Using Cementochronology to Discuss the Organization of Past Neanderthal Societies

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The spatial organization of activities in the Neanderthal's territory has often been examined through the study of stone tool production and by the economy of raw material acquisition and use ((Faivre et al. 2014)). However, Neanderthal spatial organization has not been well studied with regard to their hunting behavior (Farizy, David, and Jaubert 1994; William Rendu et al. 2012; Costamagno et al. 2006; Meignen et al. 2006). These rare studies have, however, called into question the validity of the hypothesis that Neanderthals lacked planning depth and have proposed the existence during the Mousterian of complex landuse strategies. These are thought to have been characterized, notably, by the use of communal hunting strategies and reliance on food storage in anticipation of future needs. Moreover, the organization of these activities would have been clearly structured in both time and space.

Given this background, the seasonality of hunting is obviously a key factor for identifying and understanding both the spatial and temporal organization of the subsistence economy. To consider hunting and management of food resources without first taking into account the seasonality of their procurement severely handicaps any attempt to study the subsistence economy of hunter-gatherers. Yet, for the Neanderthals this issue has rarely been addressed ((Lieberman 1993; Armand, Pubert, and Soressi 2001; William Rendu 2010).

Southwestern France context

Throughout the year, and depending on their age and sex, ungulates go through several physiological phases, including the rut, antler shedding and regrowth, pregnancy, and parturition. These biologically driven phases influence the animals' physical condition and, consequently, the quality and quantity of meat, grease, marrow, hides, antlers, and other products they are able to provide the hunters.

Linked to these biological changes, the social behavior of the prey also varies significantly with season. Gathering and dispersal of the herds, distance of daily movements, and wariness of the individuals will all vary in relatively predictable ways over the course of the year among males, females, and young within the same population. Taken together, these seasonally-linked sources of variability in the behavior of potential prey would have had important implications for the hunting strategies and settlement patterns of neandertal foragers.

With time , human populations have learnt to anticipate the fluctuations and one of the best demonstration is the development of task specific locations (sensus (Binford 1980))

dedicated to the predation where acquisition, transformation and consumption were done at least partially in different parts of the territory.

During the late Middle Paleolithic in Southwestern Europe, parallel to the development of kill sites ((Farizy, David, and Jaubert 1994; William Rendu et al. 2012)), butchery sites (Costamagno et al. 2006) and corresponding base camps, we assist at the spatiotemporal segmentation of the hunting “chaîne opératoire”.

Thus, based on the existence of task specific locations associated with specific techno-complexes, some authors (Delagnes and Rendu 2011) proposed that during the late Mousterian, some Neanderthal societies developed a logistic mobility pattern to cope with the specificity of the prey in their environments. In particular, the Quina Mousterian (which mostly developed during MIS 4) and the discoidal denticulate Mousterian (Thiébaut et al. 2010) which developed at the end of the Middle Paleolithic in Southwestern France (Jaubert 2009) have to be mentioned.

A logistic organization during the late Middle Paleolithic?

The Quina Mousterian (figure 1) is a techno-complex identified in a large part of southwestern France, more or less correlated to the cold Heinrich Stadial 6 of the MIS 4, around 60 ka (for a discussion of available absolute dates and environmental correlations, see Discamps & Royer 2017 quaternary international). One of the characteristic of the Quina Mousterian is its recurrent association with Reindeer in the northern part of the Bassin Aquitain. Indeed, on a corpus of 29 stratigraphic units with fauna associated to Quina Mousterian, 24 are largely dominated by the arctic deer’s remains, half of them (18/29) presenting a specialized faunal spectrum (sensu (Mellars 2004)) on this taxa. In total 73% of the remains found in Quina context are attributed to reindeer.

The reindeer abundance in the environment is considered to be linked to the major climatic pejoration constituting the Heinrich Stadial 6 ((Discamps and Royer 2017; Discamps, Jaubert, and Bachellerie 2011)). During this period, we assist to a major drop off of the ungulate biomass ((Discamps 2014)). In addition, the sedentary prey that were present just before this event are abruptly replaced by Reindeer, identified as a migratory specie at that time (Britton et al. 2011).

