The nomadism cycle of recent palaeolithic societies from Reindeer antler economy

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THE NOMADISM CYCLE OF RECENT PALAEOLITHIC SOCIETIES FROM REINDEER ANTLER ECONOMY

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Abstract: *Circulation in mobile hunter-gatherer societies is particularly highlighted by the transport of resources, such as lithic and animal hard materials, and by seasonal occupations. Studying the annual cycle of nomadism is especially interesting in regions where the majority of used siliceous items is allochthonous, and where there are many faunal remains and used cervid antler materials to document seasonality and procurement/exploitation patterns. Regarding the Magdalenian societies of the Massif Central (France), the challenge of our on-going studies is to identify the patterns of reindeer antler acquisition and exploitation. The integration of data stemming from the zooarchaeological and technological analysis allows us to document such strategies on a local scale as an annual cycle of nomadism within a geographical area whose boundaries remain to be defined. This is demonstrated by the study of a northern Magdalenian site (Les Petits Guinards, Allier) that required a specific method of study of faunal and reindeer antler remains (raw material, waste debris, final products) that raised focused questions. It allowed us to identify procurement and exploitation patterns that support the rare data gathered at a few other sites. It revealed for the first time the transport of objects (more or less shaped) and even of (male) shed antler rough materials from manufacturing sites currently unknown which might be located in the northern source area of procurement of the allochthonous flint and occupied during the cold season in the Massif Central—winter occupation, however, have not yet been found in the Massif Central.*

Recent Palaeolithic, Reindeer, Antler, Resource procurement, Mobility, Territory

INTRODUCTION

If reconstructing the nomadic annual cycles is one of the main issues in the study of Palaeolithic and Mesolithic hunter-gatherer societies, our understanding makes slow progress despite more numerous and diverse data. Indeed, very little is known about nomadic annual cycles from the data relating to the origin of lithic materials, the provenance of certain artefacts, the movement of animals, the hunting seasons, and the manufacturing traditions. As a matter of fact, such a goal requires the integrated study of economic systems, human group mobility and settlement patterns, drawing on 1) a multi-scale approach, requiring at least two sets of information: local and regional; 2) a definition of the questions at issue; 3) a particular attention to the kind of remains (in terms of material and type) respectively used in relation to its possible contribution to the nomadic annual cycle. Far from being a truism, does such a procedure generally remain an aspiration given some problems inherent to the archaeological field: the representativeness of the studied sample at a site and of the regional data, variable amount and still insufficient data, a time-scale too large? The main obstacle seems rather associated with the following twofold problem: on the one hand, formulating the global issues precisely (on the territory scale), which is essential for a multidisciplinary investigation; and on the other, clarifying the type of information needed for each kind of remains on the local scale by clearly distinguishing between useful and useless data and, in this view, prioritizing information.

Within our current multidisciplinary research related to economic system and human group mobility during the Recent Palaeolithic period, we seek to understand how the exploitation of animal resources—through the study of faunal remains (food and technical products)—can contribute to reconstruct the nomadic annual cycle. Focused on the exploitation of reindeer (*Rangifer tarandus*) during the Late Pleniglacial in Western Europe, our research documents the particular interest of antler materials when analyzed as variable access resources to identify the annual organization of their procurement and exploitation on

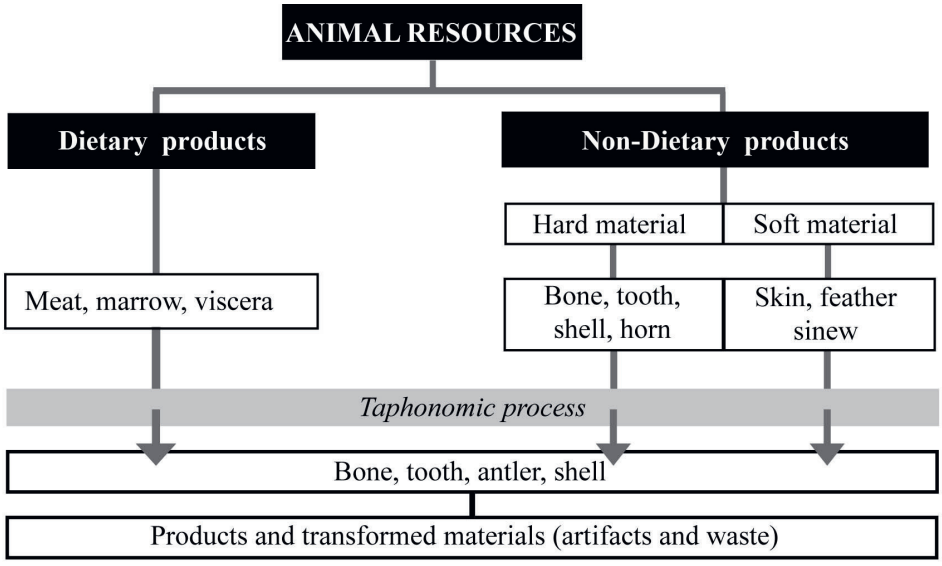

Figure 1. Animals as theoretically sourced and archaeological materials (revised after Fontana *et al.*, 2007:119/Fig. 1).

the local and regional scales. Our article presents various levels in the hierarchy of questions on reindeer antler procurement and exploitation and using examples of our preliminary results related to Magdalenian groups in the Massif Central.

Reconstructing reindeer antler economy in the annual cycle: issues and study scales

How did human groups travel and live in their territory and how were resources procurement and exploitation organized throughout the year? We focus here on the economy of reindeer antler because, during the Last Glacial in Western Europe, the economic system was based on this animal resource and the use of antler as raw material to produce weapons, tools and personal ornaments was significant. Considering this animal as a whole set of potential resources that were acquired for dietary regimes & non-dietary purposes (Fig. 1), these are studied within a global approach by integrating various informative sets of data having an initial questioning in common. With this in mind, the analysis of the archaeological material, —the reindeer as an animal game and as an animal providing the antler material—, may produce very different information as mobile, seasonal and portable or easy to collect. For instance, shed antler is a stationary but a seasonal resource; from it, the season of procurement can be suggested, but not the gathering location *ex nihilo* (if near the site or far from it, before or at the time of occupation). Reindeer antler as a mobile source represents a seasonal resource too, but the location procurement of the unshed antlers is automatically deduced from the study of the slaughtered animals *in situ*. It therefore appears that both sets of data required in the study are not quite equivalent; the implied seasonal and local versus non-local procurement possibly derives from analyzing the resource as a gathered raw material versus a processed animal species (introduced) on the site. One has thus to specify the study-scale to be used, — local rather than non-local or regional—, by formulating specific questions for reconstructing reindeer antler economy based on the known antler annual cycle from actualist studies of reindeer animal populations (*e.g.* Skoog, 1968; Bergerud, 1976). Some characteristics of the reindeer antler pertaining to certain cultural contexts and associated reconstruction of economic lines available for the lithic scales are used for the Palaeolithic, in particular the kind and the size of the antler material.

Antler economy: the territory scale

Our aim is to provide evidence of the annual organization of reindeer antler economy. It can be summed up with the following questions: what kind of antler materials were acquired

and exploited? How and where in the territory? When in the course of the year? How were they managed?

Regarding its procurement, we explore five sets of information (I to V), with the following questions:

I/ "What?" or the diversity of acquired antler

Were all types of antler acquired (shed/unshed, large/small module)? In similar amount? Or was one (or two) type (s) a priority? Are there any modules and sex ratio (from antler compared to bone) selected? Were only mature (never immature) antler (unshed) acquired?

II/ "How?" or the choice of one or two procurement strategies

What was the respective amount of collecting and hunting in the procurement? Quantification is the most significant problem caused by the general over-representation of beams and tines, since only the basal parts can be used to distinct shed from unshed antler anatomies.

III/ "When?" or the way procurement is spread out over the year

1) Did procurement take place many times throughout the year according to the antler annual cycle, meaning during its four episodes as unshed and shed (mature) materials (start and end of autumn for males, winter and spring for females)?

