba island calling them "*Ursus* sp. (*Ursus mediterraneus* Fors. Major)". We ignore other more recent occurrences of black bears in Italy.

At last, according to Kurtén (1964), white bears rapidly arose from brown bears, presumably in northern Eurasia, during the latest Pleistocene. The oldest known specimen is a right ulna found in early Würm deposits at Kew Bridge, near London.

Conclusions.

Bears are very useful for stratigraphical purposes; their history carefully reflects, and contributes to the recognition of, the main Plio-Pleistocene events of Eurasian mammals.

The elephant-*Equus* event is marked, in Europe, by the demise of primitive black bears and by the following absence of bears during a lapse of time corresponding to the beginning of the Matuyama paleomagnetic epoch. Primitive etruscan bears are present in Eurasia during an interval encompassing the Reunion and Olduvai paleomagnetic episodes. The "wolf" event of Europe corresponds to the transition from primitive to advanced etruscan bears; etruscan bears definitively disappear from Asia. The "end-Villafranchian" event is marked in Europe by the demise of the etruscan bears and their substitution by brown and cave bears. Black bears returned to Europe during the Middle Pleistocene and persisted at least until the Late Pleistocene. Cave bears definitively died out at the very beginning of the Holocene. White bears appeared in northern Eurasia during the latest Pleistocene.

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