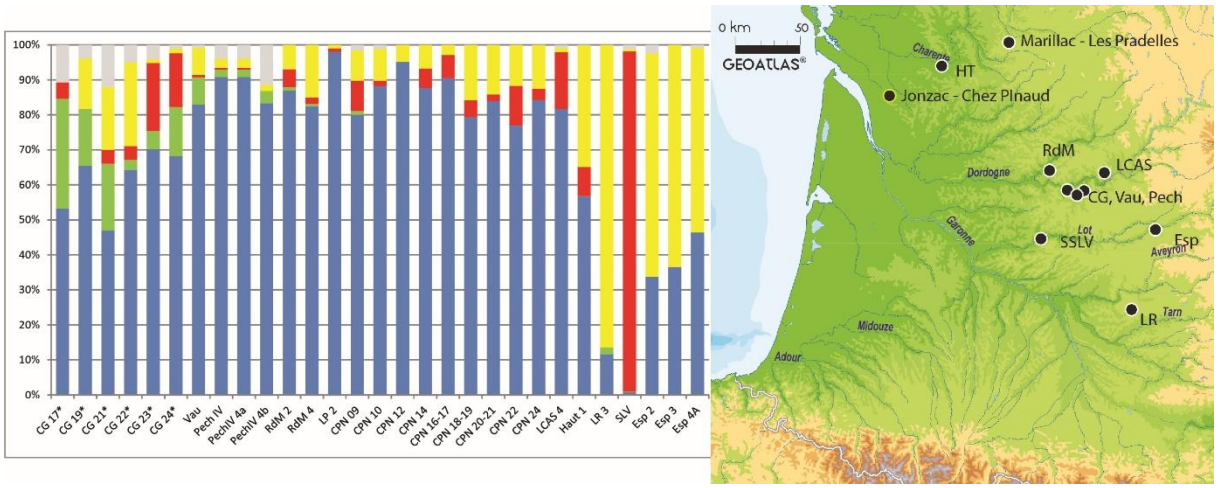

*Figure 17.1 Distribution of the main Quina sites yielding faunal assemblages in Southwetsern France, and contribution of the main prey to the faunal spectra (in %NR; Blue = reindeer, green = red deer; Red: Bison; Yellow: Horse; Grey: other). A) CG : Combe Grenal (Guadelli 1987; Laquay 1981); Vau : Vauffrey (Delpech 1996) ; PechIV : Pech de l'Azé IV (Laquay 1981; Niven 2013) ; RdM : Roc de Marsal (Castel et al. 2017); LP : Les Pradelles (Costamagno et al. 2006) ; CPN : Chez Pinaud-Jonzac (Airvaux 2004; Jaubert et al. 2008; Niven 2013); LCAS : La Chapelle-aux-Saints (William Rendu et al. 2014) ; Haut : Hauteroche (Paletta 2005) ; LR : La Rouquette (William Rendu et al. 2011) ; SLV : Sous les Vignes (Turq, Guadelli, and Quintard 1999) ; ESP : Espagnac (Jaubert 2001). Numbers correspond to the different startigraphic units. * For Combe Grenal Reindeer was under evaluated in the previous excavation due to selective sampling. Derived from (Discamps and Royer 2017). Map from Geoatlas.*

Consequently, not only the number and the kind of games had varied in this environment but most importantly, it was a major change in the behaviour of the prey to which the hunters had to answer. Due to its migration, they have to deal with the seasonal fluctuation of its distribution within their territory.

The Discoidal Denticulate Mousterian developed at the end of the Middle Paleolithic in Southwestern France during the second part of MIS 3. Based on their faunal assemblage, two groups of sites can be recognized: sites with diversified faunal spectrum and site with a specialized faunal spectrum on Bison.

The first one with a large diversity of prey seems to have worked as living camp. Part of the second one would have been used as task specific location dedicated to the capture of bison in great number ((Farizy, David, and Jaubert 1994)).