2) Was the procurement focused on one or two of these periods (maybe a single part of the year) documenting a choice in favor of one or two possible episodes?

IV/ "Where?" or the supply sources

1) Were there many gathering and hunting locations?

2) How were these distributed over the territory (distant, local)?

3) Were the antler raw materials always collected near the settlement sites or were some acquired from elsewhere or during a previous halt constituting the annual cycle of mobility?

V/ "Which way?" or the management of antler resources as a raw material

Was the antler used as raw material always acquired and subsequently transformed during the human occupation? Or was the amount of transported raw material important? This issue is essential in terms of nomadic annual cycle, when considering not only locations (procurement area, settlement site if not quite local storage facilities) but also time: were antler materials collected/recovered from carcasses in a small number of locations and moments of the year? This would involve 1) anticipating the transportation throughout the year from site to site of a certain amount of antler pieces, or 2) anticipation in transformation of most antler materials at a particular site (where acquired), some of which would later be taken away as by-products.

Regarding the antler exploitation, the questions concerning the nomadic annual cycle are focused on the local manufacture and the way the used antler material was spread out over the year: was the antler exploitation planned throughout the year and at how many sites? Or was it predominantly limited to only one or two episodes and specific sites? Was it practiced according to a local and episodic procurement? Moreover, we need to know if manufacturing was delayed in time or immediate and in which amount, and what was (if existed) the proportion and shape of transported antler items (by-products? preforms? tools?).

All these issues can be further addressed using the answers to other specific questions related to the site scale and, drawing from the analysis of antler, to other reindeer remains. To this purpose, an integrated study of faunal resources is essential to produce useful information.

Antler procurement and exploitation: the settlement-site scale

Prior to asking specific questions and then producing related data, we need to characterize the reindeer exploitation is on a local scale at each site:

Was the reindeer hunting important locally and when was the settlement site occupied?
Was this location a main antler procurement area and what kind of antler (type and module) was acquired?
Was this settlement a major manufacturing place?
Was it a place of significant use of reindeer antler artefacts?

The challenge of this issue, —identifying and quantifying specific human activities—, is to compare the sites of a particular region in order to provide evidence of a time span (annual) and space distribution of procurement, manufacturing and transport of antler as raw (rough complete or fragmented antler) or/and as worked materials (preformed, shaped, used and recycled antler products). Therefore, it is essential to measure the importance of the activities (manufacturing, gathering…) so that we create a hierarchy between them.

From our perspective, the study of each site is essential since its occupations not only reflect a position inside the annual cycle thanks to its characteristics (status) but also as it reveals what happened before and after the site was occupied. Thus, the exploitation (*sensu lato*) at a site for this key resource, —namely the reindeer antler—, is to be analyzed keeping in mind three aspects as following:

1. The site constituted a locale in the territory where antler industry was manufactured partially (the antler was prepared as blank-products, involved in debitage, pre-shaping…) or totally (until the antler is discarded once shaped as a used material object, including all its maintenance and recycling sequences);
2. The manufacturing relied on the procurement of antler material that was acquired during the site occupation (hunting/collecting) or/and before (for those antler materials that were brought onto the locale from a procurement area or another site previously occupied);
3. The manufactured and used artefacts were either discarded at the site or carried away at the end of the duration stay, and also, only part or all of these were brought onto the site.

To answer the questions mentioned above, further issues regarding the faunal remains have to be raised:

What kind of antler was <u>acquired</u> around the site (type and module)?
What was <u>introduced</u> to the site and in which form?
What was <u>manufactured</u> on the site and from what kind of antler material?
What was <u>abandoned</u> on the site and what are the items manufactured on the site?
What was <u>transported</u> out of the site and in which form?

Since there would be many possible scenarios involved in the reconstruction of an annual cycle of nomadism for the Upper Palaeolithic based on reindeer subsistence strategies (Fig. 2), we aim at providing evidence of how the procurement and exploitation of reindeer antler were organized on a site by studying the antler not only as a specific material but also in its relation to all of the reindeer remains and for which four main sets of data are examined:

1. The amount of reindeer remains;
2. The hunting seasons involved (not only reindeer);
3. The amount and types of items identified as raw material and the corresponding production on the site;
4. The seasons of antler procurement (if possible).

Therefore, we present below how we have already used these data sets.

The local scale: the antler exploitation at Les Petits Guinards

The Magdalenian annual cycle in the French Massif Central

Since we started investigating the economic system and the nomadism of hunter-gatherers who were living in the Massif Central during the Gravettian and the Magdalenian between 28,000 and 13,000 calBP, several studies related to the reconstruction of the annual

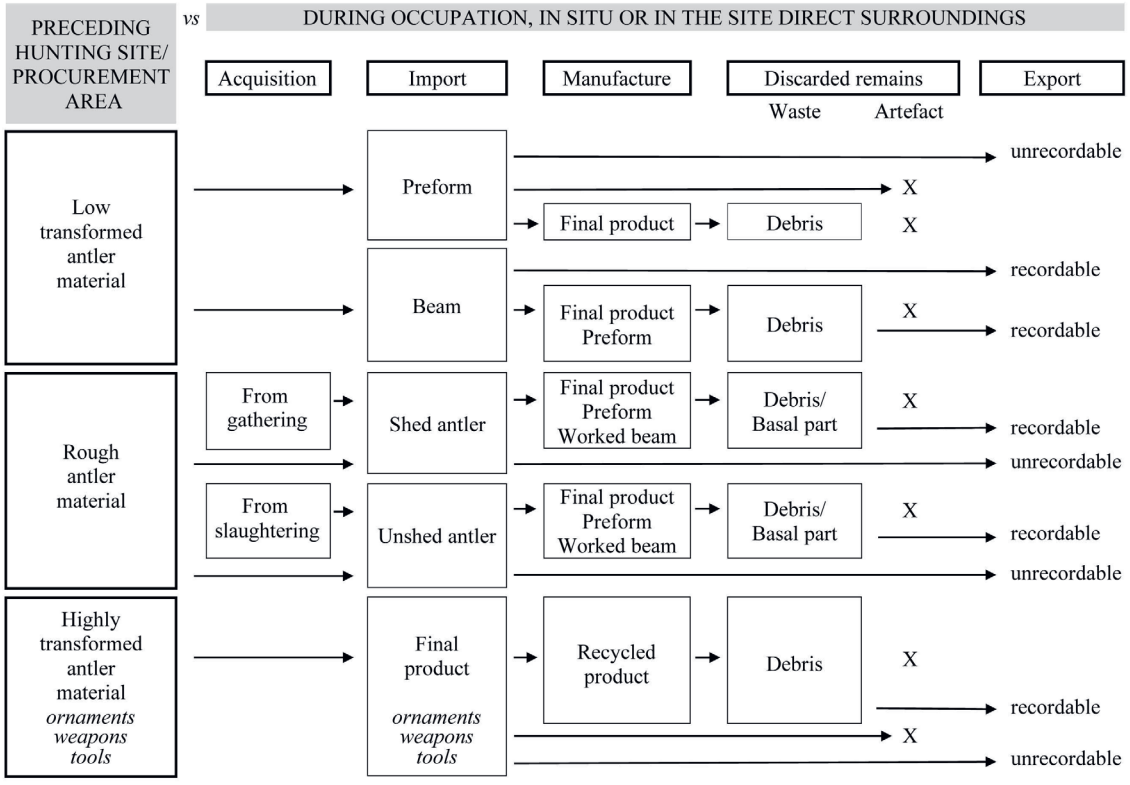

Figure 2. Approach to reconstructing the nomadic cycle of Recent Palaeolithic societies based on reindeer antler economy.

