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THE DATING OF TWO PLEISTOCENE MAMMAL ASSEMBLAGES FROM THE FLEMISH VALLEY, BELGIUM

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Two Electron Spin Resonance (ESR) age determinations of Weichselian mammoth material have enabled the assignment of the mammal assemblages in which they occur to the Early and Middle Weichselian, respectively. Although these datings do not allow a precise age attribution, they agree well with the stratigraphic and/or evolutionary stage of the mammal assemblages.

Key words — Late Pleistocene, fluvial deposits, stratigraphy, Mammalia, Electron Spin Resonance dating, NW Belgium.

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Contents

Introduction

Only a limited number of the Pleistocene mammalian faunas from the Flemish Valley (NW Belgium) have been discovered *in situ*. Even fewer assemblages have so far yielded absolute age results. Here we report on two Electron Spin Resonance (ESR) datings of material from Zemst and Rotselaar. The estimated ages are in good agreement with the stratigraphic position and/or the evolutionary stage of the assemblages studied.

The Flemish Valley mammalian faunas occur mainly in Weichselian fluvial deposits (Germonpré, 1989, 1993). During the Cromerian, the Flemish Valley started to form and during consecutive stages, the palaeovalley was enlarged by erosional phases of large rivers and, to a lesser extent, of estuaries. These phases alternated with periods of sediment accumulation. During the Weichselian, the palaeovalley filled up, although erosion occurred several times. The Pleistocene deposits may reach a thickness in excess of 15 m and are composed mainly of fluvial sands and silts. Generally, aeolian sands and loams occur at the top of the sequence (Bogemans, 1988, 1993; de Moor & Heyse, 1976; Paepe, 1967; Paepe & Vanhoorne, 1976; Paepe *et al.*, 1981).

In general, the fossil remains occur dispersed and isolated in these sediments. Collecting over several years has resulted in large assemblages, allowing a detailed analysis of their palaeontological properties (Gautier, 1985; Germonpré, 1989, 1993; Germonpré & Ervynck, 1988; van Neer & Germonpré, 1991).

Localities and discussion

1 - Zemst, Bos van Aa

The Zemst-Bos van Aa locality is situated in the eastern branch of the Flemish Valley (Fig. 1). Since the early 1980s, several sandpits have been exploited here, two of which have been thoroughly studied (*e.g.* Bogemans, 1983, 1986, 1988, 1993; Bogemans & Caspar, 1984; Germonpré, 1989, 1993; van Peer & Smith, 1990).

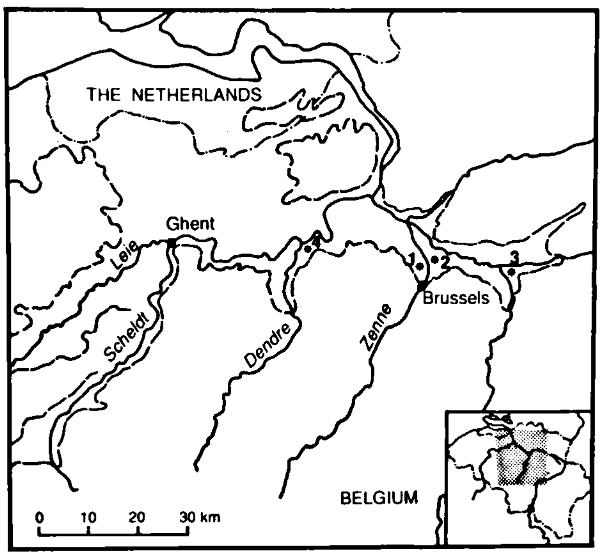

Fig. 1. The Flemish Valley with the sites of Zemst (1), Hofstade (2), Rotselaar (3) and Dendermonde (4); the dashed line indicates the boundary of the Flemish Valley (after de Moor, 1981).