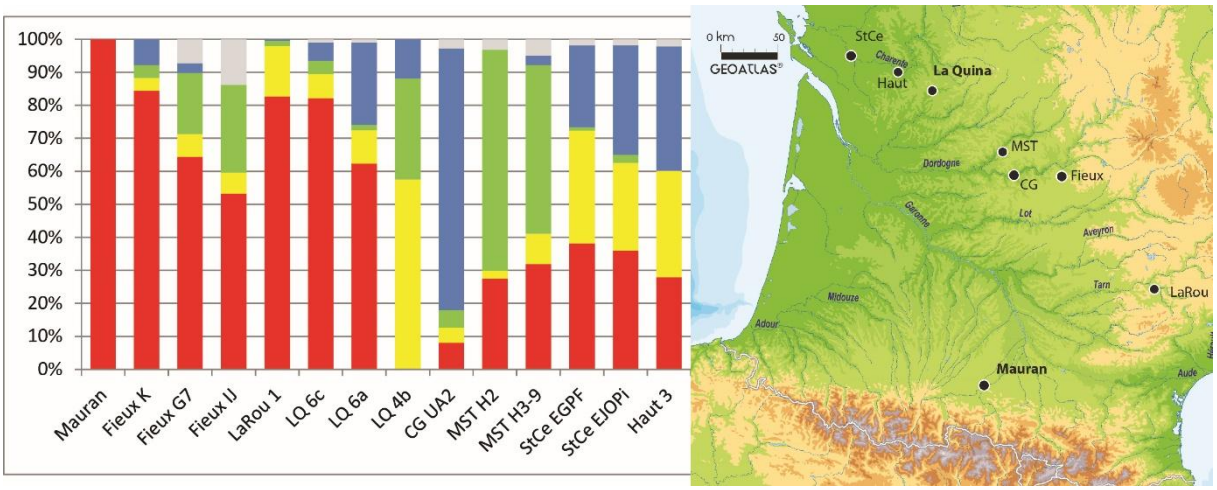

Figure 17.2 : Distribution of the main Denticulate Discoidal Mousterian sites yielding faunal assemblages in Southwetsern France, and their faunal spectra spectra (in %NR; Blue = reindeer, green = red deer; Red: Bison; Yellow: Horse; Grey: other). Mauran (Farizy, David, and Jaubert 1994) ; Les Fieux (Gerbe 2010); LaRou: La Rouquette (William Rendu et al. 2011); LQ= La Quina (Debénath and Jelinek 1998); CG= Combe Grenal (Guadelli 1987; Laquay 1981); MST= Le Moustier (Gravina and Discamps 2015) ; StCE= Saint Césaire (Morin 2012) ; Haut= Hauteroche (Paletta 2005). Derived from (Discamps and Royer 2017) see in. Map from Geoatlas.

While during these two distinct phases of the late Mousterian some task specific locations were developed the place of such task specific locations in the annual calendar of the activities of the involved populations has not been discussed. Consequently, there implications on the organization of the Neanderthal societies and their meaning in term of subsistence strategies is generally eluded.

Thus, the question of the season organization of the sites during these two periods of the recent Neanderthal area is of prime interest to better understand the diversity of their mobility. In this chapter, we propose to tackle this issue by interrogating the cementochronological data available for the task specific locations of the Quina and discoidal denticulate complexes. Two sites for each era (three sites interpreted as kill sites and one as a secondary butchery sites) have been selected.

THE QUINA ASSEMBLAGES

Level 22 at Jonzac is one of the numerous layers from a 2-meter stratigraphy of reindeer bone beds (Jaubert et al. 2008). At least 22 reindeers have been identified from an excavation area corresponding to a very small fraction of the site (maybe less than 2%). Based on the numerous anatomical articulations and the possible exportation of some reach elements, associated with the absence of evidence of fire and the introduction into the site of tools ready to use, the site was interpreted as a task specific location dedicated to the capture of reindeer in large number.

Facies 2 at Les Pradelles (Marillac) yielded at least 69 reindeers while less than 50% of the site have been excavated (Costamagno et al. 2006). Moreover it is only one of the numerous Quina units from these several meter depth stratigraphy. In Les Pradelles, Costamagno and colleagues have proposed that carcasses were brought incomplete into the site where a

second butchery was undertaken before an exportation to a base camp (Costamagno et al. 2006). The very low density of the lithic material and the systematic introduction of stone tools ready to use, heavily curated, are evidences of short-term occupations. For these reasons, Les Pradelles was defined as a secondary butchery site.

By taking into account the site extensions, it is possible to advance that several hundred reindeer were processed in these two sites, which would have been used respectively during a long period of time.

THE DISCOIDAL DENTICULATE ASSEMBLAGES

Mauran is located in the southern part of the Aquitaine Basin, it lays against a dismantled limestone ridge. It yielded an assemblage dominated at 99% by Bison remains dating from the MIS3 (Farizy, David, and Jaubert 1994). More than 137 bison are identified by the MNI but, based on the site extension, Farizy and colleagues (Farizy, David, and Jaubert 1994) have suggested that 2000 bison were hunted there by Neanderthals.