cycle of nomadism based on the "total animal resources exploitation" have already been published (Fontana, 1998, 2000, 2005, 2012 & 2022; Fontana/Chauvière, 2009; Fontana *et al*., 2009a & b; Fontana *et al*., 2018). A central research issue for this vast region concerns the Recent Palaeolithic societies, at least from the Gravettian, who used a distant non-local flint for the vast majority of their lithic industry unlike their contemporaries at the scale of Western Europe. This resource has been identified by Annie Masson as originating from Upper and Lower Turonian in the southern Paris Basin (Masson, 1981). Later on, various studies were aimed at specifying these patterns (for references, see Fontana *et al*., 2018). This systematic supply, —distributed over 200 kilometers in the region and for at least 15,000 years chronologically—, is considered as a distant and massive procurement of one of the main resources, *i.e.* an essential component of the economic system and the nomadic annual cycle, whose visibility is then incomplete on this scale. Indeed, we could conclude from the analysis of the whole published faunal data that any of these (small) sites were occupied during the cold season and that the osseous industry was rarely abandoned at these sites. In fact, whether or not this industry was constituted of antler elements with or without working traces, this osseous material is relatively rare except at Le Rond-du-Barry (Polignac, Haute-Loire), (Bayle des Hermens, 1969, 1972, 1974, 1979, 1981 & 1983; Raynal *et al*., 2014; Rémy, 2013; Rémy/Bayle des Hermens, 2014), Les Petits Guinards (Creuzier-le-Vieux, Allier), (Fontana, 2005; Fontana/Chauvière, 2009; Chauvière *et al*., 2006) and maybe Moulin-sous-Chirel (Neschers, Puy-de-Dôme), (Daugas, 1979). Since part of the nomadic annual cycle was not visible, we decided to study the reindeer antler exploitation more precisely: first from the rare antler and the very poor industry of Le Blot (Cerzat, Haute-Loire), (Chauvière, 2012; Chauvière/Fontana 2005); then, looking for sites that could have been occupied in the winter and that yielded reindeer antler industry, we excavated the site called Les Petits Guinards, in the northern part of the Massif Central, since numerous reindeer antler had been previously discovered there during the construction of a road.

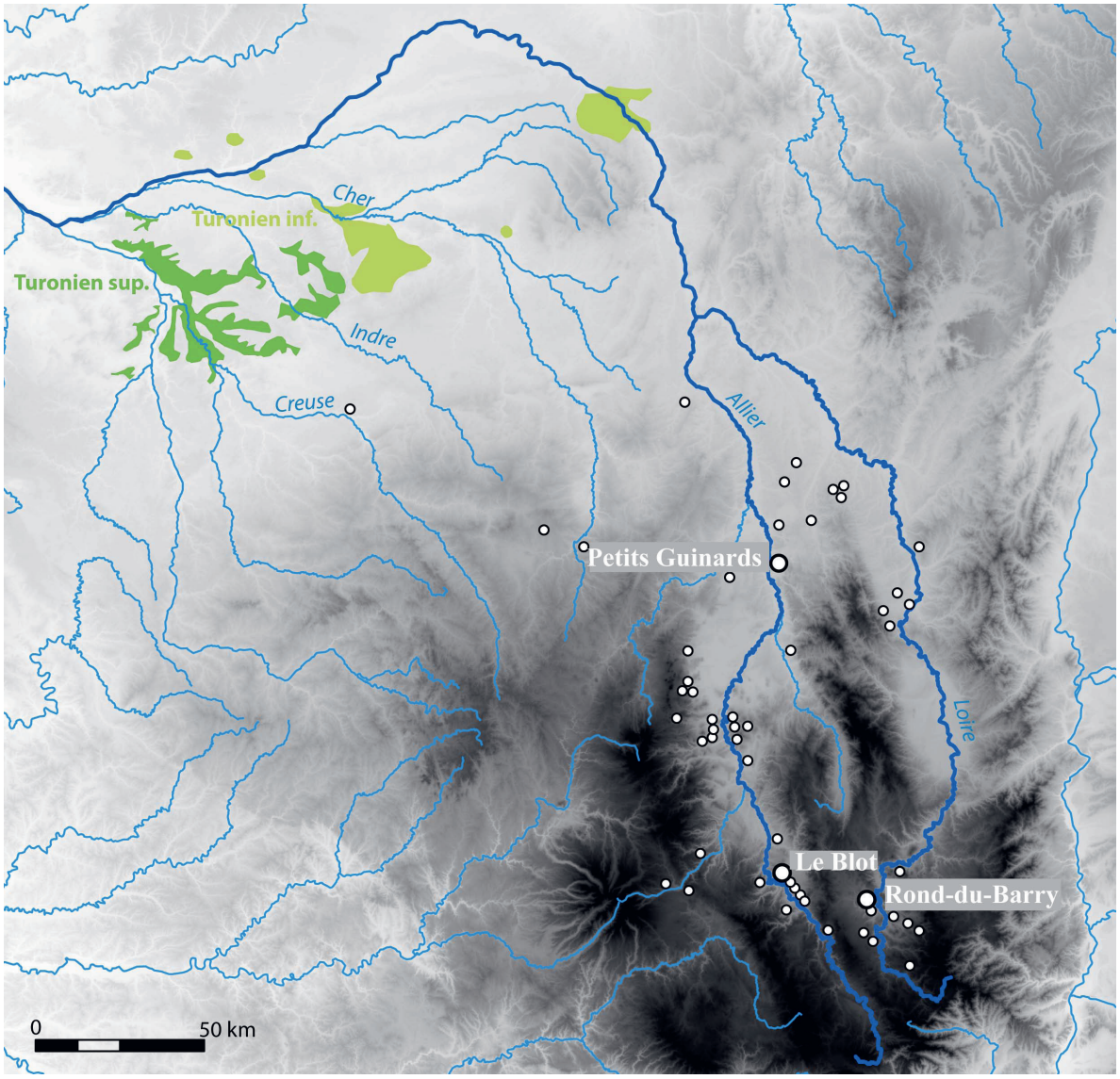

Figure 3. Map of the chert-bearing Upper and Lower Turonian outcrops in the Middle Loire Valley and location of the sites mentioned in the text (revised after Fontana *et al.*, 2018:105/Fig. 2).

Les Petits Guinards

This section provides a brief overview of the main data related to the site of Les Petits Guinard, still under study after having published various reports on this Recent Palaeolithic site (Chauvière *et al*., 2006; Fontana, 2005; Fontana/Chauvière 2007; Fontana *et al*. 2003a & b, 2014 & 2018; Fontana/Chauvière, 2009; Jeannet /Fontana, 2015). Located in the Massif Central along the Allier River and a few miles north of Vichy (Fig. 3), it lies at the foot of a steep slope with a very specific topography marked by the presence of mounds of varying size attributed to solifluction flows. Whereas it was initially characterized as an open-air site, the stratigraphic and taphonomic studies of new soundings on the slope itself conducted in 2002 allowed us to identify these deposits as secondary due to land sliding. This thin layer of sliding sediment originated initially from the filling of a rock shelter located at the top of the slope and of which remains only a limestone cliff of about twenty meters wide. Thus, we excavated this archaeological deposit despite its secondary position, which yielded a stratigraphy generally well-preserved over a surface area of about 20 m^2. The study of the newly uncovered lithic and osseous industries as well as the radiocarbon dating (AMS) of 13 bone remains (including bone industry), show that this site was actually occupied at various periods—spanning between 19,500 and 13,230 BP— particularly by Magdalenian

but also Solutrean groups (Fontana *et al.*, 2014). Nevertheless, the sedimentary matrix of the archaeological layer corresponds to sandy loams associated with limestone blocks of all sizes, and our sedimentological observations were not able to distinguish any sublayers within this archaeological level representing, to a great extent, Magdalenian occupations. Surprisingly, we exhumed out more than 1,200 antler remains, including finished items and waste in such a limited excavated area. More generally, numerous osseous and dental remains (dietary and manufacturing waste products, artefacts) document the exploitation of animal resources, and reindeer whose bone, tooth and antler account for 60-70% of the 2,000 identified remains (MNIc: 45), is the most hunted animal game (Fig. 4). The ongoing study also documents, from the stages of tooth eruption and antler growth/shedding, that reindeer and horse hunting was carried out between May and September (at least at three different times); one young Chamois has been killed at the end of August. Unfortunately, the bone fragmentation rate is high, making it impossible to identify the sex ratio from post-cranial measurements data.