On the basis of these outcrops, a fairly detailed reconstruction of the Quaternary geological evolution, with the emphasis on the identification of sedimentary palaeoenvironments, has become possible and an adapted lithostratigraphic classification has been introduced (Bogemans, 1988, 1993). Through quarrying activities, the walls of the sandpits retreated rapidly, and so facies distribution could be traced vertically and laterally, even over considerable distances. Additional data are available from cored boreholes (drilled on behalf of the Belgian Geological Survey) in neighbouring areas. In addition to the sedimentological approach, palaeobotanical and palaeozoological investigations have been carried out in order to obtain an idea of the evolution of the area in all its aspects.

Although the formation of the eastern branch of the Flemish Valley dates back to the Middle Pleistocene, only sediments of Late Pleistocene age (Eemian and Weichselian) are exposed at the Bos van Aa locality. In spite of the limited time span they represent, the facies are very diverse.

The Bos van Aa area comprises Quaternary fluvial and aeolian deposits, the latter being vertically restricted. On the basis of the channel pattern, the fluvial environment may be subdivided further into several synchronic subenvironments, which have, however, a distinct position in the Quaternary sequence.

Since the geological studies were aimed at reconstructing the sedimentary palaeoenvironments and subenvironments, it is obvious that both elements are reflected in the lithostratigraphy. The sedimentary environment, in which the formation and accumulation of the sediments took place, defines the primary lithostratigraphic units (formations): the Gent Formation, embracing aeolian and mass waste products and the Zemst Formation, incorporating all fluvial deposits (Paepe & Vanhoorne, 1976). Differences in channel pattern observed in the fluvial deposits have made possible the introduction of members.

Locally, at the base of the sandpits, meandering river sediments are preserved in the form of point bar, natural levee and flood plain deposits. Plant remains (identification by H. Doutrelepont, pers. comm.) as well as the articulated shells of the bivalve *Corbicula fluminalis* (Müller, 1774) indicate an Eemian age (Bogemans, 1988) of this unit, which is referred to as the Grimbergen Member (Bogemans, 1988, 1993). This meandering river system stopped its activities at the end of the Eemian and a period of intensive erosion followed, which resulted in a sharp erosional contact with the overlying Weichselian deposits (Bogemans, 1988, 1993).

Basically, the Weichselian deposits have a fourfold composition. The basal part formed in a grav-

Assemblage	Chronostratigraphy	Lithostratigraphy	Sediments	Fauna	Palaeoenvironment	Datings
Dendermonde II	Middle Weichselian	?	?	typical mammoth fauna	open, steppe environment	~ 30,000 y B.P. (C14)
Rotselaar	Middle Weichselian	?	sands and gravels?	typical mammoth fauna with red deer	open, steppe environment	~ 48,000 y B.P. (ESR)
Hofstade III	Middle Weichselian	Lembeke Member	sands	typical mammoth fauna	sandy braided river in an open, steppe environment	
Hofstade II	Middle Weichselian	Lembeke Member	sands	typical mammoth fauna	sandy braided river in an open, steppe environment	
Hofstade I	Middle Weichselian	Lembeke Member	sands with some gravel at the base of the deposit	typical mammoth fauna	sandy braided river in an open, steppe environment	
Dendermonde I	Early Weichselian	Dendermonde Member	sands and gravels	typical mammoth fauna	gravelly braided river in an open, steppe environment	
Zemst IIIC	Early Weichselian	Bos van Aa Member	rusty coarse gravelly sands	typical mammoth fauna with red deer	gravelly braided river in an open, steppe environment	
Zemst IIB	Early Weichselian	Bos van Aa Member	blue grey gravelly sands	typical mammoth fauna with red deer, roe deer, wild hog, beaver and aurochs	gravelly braided river in open, steppe environment with locally wooded areas or parkland	~129,000 y B.P (ESR)
Zemst A	Eemian	Grimbergen Member	fine sands and silts	red deer, roe deer, wild boar, beaver, aurochs/bison, horse, unidentified elephant and rhino	meandering river system in wooded environment	

Table 1. Overview of the assemblages discussed herein, based on Bogemans (1988, 1993), de Moor (1974), Germonpré (1989, 1993), Mourlon (1909), Rutot (1909a, b) and Vanhoorne *et al.* (1978).

