Human-Material Interaction in the Aurignacian of Europe, 35,000-27,000 BP:
An Analysis of Marine Shell Ornament Distribution

by

Lisa Rogers
B.A. (Hons), University of Victoria, 2013

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Abstract

The Aurignacian period (35,000-27,000 BP) is the earliest phase of human occupation in the European Upper Paleolithic. As early inhabitants moved across the landscape they came into contact with others and left behind material traces of these interactions. Ornaments, or beads and pendants, made from marine shells are found in large numbers in Aurignacian assemblages. These objects are particularly useful for exploring the circulation of people and materials, as their presence far from the sea can be indicative of dynamic interactions between materials, individuals, and groups.

This research explores the processes of human-material interactions during the Aurignacian based on the shapes of marine shells used as ornaments. More specifically, a network analysis is used to determine whether there are discernible patterns in the geographic distribution of marine shell shapes used for the creation of ornaments. Through the use of a social network analysis software called Gephi, this research visually maps the interactions between sites and regions during the Aurignacian. By creating network visualizations that are analyzed mathematically, in addition to geographic maps of site locations, patterns in the interactions within which materials and people were entangled are explored. Engaging with theories of materiality and material affordances (Conneller 2011; Gosden 2005; Malafouris 2013; Robb 2015; Wells 2008, 2012), this research sheds light on the active role of ornaments in the complex interactions between people and materials during the Aurignacian. The results support the notion that particular shapes of shells were preferentially selected and that some regions, such as the Dordogne of France, were important centers in the broader circulation of materials.

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Chapter 1: Introduction

Aurignacian Ornaments

The beginning of the Upper Paleolithic marks the successful movement of modern humans from areas in the Levant and Zagros Mountains regions into and across Europe. During the Aurignacian period (45,000-30,000 cal BP) humans inhabited a wide range of Europe, from the Atlantic coast of France and Portugal in the West to the Ural Mountains in the East. This time period is marked by a distinct tool technology which includes the *pointe d'Auirgnac*, or split-based bone or antler points; thick carinate or nosed scrapers; heavily retouched parallel-sided blades; Dufour bladelets which are inversely retouched; and low proportions of busked burins, or sometimes none at all (Blades 2002; Mellars 2006). While these tool types are generally found at most Aurignacian sites, some local variation exists, likely due to differences in site use and environmental conditions. This tool industry is now used as a proxy for referring to the Aurignacian as a cultural period.

The Aurignacian is associated with marine isotope stage 3 (MIS 3), which began around 60,000 BP and ended around 27,000 BP (Van Meerbeeck et al. 2011). Generally speaking, modern human populations during this time period would have experienced oscillating climatic conditions which in turn led to changing environmental conditions (Dragusin 2012). The climate across Europe was generally more humid and prone to heavy rainfall during warmer interstadials and more arid during cooler stadials (Voelker 2002). Around 35,000 years ago a gradual cooling began which led into the Last Glacial Maximum (LGM; 18,000-22,000 BP) at the end of the Pleistocene (van Andel and Davies 2003). The high degree of climactic variability during this period is highlighted by studies which demonstrate that a single phase of stability rarely remained for more than one thousand years (e.g., Lahr and Foley 2003). Climatic instability may have been a contributing factor in the maintenance of long-distance connections between different populations to aid in the exchange of materials and resources. Easily transportable objects such as ornaments, or beads and pendants made from a variety of materials, are argued to have been important facilitators in intergroup interactions (Stiner 2014; Vanhaeren and d'Errico 2006).

While there have been major theoretical and technological shifts over time, Paleolithic ornaments have been studied by researchers for over 150 years. Early researchers classified these items as minor forms of art and engaged with them from an art history perspective, which overlooked their potential to inform on social and evolutionary processes (Moro Abadía and Nowell 2015). Shifting perspectives and the introduction of new technologies for analysis during the 1960s and onward led researchers to view ornaments as symbolic objects (Moro Abadía and Nowell 2015). In recent decades, the focus of study has once again shifted from a semiotic approach to a more phenomenological one in which ornaments are understood to have an active role in the dissemination of information and construction of social identities (e.g., Joyce 2005; White 1989). In more current literature researchers have been drawing on theories of materiality and the affordances of materials in order to gain a more nuanced understanding of the role that ornaments played in the interaction between humans and materials, and what material choices were being made in the early Upper Paleolithic.

Research Questions

In this thesis I explore the materiality of marine shell ornaments and the processes of human-material interaction occurring during the earliest phase of the Upper Paleolithic–the Aurignacian (35,000-27,000 BP). The purpose of this research is to answer questions regarding the interactions between individuals and groups and to explore the material affordances of marine shells in relation to other ornaments. Specifically, this research tests the hypothesis that Aurignacian populations preferentially selected particular shapes of marine shells for the creation of ornaments, and that these preferences are reflected in the geographic distribution of the shells. The main research questions explored in this study are threefold:

1. Is there a discernible geographic patterning in the use of particular marine shell shapes as ornaments during the Aurignacian?
2. Do the other materials used as ornaments in relation to marine shells relate to the affordances of this particular material?
3. How might the circulation of ornaments have contributed to human interactions and with what effects?

An open access social network analysis software, Gephi, is used to map the connections between archaeological sites based on the number of marine shell shapes they have in common, the individual marine shell shapes themselves, and the non-shell materials used as ornaments in association with marine shells. These maps are analyzed both statistically and visually in order to answer Question 1, which helps to answer the hypothesis of whether particular shell shapes were preferentially selected in particular regions. The Gephi visualizations created based on the non-shell materials used in association with marine shells aid in answering Question 2. This question, and Question 3, are addressed from a more theoretical perspective in Chapter 7. The methodology used in this thesis was inspired by the work of Eliot Blair (2016), who used the program Gephi to create visualizations of the connections between individuals in a mortuary context. Blair (2016) explored the relationships between individuals interred at the 17th century site of Mission Santa Catalina de Guale based on the glass beads recovered with their remains.

Through his work, and the use of the Gephi software, Blair (2016) was able to identify different groupings of practice and emphasize the interconnectedness of the individuals recovered.

Defining Terms

Word choice is often reflective of the theoretical literature with which one is engaging, and words have the potential to be laden with hidden assumptions and implications. As such, some deliberate choices made with regards to the words used throughout this thesis are explained here. Additionally, it should be noted that unless otherwise indicated (e.g., cal BP), all dates included in this thesis are uncalibrated.

Ornaments–are they personal?

Traditionally ornaments have been referred to as *personal* ornaments by most researchers, including in recent literature (e.g., Cvitkušić and Komšo 2015; d'Errico and Backwell 2016; Kuhn 2014; Moro Abadía and Nowell 2015). However, in this thesis I have deliberately chosen to drop the descriptor "personal" and instead refer to these artifacts as ornaments. This is because the term personal carries with it a particular set of assumptions and implications about what is being studied. By discussing them as personal ornaments the suggestion is that they are expressions of personal identity and belonged to particular individuals. While this may certainly be the case, this may obfuscate the notion that ornaments were likely also indicative of group or regional identities and were often circulated apart from the individual through processes of trade, exchange and migration.

Are they objects or art?

This thesis also makes a deliberate attempt to discuss ornaments as objects, rather than as art or portable art. I am not disputing the claim that these objects were portable–their small size certainly allowed them to be transported for hundreds of kilometers. I am, however, avoiding the implications connected to the use of the word art. Art is often thought of as being decorative, which it certainly is. However, by using the term art to describe these objects one may inadvertently imply that ornaments themselves were simply decorative and therefore incapable of informing theories on social and cognitive evolution (Conkey 1987; White 1992). As Moro Abadía and Nowell (2015) have previously discussed, the usage of the term art in relation to ornaments in the early stages of their research led to them being understudied and disregarded as unimportant in the context of wider theories of evolution.

Social networks versus interactions

Much of the literature that I have consulted for this thesis discusses the interactions between individuals and groups, and the processes of trade and exchange that occurred through and within these interactions, in terms of social networks. Indeed, the computer program that I am using to analyze the distribution of marine shell ornaments is traditionally used for the analysis of modern-day social networks. However, I have chosen to instead discuss these processes in terms of interactions–between individuals, groups, and the materials themselves. In doing so I am putting aside the implication that networks of groups and individuals were deliberately planned and maintained by Aurignacian populations, and that these networks are entities ‘out there’ waiting to be studied.

Outline of Thesis

Chapter 2 serves as a contextualizing chapter focusing on a discussion of the time period and geographic area analyzed in this study. I first discuss what the Aurignacian is, while paying particular attention to the inherent issues in much archaeological research with regards to collapsing long and complicated periods of time into discrete analytical units. I then discuss the key environmental and climactic changes that took place between 35,000-27,000 BP, followed by a brief account of the major trends in the material culture of this time period.

The purpose of Chapter 3 is to provide context for the marine shell ornaments being studied. It opens with a brief account of the history of the study of ornaments in general, followed by a discussion of the proposed standardization in material choices being made by Paleolithic peoples when creating ornaments. I then enter into a discussion of the use of marine shells during the Aurignacian, and conclude the chapter with descriptions, sketches, and images of the specific marine shell shapes included in this study.

In Chapter 4 I outline the major theoretical trends that heavily influence the present study. I first discuss the historical development of materiality theories and how the concepts of agency and the affordances of materials play a key role in the analysis of archaeological sites and objects. I then examine how social network analysis has been used to explore the relationships between individuals, groups, and materials, followed by a discussion of how many archaeologists–and this study–are stepping back from the idea of networks and focusing more on the notion of interaction. The chapter concludes with a discussion of human-material interaction and how the concept of affordances can open new avenues for research and understanding.

Chapter 5 begins with a detailed account of how I gathered data for this study and created my database. This is followed by an explanation of the computer software Gephi that was used, and how it was used to analyze the gathered data. The chapter concludes with an explanation of the statistical analysis of the data, both descriptive and built into the Gephi software. The results of this analysis are then presented in Chapter 6.

In the final chapter, Chapter 7, I discuss the implications of the results presented in Chapter 6 and whether these results are sufficient to provide insight into the previously outlined research questions. These are discussed in relation to the context outlined in Chapters 2 and 3 and the theoretical framing explored in Chapter 4. More specifically, I enter into a discussion of the regional variability in marine shell shape use as ornaments during the Aurignacian and how the desirability of this particular material is reflected in the use of the qualities of non-shell materials that afforded Aurignacian people the ability to crate ornaments resembling marine shell. The chapter concludes with a discussion of future research directions and how this approach may be applied to different lines of inquiry.

Chapter 2: Background to the Aurignacian

The purpose of this chapter is to situate my research project within the Aurignacian of Europe. I first address the question of how the Aurignacian has been traditionally defined as a tool industry and how this has been expanded into a cultural period. Next, I enter into a discussion of what the climate and environment was like, and follow this with an analysis of the current evidence and theories surrounding the peopling of Europe. The final sections of the chapter discuss key aspects of Aurignacian material culture and behavior, such as rock art and funerary caching. Taken together, this chapter provides the context for this research project so that the natural and social world in which Aurignacian populations interacted with materials can be better understood.

What was the Aurignacian?

The earliest occupation of Europe by modern humans, dating to approximately 45,000 to 30,000 cal BP, is known by archaeologists as the Aurignacian period. While osteological remains in association with Aurignacian lithic assemblages are relatively rare, this technological tradition is assumed to have been created by early populations of modern humans. A growing corpus of stone tool evidence from the Zagros Mountains and the Levant (e.g., Garcea 2010, 2012; Otte 2011; Bosch et al. 2015) suggests that Aurignacian populations originated in this region and migrated into and across Europe some 50,000-45,000 years ago. The amelioration of the climate around this time facilitated the rapid dispersal of modern humans from the Near East via Turkey into southeastern Europe, and into central Europe via the Danube valley (Mellars 2006). While the Aurignacian was initially described as a distinct stone tool industry, which differed from that made by Neandertal populations already present in Europe, it is now used as a proxy for referring to a cultural period.

The type site for the Aurignacian tool industry is Aurignac in the French Pyrenees, which was first excavated by Louis Lartet in 1860 (Mellars 2006). The *pointe d'Aurignac*, or split-based bone or antler point, is often used as a diagnostic feature of this industry. Aurignacian stone tool assemblages are also characterized by the presence of thick carinate or nosed scrapers; parallel-sided blades with a lot of retouching; Dufour bladelets, which are inversely retouched; and low proportions of busked burins, or sometimes none at all (Blades 2002; Mellars 2006).

While the presence of these tool types is the general pattern seen in Aurignacian stone tool assemblages, some local variation does exist, most notably between Western European and Eastern European sites. Some researchers (e.g., Cohen and Stepanchuk 1999; Kozlowski 2007) consider the Aurignacian industry to be rare in Eastern Europe, where local industries dominate, while other researchers (e.g., Hoffecker 2011) argue that the differences in assemblages are due to a difference in the types of sites being studied. For instance, Western Europe is dominated by cave and rock shelter sites which were often occupied (seasonally or consecutively) for long periods of time (Hoffecker 2011). Conversely, Eastern Europe tends to have more open air sites, which are typically representative of kill-butchery sites (Hoffecker 2011). Since the Aurignacian is defined by the tool types found at habitation sites in the Franco-Cantabrian region, the simpler and more expediently manufactured tools which dominate the open air sites of Eastern Europe are instead more often attributed to local industries (Hoffecker 2011).

This discrepancy between assemblages in Western and Eastern Europe illustrates some of the problems that arise when archaeologists attempt to fit archaeological sites into previously constructed cultural or typological categories. This becomes especially apparent once the Aurignacian is described as a cultural period, rather than simply as a stone tool industry.

Archaeologists now must attempt to fit other aspects of human behavior and artifacts into a timeline that was constructed on the basis of lithic technologies.

For instance, radiocarbon dating of the famous Chauvet Cave rock art site places the age of the art firmly within the Aurignacian, between 38,500 to 31,500 BP (von Petzinger and Nowell 2014:49). However, it has long been considered to date to the Gravettian based on the apparent technical and stylistic complexity of the art (von Petzinger and Nowell 2014). This discrepancy is due in part to the categories of behavioral and cultural complexity that have been constructed along specific timelines. Rock art in Europe has previously been thought to have developed along a trajectory of simple signs and markings to more complex polychrome images of animals and anthropomorphic figures, with the former being present in the Aurignacian and the latter developing in subsequent cultural periods (von Petzinger and Nowell 2014). This has led some researchers to argue that the radiocarbon dating of Chauvet is somehow flawed (von Petzinger and Nowell 2014). However, when we consider the fact that similar geometric signs are found in contemporaneous Spanish rock art sites, in conjunction with some earlier dates for the Gravettian in central Europe, it is entirely possible that Chauvet is over 30,000 years old while being stylistically Gravettian (von Petzinger and Nowell 2014). This example demonstrates that the previously constructed and fairly rigid temporal and cultural categories created by archaeologists may need to be reassessed. Additionally, our focus should be on the variability of sites and artifacts, rather than on attempting to fit evidence into preconceived notions of distinct and discrete cultural, temporal, or typological categories.

The Proto and Early Aurignacian

Prior to the Aurignacian we have what is known as the Proto-Aurignacian, or what is sometimes referred to as Aurignacian 0 or the archaic Aurignacian (Riel-Salvatore and Negrino

2018). Understanding the relationship between Mousterian, Proto-Aurignacian, and Aurignacian assemblages is important as it can inform on theories of the technological and cultural development of the first modern humans in Europe and their interactions with Neandertals (Szmidt et al. 2010a). Banks and colleagues (2013:39) suggest that this technocomplex is limited in time to between 41,500-39,900 cal BP, while acknowledging that it may have been made by either early modern humans in Europe or late archaics (Banks et al. 2013:40) . Proto-Aurignacian assemblages are distinct from typically Aurignacian assemblages in a number of ways. Primarily, the lithic assemblages tend to be dominated by bladelets and there is evidence of long-distance lithic material transfer (Riel-Salvatore and Negroni 2018). Additionally, tools made from bone are scarce, while these assemblages are characterized by an abundance of ornaments made from different materials (Riel-Salvatore and Negroni 2018).

Until recently the Proto-Aurignacian has often been misidentified as a phenomenon found solely at Mediterranean sites, but it has also been found at sites such as the Pyrenean site of Isturitz and the Bulgrian site of Kozarnika (Riel-Salvatore and Negrino 2018; Szmidt et al. 2010a; Tsanova et al. 2012). At present the earliest known assemblages of Proto-Aurignacian tools have been found at the sites of Riparo Bombrini and Riparo Mochi in Northwest Italy (Anderson et al. 2015; Riel-Salvatore and Negrino 2018; Szmidt et al. 2010a), with dates from Riparo Bombrini placing the Proto-Aurignacian to between 43,300 and 35,900 cal BP (Riel-Salvatore and Negroni 2017, 2018:167).

While Banks and colleagues argue that the Aurignacian as a whole is a “succession of culturally distinct phases” (Banks et al. 2013: 39) recent dating of sites has shown that this full picture is much more complex than this. As noted, while the Proto-Aurignacian is said to end by 39,900 cal BP (Banks et al. 2013:39), it is found in layers at Riparo Bombrini dating to as late as

35,900 cal BP (Riel-Salvatore and Negroni 2018). However, Riel-Salvatore and Negrino (2018:170) caution that the Proto-Aurignacian in Italy, given its later date than elsewhere, should be considered “an archaeological and behavioral adaptation rather than as strictly a chronological phase.”

Additionally, there has been considerable debate around early dates for the start of the Aurignacian and the validity of these dates. For instance, dating at the site of Geißenklösterle was the source of much debate between Banks and colleagues (2013) and Higham and colleagues (2013). Higham and colleagues (2012), through extensive re-dating of materials excavated from the site, argue that the previous dates reported by Conard and Bolus (2003, 2008) for the Proto/Early Aurignacian were in fact too young. They conclude that the Aurignacian began at this site around 42,500 cal BP (Higham et al. 2012:675), at least 1,000 years earlier than the date range suggested by Banks and colleagues (2013) for the Proto-Aurignacian as a whole.

The site of Willendorf II in Austria has also been at the center of some recent debate on the origin of the Proto-Aurignacian. Prior to recent reevaluation of the site it was believed that the earliest Aurignacian level at the site dated to between 43,200 and 38,900 cal BP (Neruda and Nerudová 2013:11), with Nigst and colleagues (2014) arguing that the earliest Aurignacian dated to over 43,500 cal BP (Teyssaner and Zilhao 2018:109). These early dates led some (Conard and Bolus 2003) to claim that this signaled the start of the Aurignacian in Middle Danube. As Teyssander and Zilhao (2018) suggest, early dates such as this could suggest that the Châtelperronian tool industry, believed to be created by Neandertals, may simply be the result of acculturation. However, the modelling of Proto and Early Aurignacian dates conducted by Bank and colleagues (2013) suggests that early dates at Willendorf are a “chrono-stratigraphic anomaly" (Teyssander and Zilhao 2018:109). After a thorough reanalysis of the materials found at Willendorf, Teyssander and Zilhao (2018:134) conclude that while the Early Aurignacian may have been present between 38-40,000 cal BP, it is highly unlikely that the same is not the case before or at 43,500 cal BP.

Elsewhere in Europe, such as in Moravia, Early Aurignacian sites have not yet been identified, with the exception of along the Danube River valley, which likely served as a migration route for early humans into Europe (Higham et al. 2012; Škrdla 2017). Rather, we see the presence of so-called transitional industries such as the Bohunicin and Szeletian (Škrdla 2017), with the former argued to have been made by the early human inhabitants of the region and the latter by local Neandertal populations (Svoboda, 2005; Tostevin, 2007).

Taken together, the question of where the chronometric line is drawn between the Proto-Aurignacian and Aurignacian, and the potential evidence of early dates for the Aurignacian as a whole may call into question the validity of using Aurignacian assemblages as a proxy for the presence of modern humans. As we know there are very few human remains associated with Aurignacian assemblages, and to date there are no deliberate human burials (Pettitt 2011). We also know that Neandertals survived until 41,000-39,000 BP (Higham et al. 2014), with some authors (Alcaraz-Castaño et al. 2017; Finlayson et al. 2008; Zilhão et al. 2017) arguing that they may have survived as late as 37,000-28,000 BP. Much like the evolution of our species, the evolution of the Aurignacian and other technocomplexes in Europe was a not a neat, linear progression. Instead, it is clear that different technologies were in use in different region at different times, and attempting to categorize this dynamic time period into discrete and temporally bounded cultural phases ignores the great amount of variability that existed across Europe during the Upper Paleolithic.

Climate, Geography, and Environment

General trends across Europe

Understanding the climate of Europe during the Aurignacian is important, as it would have directly impacted the environments in which people lived, which in turn affected the resources available, and thus influenced subsistence and other practices of modern human populations. The study of marine isotope stages (MIS), typically obtained through the analysis of ice core samples, can reveal general information about the climate in Europe during the Aurignacian. The Aurignacian falls within MIS 3, which began by approximately 60,000 BP and ended by about 27,000 BP (Van Meerbeeck et al. 2011). According to Dragusin (2012), Europe's climate during this period experienced a series of frequent and rapid changes. Ice core analyses from Greenland indicate that MIS 3 is characterized by 15 abrupt climatic warming periods, which contributed to rapid environmental changes during successive cold stadial and warm interstadial periods (Van Meerbeeck et al. 2011). Researchers have found that, generally speaking, the climate across Europe was more humid and prone to periods of heavy precipitation during interstadials, more arid during the cooler stadials (Voelker 2002), and that a gradual cooling began around 35,000 years ago which led into the LGM at the end of the Pleistocene (van Andel and Davies 2003). The high degree of climactic variability during this period is highlighted by studies which demonstrate that a single phase of stability rarely remained for more than one thousand years (e.g., Lahr and Foley 2003).

Regionally specific trends

The continent-wide trends discussed above would have, of course, varied on a more regional scale. Contributing authors to van Andel and Davies' (2003) book investigating the climate of Upper Paleolithic Europe during MIS 3 discuss the climatic trends across the continent in terms of three distinct zones: the Atlantic maritime climate, the Mediterranean climate, and the continental, or northern, climate. The Atlantic Ocean, the trans-European mountain barrier, and Russian plain, respectively, anchor each of these zones (Barron et al. 2003). Each of these climatic zones are discussed in more detail below.

Atlantic maritime climate

The Atlantic maritime climate zone lies along the Atlantic coast of Spain and France, and eastward across central France and into parts of Germany. The climate was generally cooler north of the trans-European mountain barrier (which includes the Pyrenees, Alps, Carpathians, and Dinarides), although not as cool as east to the Russian plains (van Andel et al. 2003). This is reflected in the faunal assemblages found in this climactic zone, which are dominated by cold adapted, temperate, and montane species (Stewart et al. 2003). Floral analyses indicate that the majority of the landscape may have been covered by temperate grassland, while steppe tundra and warm steppe environments would have been present during colder phases (Stewart et al. 2003). It is likely that a discontinuous scattering of trees was also present (Huntley and Allen 2003).

For example, the French region of the Dordogne, in which numerous sites included in this study are found, would likely have experienced an Atlantic maritime climate ameliorated through an influence from the Mediterranean climate zone to the southeast (Davies et al. 2003). Climate modelling suggests that during the latter half of the Aurignacian the dry summer temperatures would have reached 14°C, while the wet winter temperatures could have reached -5°C (Davies et al. 2003). Additionally, it is estimated that snow accumulation likely reached no more than 10cm for a very low proportion of the year (Barron et al. 2003; Davies 2003). The majority of faunal remains found here are associated with temperate and warmer temperatures, with a few cold adapted species being present as well (Stewart et al. 2003). This data, in addition to the increasing concentration of sites in this region after 37,000 years ago, has led some to suggest that it likely served as a refugia for human populations during colder stadials (Davies et al. 2003).

Mediterranean climate

The Mediterranean climate zone extends along the Mediterranean coastlines of Spain and France, across the Italian peninsula, and further along the coast into Greece and the coastal Near East. To the north, the trans-European mountain barrier separates the winter-wet, summer-dry of the Mediterranean zone from the temperate and subarctic areas found in the maritime Atlantic and continental climate zones (Barron et al. 2003). This physical barrier, reaching 2,000-3,000 meters high, acted as a climatic shield for the Mediterranean region. Studies have shown that while other parts of Europe may have experienced cold temperatures similar to those of the LGM during the period from 37,000-28,000 years ago, the Mediterranean zone would likely have been relatively warmer, as the trans-European mountain barrier would have shielded this region from the colder climatic conditions to the north (Barron et al. 2003).

Faunal analyses from archaeological sites in this region suggest that very few cold adapted species were present during the early Upper Paleolithic (Stewart et al. 2003). Western and central Mediterranean regions were found to have no evidence of cold adapted fauna, while the eastern Mediterranean did have some warm-tolerant cold adapted fauna in addition to the arctic fox (Stewart et al. 2003). Additional evidence suggests that this region was likely to have been covered by temperate grasslands during warm intervals, and scattered warm steppe with some steppe tundra during colder intervals (Stewart et al. 2003). Overall, then, the faunal and floral evidence suggests that the Mediterranean climate zone was actually much more temperate than previously thought.

Continental or northern climate

The continental climate zone encompasses the North European Plain of central and eastern continental Europe, extending across to the Russian plains and ending in the east toward the Ural Mountains (van Andel et al. 2003). Modelling indicates that rainfall in the continental climate zone would have been quite sparse, while snowfall may have been more prevalent for a substantial portion of the year (Barron et al. 2003). While some forest fragments were likely present, this area, particularly towards the east, was dominated by steppe tundra (Huntley and Allen 2003). This is further corroborated by the faunal evidence, which indicates an absence of temperate species, and a presence of extinct and extant cold species, such as mammoth, woolly rhino, and reindeer (Stewart et al. 2003). More centrally we would have seen a mixture of temperate grasslands and fragmented forests (Huntley and Allen 2003). Here, studies of faunal remains indicate the presence of extinct and extant cold adapted species, as well as montane species (Stewart et al. 2003).

The climate of this region appears to have gradually deteriorated towards the end of the time period discussed here, which may have pushed Aurignacian populations into the relatively more temperate Atlantic and Mediterranean regions (van Andel et al. 2003). This theory is largely supported by the geographic distribution of archaeological sites as the climate deteriorated (van Andel et al. 2003). Additionally, the climate of Southeastern Europe–between the Mediterranean and the Black Sea–can best be described as an overlap between the Mediterranean and continental climate zones (Stewart et al. 2003).

The Peopling of Europe

Modern humans in the Levant

The area known as the Levant acted as a land bridge between Africa and Eurasia for migrating populations (Frumkin et al. 2011). As early as 1.8 million years ago this area was occupied by a variety of different hominin groups (Rightmire et al. 2006). The earliest evidence for the arrival of anatomically modern humans in this region comes from the caves of Skhul and Qafzeh, dating to 140,000-92,000 years ago (Grun et al. 2005; Mercier et al. 1993). Evidence suggests that, generally speaking, the climate of the Levant during this time period was relatively humid, meaning the area would have had a more favorable environment for the facilitation of these early migrations (Frumkin et al. 2011). After approximately 90,000 BP there is an absence of modern human remains in the Levant, which some have argued is evidence of a local extinction. Neandertals later migrated into this region from Europe (Frumkin et al. 2011) and modern humans arrived once again sometime around 60,000-50,000 BP (Shea 2003).

While the exact routes of migration for both hominin species into the Levant have yet to be definitively discovered, it is believed that the Zagros Mountains played a particularly important role in this process. Located in the eastern portion of the Levant, this mountain range extends from Southeastern Turkey, along the border between Iran and Iraq, and ends to the north of the Persian Gulf. The Zagros Mountains are peppered with caves and rock shelters in which evidence of early hominin occupations has been found. In Shanidar Cave, for instance, the remains of ten Neandertals have been found (Cowgill et al. 2007; Solecki 1975, 1977; Trinkaus 1978). Furthermore, stone tool technology similar to that of the Aurignacian in Europe has been excavated from Yafteh Cave, dating to approximately 36,000 BP (Otte 2011). In addition to this, a seemingly locally evolved tool technology unlike both Middle Paleolithic and Aurignacian assemblages was recovered from Ghar-e Boof Cave (Becerra-Valdivia et al. 2017). Taken together, this evidence underscores the complicated history of hominin occupation and potential migration in the Zagros Mountains.

Modern human migration into Europe

It is generally believed that the first successful migration of modern humans into Europe from the Levant occurred sometime between or before 50,000-45,000 years ago (Garcea 2010, 2012), following their repopulation of the Levant. There may have been multiple earlier attempts at migration into Europe, although such attempts were likely unsuccessful, probably due to climatic conditions or low population sizes. It has also been posited that the Danube River provided a route for early human migrations into Central and Western Europe around the Carpathian Mountain barrier (van Andel et al. 2003). After the successful migration into Europe it has been estimated that modern human populations reached western France by approximately 35,000-27,000 BP (Blades 2002). Other areas such as the Iberian Peninsula are believed to have been populated a few thousand years later, and this region in particular may have served as a refuge for dwindling Neandertal populations (Alcaraz-Castaño et al. 2017; Szmidt et al. 2010b; Zilhão et al. 2017). Research indicates that the later timing of modern human expansion into this region may be due to an expansion of a steppe-tundra landscape during Heinrich Stadial 4, which likely created a barrier for migrating populations (Daura et al. 2013).

Modern human and Neandertal interaction in the Aurignacian

Prior to the arrival of modern humans, the European continent was populated by Neandertals for a few hundred thousand years. However, Neandertal and human populations coexisted for a relatively short time span at the start of the Aurignacian in Europe (Adler et al. 2008; Villa and Roebroeks 2014). Neandertals are believed to have become extinct some 41,000-

39,000 years ago (Higham et al. 2014) although some (Alcaraz-Castaño et al. 2017; Finlayson et al. 2008; Zilhão et al. 2017) argue that they may have survived until as late as 37,000-28,000 years ago. When hominin remains are not present at a site, researchers typically rely on tool industries in order to determine the identity of the associated species. The stone tool industry that defines the Aurignacian is associated with human occupations, while the Châtelperronian is often associated with Neandertals (Bar-Yosef and Bordes 2010). This distinction, however, has been debated, with some (Bar-Yosef and Bordes 2010) suggesting that the presence of Châtelperronian tools in Neandertal contexts is related to depositional practices (i.e., digging causing disturbances between layers) and site formation processes (see also, Higham et al. 2010; Hublin et al. 2012). The Châtelperronian tool industry is characterized by the presence of the Châtelperronian point, and seems to be geographically isolated to Western Europe (Bar-Yosef and Bordes 2010).

When modern human populations began migrating into and across Europe they would likely have encountered the already present Neandertal inhabitants. The timing and extent to which these two populations interacted is the subject of considerable debate (e.g., Caron et al. 2011; d'Errico et al. 1998; Hublin et al. 2012; Mellars 1999; Villa and Roebroeks 2014). The most compelling and direct evidence of their interaction can be found in the analysis of the human genome. Genetic analyses indicate that Neandertal populations may have contributed anywhere from 1-7% of their DNA to modern human populations (Gibbons 2010; Green et al. 2010; Lohse and Frantz 2014). The extent to which these populations interacted, and in doing so exchanged ideas and technologies, continues to be a source of great debate (e.g., Caron et al. 2011; d'Errico et al. 1998; Hublin et al. 2012; Mellars 1999; Villa and Roebroeks 2014).

Material Culture

Tool technologies

As previously discussed, the Aurignacian is traditionally defined as a distinct cultural period according to the types of tools created and used presumably by modern human populations. While the Châtelperronian industry was a local development and is found in situ, the Aurignacian industry was brought into and across Europe via waves of modern human migrations. The Aurignacian tool industry is most commonly characterized by the presence of a large number of burins and end-scrapers, in addition to split-based bone and antler points (*pointe d'Aurignac*), steeply retouched scrapers, and long blades (Blades 2002). These blades were typically created through a prismatic core technology, and they were often used to create other tools such as end-scrapers and burins (Jochim 2002). It is during the Aurignacian that we see an increase in the use of materials like antler being selected for the creation of tools, in addition to stone (Tejero 2014). Tool industries found in the Levant and the Zagros Mountains have been argued to be similar to that of the Aurignacian, providing some evidence for the Levantine and Zagros routes of human dispersal into Europe (Bosch et al. 2015).

Rock painting, engraving, and finger fluting

The term 'parietal art' is used to categorize the paintings, engravings, and finger flutings found on immobile surfaces such as the walls of caves and rock shelters. While these practices are typically categorized separately from 'portable' forms of art, many archaeologists have been developing new frameworks incorporating the two for a better understanding of the Paleolithic visual world (Moro Abadía and González Morales 2013). For instance, recent lines of inquiry include investigations into how the art was made and who, on an individual level, was making it (Fritz et al. 2015), as well as understanding the link between materiality and meaning, and the effect of social processes on the creation of art (Moro Abadía and González Morales 2013).

Recently re-dated sites in Spain, France, and Romania suggest that Aurignacian populations painted images of animals, geometric signs, and hand stencils (Clottes 2013; García-Diez et al. 2013; Pike et al. 2012; von Petzinger and Nowell 2014). The most commonly used colors were black and shades of red, with evidence from later periods suggesting that the former was made from charcoal or manganese oxides and the latter from hematite (found in ochre) or heated goethite (Chalmin et al. 2003). While paint pigments would have been applied to parietal and portable surfaces in a variety of ways, the use of fingers would have been the simplest way (Bahn 2016). Additionally, ochre 'crayons' may have been used, as lumps of pigment with evidence of wear have been found in several painted caves (Bahn 2016). Later in the Upper Paleolithic items such as large shells used to crush and mix pigments have been found, and experiments have indicated that the pigments were likely applied with animal hair brushes or pads (Bahn 2016). Positive and negative hand stencils, such as those found in Spanish Aurignacian sites (Garcia-Diez et al. 2013; Pike et al. 2012), are also common in parietal rock art throughout the Upper Paleolithic. These images were created by either spitting pigment at a hand held to the wall of a cave or rock shelter to create a negative hand stencil, or by pressing a palm covered in pigment against the wall to create a positive hand stencil.

The walls of caves and rock shelters were also engraved by Aurignacian populations. Like paintings, this form of art is also found on portable artifacts such as animal bone, ivory, and pieces of stone. Animals and geometric signs are the most commonly engraved images. Among the earliest examples of portable engravings are a so-called 'phallus' engraved on a horn-core from Abri Blanchard, and an animal head engraved on a rhino vertebra from Siberia, dating to 35,000-25,000 years ago (Bahn 2016). Surfaces were sometimes prepared for engraving through grinding, after which sharp, hard stones were used to meticulously carve images into cave walls and portable materials (Bahn 2016).

Finger flutings are a lesser known and studied type of parietal art created during the Paleolithic. Essentially, Paleolithic peoples would run their fingers along the soft walls and ceilings of caves, leaving behind intricate patterns and images. Researchers have been able to determine the approximate age (child/juvenile/adult) and gender of those who created the patterns (Van Gelder 2015). Unfortunately, due to the nature of this type of art it has thus far been difficult to date, and while examples firmly associated with the Aurignacian are likely, they are not definitive.

While some (Hoffman et al. 2018; Rodríguez-Vidal et al. 2014) have argued that Neandertals may have also created art, it begins to appear in great numbers throughout Europe shortly after the arrival of the first humans. The oldest and perhaps most well-known examples are the meticulously painted walls of Chauvet Cave in France. The artwork within this cave was originally believed to belong to the Solutrean period (22,000-18,000) due to the complexity of the artwork (von Petzinger and Nowell 2014). However, researchers have now determined that the cave saw two distinct periods of human activity dating to 37,000-33,500 and 31,000-28,000 BP (Quiles et al. 2016).

Other rock art sites have been proposed to date to the Aurignacian, although many have not been directly dated as such. Chrono-stylistic analyses at Altxerri Cave in Spain, for instance, suggest that the red ochre paintings here date to the Aurignacian (González-Sainz et al. 2013). The application of ^{14}C-AMS dating to their closest archaeological contexts also seems to suggest an Aurignacian origin for the art. In addition to Altxerri Cave, some (e.g., White et al. 2012) have argued that engravings found in Abri Castanet in France could be as old as 32,000 BP. At this site researchers found an engraved roof surface that collapsed onto an Aurignacian surface, meaning that the artwork could not be older than the surface. This finding, however, is quite tenuous, as the roof may have collapsed much later than when the art was created, and thus gives us a minimum date (White et al. 2012).

Figurines

In addition to the art discussed above, portable art objects have been found in great numbers across Europe during the Upper Paleolithic. Figurines, most of which date to the Gravettian period, are perhaps the most well-known portable art objects to the general public. These types of objects tend to receive the greatest amount of media attention, and have often been at the center of intense academic debates (e.g., Conard 2009; Nowell and Chang 2014). Carved from stone, ivory, and antler, Upper Paleolithic figurines have been found depicting both human and animal forms, as well as anthropomorphic figures (Bahn 2016).

In both scientific and popular literature these objects are often referred to as ‘Venuses’, although this term is imbedded with problematic assumptions and implications. They have been interpreted in a number of ways, including as goddesses or symbols of fertility, self-portraits of women, or as sexual objects for men (Nowell 2006; White 2006). While these interpretations are interesting, analysis of the context in which they are found and processes though which they were created, as well as the relationship between the creator and the material, can bring to light much more interesting insights into the social world that both produced and was produced by them. As Nowell (2006) explains, these types of analyses enable us to ask questions about decision making, skill, and the exchange of materials, rather than simply asking what the figures may represent.

The Hohle Fels figurine excavated in Southwestern Germany is one of the most well-known examples of this type of object dating to the Aurignacian, and is one of the few, if only, female figurines from this time period. Carved from mammoth ivory, the clearly female form is dated to at least 35,000 BP (Conard 2009). Measuring only 6cm long by 3.5cm wide, the figurine has obvious female features as well as a small ring, possibly for suspension, in place of a head (Conard 2009). The discovery of this figurine was quite important, as it contradicted claims that the creation of figurative art of this type emerged later during the Upper Paleolithic (Conard 2009). However, the archaeological significance of this find has been somewhat overshadowed by the way in which its discovery was reported in the media. It was described as being a pornographic and aggressively sexual example of a pin-up girl, which, as Nowell and Chang (2014) have discussed, is a problematic and sensationalist view to perpetuate within a scientific context.

In Southwest Germany the occurrence of animal figurines dating to the Aurignacian is quite common. In particular, mammoths, lions, bison, and bear were the most commonly depicted species (Porr 2010a). Anthropomorphic figurines were also present, with three examples of human-feline statuettes found in this same region in Germany. The lack of anthropomorphic figurines depicting other species suggests that a special significance was given to feline species (Porr 2010a). The work of Martin Porr (2010a, 2010b) emphasizes the importance of understanding the figurines as related to their actual use and what this can tell us about their “relationships to bodily practice” (Porr 2010a). The association of figurines with individual bodies or people is crucial to their understanding (2010b). Analyses of many of these figurines have suggested that, based on the high degree of surface polishing, they were handled extensively (Porr 2010a). In addition to this, the figurines were more often than not discarded in insignificant contexts, such as with daily refuse. This suggests that meaning was held at an individual rather than societal level, as the objects were discarded in places without obvious significance.

Textiles

While direct evidence of textile production is difficult to find in the European Upper Paleolithic due to preservation issues, indirect evidence has been found in a number of sites. The roots of our understanding of Paleolithic textiles comes primarily from the work of Olga Soffer and J. M. Adovasio, who first reported indirect evidence of the use of textiles during the early Gravettian period (27-26,000 BP) in Moravia. At the sites of Pavlov I and Dolní Věstonice I, Soffer and Adovasio (Adovasio et al. 1996, 2001) examined pieces of clay with impressions of woven cloth that were accidentally fired due to their proximity to kilns used to fire clay figurines. Their analyses revealed that plant fibers had been deliberately woven together, creating intricate textiles (Adovasio et al. 1996, 2001). Additionally, studies of Paleolithic figurines with apparent clothing or adornment suggests that netting, basketry, and textiles were being depicted and likely used by at least 27,000 BP (Soffer et al. 2000). Soffer (2004) argues that this evidence suggests that the production of textiles must have been in place much earlier than 27,000 BP. This argument is supported by experimental use-wear analyses of tools from the site of Vogelherd dating to the Aurignacian period (32,000 BP), which show evidence of wear similar to that expected from tools used to weave mats (Soffer 2004). This site also has beveled bone points with wear patterns indicative of the production of plant-based textiles (Soffer 2004).

Ornaments

The term ‘ornaments’ is used to refer to beads, pendants, rings, bracelets, and colorants used to adorn the body (Moro Abadía and Nowell 2015). During the Upper Paleolithic of Europe and the Middle and Late Stone Age of Africa these artifacts were created with a variety of materials, including animal bone, teeth, antler, and ivory; human teeth; marine and freshwater shell; ostrich eggshell; and stone. It is reasonable to assume that they were also created from perishable materials such as wood or plant fiber (or the 'missing majority' as Hurcombe (2014) discusses); however, evidence of this is lacking due to preservation issues. While there is some evidence that Neandertals created and wore ornaments (Zilhão et al. 2009), Upper Paleolithic sites associated with modern humans yield evidence of this practice in much higher concentrations.

With the arrival and spread of *H. sapiens* into Europe, the amount of ornaments found at archaeological sites increases dramatically. They have been recovered from both coastal and inland sites, and in both lived and mortuary contexts. Depending on the materials used to create the beads, experiments suggest that it would have taken between 1-3 hours to create a single bead (White 1995, 2007). Additionally, over time it appears that these artifacts became highly standardized, with basket-shaped marine shells and animal teeth being preferentially selected, and other material such as ivory and stone being carved to mimic this shape (White 1989; Conneller 2011). While some (White 1989) argue that the structure of the material used was less important than the desired outcome, others (Conneller 2011) argue that it was the material affordances of ivory and stone, in combination with the desired shape of marine shells, which led to the emergence of this standardized form.

The history of the study of ornaments more generally and Aurignacian ornaments made specifically from marine shells are discussed in greater detail in Chapter 3.

Other Practices

Funerary caching and the processing of remains

Human remains and evidence of their deliberate burial have rarely been found at sites dating to the Aurignacian in Europe. When they have been recovered, it has usually been from rock shelter or cave sites, rather than in open-air sites (Pettitt 2010). This likely has more to do with issues of preservation and taphonomy in the archaeological record, rather than being a reflection of deliberate choices being made, although this remains a possibility. While evidence of deliberate burials during this time period have yet to be definitely discovered, there is some evidence from the Aurignacian of both funerary caching and the potential processing of human remains (Pettitt 2010).

To date, the majority of the suggested evidence for funerary caching comes from the so-called 'caves of the dead' located in Romania. Multiple human remains have been recovered from Peştera cu Oase, Peştera Cioclovina Uscată, and the Mladeč cave system, dating to between 36,000-33,000 BP, 30,000-28,000 BP, and 32,000-30,000 BP respectively (Pettitt 2010). While some assert that the remains from these caves are evidence of funerary caching, others argue that the archaeological contexts are not secure and as such this conclusion is difficult to make (Verna et al. 2012). Rather than being attributed to deliberate human action, these remains may have been deposited through carnivore action or environmental processes such as flash flooding.

In addition to funerary caching, there is some evidence that early Aurignacian populations may have been processing the remains of the dead. First of all, it is during the early Aurignacian that we see the use of human teeth as ornaments emerge (Pettitt 2010). While these teeth may have been acquired from the remains of deceased individuals, it is also entirely possible that teeth were kept for purposes of ornamentation as they were lost or pulled (Pettitt 2010). More convincing evidence of the processing of remains has been recovered from Grotte des Hyènes in France. Here archaeologists discovered a cranium which appears to have been fractured while it was still fresh (Pettitt 2010). The reason behind this potentially deliberate fracturing, however, remains unclear. Additionally, possible evidence of scalping dating to 31,000-29,000 BP has been suggested at La Crouzade in France, and remains from Les Rois (also in France) dating to 31,000-27,000 BP may show evidence of tongue removal (Pettitt 2010). While in all of these cases it is impossible to determine whether the remains were processed for subsistence or ritual purposes, it is clear that at least some populations of early Aurignacian humans were handling the dead.

Conclusions

Collectively, the climate, environments, and geography which modern human populations encountered across early Aurignacian Europe impacted their subsistence strategies, material culture, and other practices. Stone tool analyses have suggested that regions such as the Dordogne in France were sites of intensive, long-term occupation (Hoffecker 2011). This is reflected in the material culture, as we see a high concentration of rock paintings and engravings, as well as portable objects such as ornaments. Conversely, these analyses indicate that eastward towards the Russian plains populations were less concentrated and highly mobile (Hoffecker 2011). The climate and environment in regions such as the Dordogne, coastal Mediterranean, and Moravia were likely to have been more favorable to extensive human occupation when the climate began to deteriorate towards the LGM. The opposite is true of eastern continental Europe, where less favorable conditions only worsened during the Aurignacian. All of these factors taken together would have had a great impact on the ways in which Aurignacian populations lived and how they interacted with one another. Indeed, as the climate worsened over the course of this 10,000 year period, disparate populations may have begun to interact with materials and resources in different ways, and used them to facilitate mutually beneficial relationships across vast distances.

In the following chapter Aurignacian ornaments and marine shells are discussed in more detail than presented here. This chapter touches on the notion of material affordances, which is further explored in Chapter 4. The shift from a Cartesian separation between mind and body, and people and objects towards an emphasis on materiality and agency is also discussed. Chapter 5 then outlines the methods used in this study, the results of which are presented in Chapter 6. The implications of these results in the broader context of material affordances and the circulations of people and materials is explored in Chapter 7.

Chapter 3: Ornaments and Marine Shells in the Aurignacian

The purpose of this chapter is to contextualize the marine shell ornaments that are analyzed in this study. The history of the study of ornaments in archaeology has changed a lot over the last 150 years. These changes, in the context of various theoretical and technological shifts that have taken place in archaeology, is explored. Recent literature on this topic has shifted towards the view that over time Paleolithic ornaments became highly standardized. The implications of this trend and how this relates to the present study are addressed. Following from this, the various ways that marine shell use has been interpreted in archaeology is examined, with a particular focus on its use as a resource during the Upper Paleolithic. The chapter closes with an explanation and description of the genera of marine shells used to create the ornaments analyzed in this study.

A Brief History of the Study of Ornaments

The study of Paleolithic ornaments has changed dramatically since the nineteenth-century. Early researchers had a tendency to focus on these artifacts simply as objects created for the purpose of decorating the human body. Beyond this decorative explanation, ornaments were rarely discussed as “evolutionarily, artistically, or cognitively important” (Moro Abadía and Nowell 2015:953). Heavily influenced by ethnographic studies, early researchers interpreted these items as money or bartering objects, or as being used in religious and magical rituals (Moro Abadía and Nowell 2015). Research in the late 1800s and early 1900s was also heavily influenced by art history, which perceived these objects as “minor art” related to technical activities. This resulted in “pejorative attitudes towards decorative and popular arts” (Moro Abadía and Nowell 2015:956), with the items being deemed as holding little, if any, symbolic value.

The 1960s witnessed a gradual shift in research centered on Paleolithic ornaments, which can be linked to more general changes in perspectives in archeological method and theory (Moro Abadía and Nowell 2015). This shift was influenced largely by material culture studies, archaeology of the body, anthropology of art, and technological advances, such as photography and microscopy techniques (Moro Abadía and Nowell 2015). Semiotics was particularly influential in the general acceptance of these artifacts as symbolic objects, which led to their increasing use as evidence in debates concerning cognitive evolution. Moving away from a semiotic approach, researchers such as Rosemary Joyce (2005) have been particularly influential proponents of a phenomenological approach, which highlights the active, rather than passive, role that these items had in the dissemination of information and construction of social identity. As White (1989) has explained, ornaments are now widely understood to be a means by which individuals and groups construct and express their identity.

Additionally, art, or in this case ornaments, was increasingly viewed as a form of information technology by proponents such as Margaret Conkey (1984, 1985, 1987) and Alexander Marshack (1972, 1976). Authors like Mary Stiner (2014) have furthered these ideas by theorizing that ornaments are indicative of widespread systems of visual communication or language. Others have used similar approaches to suggest that these artifacts can be used to trace the ethnic and linguistic identities of early humans (e.g., Vanhaeren and d'Errico 2006).

Advances in the technological examination of ornaments has been particularly influential in shifting perspectives. Photographic techniques developed in the 1970s gave archaeologists the means to "quite literally see Paleolithic portable art and personal ornaments differently" (Moro Abadía and Nowell 2015:961). With this development researchers were able to take high resolution images of things like ornaments and rock art, which allowed for more detailed analysis of their manufacture and appearance. Additionally, Marshack (1972) used microscopy techniques to study these objects on a much more precise scale. Such techniques have been expanded in recent decades, and have been heavily used by influential researchers such as Randall White (e.g., White 1992, 1995; White and Normand 2015) and Francesco d'Errico (e.g., d'Errico et al. 2008, 2015; Henshilwood et al. 2004; Vanhaeren et al. 2006). These technological advancements have opened the door to researchers interested in manufacturing techniques, micro-wear, and use-wear analyses, and can in turn inform theories on the social processes in which these artifacts were embedded.

Furthermore, interest in social geography has opened new lines of investigation into the lives of early humans. For instance, Conkey (1984) has suggested that studying portable artifacts like ornaments is extremely important for understanding the mobility and sociality of early humans, as these types of items can move several degrees away from the people who made and used them. This means that the information embodied in portable art objects could be transferred between individuals and groups, across small and large geographic areas. Taken together, all of these influences from shifts in art history, anthropology, and archaeology have led to an emphasis on the symbolic, artistic, cognitive, and evolutionary importance of Paleolithic ornaments.

Ornaments and Standardization

In recent years it has been suggested by some researchers (e.g., Conneller 2011; Stiner 2014; White 1989, 1995, 2007) that over time Paleolithic ornaments began to take on a highly standardized form. Despite the vast array of materials that they were made from, evidence suggests that at least during the Gravettian period (approximately 27,000-20,000 BP) Paleolithic populations were preferentially selecting basket-shaped shells and similarly shaped red deer canines for the creation of ornaments (Stiner 2014). Furthermore, evidence from sites in the Dordogne region of France shows that other materials such as ivory were being deliberately carved to resemble the basket-shape of the shells and canines (Conneller 2011; White 1989). In the case of these ivory beads it can be argued that the final desired form was much more important than the material being used to create it, as these materials have affordances that enable them to resemble marine shell. Additionally, once they were polished the ivory beads could take on a surface appearance similar to that of shell or teeth (Conneller 2011). Essentially, the surface effects (shape and texture) or affordances of the ivory would allow the beads to take on the appearance of the desired material (Conneller 2011).

The predominance of basket-shaped beads in the mid to late Upper Paleolithic has led some researchers (e.g., Stiner 2014) to argue that this standardization in form is indicative of an emerging common visual communication system that transcends ethnolinguistic and cultural boundaries. Beads themselves are the most common and widespread ‘art’ of the Upper Paleolithic, which for Stiner (2014) suggests that they must have shared a common functionality. Stiner (2014) further proposes that individual beads may have functioned in a similar way to phonemes in a language–they are the minimum units that can be combined and recombined in a variety of ways to express meaning.

Similarly, Vanhaeren and d’Errico (2006) have proposed that the materials selected for the creation of ornaments during the Aurignacian are indicative of distinct entholinguistic groups. While I agree with the possibility that beads may have been embedded within broader processes of visual communication, entering into a discussion of ethnic identities based on these artifacts is problematic. The apparent distinct groupings of sites argued to be related to ethnolinguistic identities may instead have more to do with geographic distributions of materials, proximity to certain materials, and processes of interaction through which they could have been acquired. Additionally, their argument is based primarily on the types of materials being used to create the ornaments, which are classified according to stone, tooth, and bone type, as well as shell genus or species (Vanhaeren and d'Errico 2006:1109-1111). However, these taxonomic and anatomical classifications are modern constructs that would very likely not have been in use during the Aurignacian. Instead, as the present study demonstrates with regards to marine shell ornaments, material affordances such as shape, size, coloration, and surface affects should instead be considered the dominant factors when assessing the interaction between individuals, groups, and materials.

Interpretations of Marine Shell Use

In more recent archaeological and ethnographic contexts marine shells have been ascribed the status of "prestige goods," or items that were highly sought after while not being available to all members of a society (Marquardt and Kozuch 2016; Trubitt 2003, 2005; Whalen 2013). Perhaps the best known ethnographic example of this comes from the classic work by Malinowski (1922) focusing on the Trobriand Islanders' reciprocal *kula* exchange in Papua New Guinea that centered on the creation and exchange of marine shell ornaments. These items are viewed as prestige goods due to their *social* value, rather than being ascribed an economic value. By engaging in processes of long-term exchange, the Islanders ensure that social ties are created and maintained in an effort to aid in resource trade and promote peace (Trubitt 2003). These marine shell ornaments are understood as being actively engaged in the construction and maintenance of the broader social processes within which they are embedded.

It has also been argued from an archaeological perspective that marine shells held a prestige good status in some cultures. For instance, inhabitants of Cahokia (AD 1050-1350) in the Mississippi River Valley used marine shells for the creation of items such as ornaments, dippers, and cups (Trubitt 2005). Because ornaments are found most often in burial contexts, and more specifically in higher concentrations in the burials of the elite (Pauketat and Emerson 1999, 2009), they appear to have held a status as prestige goods (Trubitt 2005). The act of burying the ornaments with the deceased removes them from circulation within the broader social context, effectively raising their significance and value. This relates to materiality theories centering on the notion of presence and absence (Jones 2012)–by making these objects visually absent, they make the importance of the deceased individual more readily apparent.

Additionally, based on the volume of other prestige goods found, evidence from the site of Cahokia suggests that households with more intensive marine shell ornament production were of a higher social status (Pauketat and Emerson 1999;Trubitt 2005). Further archaeological examples of the prestige good status of marine shell artifacts, and marine shell ornaments in particular, can be found from a vast range of geographically and temporally diverse sites (e.g., Balme and Morse 2006; d'Errico et al. 2009; Whalen 2013).

Marine shell use in the Upper Paleolithic

Studies investigating the procurement and use of marine resources during the Upper Paleolithic have had a tendency to focus on their value from a subsistence perspective (Álvarez-Fernández et al. 2011; Mannino et al. 2011a, 2011b). Understanding the potential of these resources as tools and more generally as materials with desired qualities or affordances (shape, color, durability, reflectivity, etc.) has been a relatively under-investigated aspect of their study. However, marine shells in particular were used in a variety of different ways during this period that go beyond their nutritional value. For instance, use-wear analyses on Gravettian deposits of

Fuente del Salín has revealed a variety of uses, such as tools for drilling and the processing hides (Cuenca-Solana et al. 2013). In addition, the evidence from this site suggests that shells were also used to process ochre pigments for the creation of rock art (Cuenca-Solena et al. 2013).

Chemical analyses on marine shells dating to the Upper Paleolithic, as well as from Middle Paleolithic Neandertal contexts (Zilhão et al. 2009), suggests that they were also used to store pigments (Balbín-Behrman and Alcolea-González 2009), perhaps for the creation of rock art or for decorating or protecting the human body. Furthermore, shell fragments and powder have been identified in the pigments used to create cave paintings at sites such as Tito Bustillo (Balbín-Behrman and Alcolea-González 2009), and they may also have been used as scrapers to procure ochre pigments (Cuenca-Solana et al. 2013). Collectively, this research further demonstrates the wide use of marine shells as more than just a nutritional resource by Upper Paleolithic populations.

Marine shells were also commonly used throughout the Paleolithic for the creation of ornaments. While marine shells can have an overwhelmingly wide variety of colors, shapes and textures, as previously discussed the basket-shaped species seem to have been selected most commonly for ornaments. Furthermore, some researchers have suggested that the basket-shaped shells of the *Nassarius* genus were the "preferred shells of the Paleolithic" (Bar-Yosef 2015). Experimental work has demonstrated that marine shell ornaments were most likely created by being punctured with a sharped stone tool or bone, and were then either strung to be worn or possibly sewn onto clothing (White 1995).

Descriptions of Marine Shell Ornaments used in the Aurignacian

The marine shells used for ornaments during the Aurignacian were quite variable in physical appearance, ranging from tusk-like *Dentalium* shells to basket-shaped *Nassarius* shells.

The most common genera of marine shell ornaments in this study are *Nassarius, Littorina, Dentalium, Turritella,* and *Natica*. In particular, shells of the *Nassarius* genus seem to have been the most widely used, appearing at least across France, Greece, Italy, the Near East, and Russia. This echoes the previously discussed findings of other researchers (e.g., Bar-Yosef 2015; Stiner 2014) who argue that *Nassarius* sp. shells in particular, and basket-shaped shells in general, were the most common types used to create Paleolithic ornaments.

The discussion and typology for marine shells presented here is based on shell beads recovered from sites dating to the Aurignacian period (35,000-27,000 BP) that were identifiable to at least the genus level. The majority of the data comes from a 2006 article by Marian Vanhaeren and Francesco d'Errico, with some information coming from other published sources (see Appendix A). There are a few caveats that must be considered when discussing the general shape of the shells included in this study. First of all, the shell genera listed in the Vanhaeren and d'Errico (2006) study were acquired from a variety of sources, including some papers published as early as the 1970s. The taxonomy of marine mollusks–and especially gastropods–has been in flux for at least a decade. As new phylogenetic studies are conducted (e.g., Dayrat et al. 2011; Modica et al. 2013; Puillandre et al. 2014; Zielske and Haase 2015) species and genus names are often changed accordingly. Therefore, it is entirely possible that a shell identified in the data collected here as a particular genus may have since been reclassified.

An additional caveat to note is that the process of categorizing the genera identified in this study according to shell shape may be considered somewhat arbitrary. The purpose of classifying them in this manner, rather than focusing on the individual genera or even families or subfamilies, is because modern humans in Paleolithic Europe would not have identified shells according to the scientific taxonomic system that we have in place today. Rather, it is more likely that they would have selected shells for the creation of ornaments according to their physical appearance and attributes. The material quality and affordances of the shell would likely have been the most important factor.

That being said, I have identified and classified the marine shell genera analyzed in this study according to 18 categories of shape (Table 3.1). Two major groups emerge in this sample of marine mollusks–the bivalves and the gastropods. Gastropods are shells made from one piece, while bivalves are two pieces that are connected by a hinge. This study also includes some genera of brachiopods, cephalopods, and scaphopods. Within these different categories of shells there are a variety of different forms that the shells can take, with examples of the 18 general shapes sketched and pictured in Figures 3.1 and 3.2.

Table 3.1: List of marine shell shapes and genera included in this study classified by shape.