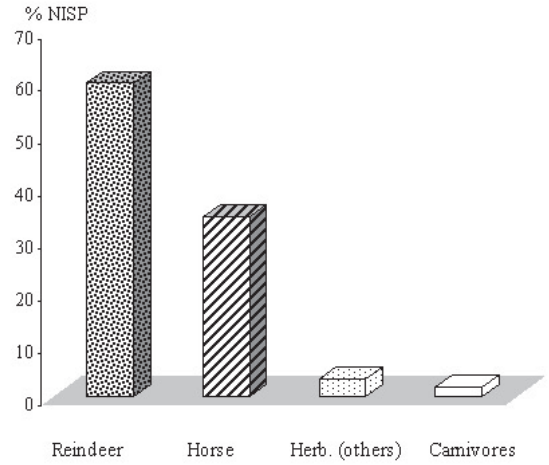

Figure 4. Distribution (percentage) of the identified taxa (from left to right–reindeer, horse, other herbivores, carnivores) at Les Petits Guinards (NISP = 2,000).

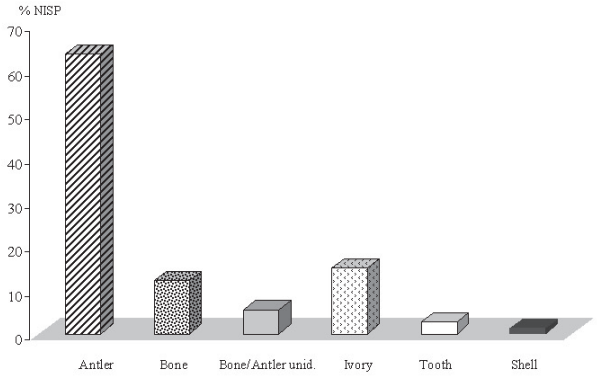

Figure 5. Distribution (percentage) of the kinds of hard-organics (from left to right–antler, bone, unidentified bone or antler, ivory, tooth, shell) at Les Petits Guinards (NISP = 73).

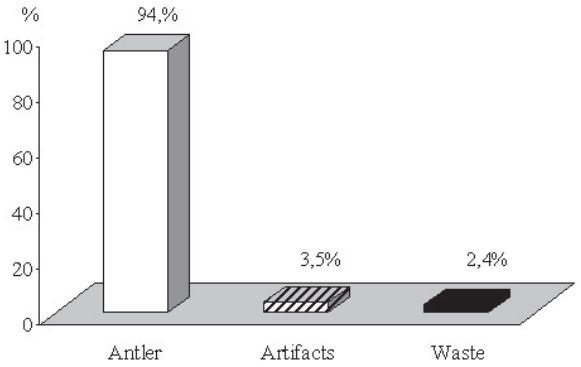

Figure 6. Distribution (percentage) of the "antler" as faunal material (94%) including rough basal parts (80 pieces) and the then (6%) industrial antler remains constituted of "artefacts" (43 pieces or 2,4%) and "waste" debris of production (30 pieces or 3,6%) at Les Petits Guinards (NISP = 1,230).

Antler exploitation in Les Petits Guinards

Reindeer bone and antler remains account for 70% of the faunal material of Les Petits Guinards of which *circa* 55% is reindeer antler and represents the most of the preserved skeletal elements (Fig. 5). Among the 73 remains recorded for the bone industry, in addition to the 80 antler basal parts yielded as reindeer faunal rests, *i.e.* as unworked basal parts of larger shed or unshed antler materials (initially worked?), reindeer antler is represented with 43 artefacts (worked materials) and 30 debris of production (Fig. 6). Thus, for the first time, the on-site manufacturing could be documented and the diverse sequences constituting the whole *chaîne opératoire* of the antler transformation were substantially available for its reconstruction.

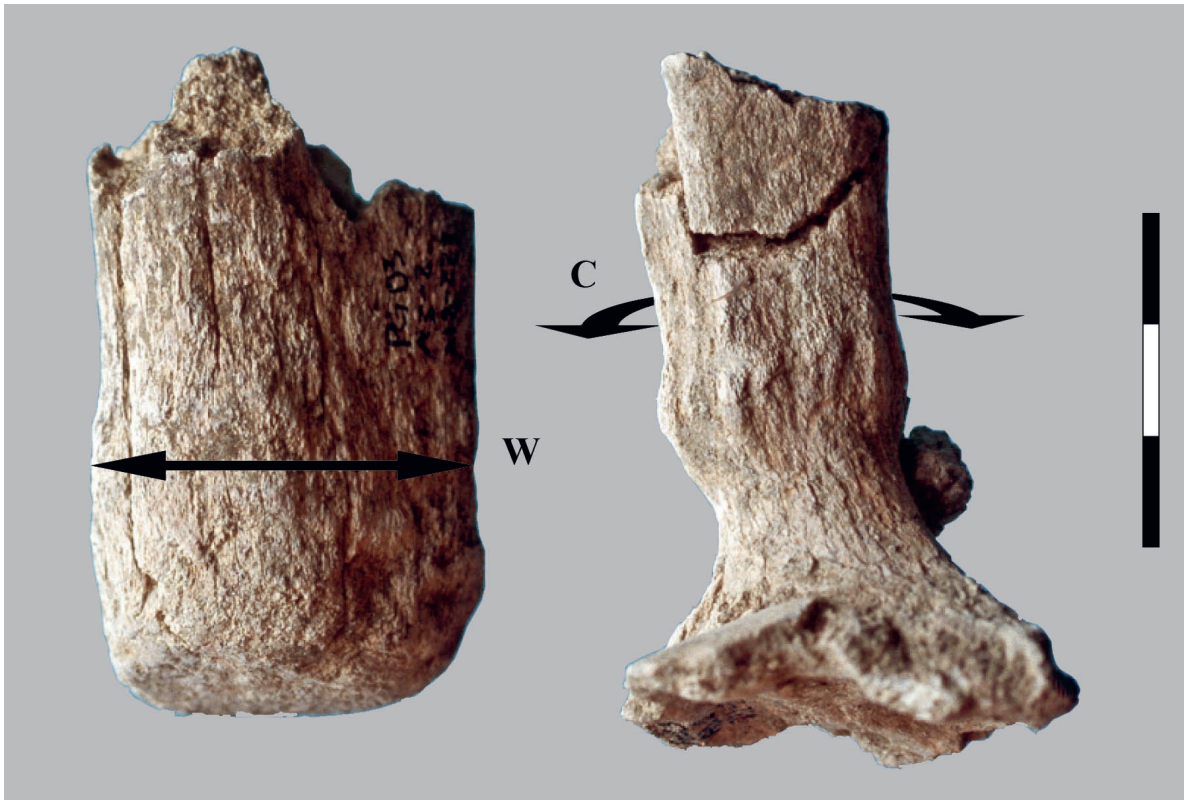

Figure 7. Basal parts of shed (left) and unshed (right) female adults or subadults reindeer antler at Les Petits Guinards (double black-arrow indicates where circumference "c" and width "w" are measured, *i.e.* above the burr on the stump). Scale subdivision in cm. Photos, F.-X. Chauvière.

Antler basal parts		Number of pieces measured	Total number of pieces measurable	Total number of pieces
shed	male	2	22	27
	female/juvenile	20		
unshed	male	3	48	53
	female/juvenile	45		
	total:	70	70	80

Table 1. Identified antler sources from the study of basal parts at Les Petits Guinards.

