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Neandertal Studies in Belgium: 2000–2005

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Abstract

On several occasions since 1830 Southern Belgium Meuse Basin caves yielded Neandertal remains, some of them having a major influence on the development of palaeoanthropology as a distinct scientific discipline; in particular, the discovery of human fossils in 1829–1830 at Engis, of a mandible in 1866 at La Naulette and of skeletons in 1886 at Spy. Yet to this day the context of these old finds is not well known. But new finds, from the last two decades, at Couvin, Scladina and Walou took place within modern multidisciplinary field and laboratory studies, backed up by stratigraphic positioning, different dating methods and palaeoenvironmental recordings. In parallel, most of the old and recent Neandertal fossils were the object of new anthropological laboratory studies using state-of-the-art technologies, notably 3D reconstruction from computer tomography scans. This article overviews all these contributions, focusing primarily on the work of the last five years.

1. INTRODUCTION

On eight occasions since 1830, several caves of the Mosan Basin of southern Belgium yielded Neandertal skeletal remains (Figure 1) which, particularly those from Engis, La Naulette and Spy, would play a major role in the genesis and early development of palaeoanthropology and prehistory *(1, 2)*.

Unfortunately, the quality of the data available on the contexts of these fossils varies widely. Some were found during recent archaeological excavations, mainly at the Scladina and Walou caves, and have reliable stratigraphic, archaeological and palaeoenvironmental contexts. Others, found during basic stratigraphic recordings in the 19th century, feature neither precise distribution plans nor contextual analyses. However, each of these remains has significantly contributed, though in varying degrees, to the corpus of knowledge about the fascinating Neandertal taxon.

In the five years following our last overview of this subject *(3)*, a series of new multidisciplinary field and laboratory programs was undertaken.

For fieldwork, excavations at the two cave sites where Neandertal fossils were found during the 1990s (Walou and Scladina) were continued. Scladina yielded several Neandertal teeth. New stratigraphic and sedimentological studies recorded the context of the human remains at both sites.

Concurrently, a new research program concerning the Neandertal sites discovered in the 19th century was started. A new excavation

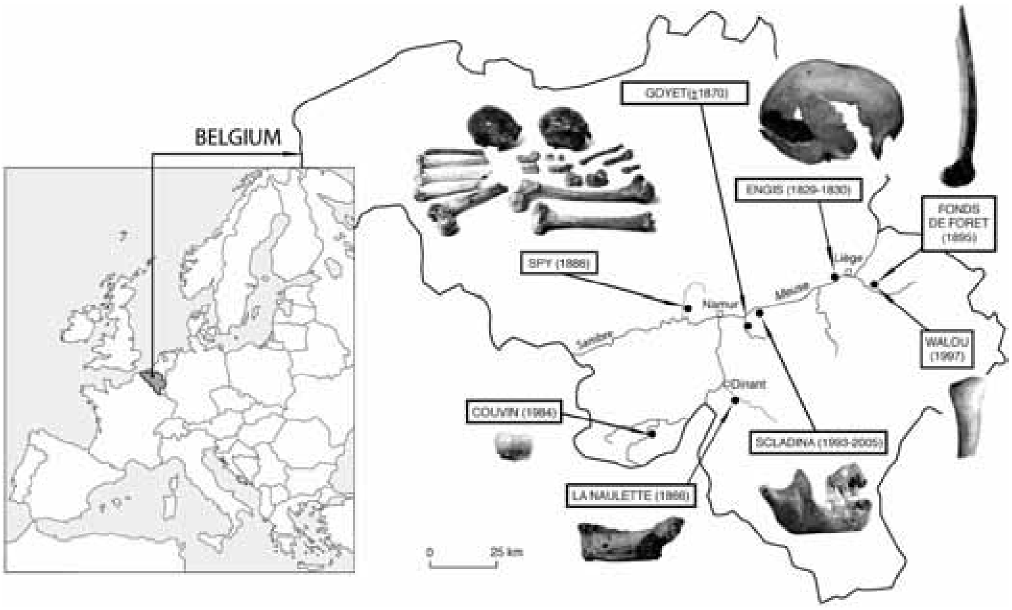

Figure 1. *Location of the sites which have yielded unquestionable Pleistocene hominid remains in Belgium.*

began at La Naulette in 1999. The standing sections cut in 1866 by E. Dupont, the first digger, were recovered and the potential of the undisturbed sediments estimated. At Fonds de Forêt, a few evaluation trenches were opened but with disappointing results.

Laboratory work included studies, now under completion, of the Scladina child skeletal remains (a mandible, a few teeth and a maxilla fragment), of the deciduous tooth discovered in 1984 at the Couvin cave and of the premolar discovered at the Walou cave in 1997. A team of palaeoanthropologists at the Royal Belgian Institute of Natural Sciences is currently examining the Spy Neandertal fossils. Each study used modern investigation techniques, such as 3D reconstruction from computer tomography scans (Figure 2), isotopic biogeochemistry or experiments in DNA extraction. They also relied largely on scientific disciplines specialized in the study of contexts, such as microstratigraphy and sedimentology and different dating methods. Finally, Belgian researchers participated in the development of tools specifically designed for the study of Neandertal man (The Neandertals Tools, TNT; Nespos society) *(4)*.

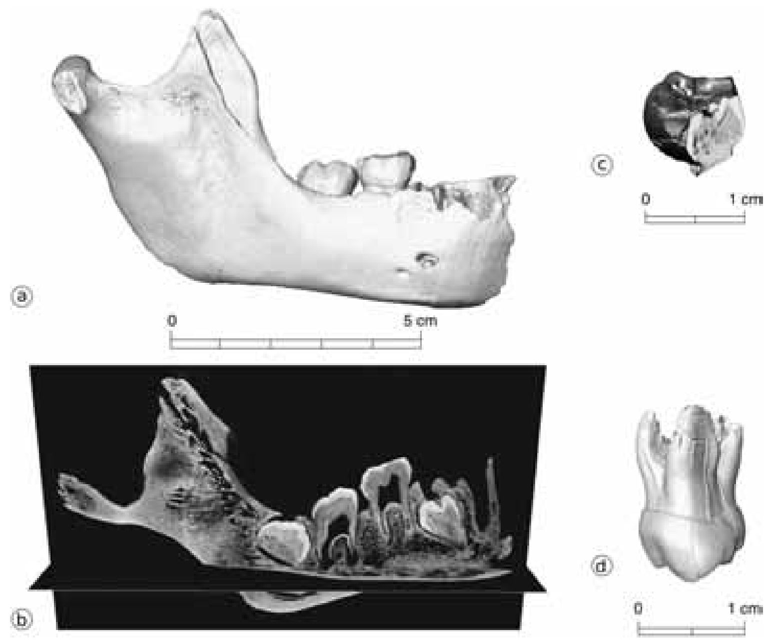

Figure 2. *Examples of visualization techniques used in 3D reconstruction from μ-computed tomography data. (a and b) Right hemi-mandible from Scladina (Scla 4A-1). (c) Probable Neandertal deciduous molar from Couvin. (d) deciduous second upper molar from Engis 2. Software used: amira®*

2. HISTORY AND ROLE OF MOSAN NEANDERTALS

In the winter of 1829–31, Ph.-Ch. Schmerling, a medical doctor and nonconformist naturalist, discovered, in the second cave of Engis, two skullcaps associated with woolly rhinoceros and mammoth bones. This find, as well as a number of other investigations in regional caves, allowed him to understand and demonstrate the contemporaneity of man with large extinct prehistoric mammals. It also helped him realize that flint objects found in association with human and animal bones were actually man-made *(5)*.