elly braided river system, in which two depositional models may be distinguished. The first model, Bos van Aa Member Weichselian I (BWI), describes the lowermost part, comprising blue grey gravelly sands, which accumulated in a few deep channels and well-developed transverse bars. Their morphology was influenced by several topographic levels; the higher levels were covered with vegetation and were inundated only sporadically. This river system's mobility was limited, and the environment can be characterised as cold but humid. The overlying braided river deposits are clearly distinguished, not only by iron coating but also by coarser grain size distribution, which resulted in a different depositional setting which was dominated by a wide variety of shallow channels and longitudinal bars. The second model, Bos van Aa Member Weichselian II (BWII), reflects a mobile fluvial system in which strong fluctuating hydraulic conditions dominated. In spite of these differences, a common sedimentary environment for both braided river systems existed, which explains why only one lithostratigraphic unit, the Bos van Aa Member, has been introduced (Bogemans, 1988, 1993).

Resting on the Bos van Aa Member, fine clastic topstratum and point bar deposits together with swale deposits are locally preserved in the outcrop. Correlation with data obtained from sedimentological and palynological (C. Verbruggen, pers. comm.) studies carried out on cored boreholes, drilled in the area, suggests these deposits to have originated in an environment dominated by a meandering river system, which was active during the Amersfoort and Brörup interstadials. These strata are known as the Hombeek Member (Bogemans, 1988, 1993); they indicate an Early Weichselian age for the Bos van Aa Member, which is sandwiched between the Hombeek Member and the Eemian Grimbergen Member.

In addition to having the largest spatial distribution, the uppermost fluvial sediments also reach the greatest thickness. These strata accumulated in a sandy braided river system, from which gravel was almost absent. Three depositional types of this sandy braided river system may be distinguished in the eastern branch of the Flemish Valley, but only one is observed in the Bos van Aa area. The stream produced sandbars separated by channels with strongly reduced topographic differences in comparison to those characterising the Bos van Aa Member; these deposits are known as the Lembeke Member and are of Middle Weichselian age (Bogemans, 1988, 1993).

In the Bos van Aa sandpits, three fossiliferous horizons occur. Germonpré (1989, 1993) provided a detailed account of the faunal assemblages collected, and an overview is here presented in Table 1. The Eemian Grimbergen Member has yielded a small collection of well-preserved, mahogany coloured bones (assemblage Zemst A). Mammalian species present, such as roe deer [*Capreolus capreolus* (Linnaeus, 1758)], wild boar (*Sus scrofa* Linnaeus, 1758) and beaver (*Castor fiber* Linnaeus, 1758), are indicative of a wooded or parkland environment in a temperate climate. Unidentified proboscidians and rhinocerotids also occurred beside aurochs or bison (*Bos/Bison*) and horse (*Equus* sp.).

The richest mammal assemblage (assemblage Zemst IIB) has been encountered in the blue grey sands of the lower part of the Bos van Aa Member. The bones are in a good state of preservation and are of a grey brown colour, probably due to reducing conditions. The assemblage comprises species such as mammoth [*Mammuthus primigenius* (Blumenbach, 1799)], woolly rhinoceros [*Coelodonta antiquitatis* (Blumenbach, 1799)], steppe bison [*Bison priscus* (Bojanus, 1827)] and horse (*Equus remagensis* Skorkowski, 1938 *sensu* Nobis, 1971), indicative of an open, steppe environment. However, the scanty remains of aurochs (*Bos primigenius* Bojanus, 1827), roe deer, wild boar and beaver exclude extreme cold/dry conditions and suggest the existence of locally wooded areas and parkland which occurred in the palaeoenvironment defined by model BWI.

A mammoth molar from this assemblage was subjected to ESR dating. For details of the method see Grün (1989a, b) and Grün & Stringer (1991). The following age determinations have been obtained:

Lab. N	Ages: EU*	LU*
374-A	114,500 +/- 13,500	122,400 +/- 15,100
374-B	135,800 +/- 16,100	140,500 +/- 17,100
374-C	134,800 +/- 17,200	138,500 +/- 18,100
374-D	119,600 +/- 13,300	126,200 +/- 14,800
average:	126,200 +/- 9,300	131,900 +/- 7,800
*EU: early U-accumulation; LU: linear U-accumulation		

These ESR datings allow assignment of the assemblage to a broad chronological interval only, which, however, coincides with an early Late Pleistocene age as already suggested by their stratigraphic position.