Concerning antler procurement, both shed and unshed materials are present (Fig. 7) but unshed antler are more numerous. Moreover, there are from adult females and males, the latter ones constituting a minority (Tabl. 1). The vast majority of basal parts belongs to adult females, juveniles and subadults (Fig. 8). We note that the value (9/10 cm) which represents the limit between the two populations interpreted as the boundary between adult males and adult females+all juveniles based on the significant profiles of plotted circumferences measurements (originally published in Fontana/Chauvière, 2009), is similarly recorded at La Madeleine (Bonnissent, 1993) including Jean-Marc Bouvier and Denis Peyrony's antler collections currently under study (Fontana/Chauvière, forthcoming). Besides, thickness measurements of the compact bone indicate that the male/female limit is around 5 mm for shed antler (Fig. 9). These two values for reindeer antler basal parts (circumference: 9/10 cm and thickness of compact bone: 5/6 mm) are otherwise identical to those published for actual European reindeer populations (see Averbouh, 2015).

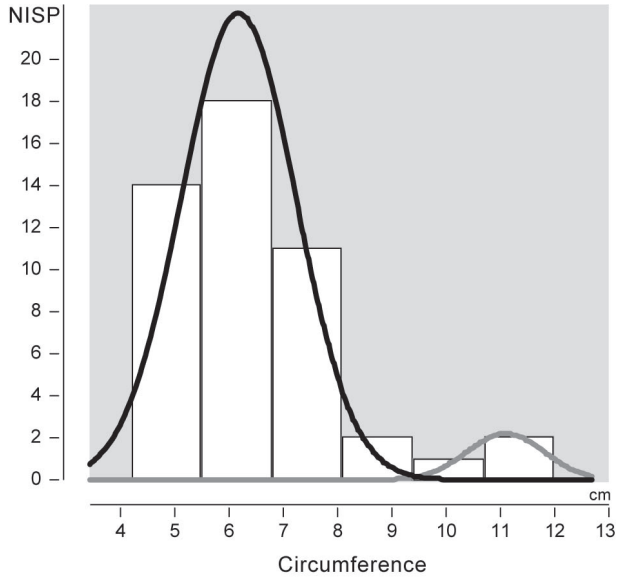

Figure 8. Distribution (in number of pieces) of the circumference (in cm) of unshed reindeer antler basal parts (NISP = 48) at Les Petits Guinards (black line–all males and females juveniles and adult females; grey line–adult males), assuming the measured antler specimens relate to only one same reindeer population, and knowing that nowadays the circumference of the adult females never reach more than 9 cm for a complete antler, regardless of the reindeer (sub)species in presence.

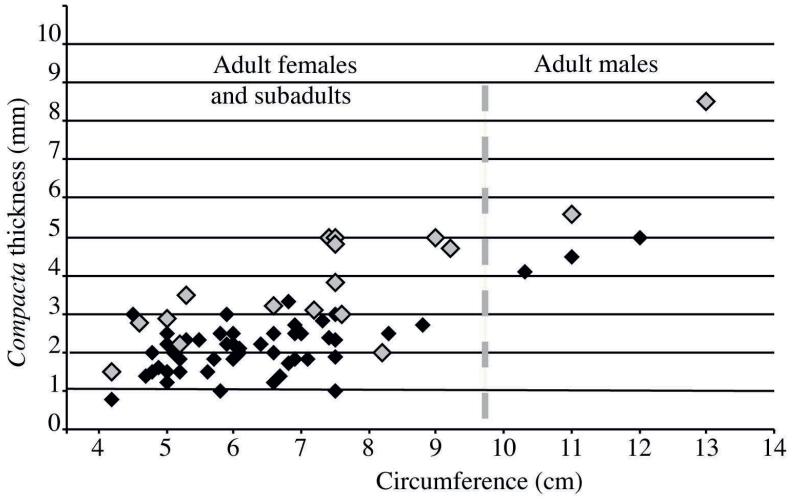

Figure 9. Ratio between the circumference (in cm) of unshed reindeer antler basal parts and the thickness of their compact bone (in mm) at Les Petits Guinards (NISP = 106).The dotted line represents the boundary suggested by the authors between adult males and adult females+all juveniles based on profiles of plotted circumferences measurements, as illustrated in previous figure, to which can be added the boundary above 4 or 5 mm in width of the compacta for the first population (adult males) versus below for the other reindeer population as expected (grey–shed; black–unshed).

It appears that a part of the shed antler pieces belonging to mainly adult females was gathered at the end of spring (as inferred from their very deep shed line), and the other part during the time of the unshed antler procurement (as inferred from the antler bearing reindeer hunt that was focused mostly on juveniles -see below) which lasted from the beginning of spring to the beginning of autumn. Thus, the proximity of the gathering area to the hunting place and to the site is possible. If mature antler of adult males were removed or gathered at the site or its proximity, it necessarily would have been done at fall (see Bouchud 1959:70/Fig. 37). In order to demonstrate whether these two procurements of shed/unshed antler materials, —juveniles+adult females *versus* adult males—, did contribute to the

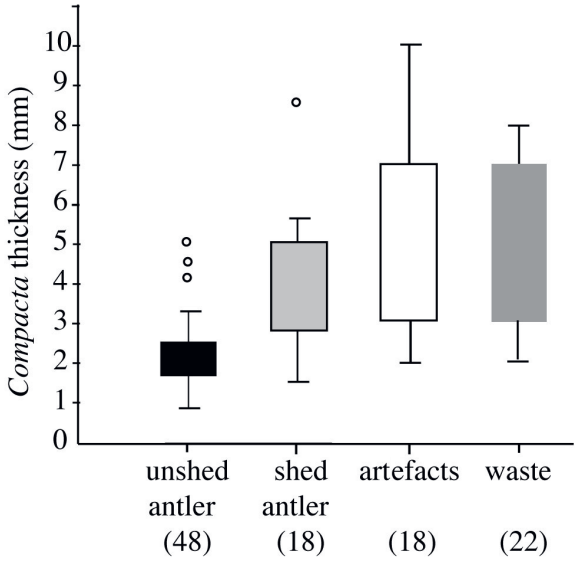

Figure 10. Boxplot of categories of reindeer antler materials (from left to right–48 unshed antler basal parts, 18 shed antler basal parts, 18 antler artefacts, 22 antler waste products) at Les Petits Guinards (NISP = 106).

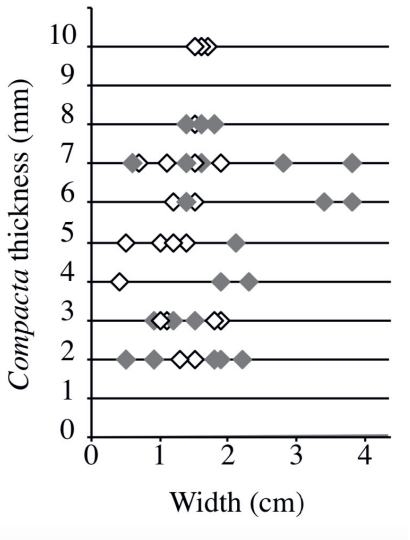

Figure 11. Ratio between the width (in cm) of 43 reindeer antler basal parts and the thickness of their compact bone (in mm) at Les Petits Guinards (grey–waste products, white–artefacts).

manufacture of antler artefacts in situ, the compacta thickness of the shed and unshed basal parts as well as the industrial products have been compared (Fig. 10). As the compacta thickness relates to the original size of the antler material (Fig. 11), the analysis revealed that the module used for waste products was often bigger than the module for unworked shed or unshed basal parts represented at the site. Since the worked pieces once shaped can leave the outer surface unmodified, the compacta thickness of artefacts corresponds then to raw antler (Averbouh, 2000; Goutas, 2004; Pétillon, 2006). Therefore, it results from the comparison that a substantial number of artefacts and waste debris was not produced *in situ*; the basal parts expected to have a thicker compact bone were found to have the thinnest compacta in contrast to the industrial remains. Thus, part of the collection has been produced from other antler preforms and/or blank-products than those left on the site, and these were eventually gathered or removed from slaughtered reindeer carcasses prior to the occupation of Les Petits Guinards. From the illustrated data, it can be drawn as a conclusion:

1. The main unshed antler procurement was deriving from hunting of adult females, subadults and juveniles, between spring and autumn;
2. The gathering of female shed antler took place partly at the same time from June, and near the site;
3. The two male shed antler pieces were probably imported from a previous procurement area and the three male unshed antler pieces came from young adults slaughtered at the end of summer/start of the fall;
4. Despite a large number of antler fragments and artefacts, the amount of on-site manufacture is low and was carried out from small and medium-sized modules; the largest modules were brought to the site as imported goods from (an)other place(s).

