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Marine invertebrates during Late Prehistory on the French Channel-Atlantic shore: state of the art and first synthesis

Caroline Mougne 1 and Catherine Dupont 2

1- UMR 7209 AASPE (Archéozoologie, Archéobotanique, Sociétés, Pratiques et Environnements), Muséum National d'Histoire Naturelle, Paris, France, caroline.mougne@gmail.com

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UMR 6566 CReAAH (Centre de Recherche en Archéologie, Archéosciences, Histoire),
Université de Rennes 1, Campus Beaulieu 1

2- CNRS UMR 6566 CReAAH (Centre de Recherche en Archéologie, Archéosciences,
Histoire), Université de Rennes, Campus Beaulieu, 263 avenue Général Leclerc, bât. 24-25
-CS74205, 35042 Rennes Cedex, France; catherine.dupont@univ-rennes.fr

Abstract

The exploitation of marine invertebrates (molluscs, crustaceans, and echinoderms) on the French Channel-Atlantic coast is a poorly known topic in archaeology for Late Prehistory (2300/2200 to 25 BC). The primary aim of our work is to assess whether this lacuna is due to the absence of data or rather to a bias related to researchers' lack of interest in this type of archaeological remains. We have drawn up an inventory of all the 240 archaeological sites (including both islands, coastal-continental and inland-continental sites) where marine invertebrates were identified. Archaeomalacological studies were available for 41 sites, 39 of which were studied by the authors of this paper. Firstly, the unprecedented discovery of some species led to new methodological developments. Secondly, the results enable us to broach a variety of issues, such as the types of exploited environments, the subsistence economy (diet, geographical specificities, exchange networks), artisanal activities (dyeing, personal ornaments, construction materials), as well as funerary and ritual practices (deposits, ritual meals). Combined with other archaeological data, the study of marine invertebrates thus contributes, in an unprecedented way, to a better understanding of the socio-economic and cultural systems of coastal and continental communities during this period.

Key words:

archaeomalacology, shell, Bronze Age, Iron Age, Atlantic French coast, economy, ritual, ornament

Résumé

Cet article propose une synthèse de l'exploitation des invertébrés marins (mollusques, crustacés et échinodermes) le long du littoral Manche-Atlantique de la France à la période protohistorique (2300/ 2200 à 25 av. J.-C.). Il intègre de nombreuses études qui se sont multipliées depuis 2010 sous l'impulsion d'une thèse dédiée à cette thématique.

Un des premiers objectifs de la synthèse proposée est de dresser un inventaire de tous les sites archéologiques qui ont livré des invertébrés marins, à savoir un total de 240 sites. Parmi eux, 41 ont fait l'objet d'une étude archéomalacologique marine, dont 39 ont été effectuées par les auteurs de cet article. Les résultats obtenus permettent d'aborder la question de l'exploitation des milieux et des pratiques alimentaires, artisanales, architecturales, funéraires et culturelles des populations protohistoriques concernées.

Ainsi, quelle que soit la zone du littoral concernée, les environnements littoraux exploités dans l'Ouest de la France durant l'âge du Bronze et l'âge du Fer sont essentiellement les milieux rocheux. Ce type de substrat a pu être choisi du fait d'une plus grande accessibilité

des espèces qui y vivent, dans la mesure où ces dernières peuvent être repérées directement à la surface du rocher. L'exploitation du milieu sableux semble, quant à elle, fortement liée à des contextes funéraires et culturels et à des utilisations singulières (parure et offrandes). La totalité des espèces consommées présentes sur les sites était collectée en zone intertidale, c'est-à-dire, à pied sec. L'environnement proche d'un site et les invertébrés marins disponibles localement ont probablement joué un rôle important dans les choix des espèces consommées, indiquant la pratique d'une collecte à pied qui s'adapte aux environs immédiats de l'habitat. Toutefois, le spectre des espèces découvertes sur les sites archéologiques révèle généralement une collecte sélective qui suggère des choix culturels parmi les espèces disponibles.

De fait, l'étude **des pratiques alimentaires** permet de souligner de façon inédite des **spécificités régionales**. Ainsi, les actuelles régions de la Basse-Normandie, de la Bretagne et des Poitou-Charentes se caractérisent par des assemblages malacologiques et un mode de sélection distincts. En Bretagne, la patelle *Patella* sp. est omniprésente, tandis qu'elle est totalement absente de l'alimentation des habitants de la Basse-Normandie. Ces derniers consomment essentiellement des moules communes *Mytilus edulis*. Pour ce qui est du Poitou-Charentes, les spectres malacofauniques varient selon les sites, même pour ceux de période identique. Il est à noter que les populations protohistoriques de cette région ne semblent pas s'être focalisées sur le ramassage d'une seule espèce, à l'inverse des régions plus septentrionales.