Marine Shell Shape	Genera Included
Basket	*Buccinum, Cantharus, Columbella, Littorina, Melanopsis, Nassarius, Nucella, Phalium, Ringicula, Thais, Tricolia*
Bivalve	*Acanthocardia, Arca, Callista, Cardium, Glycymeris, Mytilus, Ostrea, Pecten, Rhynchonella, Tapes (Ruditapes), Venus*
Cone	*Conus, Strombus*
Convolute	*Cypraea, Trivia*
Cylindrical	*Charonia, Colus, Mangelia, Ocinebrina, Rissoa, Surcula*
Discoidal	*Ammonite*
Ear	*Haliotis*
Globular	*Crommium, Cyclope, Natica, Theodoxus*
Irregular	*Vermetus*
Limpet	*Patella*
Olive	*Ancillaria (Ancilla), Mitra*
Pelican's foot	*Aporrhais*
Staircase	*Epitonium*
Sundial	*Architectonica*
Top and Turban	*Astrea, Clanculus, Gibbula, Homalopoma, Jujubinus, Osilinus, Trochus*
Tubular	*Potamides, Turritella*
Tusk	*Antalis*, Belemnite, *Dentalium*
Urchin	Urchin

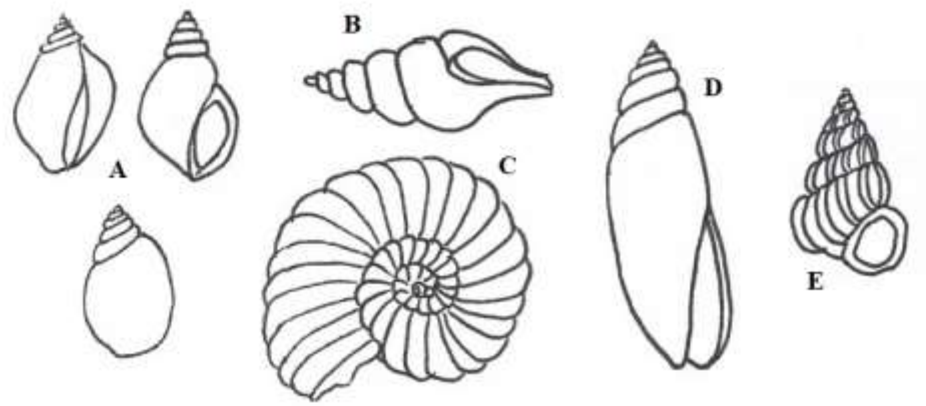


Figure 3.1: Drawings of marine shell shapes. A: basket (based on *Nassarius* sp. and *Littorina* sp.), B: cylindrical (based on *Mangelia* sp.), C: discoidal (based on Ammonite), D: olive (based on *Mitra* sp.), E: staircase (based on *Epitonium* sp.). Drawn by the author.

Figure 3.2: Pictures of marine shells representing 13 of the 18 shell shapes included in this study. A: bivalve (unknown sp.), B: cone (*Strombus* sp.), C: convolute (*Trivia* sp.), D: ear (*Haliotis* sp.), E: globular (unknown sp.), F: irregular (unknown sp.), G: limpet (*Lottia* sp.), H: pelican's foot (*Aporrhais* sp.), I: sundial (*Architectonica* sp.), J: top/turban (*Astraea* sp.), K: tusk (*Dentalium* sp.), L: tubular (*Turritella* sp.), M: urchin. Pictures taken by the author at the Royal BC Museum.

Bivalves

Marine bivalves belong to the Bivalvia class of the Mollusca phylum within the Kingdom of Animalia. The ten genera of bivalves included in this study belong to what are commonly known as the clams (*Acanthocardia, Arca, Callista, Cardium, Glycymeris, Tapes* (*Ruditapes*), and *Venus*), mussels (*Mytilus*), oysters (*Ostrea*), and scallops (*Pecten*). They are composed of two calcium carbonate shells of approximately the same shape and size which are attached together at a hinge point (Gosling 2015). As a group, the bivalves are quite diverse in their coloration, ranging from off-white to brown to green to blue-black (Gosling 2015). They also vary in their habitats, with mussels typically found in cooler rocky shorelines, oysters in muddy or rocky marine estuaries, scallops in sand or fine gravel, and clams in sandy ocean floors or brackish estuaries (Gosling 2015).

For the purposes of this study I have included the only brachiopod in my sample (*Rhynchonella*) with the bivalves. The main difference between a bivalve and a brachiopod is that the shells of a bivalve are situated to the right and left sides of the inner animal, while brachiopods are situated on the top and bottom (Bose 2013).

Scaphopods and Cephalopods

The scaphopod genera included in this study are *Antalis* and *Dentalium*. These types of mollusks are more commonly referred to as tusk-shells, due to their long, non-spiraled tusk-like appearance. There shells are usually white, off-white, or orange in color. Scaphopods are found in subtidal habitats, and are not as commonly found on modern beaches as gastropods or bivalves.

For the purposes of this research project I have included the cephalopod genus Belemnite with the scaphopods. Cephalopods are squids belonging to the Mollusca phylum which have a hard shell-like structure (rostrum) (Landman et al. 2007). The rostrum is a smooth, elongated tusk-like shape similar to that of scaphopods. In fact, genetic research suggests that scaphopods and cephalopods are closely related sister groups (Giribet et al. 2006). My sample also includes the extinct Ammonite cephalopod. Unlike the *Belemnite* genus, species of this squid had a highly coiled shell in a roughly discoidal shape.

Gastropods

The class Gastropoda of the Mollusca phylum consists of marine, freshwater, and terrestrial snails, with the vast majority residing in marine environments. The genera of gastropod included in this study fall into two main categories of spiraled and non-spiraled shells. Within these categories I have identified one general shape of non-spiraled shell and thirteen spiraled shells, each of which are discussed below.

Basket-shaped

The most numerous shape of gastropod identified in this study is the convex basket-shaped genera. This includes *Buccinum, Cantharus, Columbella, Littorina, Melanopsis, Nassarius, Nucella, Phalium, Ringicula, Thais,* and *Tricolia*. This range of basket-shaped genera is dominated by marine-only species (Abbott and Dance 1982). They are found in a wide variety of colors, from white and off-white to brown, orange, reddish, and pink (Abbott and Dance 1982). These shells have a bulbous or basket shaped body with a generally small or almost absent spire.

Cone-shaped or Obconic

The term ‘obconic’ refers to an inverted cone shape. Shells of the *Conus* and *Strombus* genera have this inverted cone-like appearance, with a smooth body and relatively low spire and typically highly patterned shells in white, off-white, orange, and red colorations (Abbott and

Dance 1982). While shells of the *Strombus* genus are not traditionally classified as cone shells (and are not in the same family–Conidae), they share many of the same visual characteristics with *Conus* sp., and both are found in shallow habitats (Abbott and Dance 1982).

Convolute-shaped

The convolute shaped shells included in this study are from the *Cypraea* and *Trivia* genera. These shells are more commonly known as cowries, although the *Trivia* sp. shells are not true cowries. The appearance of these shells is quite different from other gastropods, as they have a rounded, almost egg-like shape and lack the typical spire, with *Trivia* sp. having small ridges along the shells. Both *Trivia* sp. and *Cypraea* sp. are brown, off-white, or orange in appearance, and *Cypraea* sp. shells are sometimes spotted (Abbott and Dance 1982). These shells are most commonly found in coral reef habitats (Abbott and Dance 1982). Cowry shells have been used as money and exchange goods for thousands of years in Africa, China, and other parts of the world (Hogendorn 1986; Soh 1990; Yang 2011).

Cylindrical-shaped

Cylindrical marine shells tend to be fairly tightly coiled with relatively long spires, although not as long as the tubular shells. Shells of this shape identified in this study include those of the *Charonia, Colus, Mangelia, Ocinebrina, Rissoa,* and *Surcula* genera, which are often found in moderately deep waters (Abbott and Dance 1982). These shells may appear striped due to their mixed coloration and tightly coiled spires, and are typically a mix of off-white, brown, or orange (Abbott and Dance 1982). According to the World Register of Marine Species (WoRMS; 2018), the genus *Surcula* is accepted under the name *Turricula.* Instances of this genus in this study have been left as *Surcula* as published by the original sources.

Ear-shaped

The ear-shaped genus *Haliotis* is known most commonly as abalone. These shells are found exclusively in marine habitats (WoRMS 2018). They are convex and oval in shape, with a large opening, giving then an ear-like appearance. They also have multiple natural holes. While some *Haliotis* sp. shells have a dull exterior, most have an iridescent and highly polished interior (Abbott and Dance 1982).

Globular-shaped

Shells in the *Crommium, Cyclope, Natica*, and *Theodoxus* genera are mildly coiled with a very globular appearance, a short or almost absent spire, and a white, off-white, orange, or brown coloration (Abbott and Dance 1982). These shells are typically found in shallow sandy habitats in the subtidal zone. The genera *Crommium* and *Natica* are also known as "moon snails". The genus *Crommium* would have been extinct during the Aurignacian (WoRMS 2018), and would have only been available from fossil outcrops.

Irregular-shaped

The irregularly spiraled marine shells of the *Vermetus* genus are created by worm snails. These shells come in a variety of shapes and sizes, as their name implies, but are usually white or off-white in color. Their tubular shells mold to the snails attachment rock, typically in shallow habitats, causing them to form different shapes (Abbott and Dance 1982; Breves et al. 2017).

Limpet-shaped

This study includes only one genus of gastropod that falls into the limpet category, *Patella*. These conical or dish-shaped shells are found only in marine habitats in the intertidal zone (Abbott and Dance 1982; WoRMS 2018). *Patella* sp. shells are somewhat dull in appearance, being found in muted tones of brown and off-white, but with an often highly polished interior (Abbott and Dance 1982).

Olive-shaped

The two genera included in this study that fall into the category of olive-shaped are *Ancillaria* (or *Ancilla*) and *Mitra*. Shells of these genera are quite elongated with a spire that appears smooth on the edges. While *Ancillaria* shells traditionally fall under the category of olive-shaped, *Mitra* shells are typically referred to as mitre- or Pope's hat-shaped. However, these shells are very similar in their general appearance and have been categorized together. They are found in a variety of colors such as white, brown, orange and red, with some being striped and others being dotted (Abbot and Dance 1982). These shells are found in a wide range of habitats, from sandy intertidal zones to deep offshore waters (Abbot and Dance 1982).

Pelican's foot-shaped

The Pelican's foot-shaped genus identified in this study, *Aporrhais,* is found in offshore deep waters (Abbott and Dance 1982). These shells have a rounded, ovate body with a presence of a low spire and star-like protrusions which gives them a distinct appearance. They are typically either white or off-white in color (Abbott and Dance 1982).

Staircase-shaped

The only genus of marine shell included in this study that falls under the category of staircase-shaped is *Epitonium*–also known as wentletraps (Abbott and Dance 1982). Shells of this genus are characterized by their high spire and spiraled whorls, which are deeply ribbed giving them a very characteristic architectural appearance. Shells of the *Epitonium* sp. live in a variety of habitats from shallow to deep seas, and are typically white, off-white, or orange in coloration (Abbott and Dance 1982).

Sundial-shaped

The *Architectonica* genus is the only identified genus of sundial-shaped shells in this study. These shells resemble a mix between discoidal and top-shaped shells, although they are much flatter than the latter. They are quite beautiful–orange/reddish and white stripes spiral inwards to the center of the shell–and are found in shallow sandy habitats (Abbott and Dance 1982). Similar to discoidal shells, *Architectonica* sp. shells have whorls that spiral inwards, although they are very tightly spiraled.

Top- and Turban-shaped

The *Clanculus*, *Gibbula, Jujubinus, Osilinus* (synonymous with *Phorcus;* Donald et al. 2012) and *Trochus* genera of marine gastropods are also known as top-shaped shells, which tend to be found in the intertidal zone (Evans et al. 2011). The shells are highly spired and somewhat pyramidal with a flat base, and are found in a variety of colors such as white, brown, orange, pink, and striped (Abbott and Dance 1982). These genera are very similar in appearance to what are known as turban-shaped shells, which are also typically found in the intertidal zone (Williams and Ozawa 2006). The *Astraea* and *Homalopoma* genera included in this study have been identified as being turban-shaped.

Tubular-shaped

Tubular shells are also often known as horn shells. They are known for having highly spiraled whorls that resemble a narrow, elongated cone. The tubular genera that have been identified in this study are *Potamides* and *Turritella.* During the Aurignacian the *Potamides* sp. shells would have come from fossil outcrops, as this genus was already extinct at the time (WoRMS 2018).

Echinoidea

Sea urchins are a type of marine animal that belong to the Echinodermata phylum. While they are not marine mollusks, I have chosen to include them in my study because they are very similar in appearance and structure, and would have been found in the same context as marine shells. Sea urchins are found in a variety of habitats, including along coral reefs, in rock or tide pools, and in kelp forests (Elmasry et al. 2013). The endoskeleton of a sea urchin is typically a distinct globular shell made of fused calcium carbonate plates which are then covered in spines (Mann et al. 2008). The spines of an urchin can be a vast array of colors including black, red, and striped, while the endoskeleton is typically white, off white, pink/purple, brown, or grey. They have been classed separately from the marine shell shapes analyzed in this study, and are simply referred to as urchins.

Conclusions

The above discussion demonstrates not only the wide variety of ways in which both ornaments and marine shell resources have been studied in the past, but also the range of interpretations surrounding marine shell ornaments in particular. As new theoretical and technological approaches continue to emerge in archaeology, our understanding of these artifacts will deepen. While ornaments have been traditionally understood through a representational lens focused on what they may mean and represent, I instead draw on materiality theory (e.g., Gosden 2005; Malafouris 2013) and the concept of material affordances (e.g., Conneller 2011; Ingold 2012; Robb 2015; Wells 2008, 2012). The discussion presented here on the variety of shapes of marine shells selected for the creation of ornaments during the Aurignacian illustrates the importance of focusing attention on the materials themselves. Combining a descriptive, qualitative approach with a quantitative analysis of marine shell shapes in relation to other ornament materials will increase our understanding of the material choices being made by Aurignacian populations. While the purpose of this chapter was to provide a context for the marine shell ornaments that are analyzed in this study, the next chapter addresses the theoretical framework through which I will conduct the analysis of these artifacts.

Chapter 4: Material Affordances and Processes of Interaction

In this chapter, the concepts of materiality, material affordances, and the interactions between people and materials are explored. The purpose of this chapter is to provide a theoretical context for how the present study is conducted and interpreted. First, a brief account of the development of materiality theory is addressed, followed by a discussion of more recent shifts towards exploring the affordances of materials themselves. These discussions are grounded in an analysis of the application of these theories to investigations centering on visual perception, phenomenological approaches to ivory use, and landscape and monument studies in recent archaeological literature. This is followed by an exploration of the role of materials in human interactions, the discussion of which will center on the circulation of materials through complex processes of trade, exchange, and migration.

The Material World

A brief history of materiality

Since the work of René Descartes (see, Bardet and Noceti 2012; Lock and Farquhar 2007; Urban 2018) the relationship between humans and things has long been characterized by a separation between the two. As many archaeologists (e.g., Boivin 2004; Crossland 2010; Hicks 2010; Ingold 2000a; Knappett 2005; Renfrew 2004) have discussed, the duality of mind/body and person/object, and the preference of objectivity over subjectivity, characterized much of early archaeological research. However, the emergence of new theoretical perspectives has shifted the focus toward the entanglement of humans and objects, and the relationality of their emergent and mutually constructed existence. Material culture studies and materiality theory, which emerged as part of the material turn towards the end of the 1970s (Ingold 2012:428), have been particularly central to much of this new way of seeing the dynamic relationship between the material and social worlds.

In the 1960s-70s the work of Ferdinand de Saussure became widely influential in archaeology, particularly through the work of Claude Levi-Strauss (Hicks 2010:44). In de Saussure's view linguistic signs are reflective of mental processes, with meaning being "tied to mental representation" (Crossland 2010:395). This means that from a Saussurian perspective signs are representational–or referential–of cognitive processes. The semiology of de Saussure heavily influenced the work of researchers like Claude Levi-Strauss and Ian Hodder (1982), which in turn was influential in the development of structuralist approaches in archaeology (Hicks 2010:44). From a structuralist perspective, objects, places, and materials are symbols that are acted upon by mental processes and thoughts (Fowler 2010:355). However, structuralism did not address the relationships between mind and materials or people and things, thus failing to emphasize the relational processes through which meaning is constructed.

Critics of structuralism turned instead towards a Peircean view of semiotics which focuses on the relational process of meaning making and understanding between things or objects and people (Crossland 2010). Contrary to a Saussurian perspective, Peirce argued that "thought takes place through signs" (Crossland 2010:393) rather than signs being merely reflective of thoughts. Signs, in this case, are relational rather than referential–the means through which a sign is produced matters (Malafouris 2013:93). Take for instance the example of a university degree–if someone were to handwrite a degree on a piece of paper, from a Saussurian perspective this would have the same effect (or meaning) as an officially printed degree, as the sign is merely referential to the meaning. However, the meaning from a Peircean perspective has changed entirely, as the meaning and the sign are relational and the context of the sign matters.

Archaeologists draw on Peircean semeiotics as a framework for understanding how identity and personhood "emerges relationally through signs" (Crossland 2010:393). From this perspective signs do not merely refer to identity; rather, the two are mutually and relationally constructed. This turn towards relationality influenced the development of the post-processual movement, with its roots in the work of researchers such as Danny Miller (1987, 1990, 1998, 2005), Christopher Tilley (2002, 2004, 2007), and the later work of Ian Hodder (1999, 2012), and also drawing on the work of symbolic anthropologists such as Clifford Geertz (1973, 1974) and Victor Turner (1967, 1974). The main argument of this movement is that material culture itself is *active*, rather than passive. This view has also been expressed by theorists such as Callon and Law (1997), who argue that material culture itself actively participates in social processes, in similar ways as people. By creating, shaping, and engaging with materials and objects, people themselves are constantly being shaped by these interactions (Hollenback and Schiffer 2010). In this sense, material culture both produces, and is produced by, the social and behavioral processes in which it is actively participating.

Similarly, Malafouris (2013) proposed what he terms material engagement theory, which stresses the need to engage with people and things as relational rather than separate. With regards to semiotics, Malafouris argues that there is a distinction between linguistic and material signs, with the former being referential and the latter embodying an enactive logic (Malafouris 2013:18). Material signs (such as artifacts) are expressive, meaning that a material sign supports a concept rather than merely standing for one (Malafouris 2013:97). Material signs move beyond being symbolic–they instantiate (Malafouris 2013:97). From this perspective objects and the materials from which they are formed have agency in the social and cognitive processes within which they are embedded. This view is also key to the work of Gosden (e.g., 2005) and Robb (e.g., 2015), who both urge for attention to be paid to the agency of objects in the lives of people. Robb (2015) in particular focuses on both the social processes in which objects are embedded as well as the material characteristics (or affordances) of these objects.

Material affordances

Recently, some archaeologists (e.g., Conneller 2012; Gillings 2009, 2012; Heckel 2009; Hodder 2012; Hussain and Floss 2016; Ingold 2000, 2012; Jones 2012; Knappett 2004; Wells 2008; 2012) have expanded on the idea of materiality to now investigate the affordances of the materials being used. The term "affordance" was originally coined by psychologist James J. Gibson (1966, 1979). An affordance, as defined by Gibson (1979), is what the environment can offer or provide to an animal, or the possible interactions that can occur between the environment and an animal or individual. Affordances are considered to be inherently relational, as they are entirely dependent on the needs or intentions of the individual, or, as Gibson explains, the "needs control the perception of affordances (selective attention) and also initiate acts" (1982:411). It is important to understand that while he considers affordances to be relational, according to Gibson's definition of the term an affordance is actually separate or independent from the ability of an individual to perceive it. For instance, a glass cup may afford the user the ability to use it as a flower vase, but this affordance may not be immediately perceived by the user. Affordances are also neither subjective nor objective–Gibson argues that they cut across this deeply entrenched dichotomy which results in meaning coming from within the actor (or person) rather than coming from the object itself (Costall and Richards 2013; Hodder 2012). The roots of this duality is found in the work of René Descartes, who argued for a separation of mind from body and people from things (Costall and Richards 2013).

Gibson argues that the material and social worlds cannot be separated from one another.

The social world of an individual is entangled with the material world, and the two are mutually constructed. Our ability to perceive affordances is a learned process that is, according to Gibson, a key aspect of our early socialization (Williams and Costall 2000). Children learn to perceive affordances through using objects at a young age, and through this process of learning how to use them they "enter into the shared practices of society" (Williams and Costall 2000). Children thus enter into the social world of an object through their manipulation of it and recognition of its affordances (Williams and Costall 2000).

Donald Norman (1988) elaborated on Gibson's theory of affordances and brought it into the context of design theory. A cognitive scientist and usability engineer, Norman expanded on Gibson's original definition of affordance to include more of a perceptual element, with an increased attention on the interaction between the social and the material (McGrenere and Ho 2000). In Norman's definition of the term, an affordance is a property of an object or material that is perceived by the user (Norman 1988). An affordance may suggest to a potential user how an object or material can be used, such as a chair that "affords ('is for') support and, therefore, affords sitting" (Norman 1988:9). In this sense, an affordance can be understood as a perceived action possibility that is in an emergent relationship with the user (Norman 1999). Additionally, it was with Norman's redefining of the term that the verb "to afford" took on a new meaning in a material context to mean to suggest or to invite. For instance, one might say that the properties of ivory affords a craftsperson to mimic the properties of shell, as the materials shared properties may allow them to be perceived as mimetic of one another.

Contrary to this view of affordances as entangled with the perception of potential uses of the objects or materials, Gibson defined them as being "independent of the individual's ability to perceive" action possibilities (McGrenere and Ho 2000:1). Therefore, Gibson viewed affordances as being separate from visual perception, while Norman argued that the two were intrinsically linked. Additionally, the past experiences or knowledge of an individual were also argued by Gibson to be independent from an object or materials affordances, while Norman's use of the term acknowledges that affordances can be dependent on these factors (McGrenere and Ho 2000). This means that, in Norman's view, the experiences or cultural knowledge of one individual may allow them to perceive different material affordances than someone from a different cultural background.

Another key difference is that Gibson's definition of affordances implies that their existence is binary–they either exist and are fully acted upon or they do not exist at all (McGrenere and Ho 2000). McGrenere and Ho (2000:2) illustrate this point with the example of a staircase. From a Gibsonian perspective, the affordance of climbability either exists or does not exist for an individual. However, Gibson fails to address the fact that affordances, such as staircase climability, can be perceived and action can be undertaken by an individual, such as someone with a mobility issue, although it may be done so with difficulty. Additionally, the affordance of staircase climbability can exist regardless of whether or not it is perceived by an individual. Gibson's definition and use of affordances has a static quality to it that implies affordances are out there waiting to be discovered (Costall and Richards 2013). The agency of the materials and objects themselves is largely disregarded, as their affordances are seen as preexisting and unchanging. Contrary to this, Shotter (1983) argues that meaning and the possibility of action emerge through the relationship between a material or object and an individual.

Drawing on the foundational theory of affordances by Gibson and the later redefining of the term by Norman, Gaver (1991) further expanded on this concept. From Norman's perspective, the affordance of an object or material suggests an action to a user. For Gaver, however, it is the "design that suggests the affordance" (McGrenere and Ho:5), where "design" is the perceptual information indicating an affordance to the user. This again brings to mind the work of John Robb (2015:170), who suggests that the social intention and design of objects within the context of their symbolic meaning and material affordances leads to intended effects upon the maker, user, or viewer of the object. For Robb (2015:169) affordances are material as well as social and perceptual.

Furthermore, Gaver developed a framework through which affordances could be separated from their perceptual information. In this framework, four possibilities exist: a perceptible affordance, a hidden affordance, a false affordance, or a correct rejection (Gaver 1991). A false affordance is when perceptual information does exist, but the affordance does not, while a hidden affordance is when the affordance exists but the perceptual information is not available (Gaver 1991). A perceptible affordance is when both the affordance and the perceptual information to recognize it exist (Gaver 1991). Conversely, a correct rejection occurs when there is no perceptual information available and no affordance exists, which arguably refers to existence of nothingness, as arguably any material or object has the potential to result in a perceptible, hidden, or false affordance. Some authors (e.g., McGrenere and Ho 2000) have argued that while perceptible and hidden affordances are logical in their definitions, a false affordance actually implies that the perceptual information is false–a concept described by Gibson (1979) as misinformation which results in misperception.

Material affordances in archaeological research

The concept of affordances is said to have first been introduced to archaeological literature in the work of Tim Ingold (1992; Gillings 2009). While some archaeologists (e.g., Hodder 2012; Ingold 1992; Knappett 2012; Wells 2008, 2012) have grappled with the theoretical concept of affordances, its wider application has not always been explicit in archaeological research. Some research (e.g., Heckel 2009) does seem to engage with this concept, while not explicitly naming it as such. With regards to the Upper Paleolithic of Europe in particular, there are very few studies that engage with this concept (see Heckel 2009; Hussain and Floss 2016). In the research presented here, the Gibsonian notion of affordances as expanded in the later work of Norman serves as the theoretical lens through which the interactions between people and things is explored.

Affordances is a useful concept for archaeologists studying the relationships between people and things, which is, of course, at the core of most archaeological research. In early archaeological research, the focus was often placed on finished artifacts and what they may have meant to the people who created them. However, these objects "emerge–like the forms of living beings–within the relational contexts of the mutual involvement of people and their environments" (Ingold 2000:88). Can we ever say that an object or artifact is finished? It is within this site of mutual engagement between people and the materials from which artifacts emerge that affordances are perceived, manipulated, and acted upon. A nuanced understanding of the materials from which things were made, and what they afford the maker, can shed light on the social processes in which these artifacts are embedded.

In the work of Peter Wells (2008, 2012), for instance, particular attention is paid to the perception of the materials used to form objects and assemblages of objects. Our brains are mediators of how we perceive the world, as they interpret what we see (Wells 2008). The way that we visually perceive materials is affected by the way our brains process certain information, and this in turn has an effect on the way that we view the world. Our previous experiences and things that we have seen before can affect what we see later on, meaning that, in effect, images shape our minds (Wells 2008). Wells (2008) argues that the important aspects of images in particular are their surfaces, edges, textures, colors, decorations, glitter (or reflectivity), and lighting, and it is the surfaces, or materials, that offer affordances. The images themselves have agency as they afford variable responses from people–whether it is an emotional response or a response that affects decision-making or taking action (Wells 2008).

Wells (2012) also argues that these images can afford the modern-day viewer the opportunity to gain insight into how past people saw things and constructed their worldview. However, while we may gain insight into possible ways that past peoples viewed and constructed their world, we cannot be definitive in our findings. As Conkey (2010) has argued, the resonance that images may have for researchers today are likely not the same as they would have been for people in the past. This is particularly true in the case of images, especially Paleolithic rock art–while a researcher may feel a sense of power or mysticism from an image painted on a dimly lit cave wall, the intended reaction to the image may have been entirely different. While phenomological approaches to the study of archaeological materials are certainly pushing researchers to ask new and innovative questions resulting in interesting methodologies and conclusions, it is important to keep in mind that the way a researcher views the world can affect the way sites and materials are interpreted (e.g., Marshall and Alberti 2014).

While Wells' discussion is grounded in the context of images, when thinking about materials used to make things it is much more than just the surface that affords particular actions. Although it does not explicitly discuss the concept of affordances, Heckel's (2009) analysis of mammoth ivory as a key material used in the Upper Paleolithic stresses the importance of investigating and understanding the qualities (or affordances) of materials. This is complimented by an exploration into the phenomenological experience of using ivory as a raw material through her experimentation with fracturing and sculpting ivory using tools known from the Aurignacian period (Heckel 2009). By approaching the analysis of ivory artifacts from these two lines of inquiry, rather than simply analyzing the surface appearance of the ivory, Heckel (2009) is able to engage in a robust discussion of how the material qualities, or affordances, of ivory were manipulated and used by Paleolithic carvers. As Heckel (2009:76-77) states, "it is only by working ivory with the tools and techniques indicated in the archaeological record that one can truly appreciate the relationship between material and creative process." Additionally, things like fracture patterns and use-wear can afford a deeper understanding by modern day researchers of the processes and decisions made by Paleolithic craftspeople when engaging with ivory (Heckel 2009). The material aspects of ivory and other materials, Heckel argues, can be explored more easily than the ideology associated with the relationship between materials and Paleolithic populations (Heckel 2009:88).

Another area of research in which the concept of affordances has been applied is in the exploration of landscape with the use of GIS, as well as in phenomenological studies of the landscape (e.g., Gillings 1998, 2009, 2012; Scarre 2004; Tilley 2004). In particular, Gillings (2009) stresses the environmental aspect of affordances, focusing on Ingold's (1992:46) definition of the term as "properties of the real environment as directly perceived by an agent in a context of practical action." He argues that the term "resource," which is often used in relation to the materials used by past populations, implies that the environment is a passive and static entity (Gillings 2009).

Other authors such as Tilley (2004) have brought together phenomenological approaches in archaeology and enthnographic research in an effort to understand how meaning is constructed in relation to landscapes. Indeed it is Tilley who is often credited with an increased interest among archaeologists in phenomenological studies of monuments and landscapes (Thomas 2006). Tilley (2004) argues that sites such as monuments must be situated within the broader context of the landscape in order for more meaningful questions and potential understandings to emerge. Similarly, Scarre (2004) argues that for archaeologists to gain a more complete understanding of Neolithic megaliths they must explore not only the structures and materials themselves, but the landscapes in which they are situated. While he does not explicitly engage with the concept of affordances, Scarre's (2004) work highlights the importance of situating sites and materials within their broader contexts and processes of human-material and human-landscape interactions. This is echoed in the work of Jones (2012:183) who argues that the construction of Neolithic mounds and monuments is a performative act that brings materials and peoples together while performing the landscape itself. Gillings (2009) also explores the processes and interactions between people and their environment through his engagement with the concept of affordances. More specifically, he argues that the interactions between landscapes and people in the context of monument localities is dependent on the affordances of the landscape itself and the worldview of the people creating the monuments (Gillings 2009).

A potential caveat to this type of work, however, is that affordances are perception-based and, as Norman (1988) theorized, depend on the past experiences and knowledge of the individual. They are not analyzed easily as the affordances of objects and materials perceived by an archaeologist today could be entirely different from what would have been perceived by the original makers and users. However, I believe it is important to continue to engage with this type of theoretical framing as the potential for opening new lines of inquiry and new opportunities for understanding outweighs this potential caveat. As Thomas (2006) points out, the purpose of situating oneself within the broader context of the landscape is not to have some kind of truth revealed, but rather to open the research process up to new hypotheses and arguments.

Interaction

An SNA approach

In addition to the materials themselves actively participating in the creation of objects, items such as the ornaments examined in this study played an active role in social processes and relationships more generally (Gosden 2005; Miller 2007; Tilley 2007). The objects would have facilitated teacher-apprentice relationships, as new generations were trained in the creation of ornaments (Ingold 2000, 2007). Additionally, ornaments in particular would have been active in the construction and circulation of social identities, as wearing them in specific configurations or on certain parts of the body may have both signaled and produced aspects of social belonging to others (Micheli 2012; Wiessner 1982; Wright et al. 2014). Drawing from this, they would have also been actively participating in the production of inter-group interactions. Additionally, the act of trading or exchanging these items could have facilitated the production of complex social relationships (Wiessner 1982). In essence, ornaments may have been active in the production of ties between different groups–or in other words, they are both embedded within and productive of complex social relationships.

Studies of the lives of ancient peoples are increasingly rooted in examinations of the archaeological record through a theoretical framework centered on the application of social network analysis (SNA) techniques (e.g., Collar et al. 2015; Knappett 2013; Peeples and Haas Jr. 2013). These theories rely heavily on the notion that individual human actors can be single nodes within much wider and interconnected webs of dynamic relationships. It is the interactions between these individuals which we seek to study, and these interactions are "embedded in, structured by, and indeed constitute, broader social structure" (Coward 2013:248). In modern contexts, this type of theoretical framing has been applied by researchers to develop insight into the directionality, intensity, value, and layering of complex and varied relations within broader interactions (Coward 2013). For instance, Peeples and Haas Jr. (2013) have used the framework of social network analysis to identify settlements that likely served as mediators in large ceramic networks spanning a 200-year period in the American Southwest. By understanding the broader social relations that exist within a society, one can gain a better understanding of how these relations are "produced, reproduced, and altered by our own actions over greater timescales than those of discrete interactions" (Coward 2013:249). It is this multi-scalar application of SNA that is most useful in the study of prehistoric human populations.

In order to apply this theoretical approach to these populations, archaeologists rely heavily on the materials that people leave behind. The movement of material traces is used to construct the links between individual nodes within a social network. When applied to this type of research, SNA is most often used as a theoretical framework through which much larger scales of social processes, rather than individual interactions, can be understood. Therefore, the nodes in a network in this context may not necessarily be individual human actors or artifacts. Rather, they are often representative of much larger aggregates of information, such as the archaeological sites themselves. This multi-scalar approach enables archaeologists to enter into discussions and analyses of the broader social processes that may have existed across a variety of temporal and geographic ranges.

Beyond networks: processes of human interaction

Instead of focusing on what is more traditionally called social network theory using SNA approaches, this research instead engages with the idea of *interactions* between things and people rather than networks. As explained in Chapter 1 using the term "networks" would weigh this analysis down with certain implications and assumptions; it may imply that people were deliberately setting out to construct networks through which materials and ideas flowed, and that in turn these networks are "out there" waiting to be discovered and explained by archaeologists. By instead engaging with the concept of interactions, the present analysis is able to be more flexible in its engagement with the materials and peoples being studied.

Similarly, Hodder (2012:51) describes networks as being "riddled with dependence and dependency" and instead chooses to use the concept of entanglement to speak about the relationships between things and people. By talking about complex thing-thing and human-thing relationships in terms of networks it implies that things depend on other things and, inevitably, an inequality exists within this dependence (Hodder 2012). Additionally, a focus on network effectively "locks things into particular relationships with one another" (Hodder 2012:52), which means that the relationships between things and between things and people become static and unchanging. This is in direct contradiction with today's understanding of materiality theory, which stresses the agency of materials and things, as well as the deeply relational and entangled relationship between the material and social worlds.

The interaction between people and the circulation of materials and objects through these interactions would have occurred through processes of both direct and indirect transmission. Processes such as trade, exchange, or gift-giving would have been direct forms of the transmission of materials and objects. Migration is a process that could have facilitated both direct and indirect transmission, as contact with others may have resulted in the direct trade and exchange of materials as well as the indirect transmission of ideas and values. It is through these processes embedded in the interactions between individuals and groups that items such as ornaments would have come to be deposited in the archaeological record.

Human-Material Interactions

When items such as ornaments were made by Paleolithic populations the material and the maker would have been mutually engaged in a complex and dynamic interaction. The qualities of selected materials would have afforded particular outcomes when the craftsperson engaged with them. The surface effects of ivory, for instance, produced a brilliant shine when polished that would have been similar to that of many marine shells (Heckel 2009). These shared affordances may have afforded a craftsperson the ability to create an ivory ornament that was mimetic of the surface qualities of shell, if shell were not an available material at the time. Shell itself would have afforded particular actions. For example, many predatory marine snails drill holes into the shells of their prey, while other shells, such as abalone (*Haliotis* sp.), have naturally occurring holes. The presence of holes in shells collected along the shoreline would have afforded the stringing and hanging of shells.

In the context of trade, exchange, and migration, the interaction between individuals and groups would have been mediated by the circulation of materials and objects. The interactions that would have occurred between individuals and groups, mediated by materials and objects, would have had an effect on their visual world (Wells 2012). Similarly, the visual world itself would have also affected the interactions between people. Ornaments may have been a particularly important mediator of social relations, as their small size would afford their wide circulation through processes of direct transmission. The affordances of shell in particular–such as the presence of natural holes–could also have led to the indirect transmission of ideas, with groups in different places and times independently interacting with the material to suspend it on cord or sew it onto clothing. The complex interactions between Aurignacian populations and the materials used as ornaments will be further explored in Chapter 7 in relation to the results of the analysis outlined in Chapter 6.

Conclusions

This chapter outlined the development of a material perspective in archaeological research and recent engagements with the notion of material affordances. By shifting a focus in perspective to the active role of materials and what materials afford, the present study is able to engage with the idea of material interactions in addition to the interactions between people during the Aurignacian. While this study does borrow some concepts from SNA theory, a conscious effort has been made to re-center the focus onto the more fluid concept of interactions and the role of materials themselves within the complex processes of indirect and direct transmission of ideas and materials.

The theoretical perspective presented in this chapter serves as the lens through which the methodology outlined in the following chapter was formulated in order to answer the research questions previously discussed in Chapter 1. Following from this, in Chapter 6 I present the results of the analysis, which are then discussed in Chapter 7 through the theoretical perspective outlined here and in relation to the context provided in Chapters 2 and 3.

Chapter 5: Methods

The purpose of this chapter is to outline the methodology undertaken in order to invesigate the research questions outlined in Chapter 1. The methods through which data was collected are addressed first, followed by a brief discussion of the project database. Next, the process through which Gephi visualizations were created is outlined, followed by a similar explanation for the creation of the geographic maps. The chapter concludes with an explanation of the statistical analysis undertaken, the results of which are presented in the following chapter.

Data Collection

In order to collect the data necessary to address my research questions, I engaged in an extensive search of written materials, including journal articles, books, and site reports. I began my data collection by first looking at a 2006 paper by Vanhaeren and d'Errico, which analyzed the presence of ornaments made from a variety of materials from sites in both Europe and the Near East dating to the Aurignacian. From this source, I started out with a list of 98 sites containing ornaments that are associated with the Aurignacian (Table 5.1). I narrowed this list down to 61 sites with ornaments made specifically from shells. At this point, I used the World Register of Marine Species (http://www.marinespecies.org/) to determine whether the genera of shells listed were from marine, brackish, or freshwater sources. This had no effect on the number of sites I gathered from this source, as all shell beads from the sites identified in the Vanhaeren and d'Errico (2006) article were from marine sources.

Table 5.1: List of the 98 Aurignacian sites with ornaments from Vanhaeren and d'Errico (2006). Sites in white are reported to have marine shell ornaments, while those in gray do not.

Abri Peyrony	Figuier	Lommersum	Salpetriere
Balauziere	Flageolet I	Mladec	Sandalja
Beneito	Foradada	Mochi	Senftenberg
Blanchard	Fossellone	Mollet	Siouren
Bockstein Hohle	Fumane	Muralovka	Sirgenstein
Bockstein Torle	Garma	Ohaba-Ponor	Solutre
Bombrini	Gatzarria	Otero	Souquette
Breitenbach	Geissenklosterle	Pages	Sous-les-Roc
Cala	Goyet	Pasquet	Sous-les-Vignes
Caminade Est	Grotte des Fours	Patary	Spy
Canecaude	Grotte des Hyenes	Pataud	Tournal
Castanet	Hohle Fels	Pecheurs	Trou Magrite
Castelcivita	Hohlenstein Stadel	Pendo	Trou Mere Clochette
Cavallo	Istallosko	Poisson	Tuc d'Audoubert
Cellier	Isturitz	Pont-Neuf	Tuto de Camalhot
Chevre	Klisoura	Prince	Vachons
Ciclovina	Kostenki I	Princesse	Vogelherd
Cobalejos	Krems	Reclau Viver	Wildscheuer
Combe	Krems-Hundsteig	Régismont	Willendorf
Combe Capelle	L'Arbreda	Renne	
Combette	La Quina	Roc de Combe	Near East:
Cueva Morin	Langmannersdorf	Rochette	Hayonim
Fanciulli	Laouza	Rois	KsarAkil
Ferrassie	Lartet	Rothschild	Sefunim
Festons	Le Piage	Saint-Cesaire	Yabrud

While it proved to be extremely useful for my research, the Vanhaeren and d'Errico (2006) article was written just over a decade ago. Due to this, I engaged in more extensive research in order to supplement their data with newly found sites or more recently published information about previously known sites. The first step in this process was to access the freely available Radiocarbon Palaeolithic Europe Database (RPED; Vermeersch 2017). This database, now in its 23rd version, contains over 12,000 records of chronometric dates and other information for Lower, Middle, and Upper Paleolithic sites in Europe.

Once I had downloaded the RPED file, I was able to use built-in queries within the Microsoft Access database to sort and export the data in a variety of ways in order to determine which sites could potentially be included in the study. I first exported an Excel spreadsheet from this database listing all sites with C^{14} dates. From this list, I removed any sites that I had already obtained from the Vanhaeren and d'Errico (2006) article. After this, I excluded any sites with dates that fell outside the limits of this study–35,000-27,000 BP (or 40,000-30,000 cal BP; it should be noted that unless otherwise indicated (e.g., cal BP), all dates included in this thesis are uncalibrated). While doing so, I was careful to include sites that, when factoring in their +/- error range, would fall within this time frame. From this point, I then excluded any sites that were listed within my time frame, but with a cultural affiliation other than the Aurignacian (e.g., Gravettian or Châtelperronian).

Once I had narrowed down the list of C^{14}-dated sites, I then exported an Excel spreadsheet from the RPED database containing sites with dates obtained through accelerator mass spectrometry (AMS), as there may have been some sites dated with this method but not through C^{14}. The procedure outlined for the C^{14} spreadsheet was repeated, and the two resulting lists of potential sites were cross-referenced in order for duplicate sites to be eliminated. After this, I compared the list to that of Vanhaeren and d'Errico (2006) in order to eliminate any sites listed by the authors which they found did not contain marine shell ornaments. As a final step to ensure that no sites were missed, I then exported an Excel spreadsheet from the database listing any sites designated as Aurignacian. Sites outside of the date range examined in this study were removed, and sites already noted in the C^{14} and AMS database comparison were eliminated.

The procedure outlined above resulted in a final list of 106 sites not included in the Vanhaeren and d'Errico (2006) study (Table 5.2). The next step in my data collection was to determine whether any of these sites are known to contain marine shell ornaments dating to the Aurignacian. In order to address this question I engaged in library research to find any mention

Table 5.2: Archaeological sites dating to approximately 35,000-27,000 BP from the RPED (2017) database. Sites in white are reported to have marine shell ornaments, sites in grey did not, and sites bolded in grey do but do not list the genera.

Aitzbitarte III	Ekain	La Chaise	Ranis 3 Ilsenhohle
Alberndorf I	El Castillo	La Vina	Rascano
Aldene	El Conde	Labeko Koba	Renard
Andornaktalya-Zugo-dulo	Esquicho-Grapaou	Le Taillis-du-Coteaux	Ripiceni-Izvor
Antonilako Koba	Essen-Fischlaken	Les Cottes	Roc de Marcamps
Arenillas	Facteur	Les Renardières	Ruso
Bacho Kiro	Figueira Brava	**Lezetxiki**	Sagaydak 1- Sagajdak
Bajondillo	Fontechevade	Lisen VIII	Schwallenbach
Barca I	Franchthi	Los Toros	Serino
Bistricioara-Lutarie II	Gorham's Cave	Mallaetes	Sesselfelsgrotte
Bordes-Fitte	Grande Galerie 2	Manutowa	Starnska Skala
Borsuka Cave	Grande Grotte	**Milovice**	Stillfried B
Brillenhohle	Graulet VI	Mitoc-Malul Galben	Stratzing
Buran Kaya III	Groapa Lupului	Mokriska Jama	Temnata
Canyars	Grossweikersdorf	Muierillor de Baia de Fier	Tiene des Maulins
Cave 8, Uphill Quarry	Grotte des Gorges	Napajedla III	Tischoferhohle
Ceahlau Dirtu	Grotte du Docteur	Nerja	Tolbaga
Ceahlau-Cetatica II	Grotte XVI	Oblazowa I	Trou al Wesse
Chauvet-Pont d'Arc	Guelga	Paderborn	Trou Walou
Chez-Pinaud I	Hahnöfersand	Paglicci	Ucagizli
Combe Sauniere	Harvincourt	Paviland Cave	Varvarina Gora
Cro-Magnon	Hoyle's Mouth	Pego do Diabo	Velika Pecina 2 + 3
Crouzade	Kamenka	Pes-ko	Vindija
Cuco	Karain B	Piekary II	Weinberghohlen
Divje Babe	Kechnec	Pod Hradem	
Dubalen	Kent's Cavern	Podoli V	

of marine shell ornaments, and their specific genera, at each of the listed sites.

From this search, I was able to identify five sites (shown in white in Table 5.2) which are reported to have marine shell ornaments in their Aurignacian assemblages. The sites shown in grey had no mention of marine shell ornaments, while those that are bolded and in grey did mention marine shell ornaments, but unfortunately did not specify the genera. While completing this step, I found that the site of Spy listed in the Vanhaeren and d'Errico (2006) article as not having marine shell ornaments actually has been reported to have *Nassarius* sp. shell beads. Thus, the study includes a total of 67 sites with marine shell ornaments dating to the Aurignacian.

The Database

The data collected above is stored and managed in an Excel spreadsheet. For each of the 67 sites included in this study, the database includes the site name, archaeological layer (if known), approximate date(s) (uncal BP), latitude and longitude coordinates expressed as decimal degrees (those originally found in degrees and decimal minutes were converted using https://www.gps-coordinates.net/gps-coordinates-converter), genera of marine shell ornaments present, marine shell shapes, non-shell materials used as ornaments, and the sources from which this data was obtained (Table 5.3; full database in Appendix A).

Table 5. 3: Sample of the complete database with site name, archaeological layer (if known), approximate date (uncal BP), latitude and longitude in decimal degrees (those originally found in degrees and decimal minutes were converted using https://www.gps- coordinates.net/gps-coordinates-converter), marine shell genera, marine shell shapes, non-shell materials, and sources.

Site Name	Layer	Date (uncal BP)	Latitude	Longitude	Marine Shell Genera	Marine Shell Shapes	Non-shell Material	Sources
Krems-Rehberg		31790+-280	48.417	15.6	Dentalium	Tusk (1)	Stone	RPED 2017; Vanhaeren and d'Errico 2006
Krems-Hundsteig		35500+-2000	48.415	15.602	Clanculus, Columbella, Cyclope, Dentalium, Melanopsis	Basket (2), Globular (1), Top/Turban (1), Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006
Langmannersdorf		35000-27000	48.294	15.879	Dentalium	Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006
Senftenberg		35000-27000	48.433	15.55	Dentalium, Turritella	Tubular (1), Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006

Creation of Gephi Visualizations

In order to investigate the research questions outlined in Chapter 1, I used an open access social network software called Gephi (gephi.org) to analyze the above collected data. Essentially, by using this particular software, I created a visual representation of commonalities in attributes, which may inform on potential connections between Aurignacian sites produced through processes of social ties, trade, exchange, and migration. This analysis is based on the marine shell ornaments that are present, and the non-shell ornaments found in association with them. For the purposes of my research, I created several different maps, each outlining the underlying network based on the marine shell shapes or non-shell materials used to create the ornaments. I focused on the shape of the shells, rather than on the species–while it is certainly interesting to trace the potential trade and exchange of specific marine shell genera, it is important to keep in mind that the way modern researchers categorize this material is likely quite different from how Aurignacian populations would have perceived them. By focusing on the shapes of the shells being used, I am able to enter into a discussion of the importance of the material qualities or affordances of marine shells.

Sites with three shell shapes in common

The first type of Gephi visualization that I made is based on the amount of marine shell shapes shared between the archaeological sites. The minimum number of shared shapes that I settled on was three–while I acknowledge that this is an arbitrary number, I needed to start somewhere in order to avoid creating a map which simply showed that everything is connected to everything else. From this point, I analyzed the data to eliminate any sites with less than three shapes present, resulting in a list of 34 archaeological sites. In order to determine which sites were connected to one another I simply started from the top of my table and compared each site to one another. This resulted in a total of 298 connections between the 34 archaeological sites, which were recorded in an Excel spreadsheet.

The next step was to create two spreadsheets in Excel that could be imported into the Gephi software in order to create the network visualization. Gephi is a social network analysis software that creates network visualizations consisting of nodes and edges. In the case of my network, each node represents an individual archaeological site, while the edges are the connections between sites based on, in this example, the marine shell shapes present. The purpose of the first spreadsheet that I created was to tell Gephi what my nodes are, and how to label them in the final visualization (see Table 5.4 for a sample). Unfortunately, Gephi is unable to recognize special characters (such as è, í, etc.), and as such I could not include these in the names of the archaeology sites. Included in this spreadsheet are the latitude and longitude coordinates of each site, under the headings 'LAT' and 'LON', which later enabled me to export the network into GoogleEarth.

Table 5.4: Sample of the spreadsheet created to tell the Gephi program what the nodes (or sites) are in the visualization. 'LAT' and 'LON' are the coordinates needed in order to later import the Gephi visualization into GoogleEarth.

LABEL	ID	LAT	LON
Krems-Hundsteig	Krems-Hundsteig	48.415	15.602
Balauzerie	Balauzerie	43.968	4.525
Blanchard	Blanchard	45	1.101
Castanet	Castanet	45.007	1.099
Cellier	Cellier	44.965	1.023
Roc de Combe	Roc de Combe	44.767	1.346
Ferrassie	Ferrassie	44.952	0.938
Festons	Festons	45.367	0.65
Laouza	Laouza	43.935	4.409
Pecheurs	Pecheurs	44.408	4.207
Peyrony	Peyrony	44.572	0.901
Poisson	Poisson	44.949	0.997

The second spreadsheet that I created was to establish the edges of my network, with an edge (or line) representing the connection between two nodes (or sites). This spreadsheet essentially tells Gephi between which nodes the connections should be made, and how weighted these connections needed to be (see Table 5.5 for a sample). The "source" and "target" columns in Table 5.5 tell the program where to draw the edges. The default setting for Gephi is to create a directed network, meaning that whatever is in the source column is directed towards the target

Table 5.5: Sample of the spreadsheet created to tell the Gephi program where the edges (or connections between sites) should be made in the visualization. The 'source' and 'target' columns indicate between which nodes an edge should be created. The 'weight' column indicates how thick the line (or edge) should be–based on the amount of shell shapes in common. Having the 'type' column set to undirected means that edges will not include an arrow indicating that, for example, Krems-Hundsteig points or moves towards Rothschild.

SOURCE	TARGET	WEIGHT	TYPE
Krems-Hundsteig	Balauzerie	3	Undirected
Krems-Hundsteig	Blanchard	4	Undirected
Krems-Hundsteig	Castanet	4	Undirected
Krems-Hundsteig	Laouza	3	Undirected
Krems-Hundsteig	Pecheurs	4	Undirected
Krems-Hundsteig	Rothschild	3	Undirected
Krems-Hundsteig	Salpetriere	3	Undirected
Krems-Hundsteig	Tournal	3	Undirected
Krems-Hundsteig	Tuto de Camalhot	3	Undirected
Krems-Hundsteig	Vachons	3	Undirected
Krems-Hundsteig	Franchthi	3	Undirected
Krems-Hundsteig	Klisoura	3	Undirected

column, and the edge will include an arrow. However, I also included a "type" column with "undirected" listed for each connection, in order to convert my network to undirected. This eliminates the implication of movement or directionality in a directed network. The "weight" column in this example indicates how many marine shell shapes each set of connected sites have in common. Initially, the weighted numbers were the same as the number of shapes in common. However, for sites with ten or more in common, this resulted in very thick edges that overlapped and hid other edges and nodes. Therefore, I divided the weight by three as this was the minimum number of shapes used to establish the edges. This allowed for better visibility of the other nodes and edges, while retaining variation in the thickness of the edges.

Once the spreadsheets were created, I then imported the data into the Gephi software to create the visual representation of connections between sites. When this is done, the initial result (Figure 5.1) is a random network visualization that does not necessarily say anything about the

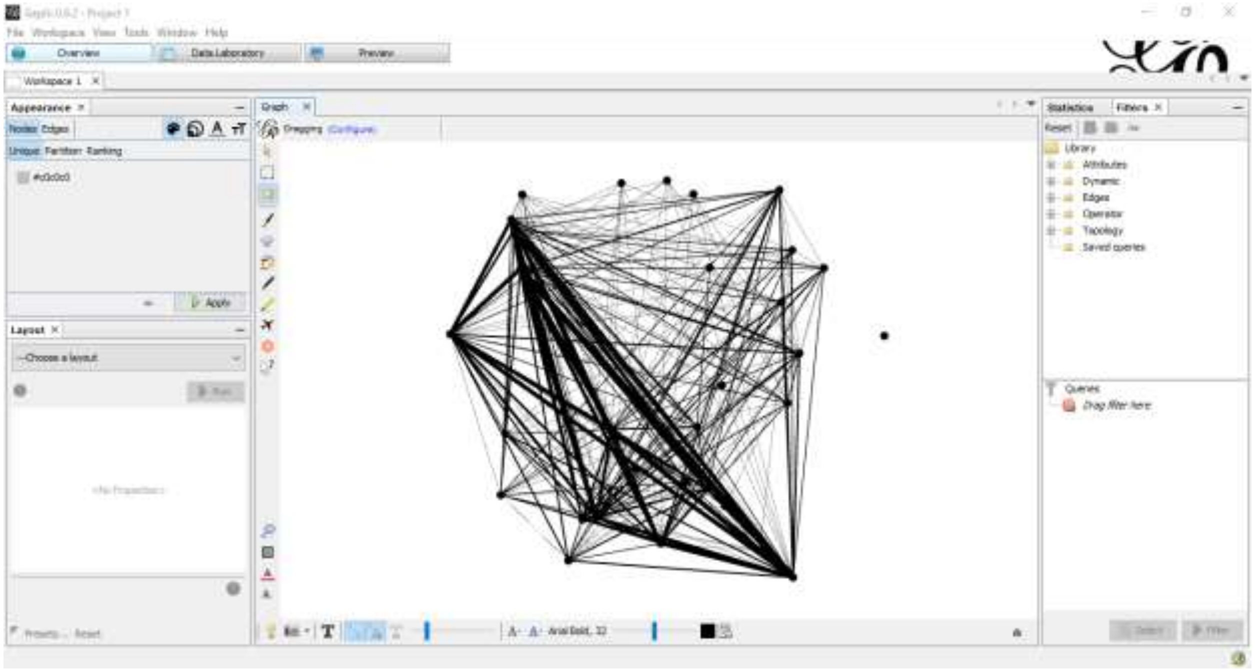


Figure 5.1: Initial Gephi visualization for sites with at least three marine shell shapes in common, showing the random distribution of the nodes (dots–representing archaeological sites) and edges (lines–representing the connections between sites).

relationships between the archaeological sites. My first step from this point was to use the "appearance" toolbox in the software in order to change the appearance of the nodes based on the connections between the sites. I adjusted both the size and the color of the nodes, so that sites with more connections are represented by darker and larger nodes, while those with less connections appear smaller and lighter in color (Figure 5.2).

To aid in the readability of the network, I then used a series of layout algorithms built into the Gephi software, which rely on different statistical measures to make the initially randomly distributed visualizations more readable. Selecting which layout I wanted to use was an important step in my research process, as the appearance of the network can influence the way in which it is subsequently interpreted. My overall aim was to find a layout that effectively communicated the underlying structure of the network, rather than simply making it look

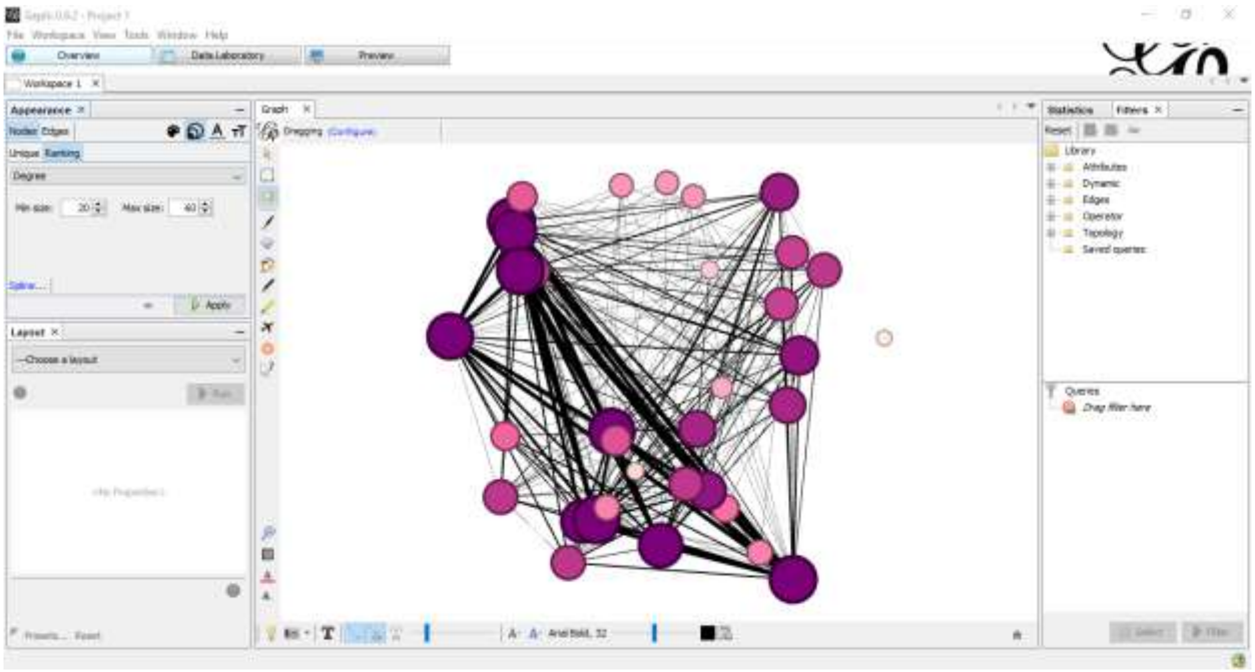


Figure 5.2: Gephi visualization for sites with at least three marine shell shapes in common. This figure shows the change in node (site) color and size. Larger and darker nodes are more connected to other nodes, while smaller and lighter nodes are less connected.

"good." Essentially, I wanted to apply a layout that would encourage similar nodes to cluster together, while still remaining distinguishable from one another. As for determining the overall structure of the network, switching between different layouts can actually allow for the underlying structure to become more apparent. The Gephi program comes with seven built-in layout algorithms, all of which are customizable to a certain extent. Since three of these layouts are either random or considered useful only for directed networks, I therefore decided to only try the remaining four, as I do not want to assume that there is a singular direction of flow in the connections.

