

## TENTATIVE TYPOLOGY AND BIOSTRATIGRAPHY OF SOME MIDDLE AND LATE PLEISTOCENE WESTERN EUROPEAN HORSES

V. Eisenmann

UA 12 du CNRS, Institut de Paléontologie, Paris, France.

**ABSTRACT** - Caballine horses from Middle and Late Pleistocene of France, Germany, Spain, and Italy, can conveniently be compared if several MCIII and upper cheek tooth characters are used. They fall well into seven main morphological types. The large Mosbach type is known from about 700,000 to about 450,000 years (L'Arago). During "Mindel-Riss", a smaller and more evolved form is present at Lunel-Viel. Later on, during "Riss", two types can be distinguished: one at La Fage I and Paglicci-Riparo, the other at La Fage II, Torralba, and possibly La Chaise. Three other successive types may be recognized during Würm: the oldest one (present at Combe Grenal 22-25) is replaced around 45,000 years ago by a smaller form (Combe Grenal 14, Camiac, Jaurens, lower Solutré), which is replaced by a still smaller one (Magdalenian of Solutré and Chasse sur Rhône).

**RIASSUNTO** - *Possibile tipologia e biostratigrafia di alcuni cavalli del medio e tardo Pleistocene dell'Europa occidentale.* I reperti fossili di cavalli rinvenuti in depositi del medio e tardo Pleistocene della Francia, Germania, Spagna ed Italia possono essere paragonati fra loro tramite i caratteri dei mascellati e del MCIII. Si possono distinguere sette tipi morfologici principali. Il grosso Mosbach si ritrova a partire da 700.000 anni fino a 450.000 anni (L'Arago). Una forma più piccola è presente a Lunel-Viel durante il Mindel-Riss. Successivamente, durante il Riss, si possono riconoscere due altri tipi: uno a La Fage I e a Paglicci-Riparo, l'altro a La Fage II, Torralba e probabilmente a Chaise. Altri tre tipi di età più recente (Würm) sono stati identificati a Combe Grenal 22-25 (il più vecchio), Combe Grenal 14, Camiac, Jaurens, Solutré (una forma più piccola del Combe Grenal 22-25 comparsa circa 45.000 anni fa) e in depositi del Magdaleniano di Solutré e Chasse-sur-Rhône (forma ancora più piccola).

**Key-words:** Middle-Upper Pleistocene, horses, W Europe  
**Parole-chiave:** Pleistocene medio-sup., cavalli, Europa occ.

### 1. INTRODUCTION

This paper is founded upon a basic question: Are Pleistocene true horses (from the *Equus caballus* group) suitable for biostratigraphical purposes? In other words, are they known enough, and different enough from one another, to allow a chronological assessment when one is dealing with horse fossils isolated from precise chronological contexts?

To answer this question, we will look at the best available samples belonging to different periods of glacial Pleistocene and see if, and how, the corresponding horse taxa can be characterized. The best samples come from Graues Mosbach (BDR), Arago, and Jaurens (France). Also a good sample of modern *Equus przewalskii* was found there. We will also discuss some "second-degree" samples, where teeth and bones are scarce, or samples for which we have not good enough data, but which correspond to interesting types of horses: Lunel-Viel, La Fage II, La Fage I, Combe Grenal 22-25, Chasse-sur-Rhône (France).

Obviously, any sample is best described when all anatomical parts are considered. But for practical reasons, only third metacarpals (MCIII) and upper cheek teeth (P3-4 and M1-2) are here taken into account. Several characters are however used to describe and compare them: a) for MCIII: (1) size of the articular facet for the magnum; (2) maximum length; (3) distal supra-articular and (4) articular widths (Eisenmann, 1979); b)

for the upper cheek teeth: (5) occlusal lengths of P3-4 and (6) of M1-2, and (7-8) the occlusal protocone lengths of the same.

To make descriptions and comparisons easier to follow, a graphic representation was devised (Fig. 1). Each biometrical character is placed on a millimetric scale. The upper and lower limits of each scale correspond roughly to the minimum and maximum values observed when all the samples are taken into account.