D'un point de vue diachronique, en Basse-Normandie et en Bretagne, les espèces sélectionnées sont les mêmes pendant l'âge du Bronze et l'âge du Fer. Ces régions se différencient des Poitou-Charentes, où une évolution des pratiques alimentaires entre le Bronze ancien et La Tène finale est clairement perceptible. En effet, si pendant l'ensemble de la Protohistoire la patelle, la moule commune et la scrobiculaire *Scrobicularia plana* sont consommées, l'huître plate *Ostrea edulis* et la palourde européenne *Ruditapes decussatus* intègrent le régime alimentaire des populations à partir de la fin de l'âge du Fer. L'inclusion de l'huître plate, voire de la palourde, en tant que composants majeurs des régimes alimentaires des populations côtières, pourrait résulter d'une influence romaine. Cette dernière est d'ailleurs connue sur d'autres produits marins, comme les poissons par exemple. D'autre part, certains habitants des côtes de la Gaule se trouvaient en contact direct avec des marchands romains et, ont pu être influencé par leur mode de vie et leurs habitudes alimentaires. La consommation de l'huître plate augmente par la suite, à savoir, au début de l'époque gallo-romaine.

À cette époque, une évolution des pratiques alimentaires se produit en Basse-Normandie et en Poitou-Charentes. Des coquillages marins frais sont importés dans l'arrière-pays pour y être consommés, et ce, jusqu'à 120 km du littoral. La consommation des coquillages dans les terres pouvait, à en juger par leur rareté, être réservée à quelques individus ou groupes sociaux d'un rang élevé. **Des réseaux d'échanges, voire un commerce** de mollusques et plus largement de produits marins, existaient probablement pour approvisionner ces sites de l'hinterland.

Outre leur place dans l'alimentation, les invertébrés marins ont également joué **un rôle dans plusieurs activités artisanales** durant la Protohistoire :

- **l'utilisation du pourpre dans des activités tinctoriales** est attestée uniquement en

Bretagne, et ce, au moins dès l'âge du Fer voire dès l'âge du Bronze, ce qui est, dans les deux cas, une attestation inédite pour l'Ouest de la Gaule. En effet, cette activité n'était connue jusqu'à présent sur tout le territoire français qu'après la conquête romaine ;

- **pour la parure**, au moins quatre espèces de coquilles ont servi de matière première, à savoir le cyprée *Trivia monacha*, la littorine obtuse *Littorina obtusata*, le dentale *Antalis* sp. et la coque *Cerastoderma* sp. Les collections étudiées se caractérisent par leur hétérogénéité, aussi bien d'un point de vue géographique, chronologique, contextuel que morphologique. Une différenciation marquée entre les espèces réservées à la parure et celles destinées à la consommation est observée pendant la Protohistoire, constat déjà réalisé pour la Préhistoire le long des côtes atlantiques françaises. Il semblerait qu'à l'âge du Bronze la coquille utilisée pour la confection de parure soit progressivement remplacée par les métaux. Ces matériaux sont plus résistants et permettant de créer des formes plus complexes ;

- les restes d'invertébrés marins et particulièrement les coquilles de mollusques sont parfois utilisés comme **matériaux de construction**. Sur la façade atlantique française, un tel recyclage de coquilles est connu dans la construction des murs ainsi que pour assainir les sols. Ce recyclage concerne deux taxons consommés en grande quantité, à savoir la patelle et l'huître plate. La réutilisation de ces deux espèces est due à leurs propriétés physico-chimiques : leurs coquilles résistent aux pressions mécaniques, drainent les flux d'eau et sont perméables, absorbant l'humidité ambiante, souvent importante en milieu côtier et insulaire. L'utilisation des coquilles dans les constructions est proportionnellement liée à l'importance de leur consommation.