Of the four layouts that I chose to test (ForceAtlas, ForceAtlas2, Fruchterman Reingold, and OpenOrd), I ultimately decided to use OpenOrd for my final network visualization (Figure 5.3). The goal of this algorithm is basically to distinguish clusters of nodes in a more precise manner, although this can result in some overlapping of nodes. When I first applied this algorithm to my network several of the site nodes ended up overlapping with one another, since

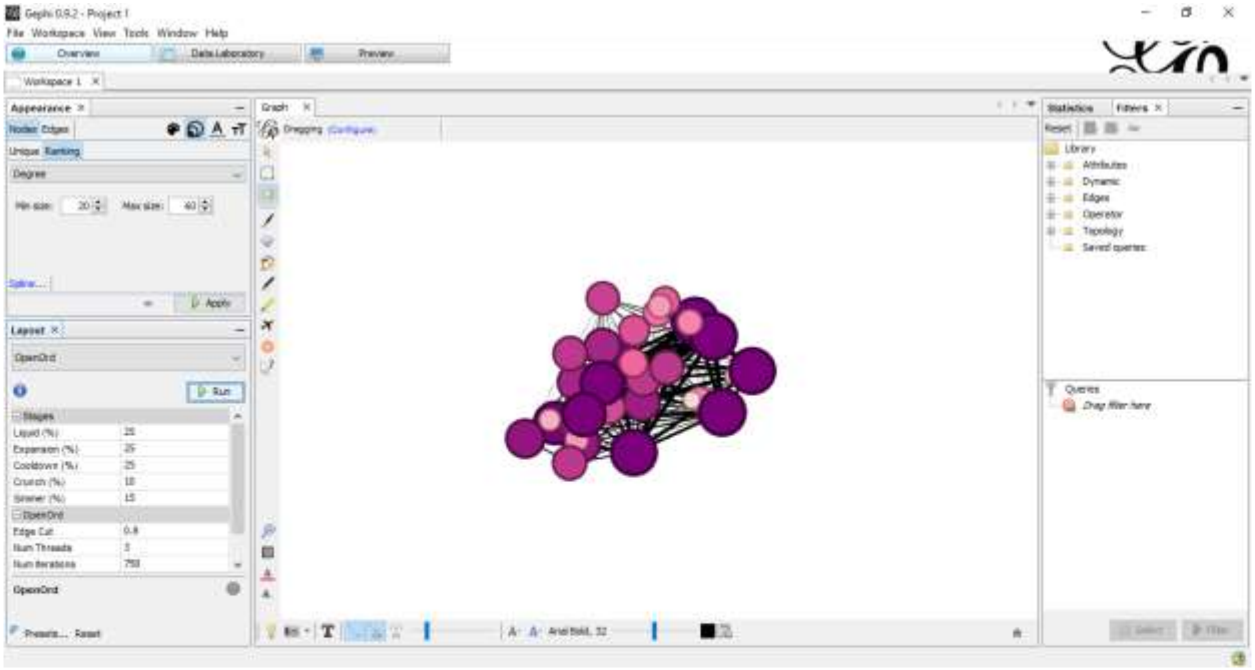


Figure 5.3: Gephi visualization for sites with at least three marine shell shapes in common. This is after the application of the OpenOrd layout algorithm which encourages the clustering of similar nodes (or sites).

they share a higher amount of connections with one another. To negate this effect, I then applied an additional algorithm called Noverlap (Figure 5.4). The purpose of this algorithm is to make the network more readable by moving and separating any overlapping nodes. I then used the

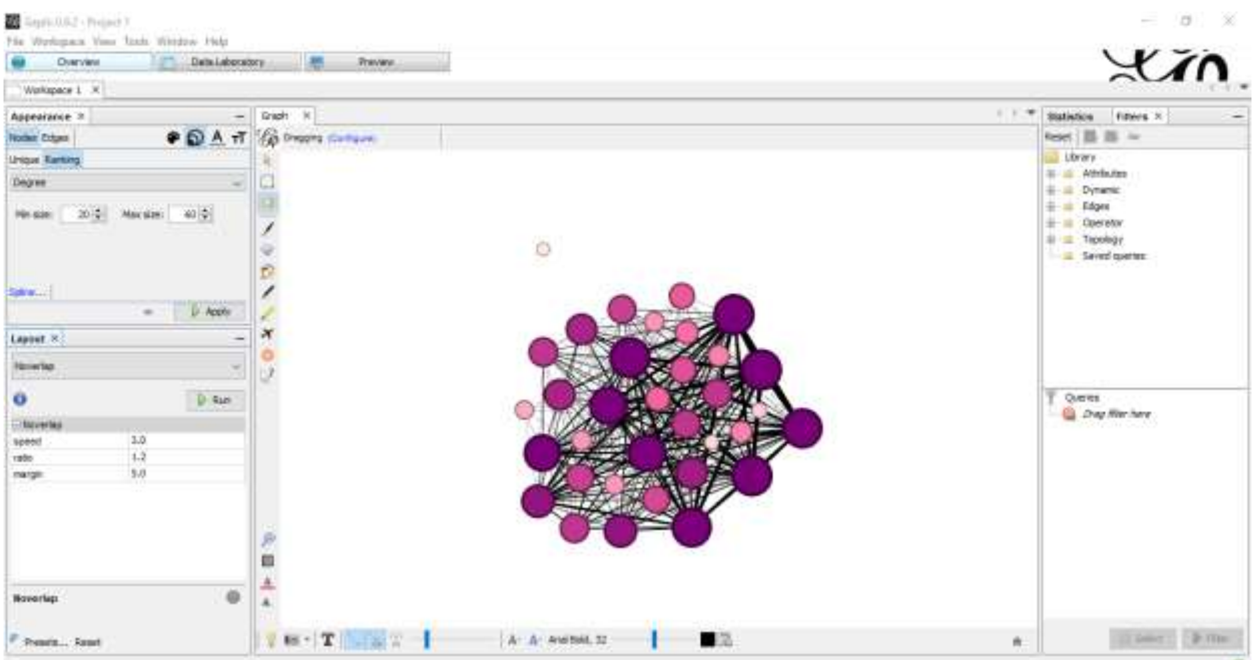


Figure 5.4: Gephi visualization for sites with at least three marine shell shapes in common. This is after the application of the Noverlap algorithm which prevents overlapping nodes (sites).

'expansion' tool within the software in order to widen the network. By doing so, I maintained the overall structure of the network, but simply increased the readability. In the 'preview' mode of the software, I added the labels for the nodes (Figure 5.5) and edited the network further in order to make the node size differences more noticeable. This final visualization was analyzed statistically, the procedure for which is outlined beginning on page 76, and the results of which are presented in Chapter 6.

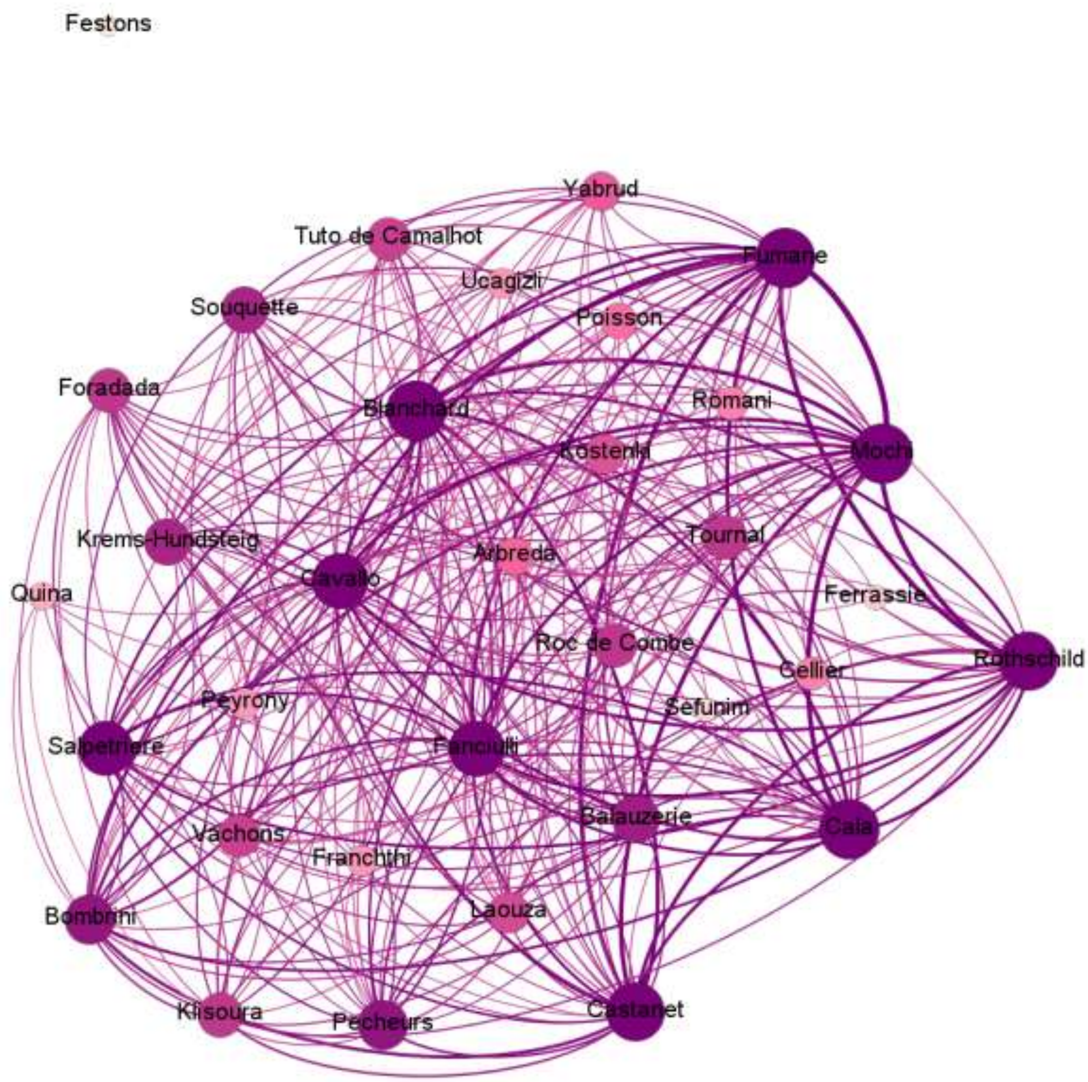


Figure 5.5: Gephi visualization for sites with at least three marine shell shapes in common. This is after the application of Expansion and the addition of node labels, which improves the readability of the visualization.

Individual marine shell shapes

Using the information gathered in Chapter 3 regarding the physical appearance of the marine shells identified in this study, I created Gephi visualizations based on the shape of marine shells found at different Aurignacian sites. Because the resulting visualizations were to be analyzed statistically, I chose not to create a Gephi visualization for any shell shapes shared by fewer than ten sites. Therefore, visualizations were created for basket-, bivalve-, convolute-, globular-, top/turban-, tubular-, and tusk-shaped shells following the procedure outlined for the creation of visualizations based on the presence of three or more shell shapes in common. Connections between sites in these visualizations are based on the shared non-shell materials used to create ornaments. By doing so, I created visualizations that could tell me about not just where certain shapes of marine shells were being used, but also what other material choices were being made and whether certain suites of materials were being used in similar areas. Once created, the visualizations were then analyzed statistically, with the results presented in Chapter 6.

Non-shell materials

The final type of Gephi visualizations that were created are based on the non-shell materials used to create ornaments. Once again visualizations were made for materials found at a minimum of ten sites–bone, ivory, stone, and teeth. The connections between sites were based on the amount of marine shell shapes they have in common. The methodology used for sites with at least three marine shell shapes in common and individual marine shell shapes was followed. The results are presented in Chapter 6.

Creation of GoogleEarth Maps

Sites with three shapes in common

Once the Excel spreadsheets and Gephi visualizations were created for the analysis of connections between archaeological sites with three or more shapes in common, it was a relatively straightforward process to then create a GoogleEarth map of these connections. In order to do so, I first downloaded the open access GoogleEarth Pro software (https://www.google.com/earth/download/gep/agree.html). Following this, I then downloaded a Gephi plugin called ExportToEarth (https://gephi.org/plugins/#/plugin/exporttoearth), which allowed me to convert the Gephi file to a .kmz format which is the file type supported by GoogleEarth. Converting to this file type allowed me to import this file into the GoogleEarth Pro software in order to create a geographic representation of the previously created Gephi visualization.

As previously explained, I divided the weight by three for the Gephi visualization in order to prevent the edges from obscuring one another. However, when I initially imported the Gephi file into GoogleEarth Pro the edges were difficult to see. Therefore, I decided to increase the weight of each edge back to the original numbers, which represented the amount of shell shapes that the sites had in common with one another. Once this was done, I imported the file again, but the edges were still quite difficult to see. I therefore decided to double the weight of each edge, which resulted in a much more clearly visible network. The resulting GoogleEarth map can be seen in Figure 5.6. Because my study is looking at sites from the entire European continent (and a few sites on the Near Eastern Mediterranean coast), some of the nodes were difficult to see in the resulting map. Close-up images of the more clustered areas of the map are presented in Appendix C.

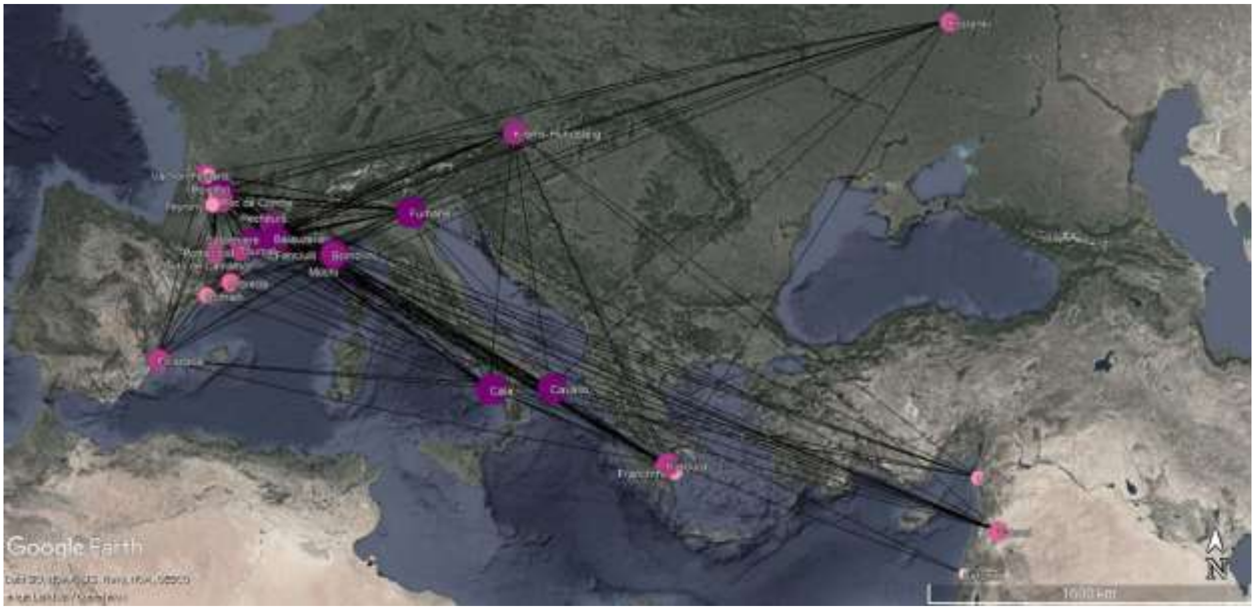


Figure 5.6: GoogleEarth map with Gephi visualization for sites with at least three marine shell shapes in common. Close-up views of more clustered areas are presented in Appendix C.

Individual marine shell shapes and non-shell materials

The process outlined above was repeated for each category of marine shell shape, in addition to each non-shell material. This included the shell shapes and non-shell materials that were previously eliminated from the Gephi visualization creation. While Gephi visualizations of shell shapes and non-shell materials found at less than ten sites would not have been conducive to statistical analysis, this study can still benefit from an understanding of the geographic distribution of these items. The results of these representations are presented in Appendix B (less than ten sites) and Appendix C (ten sites or more).

Statistical Analysis

Descriptive statistics

In order to gain a better understanding of the data prior to analyzing the Gephi network visualizations and GoogleEarth maps I calculated simple descriptive statistics for each dataset, the results of which are presented in Chapter 6. The purpose of using descriptive statistics is to summarize the data in its most basic form. From the main database I created datasets to analyze the amount of each shell shape per site and the amount of each shell shape per non-shell materials (antler, bone, ivory, stone, talon, and teeth).

For each of these datasets I calculated the mean, median, mode, and chi-square p-value. The mean measurement is calculated by determining the sum of all values and dividing by the total number of values, thus giving an average value. This tells me the average amount of shell shapes or non-shell materials identified in each dataset. The median value is the value found in the middle of the dataset, or the average of the two middle values if the dataset has an even number of values. It is useful to do this calculation in addition to the mean, as it can provide insight into what is a typical value within a dataset without being potentially skewed by very high or low values. The mode is the most common value in a dataset, which is useful to compare to the mean and median values. If the three values are very different, this tells you that you have a skewed distribution. Calculating the chi-square p-value aids in determining whether the results are due to a random selection of materials or if there was some potentially deliberate selection of shell shapes taking place.

Gephi network analysis

The use of various graphical statistics enabled me to answer key questions such as what the overall structure of the network looks like, whether the network is highly random or highly patterned/clustered, if there is evidence of "hubs" or more centralized nodes, and if certain nodes seem to be critical bridges between groups within the network. It is important to consider these variables because they can aid in determining whether particular sites may have played a key role in the circulation of marine shell and non-shell ornaments, or if particular regions appear to be using similar suites of materials to create ornaments. The purpose of applying these network measures is twofold: first, the visual assessment of the network can be supported through these more objective numbers, and second, aspects of the network that are less visually obvious can be explored. The aspects of the Gephi visualizations created for this study that I am most interested in measuring statistically are:

1. The density of the network
2. The connectivity of the nodes within the network
3. Whether there are distinct groupings identified within the network

The first aspect can be analyzed by running the graph density algorithm built into the Gephi software. This results in a measure which falls between zero and one, with numbers closer to one indicating a denser, and thus more connected, network. The connectivity of the nodes is assessed through the centrality algorithm. Similar to the graph density, the output falls between zero and one, with nodes with an output closer to one being more highly connected within the network. The final aspect that is assessed is done so using the modularity algorithm in the Gephi software. The output for this measure is a single whole number indicating the number of detected "communities". These "communities" can then be visually isolated in the network visualization by using the built in filtering options. The term "communities", in this sense, refers to groupings of nodes (or archaeological sites) that are statistically similar to one another based on the connections that they share. Rather than using the term "community" in this thesis I have chosen to refer to the output generated by the modularity analysis as groupings, in order to avoid any of the connotations associated with the use of the word community.

Conclusions

The procedures outlined above enable me to investigate my research questions regarding the geographic distribution of marine shell ornaments and the patterns that emerge in the interactions between people and materials. The results of the analysis, and examples of the Gephi networks and GoogleEarth maps, are discussed in the following chapter. More detailed Gephi networks and GoogleEarth maps for the sites with three or more genera in common, individual marine shell shapes, and non-shell materials are presented in Appendices B (less than ten sites), C (ten sites or more), and D (modularity/grouing analysis). In Chapter 7, I enter into a discussion which connects the results of this analysis to the context and theory laid out in Chapters 2, 3, and 4.

Chapter 6: Results

The purpose of this chapter is to summarize the results of the analysis laid out in Chapter 5. The chapter is divided into two sections–the first outlines the results of the descriptive statistical analysis, and the second addresses the results of the Gephi visualization analysis. In each section, I first review the measures used to analyze the data, then present the results of the three main areas of analysis. In relation to descriptive statistics, I discuss 1) the overall dataset, 2) an analysis of individual sites based on the shape of marine shells used as ornaments, and 3) an analysis of the marine shell shapes themselves based on the non-shell materials used. The Gephi analysis explores 1) the marine shell shapes found at individual sites, 2) the presence of shell shapes in relation to non-shell materials, and 3) sites with three or more marine shell shapes in common. The following chapter discusses the significance and implications of these results in relation to the theoretical and contextual framing outlined in Chapters 2-4.

Summary of Descriptive Statistics

Review of statistical measures used

The statistics measured for each of the three areas of analysis outlined above were the mean, median, mode, and chi-square p-value. The purpose of including descriptive statistics, in addition to the Gephi analysis, was to acquire a basic understanding of the data being analyzed prior to engaging in a more robust analysis of the Gephi visualizations. In particular, chi-squared tests were used to determine whether the distribution of marine shell shapes for the complete dataset, per site, and per non-shell materials used is non-random. Including this test aids in determining whether the results are due to a random selection of marine shells, or if there was some potentially deliberate selection of particular shapes occurring.

Analysis of complete dataset

The data was analyzed statistically in two different ways. First, I determined the mean, median, mode and chi-squared p-value for the total number of genera that fall into the 18 shape categories outlined in Chapter 3. I then determined the same values for the total number of instances of genera falling into each shape category–meaning that genera were counted multiple times if they were found at multiple sites. The total for each category are shown in Figures 6.1 and 6.2 and the results of the statistical analysis are summarized in Table 6.1.

For the purposes of this study the significance threshold for chi-squared is $p \leq 0.05$. In this case the null hypothesis for the chi-squared tests is that there is no intentional selection of shell shapes used for the creation of ornaments–it is purely a random selection. The alternative hypothesis is that there is evidence of deliberate selection taking place. The chi-squared values in both cases are below the $p \leq 0.05$ significance threshold, meaning that the null hypothesis is rejected. This indicates that some sort of intentional selection is taking place with regards to the marine shell shapes used to create ornaments. This is reflected in the bar graphs depicting the number and total instances of marine shell shapes (Figures 6.1 and 6.2), although the standardized values shows that the apparent dominance of basket- and bivalve-shaped shells is less pronounced. This intentional selection could be due to the natural occurrence of marine shells of particular shapes. Alternatively, it may indicate deliberate selection for desirable shapes by people. The implications of this result are discussed further in Chapter 7.

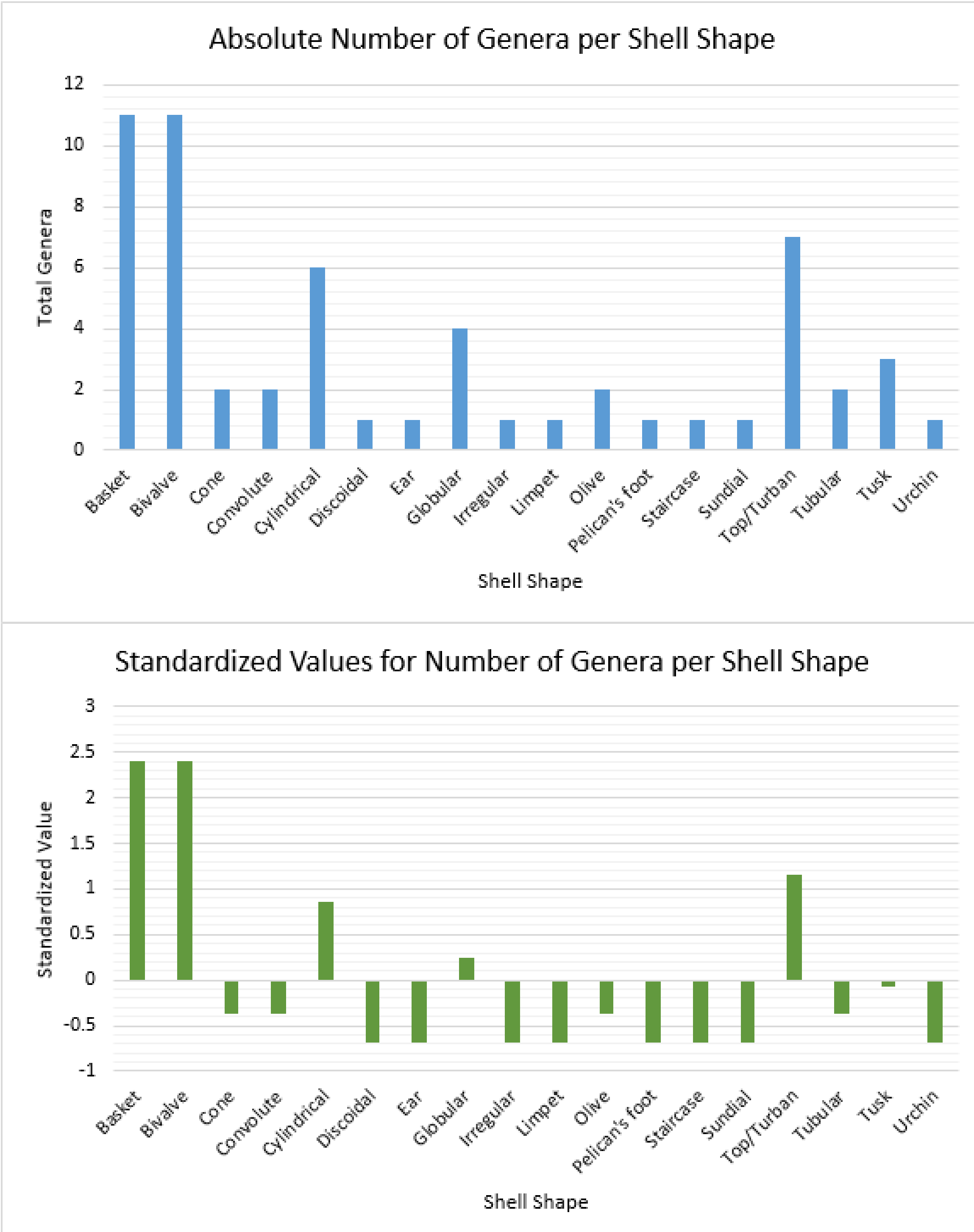


Figure 6.1: Bar graphs depicting the absolute and standardized values of the genera in each category of shell shape included in this study. Positive standardized values have observed (absolute) values that fall above the mean (=3.41), while negative standardized values have observed (absolute) values that fall below the mean.

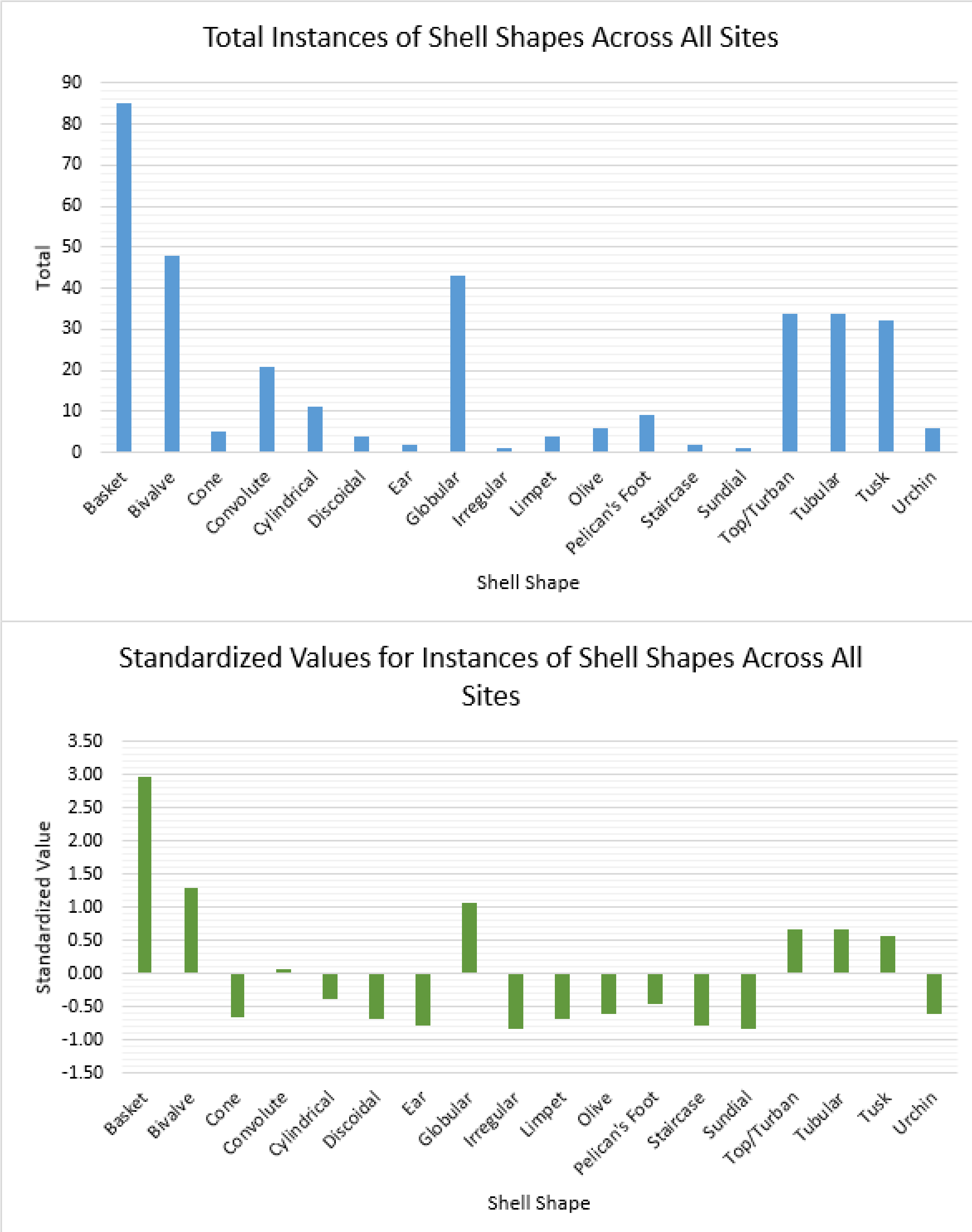


Figure 6.2: Bar graph depicting the absolute and standardized values of the total instances of each shell shape included in this study. Positive standardized values have observed (absolute) values that fall above the mean (=20.47), while negative standardized values have observed (absolute) values that fall below the mean.

Table 6.1: Summary of the results of descriptive statistics tests for complete sample.

	Mean	Median	Mode	Chi-squared P-value
Number of Genera in Sample	3.22	2	1	1.7E-6
Number of Genera at All Sites	19.33	7.5	1, 2, 4	-1.091E-85

Analysis of individual sites based on marine shell shapes

On a site by site basis a preference for particular marine shell shapes over others is certainly not always apparent. In 35 of the 67 sites analyzed in this study, either only one shell shape is present or the amount of each shell shape used is equal, meaning that of the shapes used, no one shape was represented more than the others (i.e., at Romaní there is one basket, one convolute, and one tubular shaped shell). Due to this, I did not analyze these sites statistically. In the remaining 32 sites, however, there were some differences in the distribution of marine shell shapes reported. The results of the mean, median, mode and chi-squared tests are summarized in Table 6.2.

Based on the results in Table 6.2 we can see that the average amount of genera that fall into each shell shape category for all sites ranges between 1.25 to 2.29. Additionally, the median value never falls below 1 or above 1.5 and the overwhelmingly most common mode value is 1. These results indicate that there is a fairly consistent distribution of genera across shape categories in the majority of the sites analyzed.

Furthermore, none of the 32 sites have a chi-squared p-value less than the $p \leq 0.05$ significance threshold. For these tests, the null hypothesis was once again that there is no significant selective effect taking place with regards to the marine shell shapes used as ornaments. The alternative hypothesis is that there is a selective effect–intentional or natural–taking place. Therefore, these results suggest that the selection of shell shapes used as ornaments is random.

Table 6.2: Summary of descriptive statistics tests for each archaeological site with a non-equal distribution of marine shell shapes.

Site Name	Total Genera	Total Shapes	Mean Shapes	Median Shapes	Mode Shapes	Chi-squared P-value
Balauzerie	8	5	1.6	1	1	0.736
Blanchard	14	9	1.5	1	1	0.773
Bombrini	10	6	1.43	1	1	0.494
Cala	21	9	2.1	1	1	0.099
Castanet	14	8	1.56	1	1	0.728
Cavallo	16	9	2	1	1	0.468
Cellier	4	3	1.33	1	1	0.778
Fanciulli	11	7	2.2	1	1	0.555
Festons	4	3	1.33	1	1	0.564
Foradada	7	4	1.75	1.5	1	0.666
Fumane	25	11	2.08	1.5	1	0.365
Klisoura	9	4	1.8	2	2	0.817
Kostenki	4	3	1.33	1	1	0.778
Krems-Hundsteig	5	4	1.25	1	1	0.896
KsarAkil	3	2	1.5	1.5	n/a	0.564
Laouza	5	4	1.25	1	1	0.896
Mochi	32	14	2.29	2	1	0.132
Pasquet	4	2	2	2	n/a	0.317
Pataud	3	2	1.5	1.5	n/a	0.564
Pecheurs	7	5	1.4	1.4	1	0.931
Poisson	5	3	1.66	2	2	0.818
Regismont	3	2	1.5	1.5	n/a	0.564
Roc de Combe	6	4	1.5	1	1	0.572
Rothschild	21	11	1.91	1	1	0.546
Salpetriere	8	6	1.33	1	1	0.962
Sefunim	4	3	1.33	1	1	0.778
Souquette	8	6	1.33	1	1	0.683
Sous-les-Roc	3	2	1.5	1.5	n/a	0.564
Tournal	5	4	1.25	1	1	0.896
Tuto de Camalhot	6	4	1.5	1	1	0.572
Ucagizli	4	3	1.33	1	1	0.778
Vachons	5	4	1.25	1	1	0.896

Analysis of marine shell shapes based on non-shell materials used

Next, I analyzed the marine shell shapes being used in relation to non-shell materials selected for the creation of ornaments. The purpose of analyzing the marine shell shapes in relation to non-shell materials is to gain a better understanding of the material qualities or affordances being sought for the creation of ornaments. Of the six non-shell materials used to create ornaments I did not analyze those found at less than ten sites (antler and talon). The mean, median, and mode values were calculated for the number of genera falling into each shell shape category across all sites reported to have the particular non-shell material in question (Table 6.3). The chi-squared p-value tests the significance of the overall spread of marine shell shapes across all sites reported to have the non-shell material being analyzed. This determines whether the choice in marine shell shape in the context of non-shell material choice is random.

Table 6.3: Summary of the results of descriptive statistics tests for non-shell material used as ornaments in at least ten sites. Chi-squared p-values highlighted in yellow fall at or below the 0.050 significance threshold.

Other Material	Total Sites	Total Shapes	Mean	Median	Mode	Chi-squared P-value
Bone	13	17	3	2	1, 2	0.0006
Ivory	13	14	3.79	3	2	0.006298
Stone	10	16	3.19	3	1, 3	0.142454
Teeth	36	16	8.38	4.5	4	2.486E-15

Teeth are the non-shell material used most commonly in association with marine shells for the creation of ornaments, found at 36 of the 67 total sites analyzed in this study. The teeth found at these 36 sites come from a wide range of species including beavers, deer, horses, wolves, and humans. All aspects of dentition (canines, incisors, premolars, and molars) are represented. Interestingly, when we consider the importance of shell shape for the creation of ornaments, teeth appear to be the most significant non-shell material when examined in relation to shell shape, with a p-value of 2.486E-15. For the chi-squared tests of the non-shell materials the null and alternative hypotheses were the same as before, with the former being that there is no selective effect taking place and the latter being that there is some deliberate selective action occurring. The significance threshold for the test was once again $p \leq 0.05$. In this case, two of the four non-shell materials (bone and teeth) have p-values below 0.05, meaning that the selection of marine shell shapes in association with these materials is not random.

Summary of Gephi Analysis

Review of statistical measures used

The aspects of the Gephi visualizations measured statistically were the density of the visualization, the presence of distinct groupings of statistically similar sites (groupings), and the connectivity of the nodes within the visualizations. In order to determine the density of the visualization I ran the graph density algorithm built into the Gephi software. The output of this algorithm gives me a value ranging between zero and one, in which an output of one would indicate that all of the nodes (archaeological sites) within the visualization are connected to one another (connected nodes meaning they have shell shapes in common). Therefore, if I were to obtain an output of 0.637, this would mean that 63.7% of possible connections between nodes in the visualization are present. An output such as this would indicate a rather highly connected graph, indicating that archaeological sites assessed based on the given variables (such as shell shape or non-shell materials used) tend to be more connected to one another (or have shapes or non-shell materials in common). Alternatively, a low output would suggest that the archaeological sites included in the sample are not very well connected based on the given variables used to create the visualization.

The next aspect that I measured was whether statistically similar groupings of sites could be detected within each Gephi visualization, meaning distinct groups of sites that share similar connections–or material choices–with one another. The presence of such groups may indicate that specific archaeological sites or geographic regions are more connected to one another, and thus possibly interacting, directly or indirectly, with one another. This analysis used the modularity algorithm built into the Gephi software which detects "groupings" (or in this thesis, groupings) of densely connected nodes that are more sparsely connected to other groupings (Blondel et al. 2008). The output for this measure is a single number rather than a range, with the number (e.g., three) indicating the amount of statistically similar groupings detected. Once this number is determined, I can adjust the visualization so that the detected groupings are visually partitioned according to the color of the nodes. Therefore, if the modularity number, or number of groupings, is three, then the edited visualization will show nodes in three distinct colors. This enables me to see which specific nodes belong to each detected grouping.

The final aspect of the Gephi visualizations that I explored analyzes the overall connectivity of the nodes within the network. I ran the diameter algorithm built into the Gephi software in order to understand which specific sites are the most (or least) embedded within the overall network, meaning which sites require the most (or fewest) amount of connections to reach the most (or fewest) amount of other sites. In other words, this measure will identify the archaeological site that may have been a hub or centrally located area in the direct or indirect trade and exchange of marine shell ornaments. When the built-in centrality algorithm is run, the Gephi program calculates the "betweenness" centrality, which determines which nodes are the most and least embedded within the network. Once the algorithm has been run, the visualization is filtered so that the nodes are visible or invisible based on their betweenness centrality value. This enables me to see which are the most embedded and which are the least.

Analysis of sites with at least three shapes in common

For sites with at least three marine shell shapes in common, I first created a Gephi visualization (Figure 5.5) following the methodology outlined in Chapter 5. Once the visualization was created, I then analyzed it using the built in algorithms outlined above. The results of this analysis are summarized in Table 6.4. The density value suggests that the

Table 6.4: Summary of the mathematical analysis of the Gephi network visualization for sites with at least three marine shell shapes in common.

	Total Sites	Density	Communities
Sites with at least three shapes in common	34	0.529	4

connectivity of the visualization is not extremely dense, with the 0.529 value indicating that only 52.9% of the possible connections between sites are actually present, which does not differ much from what you would expect to find in a random sample. The "groupings" value tells me that there are four clusters of sites within the larger network that are most closely connected to one another. To determine which sites are included in a grouping, I used the filter option in Gephi to isolate each one. Once the groupings were detected I isolated them individually by selecting each grouping and clicking on the filter button, as shown in Figures 6.3 and 6.4. The sites included in each grouping are summarized in Table 6.5.

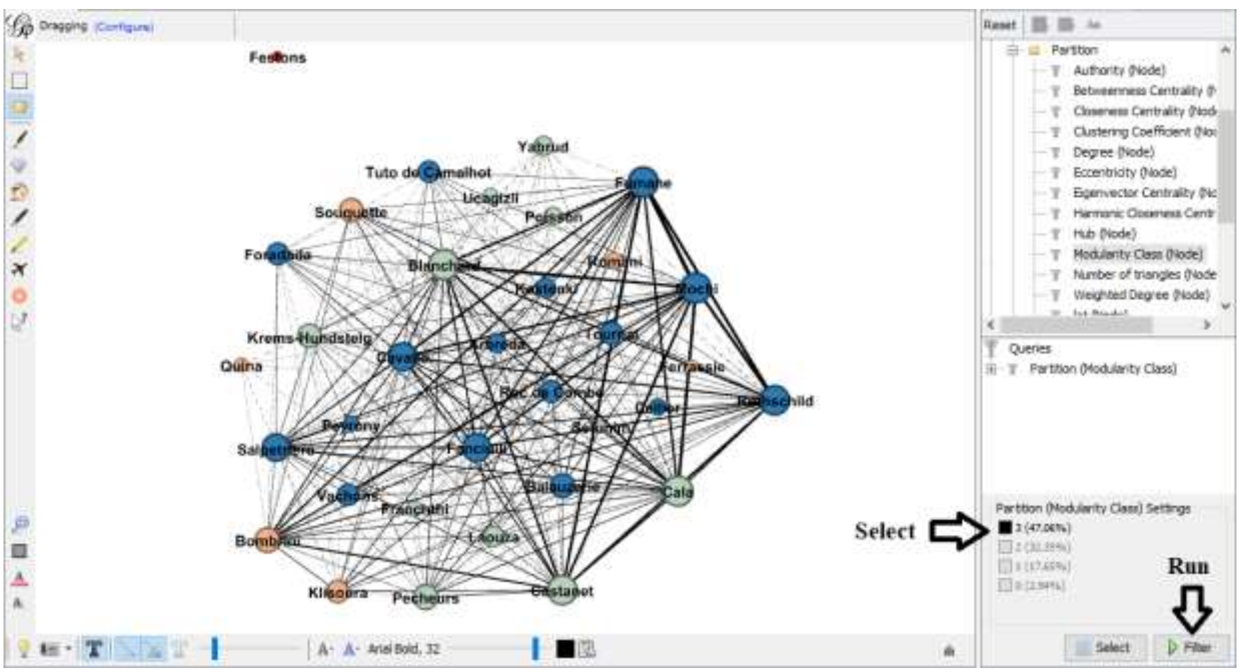


Figure 6.3: Example of how the Gephi visualizations are filtered by detected groupings using the example of sites with at least three marine shell shapes in common. The modularity class filter is selected, which then lists the four detected groupings. By clicking 'filter' the selected grouping is isolated (Figure 6.4).

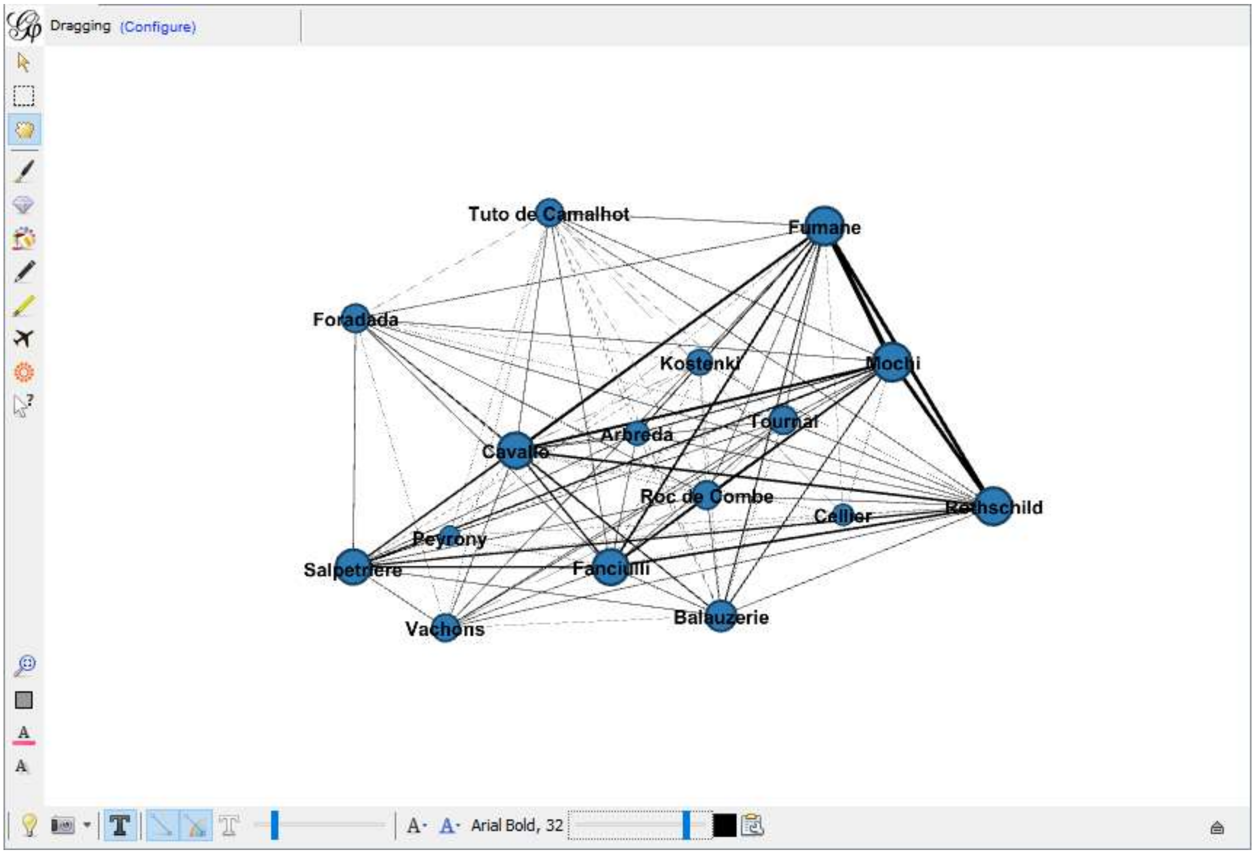


Figure 6.4: Example of how the Gephi visualizations are filtered by detected groupings using the example of sites with at least three marine shell shapes in common. Here only the nodes (sites) belonging to the grouping filtered in Figure 6.3 are shown.

Table 6.5: Sites included in the statistically similar groupings detected in the Gephi visualization of sites with at least three marine shell shapes in common.

Community	Total Sites	Site Names
Dark blue	16	Arbreda, Balauzerie, Cavallo, Cellier, Fanciulli, Foradada, Fumane, Kostenki, Mochi, Peyrony, Roc de Combe, Rothschild, Salpetriere, Tournal, Tuto de Camalhot, Vachons
Light blue	11	Blanchard, Cala, Castanet, Franchthi, Krems-Hundsteig, Laouza, Pecheurs, Poisson, Sefunim, Ucagizli, Yabrud
Light red	1	Bombrini, Ferrassie, Klisoura, Quina, Souquette, Romani
Dark red	1	Festons

The next step in my analysis of sites with at least three shapes in common was to determine the centrality of the sites. To do this I first ran the diameter algorithm and then edited the node size and color so that it was scaled according to the “betweenness” centrality. This allowed me to visually see which nodes were the most and least connected in the network

(Figure 6.5). This visual assessment was confirmed by then using the filtering tool to show only the most embedded nodes and then only the least embedded nodes. This analysis indicates that of the sites with at least three marine shell shapes Abri Blanchard is the most deeply embedded, while Festons is the least connected.

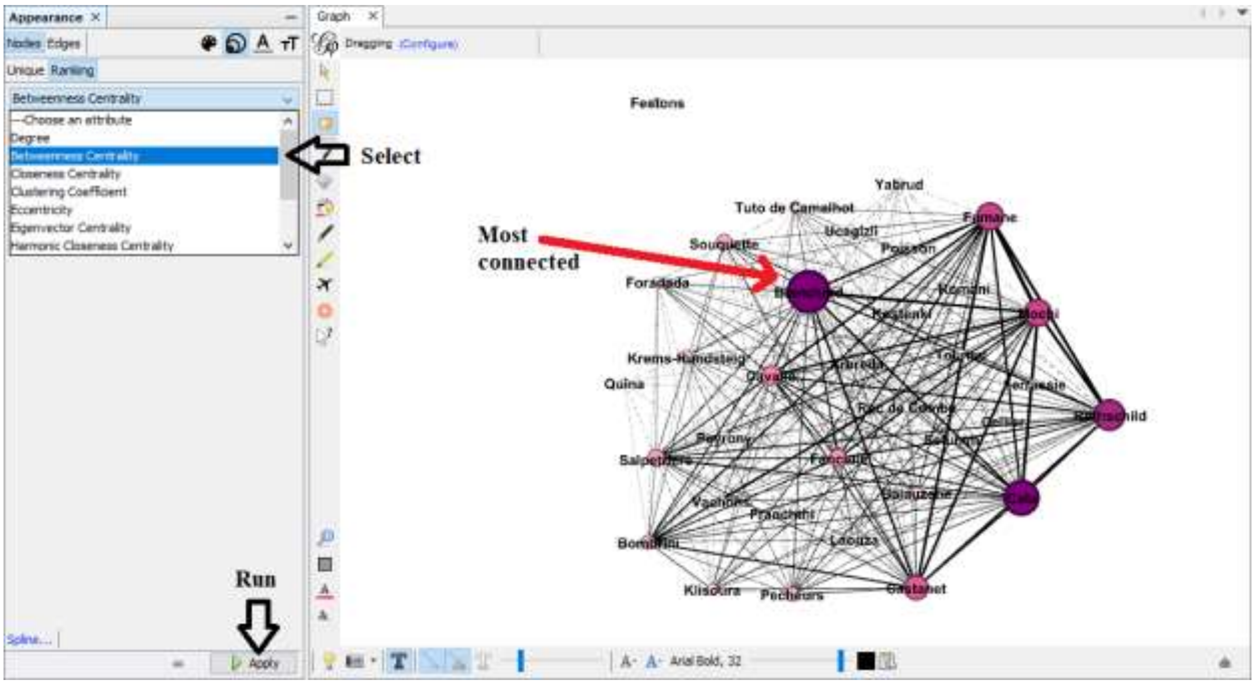


Figure 6.5: Gephi analysis of node centrality for sites with at least three marine shell shapes in common. The betweenness centrality function is selected and run by clicking ‘apply’. Nodes (sites) with the most connections become larger and darker, while those with few connections become smaller and lighter.

Figure 6.6 depicts the geographic distribution of the sites included in this portion of the analysis, with larger and darker colored nodes indicating more highly connected sites. This image was created so that the statistical analysis conducted in Gephi could be compared to the geographic distribution of the sites and shells. In order to compare the Gephi detection of groupings to the geographic distribution of the sites I edited the visualization so that each grouping is represented by a different color. This file was then exported into GoogleEarth pro, as shown in Figure 6.7 (see Appendix D for detailed views). When considering the groupings

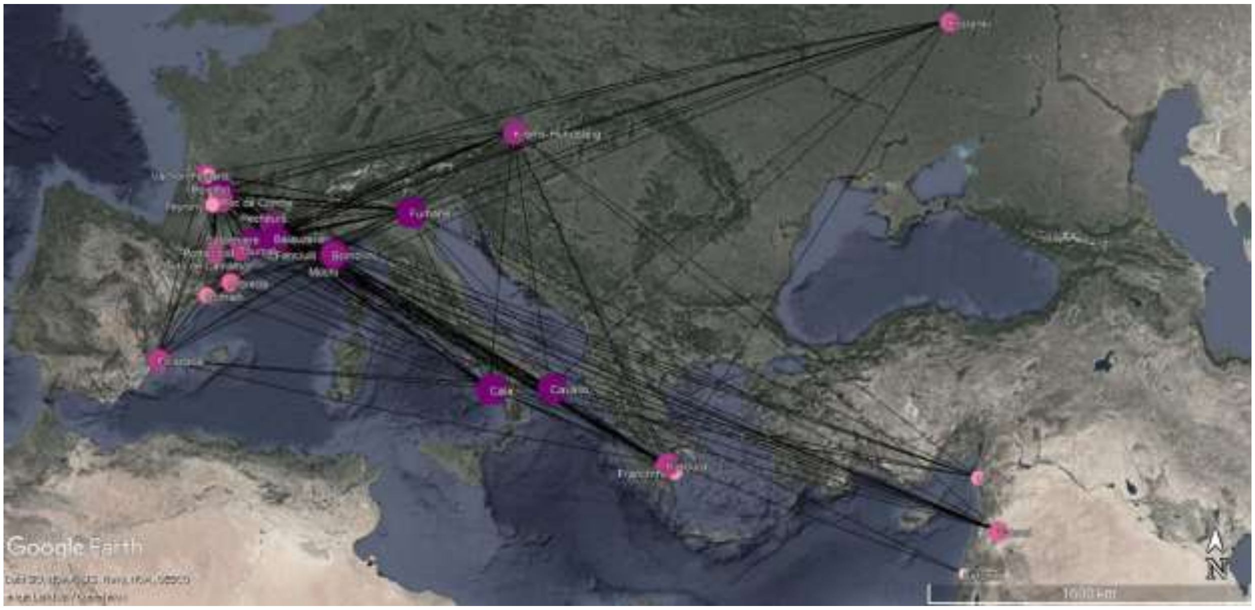


Figure 6.6: Gephi visualization for sites with at least three marine shell shapes in common mapped onto GoogleEarth Pro using the ExportToEarth plugin (see Appendix C for detailed images of highly clustered areas).

detected in the Gephi software it is clear that they are quite dispersed–the areas comprising individual groupings are not always clustered in space. Interestingly, sites that are very close to one another (i.e., Riparo Bombrini, Grotta dei Fanciulli, and Riparo Mochi) do not all belong to the same grouping detected within the Gephi visualizations, which may have something to do

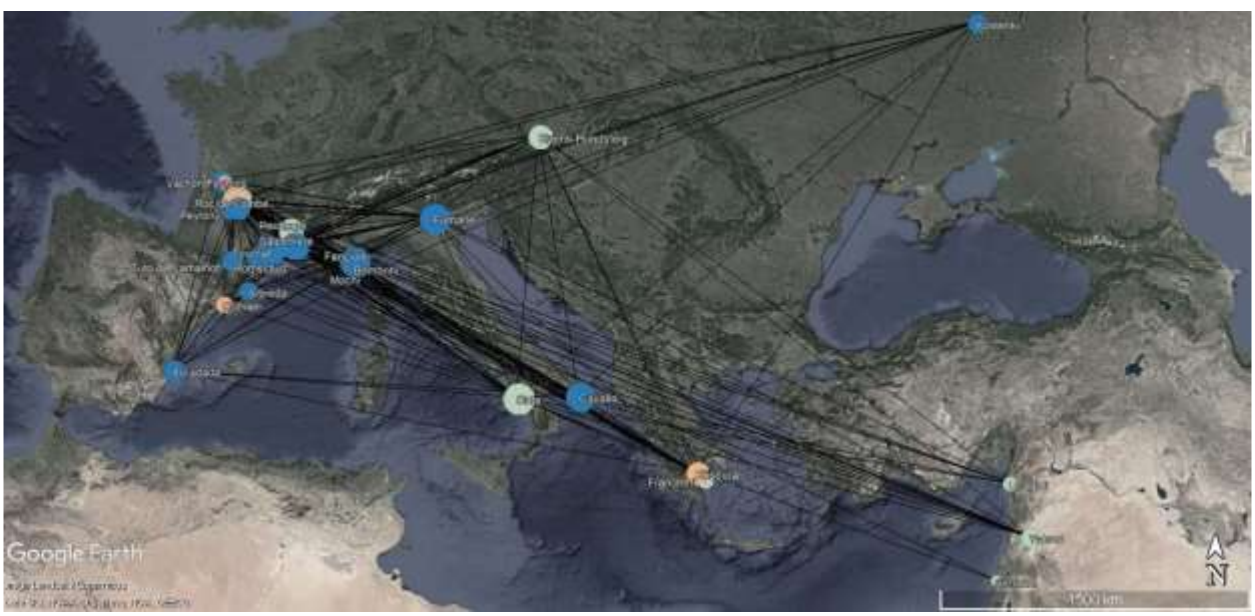


Figure 6.7: Gephi visualization for sites with at least three marine shell shapes in common edited to show detected groupings according to different node coloration and mapped onto GoogleEarth Pro. While four groupings were detected within this visualization, one grouping only included one site (Festons) which is in the Dordogne region of central France. Close up views of this and other clustered areas are in Appendix D.

with time period or site use. The possibility of these detected groupings being due to factors like time period and other activities occurring at the sites is discussed further in Chapter 7.

Analysis of marine shell shapes based on non-shell materials

In order to ensure that the results would have a higher likelihood of being statistically significant I only analyzed the marine shell shapes that were reported from at least ten sites. Therefore, of the 18 total shapes only seven (basket, bivalve, convolute, globular, top/turban, tubular, and tusk) were analyzed. The results of this analysis are summarized in Table 6.6. Two distinct groupings were detected for all but the convolute shaped shells. However, the density value for the convolute-shaped shell visualization indicates that 76.4% of all possible connections are present. Therefore, despite having some sites not directly connected to others, the groupings value indicates that the sites using convolute shaped shells are fairly highly connected to one another, possibly though indirect trade, exchange, or transmission of ideas for those sites that are not directly linked.

Table 6.6: Summary of the mathematical analysis of the Gephi network visualizations for each marine shell shape found at ten or more sites.

Shell Shape	Total Sites	Density	Communities
Basket	44	0.915	2
Bivalve	22	0.582	2
Convolute	17	0.764	1
Globular	30	0.938	2
Top-Turban	16	0.733	2
Tubular	29	0.835	2
Tusk	31	0.772	2

The Gephi visualizations for the shell shapes, not including convolute, were edited and mapped onto GoogleEarth Pro in order to visually assess the geographic patterning of the detected groupings. When this was done the groupings detected among sites with globular-, tubular-, and tusk- shaped shells appeared to be fairly randomly distributed with no discernible geographic patterning. On the other hand, for sites with basket- (Figure 6.8), bivalve- (Figure

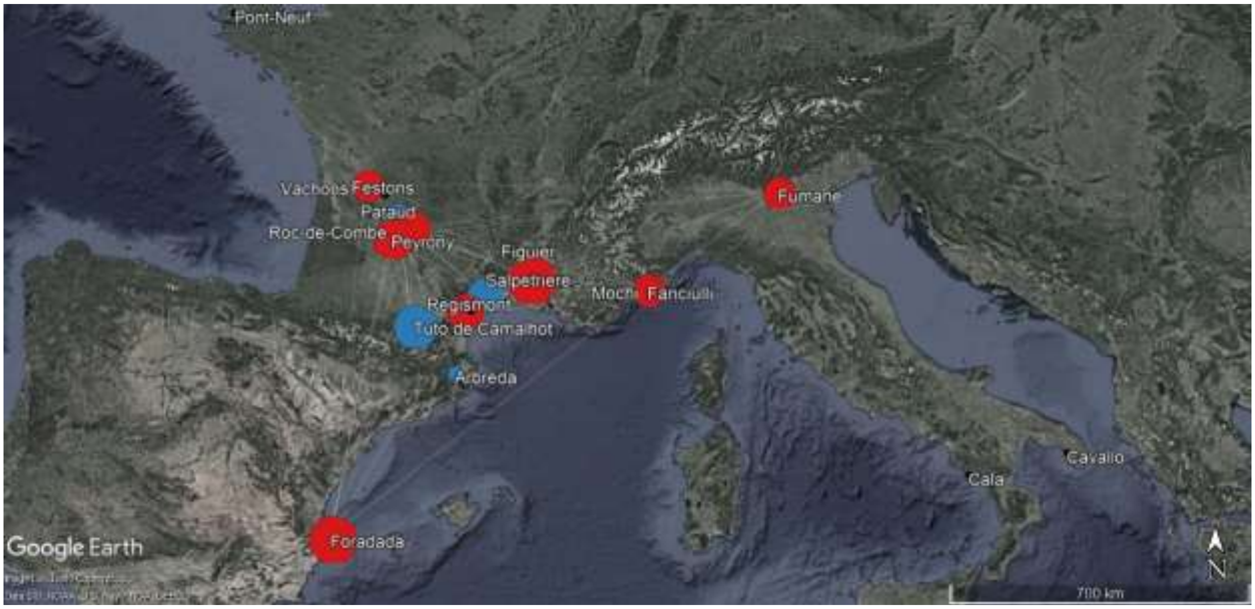


Figure 6.8: Gephi visualization of sites with bivalve-shaped shells edited to show detected groupings by different node coloration and mapped onto GoogleEarth Pro. Close-up views of more clustered areas can be found in Appendix D.