Even though this illustrious precursor did not go as far as claiming that fossil man was morphologically slightly different from modern man, it took the scientific community more than a quarter of a century to finally accept Schmerling's theories. Several key events had contributed to this: prehistoric archaeology had become more firmly established thanks to Jacques Boucher de Perthes' dedication, Charles Darwin's *The Origin of Species* (1859) had introduced the concept of transformism and the Scottish geologist Charles Lyell had come round to Schmerling's ideas, after having collaborated with the Belgian geologist C. Malaise in a cave where Schmerling did some digging thirty years earlier.

The discovery in 1866 of the famous La Naulette mandible by the geologist Édouard Dupont, in the Lesse valley, also marks an important step in the history of palaeoanthropology. The antiquity of the fossil was confirmed by a precise stratigraphic context and its association with large, extinct prehistoric mammals *(6, 7)*. On the contrary, ten years earlier, the eponymous Neandertal discoveries, in Germany, were out of context, and consequently not very well accepted. That is why, according to Paul Broca, the mandible from La Naulette constitutes: »the first event providing Darwinists with anatomical evidence. It is the first link in the chain which, according to them, extends from man to the apes«.

Two decades later, a more receptive scientific community willingly accepted the »The Man of Spy« skeletal remains, unearthed in June and July 1886 before the entrance of the 'Betche aux Rotches' cave, 20 km west of Namur *(8)*. Thanks to multidisciplinary research conducted by the geologist Max Lohest and the archaeologist Marcel De Puydt, in collaboration with the palaeontologist Julien Fraipont, this discovery was conducive to the acceptance of a human taxon anatomically slightly different from modern humans.

In 1895, the femur Doctor F. Tihon found within the caves of 'Fonds de Forêt', in the Vesdre valley, closed the 19th century Mosan Neandertal discoveries.

During most of the 20th century, regional Neandertal anthropology was confined to laboratories. Significant events were the determination of the Neandertal traits of the Engis child, more than a century after its discovery *(9)*, the comprehensive study of the Fonds de Forêt femur *(10)* and new analyses of the fossils from Spy *(11)* and La Naulette *(12)*. The only fieldwork worth mentioning was the discovery of some bones in backfill at Spy in 1953 by Twiesselmann.

In contrast, the end of the 20th century and the beginning of the 21st saw renewed interest in multidisciplinary fieldwork, mainly at the Couvin, Scladina and Walou cave sites. The results of the Neandertal research from the last five years are presented in this paper.

3. ENGIS

The Schmerling cave is located in a Dinantian limestone cliff, in the village of Les Awirs (commune of Flémalle, province of Liège), about 750 m north of the Meuse valley. A ravine, mostly hollowed out by an old quarry, isolates it from the surrounding countryside. Originally known as 'Trou Caheur', the cave was renamed 'Deuxième grotte d'Engis' (Second Engis cave) by Schmerling himself and finally 'Grotte Schmerling' (Schmerling cave) in 1939.

The first excavation Schmerling conducted, in the winter of 1829–1830, led to the discovery of two human skullcaps. Later, the site would be the subject of several archaeological investigations: in 1868 by the geologist Éd. Dupont, in 1885 by the palaeontologist J. Fraipont, then by other people such as É. Doudou from 1895 onward and J. Hamal-Nandrin in 1904; finally, over the 20th century, by teams from the 'Chercheurs de la Wallonie' association, notably in 1907 and 1956.

Since these investigations are rather old, the stratigraphic and palaeoenvironmental data, the latter gathered exclusively from macrofauna, are quite insufficient. Correlations between the stratigraphies of the different diggers are also delicate (Figure 3). As a result, precise stratigraphic positioning of the two skullcaps is problematic. However, Schmerling *(5)* wrote that the adult Engis 1 skullcap »[...] was met with at a depth of a metre and a half, hidden under an osseous breccia [...]«, whereas the juvenile Engis 2 cranium »[...] was at the bottom of this cave, near an elephant tooth [...]«. Dupont situated the human skeletal remains in his first ossiferous level, a kind of archaeological catch-all layer, and Destexhe-Jamotte *(13)* in his layer B, right in the midst of the Mousterian material.

Engis 1 has often been attributed to the Upper Palaeolithic; buried, allegedly, in what is now the Mousterian level. Yet two recent AMS dates, 4590 ± 80 BP (OxA-746) and 4920 ± 50 BP (Beta-154814), bring evidence to those who, since de Mortillet, attribute this specimen to the Neolithic period.

Engis 2 comprises a skullcap, some maxillary fragments, and some upper and lower teeth. The child died aged 4–6. It took a century to attribute these fossils to Neandertal man *(9)*. The skull presents a combination of juvenile characters, plesiomorphic (primitive) features and derived (acquired) Neandertal features *(14)*. Two radiocarbon dates have been obtained from the parietal: 26820 ± 340 BP (OxA-8827), delta 13C = – 19,3, and

EXCAVATORS' STRATIGRAPHIC DESCRIPTIONS					MODERN REVIEW	
SCHMERLING	DUPONT		DESTEXHE-JAMOTTE		ARCHAEOLOGY	ANTHR.
"Osseous breccia"	1	Silt and "Osseous breccia"	A	Very compact "osseous breccia" with Upper Paleolithic (flints) and Neolithic (pottery fragments). 5 to 25 cm thick. Fauna : horse, ox, reindeer, bat, shrew	History Neolithic Mesolithic ? Late Upper Paleo ? Gravettian	Engis 1*
Generally very dry earth with, from bottom to top, bones and rounded or angular stones, 2.5 m thick **SKULLCAPS (ENGIS 1 & 2)**	2	**First "ossiferous level"** Angular or slightly rounded stones and yellowish earth, both of them bound by calcareous infiltrations. Pottery fragments and knapped flints **HUMAN ULNA** Fauna : Ursus spelaeus, Rhinoceros, Sus scrofa, Equus caballus, Cervus tarandus, Cervus elaphus, Bos primigenius. "Mammoth Age"	?	?		
			B	Slightly or unstratified brown clayey layer with rounded stones and large amount of limestone fragments; at places over 1 m thick. Mousterian **HUMAN SKULL FRAGMENT** Fauna : mammoth, rhinoceros, deer, badger, polecat, wolf, bear, beaver, etc.	Typical Mousterian of Levallois facies	Engis 2
	3	Traces of a more clayey sheet				
	4	**"Second ossiferous level"**. No Knapped flint. Fauna : rhino, tooth, gnawed bones (hyena fair). "Mammoth Age"	C	Yellow sandy silt (max. 20 cm). Dupont : bones gnawed by hyena		
More or less compact clayey earth	5	Clayey sand	D	Yellow sand sheets with clay pockets (max. 30 cm)		
Bedrock		Bedrock	E	Bedrock		

Figure 3. *Engis – Schmerling cave. Correlation between the stratigraphic descriptions of Schmerling (5), Dupont (56, 57) and Destexhe-Jamotte (13) compared with the modern interpretation of the position of the archaeological (13, 29, 58) and anthropological material.*

30460 ± 210 BP (GrA-21545), after collagen extraction by H. Bocherens.

The first of these dates is much too recent to be acceptable, considering the regional and North-western European contexts. If, however, the second were to be confirmed by further results, this would suggest that the Meuse Basin was inhabited until relatively recently by Neandertals who may have had contact, at least occasionally, with the first Aurignacian peoples. But in our view, the archaeological context of the region invalidates this interpretation of the date. It is also too recent.

The dietary habits of Engis 2 were recently estimated by carbon and nitrogen isotopic measurements; the same technique was used on the Scladina child and one of the Spy scapulas *(15)*. The staple diet of Engis 2 was probably a protein source isotopically quite similar to carnivores; mainly herbivores meat and possibly mother's milk.