La Quina (Gardes-le-Pontaroux, Charentes) is a large site at the base of an important limestone cliff. Excavated by L. Henri-Martin then by A. Debénath and A. J. Jelinek (Henri-Martin, 1923 ; (Debénath and Jelinek 1998; Jelinek, Debénath, and Dibble 1989)) the site yielded several stratigraphic units attributed to the MIS3. Among them, the assemblage of Layer 6c is largely dominated by Bison remains (%NISP=82%; MNI=22).

On these two sites the evidence of exportation of the richest elements, the expedient butchery and the articular connections (at least at Mauran) are strong elements sustaining the use of these two sites as Bison Kill site, where collective hunting were conducted (see for a synthesis of the arguments (William Rendu et al. 2011)).

17.1 METHOD AND MATERIAL

The analyses of these different collections were made under different project but under the same protocol and by the same analysts.

NMI were established on all the faunal assemblages and each time it was possible one tooth per reconstructed individual were selected to ensure that no individual would be analyzed twice. For preservation purposes, six pictures were taken of each tooth and each sample was then molded and replicated. Then, the teeth were embedded in an Epoxy resin in a vacuum chamber. A longitudinal section was realized with a low velocity saw (Buehler Isomet saw) following the mesiodistal plan. The section were polished and finally, the samples were glued, grounded to a thickness of 100 µm and polished. The observations were conducted with a MOTIC BA 300pol. polarized microscope. Pictures were taken with a Progress CT3 camera with the Progress CapturePro2.10 software. They were processed with *ImageJ* software (Lieberman, Deacon, and Meadow 1990; Schneider, Rasband, and Eliceiri 2012). Thin sections were analyzed under natural and polarized transmitted light microscopy (x40, x100 and x400) with and without the insertion of the lambda plate (see Stutz, 2002 a, b for a complete description or (W. Rendu et al. 2009)). Weathering alterations, microbial (Geusa et al., 1999) and diagenesis modifications were systematically looked for with the use

of the lambda (λ) plate according to specifications given by Stutz (2002a, 2002b) and the integrity of the outermost cementum increment was evaluated.

Estimation of the season of death followed the classical method developed by previous researchers (e.g.: (Pike-Tay 1991; Martin 1996)). First, the **nature of the last deposit** is identified as either **(i)** a growth "**zone**," usually formed during the summer (wide, translucent in natural light, or light in cross-polarized light); or **(ii)** a rest layer or "**annulus**", usually formed in winter (thin, opaque in natural light or dark in cross-polarized light). Second, the **growth stage** of the last deposit is estimated. For a growth **zone**, three stages are defined by comparing the thickness of the last increment proportionally to the previous growth zone: **Z1-** *beginning* (width lesser than 1/3 of the previous one), **Z2-** *middle* (width lesser than 2/3 and greater than 1/3), and **Z3-** *late* (width greater than 2/3). For an **annulus**, the increment's width is usually too thin to subdivide.

Table 17.1 :Number of samples analyzed for each sites and related references.

Sites	Chronological attribution (in MIS)	Cultural attributions	Species selected	Nb samples	References
Chez-Pinaud (Jonzac)	4	Quina Mousterian	Reindeer	12	(Niven et al. 2012)
Les Pradelles (Marillac)	4	Quina Mousterian	Reindeer	12	(William Rendu et al. 2012)
Mauran	3	Discoidal Denticulate	Bison	23	(William Rendu et al. 2012)
La Quina	3	Discoidal Denticulate	Bison	12	(RENDU and ARMAND 2009)

17.2 RESULTS

For the two Quina sites, a total of 24 individuals were selected. Cementum is mostly well preserved even if some weathering alterations (longitudinal cracks) and microbial tunnels (Geusa et al. 1999) impact the seasonal record of 3 of Jonzac teeth. For the two sites, every teeth exhibited the same last increment at the same stage of growth: at Jonzac, the last increment was always an annulus, while at les Pradelles the last increments was a growth zone at the end of its growth (William Rendu et al. 2012).

Thus, the killing in these two sites happened at two different moments of the seasonal growth cycles. If comparisons are made with modern data (Pike-Tay 1995), these periods will correspond to the winter/early spring for Jonzac and the late summer/fall for Les Pradelles.