As a large amount (45) of unshed antler pieces from females/subadults/juveniles is made of small and very small modules constituted of quite much spongiosa with no shed line, these seems to principally belong to basal parts of male's and female's immature antler (ongoing research). These were removed from having slaughtered the reindeers during summer/fall. On few basal parts, we have identified scraping planes; thus, documenting that removing of the antler outer surfaces of the beam was processed. Since no beam of the corresponding

module, even as fragments, have been recovered, consequently, it seems that the beam parts from small and very small modules were deliberately transformed in situ albeit being in the shape of immature, *i.e.* as mainly constituted of spongy core, unsuitable for tools and projectile-points production. If the purpose of using such a resource, —technical or not technical—, should be addressed, the major issue at this stage of the study and from our perspective is less to understand the purpose of using the (immature) antler but rather to provide evidence that the reindeer carcasses bearing antlers recovered at Les Petits Guinards were imported to the site, where the ones from juveniles were systematically removed from the slaughtered animals and the majority of antler pieces were also deposited and exported. This juvenile antler procurement line thus leads to quite a different pattern than that of the female shed antler similarly documented from basal parts only which mature material would have been transformed on-site, as seen from the occurrence of small size waste debris.

Regional scale: the Upper Palaeolithic economy of reindeer antler in the Massif Central
The contribution of Les Petits Guinards, Le Blot and Le Rond-du-Barry

We initially thought that the site of Les Petits Guinards, which yielded numerous fragments of reindeer antler (basal parts, artefacts, waste products), was an ideal candidate for a procurement and especially manufacturing locale in the Magdalenian nomadic annual cycle. Yet, the integrated study proved it was not. Firstly, unshed antler enabled us to demonstrate that the slaughtered reindeers were, for the most part, adult females and subadults, and only three adult male antler basal parts. We are not able to provide any analysis of bone measurement that may confirm this observation, which is nevertheless similar to that of other sites (see below). Secondly, the analysis of antler measurement made clear that modules of worked basal parts, manufacturing debris, and abandoned artefacts do not perfectly match. Indeed, the largest shaped items (10 mm compacta thickness) have been produced from adult male antler which is not particularly recovered at the site (no antler basis nor waste debris of corresponding module); similarly, based on the only matching shed antler, the other artefacts and waste, between 6 and 10 mm compacta thickness, do not come from on-site manufacture. All of this indicates that half of the waste debris and two-thirds of the artefacts were produced elsewhere and brought to Les Petits Guinards, which is not really surprising. However, this had to be discussed to further identify the nature of the on-site manufacturing. Moreover, a large part of antler, female and subadults from reindeers slaughtered at the end of the summer or the start of autumn, was removed and the beams exported while still immature as an histological material.

Published data concerning reindeer antler exploitation are available for only two other sites, Le Rond-du-Barry and Le Blot (Chauvière, 2012; Chauvière/Fontana, 2005). Throughout the Final Gravettian occupations at Le Blot, human groups hunted female and subadult antlerless reindeers in the early summer. No manufacturing waste has been recovered and the only two artefacts (two beam fragments of large size class) have been brought to the site from elsewhere (Fig. 12). The situation is substantially different at Le Rond-du-Barry (Badegoulian and Magdalenian levels) where all antler pieces are identified as shed material, being in a very large part (31/33) of "large" and

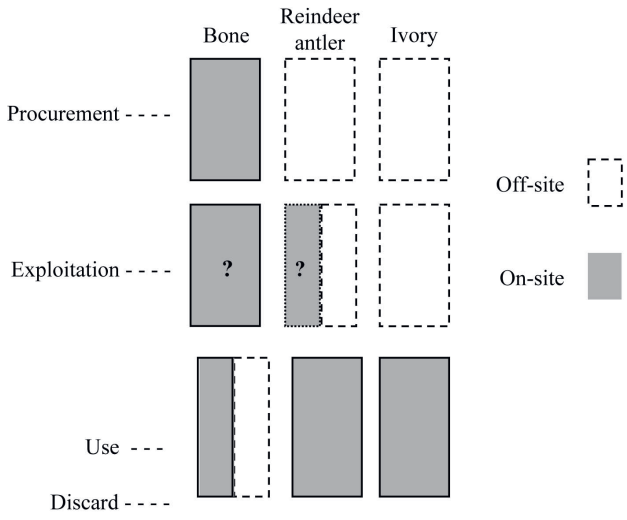

Figure 12. The various stages recognized in the exploitation of animal material-based resources at Le Blot during the Final Gravettian.

"middle size" modules. As the base circumferences are up to 95 mm (Rémy, 2013), it seems clear they belong to adult males only. If procurement sources remain unknown, these large antler pieces, at least for some of them, were exploited at the site (Rémy, 2013; Rémy/de Bayle des Hermens, 2014). But, the main issue concerning this unique site where primarily a shed male antler material was exploited is as following: was it a place where large shed antler pieces were transformed 1) (only) to produce artefacts, 2) (also) to produce many preforms or blank-products intended to be transported out of the site when leaving to the North? We cannot actually answer this question since the integrated study of antler procurement and exploitation still needs to be conducted with concern of the whole of the industrial material (is this all sorted out from the initial faunal assemblage?), especially by producing measurement data to highlight patterning of on-site manufacturing. We also note that the seasons of antler procurement are usually obtained only from unshed antler whose age, sex and maturity are identifiable and not from shed antler, notably if results from the latter do not match equivalent data obtained from teeth of fawns and possibly fetal long bone (Fontana, 2017). Unfortunately, there are still no reliable data related to reindeer hunting season at this site. So, we do not know exactly where and when these male shed antler pieces were collected: far or near the site; immediately or long after the reindeer males have shed their antler? In fact, we have no evidence of reindeer fall hunting, whereas many ibex and horse hunting episodes are identified between spring and autumn, and fishing at the start of the fall. So, we hypothesize that during the autumnal settlement, horse, ibex and fishes were acquired and reindeer (females, and males?) had been hunted only at the end of fall (excluding the mating period). Otherwise, why has any male unshed not been recovered? To get large antler, populations may have preferred or had to gather them after mating, at least before reindeer males would leave the high valley for other geographical territories (November-December?), and then, transform them maybe mostly in the shape of preforms to be transported.

The economy of reindeer antler

Our understanding of reindeer antler economy in the Recent Palaeolithic of Massif Central is at the moment still limited for two reasons. On the one hand, antler industry is very poor in this region and the low number of preserved antler materials (rough and/or transformed shed/unshed antler pieces and objects) makes any analysis of the importance of the industrial activity very difficult to grab; on the other, getting precise data and useful information relating to rare large sites is still very problematic. Nevertheless, let's try to answer as many questions as possible from the initial issue we addressed earlier in the introduction relating to the regional scale: what kind of antler was acquired and exploited, and how? Where in the territory, and when in the course of the year? How was this managed?

If all types of antler (even immature) were acquired and large modules were rather scarce, we do not know the respective part of shed and unshed antler: the diversity of procurement remains unknown. More interestingly, the male unshed antler remains are extremely rare and they never prevail at sites, indicating:

1. An apparent scarcity of fall hunting (and what about settlement?), when males and females are naturally together in the landscape before and during mating time, which remains to be explained (to the benefit of other hunts, perhaps towards the horse or ibex?);
2. Unshed antler parts were removed from slaughtered males and systematically carried away as exported raw materials, which consequently would explain why fall hunting is so badly recorded while only the unshed antler material is used to document this hunting season.