The extraction of mitochondrial DNA from Engis 2 was the subject of a recent publication *(16)*. The sample was given to M. Krings and S. Pääbo by one of the authors of the present article (M.T.) with the authorization of Professor E. Poty, curator of the fossil at the university of Liège. The DNA sequence of Engis 2 is closely related to that of other Neandertal samples analyzed in that study, such as those from La Chapelle-aux-Saints, or in previous studies of German and Russian Neandertal fossils *(17, 18)*. All these sequences differ from the modern human reference sequence. However, these results do not close the ongoing debate about an eventual contribution of Neandertal man to the gene pool of modern humans. Hopefully, nuclear DNA analysis, which will most probably be successful in a relatively near future, will bring new elements to this discussion.

Recently, most Belgian Neandertal fossils were recorded digitally using medical computed tomography and μ-computed tomography scanners *(19)*. The Engis 2 skullcap scan was acquired with a Siemens Sensation 64 slice medical scanner at the Erasme Hospital in Brussels and the teeth scans with μ-computed tomography at the University of Antwerp (Figure 2d).

4. LA NAULETTE

La Naulette is set on the left bank of the Lesse, near a hamlet called Chaleux (commune of Houyet, province of Namur). The mouth of this large cave faces north-west, 25 m above the river, in Dinantian limestones. In March 1866, during the first dig of the site, E. Dupont unearthed a human mandible, an ulna and a third metacarpal, associated with skeletal remains of extinct animal *(6, 7)*. This spectacular start, added to the significance of the stratigraphic sequence, convinced him into completing the research in the summer of the same year, hoping to find other parts of the skeleton; but a canine, now lost, was to be the sole addition to his finds.

The stratigraphic sequence of La Naulette is over 11 m high. In his first description, Dupont identified four or five »stalagmite levels« and two ossiferous levels. During the summer period he identified a third ossiferous level, below the other two, and the number of »stalagmite levels« was increased to seven. The discrepancy between the two stratigraphic descriptions confuses an already difficult comparison (Figure 4). The 1866 human bones

Dupont, 1866, p. 45-46			Dupont, 1867, p. 247			Fauna (Dupont, 1867)
Lay.	Description	Th.	Lay.	Description	Th.	
1	Alternate and thin layers of grey sandy clay and yellowish sand	2.90 m	10	Grey clay (= layer # 2 of 1866) topped by stratified clay-sand silt (= layer # 1 of 1866) At the bottom, **THIRD OSSIFEROUS LEVEL**	2.50 to 3 m	Moufion or sheep head and other ruminant bones
2	Greyish-yellow clay with fallen rocks, fallen stalagmite cones **UPPER OSSIFEROUS LEVEL**	0.45 m				
3	Stalagmite	moy : 0.30 m	9	Five more or less continuous stalagmite sheets alternating with stratified grey clay of variable thickness	1.50 m to 1.75 m	
4	Local tufa	0.10 m				
5	Grey Clay	0.15 m				
6	Stalagmite	0.15 m				
7	Grey clay	0.20 m				
8	Stalagmite	0.10 m				
9	Grey clay	0.20 m				
10	Stalagmites, discontinuous traces					
11	Alternate layers of sandy clay and sand, (like # 1) **LOWER OSSIFEROUS LEVEL** MAN Mandible, ulna & metacarpal	0.60 m	8	Grey clay like # 8 (sic) & 10 topped by stratified silt **SECOND OSSIFEROUS LEVEL** MAN Canine	0.60 à 0.70 m	Mammoth, rhinoceros, reindeer, wolf, « Ursus arctus », fox, badger, bat, marmot, water rat, horse, boar, chamois, common deer, fish and « Megaceros hibernicus »
12	Alternate layers of sandy clay and sand, like # 1 & 11	5 m	7	Second stalagmite sheet : the most continuous and generally the thickest		
			6	Grey clay with large limestone blocks topped by stratified silt **FIRST OSSIFEROUS LEVEL**	0.50 m	Fragment of Hyaena spelaea upper maxillary ; gnawed bones
			5	First stalagmite sheet of variable thickness		
			4	Yellowish grey clay containing large fallen rocks	0.80 m	
13	Stratified fine sand with some clayey veins	2 m	3	Clayey sand stratified by the alternation of small discontinuous veins of sand and sandy clay	1.15 m	
14	Gravelly sand	0.50 m	2	• Sand like # 2 (sic) and 4 •Gravels and concretions like # 3 •Yellowish fine sand like # 2 (sic) • Gravel and stalagmitic concretions ressembling Bruxellian " grès fistuleux"	0.70 m	
				Yellowish coarse sand	0.20 m	
			1	Fine gravel	0.60 m	
15	Red clay traces with shiny surface			In the text : « Under all these Quaternary sediments [...] traces of the red clay with shiny surface »		

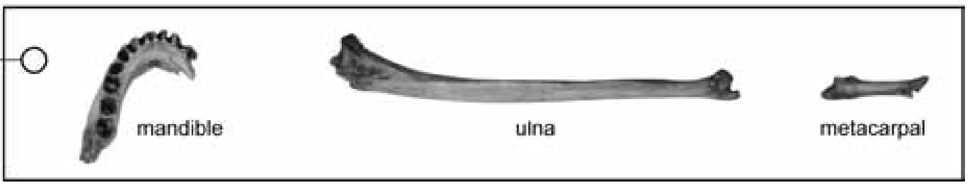

Figure 4. *La Naulette – Comparison between the two stratigraphic descriptions of E. Dupont (6, 7) and the fauna for the three 'ossiferous levels'. (Th. = thickness).*

were found in the second ossiferous level of the stratigraphy published in 1867, between the »stalagmite levels« 2 and 3. No lithic material was associated with them. The only known palaeoenvironmental information is the one given by the macrofauna.

The mandible, usually thought to have belonged to a young female, comprises the left side of the body, the symphyseal region and the anterior part of the right side of the body, extending to the P3 socket and, partially, the P4. No teeth have been found. The symphyseal region is slightly receding and the alveolar part of the buccal face of the fossil has an alveolar plane, both plesiomorphic features. The chin does not exhibit the 4 components characteristic of modern man but only an incipient *tuber symphyseos* and an *incurvatio mandibularis anterior*. The genial region is clearly close to the lower edge like many Neandertals; it presents a substantial *genioglossal fossa*, plesiomorphic in nature, furrowed by two little *cupulae*, rather than the upper genial processes. The mental foramen is double, the principal one right over P4, which is a modern character. In conclusion, some of the principal autapomorphies of Neandertal mandibles, such as a retromolar space, the backward position of the mental foramen and the flatness of the anterior face of the symphysis are missing; but these are adult characters.

The human remains from La Naulette have never been dated. However, stratigraphic and palaeoanthropological evidence suggest they may be older than 'classic Neandertals': the five overlying »stalagmite levels«, by their number and, to some extent, their thickness, invalidate their being recent; the mandible presents archaic features and fits within the biometric variability of Neandertals and their pre-Neandertal ancestors while the ulna and third metacarpal show modern morphological and metric characters *(12)*.

Hence, two hypotheses can be proposed. In the first, Dupont may have mistakenly associated an ancient mandible with modern postcranial remains because he did not differentiate the layers. But the overall precision of his stratigraphic observations, added to other evidence, such as the absence of modern human bones inside the main section of the cave, somewhat contradicts this hypothesis.

If, on the contrary, all the remains do come from the same layer, or even the same individual, then the latter might have been a very early Neandertal. In fact, the characteristics proper to Neandertals were progressively acquired »in mosaic« to end up with »classical« kinds around the Eemian interglacial. In some of their anatomical details, rather early fossils may thus be morphologically closer to modern man than to classical Neandertals. As a consequence, the seemingly modern features of the postcranial bones from La Naulette will have to be interpreted as 'plesiomorphies'.

