EQUIDAE (PERISSODACTYLA, MAMMALIA): EXTINCTIONS SUBSEQUENT TO THE CLIMATIC CHANGES.

María Teresa ALBERDI
Museo Nacional de Ciencias Naturales, CSIC
José Gutiérrez Abascal, 2. 28006 Madrid (Spain)

Francesco Paolo BONADONNA
Dipartamento di Scienze della Terra
Via Santa María, 53. 56100 Pisa (Italy)

ABSTRACT

The present knowledge of global climatic changes allows us to infer its possible influence in the extinction(s) of assemblages or faunistic groups. In the Equidae family the extinctions of both Anchitherium and Hipparion could be deduced, based upon climatic changes. The replacement of the Anchitherium faunal assemblage by that of Hipparion at about 13-12 MA in the Mediterranean area, could be related to the Serravallian climatic crisis. During this crisis there was a less warm period and drier conditions. On the other hand, the extinction of Hipparion and its replacement by Equus seems to be linked with the first cold period as approximately 3.0-2.5 MA (Alberdi, in press; Alberdi & Bonadonna, 1987 a y b).

Keywords: Anchitherium, Hipparion, Equus Morphotypes. Climatic changes. Extinctions. Eurasia and Africa.

RESUMEN

El actual conocimiento de los cambios climáticos globales nos permite inferir su posible influencia en la extinción o extinciones de asociaciones o grupos faunísticos. En la familia Equidae podríamos deducir la extinción tanto de Anchitherium como de Hipparion en base a cambios climáticos. El reemplazo de la asociación faunística de Anchitherium por la de Hipparion entorno a 13-12 MA, en el área Mediterránea puede relacionarse con la crisis climática del Serravallense que implica un periodo menos cálido y más seco. Por otra parte la extinción de Hipparion y su reemplazo por Equus parece poder estar enlazada al primer enfriamiento ocurrido alrededor de 3.0-2.5 MA (Alberdi, en prensa; Alberdi & Bonadonna, 1987 a y b).

INTRODUCTION

The presence of fossil remains of the Family Equidae (Gray, 1821) during the Neogene are frequently abundant. This is favoured by the fact of this family belonging to those which live in herds.

A recent work by Alberdi (in press) gives a whole view of the paleobiology and phylogeny of the Hipparion genus of Eurasia and Africa. She groups the different species and subspecies of Hipparion into 6 Morphotypes sensu lato based on a combination of the morphological and morphometrical characteristics and the type of skeleton structure, giving each one of them a generalized schematic classification. These six Morphotypes, related directly with the global climatic trend (Shackleton, 1984; Shackleton & Hall, 1984; redrawn), show a major or minor presence according to a greater or smaller cold period, even reaching its extinction after the lowest temperatures (about 3 MA). This period can be considered as the replacement of Hipparion by Equus (Alberdi, in press; Alberdi & Bonadonna, 1987). The lowest sea level recorded at this time (Vail et al., 1977; Summerhayes, 1986; redrawn), could be related with this migratory flux (Alberdi, in press; Alberdi & Bonadonna, 1987).

On the basis of this information, we have tried to analyse this phenomenon in other groups of the Equidae family (Anchitherium, Hipparion and Equus), during the Neogene and Quaternary, to see if there is a correlation between the presence or absence of these groups and global climatic changes.

DATA AND DISCUSSION

The entrance of Anchitherium in Eurasia at about 24-22 MA seems to be linked to a lower recorded sea level. At this moment and during the development of Anchitherium in Eurasia, the climate is rather warmer and probably more humid, thereby favouring the expansion of this group in Eurasia (Gabinia, 1985). A lower sea level is recorded again between 13-12 MA which could favour the entrance of Hipparion into Eurasia from North America. In addition, the Serravallian climatic crisis in the Mediterranean, could favour the replacement of Anchitherium by Hipparion with a slightly less warm climate but certainly drier. This could harm the former species and favour the latter ones, as they are a dry climate species. The Hipparion fauna was well developed in the Vallesian age, while some scarce remains of Anchitherium could be recorded at the beginning of this period (Forsten, 1986; Alberdi, 1972, 1974).

The first climate cooling, between 3.0-2.5 MA, gave rise to the development of the first artic ice sheet and brought about a remarkable drop in sea level (probably the latter was the result of both tectonics and eustatism). This phenomenon could have favoured the Equus migration from North America and the replacement of Hipparion by it.

Previously, relating the global climatic trend during the first registered drop in sea level, about 6 MA, the genus Hipparion could survive due to the warm climate, even though it had some oscillations. This could also give favourable conditions for the entrance of a second wave of Hipparion in Eurasia from North America, starting from Neohippopon (?) (Zhegallo, 1978; Forsten, 1982). This wave gave rise to a wide dispersion of the Hipparion caballine forms throughout Europe and Africa, mainly during the early Villafranchian (Alberdi, in press; Alberdi & Bonadonna, 1987). These forms, although more resistant, could not survive the coldest climate about 3.0-2.5 MA in Eurasia. Perhaps the Equus genus, better adapted to survive the climatic change, occupied the ecological niche of Hipparion, thereby determining its extinction (Alberdi & Bonadonna, 1987).