After the main "types" of horses have been defined, we will see which of the samples may fit into these types, and will discuss the used characters and the possible biochronology of the different types.

### 2. MAIN "TYPES" OF HORSES

#### 2.1 Mosbach

The first good sample of a caballoid horse in Europe belongs to the main fauna of Mosbach (Graues Mosbach). There are about 30 upper P3-4, 27 M1-2, and 40 MCIII. *Equus mosbachensis* described by Reichenau (1915) is a large animal. The muzzle is elongated. The teeth are large. Protocones are relatively short, longer on premolars than on molars (Eisenmann, 1980). Two characters, possibly primitive, may be observed on the MCIII: the average distal articular and supra-articular widths are equal (Eisenmann, 1979), whereas in more recent horses, the articular width is usually the biggest

one; the articular facet for the magnum is relatively little developed.

The age of the Mosbach horse is uncertain. According to Brüning (1978), the oldest fauna from Mosbach (Grobes Mosbach, or Mosbach I) belongs to the Jaramillo normal episode. The main fauna, with *E. mosbachensis*, comes from above the Brunhes-Matuyama magnetic inversion.

## 2.2 La Caune de l'Arago, Tautavel

Another horse is enough well represented in the upper sequence (soils D to H) at l'Arago (Crégut, 1980a;

1980b). There are about 37 P3-4, 42 M1-2, and 1 to 18 MCIII. The average length of the MCIII is a little smaller than the Mosbach one but the teeth are larger, and the protocones longer, especially on the P3-4. The muzzle is very short (Eisenmann et al., 1985). The MCIII are more evolved than the Mosbach ones: the distal articular width and the facet for the magnum are more developed.

Quite different figures have been proposed for the age of l'Arago (from 350 to 700,000 years). At present, an age of 400 to 500,000 years seems acceptable for the horse from soil G (Bouchez et al., 1984).

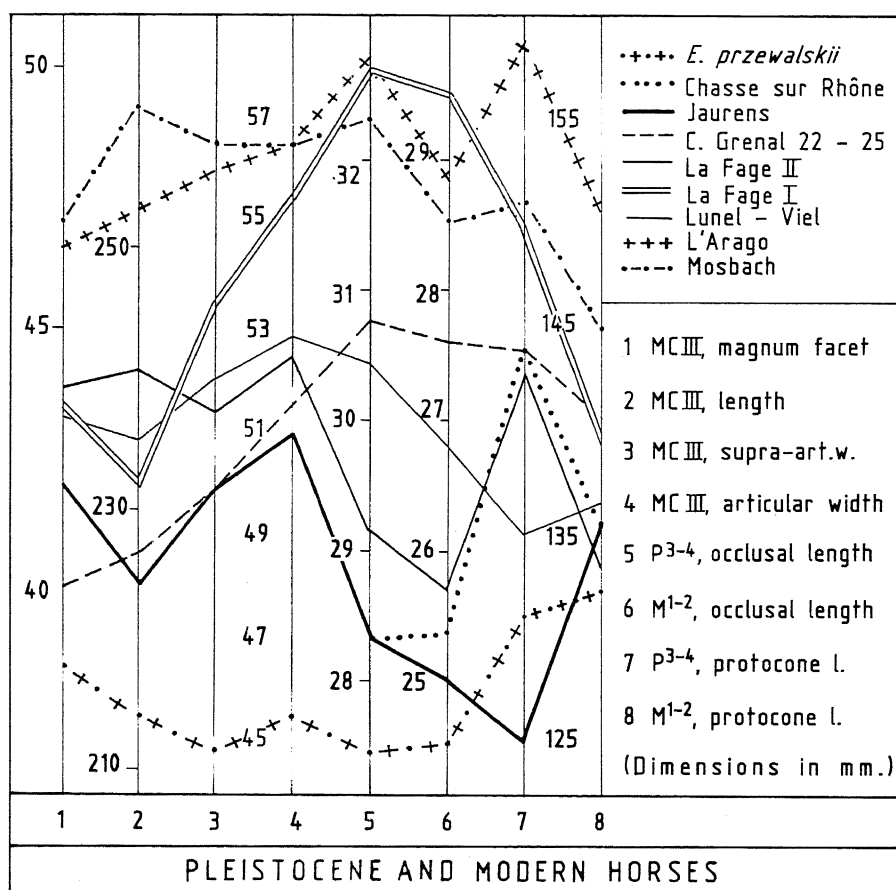


Fig. 1 - Graphic representation of selected dimensional characters of some Pleistocene and modern horses  
Rappresentazione grafica di alcune caratteristiche dimensionali di cavalli pleistocenici e moderni