This age attribution is also confirmed by the evolutionary stage of the woolly mammoth as deduced from the lamellar frequency, the enamel thickness

			Upper			
Assemblage	n	min	max	mean	sd	cv
Zemst IIB	29	6.0	9.5	7.6	0.8	11.0
Hofstade I	17	7.0	9.7	8.4	0.7	8.7
Rotselaar	5	8.0	10.0	9.2	0.8	8.1
			Lower			
Assemblage	n	min	max	mean	sd	cv
Zemst IIB	28	6.0	9.2	7.3	0.9	11.6
Hofstade I	19	6.5	10.9	8.0	1.0	12.5
Rotselaar	4	8.0	10.0	8.3	0.4	5.3

Table 2. Lamellar frequency of M6 of *Mammuthus primigenius* calculated as proposed by Maglio (1973).

			Upper			
Assemblage	n	min	max	mean	sd	cv
Zemst IIB	27	1.5	2.1	1.8	0.1	7.7
Hofstade I	10	1.3	1.7	1.5	0.1	7.2
Rotselaar	5	1.1	2.0	1.4	0.2	8.6
			Lower			
Assemblage	n	min	max	mean	sd	cv
Zemst IIB	24	1.4	2.2	1.8	0.2	12.4
Hofstade I	16	1.4	1.9	1.6	0.1	8.8
Rotselaar	4	1.1	1.9	1.5	0.2	8.7

Table 3. Enamel thickness of M6 of *Mammuthus primigenius.*

and the shearing index of the molars (Germonpré, 1985, 1989) (Tables 2-4). The values for *Mammuthus primigenius* of assemblage Zemst IIB have been compared to the mean values of these indexes provided by Maglio (1973) and indicate rather primitive forms. The evolutionary history and nomenclature of Pleistocene horses are very complex as may be seen in the overview published by Groves (1986). The different forms of Pleistocene horses from the Flemish Valley probably all belong to the Type I *sensu* Eisenmann (1991). However, the nomenclature proposed by Nobis (1971) is followed here. According to that author, European horses underwent a size reduction during the Middle and Late Pleistocene. Forsten (1991) noted the same phenomenon although she remarked that size decrease was not continuous and size stasis occurred. The horse from assemblage Zemst IIB, which is identified as *Equus remagensis sensu* Nobis, 1971, is relatively large, indicating an age early in the Weichselian (Germonpré, 1985, 1989) (Tables 4, 5).

The third assemblage (Assemblage Zemst IIIC) has been collected from the rusty gravelly sands of the Bos van Aa Member. The bones are more fragile and are of a rusty beige colour, possibly caused by oxidising conditions or exposure to iron-rich ground water. Again, remains of mammoth, woolly rhinoceros, horse and bison dominate, indicating a

Assemblage	*M. primigenius*	*M. armeniacus*
Zemst IIB	21.6	*
Hofstade I	26.7	*
Rotselaar	29.4	*
MAGLIO (1973)	26.8	14.4

Table 4. Shearing index of *Mammuthus* as defined by Maglio (1973): $2LFM^6 * 2LFM_6 * WM_6/1000$; the shearing index is indicative of the shearing ability of an elephant molar calculated with the mean of the lamellar frequency of the upper sixth molar, the mean of the lamellar frequency of the lower sixth molar and with the maximum width of the lower sixth molar.