Les invertébrés marins jouaient également un rôle non négligeable au sein des **systèmes de pensée et de croyances** des populations protohistoriques. Ils sont ainsi parfois repérés sous forme de dépôts votifs, d'offrandes alimentaires ou encore de restes de repas rituels ou communautaires. Ils ont été déposés, voire mis en scène, dans au moins trois secteurs le long de la façade française de la Manche et de l'Atlantique : en Plaine de Caen, sur les côtes bretonnes et charentaises. Les espèces d'invertébrés marins intervenant dans les pratiques funéraires et culturelles varient. Il s'agit le plus souvent de taxons consommés de manière régulière et faisant partie du régime alimentaire, comme la patelle en Bretagne ou la moule en Plaine de Caen. Les coquillages de la famille des cardiidés (coque *Cerastoderma* sp. et bucarde *Acanthocardia* sp.) semblent être également sélectionnés pour des événements particuliers liés aux pratiques culturelles en Plaine de Caen. Chaque contexte se caractérise par un assemblage spécifique, que ce soit au niveau des espèces choisies ou des objets associés. Ces pratiques sont difficilement généralisables du fait la rareté de leur découverte et de la diversité des objets et coquilles associées. Elles témoignent de pratiques variées qui pourraient correspondre des manières de faire et de penser distinctes

Cette synthèse sur les restes coquilliers marins de la Protohistoire n'en est qu'à ses débuts. Les données obtenues sont prometteuses et innovantes. Les résultats soulignent les implications de ces animaux marins dans de nombreux domaines de la vie des communautés de l'âge du Bronze et de l'âge du Fer et permettent d'aborder des thématiques inédites.

Mots clés :

archéomalacologie, coquillage, âge du Bronze, âge du Fer, Atlantique, France, pratiques alimentaires, rituel, parure

Introduction

This paper focuses on the exploitation and use of marine invertebrates (molluscs, crustaceans and echinoderms) during the Bronze Age and Iron Age, over a chronological period extending from about 2300/2200 to 25 BC (Mougne, 2015), in the continental and coastal French Channel-Atlantic area, from Normandy to Aquitaine (fig. 1; table 1). Major economic, social, and cultural changes took place during Late Prehistory, marked by the emergence and use of new metals (bronze and iron) that may explain some variations in the exploitation of marine resources.

In Western Europe, the transition from the Chalcolithic to the Bronze Age is marked by the gradual appearance of objects made from metal. The effects of the use of metal on the social organization of different cultural groups vary from one region to another over time. Changes are barely perceptible at the very beginning of the Bronze Age in many areas. Agricultural settlements, sometimes farms delimited by ditches, grouped together one or more family units. Annexes and buildings for domestic use and constructions for agropastoral purposes were spread around the main residential buildings (Marcigny et al., 2005). The first and most significant changes occurred shortly afterwards, around 1600 and 1300 BC, when bronze became available on most farms for the manufacture of tools. This had a direct impact on the food-producing economy and, consequently, on agricultural productivity, demographics, the intensification of trade and on social organization as a whole, heralding the social characteristics of the Iron Age. More land was progressively given over to farming with fields, pastures and field systems (Marcigny et al., 2005). From the Late Bronze Age to the Early Iron Age, clusters of settlements developed alongside isolated farms (Carroza and Marcigny, 2007). During the Iron Age, particularly the Late Iron Age, around the third century BC, occupation across the landscape became denser, with agricultural settlements organized in networks that indicate a certain demographic growth (Van den Bosche et al., 2009; Villard-Le-Tiec et al., 2018). Late Iron Age settlements sat within single or multiple enclosures of various types; farms, hamlets and aristocratic estates. Agriculture became more intensive in the rural world, largely thanks to the development of perfectly adapted iron tools and farms appeared to produce more than was necessary for subsistence, leading to a market driven economy of goods and mass craft production (Garcia, 2000; Vauterin et al., 2011). The beginning of urbanization is illustrated by the numerous oppida that can be qualified as towns (Guichard et al., 2000; Lafon, 2006), with varied but specialized profitable craft activities (Gruel and Haselgrove, 2006). At the end of the Iron Age, Mediterranean and Roman populations increasingly traded with Southern Gaul. The romanization of Gaul began, bringing new cultural trends, including new dietary practices, that may be detected from the first century BC onwards (Blancquaert and Malrain, 2016).