The distinct distribution of the 6 Morphotypes of Hipparion in space and time seems to depend on whether the environment is favourable or not, especially in relation to the climate (Alberdi, in press; Alberdi & Bonadonna, 1987). In the same way, the distribution of the Equus genus during the Quaternary can be examined based on the general construction of the skeleton, and the morphology and morphometry of the remains (principally the teeth, the most abundant remains).

The genus Equus can be classified into 2 Morphotypes sensu lato (zebras, asses, "beminson", "hydruntinus", etc. are excluded).

Morphotype 1.— Includes the "stenonian" types which existed between 2.5-0.9 MA.

Morphotype 2.— Includes the "caballine" types which existed from 0.9 MA up to the present.

The appearance of Morphotype 1, concomitant with the entrance of Equus in Eurasia, is recorded during the climatic deterioration period, between 3.0-2.5 MA. The replacement of Morphotype 1 by Morphotype 2 corresponds more or less with the now called Glacial Pleistocene, 0.9-0.8 MA. This period coincides with the first cooling after the first real cooling around 2.5 MA (Alberdi & Bonadonna, 1987).

In the late Pleistocene, the situation is much more complicated, as there is a great proliferation of specific and subspecific names. This can be compared (although in greater proportion) to what happens in the last 3.0 MA of the existence of Hipparion in Eurasia. During this period, this form diversified into distinct Morphotypes, as if trying to adapt itself to better morphology for survival (Alberdi & Bonadonna, 1987). In the case of Equus it becomes complicated for an uncorrected use of the nomenclature.

In the case of Anchitherium, its classification in Morphotypes is not so clear at present (Alberdi, in press) it is necessary to bear in mind that its remains are generally more scarce, both from a quantitative and qualitative point of view.

At present, the presence of Anchitherium in Eura-
sia (its presence in Africa is unknown) may be roughly grouped into three entities which cannot be readily included in the sensu lato Morphotype category.

These entities are:

1. *Anchitherium* of small size, which represent the first known forms of this genus dating from approximately NM3-NM4 Mein zones (1977).

2. *Anchitherium* of medium size, of an enormous individual variety and having a wide distribution in space and time, about 18-13 MA. This form characterizes the greater part of the Aragonian age (Fahlbusch, 1976). This group is clearly a Morphotype. What is not clear yet is whether any or none of the other groups correspond to this Morphotype or what is the relationship between them.

Figure 1. Dispersal sketch of *Anchitherium*, *Hipparion* and *Equus* through Eurasia and Africa and their correlation with the climatic and sea-level trends. Paleoecological diagram from Schackleton (1984) and Schackleton & Hall (1984) (redrawn). Sea-level oscillations from Summerhayes (1986) and Vail et al. (1977) (redrawn). For stratigraphical correlations see Alberdi & Aguirre (Eds.) (1977, Tables 1,2 and 3).
3. — *Anchitherium* of large size, probably coexisting with *Hipparion* in some places (Forsten, 1968; Alberdi, 1974; etc.). It is found around 13-12 MA in Europe.

These data are at present insufficient to be able to determine:

1. If these three groups of *Anchitherium*, which are clearly grouped over a long period of time, correspond with one and the same Morphotype or with several in the same way we have seen in *Hipparion* and *Equus*.

2. If the relationship between them is concomitant with the global climatic trend.

**SUMMARY**

Summarizing, the relatively lower level of the overall sea level could have favoured the *Anchitherium* entrance in Eurasia and the replacement of *Anchitherium* by *Hipparion* and *Hipparion* by *Equus* (Figure 1).

The different Morphotypes of *Hipparion* and *Equus* in Eurasia and Africa could be directly related to the general climatic changes.

The *Hipparion* genus is grouped in 6 Morphotypes which are related to the global climatic changes (Alberdi, in press, Figure 4).

The global climatic situation about 12.5 MA supports the first immigration wave of *Hipparion* in Eurasia from North America represented by Morphotypes 1 and 2 until 6.5-5.5 MA. The presence of *Hipparion* decreases considerably during the Upper Miocene (Messinian). It is only represented by the rare Morphotype 3 followed by two different and short lived Morphotypes: 4 and 5 (between 5 and 4 MA).

The following immigration wave of *Hipparion* causes the replacement of the latter by the well adapted Morphotype 6 ("caballine" type) that definitely dissapears, in Eurasia about 3.0-2.5 MA.

At this time, *Hipparion* is replaced by *Equus* favoured by the global climatic situation about 3.0-2.5 MA (the first ice sheet growth).

The immigration wave into Eurasia from North America of *Equus* is represented by Morphotype 1: *Equus*, "stenonis" like. It survives up to about 0.9 MA, related to a overall global climatic change (Thunell & Williams, 1983). At this moment it is replaced by the Morphotype 2: *Equus*, "caballine" like, that survives to this day.

With regard to *Anchitherium* the present knowledge is not enough to group this genus into different Morphotypes and neither to relate them to the global climatic change.

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