## 2.3 Lunel-Viel

The Lunel-Viel studied material is composed of 9 P3-4, 8 M1-2, and 26 MCIII. The horse was described by M.-F. Bonifay (1980a). It is clearly smaller than the horses from Mosbach and l'Arago, for the size of both the metapodials and teeth. The muzzle is moderately developed. Protocones are relatively short, especially on the premolars. The metacarpals have distal articular widths as evolved as those measured at l'Arago, and

better developed facets for the magnum. They are, moreover, characterized by a relatively deep distal keel, which is rather unfrequent in caballoid horses.

M.-F. Bonifay (1980a and *in litteris*) stated that the Lunel-Viel faunas belong to the Mindel Riss interglacial; their ages should be older than 0.4 MY, and the period during which the caves were filled rather long, between 60 and 100,000 years.

## 2.4 Les Abimes de la Fage

There are two fossiliferous caves at La Fage, Aven I and Aven II, which belong to the same karstic system. Only Aven II cave yielded a relatively abundant horse material which is described by Bouchud (1978) as 5 P3-4, 6 M1-2, 4 to 6 MCIII. Metacarpals are longer than at Lunel-Viel, but teeth (locus F) are smaller. On the premolars, protocones are quite longer, but they are a little shorter on the molars. On the MCIII, the average distal articular width is relatively large, like in most Würmian horses (larger than at Mosbach, l'Arago and Lunel-Viel). The articular facet for the magnum is rather little developed.

According to Bouchud (1978), Aven II cave was filled during Riss III. Bouchud attributed most of the horse material to *Equus caballus* cf. *steinheimensis*. At locus D of Aven II cave (younger than locus F), parts of a skeleton belonging to a not yet adult horse were found. Because of their supposedly large size, these fossils were attributed by Bouchud to a somewhat primitive form of the large "Rissian" horse, *E. piveteaui*. Actually, the upper cheek teeth are not worn enough to be described or measured; moreover, as already noted by Bouchud, the MTIII is rather small, and smaller than other MTIII from Aven II. Thus, to attribute to *E. cf. piveteaui* the locus D fossils is questionable. On the other hand, similarities seem to exist between the main material from Aven II cave and *E. piveteaui*, but the data available to me do not allow a good characterization of the latter. To summarize, what Bouchud referred to *E. cf. steinheimensis* may be related to *E. piveteaui*, while what Bouchud referred to *E. cf. piveteaui* is at present not known well enough to be discussed.

One P3 or P4, and one M1 or M2, both of them very large were found in La Fage Aven I (Bouchud, 1972); their size and protocone lengths are close to those observed at Mosbach and l'Arago. The rest of the material, rather poor, seems to have belonged to a middle-sized horse. The only MCIII is very massive and short. According to Mourer-Chauviré et al. (1975), Aven I cave had been filled during a rather long period of time: middle Riss, or early and middle Riss.

## 3. UPPER PLEISTOCENE HORSES

### 3.1 Würmian Horses

Horses from ancient Würm are usually identified by the name of *Equus caballus germanicus*. During Würm, their size diminished and they are considered to have evolved about 30,000 years ago into another subspecies, *E. caballus gallicus* (Prat, 1968). Later on (about 12,500 years ago) the latter was replaced by an even smaller and slenderer subspecies, *E. caballus arcelini* (Guadelli, 1986; 1987).

### 3.2 Combe Grenal 22-25

The material from Combe Grenal has been revised recently by Guadelli (1987) and attributed to *E. caballus germanicus*. The only MCIII from layer 23 (65 to 70,000 years old) is much smaller than those belonging to Rissian horses. The distal end is evolved but the facet for the hamatum is rather small. According to the measures kindly communicated by Guadelli, the teeth (22 P3-4 and 26 M1-2) are large; protocones are longer on premolars than on molars.