Assemblage	n	min	max	mean
Zemst IIB (1)	57	139	161	148.7
Zemst IIIC (1)	4	145	151	147.2
Hofstade I (2)	27	130	147	139.2
Hofstade II (3)	8	130	142	136.1
Hofstade III (4)	2	132	138	134.9
Rotselaar (3)	4	131	142	137.5
Dendermonde II (4)	4	134	139	135.9

(1) *Equus remagensis*
(2) *Equus* cf. *remagensis*
(3) *Equus* cf. *ferus*
(4) *Equus ferus*

Table 5. Greatest length of the canon bones (metacarpale, metatarsale) of horses from the Flemish Valley.

steppe environment. Temperate species are absent. This, together with the presence of the collared lemming, indicates more severe conditions than for assemblage Zemst IIB. Ecological properties of this assemblage, as well as the relatively high weathering rate of the fossil bones, agree well with model BWII for the rusty gravelly sands. The shoulder height of *Equus remagensis* can be found in Table 6.

A number of artefacts have also been collected from the blue grey and rusty gravelly sands of the Bos van Aa Member (Bogemans & Caspar, 1984). According to van Peer & Smith (1990), Middle Palaeolithic man would have visited the area only during short periods. They classified the artefacts as 'Moustérien typique'.

At Zemst, no fossil bones have been collected from the younger fluvial deposits. At the nearby site of Hofstade (Fig. 1), however, three assemblages have been recovered from the Middle Weichselian Lembeke Member. The richest assemblage, assemblage Hofstade I, occurs at the base of this unit. These sediments do not correlate with the upper part of the Bos van Aa Member as was previously assumed by Germonpré (1989) and van Neer & Germonpré (1991). Assemblage Hofstade I also comprises the typical mammoth fauna *sensu* Vereshchagin & Baryshnikov (1991). The younger age of this assemblage is indicated not only by its stratigraphic position, but also by the higher lamellar frequency, enamel thickness and shearing index of the mammoth molars and by the smaller horses, tentatively assigned to *Equus* cf. *remagensis* (Germonpré, 1985, 1989) (Tables 2-6). The measurements for the assemblages Hofstade II and Hofstade III, from higher in the Lembeke Member, of *Equus* cf. *ferus* and *Equus ferus* Boddaert, 1785, are presented in Tables 5 and 6, respectively.

			MC			
Assemblage	n	min	max	mean	sd	cv
Zemst IIB (1)	14	230	255	242.5	7.0	2.9
Hofstade I (2)	8	220	239	229.6	6.8	3.0
Hofstade III (4)	2	213	224	218.5	*	*
Rotselaar (3)	2	212	230	221.0	*	*
Dendermonde II (4)	3	220	225	221.7	2.4	1.1
			MT			
Assemblage	n	min	max	mean	sd	cv
Zemst IIB (1)	24	268	301	284.3	8.6	3.0
Hofstade I (2)	13	255	283	271.0	7.6	2.8
Hofstade II (3)	3	257	279	267.0	9.1	3.4
Rotselaar (3)	2	263	275	269.0	*	*

(1) *Equus remagensis*
(2) *Equus* cf. *remagensis*
(3) *Equus* cf. *ferus*
(4) *Equus ferus*

Table 6. Shoulder height of horses from the Flemish Valley calculated using indexes proposed by Kiesewalter (1888, *fide* von den Driesch & Boessneck, 1974).

2 - Rotselaar

The Rotselaar site (Fig. 1) was exploited in the late 1970s, but yielded no precise stratigraphic data. However, a lithological sequence, attributed to the Last Glacial, is known from the Kwellenberg, three kilometres to the south (de Smedt, 1973). Sands and gravels at the base are overlain by alternating stratified sands and loams on top of which rest aeolian sand and loam. During exploitation of this sandpit, collectors noted that most fossils appeared when a more gravelly fraction was pumped up, the fauna consisting mainly of mammoth, woolly rhinoceros, steppe bison and horse. Other less well-represented species include reindeer, giant deer [*Megaloceros giganteus* (Blumenbach, 1803)] and carnivores such as wolf (*Canis lupus* Linnaeus, 1758), cave lion [*Panthera leo* (Linnaeus, 1758)] and hyena [*Crocuta crocuta* (Erxleben, 1777)]. Red deer was found only once. The overall faunal composition indicates an open, steppe-like environment and a cold climate (van Neer & Germonpré, 1991). Some lithic artefacts are also known from this locality (van Peer, 1982), assigned to the Middle Palaeolithic and more or less comparable to those found at Zemst (van Peer & Smith, 1990). At Rotselaar, handaxes are part of the assemblage; these are missing at Zemst. However, no data are available for the relative chronologic position of Middle Palaeolithic industries in the Flemish Valley (van Peer, pers. comm.).

