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**SEASONALITY OF MAGDALENIAN CAVE OCCUPATIONS
IN THE MOSAN BASIN:
CEMENTUM INCREMENT DATA FROM BOIS LAITERIE,
CHALEUX, AND THE TROU DA SOMME**

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Introduction

In this chapter, we present results of cementum increment analysis of an ungulate tooth sample from the Magdalenian layers of the Grotte du Bois Laiterie. We also present the results of analysis of Magdalenian samples from three other Mosan Basin sites: the Trou de Chaleux, the Trou da Somme, and the Trou des Nutons à Furfooz¹. Seasonality studies of late glacial Belgian archaeological assemblages have not been extensive; our samples provide the only cementum information available for the Mosan Basin Magdalenian². While limited in scope, our results certainly complement information we have gained in the 1980's and 1990's from recent excavations and reanalysis of old collections (this volume; Charles, 1994a; Dewez, 1987; Otte, 1994).

In particular, the cementum increment data presented below can be combined with other faunal information in order to address the continuing debate about the seasonal nature Late Glacial occupation of Belgium. Sturdy (1975) and Gordon (1988) have suggested that Late Glacial hunting economies throughout Central and Western Europe were organized around the annual migrations of reindeer (*Rangifer tarandus*). This species does dominate the assemblages of a very large proportion of Late Glacial European sites, but there also appears to have been considerable variability across Europe and over the course of the Late Glacial in the diversity and proportions of ungulate species hunted. The Mosan Basin Magdalenian archaeofaunas deviate markedly from the reindeer-dominated pattern; therefore, their composition is not easily compatible with the «herd-following hypothesis». The assemblages from Mosan Basin Magdalenian sites exhibit a diverse range of ungulate species, and it is wild horse (*Equus ferus*) that is most common (see Charles, 1994a). Chaleux represents the largest assemblage and best-known example of this pattern (Charles, 1994a; Dupont, 1872; Patou-Mathis, 1994). Bois Laiterie and the Trou da Somme contain smaller archaeological accumulations, but the ungulate fauna are distributed similarly: wild horse is the most common taxon in assemblages that include large and medium cervids, large bovids, caprids, and sometimes wild boar (Gautier, 1994; Léotard, 1988a, 1988b). Nutons appears to have had only

1 The cementum increment data from these three sites was first presented in Stutz (1993).

2 To date, Gordon (1988) has published reindeer cementum increment data from the Ahrensburgian site of Rémouchamps.

a trace faunal component associated with its very small Magdalenian lithic assemblage (Charles, 1994a; Dewez, 1987), but an *Equus ferus* phalanx with cut marks has been directly dated by AMS ^{14}C assay to Magdalenian times (Charles, 1994a, 1994b).

Arguments for a specialized reindeer economy also require summer seasonality of Mosan Basin sites, since the Ardennes or the northwest European Plain would have provided calving grounds and rich summer forage for reindeer herds (Gordon, 1988; Sturdy, 1975). The cementum increment data from Bois Laiterie, Chaleux, and the Trou da Somme suggest a different scenario: while individual sites might have been preferentially utilized in one season, Magdalenian foragers resided in the Mosan Basin during winter as well as summer.

Cementum Increments and Season of Death in the Archaeological Samples

Cementum is a mineralized tissue that is deposited on the surface of the tooth root, and it functions to anchor the roots to the periodontal ligament. In most ungulate taxa, cementogenesis proceeds at a slow, but seasonally variable rate throughout the life of the tooth. The roughly semiannual change in cementum growth, which is most likely related to seasonal variation in diet³, produces tree-ring-like increments. A ground thin section of a tooth, when viewed through a microscope in transmitted cross-polarized light, reveals cementum increments as alternating translucent and opaque bands.

At least in some environments, equids are an important exception to the ungulate pattern of cementum formation (Stutz, unpublished data; but see Burke, 1993, 1994; Burke and Castanet, 1995; O'Brien, 1994). Efforts to identify seasonal incremental structures in the cementum of horse teeth from Chaleux have been unsuccessful (Stutz, unpublished data). This obviously leaves a gap in our knowledge about residential mobility among Mosan Basin Magdalenian groups, because horse appears to have such an important focus of Magdalenian hunting in this region. However, the taxa we have included in our study sample give us a broad view of the hunting and butchery of those ungulate prey that supplemented horse for Mosan Basin Magdalenian groups. Our sample includes reindeer (*Rangifer tarandus*), elk (*Alces alces*), musk ox (*Ovibos moschatus*), and ibex (*Capra ibex*)⁴.