6.9) and top/turban- (Figure 6.10) shaped shells, the detected groupings do seem to demonstrate some degree of a discernible geographic pattern. In the case of sites with basket-shaped shells, with the exception of Spy, the grouping depicted in red is more centrally located and relatively clustered, while the grouping in blue contains more outlier sites like Kostenki. The central

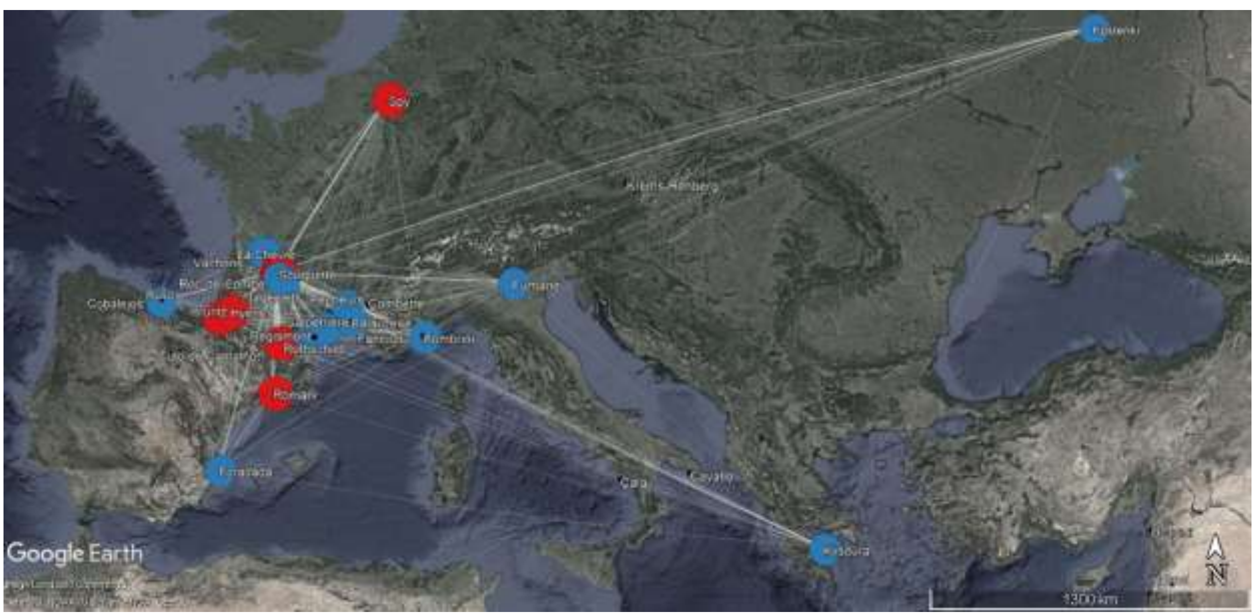


Figure 6.9: Gephi visualization of sites with basket-shaped shells edited to show detected groupings by different node coloration and mapped onto GoogleEarth Pro. Close-up views of more clustered areas can be found in Appendix D.

Figure 6.10: Gephi visualization of sites with top- and turban-shaped shells edited to show detected groupings by different node coloration and mapped onto GoogleEarth Pro. Close-up views of more clustered areas can be found in Appendix D.

France region (see Appendix D for a close up view of this area) may be an area through which materials circulated to other parts of the region, as there is a mix of sites belonging to the two groupings. A similar pattern can be seen in sites with bivalve-shaped shells, where one grouping (in blue) is more centrally located and relatively clustered, while the other (in red) has more outlier sites. Once again, this map shows a mixture of the two groupings in central France. The map for sites with top- and turban-shaped shells has a less clear pattern, although generally one grouping (in red) is located in more north-central sites, while the other (in blue) is located in more south-central sites. Interestingly, the sites of Franchthi and Klisoura, which are very close to one another, are representative of the two different statistically related groupings detected in the Gephi analysis. The implications of these maps will be discussed more in Chapter 7 in the context of trade, exchange, and migration.

The centrality of the nodes in each Gephi visualization per shell shape used was also analyzed, the results of which are summarized in Table 6.7. This analysis shows that there is quite a bit of variation between shell shapes with regards to how many and which sites are

Table 6.7: Summary of the centrality analysis for Gephi visualizations of each marine shell shape found at ten or more sites. Blanchard is the most commonly most connected site, while Fumane is the most commonly least connected site.

Shell Shape	Most Connected Site(s)	Least Connected Site(s)
Basket	Blanchard, Ferrassie, Hyénes, Isturítz, Pataud, Romaní, Souquette, Spy, Tuto de Camalhot	Balauzerie, Cellier, Cobalejos, Fanciulli, Flageolet, Foradada, Fumane, Klisoura, Kostenki, La Chevre, Pecheurs, Quina, Roc-de-Combe, Tournal, Vachons
Bivalve	Tuto de Camalhot	Fanciulli, Fumane, L'Arbreda, Mochi, Vachons
Convolute	Blanchard, Castanet, Souquette	L'Arbreda, Mochi, Rothschild
Globular	Blanchard, Castanet, Franchthi, Hyénes, Renne, Rothschild, Souquette	Balauzerie, Beneito, Fanciulli, Foradada, Fumane, Klisoura, Kostenki, Mochi, Pécheurs, Roc-de-Combe, Siouren, Tournal, Trou-Magrite, Vachons
Top/Turban	Blanchard, Castanet	Balauzerie, Fumane, Klisoura, L'Arbreda, Mochi, Pécheurs, Sous-les-Vignes
Tubular	Blanchard, Ferrassie, Souquette, Tuto de Camalhot	Balauzerie, Fanciulli, Foradada, Fumane, Klisoura, La Chevre, L'Arbreda, Peyrony, Quina, Roc-de-Combe, Saint Cesaire
Tusk	Castanet, Tuto de Camalhot	Fanciulli, Fumane, Hayonim, Krems-Rehberg, L'Arbreda, Pécheurs, Peyrony, Tournal, Vachons

mathematically the most and least connected within their respected Gephi visualizations. However, one pattern does become clear when looking at Table 6.7. Across all shell shapes there are four sites that appear most often as being the most connected: Blanchard (basket, convolute, globular, top/turban, and tubular), Castanet (convolute, globular, top/turban, and tusk), Souquette (basket, convolute, globular, and tubular) and Tuto de Camalhot (basket, bivalve, tubular, and tusk). Of these sites, the first three are located in the central France region known as the Dordogne, while the latter is located in the foothills of the Pyrenées, approximately 100km from the Mediterranean coast. The fact that the sites in the Dordogne are the most deeply embedded within many of the shell shape networks, in conjunction with the fact that the groupings detected in this region across multiple Gephi visualizations are mixed, may suggest that this region was of particular importance to the circulation of materials via processes of trade, exchange, and migration or the indirect transmission of ideas.

Analysis of non-shell ornaments based on marine shell shapes

The final step in my analysis was to determine the significance of the non-shell materials used to create ornaments that were found in association with the marine shell ornaments. Materials found at fewer than ten sites were not analyzed statistically, so only four (bone, ivory, stone, teeth) of the six non-shell materials were analyzed. The results of this analysis are summarized in Table 6.8. Of the non-shell materials used as ornaments, teeth are the most

Table 6.8: Summary of the mathematical analysis of the Gephi network visualizations for each non-shell material used as ornaments found at ten or more sites.

Other Material	Total Sites	Density	Communities
Bone	13	0.782	2
Ivory	13	0.885	3
Stone	10	0.822	1
Teeth	36	0.737	2

common, being reported at 36 of the 67 sites (or 54%). The density value of the Gephi visualization for teeth indicates that 73.7% of possible connections are present, meaning that sites using teeth as ornaments tend to use similar marine shell shapes as well. While this still indicates a dense network, it is the lowest density of the non-shell materials analyzed. For sites that also used stone as ornaments, only one distinct grouping was detected, while all other materials have two. The Gephi visualizations for the remaining materials were edited and mapped onto GoogleEarth Pro in order to visually assess the geographic patterning of the detected groupings. In addition to being the least dense visualization, the groupings among sites with teeth were very dispersed with no clear geographic patterning (Figure 6.11). However, it

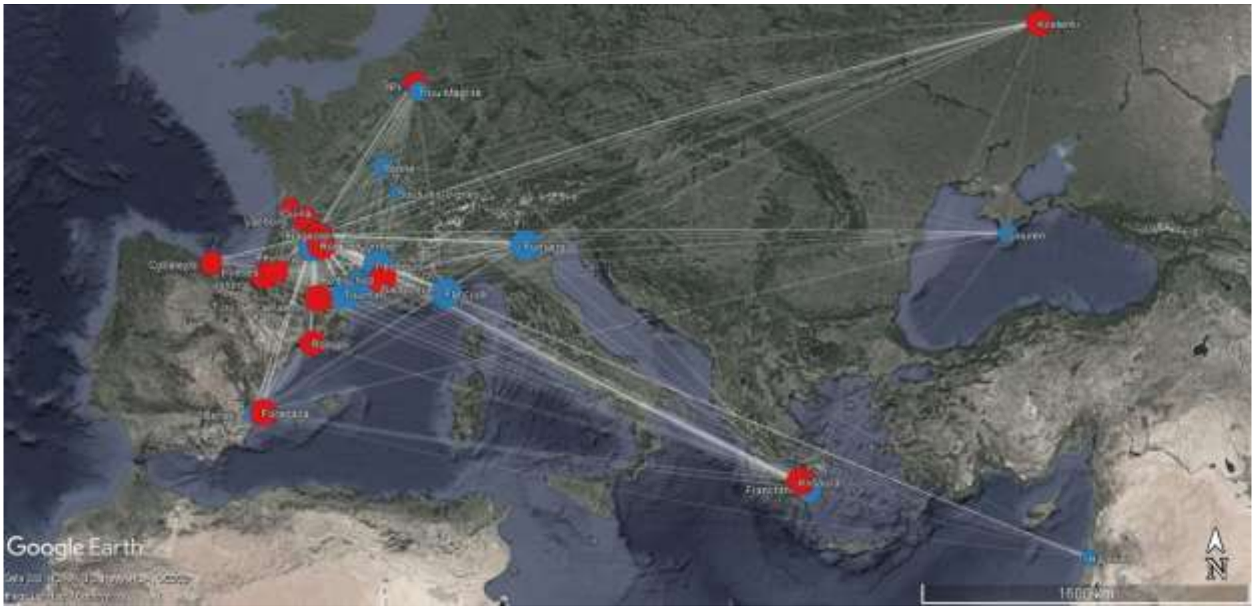


Figure 6.11: Gephi visualization of sites with ornaments made from teeth edited to show detected groupings by different node coloration and mapped onto GoogleEarth Pro. Close-up views of more clustered areas can be found in Appendix D.

appears that there is some discernible pattern to the distribution of the groupings for sites reported to have bone (Figure 6.12). Sites on the periphery of the map seem to have a clear pattern in their grouping designation, while those in central modern day France have a mixture of groupings (see Appendix D for a close-up of this area). This may suggest that central France

Figure 6.12: Gephi visualization of sites with bone ornaments edited to show detected groupings by different node coloration and mapped onto GoogleEarth Pro. Close-up views of more clustered areas can be found in Appendix D.

played a key role in the circulation of materials.

The centrality of the nodes in each Gephi visualizations for the non-shell materials used was also analyzed, the results of which are summarized in Table 6.9. Echoing the pattern seen in the analysis of the Gephi visualizations created for each marine shell shape, the sites of Blanchard and Castanet appear to be the most connected sites across all non-shell materials. Blanchard seems to be particularly embedded within each network, with the exception of sites with stone ornaments. This result further supports the idea that the Dordogne may have been a particularly important region for the circulation of materials used to create ornaments during the Aurignacian. On the other hand, Rois seems to be the least embedded site, as it is the least connected among sites with bone and ivory ornaments.

Table 6.9: Summary of the centrality analysis for Gephi visualizations of each non-shell material found at ten or more sites. Blanchard is the most commonly most connected site while Rois is the most commonly least connected site.

Other Material	Most Connected Site(s)	Least Connected Site(s)
Bone	Blanchard	Rochette, Roís
Ivory	Blanchard, Castanet, Kostenki, Souquette	Renne
Stone	Castanet, Mochi, Rothschild	Krems-Rehberg
Teeth	Blanchard	Roís

Conclusion

The purpose of this chapter was to present the results of the analysis that was conducted following the methods laid out in Chapter 5. Some interesting patterns in the geographic distribution of marine shell shapes, according to both the shapes themselves and the non-shell materials used as ornaments in relation to them, seem to be emerging. Basket-shaped shells seem to have been particularly important to Aurignacian populations, as they are reported from the highest number of sites in the greatest abundance. Additionally, the results presented here indicate that particular regions in Europe may have been more important than others with regards to the circulation of marine shell ornaments. The implications of these results will be further discussed in the context of processes of trade, exchange and migration and the material affordances of particular types of shells and non-shell materials in the following concluding chapter.

Chapter 7: Discussion and Conclusion

Revisiting the Research Questions

The main purpose of this research project was to test the hypothesis that Aurignacian populations preferentially selected particular shapes of marine shells for the creation of ornaments, and that these preferences are reflected in the geographic distribution of the shells. The questions asked in the study were threefold:

1. Is there a discernible geographic patterning in the use of particular marine shell shapes as ornaments during the Aurignacian?
2. Do the other materials used as ornaments in relation to marine shells relate to the affordances of this particular material? Are they chosen due to their material similarities?
3. How might the circulation of the ornaments have contributed to human interactions and with what effects?

In order for the hypotheses to be supported the Gephi visualizations mapped onto GoogleEarth Pro would have had to clearly depict a clustering of sites in geographically distinct areas. Furthermore, to support the hypotheses the statistical analysis of the Gephi visualizations would need to show distinct groupings (meaning sites that the Gephi program determines to be statistically similar) of closely related sites, and these groupings would be geographically clustered. Finally, statistically significant results would be expected for the ornaments made from non-shell material that have shared material qualities that may have afforded Aurignacian populations the ability to transform these materials so that they were mimetic of marine shells. The results of the analysis presented in Chapter 6 are explored here with attention paid to the broader context of this research project.

Sites with Three or More Shell Shapes in Common

For sites with three or more shell shapes in common the results of the Gephi analysis indicate that there is a fairly low density of connected sites, with only 52.9% of possible connections being present. While this seems like a low percentage, this is actually a good result as it tells me that not all of the sites contain the same or similar marine shell ornaments. This suggests that either varying shapes of marine shells were locally available to Aurignacian populations or shells of particular shapes in particular regions were preferentially selected, traded, or exchanged by them. Unfortunately the marine shells examined in this study were only identified to the genus level, meaning that exact geographic distributions for particular species, and thus shapes, of shells in the marine environment is unknown. This means that I am unable at this time to distinguish between these two possible explanations.

The analysis of node (site) connectivity indicated that Abri Blanchard is the most connected of sites with at least three marine shell shapes, and Festons is the least connected. This result may be due to the fact that Abri Blanchard has one of the most diverse selections of shell shapes and is therefore more likely to be connected to other sites that share these shapes. Alternatively, this could suggest that Abri Blanchard was an important site for trade and exchange and in the migration of Aurignacian populations, resulting in shells of a variety of shapes circulating through this area. In the case of Festons, this site has no connections with any other site with at least three different marine shell ornament shapes. This is somewhat surprising, as the site of Festons is located only approximately 50 km from Abri Blanchard and other highly connected sites such as Abri Castanet and Abri de la Souquette, all within the central French region known as the Dordogne. The shells represented at Festons are bivalve (*Cardium* sp. and *Pecten* sp.), discoidal (Ammonite), and urchin. Comparatively, these are found at few of the other sites within the Dordogne, with bivalve and discoidal shells represented at two out of seven sites and urchin at only three. Therefore, the shell ornaments at Festons were made from shapes that were relatively uncommon in the area, suggesting that this site was an outlier in the wider circulation of shell ornaments within the Dordogne. While this may have something to do with the timing of occupation, unfortunately the date for this site (35,000-27,000 BP; see Appendix A for complete database) encompasses all date ranges for the other sites in this region.

The analysis of detected groupings within the Gephi visualization (Figure 6.10) has produced mixed results with regards to the hypothesis of a regional preference for marine shell shapes. While three groupings were detected, the geographic distribution of the sites making up these groupings is widely dispersed with little evidence of clear regional clustering. Some sites that are very close to one another belong to different groupings. For instance, Riparo Bombrini, Grotta dei Fanciulli, and Riparo Mochi are located less than 300 meters from one another, yet Grotta dei Fanciulli and Riparo Mochi belong to the blue grouping and Riparo Bombrini belongs to the red grouping. The reason for this may have to do with site use as well as modern alteration of the area. These three sites may have been part of a much larger site complex with different areas used for different activities. However, in the 1800s a railway line was constructed which is today the only barrier between Riparo Mochi and Riparo Bombrini (Mussi 2002). These two sites in particular were likely one larger site at the time of occupation, but are now treated as separate due to the presence of a railway line.

Another area of interest is the Dordogne region of France. Of the eight sites within this region (Roc-de-Combe, Abri Blanchard, Abri Castanet, La Ferrassie, Peyrony, Poisson, Abri de la Souquette, and Festons) Festons is a sole outlier grouping, Roc-de-Combe and Peyrony are part of the blue grouping, and the remaining sites are part of the red grouping. This result is very interesting, as these sites in the red grouping are very close to one another–no more than 15 km apart–while Roc-de-Combe and Peyrony are approximately 30 km and 45 km away from the closest site within this cluster. Unfortunately for these sites it is difficult to say whether time is a factor as they all fall within the 35,000-27,000 BP range, with the exception of Blanchard and Castanet which are between 34,000-32,000 BP. Regardless, this suggests that, at least for the Dordogne region of central France, there may be a regional preference for particular shapes of marine shell ornaments, with the most common shapes used in this region being basket (found at all sites except Festons and Peyrony) and tubular (found at all sites except Festons and Poisson). It may also indicate that particular shapes were circulating more than others in this region. Alternatively, it may suggest that these sites were frequented by Aurignacian populations with the same or similar forms of group identification.

Individual Marine Shell Shapes

Of the 18 marine shell shapes examined in this study a total of 13 were found at less than ten sites and were therefore not analyzed with Gephi. However, the locations of these sites were still mapped onto GoogleEarth Pro. Of the 13 shapes the most interesting result is that of sites using urchin (Figure 7.1). Sites using this material during the Aurignacian are very clearly

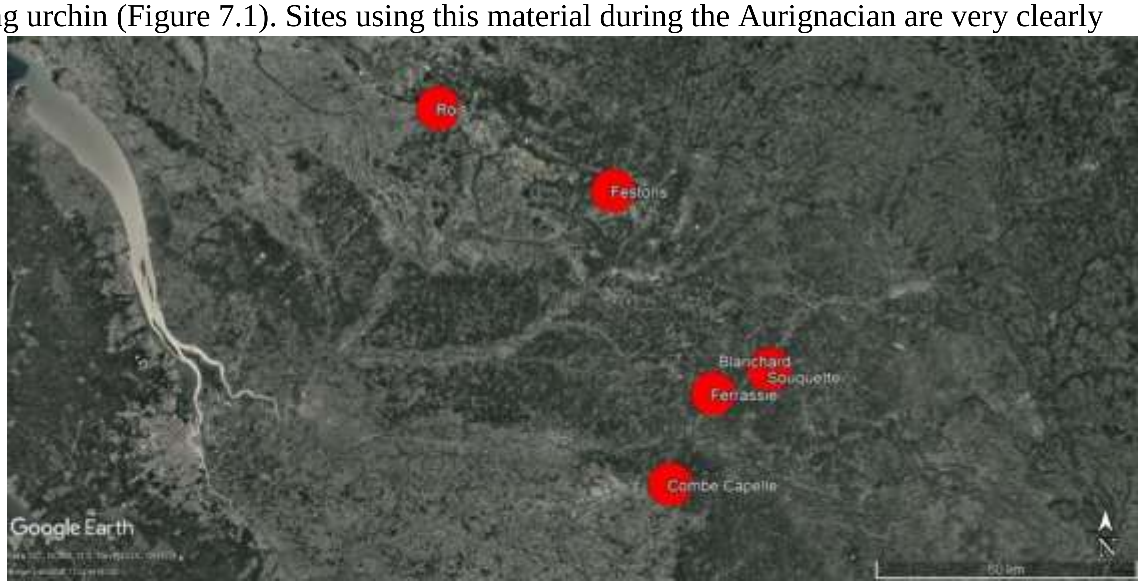


Figure 7.1: GoogleEarth map showing the location of sites using urchin as ornaments.

limited to northwest France and the central region of the Dordogne, despite being found all over the Atlantic and Mediterranean. The reason for this may be that populations in northwest France and the Dordogne had a preference for this material that was not shared by other regions in Europe. Alternatively, this result may be due to urchin either not being identified or being misidentified in assemblages for other regions.

The remaining seven shell shapes (basket, bivalve, convolute, globular, top/turban, tubular, and tusk) reported from at least ten sites were analyzed using Gephi. The connections for each of the shapes were based on the shared non-shell materials between sites in order to determine if particular suites of materials are used more commonly than others. A fairly high percentage of the possible connections between sites using basket- and globular-shaped shells are present (91.5% and 93.8 % respectively), while the density of the visualizations for the other shapes are more moderate (76.4% for convolute, 73.3% for top/turban, 83.5% for tubular, and 72.2% for tusk) or low (58.2% for bivalve). In the case of the visualization depicting the connections between sites with at least three marine shell shapes in common, the relatively moderate density value was a positive result as it indicates that my database is diverse enough so that not every site is using the same materials. However, when looking at connections between sites using particular shapes, the higher density values tell me that sites using particular shapes are also more likely to be using other similar materials. With regards to basket- and globular-shaped shells, their higher density values indicate that the vast majority of possible connections are present, suggesting that sites using these shell shapes are very similar in their use of non-shell materials as ornaments. Specifically, 56.8% of sites with basket-shaped shells and 66.67% of sites with globular-shaped shells use teeth as ornaments, with the next closest material being ivory at 25% and 20% respectively. Conversely, in the case of the bivalve shells the relatively low density value (58.2%) indicates that sites using this shell shape are often not using similar non-shell materials.

The modularity results for sites using basket- and tubular- shaped shells were quite similar in terms of geographic distribution. For basket-shaped shells the outlier sites–with the exception of Spy–belong to a single grouping. Additionally, with a few exceptions sites within one grouping seems to be focused in more centralized regions or nearer to the Atlantic coast, whereas sites within the other grouping tends to lie closer to the Mediterranean. Sites in southwest France and along the Pyrenees belong to two different groupings, which is similar to the results of the tubular-shaped shell visualization. The basket- and tubular-shaped shells are also similar in the presence of a mixture of groupings in the Dordogne region. This indicates that there is no distinct regional clustering.

Sites with bivalve shells that have at least one connection to another site seem to be more geographically clustered around central and southwest France, with a couple more dispersed sites in northern Italy and the west coast of Spain. Interestingly, these more dispersed sites all belong to one grouping, while the more clustered central and southwestern French sites are a mix between the two detected groupings. For top- and turban-shaped shells there is less mixing between detected groupings than the other marine shell shapes, with the only place where both are present very close to one another is in Greece (Klisoura and Franchthi). Sites using this type of marine shell shape with at least one connection are generally closer to the Mediterranean rather than the Atlantic, although they are also found in the Dordogne. Sites with no connections to any other sites, with the majority being in Italy, are also nearest to the Mediterranean (see Appendix D for close-up views).

For globular- and tusk-shaped shells there is a less clear patterning to the geographic distribution of detected groupings. In the case of globular-shaped shells, the more geographically dispersed sites mostly belong to one grouping (with the exception of Kostenki and Franchthi) while both groupings are mixed in central and southwestern France. Sites with tusk-shaped shells appear to be generally closer to the coast, with the exception of Krems-Rehberg and the Dordogne. If Krems-Rehberg is disregarded as an outlier a slightly clearer geographic pattern emerges with one grouping being clustered near the Pyrenees and central France, and the other being found at coastal Mediterranean sites and in central France.

Overall, the sites with the most connections to other sites using the same marine shell shapes across the seven shapes that were mapped are Abri Blanchard (basket, convolute, globular, top/turban, and tubular), Abri Castanet (convolute, globular, top/turban, and tusk), Abri de la Souquette (basket, convolute, globular, and tubular) and Tuto de Camalhot (basket, bivalve, tubular, and tusk). The first three sites are located in the Dordogne region of central France, while the last site is in the foothills of the Pyrenees in southwestern France. These results once again highlight the apparent importance of central France in particular in the circulation of certain shapes of marine shells used as ornaments.

Interestingly, the least connected sites tend to be in Italy. When considered in the broader picture this may make sense as for each marine shell shape the connections between sites are based on the shared non-shell materials. Sites in Italy are generally on or very near the coast, meaning that marine shells would have been very abundant. Therefore, if marine shell was a preferential or desired material for the creation of ornaments, than this would explain why sites in this region tend not to use other materials as ornaments. This may be a regional preference, as sites near the Mediterranean coast in southwestern France tend to use other materials as well. This could also be indicative of a lack of trade or exchange in ornaments made from non-shell materials from sites in central and southern Italy with sites in other regions of Europe. The fact that we see connections between sites in Greece (Franchthi and Klisoura) and other sites in Europe using similar non-shell materials is therefore somewhat surprising, and may indicate that people living on these islands had different preferences for ornament materials than those living in central and southern Italy.

Non-shell Materials in Relation to Marine Shell Ornaments

Of the six non-shell materials used as ornaments in relation to marine shells, only four (bone, ivory, stone, and teeth) were reported from at least ten sites. These four materials were mapped onto GoogleEarth Pro and analyzed statistically, while the remaining two materials (antler and talon) were mapped but not analyzed. Sites using stone as ornaments were not mapped according to the modularity test as only one distinct grouping was detected. This result is interesting as it suggests that sites using stone as a material for ornaments are very similar in their use of particular marine shell shapes. For instance, the sites of Abri Castanet, Rothschild, Abri de la Souquette, Tuto de Camalhot, and Riparo Mochi all have large amounts of basket-shaped shell genera present (six at Abri Castanet, seven at both Rothschild and Riparo Mochi, and three at both Abri de la Souquette and Tuto de Camalhot). With the exception of Tuto de Camalhot these sites also have convolute- and globular-shaped shells in common.

The density values of the Gephi visualizations for bone, ivory, stone, and teeth show a moderate to high amount of possible connections being present (78.2% for bone, 88.5% for ivory, 82.2% for stone, and 73.7% for teeth). Again, these relatively moderate to high values indicate that there is some similarity between sites using particular non-shell materials in relation to the shell shapes being used. For instance, all but two (Rochette and Rois) of the 13 sites using bone as ornaments also use basket-shaped shells. For the 12 sites using ivory, all but two (Renne and L'Arbreda) use basket-shaped shells and all but four (Spy, Flageolet, Hyénes, and Renne) use either tusk- or tubular-shaped shells, or both. There are ten sites that use stone as ornaments, with all but two (Krems-Rehberg and Renne) using basket-shaped shells and all but four (Spy, Hyénes, Isturitz, and Renne) using tusk- or tubular-shaped shells. Finally, of the 36 sites using teeth, the vast majority of the sites use basket-shaped shells, with the exception of 11 (Trou-Magrite, Peyrony, Renne, Rochette, Rois, Saint Cesaire, Sous les Vignes, Franchthi, Hayonim, Beneito, and Siouren). The next most common marine shell shape associated with teeth is globular, appearing at 20 of the 36 sites (Trou-Magrite, Balauzerie, Abri Blanchard, Abri Castanet, Roc de Combe, Hyénes, Pécheurs, Renne, Rothschild, Abri de la Souquette, Tournal, Vachons, Franchthi, Klisoura, Fanciulli, Fumane, Kostenki, Beneito, Cobalejos, and Foradada).

For sites using bone as ornaments the geographic distribution based on the shell shapes used shows stronger patterning. Sites located in the Pyrenees belong to one grouping, along with Spy as an outlier site, while the other grouping is only found in central France and one site in northern Italy. Central France has a mix of both groupings, once again suggesting that this area was important in the circulation of different materials used as ornaments. Sites using ivory show a similar pattern, with outliers (Kostenki, Spy, and Renne) belonging to one grouping, the second grouping being distributed along the Pyrenees and northwest Spain (with the exception of Hyenes), and a mixture of the two being located in central France. Generally, the two detected groupings seem to cluster with one containing sites closer to the Atlantic and the other containing sites closer to the Mediterranean. Teeth are the most common non-shell material used as ornaments in relation to marine shell. While two groupings were detected, they are mixed throughout all of Europe–a result that is not very surprising given their commonality and availability.

The Broader Context

Processes of interaction

The results of this research project highlight the importance of some regions over others in the transmission and circulation of marine shell ornaments during the Aurignacian period. In particular, the Dordogne region of central France appears to have played a significant role in the circulations of materials used and carried by people, and the practices that those people likely spread to others. The Aurignacian sites in the Castlemerle region of the Dordogne appear to be particularly important in the context of this research project. These sites include Abri Castanet, Abri Blanchard, and Ari de la Souquette, which are among the more connected sites across most shell shapes and non-shell materials. Other researchers have noted the apparent importance of these sites in the past, with Taborin (2004:81; quoted in Conneller 2011:41) calling this region "an Aurignacian crossroads."

This study has shown that not only do these sites tend to be more connected than others, this region also tends to be a center of mixing between detected groupings. This mixing of groupings may be indicative of broader circulations of people, materials, and ideas. The Dordogne region is particularly well suited to these larger scale movements and interactions, as it is nearly equidistant from both the Atlantic and Mediterranean coast. Additionally, the sites in this region tend to be clustered along a river valley that would have given Aurignacian populations immediate access to abundant resources. The river valley itself would have facilitated not just long-term occupation (Hoffecker 2011), but also the migration of different groups into and through the region perhaps on a seasonal basis, allowing for the movement of marine shell ornaments both into and out of the region. The region itself may have served as a refugia for later populations as the climate deteriorated elsewhere in Europe towards the LGM

(Davies et al. 2003).

While this area may have been a hub for the circulation of materials and ideas, it is also possible that the abundance of materials recovered here are a product of selection bias. The Dordogne region itself has been extensively excavated for over 100 years (Tartar et al. 2014). This can lead to something of a feedback loop or confirmation bias; because researchers know that important Paleolithic sites have been found there before they choose to continue to excavate there, while not necessarily excavating in lesser known areas that may prove to be equally important. This can lead to an abundance of material being recovered from one particular area, thus making that area seem particularly important.

Sites in central and southern Italy are consistently excluded from having connections with other sites in Europe based on the non-shell materials used as ornaments. However, those in northern Italy along possible migration routes from Eastern Europe into Western Europe are consistently connected to other sites across Europe, especially those in southwestern and central France. This may indicate that populations in central and southern Italy during the Aurignacian were isolated from the broader circulations of ornaments made from non-shell materials. One possible explanation for this is that sites in this region would have fairly immediate access to an abundance of marine shells to use as ornaments, and if marine shell was a desired resource they had little reason to create ornaments from other materials. This undermines the notion that ornaments were an important item for trade in order to establish and maintain social connections vital to survival during times of resource scarcity and fluctuating environmental conditions. As previously discussed in Chapter 2, central and southern Italy had a relatively mild climate (part of the Mediterranean climate zone) during MIS 3 and could have served as a refuge for populations during the Last Glacial Maximum. Therefore, it may not have been necessary for populations in this region to maintain extensive interactions with other groups through the exchange of ornaments in the comparatively milder Aurignacian period, as the climate and availability of resources remained relatively stable.

Much of the overlap between detected groupings may be due to processes of interaction or, alternatively, due to differences in site use and timing of occupation. The Greek sites of Franchthi and Klisoura, for example, were found to belong to two different groupings for top/turban shaped shell. Dates for Aurignacian levels at Franchthi Cave place it around 39,000 cal BP, whereas the Aurignacian of Klisoura is dated to 27-29,000 ^{14}C ka BP to 32-33,000 ^{14}C ka BP (Stiner et al. 2012). This difference in the timing of Aurignacian occupations may have led to different types of shells being available or differences in the preferences for particular materials. The availability of particular shells may have varied in relation to the climatic and environmental oscillations that were fairly common during the Aurignacian period, as discussed in Chapter 2. This study also showed a consistent difference in grouping affinity between Riparo Mochi and Riparo Bombrini which, as previously discussed, were likely once a single occupation site that was later bisected by a railway.

On the affordances of marine shells

The apparent preference for marine shell ornaments in regions like central and southern Italy speaks to the affordances of this material. Marine shells are a relatively easy material to work with when making ornaments when compared to non-shell materials such as ivory or bone. The effort required to perforate a shell is much lower than that required to prepare, shape, and perforate a piece of ivory. Experimental studies have demonstrated that it could have taken a skilled craftsperson close to three hours to create a single ivory bead (White 1995, 2007). Comparatively, experiments have shown that it takes no more than just a few minutes to perforate marine shells with a variety of different techniques and implements (Tátá et al. 2014). Additionally, if shells were collected on beaches after being washed ashore it is entirely likely that in many cases they may have already been perforated by predatory snails. While the information gathered for this study does not explicitly demonstrate if such natural perforations were taken advantage of by Aurignacian populations, such perforations would have afforded the gatherers of the shells to immediately use them as ornaments with very little effort (Bar-Yosef 2005). Other shells, such as abalone (*Haliotis* sp.), have naturally occurring holes in their shells that are not caused by predatory snails, which could also have afforded an immediate use as ornaments or pendants with minimal effort.

Of the non-shell materials used as ornaments in relation to shell, teeth are the most commonly observed material in this study. If shell was a desired material, then the material qualities of teeth may have afforded Aurignacian populations the ability to mimic the qualities of shell. When they are polished teeth, as well as ivory, can mimic the bright white coloration of many marine shells as well as the reflectivity of shell (Conneller 2011). Additionally, as discussed in Chapter 2 red deer canines mimic the basket shape of the most commonly selected marine shells during the Palaeolithic in general (Stiner 2014). Similarly, the material qualities of ivory may have afforded the use of this material to resemble the surface appearance of shell ornaments. At the Gravettian site of Pair-non-Pair in France, for instance, a piece of ivory carved to resemble a cowrie shell and used as an ornament was recovered (Taborin 2000).

It is not surprising that although these two materials share many of the same qualities that could afford the users the ability to create ornaments resembling shell, teeth are more commonly used than ivory. Teeth would have been a much more commonly acquired resource for Aurignacian populations, as ivory was collected from woolly mammoth remains, an animal which was not common in some southern regions of Europe. Additionally, the size of teeth compared to ivory would have afforded fewer uses of the material for Aurignacian populations, while ivory could be shaped and used in more ways. That being said, the large quantity of ivory being used as ornaments in areas such as the Dordogne (Heckel and Wolf 2014) suggests that these ornaments were likely circulated among Aurignacian populations in distant locations through processes of migration, trade, and exchange.

The creation of ornaments resembling shell through other materials speaks to the affordances of both shell and non-shell materials. To make an object or material present or more visible can in turn bring attention to the absence of something else (Jones 2012:21). An affordance of materials like ivory, stone, and teeth is their ability to be transformed to resemble marine shell. The presence of non-shell materials in the form of shells can make present the absence of shell as a material at particular sites. Furthermore, the abundant presence of shell ornaments at sites in central and southern Italy makes more present the absence of non-shell material, thus highlighting the importance of shell as a resource.

What can we say about Aurignacian society?

The results of this study allow us to make some inferences about the lived lives of everyday Aurignacian populations. Primarily, the vast geographic range in which marine shell ornaments are found suggests that Aurignacian people were highly mobile, travelling long distances to acquire marine shells and other resources, or were connected through complex processes of trade and exchange of material goods. It is most likely that a combination of the two took place.

Additionally, the consistency of the presence of marine shell ornaments at archaeological sites ranging from coastal Portugal to the interior of Germany to the caves of the Near East suggests that there was a consistency in the social and aesthetic values of Aurignacian societies. With regards to the aesthetic quality of marine shell and non-shell ornaments in the context of an Aurignacian society, the production of sound and reflection of light would have played an important role. Ornaments strung together as bracelets, anklets, and necklaces, or sewn onto clothing, would have resulted in the production of a complex soundscape. The lived experience of an Aurignacian person performing simple movements such as walking or gathering foods to more complex movements such as dancing would be highly dynamic, as ornaments worn on the body and knocking together would transform these activities.

Light and the aesthetic quality of reflectivity would have also played a key role in the daily lives of Aurignacian populations in the context of ornaments. When they are polished marine shells can be highly reflective. This is also true of non-shell materials that were used as ornaments, such as teeth and ivory. Much of the daily lives of Aurignacian people would have been spent gathered around fires, and it is in the flickering firelight that the reflectivity of marine shell ornaments would have been most apparent. For thousands of years the hearth has been the place of social gathering and connection, and flickering light of the fire playing off the polished ornaments tinkling with every movement would have transformed this experience for Aurignacian people.

While the aesthetic qualities of marine shell and non-shell ornaments were likely very important in Aurignacian societies, they were also likely more than simply aesthetic additions to the human form. Some authors (Kuhn and Stiner 2007; Stiner 2014; Vanhaeren 2005) have argued that ornaments played an important role in signaling social belonging and group affinity. Due to the fact that the ornaments discussed in this thesis were largely recovered from habitation sites, rather than being found with associated human remains, it is unknown in what configurations the ornaments would have been worn during the Aurignacian. However, some of the results of this study suggest that there may have been some regional preferences for particular materials that may have been a reflection of social and group affinity.

For instance, the previously discussed presence of sea urchin ornaments constrained only to sites located in the Dordogne region of central France, while urchin is and was available in Atlantic and Mediterranean contexts, may suggest that this was a visual signifier of people in this region. Alternatively, the lack of urchin reported from other sites may be due to differences in recording of finds or misidentification of materials. Additionally, the lack of non-shell materials used as ornaments and the heavy reliance on marine shells as ornaments from sites in central and southern Italy may similarly be a signifier of people from this region. Again, however, this may instead be due to the abundance of marine shells available in these areas. However, we also see marine resource rich sites such as Klissoura and Franchthi using more than just marine shells as ornaments.

Taken together it is clear that Aurignacian populations placed importance on marine shells as ornaments. The vast distances over which people travelled to acquire shells or exchanged other materials for shells demonstrates their value as a desired material. It is also very likely that the aesthetic qualities of these materials played a key role in Aurignacian societies. More research needs to be done to draw conclusions on the role of these ornaments in the signifying of social and group affinity, but the present study presents tantalizing evidence that some form of group identity may have been signaled through the use of these items.

Future Research

The limitations of this research project demonstrate the need for more detailed analysis of marine shell ornaments recovered from archaeological sites during the Paleolithic in general. A more robust examination of the circulations of these objects would be possible if they were identified to the species level and if the exact number of ornaments per species were known. While many species of marine shells are known to have inhabited both the Mediterranean Sea and Atlantic Ocean, there are many species that would have been found in more isolated regions. By knowing the exact species of shell ornaments recovered at sites it may be possible to trace where the shells would have originated from, which can open the door to new projects centered on the migration patterns of Paleolithic populations and the trade and exchange of ornaments. Isotopic analysis and other chemical analyses of these shells may further this type of research by determining more precisely where the shells would have originated.

Future access to collections of marine shell ornaments from the Paleolithic could add to and strengthen research into the material choices being made by Paleolithic populations. While the present study focused solely on the shape of the marine shells used as ornaments during the Aurignacian, access to collections would have allowed for a more detailed analysis of the affordances of the shells used. Information on the coloration, texture, and size of the shell ornaments, in conjunction with their shape, would lead to a more robust analysis of the material choices that were made. In addition to this, detailed information on the non-shell materials used in association with marine shells could strengthen our understanding of material choice in the Aurignacian. While the types of teeth used as ornaments were known for most sites included in this study (see Appendix A for complete database), the subdivision of teeth into further categories of canine, incisor, molar, and premolar was not explored. In the future, such categorization may reveal more about the material choices being made with regards to ornament shape. Additional information on the shape of ivory, stone, and bone ornaments could add to this discussion as well.

Further studies on the shells themselves could also guide research on the procurement strategies of Paleolithic populations. Were the shells used for ornaments collected after they had washed up on shore? Does microscopic analysis of the shells indicate that they were first harvested as a food resource and then repurposed as ornaments? Did Paleolithic populations take advantage of shells naturally perforated by predatory species? Investigations into these types of questions can help to build a more complete picture of the material choices that were made during the Aurignacian in particular and the Paleolithic more generally. Such avenues of research could be important to our understanding of how Paleolithic peoples may have taken advantage of the diversity of resources available to them and how this, in turn, allowed our species to form and maintain long distance relationships that enabled us to survive the later harsh conditions of the Last Glacial Maximum.

Conclusion

This study has demonstrated the potential of using social network analysis software to gain a better understanding of the material choices made by Aurignacian populations. The results suggest that particular regions such as the Dordogne of central France were likely very important in the broader circulations of people, materials, and objects. Additionally, areas like Italy were highlighted as being somewhat isolated from the wider circulations of non-shell materials used for the creation of ornaments, highlighting the importance of shell as a material in this region. The interaction between shell and non-shell materials suggests that shell may have been a preferred material that was mimicked in other materials when not readily available. Additionally, the presence of marine shell ornaments in sites far from the sea, such as Kostenki and Krems-Rehberg, indicates that these materials were involved in processes of individual and group interactions across vast geographic areas and were likely carried by migrating populations.

By looking into the affordances of the materials used as ornaments during the Aurignacian this study has demonstrated the potential for the use of this theoretical framework in asking and exploring new and interesting questions. Rather than focusing on the potential meaning of the objects, by investigating the affordances of materials one can gain a better understanding of the material choices being made. Material choice is important to investigate because it can inform on other areas such as manufacturing techniques, group identities, and the direct and indirect transmission of ideas. This study should be seen as an initial attempt to build a framework for investigating these lines of inquiry with a particular focus on marine shell ornaments. Future studies can build off the foundation laid here to gain a more nuanced understanding of the material choices made by past peoples and what this can tell us about their lived lives.

Bibliography

Abbott, T. and P. Dance. 1982. *Compendium of Seashells: A Color Guide to More than 4,200 of the World's Marine Shells.* New York: E.P. Dutton, Inc.

Adler, D., O. Bar-Yosef, A. Belfer-Cohen, N. Tushabramishvili, E. Boaretto, N. Mercier, H. Valladas, and W. J. Rink. 2008. "Dating the Demise: Neandertal Extinction and the Establishment of Modern Humans in the Southern Caucasus." *Journal of Human Evolution* 55 (5):817–33. https://doi.org/10.1016/j.jhevol.2008.08.010.

Adovasio, J.M., O. Soffer, D. Hyland, D. Illingworth, B. Klíma, and J. Svoboda. 2001. "Perishable Industries from Dolní Vestonice I: New Insights into the Nature and Origin of the Gravettian." *Archaeology Ethnology and Anthropology of Eurasia* 2. 48-65.

Adovasio, J., O. Soffer, and B. Klíma. 1996. "Upper Palaeolithic Fibre Technology: Interlaced Woven Finds from Pavlov I, Czech Republic, c. 26,000 Years Ago." *Antiquity* 70 (269):526–34. https://doi.org/10.1017/S0003598X0008368X.

Alcaraz-Castaño, M., M. López-Recio, F. Tapias, F. Cuartero, J. Baena, B. Ruiz-Zapata, J. Morín, A. Pérez-González, and M. Santonja. 2017. "The Human Settlement of Central Iberia during MIS 2: New Technological, Chronological and Environmental Data from the Solutrean Workshop of Las Delicias (Manzanares River Valley, Spain)." *Quaternary International* 431:104–24. https://doi.org/10.1016/j.quaint.2015.06.069.

Álvarez-Fernández, E. 2006. ""'Atlantic versus Mediterranean": Personal Ornaments made from Mollusc Shells in Europe During the Upper Palaeolithic and Mesolithic." *Bone Commons*. Accessed November 10, 2016.

Álvarez-Fernández, E. 2011. "Humans and Marine Resource Interaction Reappraised: Archaeofauna Remains during the Late Pleistocene and Holocene in Cantabrian Spain." *Journal of Anthropological Archaeology* 30 (3):327–43. https://doi.org/10.1016/j.jaa.2011.05.005.

Anderson, L., F. Bon, J-G Bordes, A. Pasquini, L. Slimak, and N. Teyssandier. 2015. "Relier des espaces, construire de nouveaux réseaux: aux origines du Protoaurignacien et des débuts du Paléolithique supérieur en Europe occidentale.", In *Les systèmes de mobilité de la Préhistoire au Moyen-Age*, edited by N. Naudinot, L. Meignen, D. Binder, and G. Querré, 93–109. Antibes: ADPCA.

Bahn, P. 2016. *Images the of Age*. Oxford: Oxford University Press.

Balbín Behrmann, R., and J. Javier Alcolea González. 2009. "Les Colorants de l'art Paléolithique Dans Les Grottes et En Plein Air." *Anthropologie* 113 (3–4):559–601. https://doi.org/10.1016/j.anthro.2009.09.012.

Balme, J., and K. Morse. 2006. "Shell Beads and Social Behaviour in Pleistocene Australia." *Antiquity* 80 (310):799–811. https://doi.org/10.1017/S0003598X00094436.

Banks, W., F. D'errico, and J. Zilhão. 2013. "Humane-climate Interaction during the Early Upper Paleolithic: Testing the Hypothesis of an Adaptive Shift between the Proto-Aurignacian and the Early Aurignacian." *Journal of Human Evolution* 64:39-55 https://doi.org/10.1016/j.jhevol.2012.10.001.

Bar-Yosef, O., and J.G. Bordes. 2010. "Who Were the Makers of the Châtelperronian Culture?" *Journal of Human Evolution* 59 (5):586–93. https://doi.org/10.1016/j.jhevol.2010.06.009.

Bar-Yosef Mayer, D. 2015. "Nassarius Shells: Preferred Beads of the Palaeolithic." *Quaternary International* 390:79–84. https://doi.org/10.1016/j.quaint.2015.05.042.

Bar-Yosef Mayer, D. and I. Zohar. 2005. "The exploitation of shell as beads in the Palaeolithic and Néolithic of the Levant." *Paléorient* 31(1):176–85. https://doi.org/10.3406/paleo.2005.4796.

Bardet, M., and F. Noceti. 2012. "With Descartes, against Dualism." *Journal of Dance & Somatic Practices* 4 (2):195–209. https://doi.org/10.1386/jdsp.4.2.195_1.

Barron, E., T. van Andel, and D. Pollard. 2003. "Glacial Environments II: Reconstructing the Climate of Europe During the Last Glaciation." In *Neanderthals and Modern Humans in the European Landscape During the Last Glaciation: Archaeological Results of the Stage 3 Project*, edited by T. van Andel and W. Davies, 57-78. University of Michigan: McDonald Institute for Archaeological Research.

Becerra-Valdivia, L., K. Douka, D. Comeskey, B. Bazgir, N. J Conard, C. Marean, and A. Ollé 2017. "Chronometric Investigations of the Middle to Upper Paleolithic Transition in the Zagros Mountains Using AMS Radiocarbon Dating and Bayesian Age Modelling." *Journal of Human Evolution* 109:57–69. https://doi.org/10.1016/j.jhevol.2017.05.011.

Blades, B. 2001. *Aurignacian Lithic Economy: Ecological Perspectives from Southwestern France*. *Interdisciplinary Contributions to Archaeology*. Kluwer Academic/Plenum Pub.

Blair, E. 2016. "Glass beads and constellations of practice." In *Knowledge in Motion: Constellations of Learning Across Time and Place*, edited by A. Roddick and A. Stahl. Tucson: University of Arizona Press. Pp 97-125

Blondel, V., J. Loup Guillaume, R. Lambiotte, and E. Lefebvre. 2008. "Fast Unfolding of Communities in Large Networks." *Journal of Statistical Mechanics: Theory and Experiment* 2008 (10). https://doi.org/10.1088/1742-5468/2008/10/P10008.

Boivin, N. 2004. "Mind over matter? Collapsing the mind-matter dichotomy in material culture studies." In *Rethinking materiality: the engagement of mind with the material world*, edited by E. DeMarrais, C. Gosden and C. Renfrew, 63-72. Cambridge: McDonald Institute for Archaeological Research.

Bosch, M., M. Mannino, A. Prendergast, T. O'Connell, B. Demarchi, S. Taylor, L. Niven, J. van der Plicht, and J. Hublin. 2015. "New Chronology for Ksâr 'Akil (Lebanon) Supports Levantine Route of Modern Human Dispersal into Europe." *Proceedings of the National Academy of Sciences* 112 (25):7683–88. https://doi.org/10.1073/pnas.1501529112.

Bose, R. 2013. *Palaeobiology of Middle Paleozoic Marine Brachiopods: A Case Study of Extinct Organisms in Classical Paleontology*. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-00194-4.

Breves, André, Maria Teresa M. de Széchy, Helena P. Lavrado, and Andrea O.R. Junqueira. 2017. "Abundance of the Reef-Building Petaloconchus Varians (Gastropoda: Vermetidae) on Intertidal Rocky Shores at Ilha Grande Bay, Southeastern Brazil." *Anais Da Academia Brasileira de Ciencias* 89 (2). Academia Brasileira de Ciências:907–18. https://doi.org/10.1590/0001-3765201720160433.

Callon, M. and J. Law 1997. "After the individual in society: Lessons on collectivity from science, technology and society." *Canadian Journal of Sociology* 22(2): 165-182

Camps, M., and T. Higham. 2012. "Chronology of the Middle to Upper Palaeolithic Transition at Abric Romaní, Catalunya." *Journal of Human Evolution* 62 (1):89–103. https://doi.org/10.1016/j.jhevol.2011.10.010.

Caron, F., P. Del Moral, F. Santos, and J. Zilhão. 2011. "The Reality of Neandertal Symbolic Behavior at the Grotte Du Renne, Arcy-Sur-Cure, France." *PLOS One* https://doi.org/10.1371/journal.pone.0021545.

Chalmin, E., M. Menu, and C. Vignaud. 2003. "Analysis of Rock Art Painting and Technology of Palaeolithic Painters." *Measurement Science and Technology* 14 (9):1590–97. https://doi.org/10.1088/0957-0233/14/9/310.

Clottes, J. 2013. "Why Did They Draw in Those Caves?" *Time and Mind* 6 (1):7–14. https://doi.org/10.2752/175169713X13500468476321.

Cohen, V., and V. Stepanchuk. 1999. "Late Middle and Early Upper Palaeolithic Evidence from the Eastern European Plane and the Caucasus: A New Look at Variability, Interactions and Transitions." *Journal of World Prehistory* 13 (3):265–319. https://doi.org/10.2307/25801145.

Collar, A., F. Coward, T. Brughmans, and B. Mills 2015. "Networks in archaeology: phenomena, abstraction, representation." *Journal of Archaeological Method and Theory* 22: 1-32

Conard, N. 2009. "A Female Figurine from the Basal Aurignacian of Hohle Fels Cave in Southwestern Germany." *Nature* 459 (7244):248–52. https://doi.org/10.1038/nature07995.

Conard, N.J. and M. Bolus. 2003. "Radiocarbon dating the appearance of modern humans and timing of cultural innovations in Europe: new results and new challenges." *Journal of Human Evolution* 44:331-371.

Conard, N. J. and M. Bolus. 2008. "Radiocarbon dating the late Middle Paleolithic and the Aurignacian of the Swabian Jura." *Journal of Human Evolution* 55:886–897.

Conkey, M. W. 1984. "To find ourselves: Art and social geography of prehistoric hunter gatherers." In *Past and present in hunter gatherer studies*, edited by C. Schrire, 253–276. Orlando: Academic Press.

Conkey, M. W. 1985. "Ritual communication, social elaboration, and the variable trajectories of Paleolithic material culture." In *Prehistoric hunter-gatherers: The emergence of cultural complexity*, edited by T. D. Price & J. A. Brown, 299–323. Orlando: Academic Press.

Conkey, M. W. 1987. "New approaches in the search for meaning? A review of research in 'Paleolithic art'." *Journal of Field Archaeology*, 14, 413–430.

Conkey, M. 2010. "Images without Words: The Construction of Prehistoric Imaginaries for Definitions of 'Us.'" *Journal of Visual Culture* 9 (3):272–83. https://doi.org/10.1177/1470412910380341.

Conneller, C. 2011. *An Archaeology of Materials: Substantial Transformations in Early Prehistoric Europe*. Routledge.

Costall, A., and A. Richards. 2013. "Canonical affordances: the psychology of everyday things." In *The Oxford handbook of the archaeology of the contemporary world*, edited by P. Graves-Brown, R. Harrison and A. Piccini. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199602001.013.047.

Coward, F. 2013. "Grounding the net: social networks, material culture, and geography in the Epipaleolithic and early Neolithic of the Near East (~21-6,000 cal BCE)." In *Network analysis in archaeology: new approaches to regional interaction*, edited by C. Knappett, 247-280. Oxford: Oxford University Press.

Cowgill, L., E. Trinkaus, and M. Zeder. 2007. "Shanidar 10: A Middle Paleolithic Immature Distal Lower Limb from Shanidar Cave, Iraqi Kurdistan." *Journal of Human Evolution* 53 (2):213–23. https://doi.org/10.1016/j.jhevol.2007.04.003.

Crossland, Z. 2010. "Materiality and embodiment." In *The Oxford handbook of material culture studies*, edited by D. Hicks and M. Beaudry, 386-405. Oxford: Oxford University Press

Cuenca-Solana, D., F. Gutiérrez-Zugasti, M. González-Morales, J. Setién-Marquinez, E. Ruiz-Martinez, A. García-Moreno, and I. Clemente-Conte. 2013. "Shell Technology, Rock Art, and the Role of Marine Resources during the Upper Paleolithic." *Current Anthropology* 54 (3):370–80. https://doi.org/10.1086/670325.

Cvitkuši, B., and D. Komšo. 2015. “Display Modes of Personal Ornaments in the Upper Palaeolithic Sites of Istria, Croatia.” *Collegium Antropologicum* 39 (2):481–88. http://www.ncbi.nlm.nih.gov/pubmed/26753470.

d’Errico, F., J. Zilhão, M. Julien, D. Baffier, and JacJ.ques Pelegrin. 1998. “Neanderthal Acculturation in Western Europe? A Critical Review of the Evidence and Its Interpretation.” *Current Anthropology* 39 (S1):S1–44. https://doi.org/10.1086/204689.

d’Errico, F., M. Vanhaeren, and L. Wadley. 2008. “Possible Shell Beads from the Middle Stone Age Layers of Sibudu Cave, South Africa.” *Journal of Archaeological Science* 35 (10):2675–85. https://doi.org/10.1016/j.jas.2008.04.023.

d’Errico, F., M. Vanhaeren, N. Barton, A. Bouzouggar, H. Mienis, D. Richter, J.-J. Hublin, S. P. McPherron, and P. Lozouet. 2009. “Additional Evidence on the Use of Personal Ornaments in the Middle Paleolithic of North Africa.” *Proceedings of the National Academy of Sciences* 106 (38):16051–56. https://doi.org/10.1073/pnas.0903532106.

d’Errico, F., M. Vanhaeren, K. Van Niekerk, C. S. Henshilwood, and R. M. Erasmus. 2015. “Assessing the Accidental Versus Deliberate Colour Modification of Shell Beads: Case Study on Perforated Nassarius Kraussianus from Blombos Cave Middle Stone Age Levels.” *Archaeometry* 57 (1):51–76. https://doi.org/10.1111/arcm.12072.

d’Errico, Francesco, and Lucinda Backwell. 2016. “Earliest Evidence of Personal Ornaments Associated with Burial: The Conus Shells from Border Cave.” *Journal of Human Evolution* 93:91–108. https://doi.org/10.1016/j.jhevol.2016.01.002.

Daura, J., M. Sanz, N. García, E. Allué, M. Vaquero, E. Fierro, and J.S. Carrión. 2013. “Terrasses de La Riera Dels Canyars (Gavà, Barcelona): The Landscape of Heinrich Stadial 4 North of the ‘Ebro Frontier’ and Implications for Modern Human Dispersal into Iberia.” *Quaternary Science Reviews* 60:26–48. https://doi.org/10.1016/j.quascirev.2012.10.042.

Davies, W., P. Valdes, C. Ross, and T. van Andel.2003. “The Human Presence in Europe During the Last Glacial Period III: Site Clusters, Regional Climates and Resource Attractions”. In *Neanderthals and Modern Humans in the European Landscape During the Last Glaciation: Archaeological Results of the Stage 3 Project,* edited by Tjeerd van Andel and Williams Davies, 191-220. University of Michigan: McDonald Institute for Archaeological Research.

Dayrat, B.M., M. Conrad, S. Balayan, T. R. White, C. Albrecht, R. Golding, S. R. Gomes, M. G. Harasewych, and A. de Frias Martins. 2011. “Phylogenetic Relationships and Evolution of Pulmonate Gastropods (Mollusca): New Insights from Increased Taxon Sampling.” *Molecular Phylogenetics and Evolution* 59 (2):425–37. https://doi.org/10.1016/j.ympev.2011.02.014.

Donald, K. M., JoaJ.nne Preston, S. T. Williams, D. G. Reid, DaD.vid Winter, RaR.quel Alvarez, B Buge, S. Hawkins, J. Templado, and H. G. Spencer. 2012. “Phylogenetic Relationships Elucidate Colonization Patterns in the Intertidal Grazers Osilinus Philippi, 1847 and

Phorcus Risso, 1826 (Gastropoda: Trochidae) in the Northeastern Atlantic Ocean and Mediterranean Sea.” *Molecular Phylogenetics and Evolution* 62 (1):35–45. https://doi.org/10.1016/j.ympev.2011.09.002.

Dragusin, V.. 2012. “A MIS 3 Stable Isotope Record from Petera Ascuns, Romania – Implications for Understanding Regional Climate Dynamics at the Time of Early Modern Human Migration into Europe.” *Quaternary International* 123:279–280. https://doi.org/10.1016/j.quaint.2012.08.019.

Elmasry, E., H A Omar, F A Abdel Razek, and M A El-Magd. 2013. “Preliminary Studies on Habitat and Diversity of Some Sea Urchin Species (Echinodermata: Echinoidea) on the Southern Levantine Basin of Egypt Production and Hosting by Elsevier Egyptian Journal of Aquatic Research.” *The Egyptian Journal of Aquatic Research* 39:303–11. https://doi.org/10.1016/j.ejar.2013.12.009.

Evans, J., J. A. Borg, and P. J. Schembri. 2011. “Distribution, Habitat Preferences and Behaviour of the Critically Endangered Maltese Top-Shell Gibbula Nivosa (Gastropoda: Trochidae).” *Marine Biology* 158 (3):603–11. https://doi.org/10.1007/s00227-010-1584-4.

Finlayson, C., D. Fa, FranF. Jiménez Espejo, J. Carrión, G. Finlayson, F. Pacheco, J. Rodríguez Vidal, C. Stringer, and F. Martínez Ruiz. 2008. “Gorham’s Cave, Gibraltar-The Persistence of a Neanderthal Population.” *Quaternary International* 181 (1):64–71. https://doi.org/10.1016/j.quaint.2007.11.016.

Fossil Works. Accessed May 15, 2017. http://fossilworks.org/

Fowler, C. 2010. “From identity and material culture to personhood and materiality.” In *The Oxford handbook of material culture studie*s, edited by D. Hicks and M. Beaudry, 352 385. Oxford: Oxford University Press

Fritz, C., G. Tosello, and M. Conkey. 2016. “Reflections on the Identities and Roles of the Artists in European Paleolithic Societies.” *Journal of Archaeological Method and Theory* 23 (4):1307–32. https://doi.org/10.1007/s10816-015-9265-8.

Frumkin, A., O. Bar-Yosef, and H. P Schwarcz. 2011. “Possible Paleohydrologic and Paleoclimatic Effects on Hominin Migration and Occupation of the Levantine Middle Paleolithic Q.” *Journal of Human Evolution* 60:437–51. https://doi.org/10.1016/j.jhevol.2010.03.010.