The mean ESR datings obtained on two plates of mammoth molars from Rotselaar are the following: 52,000 y BP (sample 45) and 43,500 y BP (sample 46). These results, although precluding a precise age attribution, indicate a Middle Weichselian age. The evolutionary stages of the mammoth and horse remains of the Rotselaar assemblage (Tables 2-6) are indeed much closer to the Middle Weichselian assemblages from Hofstade than they are to the Early Weichselian assemblage from Zemst IIB and thus confirm the ESR datings. The evolutionary stages of mammoth and horse seem to indicate that Rotselaar is younger than Hofstade I. However, datings to confirm this are not yet available. A radiocarbon dating of a mammoth tusk from Dendermonde yielded an age of 29,880 +/- 930 y BP (Vanhoorne *et al.*, 1978). Two assemblages have been recognised at this site: assemblage Dendermonde I, collected *in situ* from the Early Weichselian Dendermonde Member (de Moor, 1974); the dated mammoth tusk is thought to have been part of assemblage Dendermonde II. Measurements on the *Equus ferus* material from this assemblage are incorporated in Tables 5 and 6.

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References

Bogemans, F., 1983. Kwartairgeologische opnamen in het Bos van A te Zemst. — Belgische Geologische Dienst, Professional Paper, 1983/7(202): 31 pp.

Bogemans, F., 1986. Application of some statistical parameters to the Quaternary deposits of Bos van A. — Bulletin de la Société belge de Géologie, 95: 227-233.

Bogemans, F., 1988. Thematische kwartairgeologische voorstellingen als toepassingsmodellen in de economische ontwikkeling. Brussel (Ph.D. thesis Vrije Universiteit), 208 pp. (unpubl.).

Bogemans, F., 1993. Quaternary geological mapping on basis of sedimentary properties in the eastern branch of the Flemish Valley (sheets Boom-Mechelen and Vilvoorde-Zemst). — Mémoires pour servir à l'explication des Cartes géologiques et minières de Belgique, 35: 49 pp.

Bogemans, F., & J.P. Caspar, 1984. Bois de A, site des artefacts. — Bulletin de la Société belge de Géologie, 93: 245-248.

Driesch, A. von den, & J. Boessneck, 1974. Kritische Anmerkungen zur Widerristhöhenberechnung aus Längenmassen vor- und frühgeschichtlicher Tierknochen. — Säugetierkundliche Mitteilungen, 22: 325-348.

Eisenmann, V., 1991. Les chevaux quaternaires européens (Mammalia, Perissodactyla). Taille, typologie, biostratigraphie et taxonomie. — Geobios, 24: 747-759.

Forsten, A., 1991. Size decrease in Pleistocene-Holocene true or caballoid horses of Europe. — Mammalia, 55: 407-419.

Gautier, A., 1985. Pleistocene zoogdieren in België en waar ze gevonden worden. — Lutra, 28: 121-123.

Germonpré, M., 1985. Some preliminary results on the Upper Pleistocene mammals of the Bos van A at Zemst (Brabant, Belgium). — Lutra, 28: 113-120.

Germonpré, M., 1989. De boven-pleistocene zoogdieren uit de oostelijke uitloper van de Vlaamse Vallei (België). Brussel (Ph.D. thesis Vrije Universiteit), 234 + 204 pp. (unpubl.).

Germonpré, M., 1993. Taphonomy of Pleistocene mammal assemblages of the Flemish Valley, Belgium. — Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre, 63: 271-309.

Germonpré, M., & A. Ervynck, 1988. Pleistocene zoogdierresten te Uitbergen (Oost-Vlaanderen, België). — Cranium, 5: 5-7.

Groves, C.P., 1986. The taxonomy, distribution, and adaptations of recent equids. *In*: R.H. Meadow & H.P. Uerpmann (eds). Equids in the Ancient World. Wiesbaden (L. Reichert): 11-65.