3 Several sources of data suggest that bands in cementum form in response to regular seasonal shifts in diet. Controlled feeding experiments on domesticated nubian goats (*Capra hircus*) illustrate how changes in the physical and nutritional qualities of diet affect cementum increment formation (Lieberman 1993a, 1993b, 1994). Keeping in mind the results of the feeding experiments, we can examine ecological data on annual foraging cycles (and possibly endocrine-related physiological cycles, and periodicity in mating and birth events) to infer the parameters on the rate of cementum growth, its composition, and the orientation of the collagenous fibers that give cementum flexibility and a structural anchor to the periodontal ligament (cf. Lieberman 1993a; 1993b, 1994; Lieberman and Meadow 1992; Spiess 1990). Finally, we can utilize analyses of cementum increments in the teeth of modern wild ungulates of known age and season of death (Gordon 1988; Grue and Jensen 1979; Klevezal 1988; Klevezal and Kleinenberg 1969; Lieberman 1993b, 1993c; Pike-Tay 1991; Spiess 1976, 1990). These results reveal that the timing of formation of these semiannual cementum increments corresponds to the timing of seasonal changes in diet.

4 The ibex, reindeer, elk, and musk ox specimens from Bois Laiterie were excavated during the 1994 and 1995 campaigns. The Chaleux specimens were excavated by Otte et al. from the cave's terrace and entrance (cf. Otte 1994). The Trou da Somme material was recovered by Léotard (1988a, 1988b). The Magdalenian layers from these three sites included remains of stone-paved floors, antler sagaies with bevelled bases, and

Analysis of modern *Rangifer*, *Ovibos*, and *Alces* field specimens of known age and season of death demonstrates that populations of these taxa throughout North America and Europe - regardless of latitude, altitude, or microhabitat - exhibit growth of «translucent» cementum from spring (usually late spring) through late fall or the beginning of winter (November through January), and of «opaque» cementum through winter and perhaps early spring (Grue and Jensen, 1979:p.13-17 and references therein; see also Gordon, 1988; Pike-Tay, 1991; and Spiess, 1976, 1990). There is no comparably thorough documentation of the timing of growth of translucent and opaque cementum in modern ibex. However, other *Ovicapridae* inhabiting cool, continental regions exhibit a similar timing of translucent and opaque band growth (Grue and Jensen, 1979).

Determining Season of Death

Season of death is approximated from the optical nature of the tooth's youngest, outermost acellular cementum band, which can be seen most clearly at and just below the gum line (Fig.1). As discussed above - and this cycle characterizes only those ungulate populations occupying temperate and subarctic habitats - an opaque outer increment indicates that the animal died in winter or early spring; a translucent outer band demonstrates a death in late-spring, summer, or fall. It is also possible to infer season of death more precisely. Lieberman (1993b) and Spiess (1990) have shown that the growth rate of a seasonal increment is statistically predictable, so that one can maintain, for example, that a *Rangifer* molar with a very thick outermost translucent band (e.g., >15 mm) died near the end of that growth phase, or, conservatively, between October and December.

It is stressed that variations in the rate of cementogenesis do occur. In order to err on the side of caution, we only make precise season of death determinations when the outermost band is either very thick or very thin. We estimate the width of the outermost band relative to that of the same band (translucent or opaque) from the previous year (cf. Spiess, 1990). Tab.1 shows the seasonal relationship between «thin», «medium», and «thick» outer bands and season of death. A medium band is approximately the same width as the previous year's band; a thin band exhibits <50% of the width of the previous year's band; and a thick increment is >150% of the previous year's band. The width assessments represent an increment's width relative to the thickness of the same band (translucent or opaque) from the previous year. We also caution that precise determinations of season of death in subadults (≤ 3 years) display relatively high error ranges, because young animals are most likely to undergo fluctuations in growth rates from year to year (Spiess, 1990).

lithic assemblages with high proportions of backed bladelets. The Nutons reindeer material is not positively associated with the small Magdalenian lithic and antler point assemblage from the site. Charles (1994a, 1994b) has demonstrated that Dupont made no stratigraphic separation between Late Glacial and Holocene deposits; she reports an AMS ^{14}C date on a Nutons red deer (*Cervus elaphus*) bone at ca. 2000 BP. The reindeer from Nutons are certainly Pleistocene in age, and consequently, they might reflect Magdalenian hunting and butchery.

Tab.1

CEMENTUM INCREMENTS AND SEASON OF DEATH		
Outermost Cementum Increment		
Appearance and Width *	Season of Death	Approximate Months**
Opaque	Winter - Early Spring	January - April
Thin Traslucent	Late Spring - Early Summer	May - July
Medium Translucent	Summer - Fall	June - December
Thick Translucent	Fall	October - December

* The «opaque» and «translucent» terminology refers here to cementum's analysis under transmitted cross polarized light.