Since 1999, and more intensively since 2005, a new programe of multidisciplinary research has been undertaken at La Naulette, funded by the Department of Archeology of the Regional Ministry of Wallonia. The object of this programe is fourfold: first, study the stratigraphy and the palaeoenvironment; second; date the context of the human skeletal remains; third, look for evidence supporting either hypotheses presented above; and last, ascertain whether the undisturbed deposits can yield new human fossils *(20, 21)*.

We also found a tunnel E. Dupont dug in 1866 right through the bottom deposits. Its comprehensive study shed light on a somewhat intriguing 19th century excavation technique that pioneering cave diggers like Dupont sometimes resorted to *(22)*.

5. SPY

The cave of Spy (commune of Jemeppe-sur-Sambre, province of Namur) is situated about fifteen metres above the Orneau river, on the left bank. Its principal entrance faces south-southwest, in Dinantian limestones.

The site was first explored by amateur archaeologists. Then M. Lohest, geologist at the University of Liège, and M. De Puydt began an excavation campaign in August 1885. In June and July 1886, human remains were unearthed in stratigraphic context and in association with extinct animal remains and lithic material. The study of the animal and human bones was entrusted to J. Fraipont, paleontologist at the University of Liège *(8)*.

Later, several digs were conducted by the Royal Museums of Art and History between 1903 and 1909, by the University of Liège from 1927 to 1933, by F. Twiesselmann and the Royal Belgian Institute of Natural Sciences from 1948 to 1956, and finally by the 'S.O.S. Fouilles' public organization from 1979 to 1981. Many amateur collectors also did some digging of their own all over the site.

De Puydt and Lohest's 1886 excavation was the most interesting for palaeoanthropology: dozens of human skeletal bones were discovered in the 'third ossiferous level' before the mouth of the cave. Later, Twiesselmann found some Neandertal bone fragments and some teeth in De Puydt and Lohest's excavation backfill.

Unfortunately, De Puydt and Lohest's excavation techniques were anything but faultless: the timbered galleries, reminiscent of Dupont's tunnel at La Naulette, were most probably responsible for the perturbation of various archaeological occupations typological studies recently identified and for the lack of distribution plans of the Neandertal remains.

We now know that there has been at least seven Palaeolithic occupations at Spy; but only three ossiferous levels were identified in 1886 (though this definition of ossiferous level is rather vague in this context, for it seems to have been, for the first diggers, synonymous with archaeological occupation). Added to the lack of detail in the sedimentary study, some confusion arises from the diggers' various descriptions: for example, the number of layers with knapped flints varies from three to five depending on De Puydt, Lohest and Fraipont's different papers. Their understanding of the palaeoenvironment of the Spy deposits was also unsatisfactory. The only data available relate to the macrofauna, but the approximations described above make interpretation difficult. Following these reservations, the description of the Spy deposits must be taken with some precaution; it is generally said to contain at least 3 Mousterian and 4 Upper Palaeolithic occupations (Figure 5). The Neandertal remains were probably associated with a Quina-type Charentian industry, which would make them relatively recent. Two Mousterian points and some other artefacts were in context with the human skeletal remains.

The Spy hominid skeletons were initially thought to belong to two adult individuals, known as Spy 1 and Spy 2 *(8)*. They are both comprised of a skullcap, some maxillary and mandibular fragments and a number of postcranial bones, often fragmented, that can belong as much to upper as to lower limbs. According to Thoma *(11),* Spy 1 is a female with a cranial capacity of around 1300 cm^3 and Spy 2 a rather young male with around 1500 cm^3 of cranial capacity. The various Spy remains show many plesiomorphic and derived characters; some shared with modern man (synapomorphic), others specific to Neandertals (autapomorphic). All these remains are definitely Neandertal *(11)* and cannot, contrary to the theory held by Hrdlička *(23)*, be construed as members of a phyletic transition between Neandertal Man and Modern Man.

There are also some additional remains of a young child (Spy 3) *(24)* and, according to Trinkaus *(25)*, at least two other adult individuals.

The diet of Spy 1 and 2 was recently estimated by means of carbon and nitrogen isotopic analyses of a scapula sample *(15)*. The isotopic composition of the sample is consistent with that of an individual with a diet high in protein, provided by large herbivores.

Several radiocarbon dates were obtained from Spy specimens. A cranial fragment morphologically modern yielded a Neolithic date, suggesting that the cave, during

OLD EXCAVATIONS						MODERN REVIEW	
1886 EXCAVATORS' STRATIGRAPHY				FAUNA	INDUSTRY	ARCHAEOLOGY	ANTHROPO.
A	Brown clay sometimes mixed with very large limestone blocks (scree)	25cm to 3m		*No mentionned fauna*		History Neolithic Mesolithic	Neolithic ? ?
B	Very calcareous yellow clay locally changing into tufa (breccia) and containing angular limestone blocks. Ossiferous level in the upper part	80cm to 1m	1st OSSIFEROUS LEVEL	Mammoth, woolly rhinoceros, reindeer, deer, cave bear, cave hyena, hare, wolf, fox	Knapped flints	Creswellian/Magdalenian Gravettian	
C	Almost totally red-coloured area, formed by a tufa (breccia) containing numerous mammoth ivory fragments, charcoal, knapped flints and limestone fragments	5 to 30cm	2nd OSSIFEROUS LEVEL	Mammoth, woolly rhinoceros, reindeer, deer, megacerin deer, aurochs, bison, horse, cave bear, cave hyena, roe-deer, cave lion, fox, boar	Knapped flints	Aurignacian Foliate points industry Late Mousterian	
D	Yellow clay with limestone blocks, locally changing into a tufa similar to B (breccia). There was a thin charcoal bed at the bottom	15cm	3rd OSSIFEROUS LEVEL	Mammoth, woolly rhinoceros, reindeer, deer, megacerin deer, aurochs, horse, cave bear, cave hyena, cave lion, wolf, glutton, badger	Knapped flints	Charentian	
E	Human bones	?			Knapped flints		SPY NEAND.
F	Very dark brown clay, locally blackish, with small limestone elements	?			Knapped flints	? ? Moust. of Acheulean tradition	

Figure 5. *Spy – Stratigraphy recorded by the geologist Lohest in 1886 (8, 59); fauna list for each 'ossiferous level' (compiled in 59, based upon all the excavations); position of knapped flints according to the 1886 excavators; modern interpretation of the archaeology (58, 29) and anthropology.*

one of its latest periods of prehistoric occupation, was used as a collective burial *(26)*.

Other dates refer specifically to Neandertals: two were obtained from the right scapula: 23880 ± 240 BP (OxA-8912), delta ^{13}C = –19.0 and 31810 ± 250 BP (GrA-21546), delta ^{13}C = – 19.8, after collagen extraction by H. Bocherens. A third date was obtained from a vertebra picked up by Ph. Pirson on the slope leading to the cave: 36250 ± 500 BP (OxA–10560), with a somewhat high delta ^{13}C = –22.9. The same reservations as those expressed about the Engis 2 skullcap must be made: the first date is so recent it cannot be correct. However, were the second to be confirmed, it would suggest that the Meuse Basin was inhabited until relatively recently by Neandertals, but the archaeological context of the region invalidates this interpretation. The third date is probably closer to the very end of the Neandertal occupation of the South Belgium Meuse Basin.

Recently, our colleagues from the Department of Anthropology and Prehistory at the Royal Institute of Natural Sciences of Belgium began a new comprehensive and multidisciplinary study of the collections from the 19th and 20th century excavations at Spy (De Puydt and Lohest's initial dig in 1886, as well as those of other excavators, notably Twiesselmann's during the 1950s). This already allowed them to add new bone fragments and teeth to the corpus of Spy Neandertals remains and to re-assemble some of the fragments *(27)*.