### 3.3 Jaurens

The currently best known Würmian horse is the horse from Jaurens, dated to approximately 30,000 years (Mourer-Chauviré, 1980): 38 P3-4, 37 M1-2, 16 MCIII. It has been classified as *E. caballus* cf. *gallicus*. The muzzle is short, the teeth are small, with short protocones. On the average, protocones are shorter on the premolars than on molars. The metacarpals are evolved: the facet for the magnum is well developed, the average distal articular width is larger than the average distal supra-articular one.

### 3.4 Chasse sur Rhône

Ages of about 12,000 and 14,000 years were given to the bones collected at Chasse sur Rhône (Chapotat et al., 1980). The material from Chasse sur Rhône is poor: 7 P3-4, 8 M1-2, no MCIII. However, pending the description of the much better Magdalenian material from Solutré by Combier, Guadelli and Prat, Chasse sur Rhône material can be used to give an idea of Magdalenian horses.

The teeth have about the same size as those found at Jaurens, but the protocones on the premolars are much much longer.

### 3.5 The Przewalski Horse

The data at our disposal are relatively abundant: 36 P3-4, 38 M1-2 and 29 MCIII. By its MCIII and teeth dimensions, *E. przewalskii* is smaller than all fossil caballoid horses here discussed. Figure 1 shows that the Würmian horses from Combe Grenal 22-25, and from Jaurens do not look like *E. przewalskii*. There are, however, some resemblances in tooth proportions with the Magdalenian horse from Chasse sur Rhône.

## 4. TYPOLOGY OF PLEISTOCENE CABALLOID HORSES

Figure 1 shows seven main types of Middle and Late Pleistocene horses, namely:

1) *E. caballus mosbachensis* (Reichenau, 1915), Mosbach.

A harmoniously large horse with primitive metapodials and rather short protocones on molars. The horse from l'Arago, *E. caballus tautavelensis* (Crégut,

1980a), belongs to the same type but it has more evolved MCIII, larger teeth, longer protocones, and a much shorter muzzle.

2) *E. caballus palustris* (Bonifay, 1980), Lunel-Viel. A harmoniously middle-sized horse with evolved MCIII, rather short protocones on premolars, and a moderately elongated muzzle.

### 3) La Fage I

A dysharmonious horse, with short but robust MCIII, very large teeth and relatively small protocones on molars. The poorness of the material would not have justified to consider it as a "type" unless the ante-Mousterian horse from Paglicci-Riparo (Italy), kindly shown to me by C. De Giuli, had seemed similar. This sample is however also poor (1 P3-4, 2 M1-2, 2 distal fragments of MCIII).

### 4) La Fage II

A dysharmonious middle sized horse with very small teeth and very long protocones on the premolars. *E. caballus torralbae* described by Prat (1977) looks like a "miniature" of this type. On the contrary, the large Rissian horse from La Chaise, *E. caballus piveteaui* (David et Prat, 1962; Prat, 1968) may be an "enlargement" of the same. The horse from Chatillon-Saint-Jean (Chauviré, 1962; Mourer-Chauviré, 1972) could belong to this type, but most of tooth characters do not agree; the teeth sample is however very small. A better knowledge of all these horses is desirable.

### 5) *E. caballus germanicus* (Reichenau, 1915), Combe Grenal 22-25

A horse with rather small MCIII and rather large teeth, but not as dysharmonious as the La Fage I type. The horse from Monte Agudo del Castillo (Spain) probably belongs to that type (Eisenmann et al., in press).

### 6) *E. caballus gallicus*, (Prat, 1968), Jaurens

A dysharmonious small horse with very small teeth and relatively long protocones on the molars. The horses from Combe Grenal layer 14 (about 40 to 50,000 years), from Camiac (about 35,000 years), and from the lower layers of Solutré (23 or 24,000 years) revised by Guadelli (1987) belong to the same type.