** See Gordon 1988, Grue and Jensen 1979, Pike-Tay 1991, Spiess 1976 and 1990.

In order to «read» the cementum bands in an archaeological tooth the researcher requires a method of obtaining a cross-section view of the archaeological tooth and a means of observing and assessing the cementum itself. We follow the petrographic thin section procedure described in Lieberman *et al.* (1990). For most specimens we only prepared one section through the tooth from crown to apex in a mesio-distal plane. However, if the cementum appeared abraded, we prepared additional sections in order to increase the surface area analyzed. The polished thin sections were observed under cross-polarized transmitted light on an Olympus™ BH-2 bifocal microscope at magnifications of 40x, 100x, and 200x. The higher magnifications have proved essential in distinguishing cementum increments in poorly preserved archaeological teeth.

Materials, Results, and Conclusions

Nearly half of the thin sections reveal cementum too poorly preserved to convey season of death. Positive results, then, are indeed limited in scope. However, ibex teeth from Chaleux and Trou da Somme provide two independent indications that Magdalenians occupied the Mosan Basin during winter or early spring. One reindeer specimen from Nutons also reveals winter-early spring death; if the Nutons reindeer remains are associated with Magdalenian activity, then we have three separate instances of cold-season occupation of the Mosan Basin. These cementum increment data are consistent with the hypothesis that a «Magdalenian regional band» occupied the Meuse River valley year-round during the Bölling oscillation (Straus *et al.* n.d.). The reindeer teeth from Bois Laiterie provide two examples of summer or summer-fall kills. In part, this information provides additional confirmation for the year-round occupation hypothesis. It also hints that reindeer were hunted primarily in the summer or fall (two of three specimens from Nutons exhibit the same seasonality as the reindeer from Bois Laiterie). If future finds do support this trend, it would indicate that as Sturdy (1975) and Gordon (1988) have asserted, Late Glacial *Rangifer* populations utilized the Ardennes as a calving ground and for summer forage. During the Bölling oscillation, though, reindeer provided a significant but minor - and perhaps seasonal - supplement to a Magdalenian hunting

economy that appears to have focussed largely on *Equus* (Charles, 1994a; Patou-Mathis, 1994). We contend that the results reported above help to illuminate the diversity of human social and economic adaptations that characterizes the end of the Pleistocene in Europe (Otte, 1992).

Tab.2

Results of Cementum Increment Analysis from Bois Laiterie (BL), Chaleux (CHA), Trou da Somme (TDS) and Trou des Nutons à Furfooz (FUR).

Section	Catalog.	Species	Element	Outer Band	Est. Season of Death
BL 1	CBL U7-22	<i>R. tarandus</i>	r. mandible P4	med. translucent	summer-fall
BL 2	CBL T6-30.1	<i>O. moschatus</i>	r. mandible P2	n.a.	n.a.
BL 3	CBL U6-211	<i>Capra</i>	l. mandible M1 or M2	n.a.	n.a.
BL 4	CBL V9-3	<i>Capra</i>	l. mandible M2	n.a.	n.a.
BL 5-3	CBL V2-5	<i>R. tarandus</i>	l. mandible P4 M1 M2	n.a. med.-thin translucent med. translucent	n.a. summer summer-fall
BL 6-4	CBL W3-5	<i>Alces alces</i>	isolated r. lower M1	n.a.	n.a.
CHA 5	Cha R6 113	<i>Capra</i>	r. mandible M2	opaque	winter - early spring
CHA 6	Cha R6 128	<i>Capra</i>	r. mandible M1	n.a.	n.a.
TDS 1	TDS 88 P21-51	small ungulate*	l. maxilla M1	med. translucent	summer-fall
TDS 2	TDS 88 O21-137	<i>Capra</i>	r. mandible M2	med. translucent	summer-fall
FUR 1 **	E. Dupont 2533	<i>R. tarandus</i>	l. mandible P2, P3, M1 M3	med. translucent	summer-fall
FUR 1 **	E. Dupont 2533	<i>R. tarandus</i>	r. mandible M1-M3	med. translucent	summer-fall
FUR 1 **	E. Dupont 2533	<i>R. tarandus</i>	l. mandible dp3	opaque	winter - early spring

* unidentified small cervid or caprine, possibly chamois (*Rupicapra rupicapra*).

** The Trou des Nutons (Furfooz) specimens were recovered by E. Dupont's team in 1864. They are not definitely associated with the Magdalenian component of this site.

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