In both cases, sex ratio can be known from the bone material measurements to identify and quantify the proportion of male reindeers. Next, antler procurement took place in various locations from North to South, in spring and autumn, at least at three different episodes:

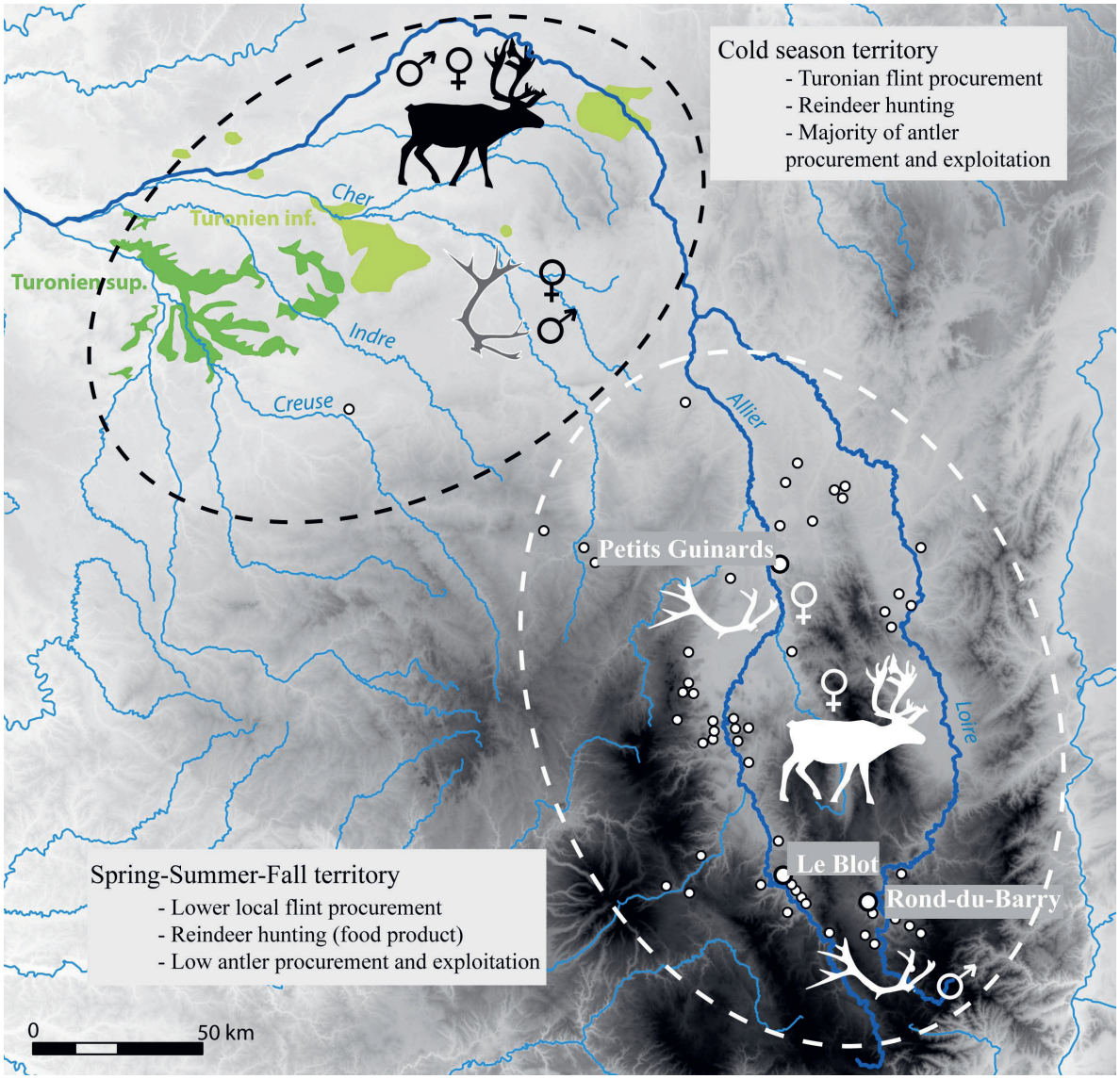

Figure 13. Reconstructed annual cycle of nomadism of Recent Palaeolithic societies (Magdalenian, Badegoulian, Final Gravettian, Recent Gravettian) from the studied archaeological sites located in the Massif Central based on the antler economy with consideration the lithic economy.

before females shed their antler (May); after they did (from June); and when males carried mature antler and females carried immature antler (fall). We ignore if this supply, spanning half of the year, was limited to spring or autumnal periods, and, the geographical zones for gathering are unknown, perhaps close to Les Petits Guinards, and Le Rond-du-Barry. Such a procurement, distributed in spring and fall, involves rather an on-site manufacturing of the major part of antler (where there were acquired). Finally, the management of antler resource as a raw material is the less known within the antler economy. We just provided here evidence of the import and the discard in situ of some artefacts at Les Petits Guinards and Le Blot, which were previously made elsewhere from large modules and at an unidentified settlement site. Since the manufacture of antler was not an important activity in this vast region, and, without any unshed male antler exploitation, it is possible that the proportion of transported raw material was low, except if large modules were transported between the North to the South, in one or both directions. We concluded our 2009 article by stating that, if sites of male shed antler exploitation existed in the Massif Central, they should be identified, thus making the completion of Le Rond-du-Barry's antler production (Fontana

et al., 2009a). Preliminary results confirm our hypothesis that not only some shaped items and antler preforms but also the single male shed antler from Les Petits Guinards came from an outdoor procurement and manufacture although the original site was not identified. We now believe that Le Rond-du-Barry could endorse this location for gathering male antler pieces as raw material and preforms used to manufacture the equipment, when people were about to leave the southern zone of the Massif Central before stopping at Les Petits Guinards on their way to the northern region just before winter. However, this does not preclude the reverse possibility for some large artefacts at Les Petits Guinards: to come from the northern area when Magdalenian populations came back to the Massif Central the following year.

The mobility of Upper Palaeolithic human groups

Considering the data from three sites dated to the Final Gravettian, the Badegoulian, and the Magdalenian (Fig. 13), we noticed that we still do not know any location for the origin of the unshed antler of adult males, whereas the gathering area of their shed antler was potentially close to a mating zone, supposedly not very far from Le Rond-du-Barry. Male hunting is rarely documented due to the fact that unshed antler precisely is scarce at these sites. This is no archaeological bias, but it means that hunting reindeer was rather uncommon during the fall, even when people still lived there in the region as they eventually hunted other animals. In the same way, the manufacture of the antler industry rarely occurred in the Massif Central as documented at Le Rond-du-Barry (male antler) and Les Petits Guinards (female and subadult antler based). However, antler of reindeer adult males was essential to the production, notably to implement the daily equipment (mainly weapons and tools) for which these antler matrices were only available through slaughtering during the first part of fall and through gathering as from November. Regarding the mature and smaller antler pieces that belong to adult females and subadults, only the winter hunting made a direct procurement possible whereas their gathering was between mid-winter and June based on the reindeer age restituted from the study of these sites. It is therefore possible that a large part (still to be characterized) of reindeer antler procurement and production occurred in the autumn and the winter outside of this vast region in some adjacent northern territories (Fontana *et al*., 2018). This hypothesis is even more likely since we consider that such scarcity of industrial antler remains could be linked to the absence of winter occupations as known as in many other regions (Fontana, 2012).

The various evidences suggest that human groups were living in a very vast area used distinctively depending on the seasons, from the Loire and Allier high valleys to Middle Loire (Touraine region): to fulfill most of the annual cycle needs, they spent the cold season in the North for acquiring and transforming antler resources (Fontana, 2012; Fontana/Chauvière, 2009; Fontana *et al*., 2009b, 2014 & 2018), and in the Massif Central conversely, the exploitation of reindeer hunting was almost exclusively turned towards consumption lines. Keeping in mind the treatment of all the immature beams at Les Petits Guinards and even if we do not presently understand the reason of such a practice as linked to the usual reindeer exploitation and antler export, it is unknown whether this resource was common, perhaps a priority during a specific period (end of summer/start of fall). In parallel, the procurement of Upper and Lower Turonian siliceous rocks took place during the cold season whereas in the Massif Central local flints were then mainly acquired during the rest of the year. In such a setting, other sites corresponding to the autumn-winter occupations should be found with regard to the same antler and flint exploitation patterns (see Fontana *et al*., 2018).