### 7) Chasse sur Rhône

A small horse with very large protocones, especially on the premolars. *E. caballus arcelini* from the upper (Magdalenian) levels of Solutré (Guadelli, 1986; 1987), the Magdalenian horses from Pekarna Hohle (Musil, 1969), and possibly also from Oelknitz (Musil, 1985) belong probably this type.

## 5. ANALYSIS AND DISCUSSION OF THE CHARACTERS

Some of the characters used for this "typology" seem to give direct chronological information, while others, probably influenced by environmental conditions, have to be considered in relation to their context. Let us discuss them in the order in which they appear in Fig. 1:

### 1) Relative development of the magnum facet

When samples are good (Mosbach, l'Arago, Lunel-Viel, Jaurens), there is on the whole a progressive development of the facet for the magnum. In Fig. 1, this is shown by the ascending direction of the line uniting column 1 (size of the facet) and column 2 (length of the MCIII) in more ancient horses, while the direction is descending in more recent horses. The interpretation is more difficult for small samples. It seems, however, that with the exception of Lunel-Viel and La Fage I, the facet remains poorly developed until about 30,000 years ago. At any rate, Combe Grenal 23 and Camiac are more "primitive" than Combe Grenal 12, Jaurens, lower Solutré, and upper Solutré. We have no data for Torralba nor for the Central European Magdalenian.

### 2) Length of metacarpals

The size diminishes from Mosbach to Lunel-Viel. Later on, large MCIII may be still observed (*E. caballus piveteaui*, La Fage I and II, Chatillon-Saint-Jean) but during Würm, the size diminishes again (Combe Grenal 23, Camiac, Jaurens, upper layers of Solutré).

### 3 and 4) Distal MC III proportions

The two distal widths are equal only at Mosbach. First at l'Arago, then at Lunel-Viel, the articular width tends to predominate. There are nearly no exceptions to this trend.

### 5 and 6) Occlusal dimensions of P3-4 and M1 M2

On the whole, the cheek teeth dimensions diminish. However the very large teeth of Combe Grenal 22-25 is worth noting. Also disproportions between MCIII and teeth size are to be noted because may characterize some "types" of horses: relatively small teeth at La Fage II, Torralba, and in *E. caballus piveteaui*; relatively large teeth at Combe Grenal 22-25.

### 7 and 8) Occlusal protocone lengths of P3-4 and M1-2

This character is obviously related to something else than geological age alone. At Lunel-Viel and in most Würmian horses (Combe Grenal 14, Camiac, Jaurens, lower layers of Solutré), premolar protocones (column 7) are short relatively to the lengths of molars (column 6) and the molar protocones (column 8). At the opposite, premolar protocones are large relatively to both