6. FONDS DE FORÊT

The two caves of Fonds de Forêt (commune of Trooz, province of Liège) open on the left bank of the Magne stream, a tributary of the Vesdre river. The larger, upstream cave, or 'first cave', faces west. A curved gallery 30 meters long leads into a vast chamber.

All the Fonds de Forêt excavations are quite old. Ph.-Ch. Schmerling dug the main gallery around 1830. In 1895, Dr. F. Tihon opened two trenches in the level ground before the caves then began digging within the cave, probably in the curved gallery, where he unearthed a Neandertal femur and an upper left molar. Then came J. Hamal-Nandrin in 1906, 1914 and from 1931 to 1933; the geologist A. Rutot and the Royal Belgian Institute of Natural Sciences in 1907; M. Exsteens also in 1907; Lequeux in 1916.

The digs by Tihon, Exsteens and Rutot provide most of the recorded evidence about the stratigraphy of the cave inside, where the Neandertal skeletal remains were exhumed. The differences between these three stratia)

EXCAVATORS' STRATIGRAPHIC DESCRIPTIONS							MODERN REVIEW				
SCHMERLING	TIHON		EXSTEENS		RUTOT		Archaeology	Anthropology	Chronostratigraphy and M.I.S.		
« Vegetal earth » Stalagmite layer (a few cm to 20 cm thick)	a	« Vegetal earth » (max. 10 cm) ; sterile			A	Irregular stalagmitic cover			1	HOLOCENE	
Rather loose clayey earth of variable thickness (a few cm to 4m) containing bones, stone blocks, quartz pebbles and flints Fauna : rhinoceros, horse, bear, hyena, etc.	b	Layer of variable thickness. Silt, blocks and smaller stone elements. Yellowish colour. No industry. Fauna : sterile in the first gallery. In the second gallery, Ursus arctos and Cervus elaphus	I	Yellowish earth of variable thickness. At the bottom : kropped blades on black layer II. Magdalenian.	B	Scree of large blocks fallen from the roof. 0.60m. No industry. Rather poor fauna : reindeer and Ursus arctos.	Early Upper Paleolithic Gravettian		2	UPPER PLENIGLACIAL AND LATE GLACIAL	UPPER PLEISTOCENE
					C	Silty beds with small limestone blocks and animal bones. 0.15m. **FIRST OSSIFEROUS LEVEL**					
					D	Scree of large blocks fallen from the roof ; embedded in silt. 0.30m					
					E	Brownish yellow silty layer. **SECOND OSSIFEROUS LEVEL**. 0,30 m. Clearly Magdalenian industry. Mammoth fauna (reindeer and rhinoceros teeth ; broken bones).					
	c	Clayey silt (max. 70 cm) with numerous of limestone blocks. Variable colour : black at 10m from the entrance (15cm) ; fireplace traces. Greyish towards the entrance. Yellowish along the sidewalls. Knapped flints everywhere (especially at the bottom, on the black earth). **HUMAN BONES** Fauna : Ursus spelaeus, Equus caballus, Hyaena spelaea, Rhinoceros tichorhinus, Elephas primigenius, Cervus elaphus, etc.	II	Black earth (about 1m thick) ; very rich in artifacts (Lower Aurignacian). Fauna : Ursus spelaeus, Hyaena spelaea, Elephas primigenius, Rhinocerus tichorhinus, Equus caballus, Cervus tarandus, etc.	F	Thick layer of limestone blocks of all sizes in a blackish or dark grey layer. Knapped flints from bottom to top. **THIRD OSSIFEROUS LEVEL**. 1,00 m. Mammoth fauna (mammoth, Rhinoceros tichochinus (sic), Ursus spelaeus, Hyena spelaea, reindeer, horse, etc.).	Aurignac. Quina Type Mousterian	Femur and molar	3 ? ? 4?	MIDDLE PLENIGLACIAL LOWER PLEN.	
Very compact greyish-yellow clayey earth	d	Fine yellowish sandy silt	III	Yellowish earth (ca. 40 cm) ; sterile	G	In the bedrock fissures, micaceous clayey sand with flint pebbles and tertiary « eoliths ». 0,30m. Sterile			?		
	Bedrock				Bedrock				VISEAN		

b)

TWIESSELMANN			FOURMARIER			ULRIX-CLOSSET			OTTE		
TIHON	EXSTEENS	RUTOT	TIHON	EXSTEENS	RUTOT	TIHON	EXSTEENS	RUTOT	TIHON	EXSTEENS	RUTOT
a		A			A+B	a		A+B	a		A+B+C+D
b	I	B+C+D+E	a + b	I	C+D+E	b	I	C+D+E	b	I	E
c	II	F	c	II	F	c	II	F	c	II	F
d	III	G	d	III	G	d	III	G	d	III	G

Figure 6. *Fonds de Forêt – a) Correlation between stratigraphic descriptions of Schmerling (5), Tihon (61), Exsteens (62) and Rutot (63); fauna from layers E et F: Rutot 64) compared with the modern interpretation of the position of the archaeological (29, 58) and anthropological material. The table also shows our chronostratigraphic interpretation of the Fonds de Forêt sequence (65, 66), based upon the comparison with other Upper Pleistocene Belgian cave sequences as well as the reference sequence of the Belgian loess belt. b) Comparison of correlations between three excavators' stratigraphies (10, 29, 58, Fourmarier in 67).*

graphies may be partly explained by their having been located in apparently different sections of the cave, yet there is some consistency between the various descriptions (Figure 6a). Many attempts at correlating the different stratigraphies have been made (Figure 6b). The correlation from Twiesselmann seems the most relevant. Unfortunately, it looks as though the different layers of the deposit have frequently been mistaken one for the other. As a consequence, the study of the fauna hardly makes palaeoenvironmental interpretations possible.

All the Middle Palaeolithic lithic artefacts seem homogeneous. They are related to a Quina-type Charentian industry, as probably are the human remains. However, the exact location where the molar and femur were found is unknown.

The femur was studied for the first time in 1961 *(10)*. It is a robust left bone, with only the lower four fifths remaining. It belonged to an adult individual. Its shaft shows an anteroposterior curvature and is rounded in its cross section, characters found on classical Neandertals. The biometric study reveals that the femur of Fonds de Forêt resembles the specimens from Spy and the eponymous Neandertal, notably in the trochlear dimensions, the sub-trochanteric diameters and the mid body dimension.

In 2003, the Department of Archaeology of the Regional Ministry of Wallonia dug a trench inside the mouth of each cave. The two trenches reached the bedrock at a depth of 1 to 1.5 m, but most of the deposits were backfill from the previous digs. Only very partial sediment layers were in situ, in contact with the bedrock and with almost no archaeological or palaeontological material. A third trench cut into the level ground before the two caves proved as disappointing: a rather thick layer of backfill covering undisturbed deposits with no archaeological material *(28)*.

7. COUVIN

The 'Trou de l'Abîme', on the right bank of the Eau Noire river, at Couvin (province of Namur), was excavated on several occasions since the end of the 19th century. According to Otte *(29)*, the artefacts found at the beginning of the 20th century correspond to the transitional phase between the Middle and Upper Palaeolithic techno-complexes, also known as the 'Couvin facies'.

Between 1984 and 1986, a partial dig was carried out in front of the cave entrance *(30, 31)*. The crown of a human deciduous lower right second molar (Figure 2c) was found at the bottom of layer II, about 2 meters below the present surface, together with abundant lithic artefacts and micro- and macrofauna.