Garcea, E. 2010. “South-Eastern Mediterranean Peoples Between 130,000-10,000 Years Ago.” Oxbow Books.

Garcea, E. 2012. “Successes and Failures of Human Dispersals from North Africa.” *Quaternary International* 270:119–28. https://doi.org/10.1016/j.quaint.2011.06.034.

García-Diez, M., D. L. Hoffmann, J. Zilhão, C. de las Heras, J. A. Lasheras, R. Montes, and A. W.G. Pike. 2013. "Uranium Series Dating Reveals a Long Sequence of Rock Art at Altamira Cave (Santillana Del Mar, Cantabria)." *Journal of Archaeological Science*: 40(11):4098-4106 https://doi.org/10.1016/j.jas.2013.05.011.

Gaver, W. 1991. "Technology Affordances." *In* Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Reaching through Technology - CHI '91, 79–84. New York: ACM Press. https://doi.org/10.1145/108844.108856.

Geertz, C. 1973. *The interpretation of cultures*. New York: Basic Books.

Geertz, C. 1974. *Myth, symbol, and culture*. New York: W. W. Norton.

Gephi. Accessed February 10, 2017. https://gephi.org/

Gibbons, A.. 2010. "Tracing Evolutions Recent Fingerprints." *Science* 329 (5993):740-742. https://doi.org/10.1126/science.329.5993.740.

Gibson, J. J. 1966. *The senses considered as perceptual systems*. University of Michigan: Houghton Mifflin.

Gibson, J. J. 1979. *The ecological approach to visual perception.* Boston: Houghton Mifflin.

Gibson, J. J., E. Reed, and R. Jones. 1982. *Reasons for realism: selected essays of James J. Gibson*. University of Michigan: L. Erlbaum.

Gillings, M. 1998. "Embracing Uncertainty and Challenging Dualism in the GIS-Based Study of a Palaeo-Flood Plain." *European Journal of Archaeology* 1(1):117–44. https://doi.org/10.1179/eja.1998.1.1.117.

Gillings, M. 2009. "Visual Affordance, Landscape, and the Megaliths of Alderney." *Journal of Archaeology* 28 (4):335–56. https://doi.org/10.1111/j.1468-0092.2009.00332.x.

Gillings, Mark. 2012. "Landscape Phenomenology, GIS and the Role of Affordance." *Journal of Archaeological Method and Theory* 19(4):601-611. https://doi.org/10.2307/23365981.

Giribet, G., A. Okusu, A. Lindgren, S. Huff, M. Schrödl, and M. Nishiguchi. 2006. "Evidence for a Clade Composed of Molluscs with Serially Repeated Structures: Monoplacophorans Are Related to Chitons." *Proceedings of the National Academy of Sciences of the United States of America* 103 (20):7723–28. https://doi.org/10.1073/pnas.0602578103.

González-Sainz, C., A. Ruiz-Redondo, D. Garate-Maidagan, and E. Iriarte-Avilés. 2013. "Not Only Chauvet: Dating Aurignacian Rock Art in Altxerri B Cave (Northern Spain)." *Journal of Human Evolution* 65 (4):457–64. https://doi.org/10.1016/j.jhevol.2013.08.001.

GoogleEarth Pro. Accessed March 3, 2017. https://www.google.com/earth/download/gep/agree.html

Gosden, C., 2005. “What do objects want?” *Journal of Archaeological Method and Theory* 12(3):193-211

Gosling, Elizabeth. 2015. *Marine Bivalve Molluscs*. Wiley. https://doi.org/10.1002/9781119045212.

Green, R., J. Krause, A. Briggs, T. Maricic, U. Stenzel, M. Kircher, and N. Patterson. 2010. “A Draft Sequence of the Neandertal Genome.” *Science* 328 (5979):710–22. https://doi.org/10.1126/science.1188021.

Grün, R., C. Stringer, F. Mcdermott, R. Nathan, N. Porat, S. Robertson, L. Taylor, G. Mortimer, S. Eggins, and M. Mcculloch. 2005. “U-Series and ESR Analyses of Bones and Teeth Relating to the Human Burials from Skhul.” *Journal of Human Evolution* 49(3):316-334. https://doi.org/10.1016/j.jhevol.2005.04.006.

Heckel, C., 2009. “Physical characteristics of mammoth ivory and their implications for ivory work in the Upper Paleolithic.” *Mitteilungen der Gesellschaft für Urgeschichte* 18:71.

Heckel, C. and S. Wolf. 2014. “Ivory debitage by fracture in the Aurignacian: experimental and archaeological examples.” *Journal of Archaeological Science* 42:1-14. https://doi.org/10.1016/j.jas.2013.10.021

Henshilwood, C., M. Vanhaeren, K. Van Niekerk, and Z. Jacobs. 2004. “Middle Stone Age shell beads from South Africa.” *Science* 304:404.

Hicks, D. 2010. “The Material-Cultural Turn: event and effect.” In T*he Oxford handbook of material culture studies,* edited by D. Hicks and M. Beaudry, 25-98. Oxford: Oxford University Press

Higham, T., R. Jacobi, M. Julien, F. David, L. Basell, R. Wood, W. Davies, and C. Bronk Ramsey. 2010. “Chronology of the Grotte Du Renne (France) and Implications for the Context of Ornaments and Human Remains within the Chatelperronian.” *Proceedings of the National Academy of Sciences* 107 (47):20234–39. https://doi.org/10.1073/pnas.1007963107.

Higham, T., L. Basell, R. Jacobi, R. Wood, C. Bronk Ramsey, and N. Conard. 2012. “Testing Models for the Beginnings of the Aurignacian and the Advent of Figurative Art and Music: The Radiocarbon Chronology of Geißenklosterle.” *Journal of Human Evolution* 62:664–76. https://doi.org/10.1016/j.jhevol.2012.03.003.

Higham, T., R. Wood, L. Moreau, N. Conard, and C. Bronk Ramsey. 2013. “Comments on `Human-Climate Interaction during the Early Upper Paleolithic: Testing the Hypothesis of an Adaptive Shift between the Proto-Aurignacian and the Early Aurignacian’ by Banks et Al.” *Journal of Human Evolution* 65:806–9. https://doi.org/10.1016/j.jhevol.2013.06.010.

Higham, T., K. Douka, R. Wood, C. Bronk Ramsey, F. Brock, L. Basell, and M. Camps. 2014. "The Timing and Spatiotemporal Patterning of Neanderthal Disappearance." *Nature* 512 (7514):306–9. https://doi.org/10.1038/nature13621.

Hodder, Ian 1982. *Symbols in action: ethnoarchaeological studies of material culture*. Cambridge University Press

Hodder, I. 1999. *The archaeological process: an introduction*. Wiley-Blackwell Press

Hodder, I. 2012. *Entangled: An Archaeology of the Relationships between Humans and Things*. Wiley-Blackwell.

Hodder, I. 2014. "The Entanglements of Human and Things: A Long-Term View." *New Literary History* 45(1): 19-36

Hoffecker, J. 2011. "The Early Upper Paleolithic of Eastern Europe Reconsidered." *Evolutionary Anthropology* 20 (1):24–39. https://doi.org/10.1002/evan.20284.

Hoffmann, D L, C D Standish, M García-Diez, P B Pettitt, J A Milton, J Zilhão, and J J Alcolea-González. 2018. "U-Th Dating of Carbonate Crusts Reveals Neandertal Origin of Iberian Cave Art." *Science* 359(6378):912–15. https://doi.org/10.1126/science.aap7778.

Hogendorn, J., and M. Johnson. 1986. "The Shell Money of the Slave Trade." Cambridge University Press, 230. http://voyager.library.uvic.ca/vwebv/holdingsInfo?bibId=89747.

Hollenback, K. and M. Schiffer. 2010. "Technology and material life." In *The Oxford handbook of material culture studies*, edited by D. Hicks and M. Beaudry, 313-332. Oxford: Oxford University Press

Hublin, J.-J., S. Talamo, M. Julien, F. David, N. Connet, P. Bodu, B. Vandermeersch, and M. Richards. 2012. "Radiocarbon Dates from the Grotte Du Renne and Saint-Cesaire Support a Neandertal Origin for the Chatelperronian." *Proceedings of the National Academy of Sciences* 109 (46):18743–48. https://doi.org/10.1073/pnas.1212924109.

Huntley, B. and . Allen. 2003 "Glacial Environments III: Paleo-vegetation patterns in Late Glacial Europe." In *Neanderthals and Modern Humans in the European Landscape During the Last Glaciation: Archaeological Results of the Stage 3 Project,* edited by Tjeerd van Andel and Williams Davies, 79-102. University of Michigan: McDonald Institute for Archaeological Research, 2003.

Hurcombe, L. 2014. *Perishable Material Culture in Prehistory: Investigating the Missing Majority*. *Perishable Material Culture in Prehistory: Investigating the Missing Majority*. https://doi.org/10.4324/9781315817729.

Hussain, S., and H. Floss. 2016. "Streams as Entanglement of Nature and Culture: European

Upper Paleolithic River Systems and Their Role as Features of Spatial Organization." *Journal of Archaeological Method and Theory* 23 (4):1162–1218. https://doi.org/10.1007/s10816-015-9263-x.

Ingold, T. 1992. "Culture and the Perception of the Environment." In *Bush base, forest farm: culture, environment, and development,* edited by E. Croll and D. Parkin, 39-56. London.

Ingold, T., 2000a. *The Perception of the Environment: Essays in Livelihood, Dwelling, and Skill*. London: Routledge.

Ingold, T., 2000b. "Making culture and weaving the world."In *Matter, Materiality and Modern Culture,* edited by P.M. Graves-Brown, 50-71. London: Routledge.

Ingold, T., 2007. "Materials against materiality." *Archaeological Dialogues* 14(1):1-38

Ingold, T.. 2012. "Toward an Ecology of Materials." *Annual Review of Anthropology* 41 (1):427–42. https://doi.org/10.1146/annurev-anthro-081309-145920.

Jochim, M.. 2002. "The Upper Palaeolithic." In *European Prehistory: A Survey,* edited by Sarunas Milisauskas, 55–68. New York: Kluwer Academic.

Jones, A. 2012. *Prehistoric materialities*. Oxford: Oxford University Press.

Jones, A. and N. Boivin 2010. "The malice of inanimate objects: material agency." In *The Oxford handbook of material culture studies,* edited by D. Hicks and M. Beaudry, 333-351. Oxford: Oxford University Press

Joyce, R. 2005. "Archaeology of the body." *Annual Review of Anthropology,* 34:139–158.

Knappett, C. 2004. "The affordances of things: a post-Gibsonian perspective on the relationality of mind and matter." In *Rethinking materiality: the engagement of mind with the material world,* edited by DeMarrais, E., C. Gosden, and C. Renfrew, 43-51. Oxford: Oxbow Books.

Knappett, C. 2005. *Thinking through material culture*. Philadelphia: University of Pennsylvania Press.

Knappett, C. 2013. *Network analysis in archaeology: new approaches to regional interaction*. Oxford: Oxford University Press

Koumouzelis, M., B. Ginter, J. Kozlowski, M. Pawlikowski, O. Bar-Yosef, R. Maria Albert, and M. Litynska-Zajac. 2001a. "The Early Upper Palaeolithic in Greece: The Excavations in Klisoura Cave." *Journal of Archaeological Science* 28:515–39. https://doi.org/10.1006/jasc.2000.0599.

Koumouzelis, M., J. Kozlowski, C. Escutenaire, V. Sitlivy, K. Sobczyk, H. Valladas, and N. Tisneratlaborde. 2001b. "La Fin Du Paléolithique Moyen et Le Début Du Paléolithique Supérieur En Grèce: La Séquence de La Grotte 1 de Klissoura." *L'Anthropologie* 105 (4):469–504. https://doi.org/10.1016/S0003-5521(01)80049-2.

Kozlowski, J. 2007. "The significance of blade technologies in the period 50-35 kya BP for the Middle-Upper Palaeolithic transition in central and Eastern Europe." In *Rethinking the human revolution: new behavioural and biological perspectives on the origin and dispersal of modern humans,* edited by P. Mellars, K.Boyle , O. Bar-Yosef, and C. Stringer. Cambridge:

Kuhn, S. 2014. "Signaling theory and technologies of communication in the Paleolithic." *Biological Theory* 9(1): 42-50

Kuhn, S. & M. Stiner. 2007. "Body ornamentation as information technology: Towards an understanding of the significance of early beads," in *Rethinking the human revolution: New behavioural and biological perspectives on the origin and dispersal of modern humans*, ed. Mellars, P., Boyle, K., Bar-Yosef, O. & C. Stringer, 45–54. Cambridge: McDonald Institute for Archaeological Research.

Kuhn, S., M. Stiner, E. Güleç, I. Özer, H. Yilmaz, I. Baykara, and A. Açikkol. 2009. "The Early Upper Paleolithic Occupations at Üçağizli Cave (Hatay, Turkey)." *Journal of Human Evolution* 56 (2):87–113. https://doi.org/10.1016/j.jhevol.2008.07.014.

Lahr, M. and R. Foley. 2003. "Demography, Dispersal and Human Evolution in the Last Glacial Period." In *Neanderthals and Modern Humans in the European Landscape During the Last Glaciation: Archaeological Results of the Stage 3 Project,* edited by Tjeerd van Andel and Williams Davies, 241-256. University of Michigan: McDonald Institute for Archaeological Research.

Landman, N., R. Davis, and R. Mapes. 2007. *Cephalopods Present and Past: New Insights and Fresh Perspectives*. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-1-4020-6806-5.

Lock, M. and J. Farquhar. 2007. *Beyond the Body Proper: Reading the Anthropology of Material Life*. Durham: Duke University Press.

Lohse, K., and L. Frantz. 2014. "Neandertal Admixture in Eurasia Confirmed by Maximum-Likelihood Analysis of Three Genomes." *Genetics* 196 (4):1241–51. https://doi.org/10.1534/genetics.114.162396.

Malafouris, L. 2013. *How Things Shape the Mind : A Theory of Material Engagement*. MIT Press. http://cognet.mit.edu.ezproxy.library.uvic.ca/book/how-things-shape-mind.

Malinowski,B. 1992. *Argonauts of the Western Pacific: an Account of Native Enterprise and Adventure in the Archipelagoes of Melanesian New Guinea*. London: Routledge.

Mann, K., A. Poustka, and M. Mann. 2008. "The Sea Urchin (Strongylocentrotus Purpuratus) Test and Spine Proteomes." *Proteome Science* 6 (1):22. https://doi.org/10.1186/1477-5956-6-22.

Mannino, M., R. Di Salvo, V. Schimmenti, C. Di Patti, A. Incarbona, L. Sineo, and M. Richards

2011a. "Upper Paleolithic hunter-gatherer subsistence in Mediterranean coastal environments: an isotopic study of the diets of the earliest directly-dated humans from Sicily." *Journal of Archaeological Science* 38(11): 3094-3100

Mannino, M., K.D. Thomas, M.J. Leng, R. Di Salvo, and M.P. Richards 2011b. "Stuck to the shore? Investigating prehistoric hunter-gatherer subsistence, mobility and territoriality in a Mediterranean coastal landscape through isotope analyses on marine mollusc shell carbonates and human bone collgen." *Quaternary International* 244(1): 88-104

Marquardt, W. and L. Kozuch. 2016. "The Lightning Whelk: An Enduring Icon of Southeastern North American Spirituality." *Journal of Anthropological Archaeology* 42:1–26. https://doi.org/10.1016/j.jaa.2016.01.005.

Marshack, A. 1972. *The roots of civilization: The cognitive beginnings of man's first art.* New York: McGraw-Hill.

Marshack, A. 1976. "Some implications of the Paleolithic symbolic evidence for the origin of language." *Current Anthropology,* 17:274–282.

Marshall, Y. and B. Alberti. 2014. "A Matter of Difference: Karen Barad, Ontology and Archaeological Bodies." *Cambridge Archaeological Journal* 24(1):19-36.

McGrenere, J., and Ho, W. 2000. "Affordances: clarifying and evolving a concept." *Proceedings of Graphics Interface*, 179–186

Mellars, P. 1999. "Chatelperronian chronology and the case for Neandertal/modern human "acculturation" in western Europe." *Current Anthropology* 40(3): 341-350

Mellars, Paul. 2006. "Archeology and the Dispersal of Modern Humans in Europe: Deconstructing the 'Aurignacian.'" *Evolutionary Anthropology* 15(5):167-182. https://doi.org/10.1002/evan.20103.

Mercier, N., H. Valladas, O. Bar-Yosef, B. Vandermeersch, C. Stringer, and J. L. Joron. 1993. "Thermoluminescence Date for the Mousterian Burial Site of Es-Skhul, Mt. Carmel." *Journal of Archaeological Science* 20 (2):169–74. https://doi.org/10.1006/jasc.1993.1012.

Micheli, R. 2012. "Personal ornaments, Neolithic groups and social identities: some insights from Northern Italy." *Documenta Praehistorica* 39: 227-255

Miller, D. 1987. *Material culture and mass consumption*. Oxford: Blackwell.

Miller, D. 1990. "Persons and blue jeans: beyond fetishism." *Etnofoor* 3:97-111

Miller, D. 1998. "Why some things matter." In *Material cultures: why some things matter,* edited by D. Miller, 3-21. London: Routledge.

Miller, D. 2005. *Materiality*. Durham: Duke University Press.

Miller, D. 2007. “Stone age or plastic age?” *Archaeological Dialogues* 14(1):23-7.

Modica, M.V., P. Mariottini, J. Prkić, and M. Oliverio. 2013. “DNA-Barcoding of Sympatric Species of Ectoparasitic Gastropods of the Genus Cerithiopsis (Mollusca: Gastropoda: Cerithiopsidae) from Croatia.” *Journal of the Marine Biological Association of the United Kingdom* 93(4):1059–65. https://doi.org/10.1017/S0025315412000926.

Moro Abadía, O. and A. Nowell. 2015. “Palaeolithic Personal Ornaments: Historical Development and Epistemological Challenges.” *Journal of Archaeological Method and Theory* 22 (3):952–79. https://doi.org/10.1007/s10816-014-9213-z.

Moro Abadía, O., & González Morales, M. R. 2013. “Paleolithic art. A cultural history.” *Journal of Archaeological Research* 21:269–306.

Mussi, M. 2002. *Earliest Italy: an overview of the Italian Paleolithic and Mesolithic.* New York: Kluwer Academic.

Neruda, P. and Z. Nerudova. 2013. “The Middle-Upper Palaeolithic transition in Moravia in the context of the Middle Danube region.” *Quaternary International* 294:3-19.

Nigst, P. R., P. Haesaerts, F. Damblon, C. Franck, C. Mallol, C. Viola, M. Götzinger, L. Niven, G. Trnka, and J-J Hublin. 2014. “Early modern human settlement of Europe north of the Alps occurred 43,500 years ago in a cold steppe-type environment.” *PNAS* 111(40):14394–14399.

Norman, D. 1988. *The psychology of everyday things. Basic Books*, 257p.

Norman, D. 1999. “Affordance, Conventions and Design.” *Interactions* 6(3):38-43.

Nowell, A. 2006. “From a Paleolithic Art to Pleistocene Visual Cultures (Introduction to Two Special Issues on ’Advances in the Study of Pleistocene Imagery and Symbol Use’).” *Journal of Archaeological Method and Theory* 13(4):239-249. https://doi.org/10.1007/s10816-006-9020-2.

Nowell, A., and M. Chang. 2014. “Science, the Media, and Interpretations of Upper Paleolithic Figurines.” *American Anthropologist* 116(3):562–77. https://doi.org/10.1111/aman.12121.

Otte, M., S. Shidrang, N. Zwyns, and D. Flas. 2011. “New Radiocarbon Dates for the Zagros Aurignacian from Yafteh Cave, Iran.” *Journal of Human Evolution* 61 (3):340–46. https://doi.org/10.1016/j.jhevol.2011.05.011.

Pauketat, T., and T. Emerson. 1997. *Cahokia: Domination and Ideology in the Mississippian World*. University of Nebraska Press. https://www-fulcrum-org.ezproxy.library.uvic.ca/concern/monographs/9w0323242?locale=en.

Pauketat, T. 2009. *Cahokia: Ancient America's Great City on the Mississippi*. *The Penguin Library of American Indian History*. New York: Viking. http://voyager.library.uvic.ca/vwebv/holdingsInfo?bibId=1814818.

Peeples, M. and W. Haas Jr. 2013. "Brokerage and Social Capital in the Prehispanic U.S. Southwest." *American Anthropologist* 115(2): 232-247

Perlès, C., and M. Vanhaeren. 2010. "Black Cyclope Neritea Marine Shell Ornaments in the Upper Palaeolithic and Mesolithic of Franchthi Cave, Greece: Arguments for Intentional Heat Treatment." *Journal of Field Archaeology* 35 (3):298–309. https://doi.org/10.1179/009346910X12707321358874.

Pettitt, P. 2011. *The Palaeolithic Origins of Human Burial*. New York: Routledge.

Pike, A. W.G., D. L. Hoffmann, M. García-Diez, P. B. Pettitt, J. Alcolea, R. De Balbín, and C. González-Sainz. 2012. "U-Series Dating of Paleolithic Art in 11 Caves in Spain." *Science* 336 (6087):1409–13. https://doi.org/10.1126/science.1219957.

Porr, M. 2010a. "The Hohle Fels 'Venus': Some Remarks on Animals, Humans and Metaphorical Relationships in Early Upper Palaeolithic Art." *Rock Art Research* 27 (2):147–59.

Porr, M. 2010b. "Palaeolithic Art as Cultural Memory: A Case Study of the Aurignacian Art of Southwest Germany." *Cambridge Archaeological Journal* 20 (1):87–108. https://doi.org/10.1017/S0959774310000065.

Puillandre, N., R. Stöcklin, P. Favreau, E. Bianchi, F. Perret, A. Rivasseau, L. Limpalaër, E. Monnier, and P. Bouchet. 2014. "When Everything Converges: Integrative Taxonomy with Shell, DNA and Venomic Data Reveals Conus Conco, a New Species of Cone Snails (Gastropoda: Conoidea)." *Molecular Phylogenetics and Evolution* 80:186192. https://doi.org/10.1016/j.ympev.2014.06.024.

Quiles, A., H. Valladas, H. Bocherens, E. Delqué-Količ, E. Kaltnecker, J. van der Plicht, and J.J. Delannoy. 2016. "A High-Precision Chronological Model for the Decorated Upper Paleolithic Cave of Chauvet-Pont d'Arc, Ardèche, France." *Proceedings of the National Academy of Sciences* 113 (17):4670–75. https://doi.org/10.1073/pnas.1523158113.

Renfrew, C. 2004. "Towards a theory of material engagement." In *Rethinking materiality: the engagement of mind with the material world*, edited by E. DeMarrais, C. Gosden and C. Renfrew, 23-32. Cambridge: McDonald Institute for Archaeological Research.

Riel-Salvatore, J., and F. Negrino. 2018. "Human Adaptations to Climatic Change in Liguria across the Middle-Upper Paleolithic Transition." *Journal of Quaternary Science* 33 (3):313–22. https://doi.org/10.1002/jqs.3005.

Rightmire, P., D. Lordkipanidze, and A. Vekua. 2006. “Anatomical Descriptions, Comparative Studies and Evolutionary Significance of the Hominin Skulls from Dmanisi, Republic of Georgia.” *Journal of Human Evolution* 50 (2):115–41. https://doi.org/10.1016/j.jhevol.2005.07.009.

Robb, J. 2015. “What Do Things Want? Object Design as a Middle Range Theory of Material Culture.” *Archeological Papers of the American Anthropological Association* 26 (1):166–80. https://doi.org/10.1111/apaa.12069.

Rodríguez-Vidal, J., F. D’Errico, F. Giles Pacheco, R. Blasco, J. Rosell, R. P. Jennings, and A. Queffelec. 2014. “A Rock Engraving Made by Neanderthals in Gibraltar.” *Proceedings of the National Academy of Sciences* 111 (37):13301–6. https://doi.org/10.1073/pnas.1411529111.

Scarre, C. 2004. Displaying the stones: the materiality of ‘megalithic’ monuments. *In* Rethinking materiality: the engagement of mind with the material world. Ed. by E. DeMarrais, C. Gosden and C. Renfrew, pp. 141-152. Cambridge: McDonald Institute for Archaeological Research.

Shea, J. 2003. “Neandertals, Competition, and the Origin of Modern Human Behavior in the Levant.” *Evolutionary Anthropology* 12:173-187. https://doi.org/10.1002/evan.10101.

Shotter, J. 1983. “‘Duality of structure’ and ‘intentionality’ in an ecological psychology.” *Journal for the Theory of Social Behavior* 13:19-43

Škrdla, P. 2017. “Middle to Upper Paleolithic Transition in Moravia: New Sites, New Dates, New Ideas.” *Quaternary International* 450:116–25. https://doi.org/10.1016/j.quaint.2016.07.029.

Soffer, O. 2004. “Recovering Perishable Technologies through Use Wear on Tools: Preliminary Evidence for Upper Paleolithic Weaving and Net Making.” *Current Anthropology* 45 (3):407–13. https://doi.org/10.1086/420907.

Soffer, O, J M Adovasio, and D C Hyland. 2000. “The ‘Venus’ Figurines Textiles, Basketry, Gender, and Status in the Upper Paleolithic.” *Current Anthropology* 41 (4):511–37. https://doi.org/10.1086/317381.

Soh, D.1990. *From cowries to credit cards : stories of Singapore's money*. Singapore: Federal Publications.

Solecki, R. S. 1975. “Shanidar IV, a Neanderthal Flower Burial in Northern Iraq.” *Science* 190 (4217):880–81. https://doi.org/10.1126/science.190.4217.880.

Solecki, R. S. 1977. “The Implications of the Shanidar Cave Neanderthal Flower Burial.” *Annals of the New York Academy of Sciences* 293 (1):114–24. https://doi.org/10.1111/j.1749-6632.1977.tb41808.x.

Stewart, J., T. van Kolfschoten, A. Markova, and R. Musil. 2003. “The Mammalian Faunas of Europe During Oxygen Isotope Stage Three.” In *Neanderthals and Modern Humans in the European Landscape During the Last Glaciation: Archaeological Results of the Stage 3 Project*, edited by Tjeerd van Andel and Williams Davies, 103-130. University of Michigan: McDonald Institute for Archaeological Research.

Stiner, M. 2014. “Finding a Common Bandwidth: Causes of Convergence and Diversity in Paleolithic Beads.” *Biological Theory* 9 (1):51–64. https://doi.org/10.1007/s13752-013-0157-4.

Stiner, M., N. Munro, and B. Starkovich. 2012. “Material input rates and dietary breadth during the Upper Paleolithic through Mesolithic at Franchthi and Klissoura 1 caves (Peloponnese, Greece).” *Quaternary International* 275:30-42. https://doi.org/10.1016/j.quaint.2011.08.006

Svoboda, J.A. 2005. “The Neandertal extinction in eastern Central Europe.” *Quaternary International* 137(1):69-75.

Szmidt, C. C., L Brou, and L. Jaccottey. 2010a. “Direct radiocarbon (AMS) dating of split-based points from the (Proto)Aurignacian of Trou de la Mère Clochette, northeastern France: implications for the characterization of the Aurignacian and the timing of technical innovations in Europe.” *Journal of Archaeological Science* 37:3320–3337.

Szmidt, C., C. Normand, G. Burr, G. Hodgins, and S. LaMotta. 2010b. “AMS 14C Dating the Protoaurignacian/Early Aurignacian of Isturitz, France. Implications for Neanderthal-Modern Human Interaction and the Timing of Technical and Cultural Innovations in Europe.” *Journal of Archaeological Science* 37 (4). https://doi.org/10.1016/j.jas.2009.11.006.

Taborin, Y. 1999. “Gravettian body ornaments in Western and Central Europe.” In *Hunters of the Golden Age : The Mid Upper Palaeolithic of Eurasia, 30,000-20,000 BP*, edited by W. Roebroeks, 135-142. University of Leiden.

Tartar, E., R. White, L. Chiotti, C. Cretin, and R. Mensan. 2014. “Which Aurignacians were at Abri Blanchard (Sergeac, Dordogne, France)? Data from bone and antler artifacts in American collections and from new field operations.” *PALEO* 25:309-331.

Tátá, F., J. Cascalheira, J. Marreiros, T. Pereira, and N. Bicho. 2014. “Shell Bead Production in the Upper Paleolithic of Vale Boi (SW Portugal): An Experimental Perspective.” *Journal of Archaeological Science* 42 (1). Academic Press:29–41. https://doi.org/10.1016/j.jas.2013.10.029.

Tejero, J.-M.. 2014. “Towards Complexity in Osseous Raw Material Exploitation by the First Anatomically Modern Humans in Europe: Aurignacian Antler Working.” *Journal of Anthropological Archaeology* 36:72–92. https://doi.org/10.1016/j.jaa.2014.08.004.

Teyssandier, N., and J. Zilhão. 2018. “On the Entity and Antiquity of the Aurignacian at Willendorf (Austria): Implications for Modern Human Emergence in Europe.” *Journal of Paleolithic Archaeology* 1(2):107–38. https://doi.org/10.1007/s41982-017-0004-4.

Thomas, Julian. 2006. “Phenomenology and Material Culture.” In *Handbook of Material Culture*, edited by C. Tilley, W. Keane, S. Kuchler, M. Rowlands, and P. Spyer, 43–59. London: SAGE. https://doi.org/10.4135/9781848607972.n4.

Tilley, C. 2002. “Metaphor, materiality, and interpretation.” In *The material culture reader*, edited by V. Bucheli, 23-26, Oxford: Berg.

Tilley, C. 2004. *The materiality of stone: explorations in landscape phenomenology*. Oxford: Berg

Tilley, C., 2007. “Materiality in materials.” *Archaeological Dialogues* 14(1):16-20

Tostevin, G. 2007. “Social intimacy, artefact visibility, and acculturation models of Neanderthal-modern human interaction.” In *Rethinking the Human Revolution: New Behavioural and Biological Perspectives on the Origins and Dispersal of Modern Humans*, edited by P. Mellars, K. Boyle, O. Bar-Yosef, and C. Stringer, 341-357. Cambridge: MacDonald Institute for Archaeological Research Monographs

Trigger, B. 2006. *A history of archaeological thought*. Cambridge: Cambridge University Press.

Trinkaus, E. 1978. “Dental Remains from the Shanidar Adult Neanderthals.” *Journal of Human Evolution* 7 (5):369-376. https://doi.org/10.1016/S0047-2484(78)80087-6.

Trubitt, M.B. 2003. “The Production and Exchange of Marine Shell Prestige Goods.” *Journal of Archaeological Research* 11 (3):243–77. https://doi.org/10.1023/A:1025028814962.

Trubitt, M.B. 2005. “Crafting Marine Shell Prestige Goods at Cahokia.” *North American Archaeologist* 26 (3):249–66. https://doi.org/10.2190/4NR2-8C4H-AWXB-JVPE.

Tsanova, T., N. Zwyns, L. Eizenberg, N. Teysandier, F. Le Brun-Ricalens, and M. Otte. 2012. “Le plus petit dénominateur commun : réflexion sur la variabilité des ensembles lamellaires du Paléolithique supérieur ancien d’Eurasie. Un bilan autour des exemples de Kozarnika (est des Balkans) et Yafteh (Zagros central).” *L’Anthropologie* 116:469–509.

Turner, V. 1967. *The forest of symbols: Aspects of Ndembu ritual*. New York: Cornell University Press

Tuner, V. 1974. *Dramas, fields, and metaphors:Symbolic action in human society*. New York: Cornell University Press.

Urban, E. 2018. “On Matters of Mind and Body: Regarding Descartes.” *Journal of Analytical Psychology* 63 (2):228–40. https://doi.org/10.1111/1468-5922.12395.

Van Andel, T. and W. Davies. 2003. *Neanderthals and Modern Humans in the European Landscape During the Last Glaciation: Archaeological Results of the Stage 3 Project*. University of Michigan: McDonald Institute for Archaeological Research.

Van Andel, T., W. Davies and B. Weninger. 2003. "The Human Presence in Europe During the Last Glacial Period I: Human Migrations and the Changing Climate." In *Neanderthals and Modern Humans in the European Landscape During the Last Glaciation: Archaeological Results of the Stage 3 Project*, edited by Tjeerd van Andel and Williams Davies, 31-56. University of Michigan: McDonald Institute for Archaeological Research.

Van Gelder, L. 2015. "Counting the Children: The Role of Children in the Production of Finger Flutings in Four Upper Palaeolithic Caves." *Oxford Journal of Archaeology* 34 (2):119–38. https://doi.org/10.1111/ojoa.12052.

Van Meerbeeck, C. J., H Renssen, D M Roche, B Wohlfarth, S. J.P. Bohncke, J. A.A. Bos, and S Engels. 2011. "The Nature of MIS 3 Stadial-Interstadial Transitions in Europe: New Insights from Model-Data Comparisons." *Quaternary Science Reviews* 30 (25–26):3618–37. https://doi.org/10.1016/j.quascirev.2011.08.002.

Vanhaeren, M. 2005. "Speaking with beads: The evolutionary significance of personal ornaments," in *From tools to symbols: From early hominids to modern humans*, ed. d'Errico, F. & L. Blackwell, 525–553. Johannesburg: Witwatersrand University Press.

Vanhaeren, M., and F. D'Errico. 2006. "Aurignacian Ethno-Linguistic Geography of Europe Revealed by Personal Ornaments." *Journal of Archaeological Science* 33 (8):1105–28. https://doi.org/10.1016/j.jas.2005.11.017.

Vanhaeren, M., F. D'Errico, C. Stringar, S. Jamas, J. Todd, and H. Mienis. 2006. "Middle Paleolithic Shell Beads in Israel and Algeria." *Science* 312 (5781):1785–88. https://doi.org/10.1126/science.1128139.

Vermeersch, P.M. 2017. "Radiocarbon Palaeolithic Europe Database, Version 23." http://ees.kuleuven.be/geography/projects/14c-palaeolithic/index.html.

Verna, C., V. Dujardin, and E. Trinkaus. 2012. "The Early Aurignacian Human Remains from La Quina-Aval (France)." *Journal of Human Evolution* 62 (5):605–17. https://doi.org/10.1016/j.jhevol.2012.02.001.

Villa, P., and W. Roebroeks. 2014. "Neandertal Demise: An Archaeological Analysis of the Modern Human Superiority Complex." *PLoS ONE* 9 (4):96424. https://doi.org/10.1371/journal.pone.0096424.

Voelker, A. 2002. "Global distribution of centennial-scale records for Marine Isotope Stage (MIS) 3: a database." *Quaternary Science Reviews* 21(10): 1185-1212

Von Petzinger, G., and A. Nowell. 2014. "A Place in Time: Situating Chauvet within the Long Chronology Ofsymbolic Behavioral Development." *Journal of Human Evolution* 74:37–54. https://doi.org/10.1016/j.jhevol.2014.02.022.

Wells, P. 2008. *Image and response in early Europe*. Bloomsbury Academic, 168p.

Wells, P. 2012. *How ancient Europeans saw the world: vision, patterns, and the shaping of the mind in prehistoric times*. Princeton University Press, 285p.

Whalen, M. 2013. "Wealth, Status, Ritual, and Marine Shell at Casas Grandes, Chihuahua, Mexico." *American Antiquity* 78 (4):624–39. https://doi.org/10.7183/0002-7316.78.4.624.

White, R. 1989. "Production complexity and standardization in early Aurignacian bead and pendant manufacture: Evolutionary implications." In *The human revolution: Behavioral and biological perspectives in the origins of modern humans,* edited by P. Mellars & C. Stringer, 360–399. Edinburgh: Edinburgh University Press.

White, R. 1992. "Beyond art: toward an understanding of the origins of material representation in Europe." *Annual Review of Anthropology* 21:537–564.

White, R. 1995. "Ivory personal ornaments of Aurignacian age: Technological, social and symbolic perspectives." In *Le travail et l'usage de l'ivoire au Paléolithique Supérieur,* edited by J. Hahn, M. Menu, Y. Taborin, P. Walter, & F. Widemann, 29–62). Ravello: Centre Universitaire Européen pour les Biens Culturels.

White, R. 2006. "The women of Brassempouy: a century of research and interpretation." *Journal of Archaeological Method and Theory* 13(4):251-304

White, R. 2007. "Systems of personal ornamentation in the Early Upper Palaeolithic: Methodological challenges and new observations." In *Rethinking the human revolution: New behavioural and biological perspectives on the origin and dispersal of modern humans,* edited by P. Mellars, K. Boyle, O. Bar-Yosef, and C. Stringer, 287–302. Cambridge: McDonald Institute for Archaeological Research.

White, R. & C. Normand. 2015. "Early and Archaic Aurignacian Personal Ornaments from Isturitz Cave: Technological and Regional Perspectives." In *Aurignacian Genius: Art, Technology and Society of the First Modern Humans in Europe*, edited by R. White and R. Bourrillon, 138-164. New York: New York University.

White, R., R. Mensan, R. Bourrillon, C. Cretin, T. Higham, A. E. Clark, and M. L. Sisk. 2012. "Context and Dating of Aurignacian Vulvar Representations from Abri Castanet, France." *Proceedings of the National Academy of Sciences* 109 (22):8450–55. https://doi.org/10.1073/pnas.1119663109.

Wiessner, P., 1982. "Risk, reciprocity and social influences on! Kung San economics." In *Politics and history in band societies,* edited by Leacock E. and R. Lee, 61-84. Cambridge University Press, Cambridge.

Williams, E. and A. Costall. 2000. “Taking things more seriously: psychological theories of autism and the material-social divide.” In *Matter, materiality and modern culture,* edited by P. Graves, 97-112. Psychology Press.

Williams, S T, and T Ozawa. 2006. “Molecular Phylogeny Suggests Polyphyly of Both the Turban Shells (Family Turbinidae) and the Superfamily Trochoidea (Mollusca: Vetigastropoda).” *Molecular Phylogenetics and Evolution* 39 (1):33–51. https://doi.org/10.1007/3-540-30023-6_3.

World Register of Marine Species (WoRMS). Accessed May 15, 2017. http://www.marinespecies.org/

Wright, D., L. Nejman, F. d’Errico, M. Králik, R. Wood, M. Ivanov, and S. Hladilová 2014. *Antiquity* 88(339): 30-46

Yang, B. 2011. “The Rise and Fall of Cowrie Shells: The Asian Story.” *Journal of World History* 22 (1):1–25. https://doi.org/10.1353/jwh.2011.0011.

Zielske, S., and M. Haase. 2015. “Molecular Phylogeny and a Modified Approach of Character-Based Barcoding Refining the Taxonomy of New Caledonian Freshwater Gastropods (Caenogastropoda, Truncatelloidea, Tateidae).” *Molecular Phylogenetics and Evolution* 89:171–81. https://doi.org/10.1016/j.ympev.2015.04.020.

Zilhão, J., D. Angelucci, E. Badal-Garcia, F. d’Errico, F. Daniel, L. Dayet, K. Dourka, T. Higham, M. Martinez-Sanchez, R. Montes-Bernandez, S. Murcia-Mascaros, C. Perez Sirvent, C. Roldan-Garcia, M. Vanhaeren, V. Villaverde, R. Wood, and J. Zapata 2009. “Symbolic use of marine shells and mineral pigments by Iberian Neandertals.” *Proceedings of the National Academy of Sciences* 107(3): 1023-1028

Zilhão, J., D. Anesin, T. Aubry, E. Badal, D. Cabanes, M. Kehl, N. Klasen. 2017. “Precise Dating of the Middle-to-Upper Paleolithic Transition in Murcia (Spain) Supports Late Neandertal Persistence in Iberia.” *Heliyon* 3 (11):e00435. https://doi.org/10.1016/j.heliyon.2017.e00435.

Appendix A: Marine Shell Shapes and Site Information

A.1: List of marine shell genera, general environment, and shapes.

Unless otherwise noted in Other Information, all non-bivalve shells are Gastropods. Environment and other information gathered from WoRMS 2018.

Genera	General Environment	Shell Shape	Other Information
Acanthocardia sp.	marine	bivalve	Can be synonymized with *Cardium* sp.
Ammonite sp.	fossil outcrops	discoidal	
Ancillaria sp.	marine	olive	Also known as *Ancilla* sp.
Antalis sp.	marine	tusk	Scaphopod; can be synonymized with *Dentalium* sp.
Aporrhais sp.	marine	Pelican's foot	
Arca sp.	marine	bivalve	
Architectonica sp.	marine	sundial	
Astrea sp.	marine	top/turban	
Belemnite	fossil outcrops	tusk	Extinct Cephalopod; similar in appearance to Scaphopods
Buccinum sp.	marine	basket	
Callista sp.	marine	bivalve	
Cantharus sp.	marine	basket	
Cardium sp.	marine	bivalve	
Charonia sp.	marine	cylindrical	
Clanculus sp.	marine	top/turban	
Columbella sp.	marine	basket	
Colus sp.	marine	cylindrical	
Conus sp.	marine	cone	
Crommium sp.	marine	globular	Extinct during Aurignacian
Cyclope sp.	marine	globular	Also known as *Tritia*
Cypraea sp.	marine	convolute	Known as cowries
Dentalium sp.	marine	tusk	Scaphopod

Epitonium sp.	marine	staircase	
Gibbula sp.	marine	top/turban	
Glycymeris sp.	marine	bivalve	
Haliotis sp.	marine	ear	Known as abalone
Homalopoma sp.	marine	top/turban	
Jujubinus sp.	marine	top/turban	
Littorina sp.	marine	basket	
Mangelia sp.	marine	cylindrical	
Melanopsis sp.	marine	basket	
Mitra sp.	marine	olive	
Mytilus sp.	marine	bivalve	
Nassarius sp.	marine	basket	
Natica sp.	marine	globular	
Nucella sp.	marine	basket	
Ocinebrina sp.	marine	cylindrical	
Osilinus sp.	marine	top/turban	
Ostrea sp.	marine	bivalve	
Patella sp.	marine	limpet	
Pecten sp.	marine	bivalve	
Phalium sp.	marine	basket	
Potamides sp.	marine	tubular	Extinct during Aurignacian
Rhynchonella sp.	fossil outcrops	bivalve	
Ringicula sp.	marine	basket	
Rissoa sp.	marine	cylindrical	
Strombus sp.	marine	cone	
Surcula sp.	marine	cylindrical	Also known as *Turricula*
Tapes sp.	marine	bivalve	Also known as *Ruditapes*
Thais sp.	marine	basket	
Theodoxus sp.	marine	globular	
Tricolia sp.	marine	basket	

Trivia sp.	marine	convolute	
Trochus sp.	marine	top/turban	
Turritella sp.	marine	tubular	
Urchin	marine	urchin	*Echinoidea*
Venus sp.	marine	bivalve	
Vermetus sp.	marine	irregular	

A.2: List of sites with layer, date(s) (uncal BP), coordinates, marine shell genera and shapes, non-shell materials, and sources.

For teeth i=incisor, c=canine, m=molar.

Site Name	Layer	Date (uncal BP)	Latitude	Longitude	Marine Shell Genera	Marine Shell Shapes	Non-shell Material	Sources
Krems-Rehberg		31790+-280	48.417	15.6	Dentalium	Tusk (1)	Stone	RPED 2017; Vanhaeren and d'Errico 2006
Krems-Hundsteig		35500+-2000	48.415	15.602	Clanculus, Columbella, Cyclope, Dentalium, Melanopsis	Basket (2), Globular (1), Top/Turban (1), Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006
Langmannersdorf		35000-27000	48.294	15.879	Dentalium	Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006
Senftenberg		35000-27000	48.433	15.55	Dentalium, Turritella	Tubular (1), Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006
Willendorf	II-IV	34100+-1200	48.323	15.399	Dentalium	Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006

Spy		30170+-160	50.479	4.676	Nassarius	Basket (1)	Bone, Ivory, Stone, Teeth (fox c; deer c; wolf I; boar i)	Alvarez Fernandez 2006; RPED 2017; Vanhaeren and d'Errico 2006
Trou-Magrite		30890+-660, 28640+-480, 27900+-3400	50.227	4.916	Crommium	Globular (1)	Teeth (badger c; deer c, i)	RPED 2017; Vanhaeren and d'Errico 2006
Balauzerie		35000-27000	43.968	4.525	Acanthocardia, Littorina, Natica, Osilinus, Phalium, Tapes, Turritella, Venus	Basket (2), Bivalve (3), Globular (1), Top/Turban (1), Tubular (1)	Teeth (deer c)	RPED 2017; Vanhaeren and d'Errico 2006
Blanchard (Abri)		34000-32000	45	1.101	Ancillaria, Aporrhais, Belemnite, Columbella, Conus, Cypraea, Dentalium, Homalopoma, Littorina, Nassarius, Nucella, Urchin, Potamides, Theodoxus, Turritella	Basket (4), Cone (1), Convolute (1), Globular (1), Olive (1), Pelican’s Foot (1), Top/Turban (1), Tubular, (2), Tusk (2), Urchin (1)	Bone, Ivory, Teeth	RPED 2017; Vanhaeren and d'Errico 2006; White 1997, 2004
Caminade Est		37200+-1500, 35400+-1100, 34140+-990	44.876	1.257	Dentalium	Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006
Castanet (Abri)		34000-32000	45.007	1.099	Ancillaria, Aporrhais, Charonia, Cypraea, Dentalium, Homalopoma, Littorina, Nassarius, Natica, Nucella, Phalium,	Basket (4), Convolute (1), Cylindrical (2), Globular (1), Olive (1), Pelican’s Foot (1), Top/Turban (1), Tubular (2), Tusk (1)	Ivory, Stone, Teeth (bovid i; deer i; fox c, i; hyena c)	RPED 2017; Vanhaeren and d'Errico 2006

					Potamides, Surcula, Turritella			
Cellier (Abri)		35000-27000	44.965	1.023	Dentalium, Turritella, Littorina, Nassarius	Basket (2), Tubular (1), Tusk	Ivory, Teeth (wolf c)	RPED 2017; Vanhaeren and d'Errico 2006
Combe (Roc de)		35000-27000	44.767	1.346	Arca, Littorina, Nassarius, Natica, Nucella, Turritella	Basket (3), Bivalve (1), Globular (1), Tubular (1)	Teeth (deer c, i; human)	RPED 2017; Vanhaeren and d'Errico 2006
Combe Capelle		35000-27000	44.767	0.813	Urchin	Urchin (1)		RPED 2017; Vanhaeren and d'Errico 2006
Combette		35000-27000	44.467	5.15	Cypraea, Thais	Basket (1), Convolute (1)		RPED 2017; Vanhaeren and d'Errico 2006
Ferrassie (la)	F	35000-27000	44.952	0.938	Ammonite, Architectonatica, Turritella, Nucella, Urchin	Basket (1), Discoidal (1), Sundial (1), Tubular (1), Urchin (1)	Antler, Bone, Ivory, Teeth (bovid i; deer c)	RPED 2017; Vanhaeren and d'Errico 2006
Festons		35000-27000	45.367	0.65	Ammonite, Cardium, Urchin, Pecten	Bivalve (2), Discoidal (1), Urchin (1)		RPED 2017; Vanhaeren and d'Errico 2006
Figuier		35000-27000	44.323	4.549	Glycymeris	Bivalve (1)		RPED 2017; Vanhaeren and d'Errico 2006
Flageolet I (le)		34300+/-1100, 33800+/-1800, 32040+/-850	44.85	1.083	Cardium, Littorina	Basket (1), Bivalve (1)	Ivory, Teeth (fox c; deer c)	RPED 2017; Vanhaeren and d'Errico 2006

Hyénes (Grotte de)		30600+/-200, 33600+/-240	43.638	-0.692	Natica, Nucella	Basket (1), Globular (1)	Bone, Ivory, Stone, Teeth (deer c; fox c; human; lion c; deer c; wolf c)	RPED 2017; Vanhaeren and d'Errico 2006
Isturitz	4c and 4d	34630+/-560, 36550+/-610	43.367	-1.196	Littorina, Turritella	Basket (1), Tubular (1)	Bone, Stone, Teeth (bear c; bovid i; deer i; fox c; horse c, i; human hyena c; wolf i)	RPED 2017; Vanhaeren and d'Errico 2006
La Chevre		35000-27000	45.316	0.6	Nucella, Potamides	Basket (1), Tubular (1)	Bone	RPED 2017; Vanhaeren and d'Errico 2006
Laouza		35000-27000	43.935	4.409	Cypraea, Dentalium, Nassarius, Natica, Trivia	Basket (1), Convolute (2), Globular (1), Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006
Lartet		35000-27000	44.948	0.998	Glycymeris, Nassarius	Basket (1), Bivalve (1)		RPED 2017; Vanhaeren and d'Errico 2006
Pasquet		35000-27000	44.933	1.017	Littorina, Nassarius, Nucella, Turritella	Basket (3), Tubular (1)		RPED 2017; Vanhaeren and d'Errico 2006
Pataud (Abri)	14 (C')	35000-27000	44.938	1.012	Littorina, Pecten, Rhynchonella	Basket (1), Bivalve (2)	Bone, Ivory, Teeth (bovid i; deer c; fox c; lion c; wolf i)	RPED 2017; Vanhaeren and d'Errico 2006
Pécheurs (les)		35000-27000	44.408	4.207	Cyclope, Dentalium, Homalopoma, Nassarius, Natica, Ringicula, Trivia	Basket (2), Convolute (1), Globular (2), Top/Turban (1), Tusk (1)	Teeth (deer c)	RPED 2017; Vanhaeren and d'Errico 2006
Peyrony (Abri)		35000-27000	44.572	0.901	Dentalium, Turritella, Pecten	Bivalve (1), Tubular (1), Tusk (1)	Teeth (deer c; fox c)	RPED 2017; Vanhaeren and d'Errico 2006
Poisson (Abri)		35000-27000	44.949	0.997	Littorina, Nassarius, Natica, Theodoxus, Trivia	Basket (2), Convolute (1), Globular (2)		RPED 2017; Vanhaeren and d'Errico 2006

Pont-Neuf		35000-27000	48.517	-4.3	Pecten	Bivalve (1)		RPED 2017; Vanhaeren and d'Errico 2006
Quina (la)		35000-27000	45.498	0.288	Colus, Littorina, Turritella	Basket (1), Cylindrical (1), Tubular (1)	Teeth (bovid i; fox c, i; horse i, pm; hyena c; wolf i, m)	RPED 2017; Vanhaeren and d'Errico 2006
Régismont		35000-27000	43.317	3.083	Acanthocardia, Glycymeris, Phalium	Basket (1), Bivalve (2)		RPED 2017; Vanhaeren and d'Errico 2006
Renne (Grotte de)	VII	30800+/-250, 31800+/-1240	47.591	3.765	Crommium	Globular (1)	Ivory, Stone, Teeth (bear i)	d'Errico et al. 1998; RPED 2017; Vanhaeren and d'Errico 2006, White 2002; Zilhão and d'Errico 1999
Rochette		35000-27000	45.017	1.102	Dentalium	Tusk (1)	Bone, Teeth (fox ; lion c)	RPED 2017; Vanhaeren and d'Errico 2006
Rois		35000-27000	45.535	0.141	Urchin	Urchin (1)	Antler, Bone, Teeth (bovid i; deer c; fox c; horse i; human, hyena c; reindeer c, i; wolf c)	RPED 2017; Vanhaeren and d'Errico 2006
Rothschild		35000-27000	43.636	3.367	Ammonite, Aporrhais, Cardium, Columbella, Cyclope, Cypraea, Dentalium, Glycymeris, Littorina, Mitra, Nassarius, Natica, Nucella, Ocinebrina, Patella, Pecten,	Basket (5), Bivalve (3), Convolute (2), Cylindrical (1), Discoidal (1), Globular (3), Limpet (1), Olive (1), Pelican's Foot (1), Tubular (2), Tusk (1)	Stone, Teeth (deer c)	RPED 2017; Vanhaeren and d'Errico 2006

					Phalium, Potamides, Theodoxus, Trivia, Turritella			
Saint-Cesaire		35000-27000	45.747	-0.506	Turritella	Tubular (1)	Teeth (bovid i; deer c)	RPED 2017; Vanhaeren and d'Errico 2006
Salpetriére (la)		35000-27000	43.94	4.56	Cardium, Cypraea, Dentalium, Nassarius, Natica, Pecten, Phalium, Potamides	Basket (2), Bivalve (2), Convolute (1), Globular (1), Tubular (1), Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006
Souquette (Abri la)		35000-27000	45.001	1.103	Ammonite, Littorina, Nassarius, Natica, Nucella, Urchin, Potamides, Trivia	Basket (3), Convolute (1), Discoidal (1), Globular (1), Tubular (1), Urchin (1)	Antler, Bone, Ivory, Stone, Teeth (bovid i; deer c; fox c; hyena c)	RPED 2017; Vanhaeren and d'Errico 2006; White 1989
Sous-le-Roc		35000-27000	44.926	0.902	Littorina, Nassarius, Turritella	Basket (2), Tubular (1)		RPED 2017; Vanhaeren and d'Errico 2006
Sous-les-vignes		35000-27000	46.818	4.72	Homalopoma, Trivia	Convolute (1), Top/Turban	Teeth (deer c; fox c)	RPED 2017; Vanhaeren and d'Errico 2006
Tournal (le)		35000-27000	43.317	2.883	Acanthocardia, Cyclope, Dentalium, Littorina, Natica	Basket (1), Bivalve (1), Globular (2), Tusk (1)	Teeth (bear c; deer c)	RPED 2017; Vanhaeren and d'Errico 2006
Tuto de Camalhot		35000-27000	43.01	1.629	Buccinum, Dentalium, Littorina, Nassarius, Pecten, Turritella	Basket (3), Bivalve (1), Tubular (1), Tusk (1)	Bone, Ivory, Stone, Teeth (bovid i; deer c; fox c)	RPED 2017; Vanhaeren and d'Errico 2006
Vachons		35000-27000	45.517	0.117	Dentalium, Natica, Nucella, Ostrea, Pecten	Basket (1), Bivalve (2),	Teeth (deer c, i; fox c; wolf c, i)	RPED 2017; Vanhaeren and d'Errico 2006

						Globular (1), Tusk (1)		
Franchthi		30,000, 29,780+-160, 23,510+-90	37.423	23.131	Cyclope, Homalopoma, Antalis	Globular (1), Top/Turban (1), Tusk (1)	Bone, Teeth	Perles and Vanhaeren 2010; RPED 2017
Klisoura	III	30,925+-420	37.689	22.808	Clanculus, Columbella, Cyclope, Nassarius, Natica, Ocinebrina, Potamides, Theodoxus, Trochus	Basket (2), Cylindrical (1), Globular (3), Top/Turban (2), Tubular (1)	Teeth	Koumouzelis et al. 2001a, 2001b; RPED 2017; Vanhaeren and d'Errico 2006
Bombrini	III	35000-27000	43.784	7.535	Aporrhais, Clanculus, Cyclope, Gibbula, Homalopoma, Nassarius, Ocinebrina, Osilinus, Trivia, Turritella	Basket (1), Convolute (1), Cylindical (1), Globular (1), Pelican's Foot (1), Top/Turban (4), Tubular (1)		RPED 2017; Vanhaeren and d'Errico 2006
Cala		35000-27000	40.001	15.379	Astraea, Cantharus, Clanculus, Columbella, Conus, Cyclope, Dentalium, Gibbula, Glycymeris, Haliotis, Homalopoma, Jujubinus, Mitra, Nassarius, Natica, Osilinus, Pecten, Phalium, Potamides, Tricolia, Trivia	Basket (5), Bivalve (2), Cone (1), Convolute (1), Ear (1), Globular (2), Olive (1), Top/Turban (6), Tubular (1), Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006

Castelcivita		35000-27000	40.483	15.233	Homalopoma	Top/Turban (1)		RPED 2017; Vanhaeren and d'Errico 2006
Cavallo		35000-27000	40.156	17.961	Aporrhais, Cardium, Columbella, Cyclope, Dentalium, Glycymeris, Mytilus, Nassarius, Natica, Patella, Pecten, Potamides, Trochus, Turritella, Venus, Vermetus	Basket (2), Bivalve (5), Globular (2), Irregular (1), Limpet (1), Pelican's Foot (1), Top/Turban (1), Tubular (2), Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006
Fanciulli		35000-27000	43.785	7.533	Acanthocardia, Aporrhais, Arca, Cyclope, Cypraea, Dentalium, Glycymeris, Nassarius, Nucella, Pecten, Potamides	Basket (2), Bivalve (4), Convolute (1), Globular (1), Pelican's Foot (1), Tubular (1), Tusk (1)	Teeth (deer c)	RPED 2017; Vanhaeren and d'Errico 2006
Fumane (Riparo di)	A3-A2	35000-27000	45.506	10.967	Aporrhais, Cantharus, Clanculus, Cyclope, Cypraea, Dentalium, Epitonium, Gibbula, Glycymeris, Homalopoma, Jujubinus, Littorina, Mangelia, Mitra, Mytilus, Nassarius, Natica, Ocinebrina, Osilinus, Patella,	Basket (3), Bivalve (2), Convolute (2), Cylindrical (3), Globular (3), Limpet (1), Olive (1), Pelican's Foot (1), Staircase (1), Top/Turban (6), Tubular (1), Tusk (1)	Teeth (deer i)	RPED 2017; Vanhaeren and d'Errico 2006

					Potamides, Rissoa, Theodoxus, Trochus, Trivia			
Mochi (Riparo)	F/II	35000-27000	43.784	7.535	Acanthocardia, Aporrhais, Arca, Astraea, Callista, Charonia, Clanculus, Conus, Cyclope, Cypraea, Dentalium, Epitonium, Fusus, Gibbula, Glycymeris, Haliotis, Homalopoma, Jujubinus, Littorina, Mitra, Mytilus, Nassarius, Natica, Nucella, Nummilite, Ocinebrina, Osilinus, Ostrea, Patella, Pecten, Potamides, Strombus, Trivia, Turritella	Basket (4), Bivalve (7), Cone (2), Convolute (2), Cylindrical (2), Ear (1), Globular (2), Limpet (1), Olive (1), Pelican's Foot (1), Staircase (1), Top/Turban (5), Tubular (2), Tusk (1)	Bone, Stone	RPED 2017; Vanhaeren and d'Errico 2006
Hayonim		35000-27000	32.92	35.218	Dentalium	Tusk (1)	Teeth (wolf c; deer c, i; fox c; horse i)	RPED 2017; Vanhaeren and d'Errico 2006
KsarAkil		35000-27000	33.917	35.6	Columbella, Dentalium, Nassarius	Basket (2), Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006
Sefunim		35000-27000	32.736	34.977	Columbella, Conus, Cyclope, Nassarius	Basket (2), Cone (1), Globular (1)		RPED 2017; Vanhaeren and d'Errico 2006