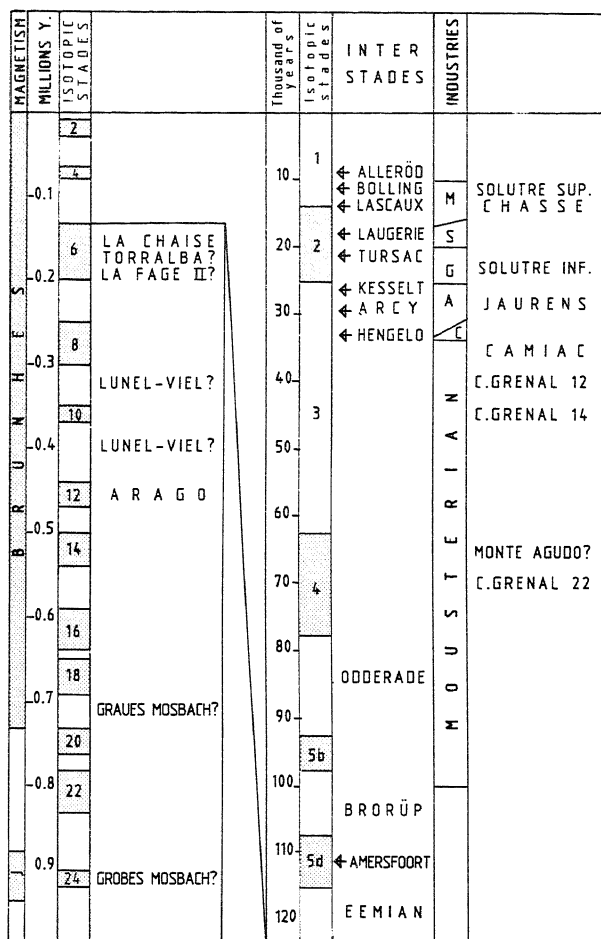


Fig. 2 - Tentative chronology of the localities discussed in the present paper

*Possibile cronologia della località considerata*

parameters at l'Arago, La Fage II, Torralba, and in Magdalenian horses. At Mosbach, Combe Grenal 22-25, and Monte Agudo, protocones are larger on the premolars than on the molars, but they do not seem exceptionally large when compared to the size of the molars; at La Fage I, they seem even small when compared to the size of the molars.

According to Gromova (1949), followed by Guadelli (1987), the protocone lengthening may be a functional reaction to environmental requirements such as a food more abrasive by itself or by the inclusion of dust particles during very dry climatic conditions. If lengthening of protocones (and possibly also of teeth) did not occur in a perfectly isometric and simultaneous way on P3-4 and M1-2, evolutive rearrangements could have generated this very variety of proportions. When the succession of horses is better documented, we may be able to find whether the shifts proceeded always in the same manner. At present it may be suggested that the shift from *E. caballus germanicus* to

*E. caballus gallicus* involved a diminution in size and a relative lengthening of the molar protocones. The shift from the latter subspecies to *E. caballus arcelini* has involved a further reduction in size and a relative lengthening of the premolar protocones.

## 6. BIOCHRONOLOGY

Figure 2 presents a tentative biochronology of the localities discussed here. It is mainly based on papers by Shackleton and Opdyke (1973; 1976), Brüning (1978), Bonifay (1980b), Bouchez et al. (1984), Renault-Miskowsky (1986), Vergnaud-Grazzini (1987), Guadelli (1987).

### 6.1 Mosbach, l'Arago, Lunel-Viel, La Fage, Chatillon-Saint-Jean

At present there are two biozonations based on macromammals: one published by Guérin (1982; see also 1980), the other by Cordy (1982). Both authors agree to insert the Lunel-Viel zone between a lower zone to which belongs the main fauna from Mosbach, and an upper zone inside which Chatillon-Saint-Jean and La Fage are included. There is disagreement as far as the relative age of l'Arago is concerned: Cordy places Lunel-Viel and l'Arago in the same zone (above the Mosbach zone) while Guérin places Lunel-Viel alone in a zone above the one which contains Mosbach at the base and l'Arago at the top (Guérin, 1987).

What we know about the corresponding horses is in agreement with Guérin interpretation: the horse from l'Arago is more evolved than the one from Mosbach, but it looks more like the latter than like the one from Lunel-Viel.

What we know about "Rissian" horses does not allow any precise chronological discussion. Let us just remark that the horses from La Fage I and La Fage II are different. A form close to the first may also be present in ante-Mousterian Italian levels, while a form related to the latter was found in Spanish Acheulean levels. The place of the Chatillon-Saint-Jean horse is problematic.

### 6.2 Upper Pleistocene Horses

What we know about of Upper Pleistocene horses is in agreement with the currently accepted chronology.

It is to be noted however, that the shift from *E. caballus germanicus* to *E. caballus gallicus* seems to happen earlier than usually admitted. It is probable that the Combe Grenal 14 fossils (about 40 to 50,000 years old) belong already to the latter subspecies, which are also present at Camiac, Jaurens, and in the lower levels of Solutré. The date of the next shift, to the Magdalenian *E. caballus arcelini*, needs further studies to be determined exactly.

## ACKNOWLEDGEMENTS

I am greatly indebted for helpful information, discussions, and suggestions to F. David, C. Mourer-Chauviré, C. De Giuli and J.-C. Guadelli. Drawings were made by H. Lavina.