Metals, salt and Italian imports (wine, Campanian ceramics, luxury goods) provide strong evidence for the development of medium and long-distance trade along the Atlantic coast, particularly with the Mediterranean and British Isles (Landreau et al., 2009; Lemaître et al., 2009; Daire et al., 2015a). The distribution map of amphorae that were abundant on the coast indicates a well-developed maritime trade, potentially linked to distribution networks for salt (Daire et al., 2015a). This growth in trade on the coast, but also in crop trading in the hinterland, was made possible by an expanding road network (Coulon, 2007; Buchsenschutz,

2009; Villard-Le-Tiec et al., 2018), the use of traditional waterways (Audouze and Buchsenschutz, 1989) and new maritime routes. The discovery of boats shows that they date as early as the Bronze Age (Briard, 1997; Marcigny et al., 2005; Lehoërf and Talon, 2017). However, Normandy seems to have been largely excluded from these Mediterranean exchange networks. In fact, amphorae are few in this region and are the only regional evidence of trade relations with the Mediterranean world (Vauterin et al., 2011; Cherel, 2012). Continental and insular coastal territories include various types of more or less dense settlements, depending on the region and the period (Briard, 1998; Daire et al., 2015a). Overall, coastal occupation is well documented in the Bronze Age and intensifies during the Iron Age, particularly in the Late Iron Age. This phenomenon is largely linked to demographic growth, on the one hand, and to salt production, on the other, particularly in Brittany and Aquitaine (Daire, 2003; Landreau et al., 2009). In Normandy, evidence from several settlements on the coast and several kilometres inland attest to the use of salt by the presence of fragments of briquetage (or troughs) destined to contain brine and salt loaves during production. These artefacts constitute evidence of direct contact between the hinterland and the shore (Vauterin et al., 2011).

During late Prehistory in Western France, terrestrial mammals are mainly represented by domesticated animals (Auxiette, Baudry and Méniel, 2010; Méniel and Clavel, 2013; Baudry, 2018; Auxiette and Hachem, 2021). Throughout the Atlantic region, the horse *Equus caballus* was domesticated as early as the Bronze Age (Arbogast et al., 2002; Baudry, 2018). Hunting activities were rare (Germinet, 2009; Baudry, 2018). As for marine mammals and seabirds, several remains have been identified in Brittany. Only the grey seal *Halichoerus grypus* and alcids, such as the penguin *Alca torda* or the Atlantic puffin *Fratercula arctica*, appear to have been consumed, based on the selection of anatomical parts and butchery marks as well as traces of heating on some bones (Méniel and Clavel, 2013; Baudry, 2018). The consumption of fish is attested for both the Bronze and Iron Ages, mainly in Brittany, particularly in insular contexts (e.g., Dréano, 2012; Méniel and Clavel, 2013; Dréano, 2019). Regardless of the sites and the periods, all fish could have been caught from the shore without the use of a boat by angling, netting, hand fishing, as well as traps placed in fishing areas (Dréano, 2019; Daire et al., 2018). Available data are presented below in order to discuss the importance of marine invertebrates and other resources in the Bronze and Iron Age diet.

The importance of such major economic, social and cultural changes during this period contrasts with the lack of interest in shells. Molluscs can be used in various activities and can thus provide complementary data on such changes (Bar-Yosef Mayer, 2005; Álvarez Fernández et al., 2010; Çakırlar, 2011; Bailey et al., 2013; Szabo et al., 2014). This lack of interest in marine shells by archaeologists specialized in Late Prehistory may be in part related to the importance of other artefacts, namely metal, as well as to the fact that archaeomalacology is a new discipline (Claassen, 1998). The absence of sieving in the field also explains the absence of seashells on some archaeological sites.

At the beginning of the twentieth century, published archaeomalacological data from Late Prehistory in France and abroad were still sparse. Few studies have been carried out on the exploitation and use of marine invertebrates during the Bronze and Iron Ages (2300/2200 to

25 BC) in the French Atlantic area, but studies on the use of shells as ornaments during the Bronze Age on the Mediterranean coast do exist (Taborin, 1974; Barge, 1982; Weydert, 1994). More studies on this period began to see the light at the beginning of the twenty-first century (for example, Mc Cormick et al., 1996; Prummel, 2002; Minniti, 2005; Theodoropoulou, 2007; Çakırlar, 2009; Sureda et al. 2016). For the Iron Age, few studies are published for the French coasts of the Channel (Dupont, 2006a; Campbell G., 2007), the Atlantic (Gruet, 1998; Dupont, 2009) and the Mediterranean (Brien-Poitevin, 1992, 1993), while studies on other parts of Europe are more numerous (for example: Cunliffe and Hawkins, 1988; Mc Cormick et al., 1996; Cabral and Silva, 2003; Belarte and Py, 2004; Berghe et al., 2009; Bejega García et al., 2010; Bejega García, 2015).