Yabrud		35000-27000	33.977	36.647	Dentalium, Nassarius, Theodoxus	Basket (1), Globular (1), Tusk (1)		RPED 2017; Vanhaeren and d'Errico 2006
Kostenki I		35000-27000	51.395	39.042	Cyclope, Nassarius, Potamides, Theodoxus	Basket (1), Globular (2), Tubular (1)	Ivory, Teeth (fox c)	RPED 2017; Vanhaeren and d'Errico 2006
Arbreda (l')		37340+/-1000, 35480+/-820	42.161	2.747	Dentalium, Homalopoma, Pecten, Potamides, Trivia	Bivalve (1), Convolute (1), Top/Turban (1), Tubular (1), Tusk (1)	Ivory	Maroto, Soler, and Fullola 1996; RPED 2017; Vanhaeren and d'Errico 2006
Beneito		35000-27000	38.798	-0.466	Dentalium, Theodoxus	Globular (1), Tusk (1)	Teeth (lynx c)	RPED 2017; Vanhaeren and d'Errico 2006
Cobalejos		35000-27000	43.387	-3.957	Littorina	Basket (1)	Antler, Teeth (deer c, i; fox c)	RPED 2017; Vanhaeren and d'Errico 2006
Foradada		35000-27000	38.92	-0.12	Buccinum, Columbella, Glycymeris, Mytylus, Pecten, Theodoxus, Turritella	Basket (2), Bivalve (3), Globular (1), Tubular (1)	Teeth (lynx c)	RPED 2017; Vanhaeren and d'Errico 2006
Romaní (Abric)		37,900+-1000 to 23,160+-490	41.535	1.688	Cypraea, Nassarius, Turitella	Basket (1), Convolute (1), Tubular (1)	Bone, Teeth	Camps and Higham 2012; RPED 2017
Ruso I (El)		27,620+-180	43.439	-3.883	Littorina	Basket (1)		Alvarez-Fernandez 2006; RPED 2017
Karain B		27,980+-240, 18,960+-180	38.6	35	Dentalium	Tusk (1)		Albrecht 1988; Kuhn et al. 2009; RPED 2017
Ucagizli		35000-27000	35.993	35.988	Dentalium, Nassarius, Gibbula, Columbella	Basket (2), Top/Turban (1), Tusk (1)	Talon	Kuhn et al. 2009; RPED 2017

Siouren		35000-27000	44.638	33.851	Aporrhais, Theodoxus	Globular (1), Pelican’s Foot (1)	Teeth (beaver i; deer c)	RPED 2017; Vanhaeren and d'Errico 2006

Appendix B: GoogleEarth Maps for Shell Shapes and Non-shell Materials at Less than Ten Sites

B.1: Marine Shell Shapes

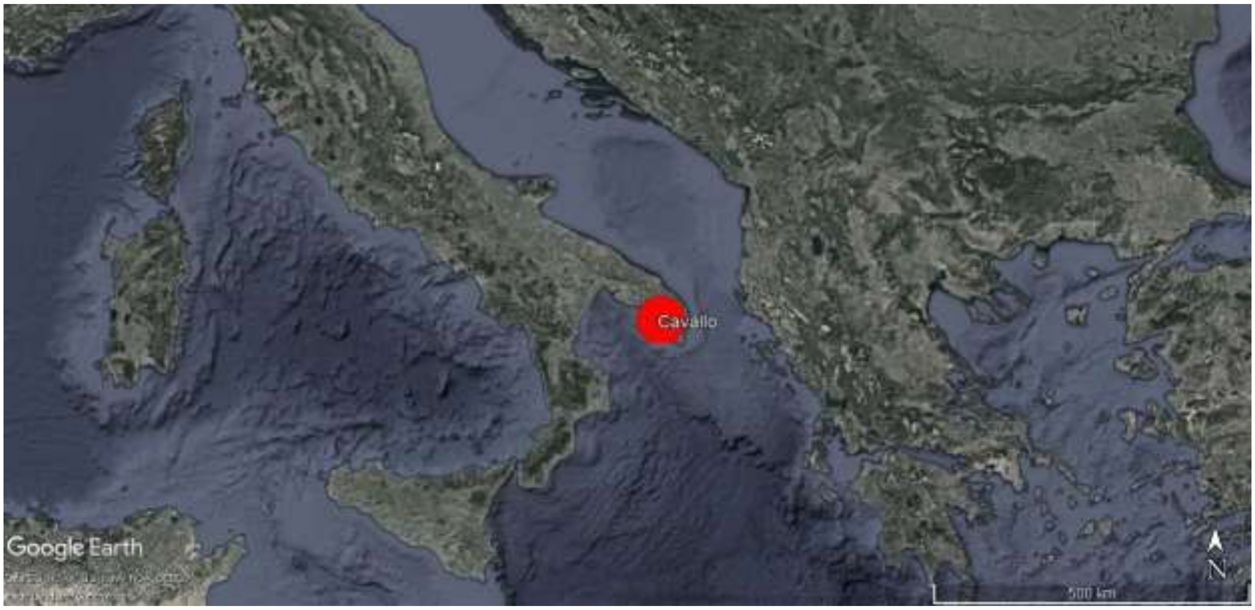
B.1.1: Cone

B.1.2: Cylindrical

B.1.3: Discoidal

B.1.4: Ear

B.1.5: Irregular



B.1.6: Limpet

B.1.7: Olive

B.1.8: Pelican's Foot

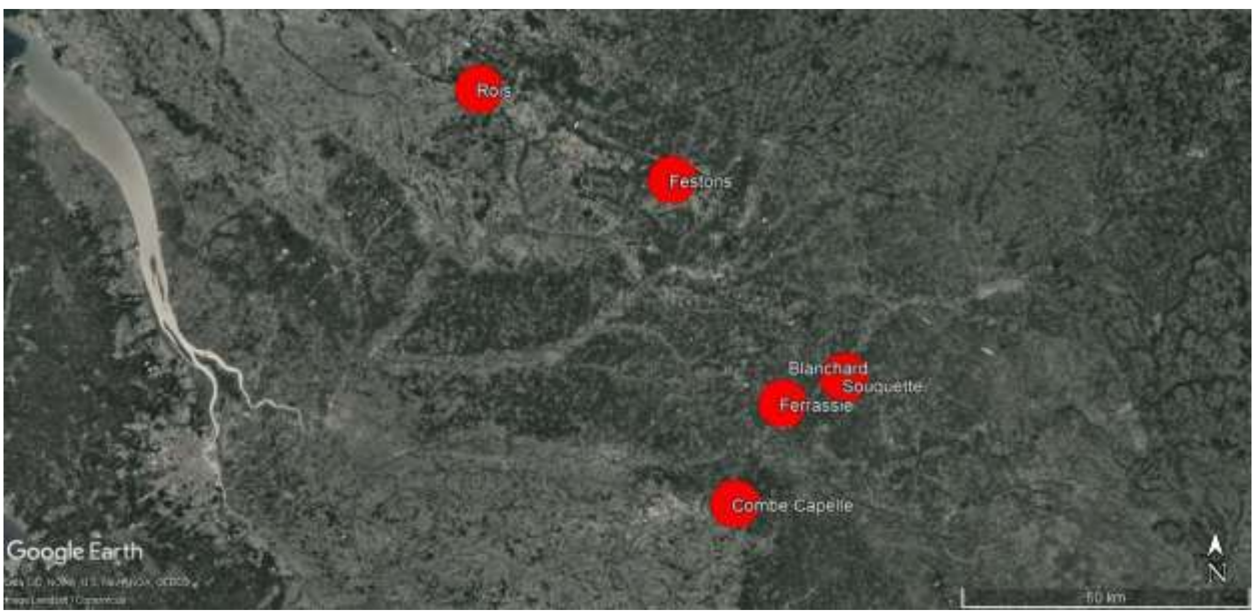
Full Map

Central and Southeastern France and Northwestern Italy

B.1.9: Staircase

B.1.10: Sundial

B.1.11: Urchin



B.2: Non-shell Materials

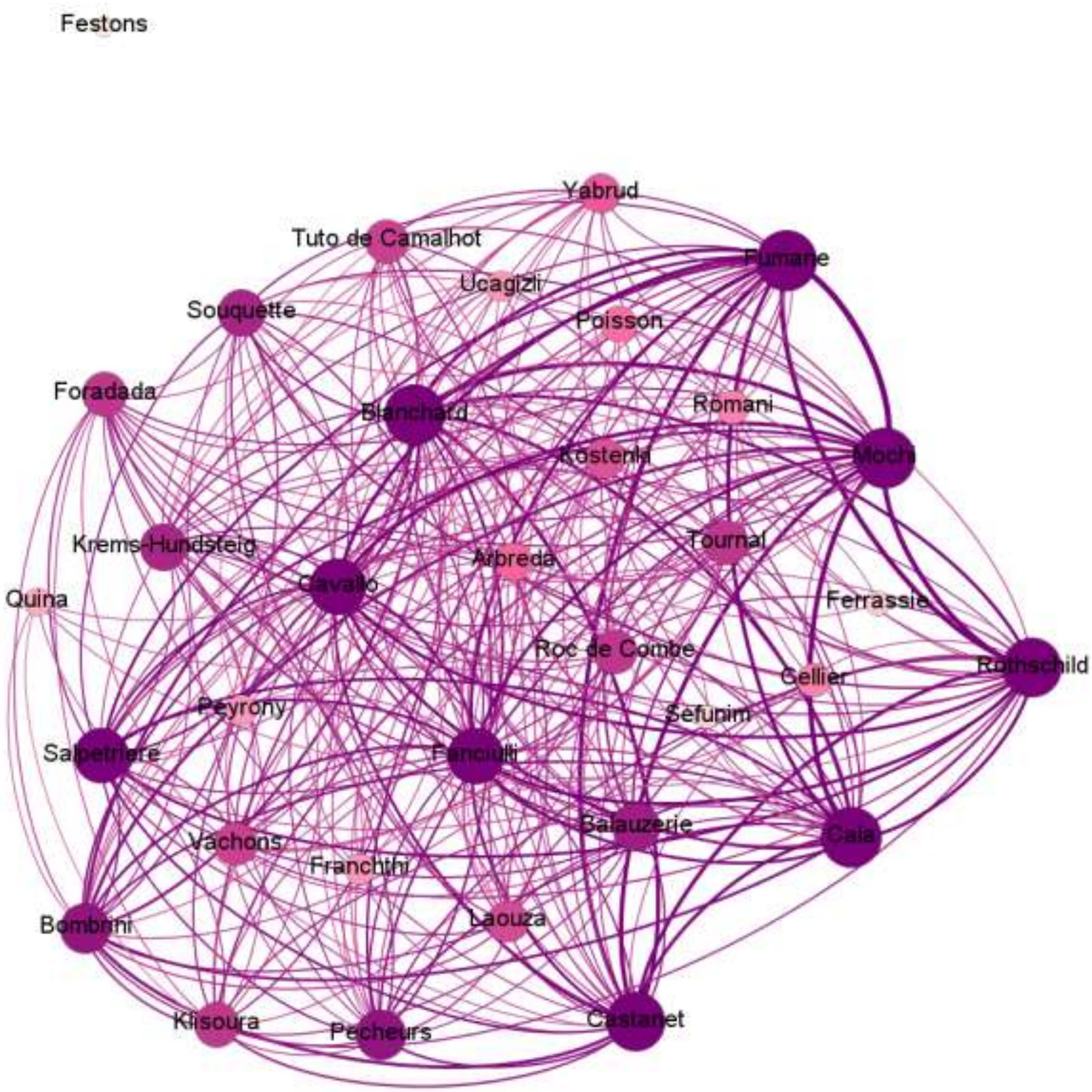
B.2.1: Antler

B.2.2: Talon

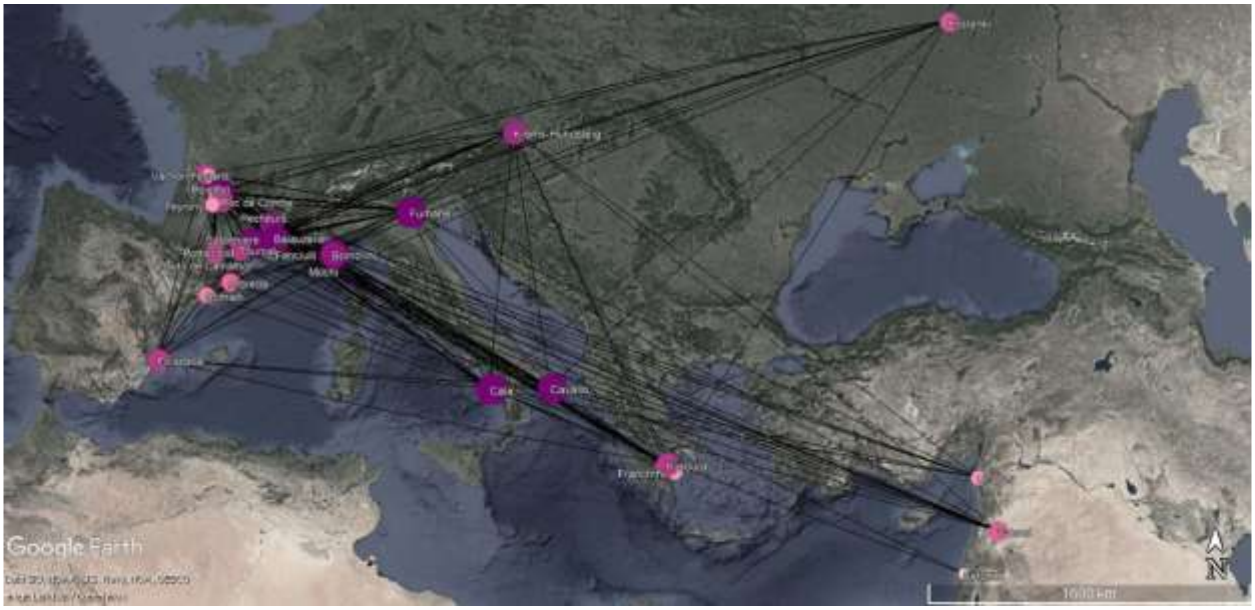
Appendix C: Gephi Visualizations and GoogleEarth Maps For Shell Shapes and Non-shell Materials at Ten or More Sites

C.1: Sites With at Least Three Marine Shell Shapes in Common

Gephi Visualization

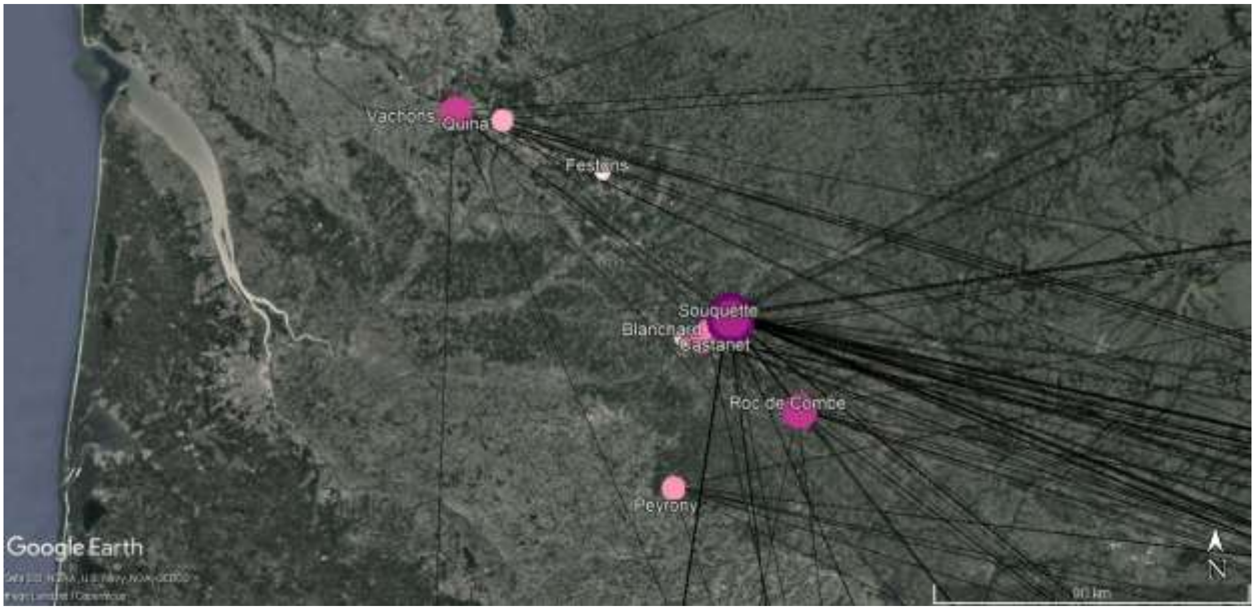


GoogleEarth: Full Map

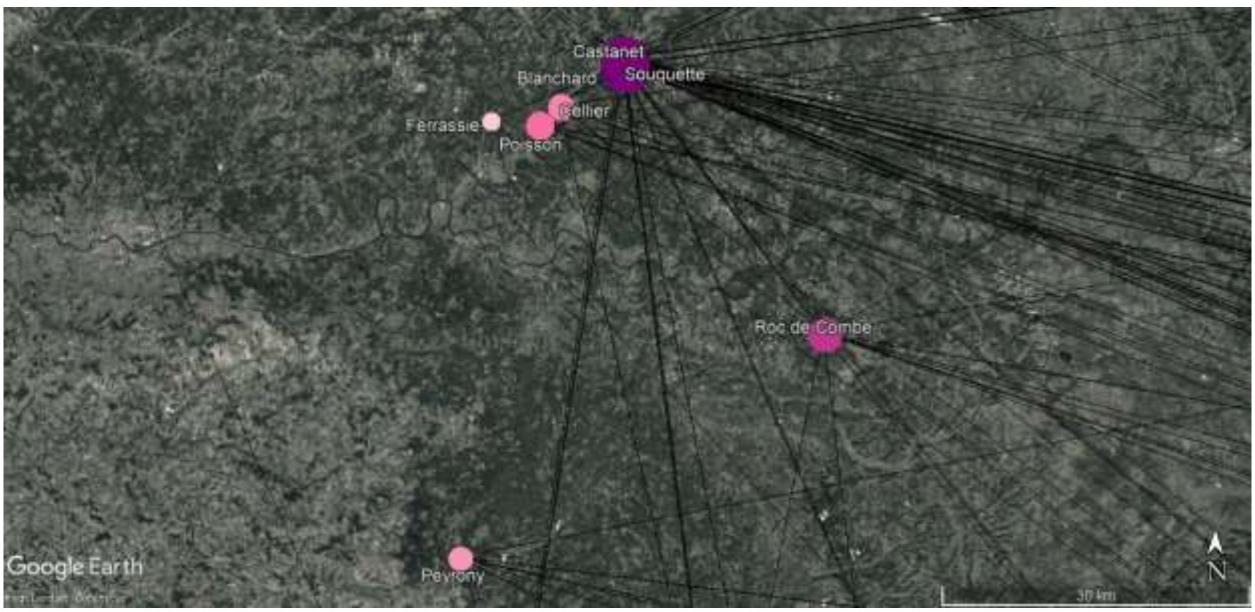


Southeast France

Northwest and Central France



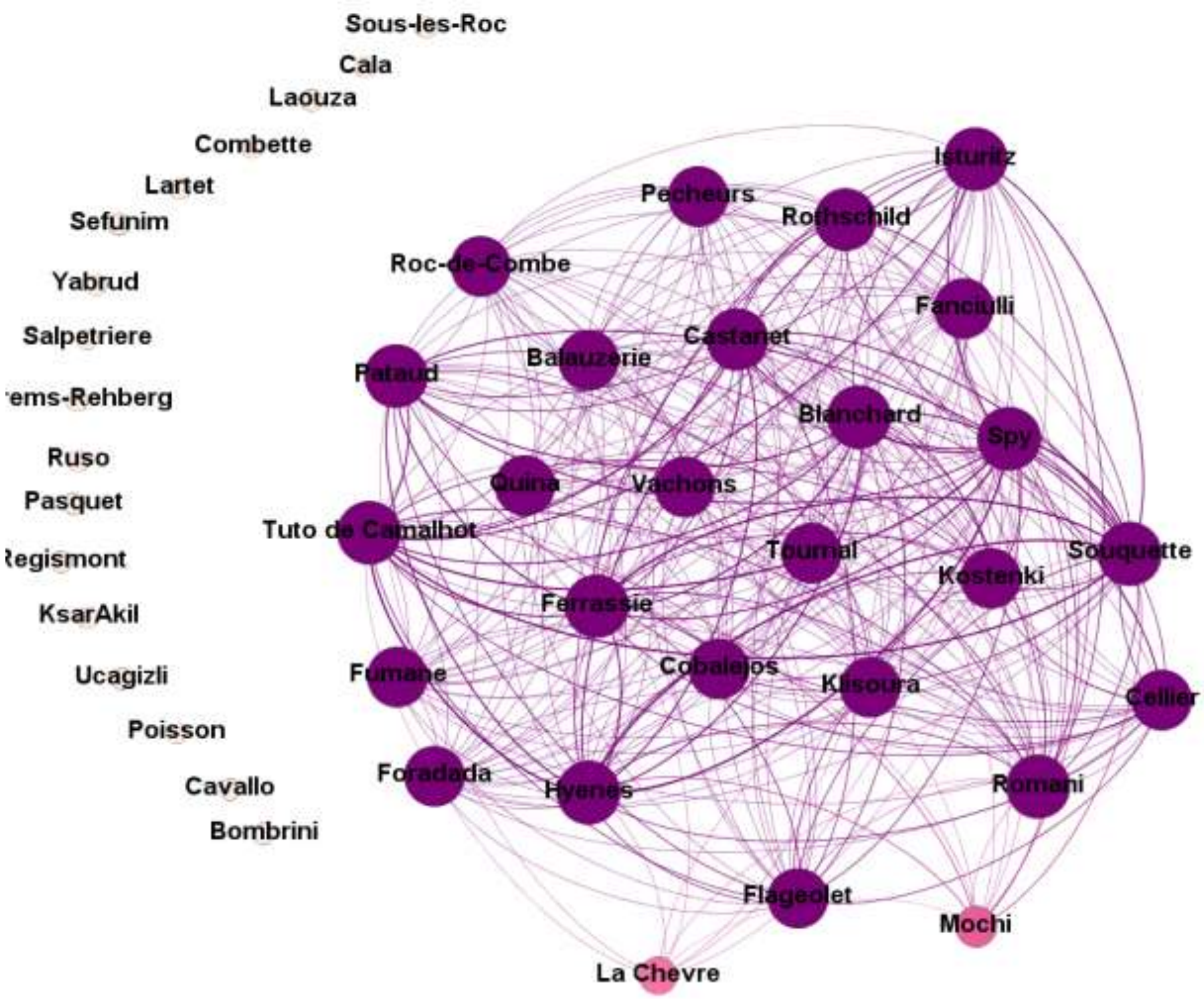
Dordogne



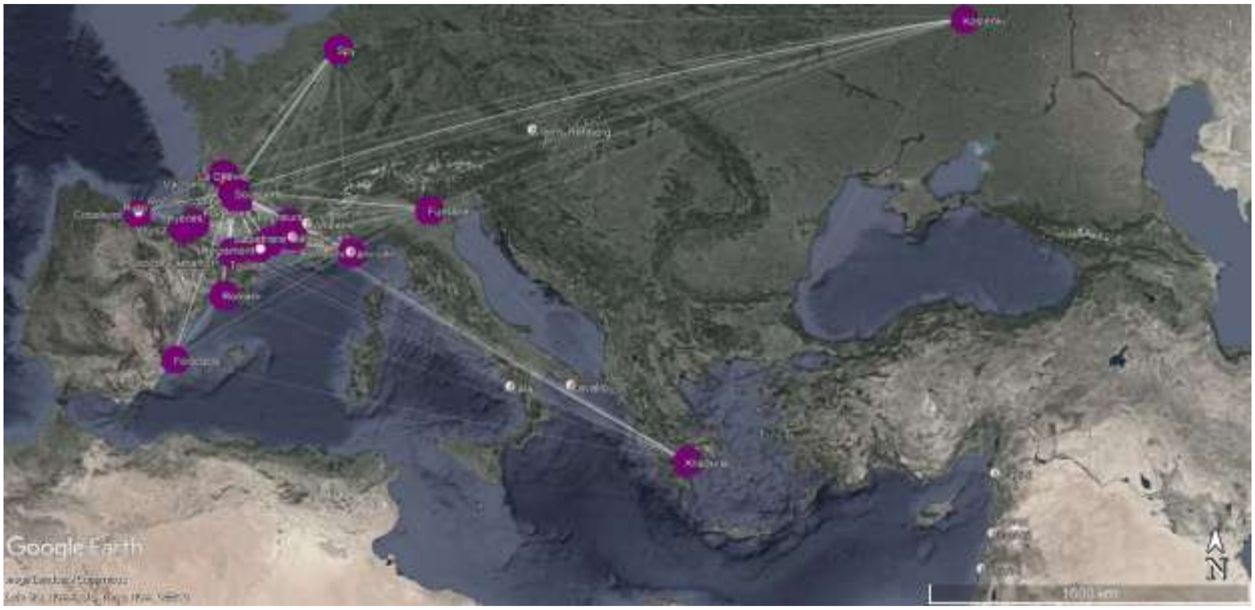
C.2: Individual Marine Shell Shapes

C.2.1: Basket

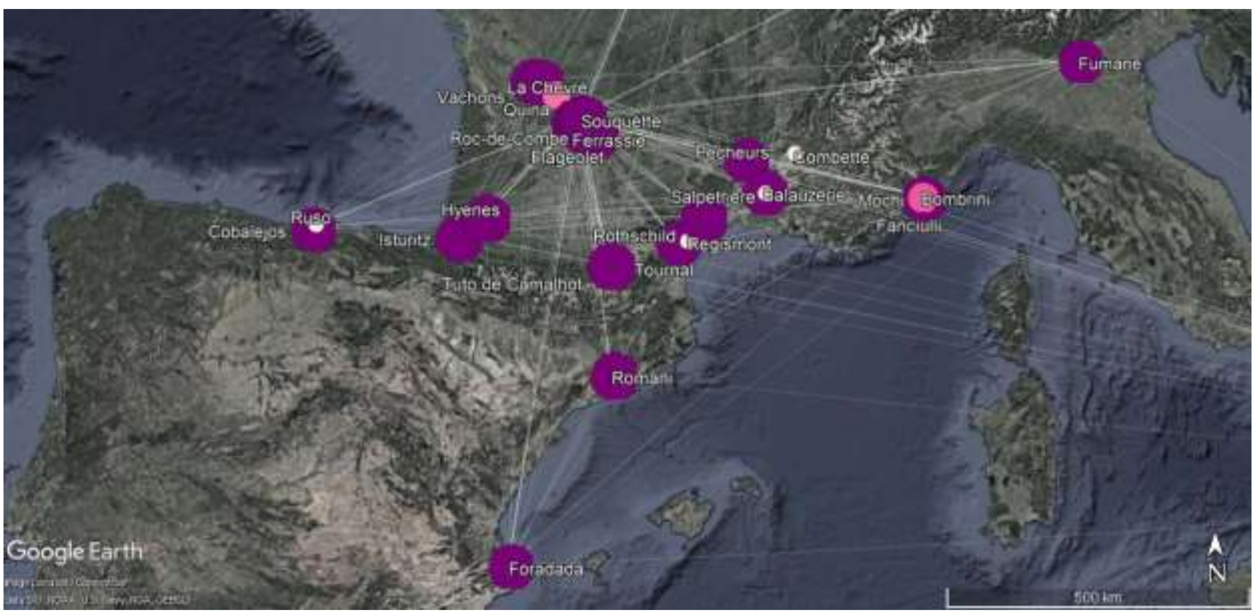
Gephi Visualization



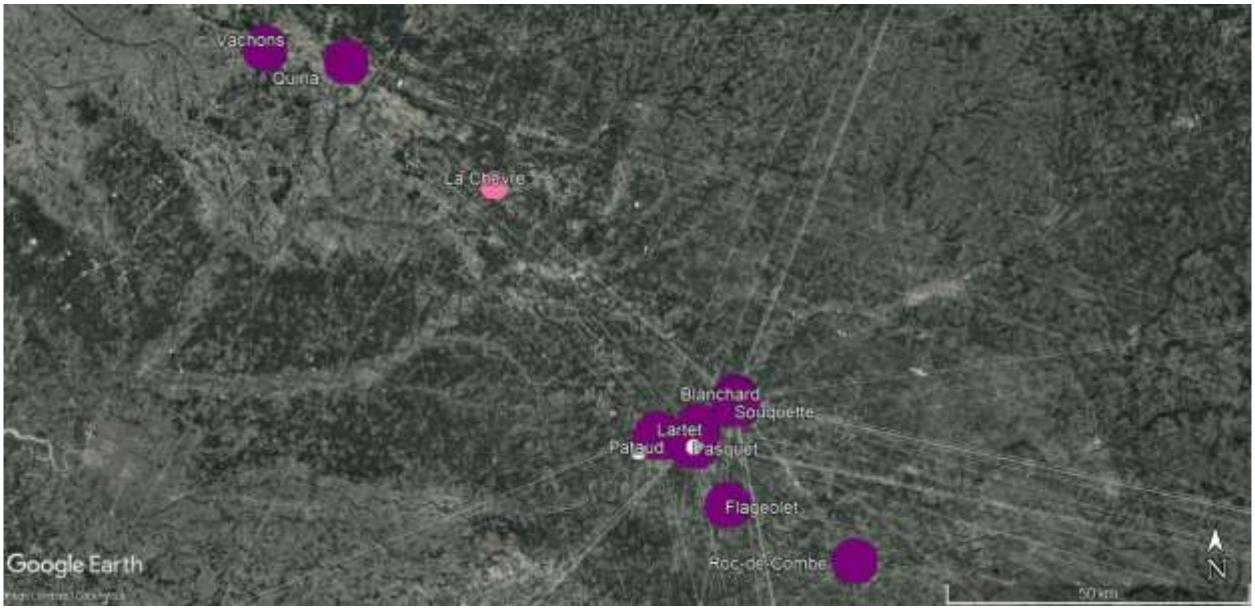
GoogleEarth: Full Map



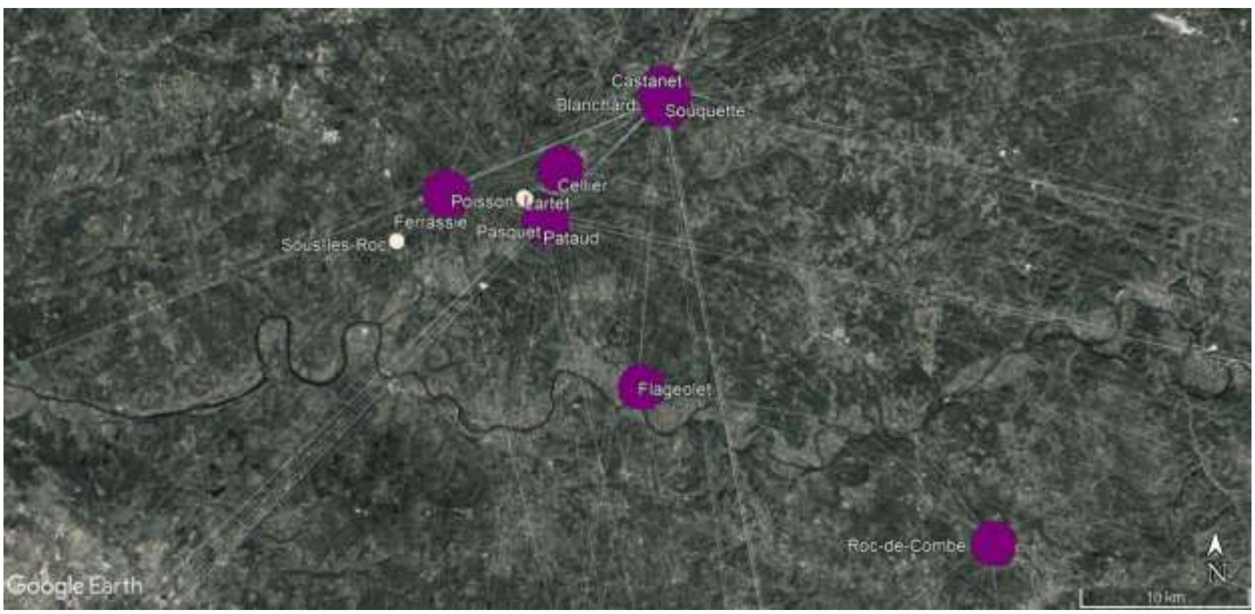
Spain, Southern France, and Northern Italy



Northwest and Central France

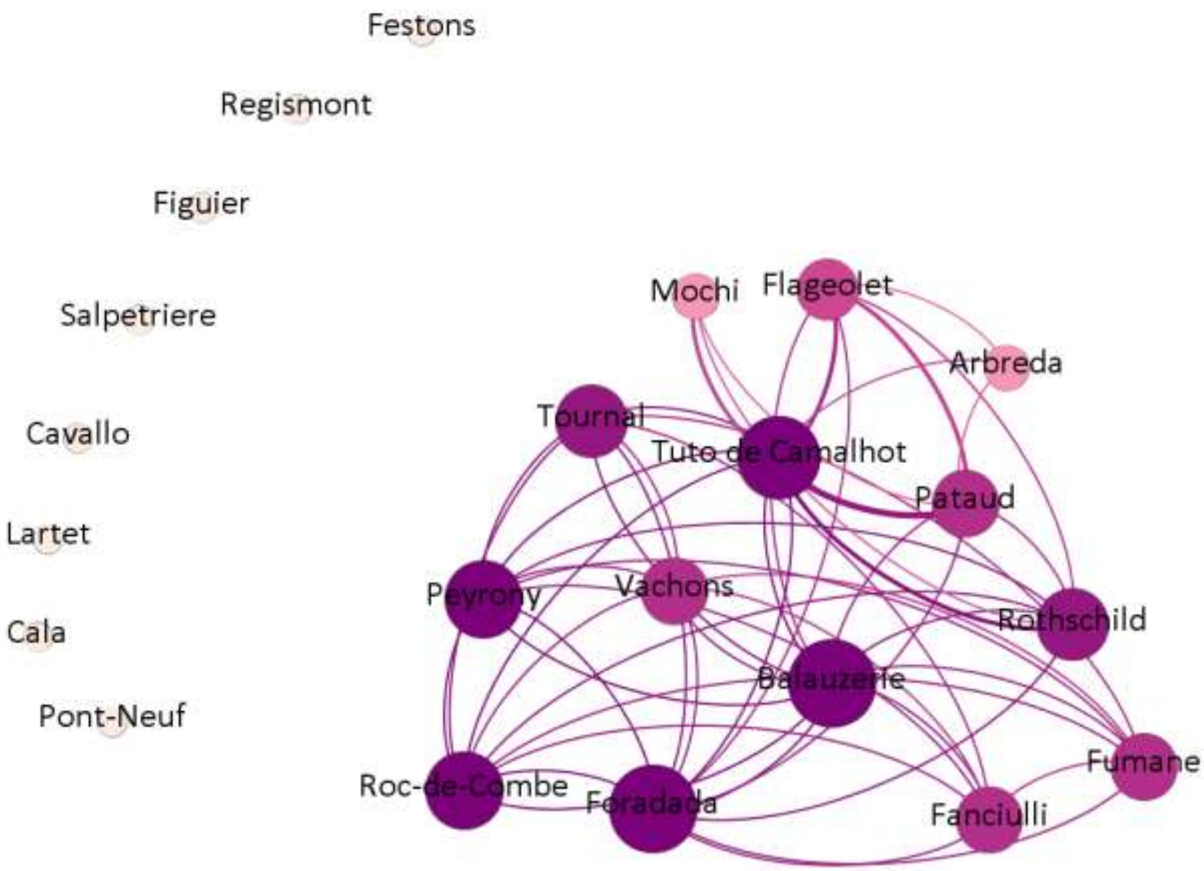


Dordogne

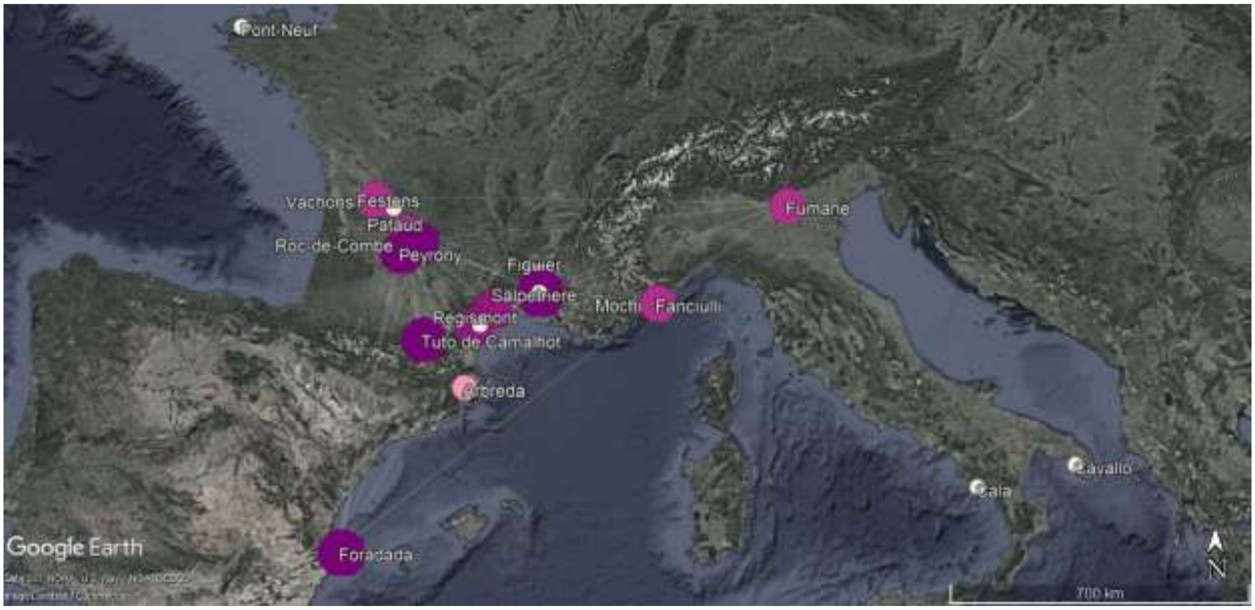


C.2.2: Bivalve

Gephi Visualization

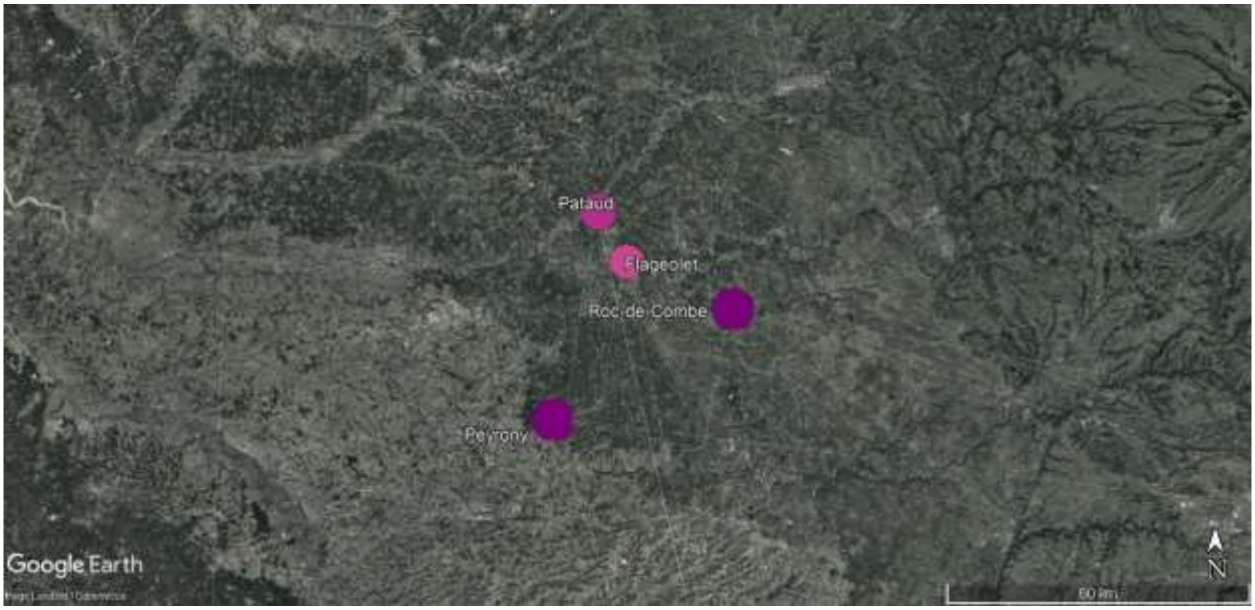


GoogleEarth: Full Map



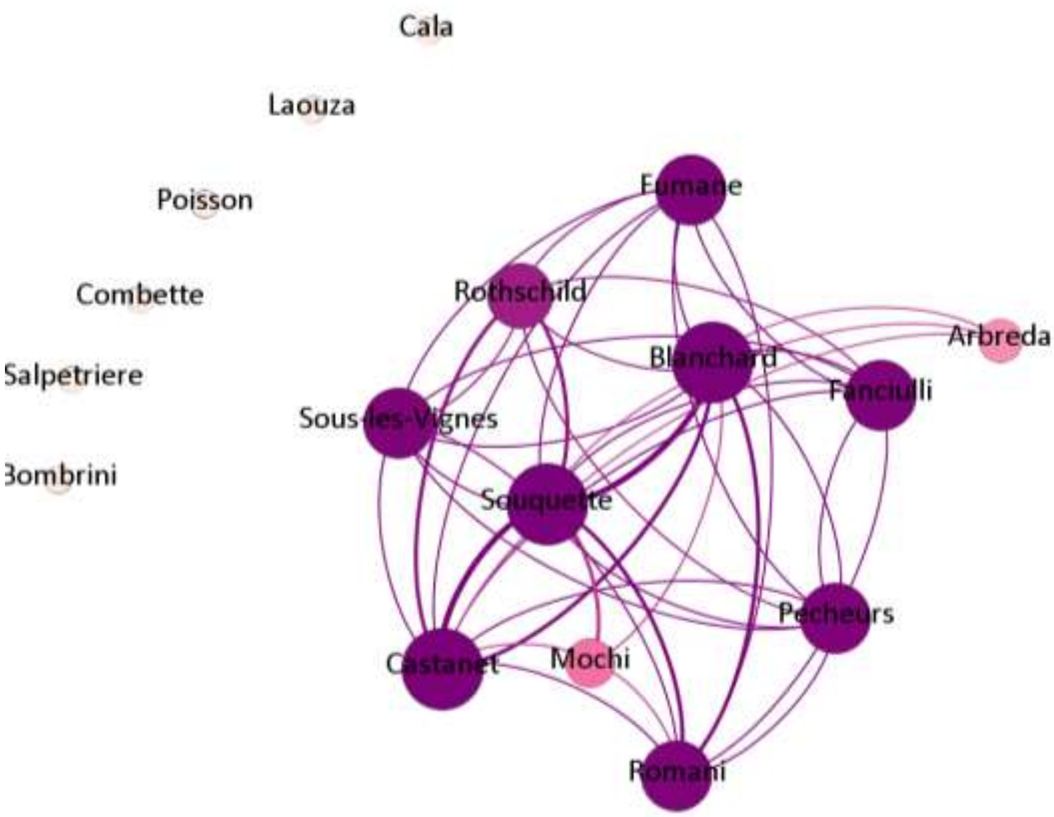
Southeastern France, Northeastern Spain, and Northwestern Italy

Dordogne



C.2.3: Convolute

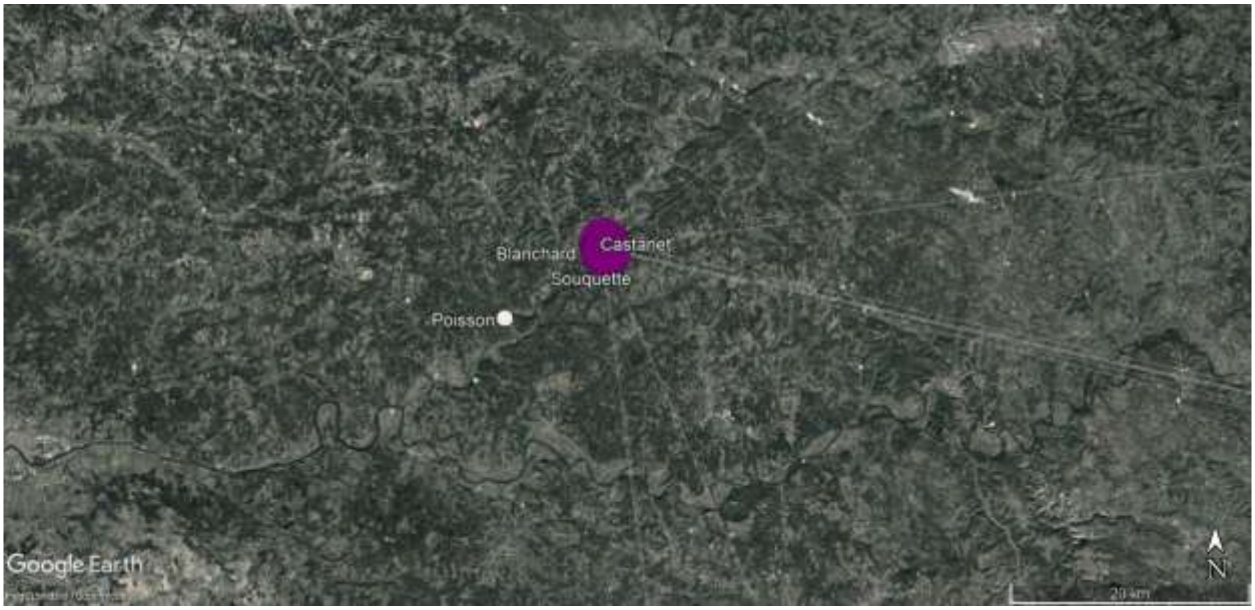
Gephi Visualization



GoogleEarth: Full Map

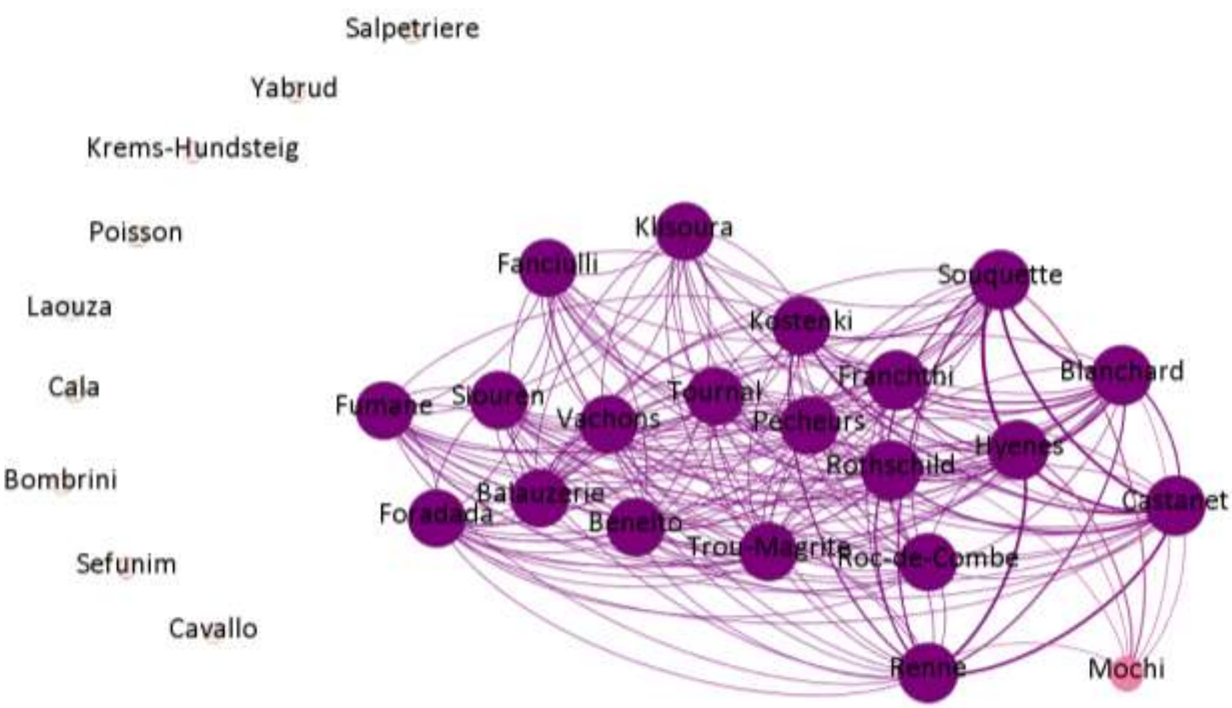
Southeastern France and Northwestern Italy

Dordogne



C.2.4: Globular

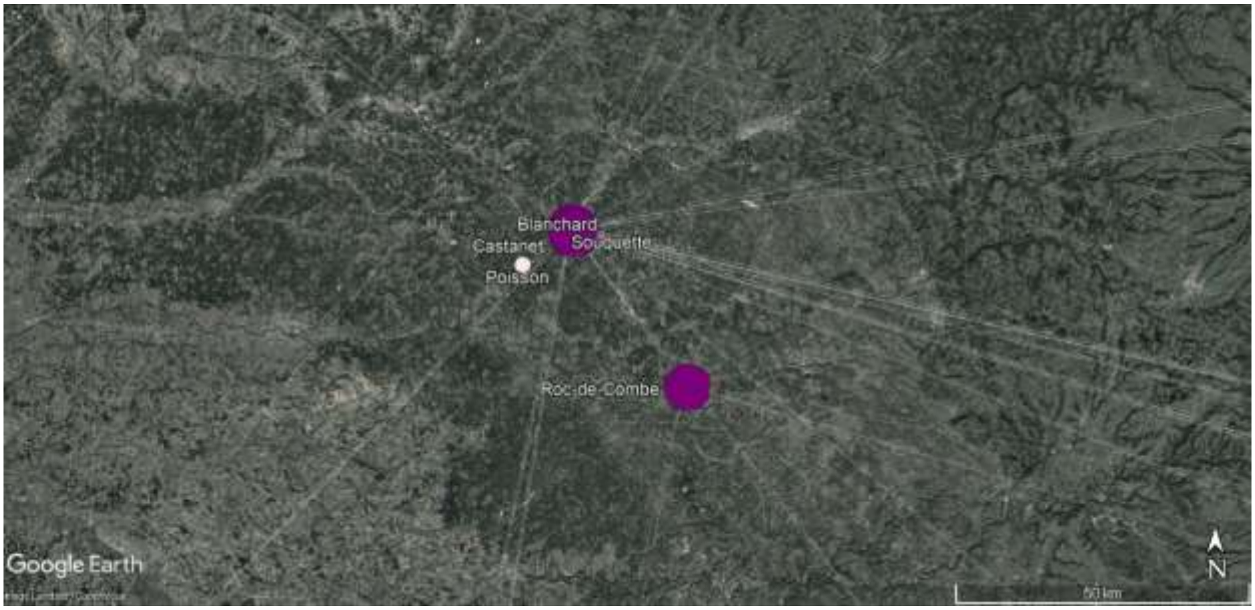
Gephi Visualization



GoogleEarth:Full Map

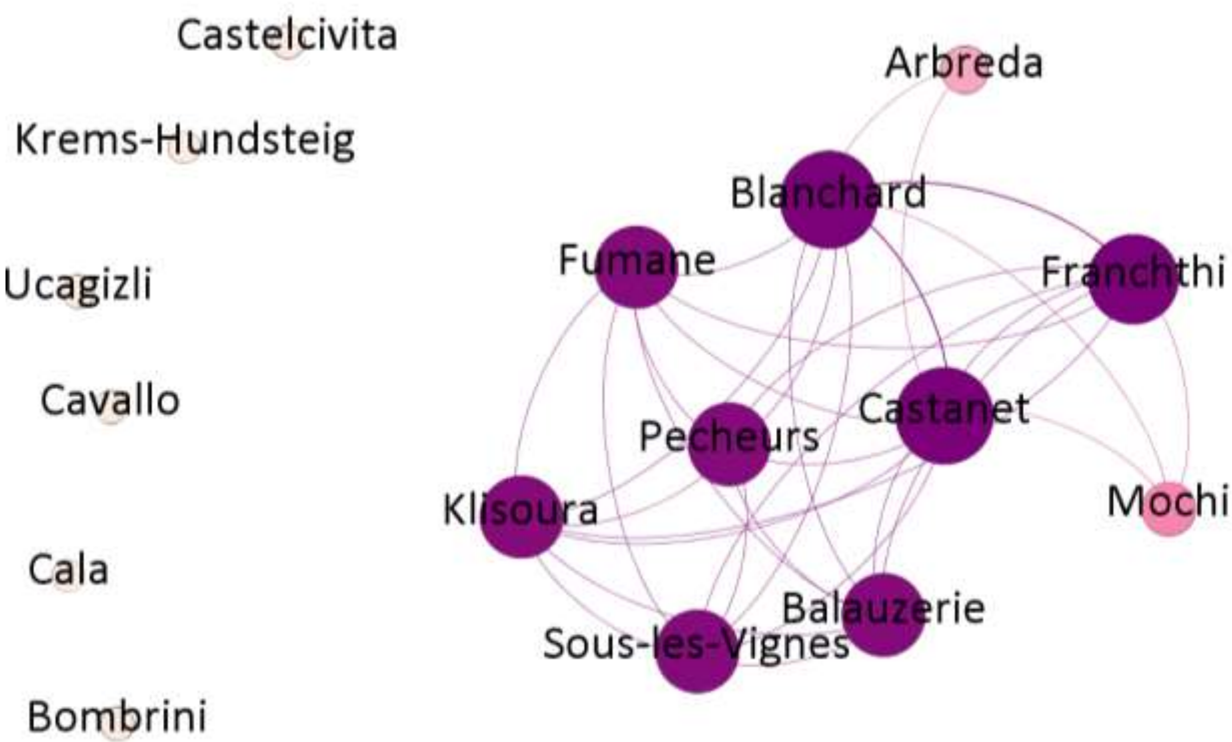
Southeastern France and Northwestern Italy