## REFERENCES

- Bonifay M.-F. (1980a) *Le Cheval du Pléistocène moyen des Grottes de Lunel-Viel (Hérault) Equus mosbachensis palustris n. ssp.* Gallia Préhistoire, **23** (2), 233-281, 26 fig., 33 tabl.
- Bonifay M.-F. (1980b) *Relations entre les données isotopiques océaniques et l'histoire des grandes faunes européennes plio-pléistocènes: Quaternary Research*, **14**, 251-262, 3 fig.
- Bouchez R., Lopez Caranza E., MA J.-L., Amosse J., Piboule M., Cornu A., Diebolt J., Galland D., Rey P., Lumley H. de, Ramirez Pareja J.A., Guerin C. (1984) *Datation par spectrométrie RPE d'émail dentaire fossile dans le domaine de 50.000 ans plusieurs millions d'années.* Revue d'Archéométrie, **8**, 70-79, 2 fig. 7 tab.
- Bouchud J. (1972) *Les grands herbivores rissiens des "Abimes de La Fage" en Corrèze.* Nouv. Arch. Mus. Hist. nat. Lyon, **10**, 33-59, fig. 15-20, pl. 10-13.
- Bouchud J. (1978) *Les grands herbivores rissiens de l'Aven II des Abimes de La Fage Noailles (Corrèze).* Nouv. Arch. Mus. Hist. nat. Lyon, **16**, 9-39, 26 tabl., 4 pl.
- Bruning H. (1978) *Zur Untergliederung der Mosbacher Terrassenabfolge und zum klimatischen Stellenwert der Mosbacher Tierwelt im Rahmen des Cromer-Komplexes.* Mainz Naturw. Arch., **16**, 143-190, 12 fig., 4 tabl., 1 photo.
- Chapotat G., David L., Dreyon G., Evin J., Guerin C., Mabilon G., Marien G., Walter B. (1980) *Nouvelles datations par le radiocarbonate des formations alluviales de la moyenne vallée du Rhône liées aux fronts glaciaires Würmiens des Alpes occidentales.* C.R. Acad. Sci., **291**, 159-162.
- Chauviré C. (1962) *Les gisements fossilifères quaternaires de Chatillon-Saint-Jean (Drome).* Thèse de Doctorat de 3ème cycle, Lyon, 216 pp., 17 fig., 2 pl.
- Cordy J.-M. (1982) *Biozonation du Quaternaire post-villafranchien continental d'Europe occidentale partir des grands Mammifères.* Annales de la Société Géologique de Belgique, **105**, 303-314, 2 tabl.
- Crégut E. (1980a) *Equus mosbachensis tautavelensis nov. subsp., un nouvel Equide (Mammalia, Perissodactyla) du gisement pléistocène moyen ant-rissien de la Caune de l'Arago (Tautavel, Pyrénées-Orientales, France).* Géobios, **13**(1), 121-127, 2 tabl., 1 pl.
- Crégut E. (1980b) *La Faune de mammifères du gisement pléistocène moyen ant-rissien de la Caune de l'Arago (Tautavel, Pyrénées-Orientales, France).* C.R. Acad. Sc., D, **290**, 751-754.
- David P. et Prat F. (1962) *Sur la présence d'un cheval de grande taille dans certains horizons moustériens de la station de la Chaise de Vouthon (Charente).* Bull. et Mém. Soc. Arch. Hist. Charente, 1961-1962, 20 pp., 1 pl.
- Eisenmann V. (1979) *Les métapodes d'Equus sensu lato (Mammalia, Perissodactyla).* Géobios, **12**(6), 863-886, 19 fig., 11 tabl.
- Eisenmann V. (1980) *Les Chevaux (Equus sensu lato) fossiles et actuels: cranes et dents jugales supérieures.* Cahiers de Paléontologie, CNRS: 186 pp., 67 fig., 22 pl., 72 tabl.
- Eisenmann V., Crégut-Bonnoure E., Moigne A.-M. (1985) *Equus mosbachensis et les grands Chevaux de la Caune de l'Arago et de Lunel-Viel: craniologie comparée.* Bull. Mus. nat. Hist. nat., 4ème série, C, **7**(2), 157-173, 5 fig., 2 tabl.
- Guadelli J.-L. (1986) *Révision de la sous-espèce Equus caballus gallicus; contribution du Cheval la connaissance des paléoenvironnements.* 11ème Réunion des Sciences de la Terre, Clermont-Ferrand, Soc. Géol. Fr. édit.: 85, Paris.
- Guadelli J.-L. (1987) *Contribution à l'étude des Zoo-cénoses préhistoriques en Aquitaine (Würm ancien et interstade Würmien).* Thèse de Doctorat, Univ. de Bordeaux I, 3 vol., 568 pp., 163 fig., 424 tabl.
- Gromova V. (1949) *Istorija loshadej (roda Equus) v Starom Svete, Chast'2. Evoljutsija i klassifikatsija roda.* Trudy Paleontologicheskogo Instituta Akademii Nauk SSSR, **17**(2), 162 pp.
- Guerin C. (1980) *Les Rhinocéros (Mammalia, Perissodactyla) du Miocène terminal au Pléistocène supérieur en Europe occidentale. Comparaison avec les espèces actuelles.* Documents Lab. Géol. Lyon, **79**(1-3), 1185 p., 115 fig., 21 pl., 161 tabl.
- Guerin C. (1982) *Première biozonation du Pléistocène européen, principal résultat biostratigraphique de l'étude des Rhinocerotidae (Mammalia, Perissodactyla) du Miocène terminal au Pléistocène supérieur d'Europe Occidentale.* Géobios, **15**(4), 593-598, 1 fig.
- Guerin C. (1987) *Biochronologie.* In: *Géologie de la Pré-histoire*, sous la direction de J.-C. Miskowski, Gèopre, Paris: 931-935.
- Mourer-Chauviré C. (1972) *Etude de nouveaux restes de Vertébrés provenant de la Carrière Fournier Chatillon-Saint-Jean (Drome). III. - Artioctyles, Chevaux et Oiseaux.* Bull. Ass. fr. Etude du Quaternaire, **4**, 271-305, 3 pl., 28 tabl., Paris.
- Mourer-Chauviré C. (1980) *Le gisement pléistocène supérieur de la grotte de Jaurens Nespouls, Corrèze, France: les Equidés (Mammalia, Perissodactyla).* Nouv. Arch. Mus. Hist. nat. Lyon, **18**, 17-60, 6 fig.,