For the two sites the other seasonal proxies (tooth wear and eruption sequences, and presence of fetal bones at Jonzac) support the seasonal interpretation (Costamagno et al. 2006; Niven et al. 2012). Thus, it seems that the two sites were used seasonally, but at different moments of the year.

For the discoidal denticulate Mousterian sites, several preservation issues were identified. Mauran teeth were largely impacted by microbial alteration and tunnel (Geusa et al. 1999), going from the dentin to the cementum, are present on all the teeth. For three teeth, the alterations completely destroyed the seasonal record. The intensity of these alterations can be explained by the fact that the site is mostly an open-air site where numerous bones were largely impacted by the weathering, most of their cortical surfaces are destroyed (Farizy, David, and Jaubert 1994). At La Quina, it is mostly weathering with longitudinal crack within the cementum that is recorded. In addition, some local recrystallization of the cementum were identified (Stutz 2002). Four teeth were excluded from the analysis.

For all the other teeth, for both sites, it was possible to identify the last increment as a growth zone at the end of its formation. These results agree with the other seasonal proxies from these sites (Farizy, David, and Jaubert 1994). Thus, for these two kill sites, all the bison were killed during the same period of the cementum growth cycle.

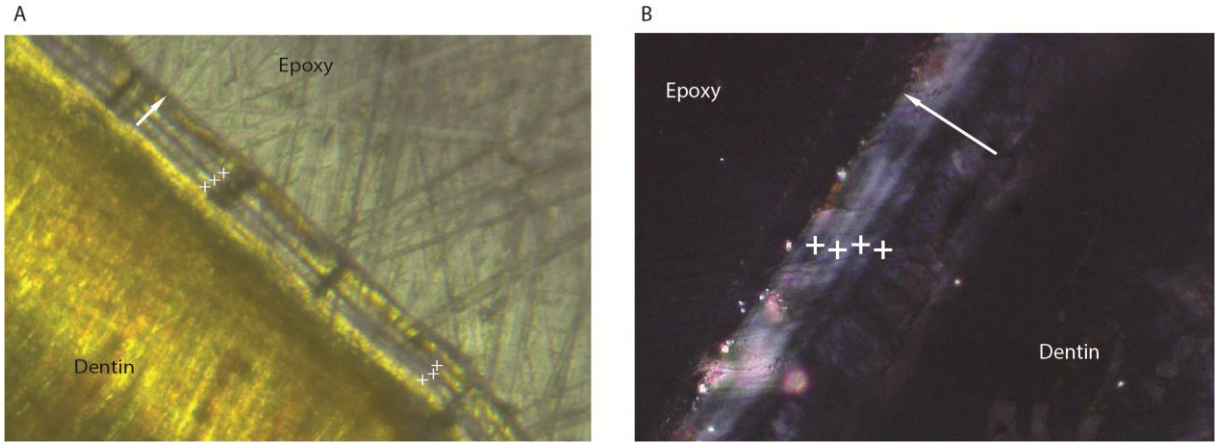

Figure 17.3 : A) Observation at X100 of cementum line of a teeth from Les Pradelles. Three annulus can be couted. The last increment is a fast growth deposit at its end of growth. B) Observation at high magnification (X400) of a tooth from Mauran site. Cementum increments are difficult to see but four annulus can be counted. The last increment is a fast growth deposit at the end of its growth.

17.3 DISCUSSION

Two different patterns seem to emerge in the Aquitaine Bassin from these results. Firstly, during the Quina, the faunal spectra dominated by reindeer remains seem to results from occupations at different moments of the year. There is unfortunately very few other sites furnishing seasonal data for this period. However, layer 4 at La Chapelle-aux-Saints yielded a Quina assemblage associated with reindeer. In this layer interpreted as a potential residential camp, the seasonal proxies indicate that the carcasses were accumulated during the spring-early summer period ((William Rendu et al. 2014)). For Roc-de-Marsal layer 4, a Quina assemblage also dominated by reindeer, zooarchaeological analysis favour the hypothesis of a base camp or second butchery site potentially used throughout the year (Castel et al 2017 QI). Therefore, whatever the season, reindeer always dominate the faunal spectra in Quina Mousterian in the north of the Aquitaine Bassin. Thus, the over

representation of reindeer remains is likely not linked to the seasonal availability of the prey nor the site function but should reflect at least in part what was available in the environment.