Dordogne



C.2.5: Top/Turban

Gephi Visualization



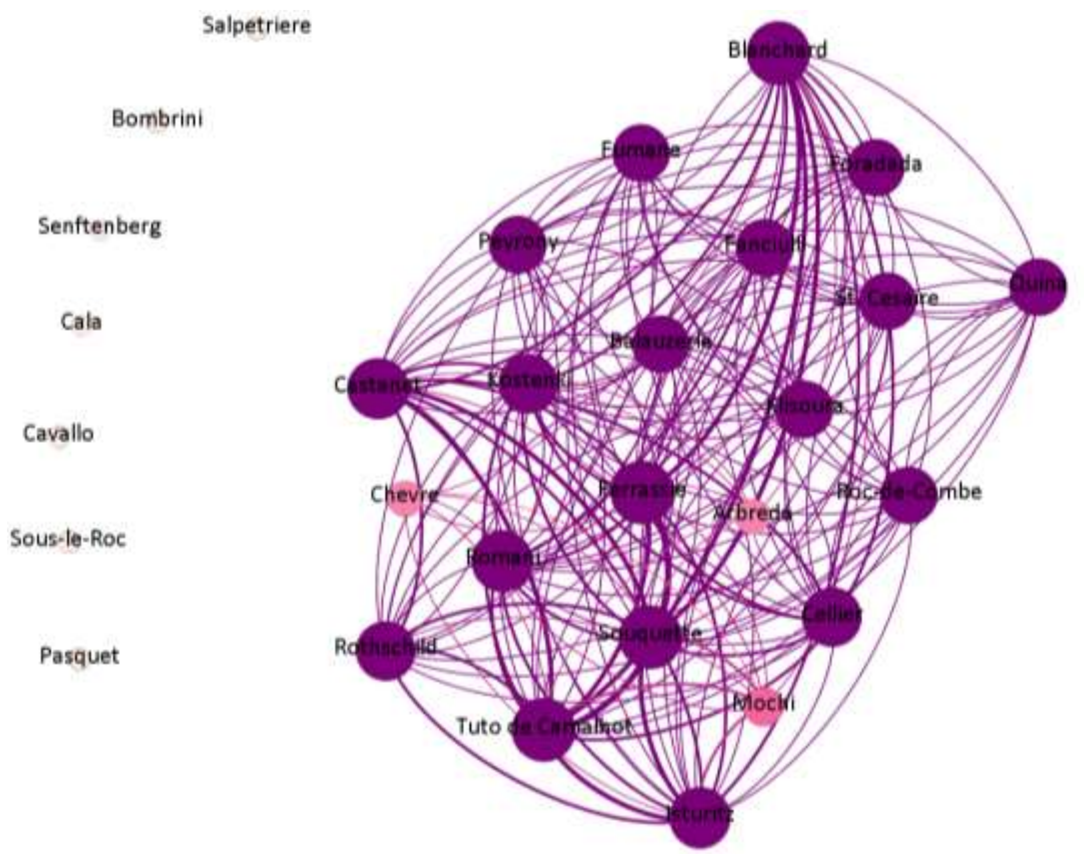
GoogleEarth: Full Map

Southeastern France and Northwestern Italy

Dordogne

C.2.6: Tubular

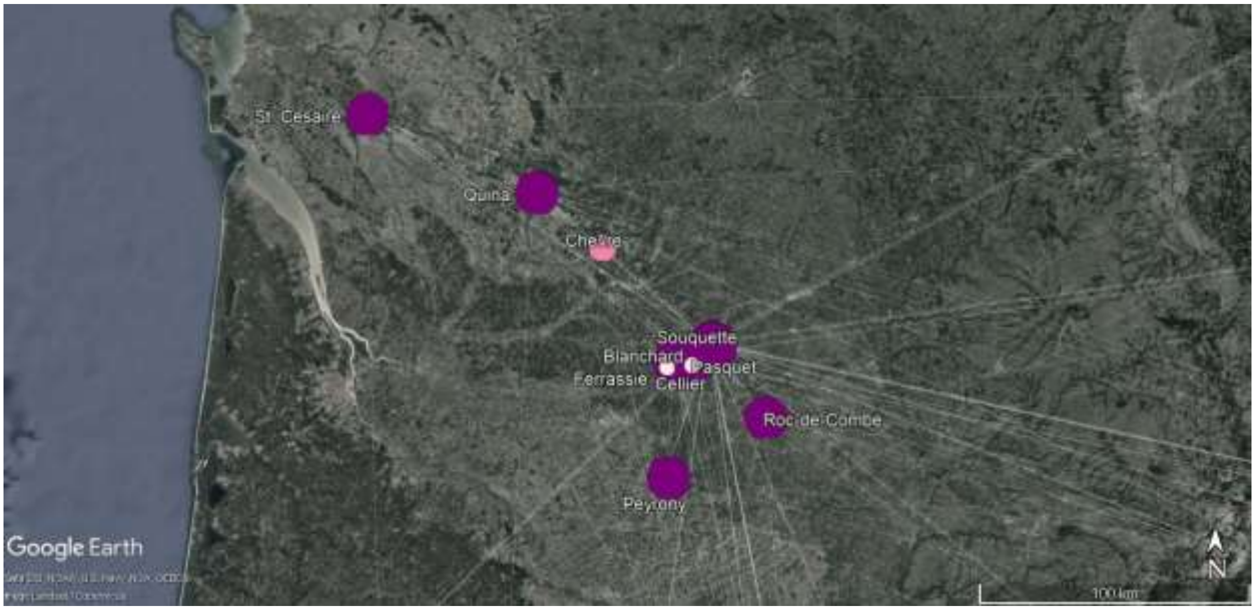
Gephi Visualization



GoogleEarth: Full Map

Northeastern Spain, Southeastern France, and Northwestern Italy

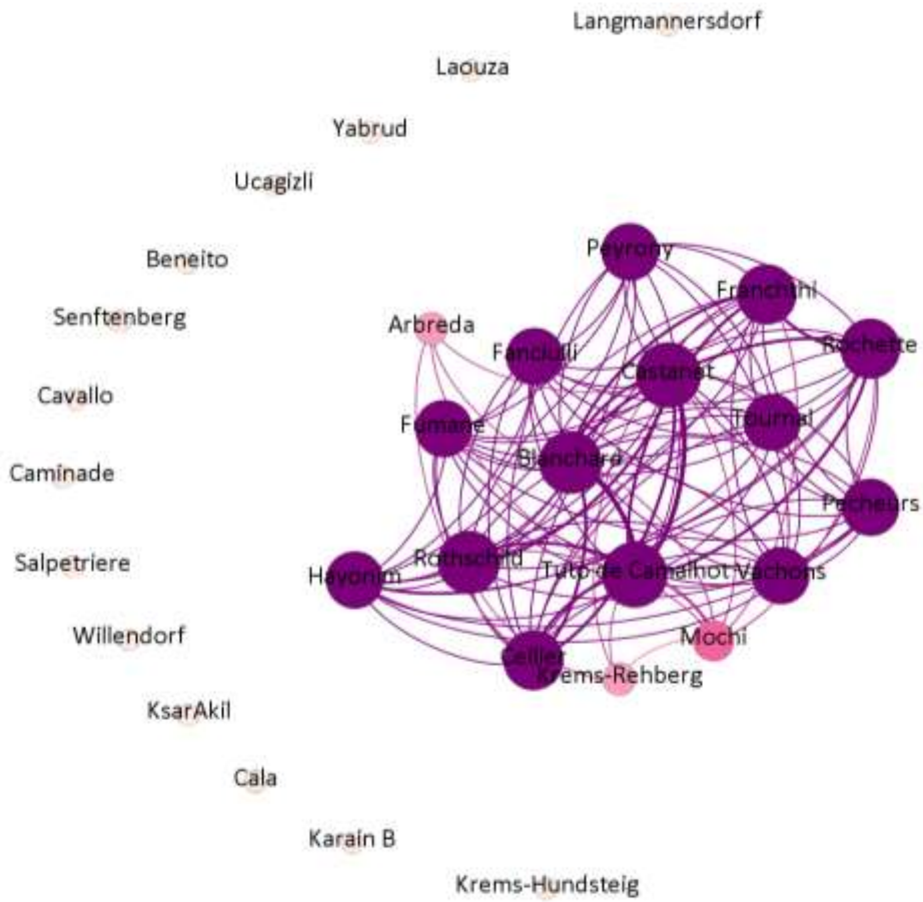
Northwestern and Central France



Dordogne

C.2.7: Tusk

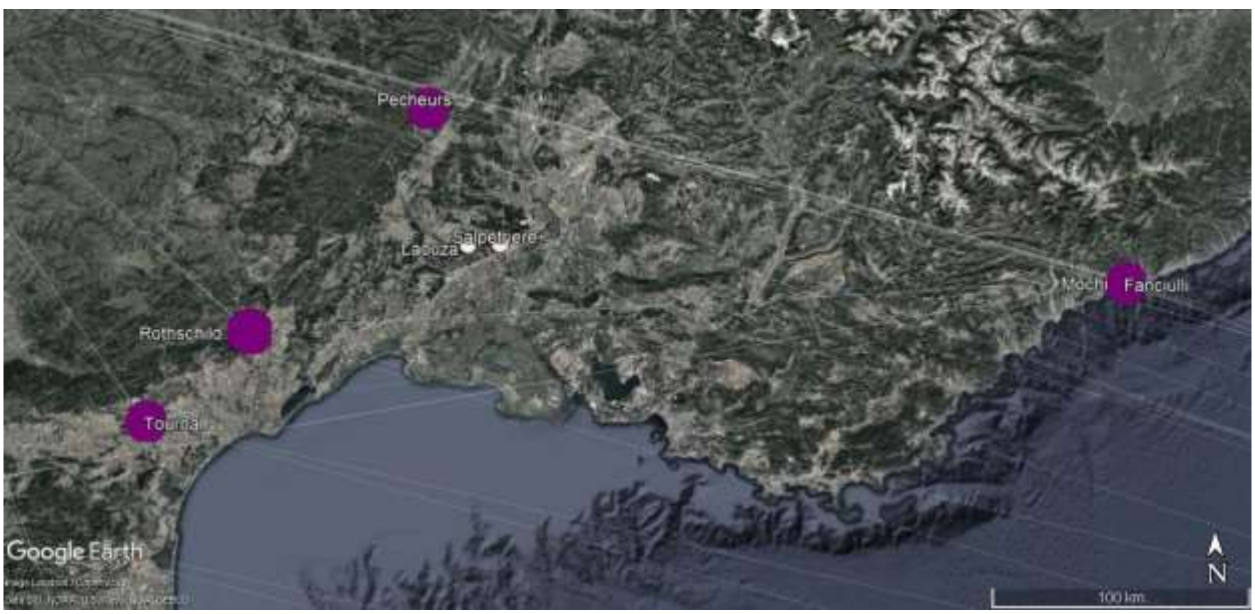
Gephi Visualization



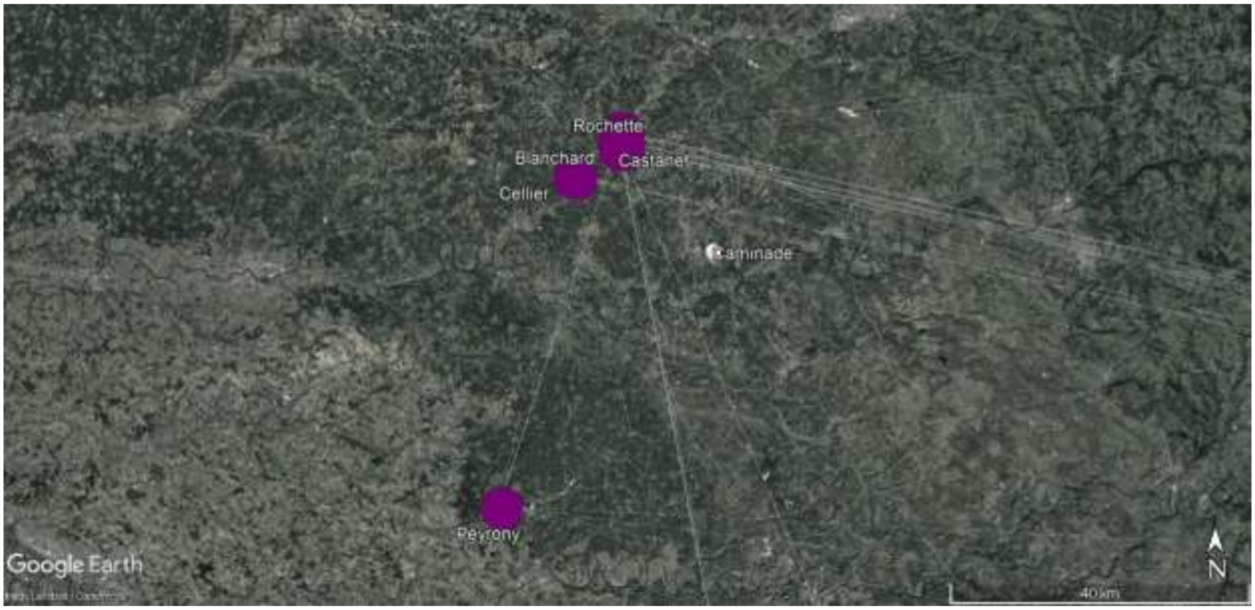
GoogleEarth: Full Map

Austria

Southeastern France and Northwestern Italy



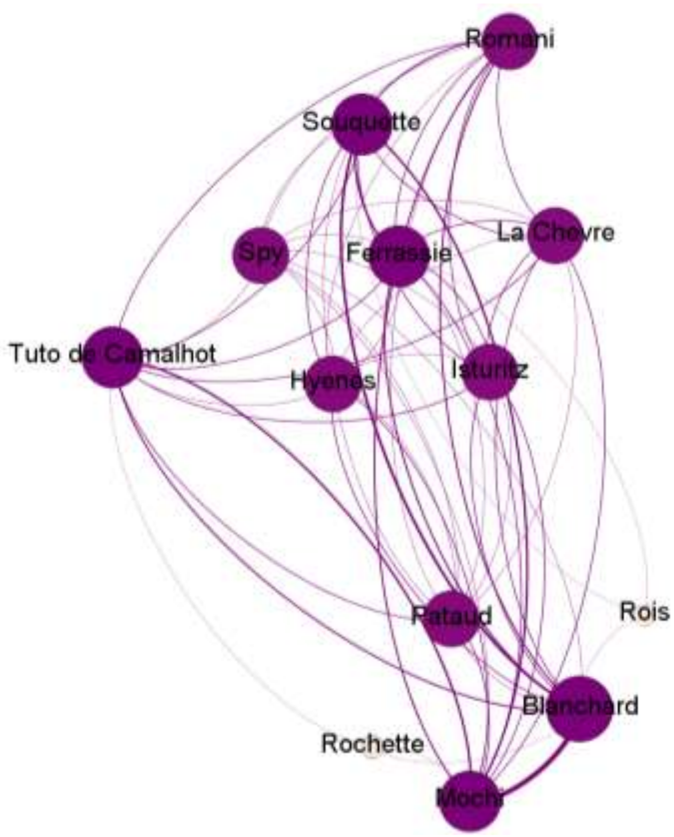
Dordogne



C.3: Non-shell Materials

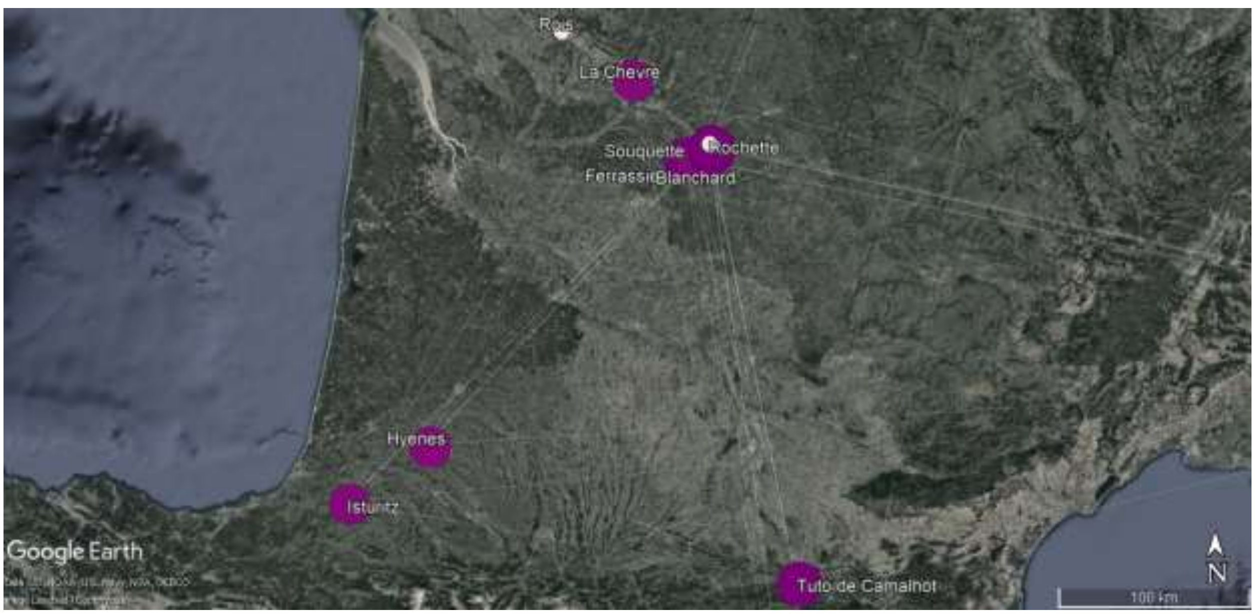
C.3.1: Bone

Gephi Visualization



GoogleEarth: Full Map

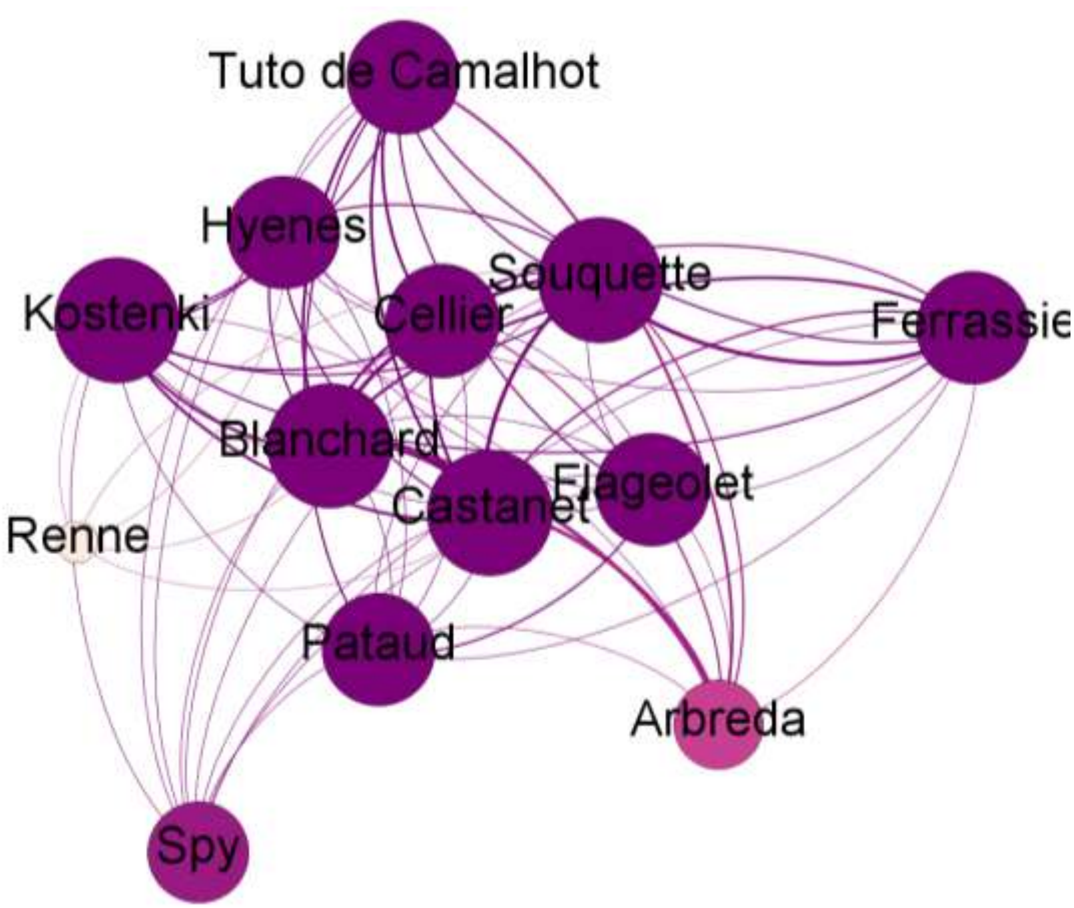
Southern and Central France



Dordogne

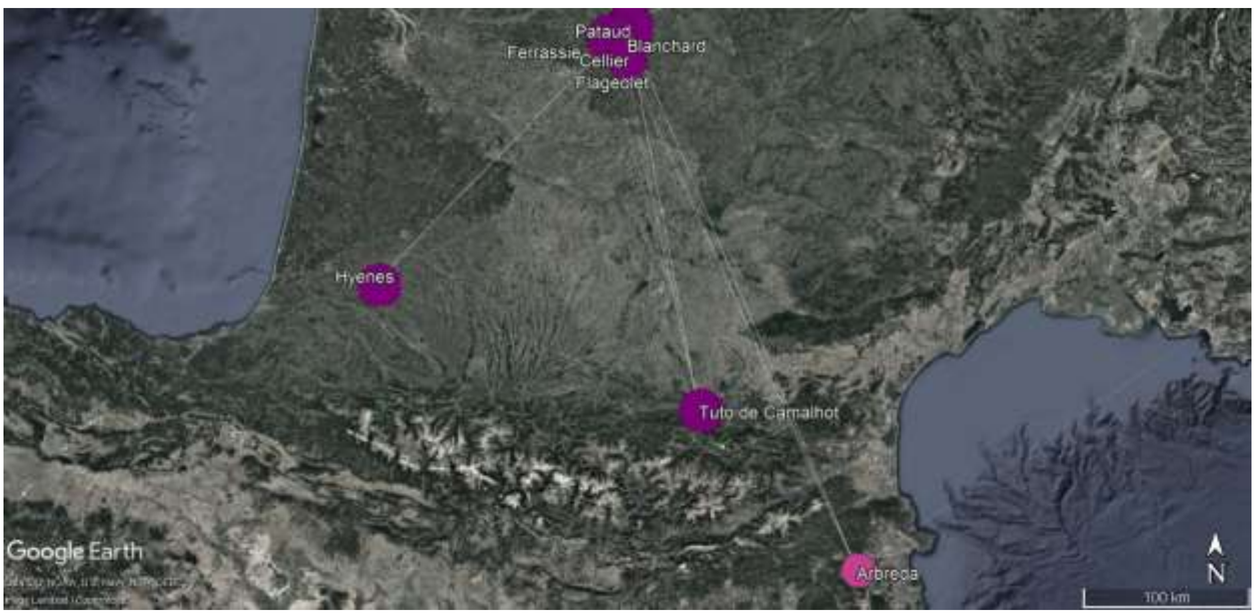
C.3.2: Ivory

Gephi Visualization

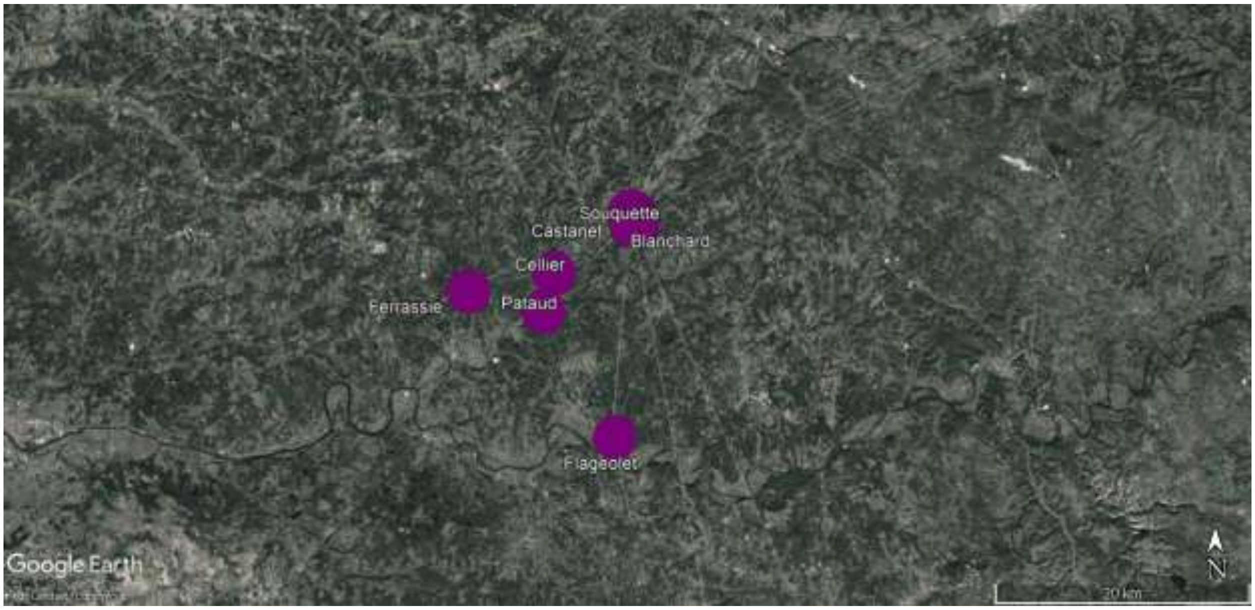


GoogleEarth: Full Map

Northern Spain and Central and Southern France

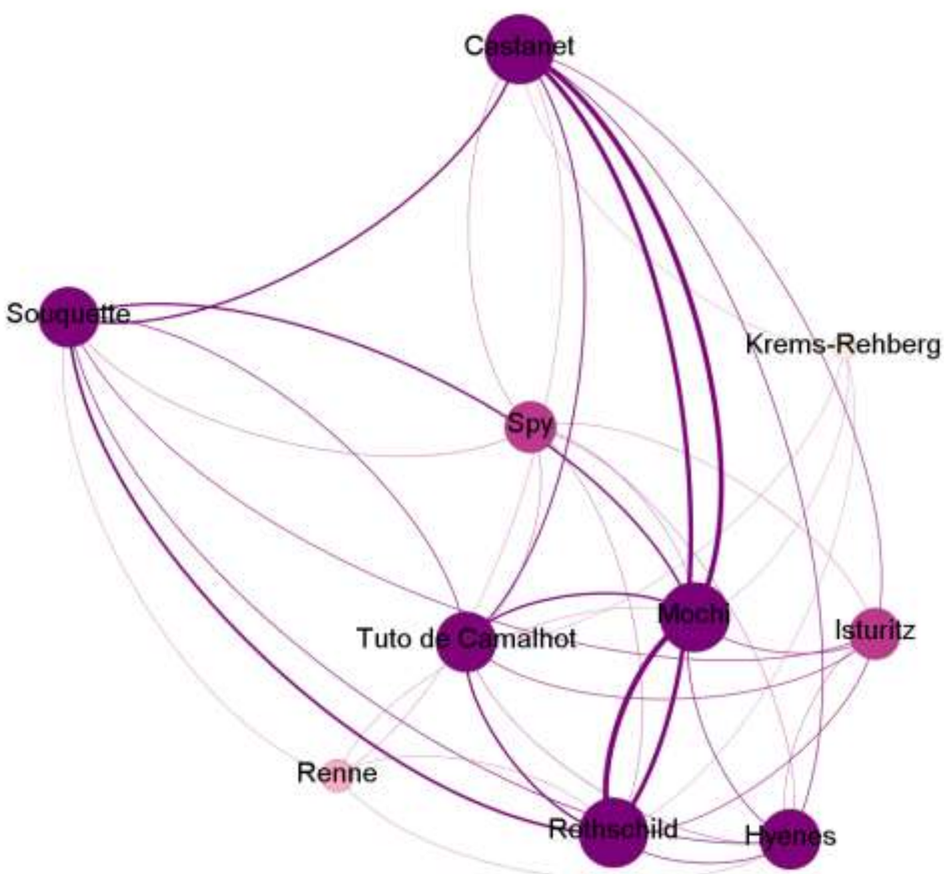


Dordogne

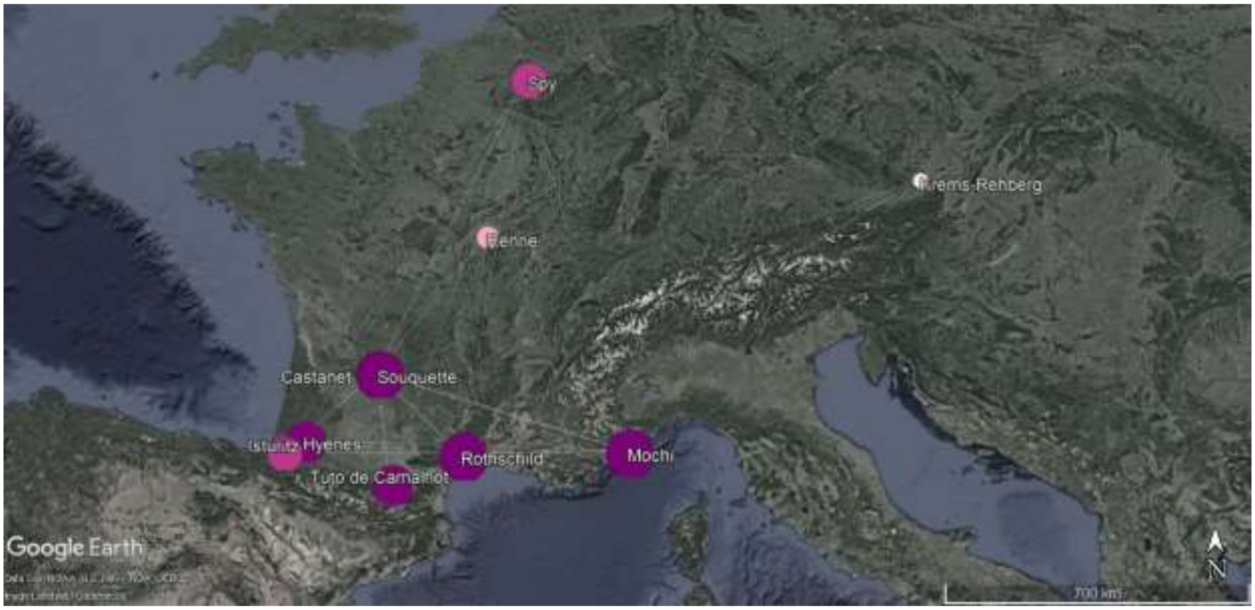


C.3.3: Stone

Gephi Visualization

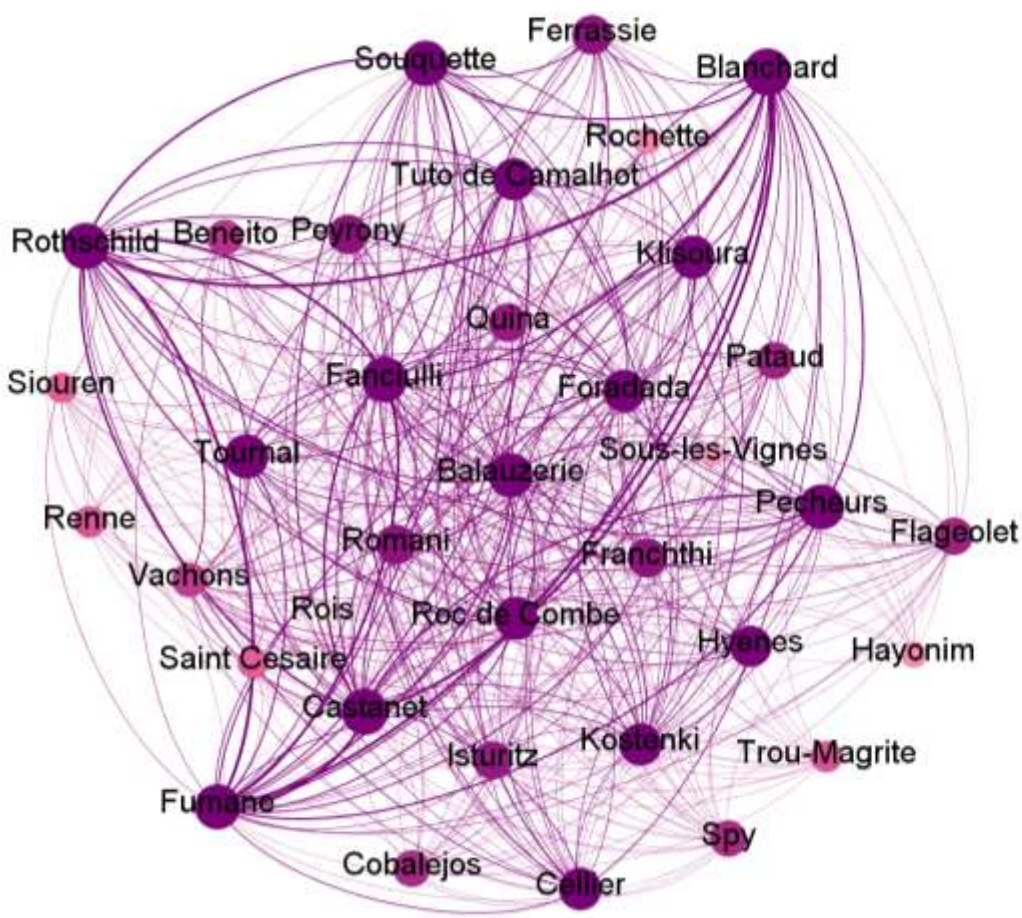


GoogleEarth: Full Map

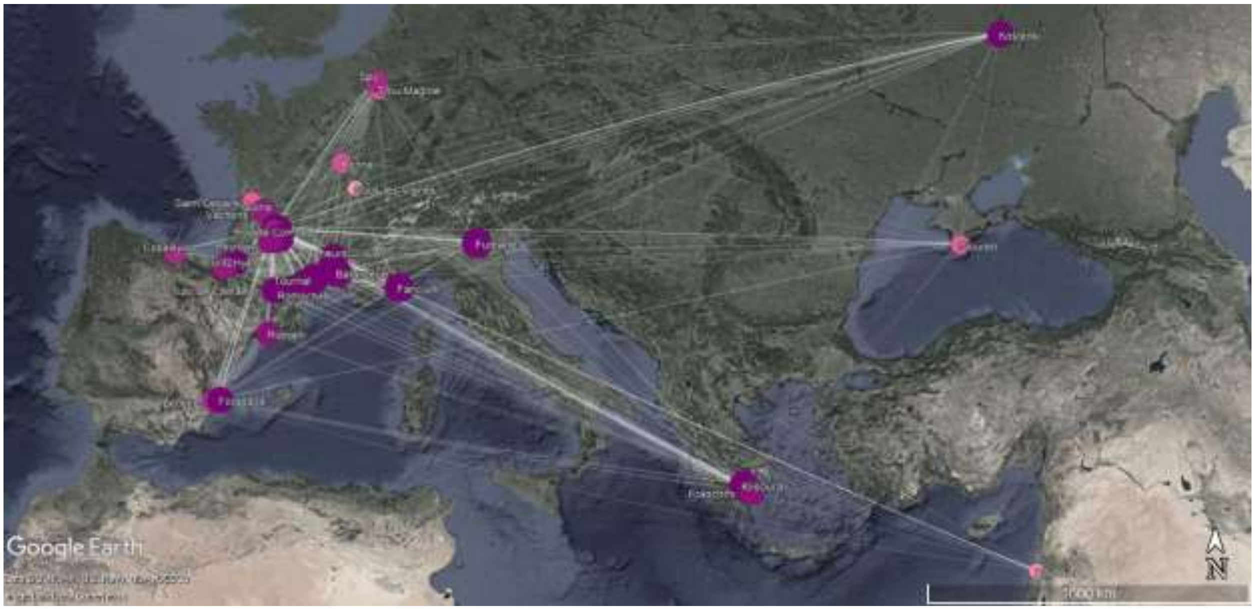


C.3.4: Teeth

Gephi Visualization



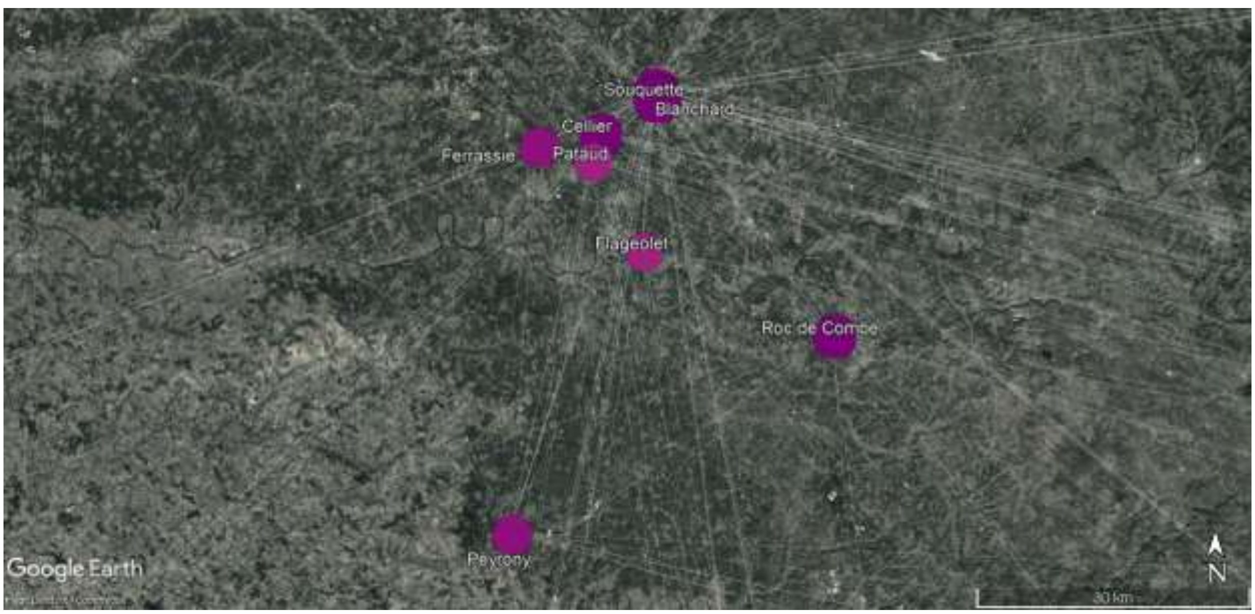
GoogleEarth: Full Map



Spain, Southern and Central France, and Northern Italy

Southeastern France and Northwestern Italy

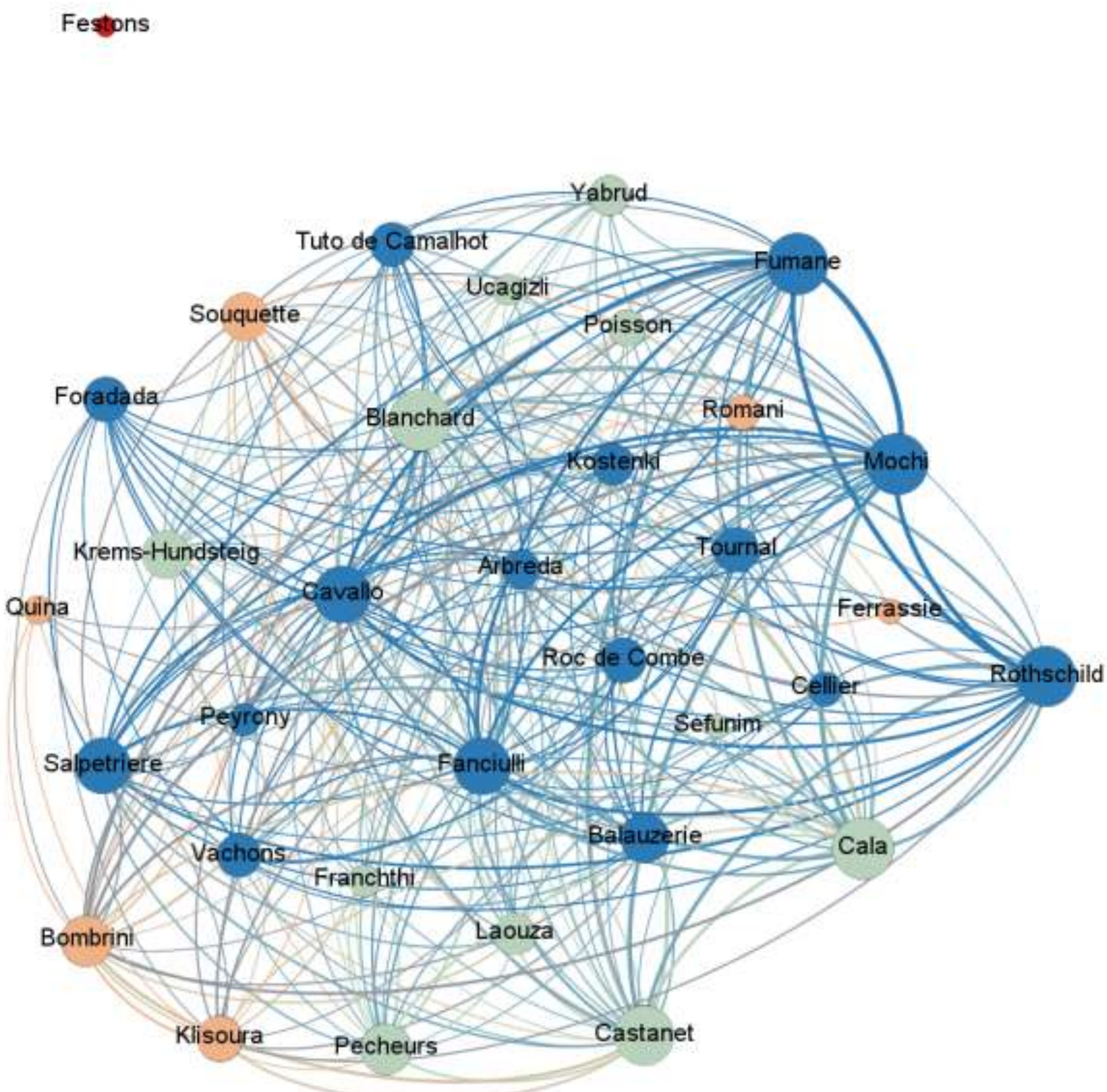
Dordogne



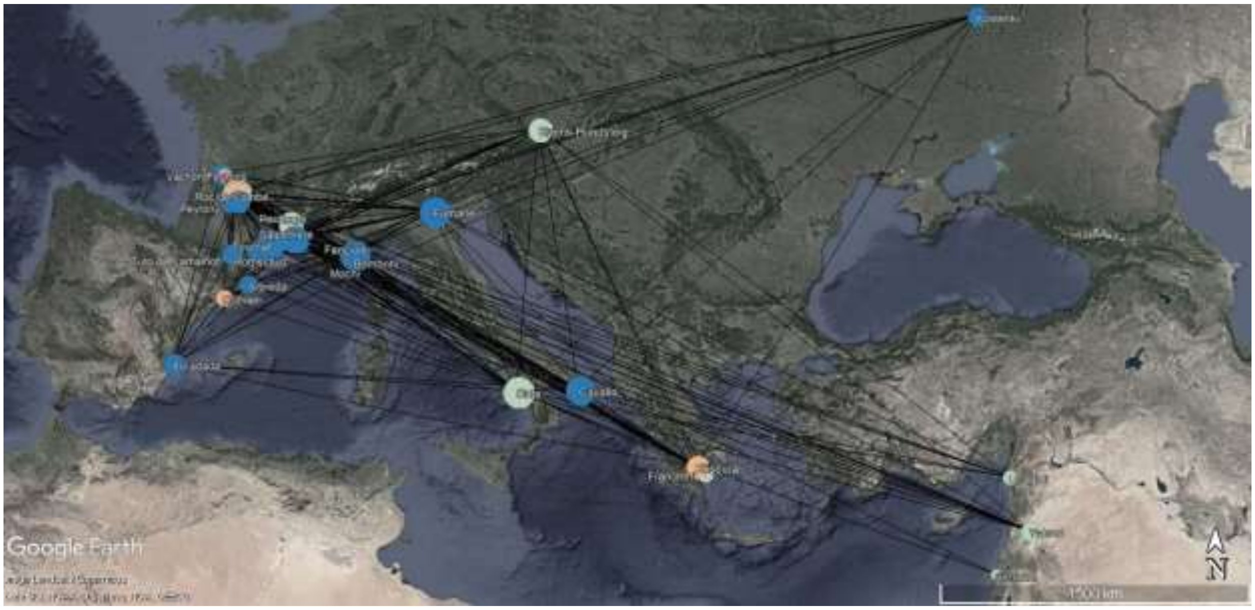
Appendix D: Modularity (Grouping) Analysis Gephi Visualizations and GoogleEarth Maps for Shell Shapes and Non-shell Materials at Ten or More Sites

D.1: Sites With at Least Three Marine Shell Shapes in Common

Gephi Visualization

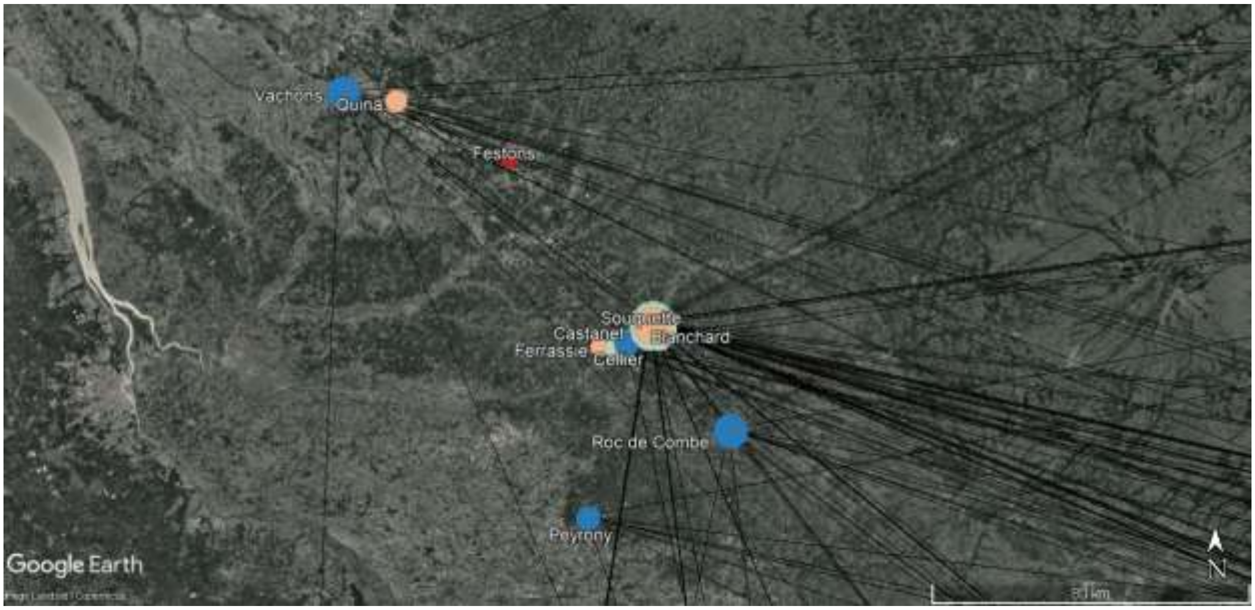


GoogleEarth: Full Map

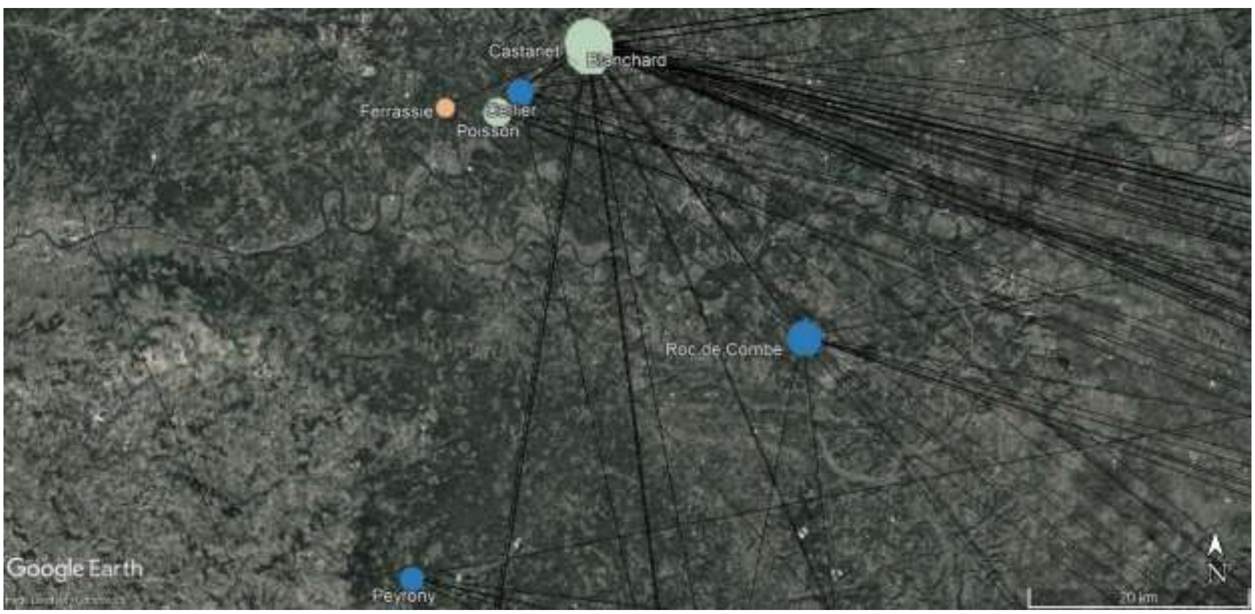


Southeast France and Northern Italy

Northwest and Central France



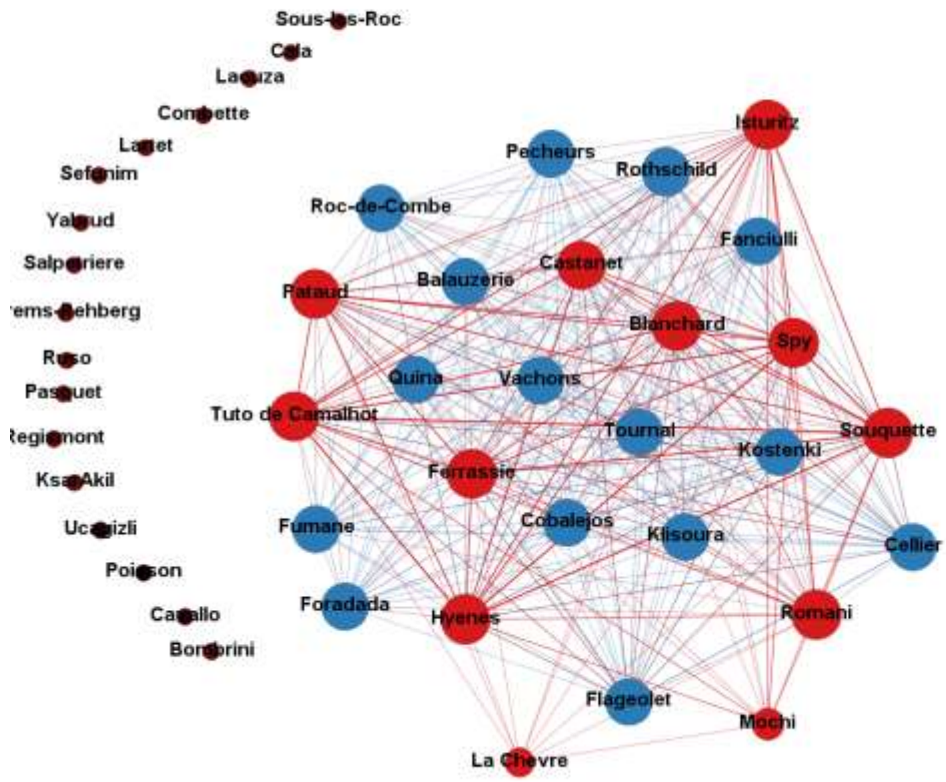
Dordogne



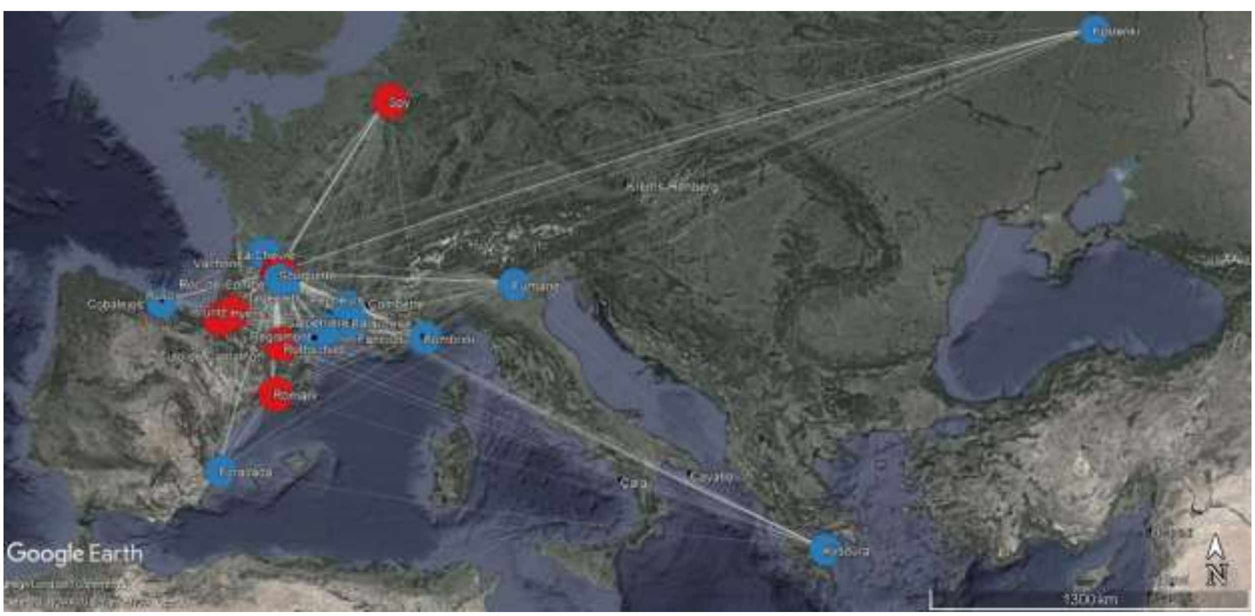
D.2: Individual Marine Shell Shapes

D.2.1: Basket

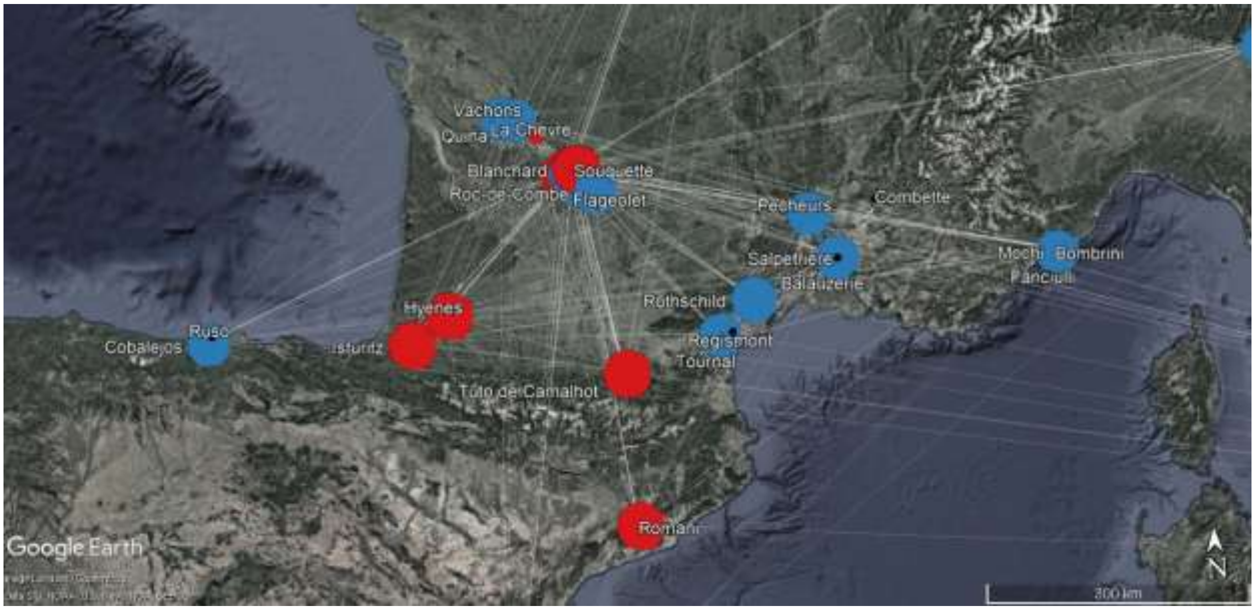
Gephi Visualization



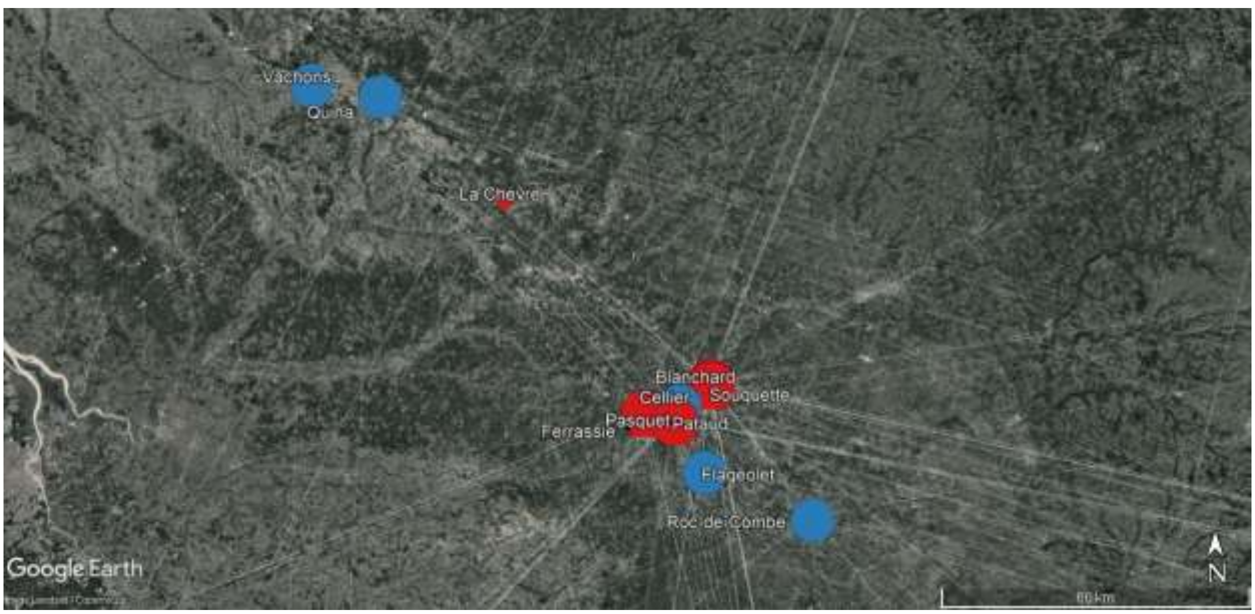
GoogleEarth: Full Map



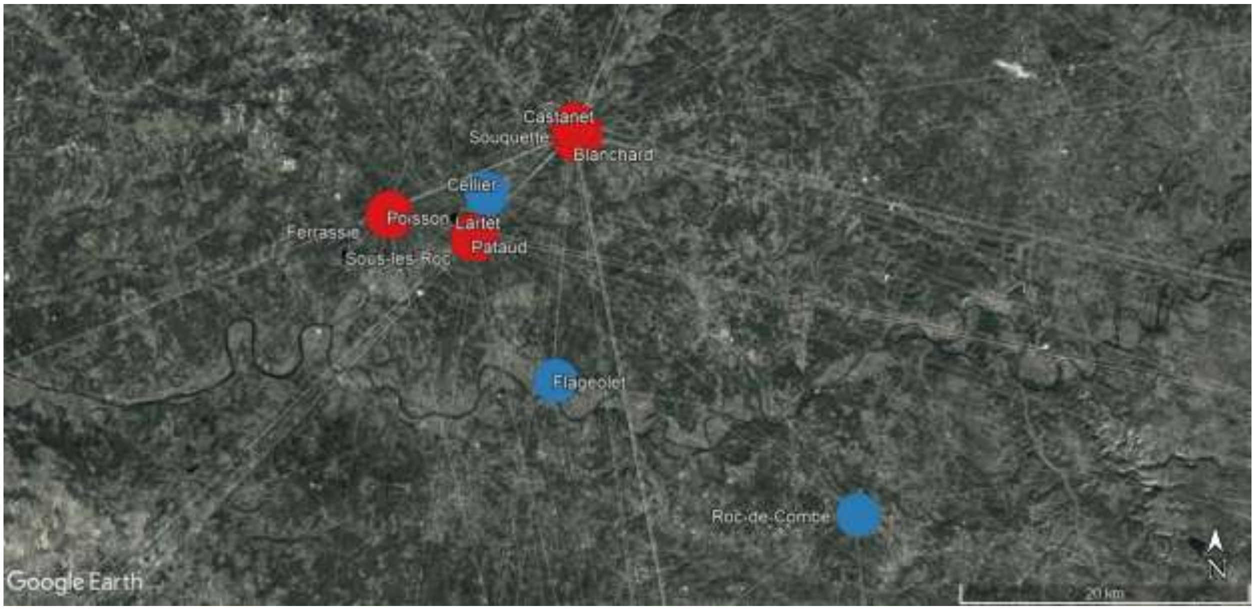
Northern Spain, Southern and Central France, and Northeastern Italy