According to the 1984 excavator the lithic material found in association with the human tooth belonged to the end of the Middle Palaeolithic *(32)*; consequently, this cannot be a transitional facies. The associated microfauna is consistent with an interstadial period. Radiocarbon dating gives 46820±3290 BP (Lv 1559). Based on the published description of the deposits, we are inclined to believe that layer III, above layer II, may be a palaeosol, probably a brown soil ('red clay with prismatic structure')*(31)*. By comparison with the well documented pedostratigraphic loess sequence of Middle Belgium, the most recent soil of this type is the 'Les Vaux' soil, dated around 42–40 ka.

On the basis of the archaeological context, the human tooth of Couvin has to be Neandertal, since the latter is the only human taxon known associated with Middle Palaeolithic in Western Europe. The ^{14}C date reinforces this assessment, as does the stratigraphic position of the tooth if one agrees with our recent stratigraphic attribution of layer III to the 'Les Vaux' soil.

A palaeoanthropological study of the fossil is underway, using computer tomography scans and comparative metrics and morphology. We do hope this will yield additional data to substantiate this taxonomic affiliation.

8. SCLADINA

The Scladina cave, identified in 1971, is located in Sclayn (commune of Andenne, province of Namur), in Dinantian limestones, on the left side of Fond des Vaux, a stream tributary of the Meuse. At the present stage of the research, the cave is more than 40 metres long, 5–6 meters wide and roughly 6 meters high. The site has been excavated without interruption since 1977–78 by the Department of Prehistory of the University of Liège and the Archéologie Andennaise Association. Two significant Middle Palaeolithic occupations have been discovered in layers 5 and 1A, and a few scattered archaeological remains in other layers *(33, 34, 35)*. Since 1993 three mandibular and maxillary fragments and sixteen teeth, all belonging to a Neandertal child, have been unearthed (Figure 7)*(36, 37, 38, 39)*.

Several geologists conducted sporadic stratigraphic studies of the sequence at the end of the 20th century (Gullentops & Deblaere, *33*; Haesaerts, *33*; Benabdelhadi, *34*). An overview of these studies relative to the inside of the cave (Fig. 8b left) was the subject of a publication by Bonjean *(34)*. Palaeoenvironmental studies were also conducted: palynology (Bastin)*(33)*, micro-

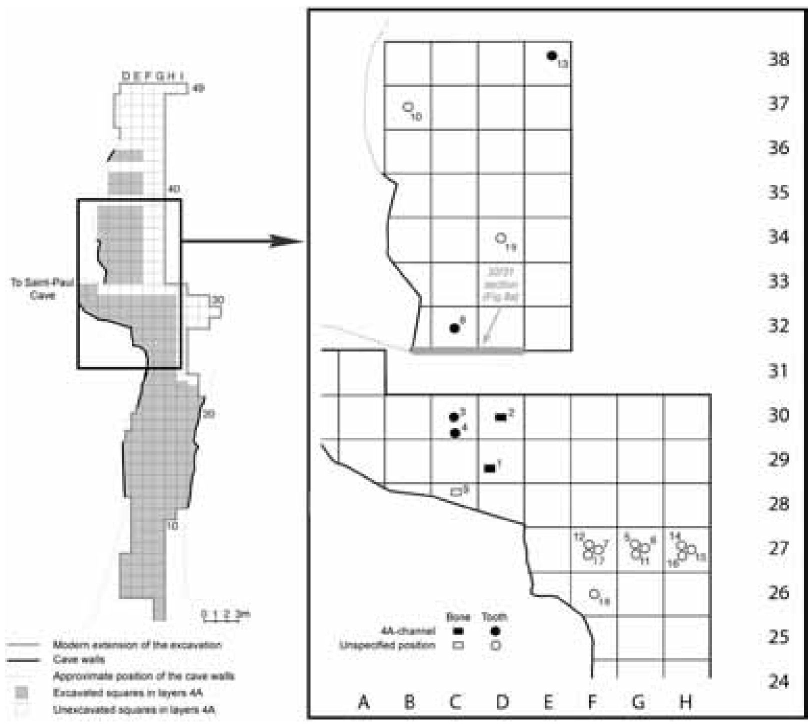

Figure 7. *Scladina – Spatial distribution of the juvenile anthropological remains (39).*

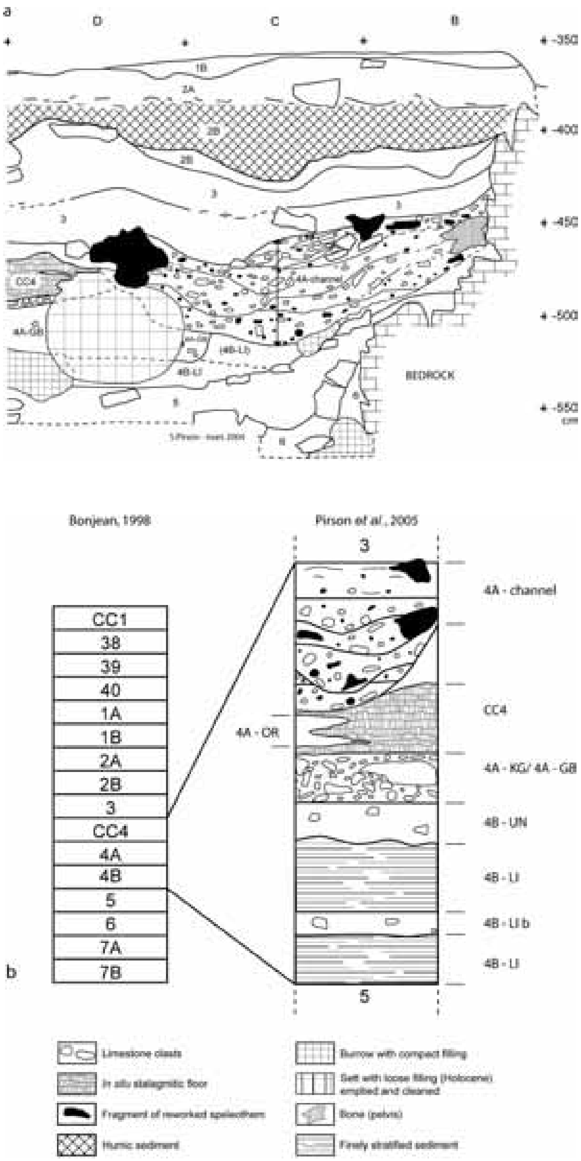

Figure 8. *Scladina – a. 32/31 transverse section from B to D showing the erosion of CC4 and underlying layers by the '4A-channel' complex. The details of layers 6, 5, 3, 2B, 2A and 1B are not shown. The limestone clasts are only figured in unit 4, except those coarser than 20 cm. b. Synthetic stratigraphic log of unit 4 (39) compared to the 'classic stratigraphy' (Bonjean in 34).*

fauna (Cordy)*(33)*, macrofauna (Simonet) *(33)*, sedimentology (Deblaere, Gullentops & Haesaerts, *33*; Benabdelhadi, *34*) and magnetic susceptibility *(40)*. The dates and chronostratigraphic data available today suggest the recording spans all the Upper Pleistocene and Holocene and, probably, the end of the Middle Pleistocene *(33, 34)*.