CONCLUSION

The study of reindeer antler contributes to reconstructing the nomadic annual cycle of Recent Palaeolithic hunter-gatherers. The data presented in this paper, though these are scarce and of diverse nature, illustrate this purpose well. The case of the Massif Central, despite the fact that it is very specific on the scale of France, highlights the two main difficulties of

the economic study of reindeer antler, namely its exploitation patterns on the annual and spatial scales: occurrence and location of the related practices (gathering, transport) and their relative importance with regard to the possible various economic lines in using the antler. To proceed to the identification of the main features and the ranking of procurement and exploitation patterns within the whole economic system, the study of more sites (be they from old or recent excavations) where antler is a well-preserved material is therefore required further with, as a priority, the quantification of any of the on-site activities. Even if this could be problematic, the antler debitage being hardly reconstructed from the occurrence of only rare waste debris of production, our examination shows that the reconstruction of reindeer antler economy is necessarily limited when it lacks an integrated study, *i.e.* when the other data from animal resources are not fully integrated due to being regarded as only partly significant. In our opinion, it is only in considering the different sets of data obtained from the various sites as a whole that a relevant scenario will be finally reconstructed. The understanding of the antler economy then includes integrating a discussion on hunting seasons regardless of the animal game (from teeth and fetal data) as well as on the reindeer hunting strategies (based on ages of death and sex ratios). The proportion of adult males to identify the hunting seasons (not from the study of antler) indeed is the only data to evidence the presence of people and reindeer at specific locations. At a final study stage when the analysis is therefore conduct as deriving from a single research achievement (not as a pile of data), it benefits from other aspects notably the lithic resource procurement although precise issues related to complete annual cycle reconstructions from diverse raw materials still need to be formulated more clearly (Fontana, 2022; Fontana *et al*., 2009a & 2018). Such an integrated study—as we continuously try to improve—is the only way to identify the status of the site used to discuss Palaeolithic antler economy (procurement/manufacturing locations) and choices in terms of sites function and economic strategies. Obviously, these choices are driven in their patterns by the exploitation of other resources such as flint, —especially when procurement areas are relatively distant geographically—, and further study will progress if relevant aspects related to flint economy are available.

As long as winter reindeer hunting has not been demonstrated so far for the Massif Central otherwise than with the occurrence of shed antler from males on sites, which is not sufficient as already demonstrated (Fontana, 2017), the hypothesis of the Massif Central being part of a vast territory including a northern area remains positively relevant. This adjacent northern area where Cretaceous flint was acquired and transformed was probably the zone where adult males and females with mature antler were originally slaughtered in the cold season. The way antler and flint were transformed (or not) and transported when populations left this cold seasonally-used area to join the Massif Central from the spring and until the next fall is still to be understood, notably by studying sites located in the Touraine such as La Garenne (Saint-Marcel, Indre) for instance.

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RÉSUMÉ

LE CYCLE DE NOMADISME DES SOCIÉTÉS DU PALÉOLITHIQUE RÉCENT À PARTIR DE L'ÉCONOMIE DU BOIS DE RENNE

La reconstitution du cycle annuel de nomadisme des sociétés paléolithiques est un exercice délicat dans la mesure où sa visibilité archéologique (habitats, lieux d'approvisionnement et déplacements) est réduite et son étendue, méconnue. Chaque type de vestige est un témoin du sous-système économique, dont chaque site représente un épisode fragmentaire, en termes d'activités, de lieu et de temps. C'est pourquoi l'analyse de l'exploitation des ressources contribue à documenter le cycle de nomadisme des chasseurs collecteurs, mais ceci a deux conditions : travailler aux échelles locale et régionale et formuler des questions précises en les hiérarchisant depuis la problématique globale jusqu'à la production des données. Dans cette perspective, l'étude de l'économie du bois de renne est un excellent moyen de produire des informations indispensables à la connaissance du cycle annuel de nomadisme paléolithique. L'article présente, aux deux échelles, deux niveaux de hiérarchie de questions dans l'étude des bois de renne, puis une application de ce type d'étude dans la perspective de reconstruction du cycle annuel de nomadisme des sociétés du Paléolithique récent du Massif Central.

À l'échelle du territoire, notre objectif étant d'identifier l'organisation annuelle de l'exploitation des bois, nos questions ont porté sur la diversité des bois acquis et exploités (chute/massacre, gros ou petit module, maturité), au choix d'une ou plusieurs stratégies d'acquisition (collecte, chasse), à la répartition de l'approvisionnement et de la fabrication dans l'année et au sein du territoire, à la gestion de cette matière première en termes de degré de mobilité (transport) et de formes de circulation. À l'échelle locale, il fallait caractériser le site du point de vue de l'acquisition et l'exploitation des bois : était-il un lieu majeur de chasse au renne et d'acquisition des bois de massacre, et à quel(s) moment(s), ou plutôt de collecte de bois de chute ? Était-il un endroit majeur de transformation/fabrication de produits en bois de renne ? Pour caractériser les sites du point de vue de l'exploitation de cette ressource, il apparaît impératif d'identifier et de quantifier ce qui fut acquis durant l'occupation du site, de ce qui fut apporté, fabriqué (et à partir de quel type de bois ?) et abandonné sur le site ou emporté à l'issue de l'occupation. Ce type d'étude a été mené sur un site du Massif Central, région où l'économie lithique des sociétés du Paléolithique récent était en partie fondée sur l'exploitation d'un silex allochtone septentrional, et où l'économie du bois de renne est très faiblement documentée, alors que l'occupation hivernale ne l'est pas du tout. Ce site magdalénien des Petits Guinards, de l'extrémité nord du Massif Central, est un des très rares sites à avoir livré de nombreux fragments de bois de Renne de tous types (bases, objets et déchets de fabrication) mais nous avons démontré qu'il n'était pas un lieu privilégié d'acquisition ou de fabrication. En effet, en dépit du grand nombre de bases, de déchets et d'objets, la part de la fabrication sur place est très faible et fut réalisée en très grande partie à partir de petits et moyens modules appartenant à des femelles adultes et à des subadultes abattus entre le printemps et l'automne : les rares bois appartenant à des mâles adultes ont été acquis ailleurs et apportés sur le site, et les deux tiers des objets ont été réalisés vraisemblablement sur un autre site.

À l'échelle du Massif Central, il apparait à présent que 1) les bois de massacre de mâles restent exceptionnels, ce qui témoigne, soit de la rareté des chasses automnales (et donc des occupations ?), soit d'un prélèvement systématique de ces bois avec emport hors site ; 2) l'approvisionnement, faible, en bois de renne a eu lieu dans cette région en plusieurs endroits, durant le printemps et à l'automne ; 3) la fabrication de l'industrie en bois de renne était donc une activité peu importante dans cette région en particulier ; 4) le transport de bois de renne bruts ou mis en forme, suggéré pour les Petits Guinards et Le Rond-du-Barry, attesterait du transport de ce matériau entre le nord et le sud du territoire. La très grande rareté des bois de mâles adultes et celle de la fabrication, ainsi que l'absence de sites d'hiver suggèrent que la plus grande part de l'acquisition et de l'exploitation du bois de renne se serait déroulée durant les mois d'automne et d'hiver sur un territoire adjacent. Probablement que les groupes humains vivaient dans une région très vaste à l'échelle d'un territoire fréquenté saisonnièrement, depuis les hautes vallées de la Loire et de l'Allier, au Sud, jusqu'à la Touraine, au Nord. Ce secteur nord aurait alors été occupé à la saison froide, période pendant laquelle les bois de renne matures auraient été principalement acquis et transformés dans l'optique d'une utilisation immédiate et différée, notamment à l'échelle du cycle entier vers les sites septentrionaux du Massif Central.