During the MIS 4, Quina Neanderthal from the north of the Aquitaine Bassin are characterized by a hunting specialization on the reindeer and the lack of diversity in their diet. The association of faunal spectra, site functions and seasonal data imply that this specialization seems to results principally from the overrepresentation of reindeer in the environment.

The recurrent use of task specific location over a great period of time associated with the fact that reindeer was a migratory specie during the Quina (Britton et al. 2011), it seems reasonable to think that the reindeer movements conditioned the settlement pattern of the Quina populations in the region, and the implantation of sites within the territory. In fact, it seems that a virtual calendar of the territory occupation was established at that time, conducting the Quina society to adopt a logistic mobility (Binford 1980).

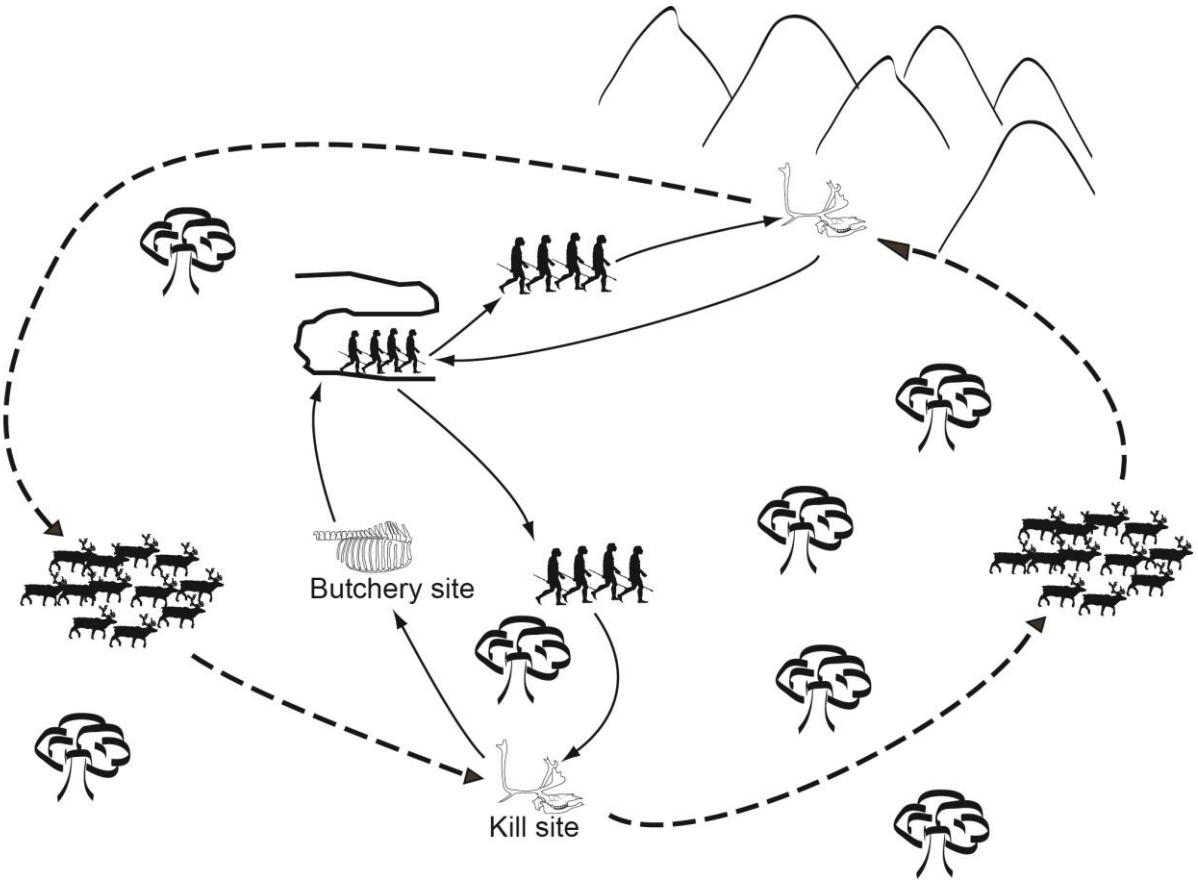

Figure 17.4: Reconstruction of the logistic mobility developed by Quina populations in the northern part of the Aquitaine Bassin, modified from (Delagne and Rendu, 2011)

On the contrary, during the discoidal denticulate Mousterian, the two studied task specific location are occupied at the end of the summer or early fall. Les Fieux layer K, a contemporaneous discoidal denticulate site, dominated by Bison remains and interpreted as a task specific location was occupied during the same period as demonstrated by M. Gerbe

(2009) on the base of tooth wear and eruption sequences. Thus, assemblage with a faunal spectrum specialized on Bison seem to result from task specific location used during this period at the same season of the year, the moment when the Bison is gatherer in large group for the rut and the autumn migration (Berger and Cunningham 1991; Peck 2004). Neanderthal would have come back every end of summer to perform their collective hunts using the predictable bisons habits to optimized their capture.