In October 2003, an overall revision of the deposits was started, focusing on careful observation of a maximum of standing sections. This revision in progress by one of us (S.P.) highlighted a great variety of facies, sedimentary processes and geometries, and particularly, a significant number of climatic ameliorations (reworked palaeosols, speleothems), complementing the data previously recorded and confirming the exceptional importance of this sequence. In the course of this revision, a reexamination of the area of the stratigraphy where the Neandertal fossils were found (unit 4) was recently published *(39)*. Rather than the succession 'layer 4B/layer 4A/stalagmitic floor CC4', more than 7 layers were identified, with widely different lithologies but also, and most importantly, a distribution of the different lithostratigraphic units around stalagmitic floor CC4 which was more complex than previously thought. Three sets of layers were identified: a group of pre-floor layers, a syn-floor layer and a group of post-floor layers (Figure 8a and 8b right). Another key element of the new stratigraphic interpretation is the discovery, in the upper part of unit 4, of an important channel structure perturbing in some places floor CC4 and eroding the subjacent layers, sometimes as low as layer 5.

The new stratigraphy of the unit 4 complex is of significance for the Neandertal fossils. The original location of 6 out of the 19 child fossils known today could be reliably identified in the new stratigraphy: they all were in the channel. At the current state of the research, the attribution of the 13 other remains is unclear among unit 4A, even though at least 11 of them were also probably in the channel.

The perturbation of the child remains was already known *(36, 37, 38)*. The discovery of the channel allows us to explain how they were deposited and provide insight into their longitudinal dispersion (Figure 7). An important perturbation is a plausible explanation. A shift of the remains from a place distant from the discovery area cannot be excluded. The most probable direction for the bones displacement is from cave mouth to cave interior.

The new recordings also clarify the relative chronology of the events, including the relative age of the child. Its minimum antiquity corresponds to the age of the deposit it was unearthed in, that is the channel; in that case, the child post-dates the stalagmitic floor CC4, which yielded disparate dates but mainly related to the MIS 5 *(34)*. However, no maximum antiquity can be suggested on a stratigraphic basis; it is quite possible that the bones lay originally in one of the layers later reworked by the channel, perhaps even in layer 5. Direct gamma spectrometry dating (127 +46/–32 ka; Yokoyama and Falguère in 38) is therefore the most reliable information available today about the age of the Neandertal child.

Excavations are continuing at Scladina. The revision of unit 4 opens promising perspectives for understanding the geographic and stratigraphic origin of the human remains. The monograph in progress will be a good opportunity to overview the current data, especially in the fields of palaeoanthropology, stratigraphy, palaeoenvironment and chronology.

The 19 fossils are from a child's mandible and right maxilla (Figure 7). Dental age determination compared with cutting teeth and molar roots formation in modern humans suggest the child died aged 12. Yet the persistence of deciduous molars is consistent with a younger age, but probably not less than 10. In addition, Granat and Heim's *(41)* new method of Neandertal dental age determination seem to indicate the child could not have been older than 8.5.

The maxillary fragment is too partial to allow to estimate with any precision whether it was in flexion or in extension. The symphyseal region of the mandible has a slightly recessed sagittal profile. The anterior flatness of the incisive region is absent. The upper portion of the posterior face shows a plesiomorphic *planum alveolare* over a slight *torus transversus superior.* The *fovea genioglossa*, also a plesiomorphic character, is crossed by three vertical crests with the median one going down between the *digastric fossae*. The anterior face of the symphyseal region exhibits a very slight depression under the alveolar process suggesting the presence of an incipient *incurvatio mandibulae anterior.* There are no lateral tubercles, only an incipient *tuber symphyseos*. The condylar process of most Neandertal mandibles is projecting partly outside of the branch, whereas it is situated almost uniquely on the medial side in modern man. On this maxilla, the condylar process is the same as that of Neandertal man. The branch is wide (35 mm). The mandibular foramen does not have the 'horizontal-oval' shape present on about half the Neandertal bones. The thickness of the body decreases and thickens progressively from the front to the back. Neither side has a retromolar space; but this derived feature, characteristic of the majority of adult Neandertal fossils, is absent in children.

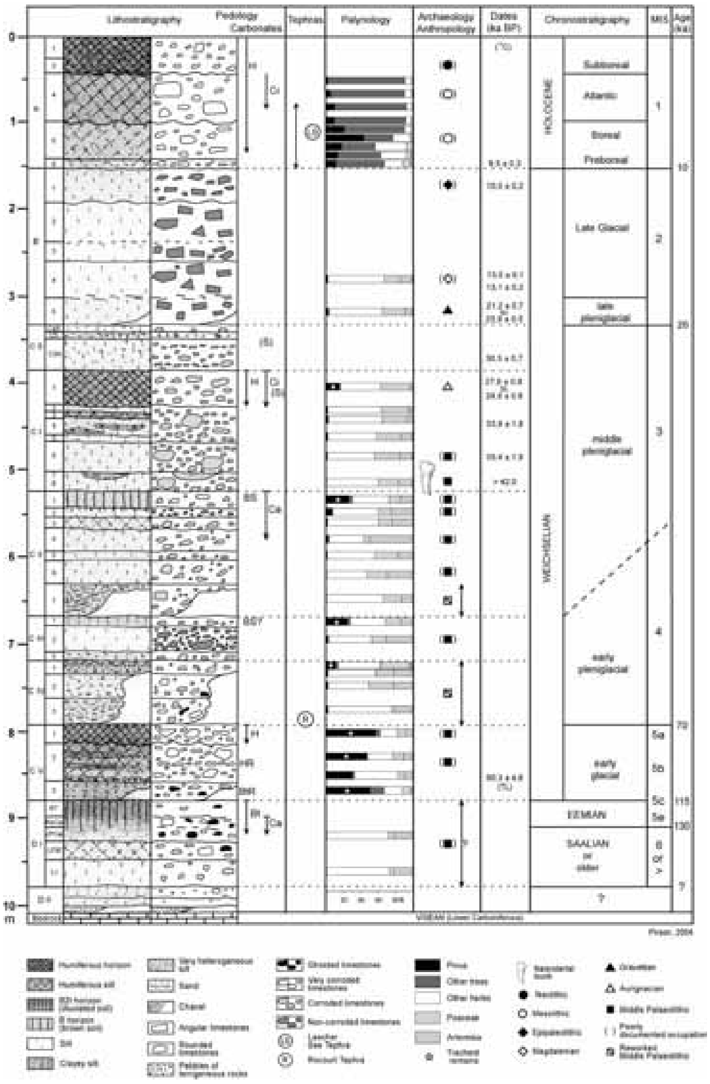

Figure 9. *Walou – The new stratigraphic sequence (48). Most of the data from units A and B are from Dewez et al. (44). For palynology, the percentage of each taxa is calculated in accordance with the total number of pollen grains of terrestrial plants. Palynological data of unit A are from Heim (44) and the others are from Court-Picon (48). Abbreviations: H = humiferous soil; HR = reworked humiferous soil; BS = brown soil; Bt = illuviated horizon; BtR = reworked illuviated horizon; Ci = carbonate cement in the matrix; Ca = carbonate concretions; S = small speleothem; MIS = possible correlation with the marine oxygen isotopic stages.*

The mental foramen is double: the principal one below P_4 and the secondary one below the septum separating P_4 from M_1.

In conclusion, the Scladina mandible does not exhibit the standard derived Neandertal features, such as a retromolar space or an anterior flatness of the incisive region. Yet the lateral development of the condylar process, the large width of the branch and the double mental foramen are all characters the specimen shares with other European Neandertals, which differentiates it somewhat from modern humans. Several plesiomorphic features are also well present on the mandible, e.g. the lack of a prominent chin and the presence of a *fovea genioglossa* or a *planum alveolare*. The teeth present a combination of traits characteristic of Neanderthals, such as maxillary incisors with a strong shovel shaping, labial convexity and developed lingual tubercle.

The diet of the layer 4A child was estimated by means of carbon and nitrogen isotope analysis of the bones, the same technique used on the Engis 2 skull and one of the Spy scapulas *(15)*. After comparison with isotopic analyses of many bones from herbivores, omnivores and carnivores from layers 1A, 1B, 3 and 4A *(42)*, the Scladina child seems to have had a protein source isotopically quite similar to carnivores; he ate mostly meat from herbivores living in open country (prairie rather than forest).