Northern and Central France

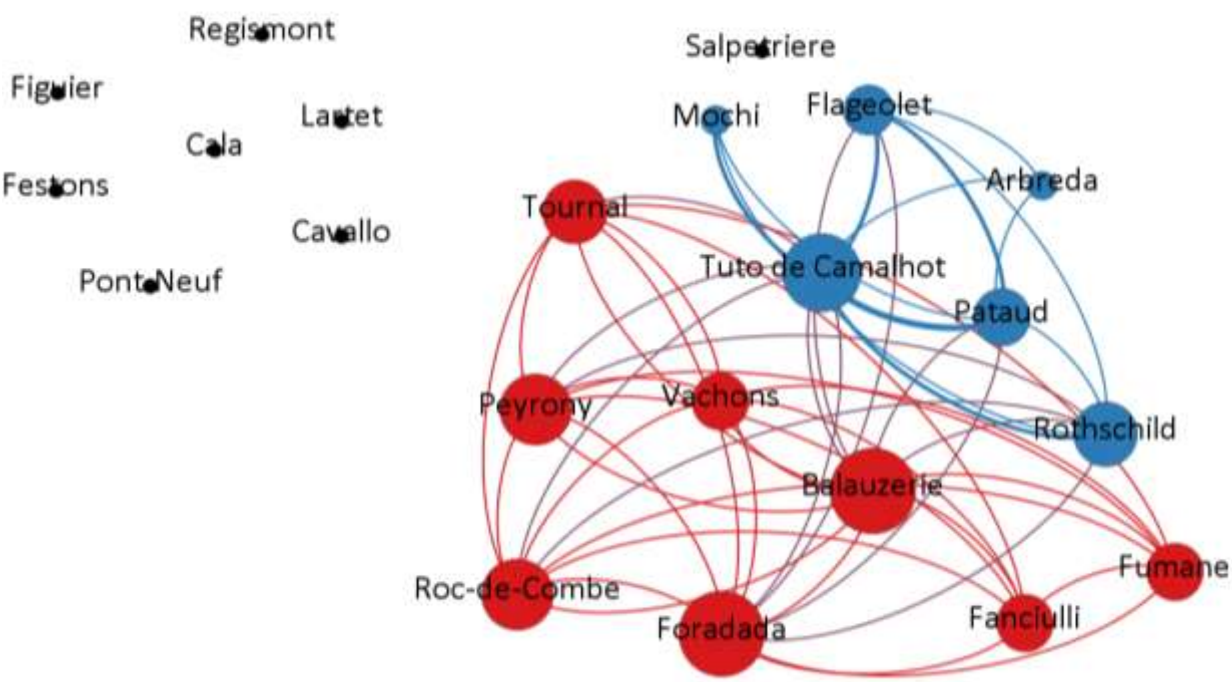


Dordogne

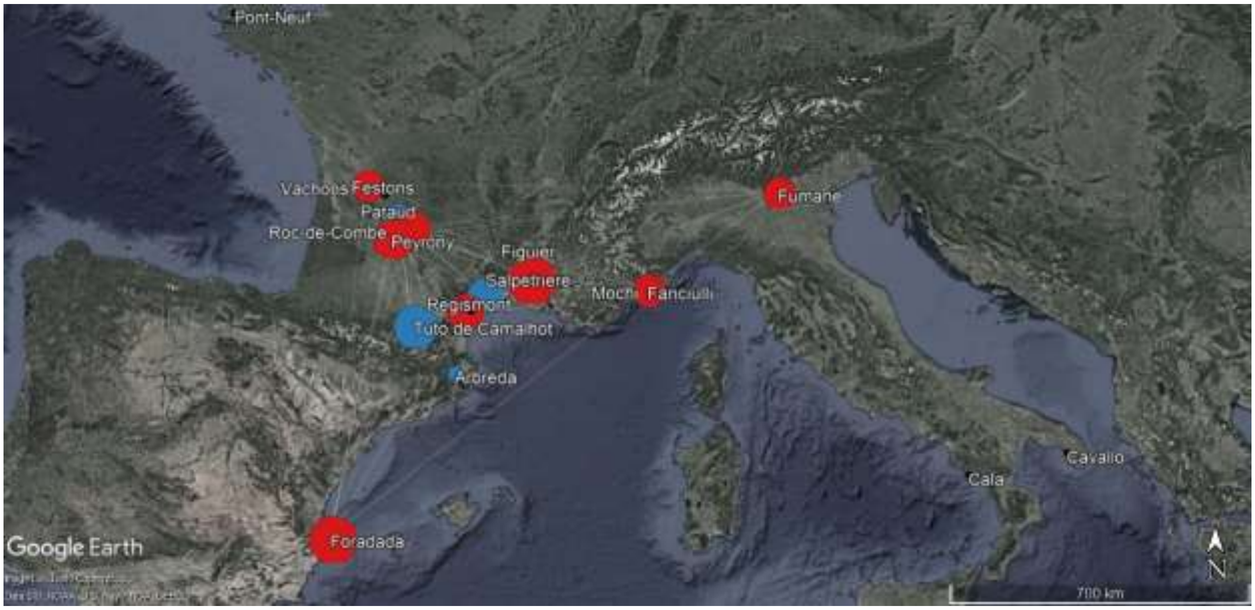


D.2.2: Bivalve

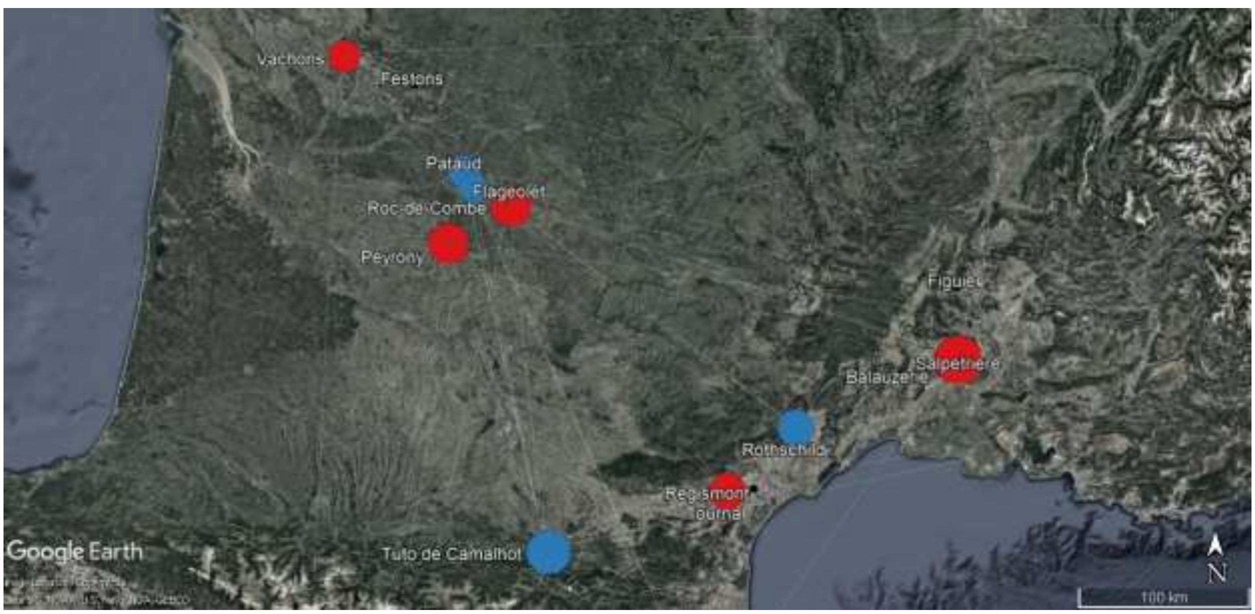
Gephi Visualization



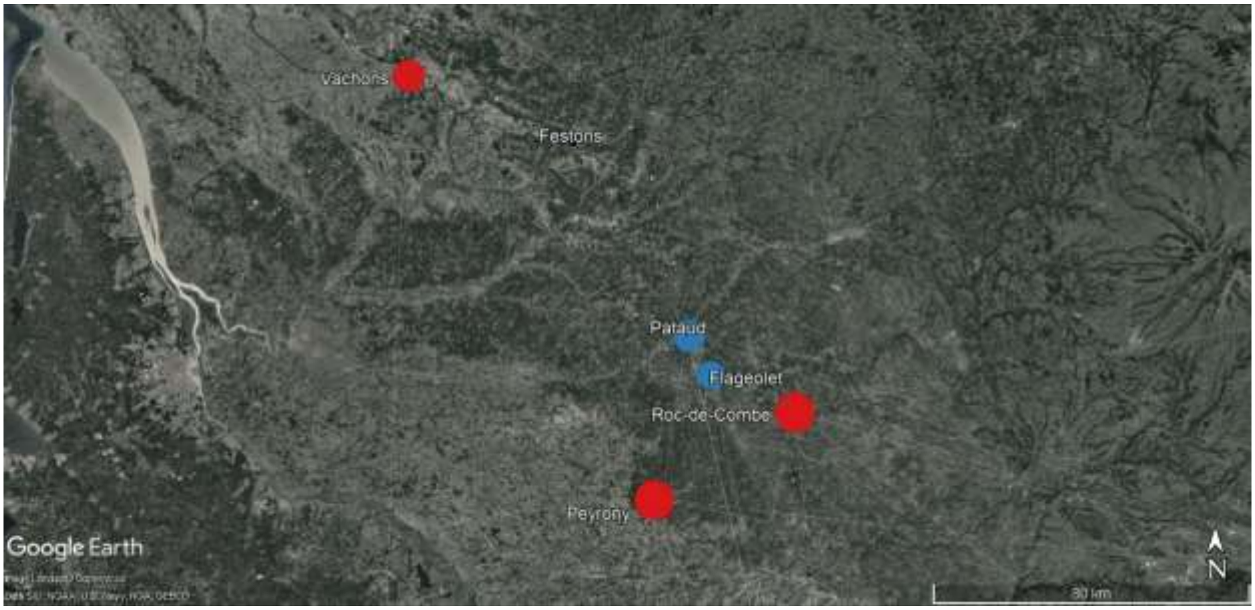
GoogleEarth: Full Map



Southeastern and Central France



Northwestern France and the Dordogne

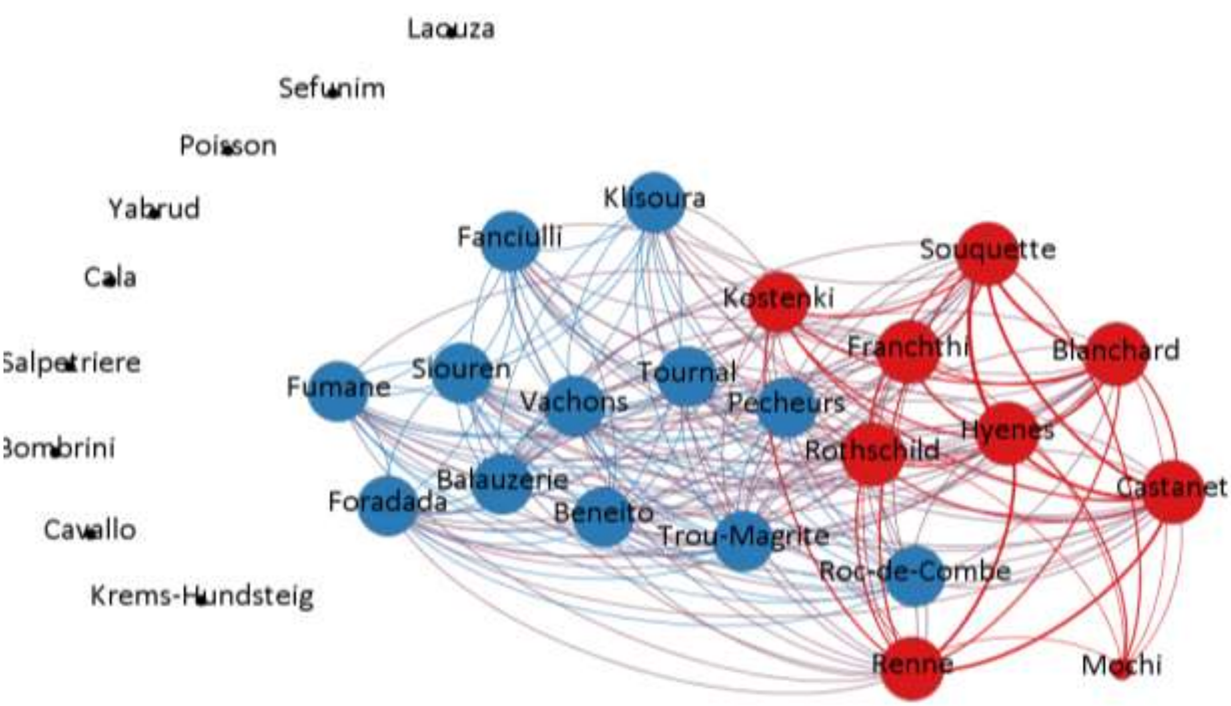


D.2.3: Convolute

Unmapped–only one grouping detected

D.2.4: Globular

Gephi Visualization

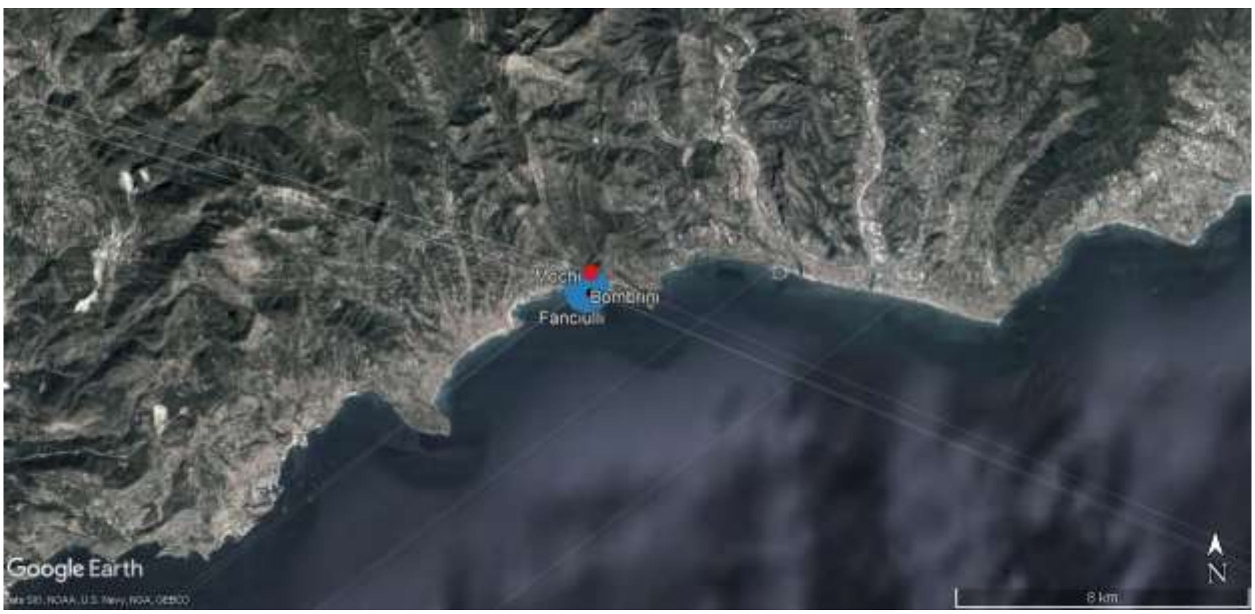


GoogleEarth: Full Map

Greece

Southeastern France and Northwestern Italy

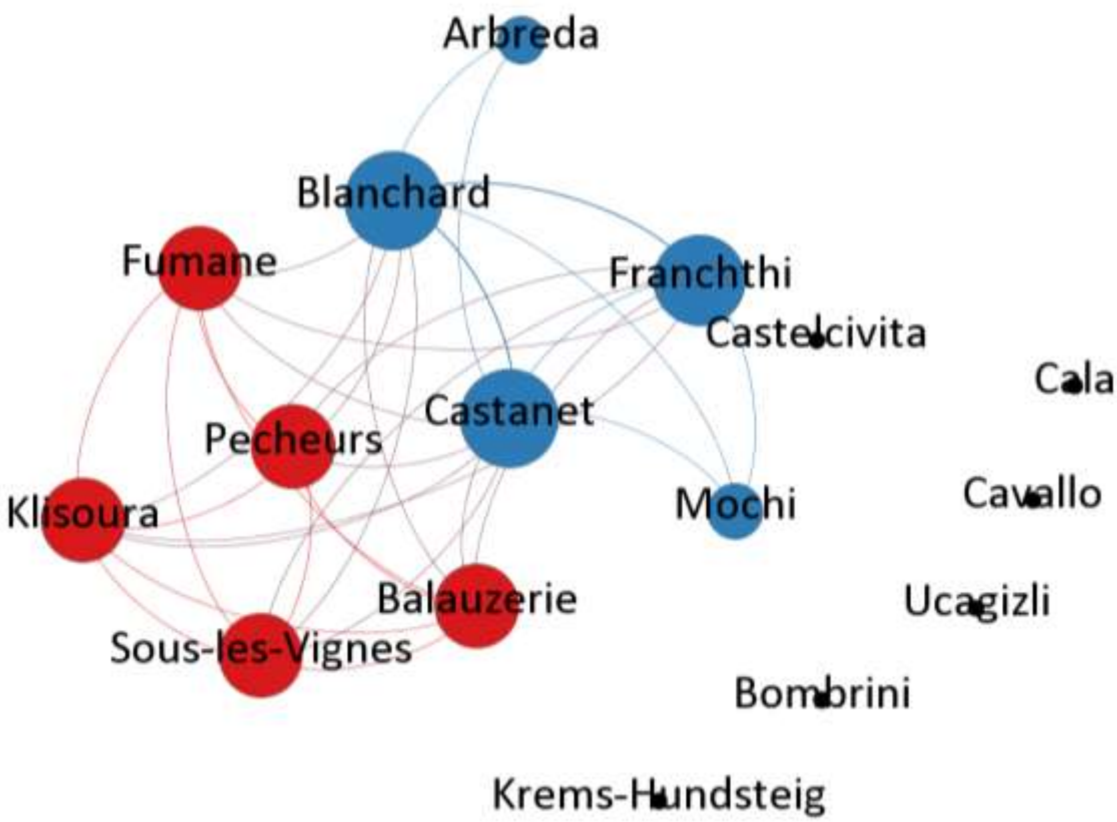
Northwestern Italy



Dordogne

D.2.5: Top/Turban

Gephi Visualization



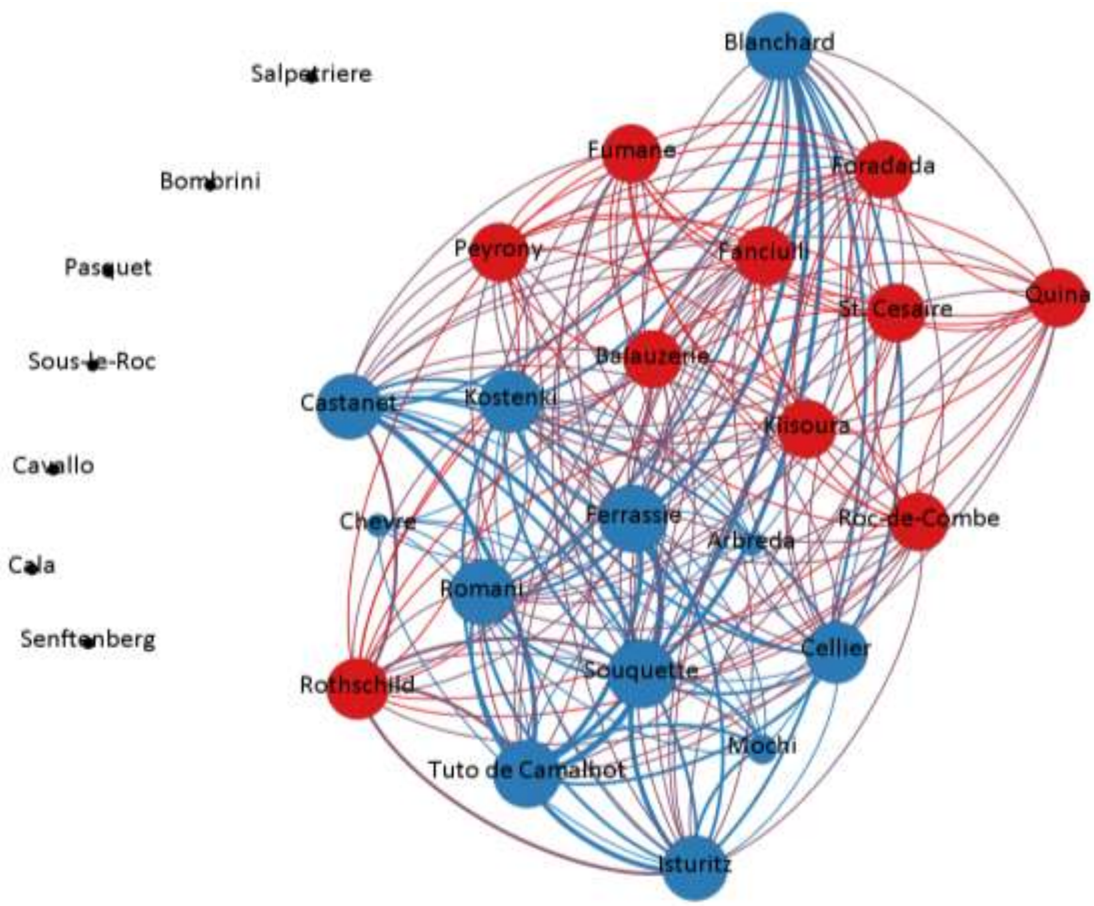
GoogleEarth: Full Map

Greece

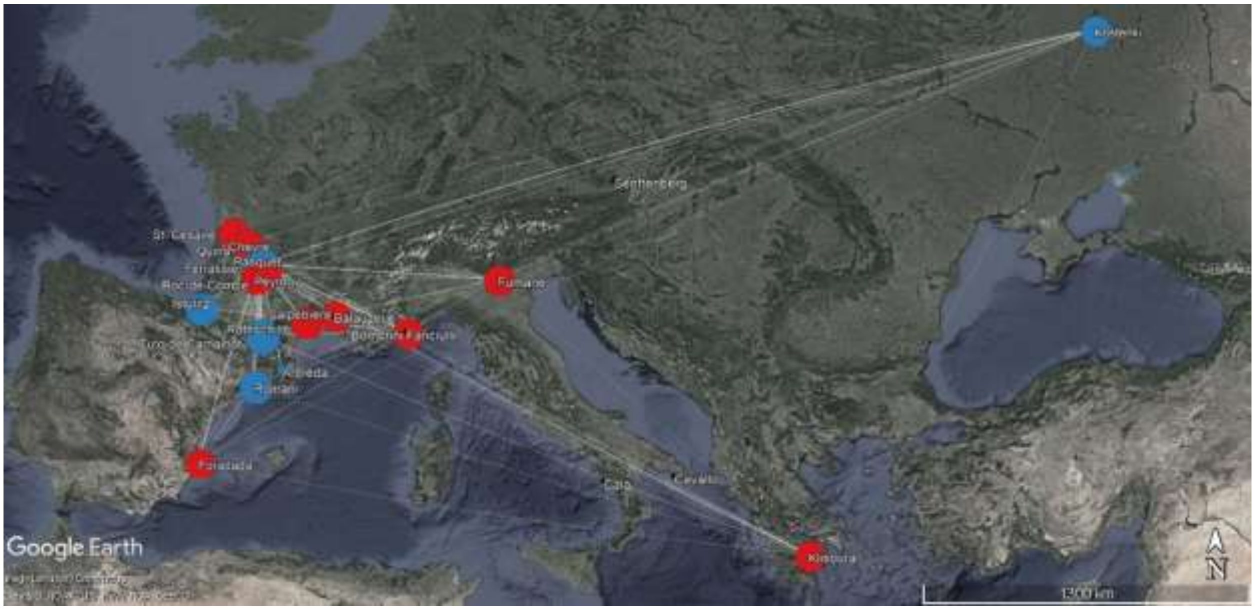
Southeastern France and the Dordogne

D.2.6: Tubular

Gephi Visualization

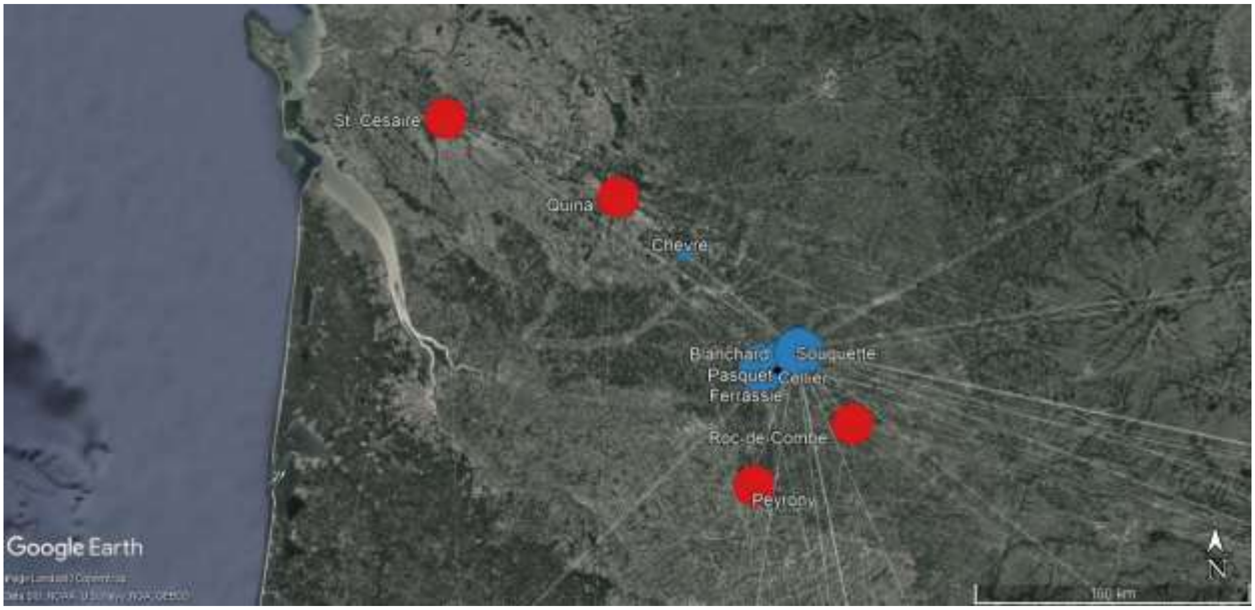


GoogleEarth: Full Map

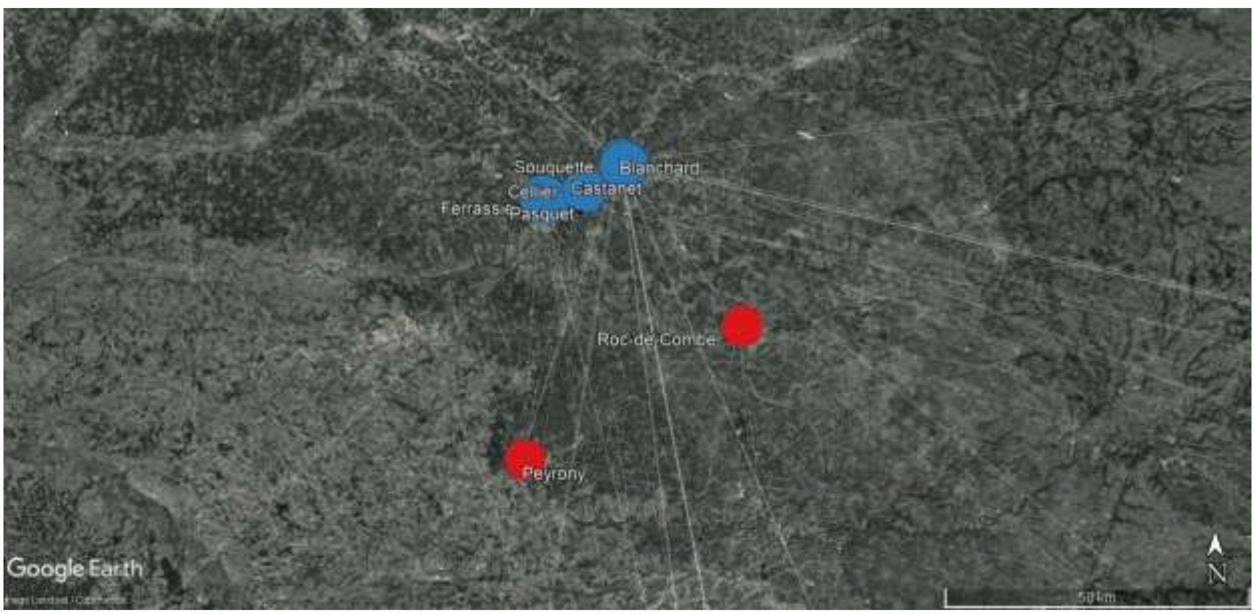


Central and Southeastern France, Northeastern Spain, and Northwestern Italy

Northwest and Central France

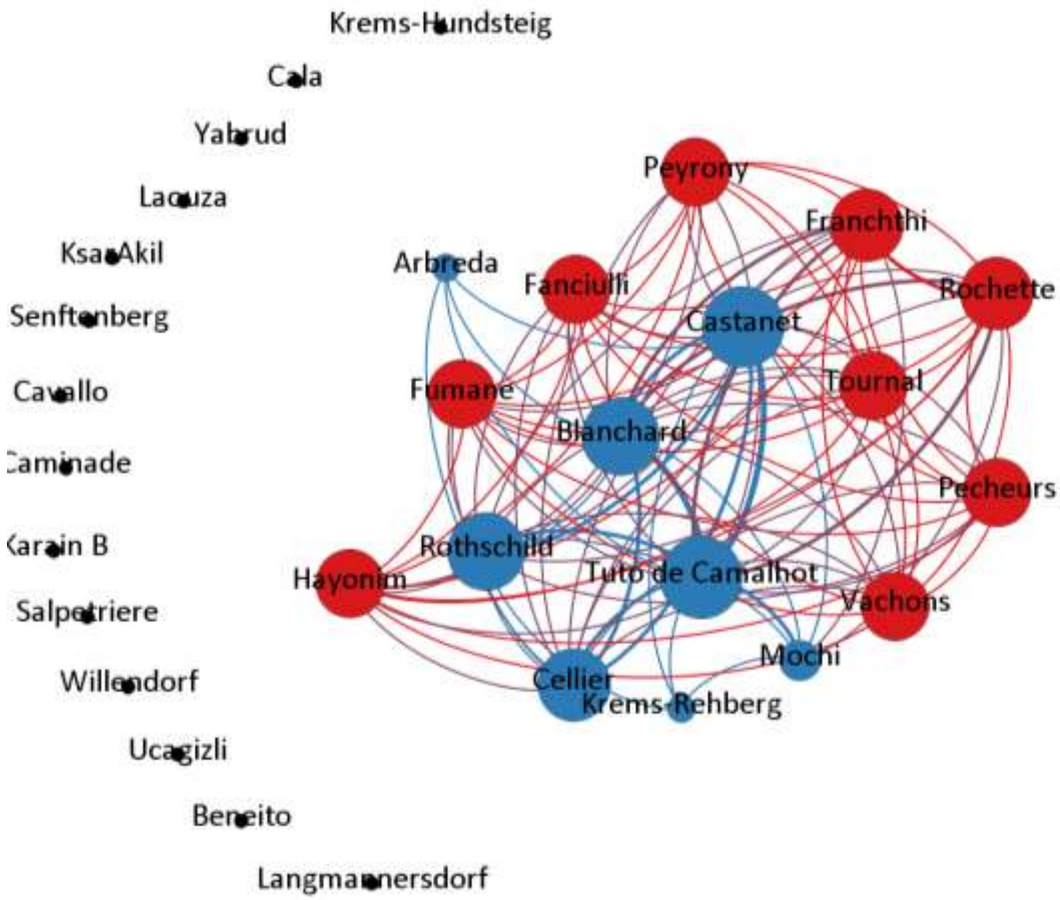


Dordogne



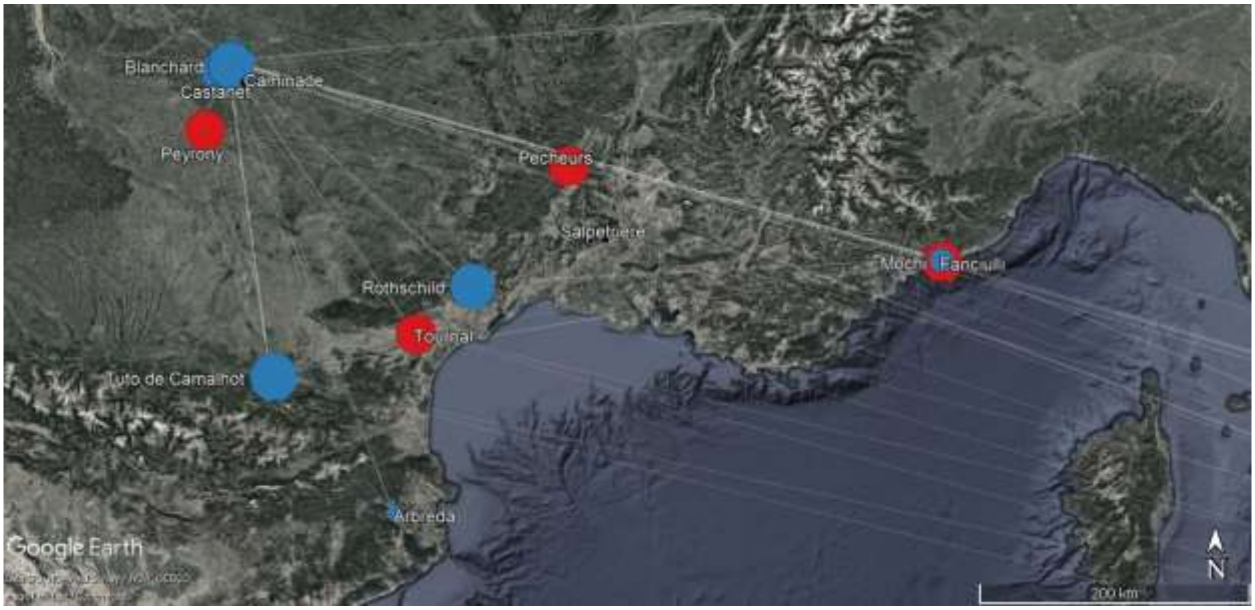
D.2.7: Tusk

Gephi Visualization

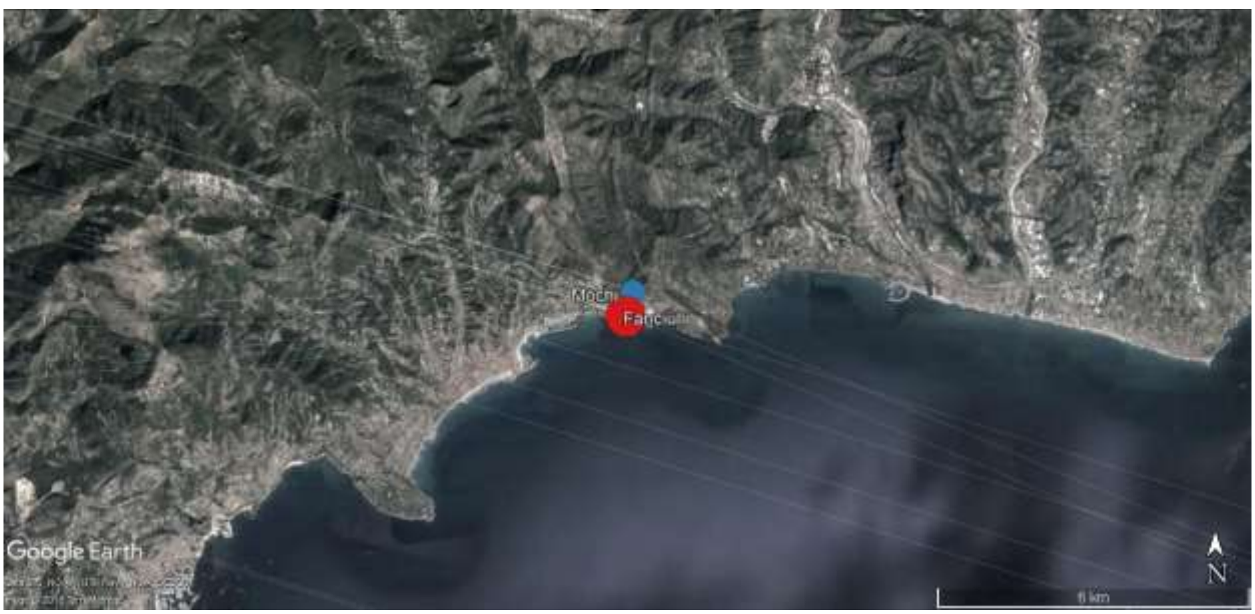


GoogleEarth: Full Map

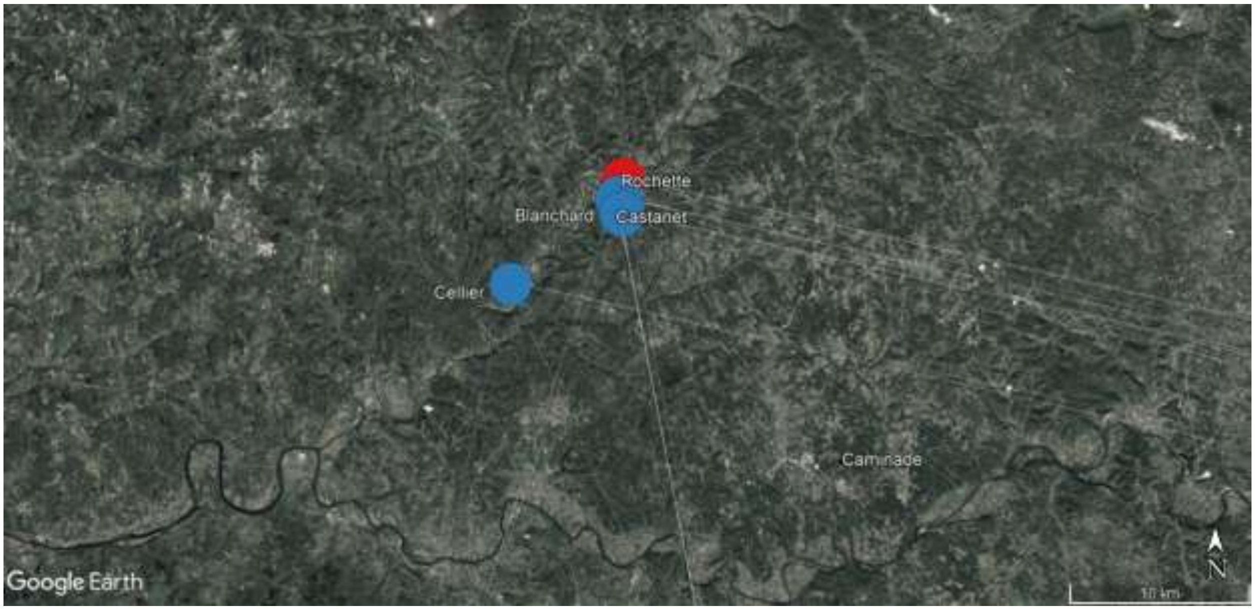
Central and Southeastern France, Northeastern Spain, and Northwestern Italy



Northwestern Italy



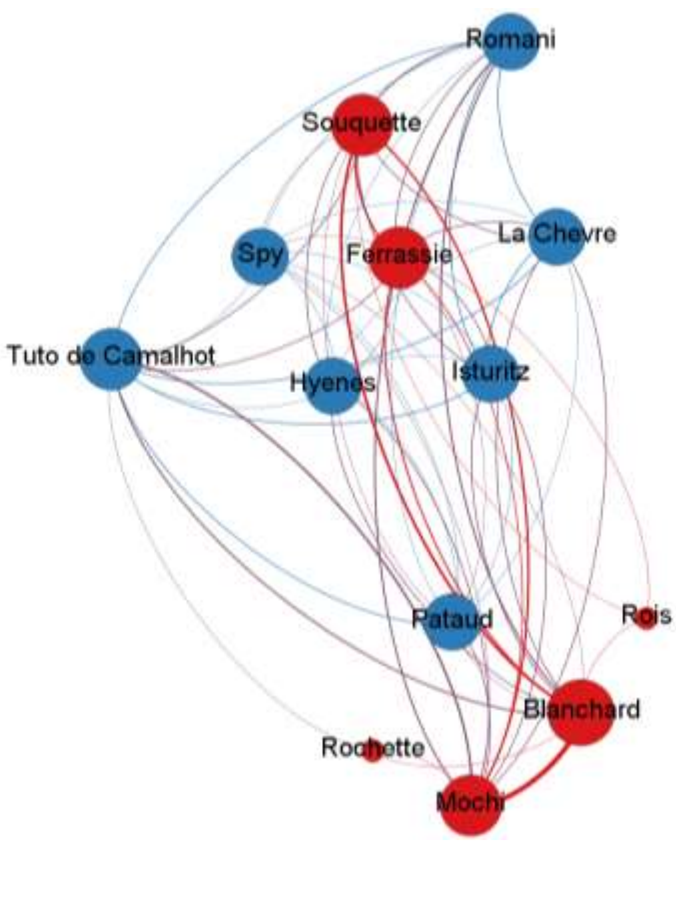
Dordogne



D.3: Non-shell Materials

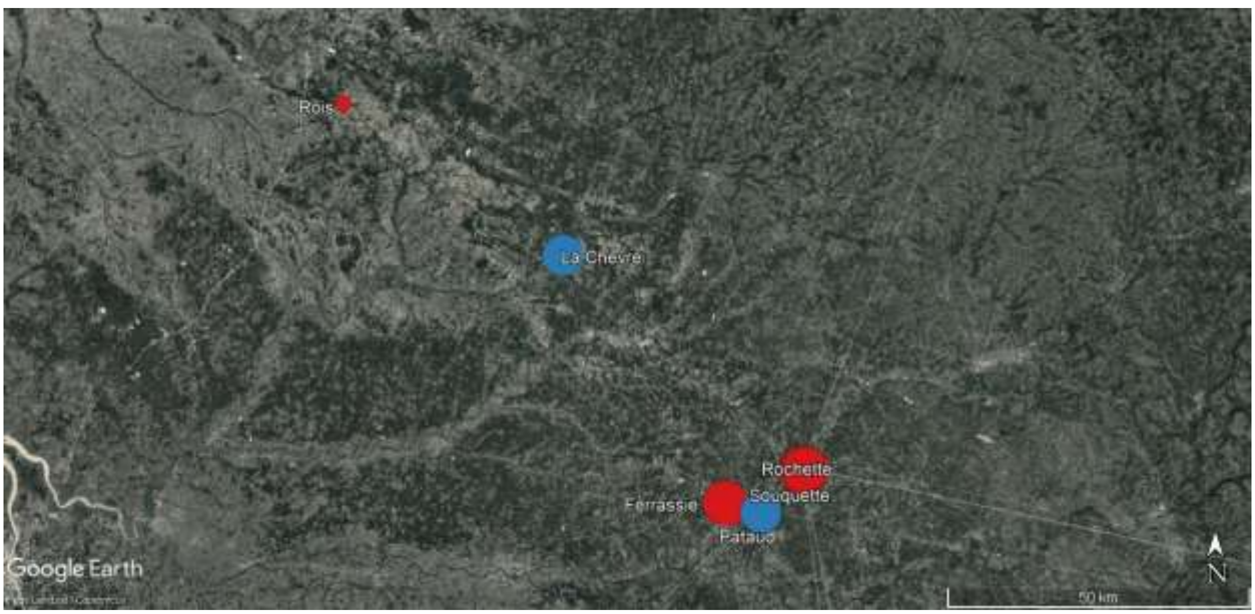
D.3.1: Bone

Gephi Visualization



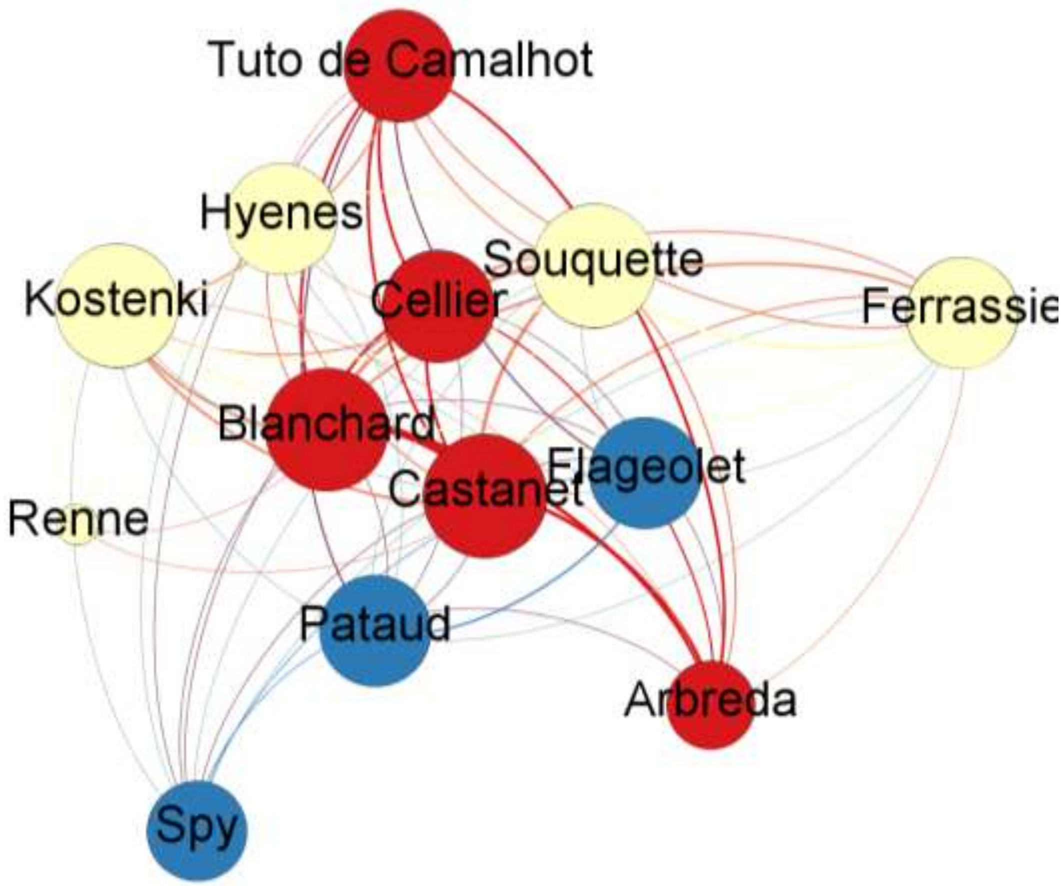
GoogleEarth: Full Map

Dordogne



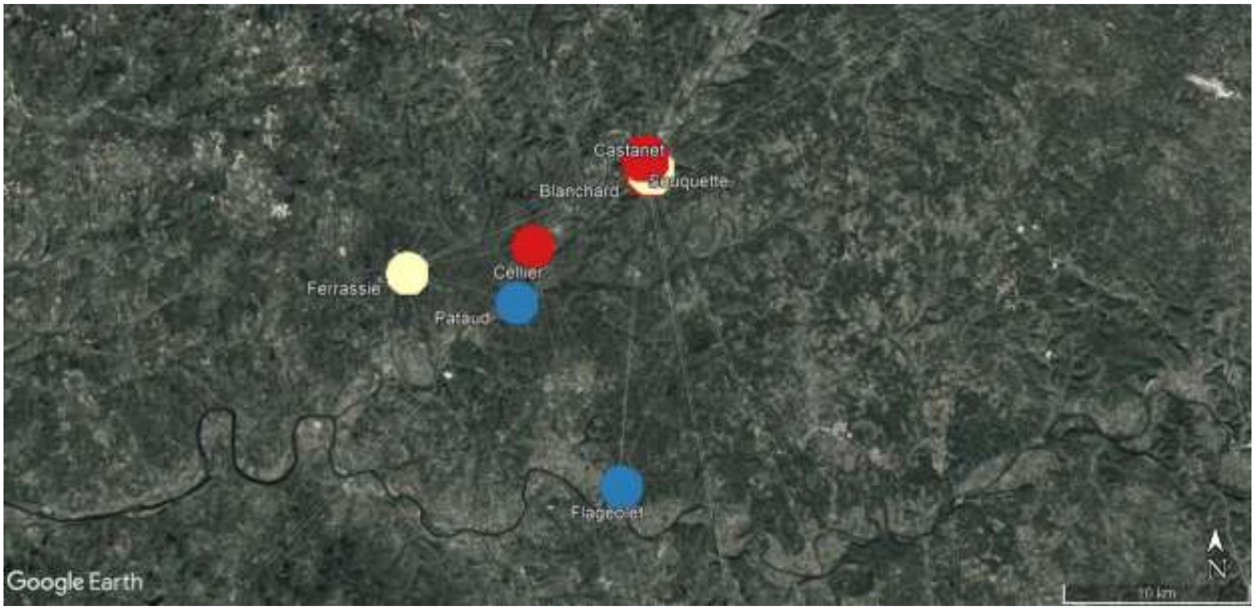
D.3.2: Ivory

Gephi Visualization



GoogleEarth: Full Map

Dordogne

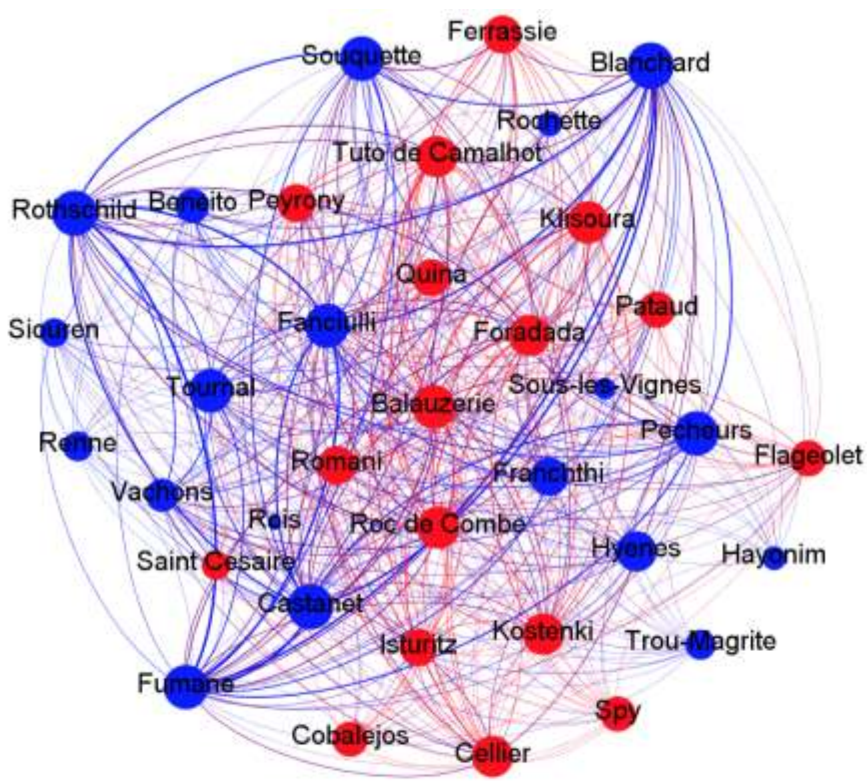


D.3.3: Stone

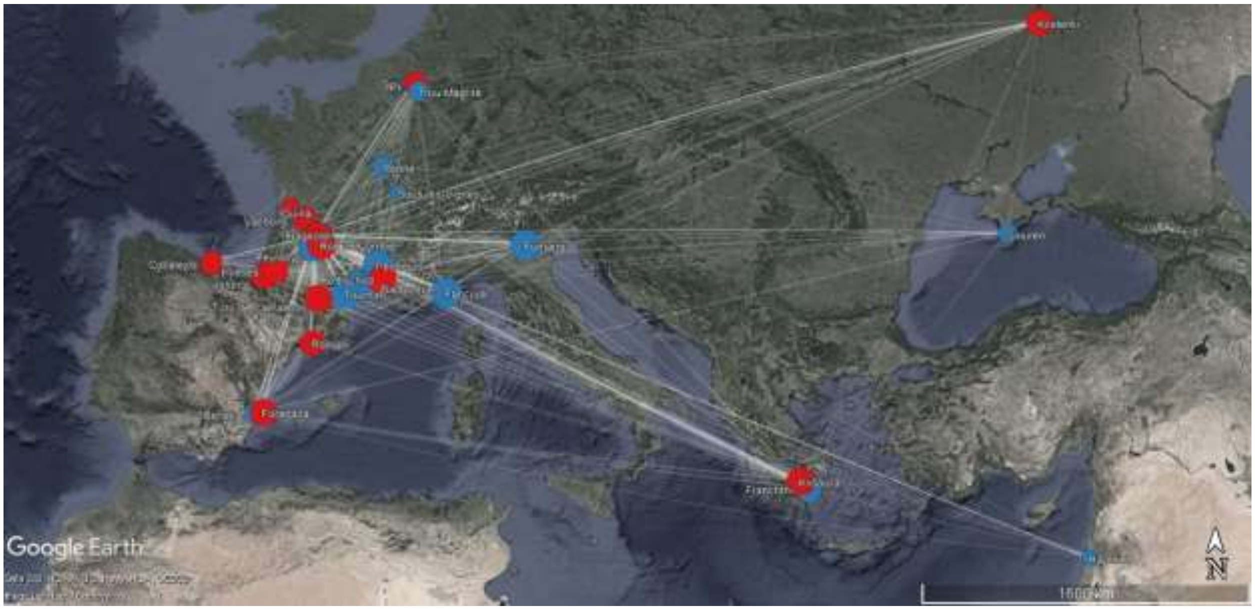
Unmapped–only one grouping detected

D.3.4: Teeth

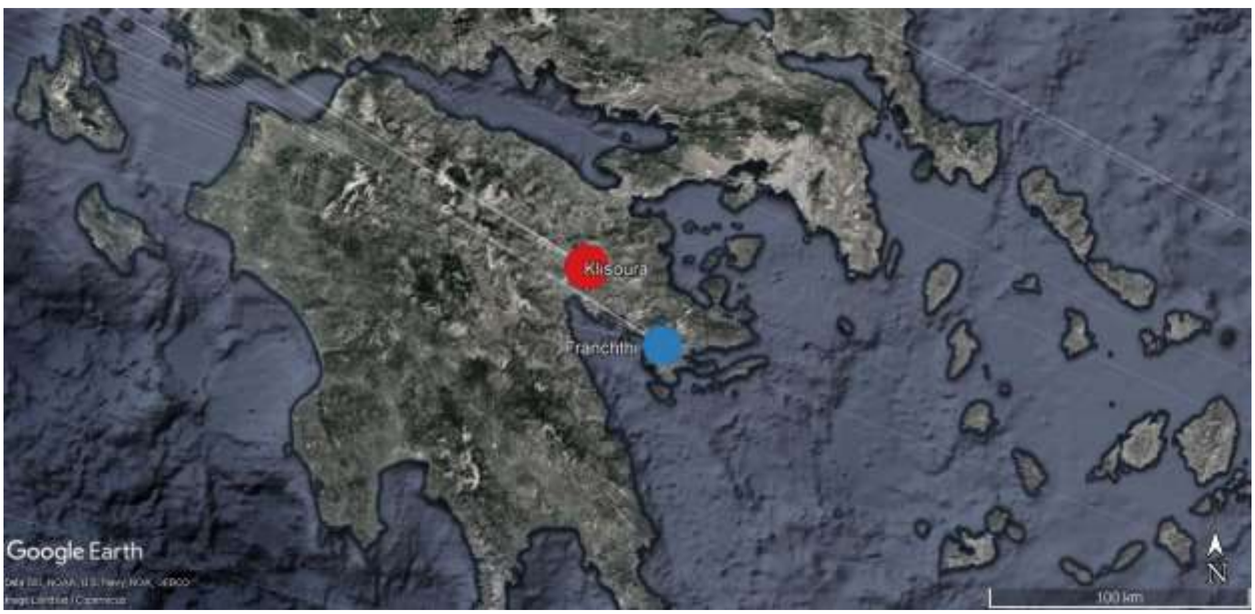
Gephi Visualization



GoogleEarth: Full Map

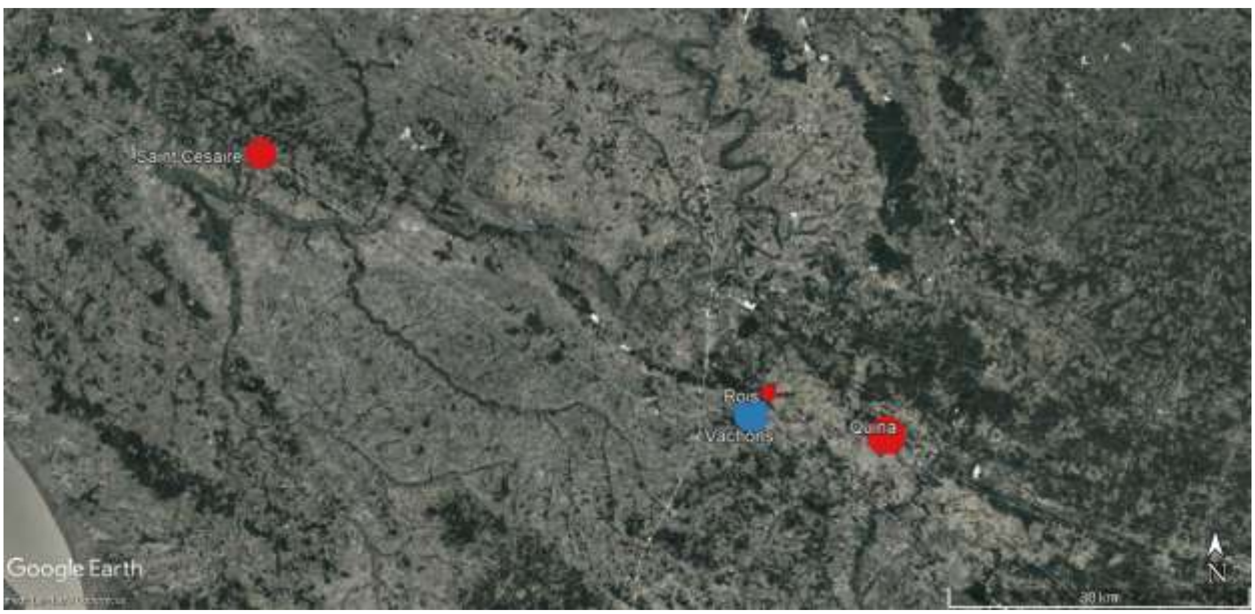


Greece

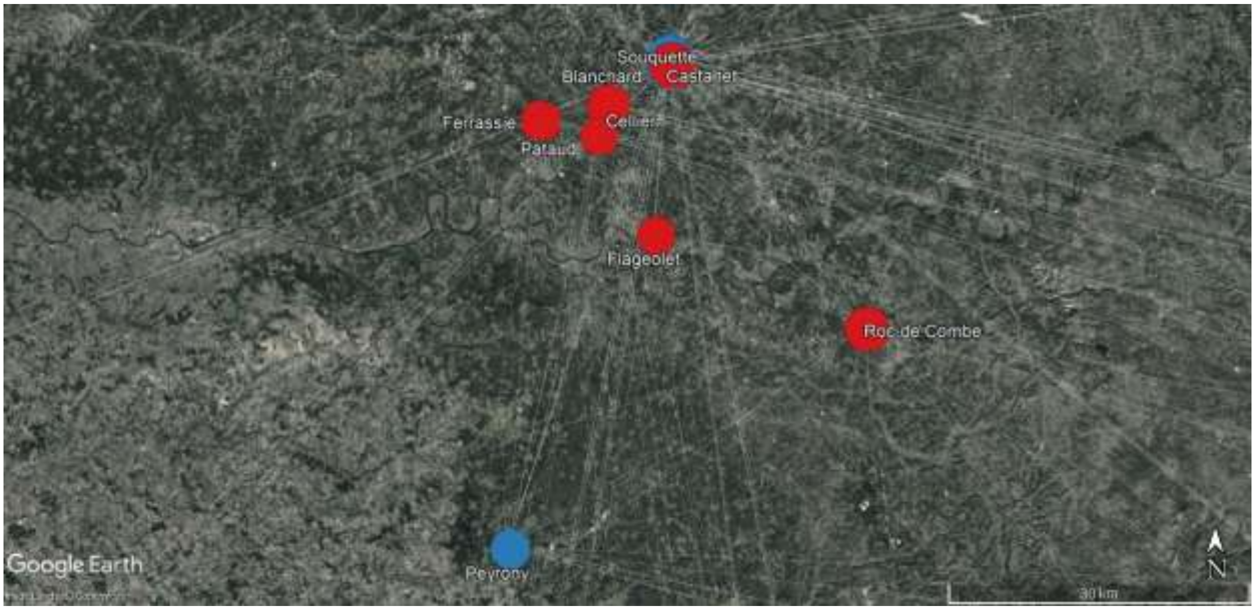


Southeastern France and Northwestern Italy

Northwestern France



Dordogne


Souquette
Blanchard
Castanet
Ferrassie
Cellier
Pataud
Flageolet
Roc de Combe
Peyrony
Google Earth
30 km
N