Grün, R., 1989a. Die ESR Altersbestimmungsmethode. Heidelberg (Springer), 132 pp.

Grün, R., 1989b. Electron Spin Resonance (ESR) dating. — Quaternary International, 1: 65-109.

Grün, R., & C.B. Stringer, 1991. Electron Spin Resonance dating and the evolution of modern humans. — Archaeometry, 33: 153-199.

Kiesewalter, L., 1888. Skelettmessungen an Pferden als Beitrag zur theorethischen Grundlage der Beurteilungslehre des Pferdes. Leipzig (not seen, cited from von den Driesch & Boessneck, 1974).

Maglio, V.J., 1973. Origin and evolution of the Elephantidae. — Transactions of the American Philosophical Society, n.s., 63: 149 pp.

Moor, G. de, 1974. De afzetting van Dendermonde en haar betekenis voor de jongkwartaire evolutie van de Vlaamse Vallei. — Natuurwetenschappelijk Tijdschrift, 56: 45-75.

Moor, G. de, 1981. Periglacial deposits and sedimentary structures in the Upper Pleistocene infilling of the Flemish Valley (NW Belgium). — Biuletyn perygalcjany, 28: 277-290.

Moor, G. de, & I. Heyse, 1976. Kwartairgeologie en geomorfologie in noordwestelijk Vlaanderen. — Werkstukken Nationaal Centrum Geomorfologisch Onderzoek, 16: 1-71.

Mourlon, M., 1909. Découverte d'un dépôt quaternaire campinien avec faune du mammouth et débris végétaux, dans les déblais profonds à Hofstade, à l'est de Sempst. — Bulletin de l'Académie royal de Belgique, Classes des Sciences, 2: 427-434.

Neer, W. van, & M. Germonpré, 1991. Les mammifères du Pléistocène supérieur de Rotselaar (Brabant, Belgique). —

Bulletin de l'Institut royal des Sciences naturelles de Belgique, Sciences de la Terre, 61: 211-226.

Nobis, G., 1971. Vom Wildpferd zum Hauspferd. Köln (Böhlau), 96 pp.

Paepe, R., 1967. The rock sequences of the Late Pleistocene. *In*: R. Paepe & R. Vanhoorne (eds). The stratigraphy and palaeobotany of the Late Pleistocene in Belgium. — Mémoires pour servir à l'explication des Cartes géologiques et minières de la Belgique, 8: 13-57.

Paepe, R., C. Baeteman, R. Mortier, R. Vanhoorne & C.Q.S., 1981. The marine Pleistocene sediments in the Flandrian area. — Geologie en Mijnbouw, 60: 321-330.

Paepe, R., & R. Vanhoorne, 1976. The Quaternary of Belgium in its relationship to the stratigraphical legend of the geological map. — Mémoires pour servir à l'explication des Cartes géologiques et minières de la Belgique, 18: 38 pp.

Peer, P. van, 1982. A middle palaeolithic industry from Rotselaar (Brabant). — Helinium, 22: 238-254.

Peer, P. van, & R. Smith, 1990. Zemst "Bos van Aa": un site du paléolithique moyen de la partie orientale de la Vallée Flamande. — Helinium, 30: 157-171.

Rutot, A., 1909. Note préliminaire sur la coupe des terrains quaternaires à Hofstade. — Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie, 23: 235-245.

Rutot, A., 1909b. Nouvelles observations dans les couches quaternaires à Hofstade. — Bulletin de la Société belge de Géologie, de Paléontologie et d'Hydrologie, 23: 338-347.

Smedt, P. de, 1973. Paleogeografie en kwartair-geologie van het confluentiegebied Dijle-Demer. — Acta Geographica Lovaniensia, 11: 1-141.

Vanhoorne, R., M. van Strijdonck & A.D. Dubois, 1978. Antwerp university radiocarbon dates III. — Radiocarbon, 20: 192-199.

Vereshchagin, N.K., & G.F. Baryshnikov, 1991. The ecological structure of the "Mammoth fauna" in Eurasia. — Annales Zoologici Fennici, 28: 253-259.

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