Recently, DNA extraction was attempted on the Scladina Neandertal child, first by M. Krings and S. Pääbo, but without success, then successfully by L. Orlando and C. Hänni *(43)*.

9. WALOU

The Walou cave (commune of Trooz, province of Liège) lies about 30 m above the left bank of the Magne river, a tributary of the Vesdre, in Dinantian limestones. The site, which has been known for about forty years, was the subject of two government-funded programs of multidisciplinary archaeological excavations, first from 1985 to 1990 *(44)* then from 1996 to 2004 *(45, 46)*. In 1997, a human tooth was found in the Mousterian layer CI-8 *(47)*. The site is no longer excavated. The 1996–2004 campaign will be dealt with in a monograph in progress.

During Dewez's excavation four major sedimentary units were identified (Collcutt, *44*) and a detailed stratigraphic recording of the upper half sequence of the main section of the site was completed. But easy access to the lower half sequence was impossible until the 1996–2004 campaign, when a thorough examination of many standing sections could be undertaken *(48)*. The integration of both sets of stratigraphic data resulted in the definition of ten sedimentary cycles (Figure 9).

Field geological studies highlighted a number of clear climatic signals, particularly those recorded by pedological and sedimentary processes (e.g. in situ or reworked palaeosols, cryoturbations, melting channel, loess deposition). The significance of these signals is reinforced by palynological, anthracological and palaeontological data. The chronostratigraphic framework is also particularly coherent, thanks to tephrostratigraphy (identification of the Rocourt and Laacher See Tephras) and the excellent correlation with the loess sequences of Middle Belgium *(48)*; this framework is further supported by radiocarbon and TL dates, archaeology and palaeontology. The Walou sequence spans from the pre-Eemian down to the Holocene, including the Eemian, Early Glacial, Lower, Middle and Upper Pleniglacial, as well as the Late Glacial (Figure 9). It is therefore the most complete and best documented Upper Pleistocene sequence available for all the Belgian caves.

The sum of these results combine into a sound chronological framework for the Walou human tooth and the associated Middle Palaeolithic occupation of layer CI-8. More specifically, the age of the underlying CII-1 palaeosol provides a terminus post-quem. This palaeosol can be correlated with the 'Les Vaux' Soil observed at Harmignies *(49)* and Remicourt *(50)* in the Middle Pleniglacial. 'Les Vaux' Soil bears close similarities with the Bohunice Soil *(51)* with a date range between 42000 BP to 40000 BP in Central Europe *(52)*. According to these correlations, and considering the terminus ante-quem provided by the radiocarbon dates from the layers above CI-8 (Figure 9), this tooth can reasonably be dated between ca. 42000 BP and 40000 BP and is therefore the best dated Upper Pleistocene human fossil from Belgium.

The palaeoenvironmental context from layer CI-8 is problematic in that it suffers from a number of contradictions between both palaeontological data *(53)* and geological and palynological data *(48)*. The lithic industry associated with the human tooth is Mousterian, with an abundance of flakes. The artefacts comprise, notably, pseudo-Levallois points, various types of scrapers, some backed knives and a few Mousterian points *(45)*.

The tooth is a lower left premolar, probably a P3, exhibiting preservation and fossilisation features similar to the other palaeontological remains gathered in the same layer, which is not disturbed by fossils from the upper layers of the stratigraphy. The tooth has a single root and is somewhat flattened in the mesial-distal direction. The crown is strong and its maximal vestibular-lingual and mesial-distal diameters are within range of Neandertal values.

Since nothing indicates modern man may have lived at such an early stage in a Mousterian north-west Europe, it is reasonable to attribute the recently discovered Walou premolar to Neandertal man.

10. GOYET

In 1997, our team undertook new excavations in several caves of Goyet, in order to clarify the stratigraphy of the site, which has yielded a succession of Middle and Upper Palaeolithic occupations *(54)*. This was part of our broader research program on some Neandertal fossil-yielding cave sites, which also include La Naulette and Fonds de Forêt. We have hitherto found a Neolithic burial *(55)* and a layer with Upper Palaeolithic artefacts; but we have not found Mousterian industries nor Neandertal remains in situ. So, while tremendous work has been done on the field, it is in the collections of one of the old digs that a Neandertal remain, a fragment of a mandible body and a tooth discovered around 1870 by the geologist Edouard Dupont, were recently found *(19)*.

11. CONCLUSION AND PERSPECTIVES

The last years have seen new developments in the study of the Neandertals of the South Belgium Meuse Basin, on the field as much as in laboratories.

Excavations have-been carried out at Scladina, where the first Neandertal skeletal remains were identified in 1993, with new discoveries, mainly teeth. The 1996–2004 excavation campaign at Walou yielded a human tooth in a Mousterian context stratigraphically well documented. New research was undertaken at some classic sites (La Naulette, Fonds de Forêt and Goyet) in order to specify the context of the palaeolithic occupations and assess the potential of the undisturbed deposits which may possibly contain Neandertal fossils. Yet until now there were no field results relating to Neandertal anthropology.

Laboratory work involves the Department of Archaeology of the Regional Ministry of Wallonia and the Royal Belgian Institute of Natural Sciences, sometimes in collaboration. This work includes thorough studies of the Scladina child, the deciduous molar of Couvin and the premolar of Walou, as well as the reexamination of the Spy collections. All this using modern investigation techniques, such as 3D reconstruction from computer tomography scans, isotopic biogeochemistry or experiments in DNA extraction.

Scientific disciplines dealing with the study of context, such as microstratigraphy and sedimentology, and different dating methods, are also involved in the process. The first results from the last years, particularly at Walou and Scladina, lead to a better chronological and stratigraphical positioning of the Neandertal fossils.

Interesting prospects exist for future Neandertal research in Belgium, both on the field and in the laboratory.

The ongoing excavations at Scladina will hopefully yield additional fossils in the near future. The resumption of research at La Naulette will provide useful information on the palaeoenvironment and help give a date to the bones discovered by Dupont in 1866. Since there are undisturbed deposits left, new palaeoanthropological discoveries are possible. We can also hope for new Neandertal finds in the deposits of sites like Goyet, where our team is still busy doing field research, and like Trou Al'Wesse, where a new dig is in process by the University of Liège, whereas they are improbable at Fonds de Forêt. The year 2006 will also see a new field program at Spy which will begin by the sieving of the 1886 excavation backfills, inspired by the fact that Twiessemann found in that area a few Neandertal fossils De Puydt and Lohest missed.

The current data from key sites with developed stratigraphies such as Scladina, Walou and Trou Al'Wesse should be an encouragement to develop systematic programs of palaeoenvironmental, stratigraphic, and sedimentary studies in Palaeolithic caves to gain better knowledge of the contexts Neandertals evolved. As for taphonomy, we can also hope for decisive progress in the comprehension of the processes involved in the introduction of the Neandertal fossils in Scladina cave.

AMS determination, where applicable, should be done on the relatively recent Neandertal fossils of Engis, Spy, Fonds de Forêt, Couvin and Goyet. Other methods of direct dating should be used on the older fossils, such as those of La Naulette.

Furthering the dietary analyses, as already done at Sclayn, Engis and on some Spy fragments, is also fundamental for the better understanding of the variability of Neandertals' diet. As for DNA, new mitochondrial DNA analyses and trials in nuclear DNA extraction should be attempted on the specimens not yet tested.

As a conclusion, we stress the renewed interest in Belgian karst Neandertal studies during the last decade, in both field and laboratory studies, and express our hope that the coming years will see this trend develop even further.

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