Simultaneously, the Discoidal denticulate layer EGPF at Saint-Césaire, interpreted as a residential camp with a diversified faunal spectrum shows evidence of an occupation during winter and spring (Morin 2012). In the similarly diverse fauna of layer H2 from Le Moustier, seasonal data is sparse but point to occupations at least in the spring and fall (Discamps and Lemeur 2019). This is for now the only available seasonal data for sites with diversified faunal spectra. However, here it highlights the fact that while bison were hunted in large number at the end of summer/early fall, the rest of the year the Discoidal Denticulate population would have had a less selective hunting activity.

Discoidal denticulate hunting would have thus been diversified and seasonally completed by Bison specialized hunts. Therefore, Neanderthals would have taken advantage of the seasonal behavior of Bison to develop some task specific locations dedicated to their capture. The exploitation of diversified prey would have counterbalanced the seasonal fluctuation of the bison concentration within the environment.

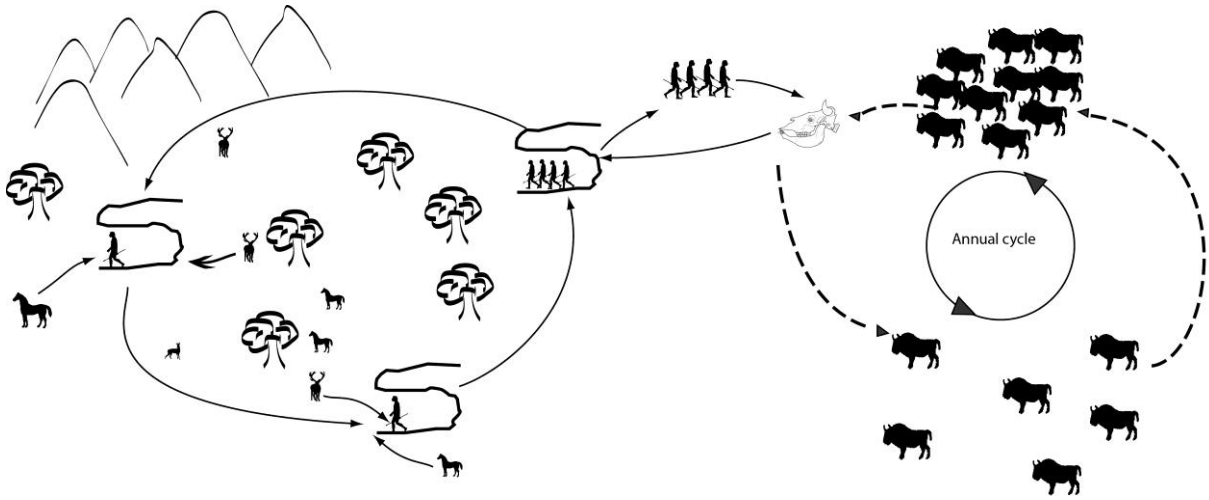

Figure 17.5: Reconstruction of the mixed mobility developed by Discoidal Denticulate populations, modified from (Delagnes and Rendu, 2011)

17.4 Conclusion

Within the Quina and denticulate, the repeated use of a specific sites at a precise time of the year for the same hunting purpose attest of the scheduling of the hunting activities according to a year-round pattern which influenced the movement of the Neanderthal populations.

However, while Quina Mousterian would have been constrained to follow reindeer migrations, the Denticulate population seems to have been able to exploit a larger range of prey and practicing specialized hunting only during some restricted period of the year.

What seems here really important is the development during this late Middle Paleolithic of Landmark sites that would have been used every year at the same moment. It appears that the predation system begin to structure the organization of the activity within the territory in both time and space and that the behavior characteristic of the prey directly impacted the social organization of the human group.

17.5 Acknowledgement

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