- 5 pl.
- Mourer-Chauviré C. avec la collaboration de R. Ballesio, M. Beden, J. Bouchud, J. Chaline, L. David, C. Guerin, M. Hugueney, D. Jammot, P. Mein, J.-C. Rage et R. Vilain (1975) *Conclusions générales sur les faunes de l'Aven I des Abimes de La Fage (Corrèze)*. Nouv. Arch. Mus. Hist. nat. Lyon, **13**, 123-129.
- Musil R. (1969) *Die Pferde der Pekarna Hohle*. Zeitschrift für Tierzucht und Zuchtungsbiologie, **86(2)**, 147-193, 2 fig., 5 tabl.
- Prat F. (1968) *Recherches sur les Equidés pléistocènes de France*. Thèse de Sci. nat., Bordeaux: Fac. Sci., 4 vol., 662 pp., 149 fig., 126 tabl.
- Reichenau W. von (1915) *Beiträge zur näheren Kenntnis fossiler Pferde aus deutschen Pleistozän, insbesondere über die Entwicklung und die Abkaustadien des Gebisses vom Hochterrassempferd (*Equus mosbachensis* v. R.)*. Abh. hess. geol. Landesanst., **7(1)**, 155 pp., 164 fig., 14 pl.
- Shackleton N.J. and Opdyke N.D. (1973) *Oxygen isotope and Paleomagnetic stratigraphy of Equatorial Pacific Core V.28-238 = Oxygen Temperatures and Ice Volume on a 10<sup>5</sup> Year and a 10<sup>6</sup> Year Scale*. Quaternary Research, **3**, 39-55.
- Shackleton N.J. and Opdyke N.D. (1976) *Oxygen isotope and Paleomagnetic stratigraphy of Equatorial Pacific Core V. 28-239. Late Pliocene to latest Pleistocene*. Geological Society of America, **145**, 449-464.

Accettato per la stampa il 30.9.1988