The synthesis presented in this paper aims to enhance our understanding of the organization of Metal Ages societies from an archaeomalacological perspective, and to answer to the following questions:

- Are differences in shellfish consumption observed across the territory, through time and in relation to the status of human communities?
- What was the impact of the development of circulation networks on the diffusion of marine resources to the hinterland?
- How did the romanisation of Gaul change food practices related to marine invertebrates?
- Did the demographic increase along the Atlantic coast lead to the overexploitation of marine resources?
- Did marine resource availability attract human groups to coastal areas?
- What was the status of marine invertebrates in the diet?
- Are changes in the use of shells in body ornamentation apparent in the transitional period from the Chalcolithic to the Bronze Age, in conjunction, among others, to the arrival of new metals?
- What was the role of the marine world in the symbolisms and rituals of Late Prehistoric communities?

We will first present the methodology chosen for this synthesis. We especially draw attention to the limits of the archaeomalacological material and offer some tools to overcome methodological constraints. We will then present, compare and discuss the results of the archaeomalacological analysis of 41 sites.

2. Material and Methods

Our synthesis is based on the archaeomalacological analysis from 41 sites that produced marine shell assemblages. As shown on the map (table 1; fig. 1), these sites are more or less equally distributed along the seashore from the Seine to the Garonne. Around 200 additional sites are known to have produced marine invertebrate remains, but unfortunately, in most cases, shells were not kept or studied. Site distribution exhibits similar absences in the north and the south (Mougne, 2015), clearly linked to sea level variations and related phenomena. Sand dune formations are evidently one of the major factors affecting the destruction of coastal archaeological sites (Stéphan et al., 2019).

The corpus used in this study is rich and diversified, in terms of types of sites, location and

chronology (table 1). Selected contexts span from the beginning of the Bronze Age (2300/2200 BC) to the end of the Iron Age (25 BC). They include insular, coastal and inland sites. With respect to their type, they are primarily domestic sites. Some contexts are also linked to artisanal activities, such as the production of marine salt. Ritual and funerary sites were also included in the study.

The selected sites were also chosen according to the precision of site's dating, excavation and sampling techniques (sieving of the sediment preferred over hand collection) and the overall condition of the material.

Sieving is essential for obtaining a representative faunal spectrum. It avoids underestimating small-sized species or very fragmented specimens and provides more reliable estimates of the relative proportions of species than mere hand collection. In most archaeological sites included in this study (table 1 n°1-27 and 30-40), 4 mm and 2 mm meshes were used. The high diversity as well as the very small size of some of the retrieved species (>10 mm) underline the high quality of sampling. In three of the sites (table 1 n°28, 29 and 41), no sieving was conducted and the shells were hand-picked.

The nomenclature used for the identified marine molluscs was checked with the international standards of the WoRMS (5 december 2022). Shell remains were identified with the help of a modern reference collection (C. Dupont and Y. Gruet, CReAAH /University of Rennes) as well as malacological atlases (Poppe and Goto, 1991, 1993; Tebble, 1966; Hayward and Ryland, 1995).

In order to estimate the relative abundance of each species and make inter-site comparisons, different quantification methods were used: the Number of Identified Specimens (NISP), the Minimum Number of Individuals (MNI) and the Weight of Remains (WR). Each of the three quantification methods presents advantages and disadvantages (Thomas and Mannino, 2017). For the purposes of this paper, we only used the MNI, which was estimated upon different anatomical parts, depending on the species (Mougne, 2015).

For size estimations, when shells were intact, we measured the length with an electronic caliper (precision 0.01 mm), following the references used by C. Dupont (2006b). For fragmented remains, we developed a specific methodology to reconstruct original length (fig. 2; for details Mougne, 2015, p. 106-115).

3. Results

A total of 112 invertebrate species were identified in the corpus. They consist of 97 molluscs (46 gastropods, 47 bivalves, two scaphopods, one cephalopod and one polyplacophora), 14 crustaceans (seven decapods and seven cirripeds) and one echinoderm (table 2). This corpus seems a fairly representative sample of marine biodiversity along the French Channel/Atlantic coast during Late Prehistory, even though not all of the species present in the assemblages were voluntarily collected and transported to the settlements by humans (Mougne, 2015, p. 421-431). The wide variety of species also highlights the diversity of activities that involved marine invertebrates.

3.1. Food practices

3.1.1. Selection of seafood

When opening marks were not observed on a shell, the following criteria were used to

ascertain if a species was consumed: the presence of medium to large individuals, the lack of evidence of collection of dead shells, the presence of accumulations of at least 20 individuals. Overall, at least 15 species of marine invertebrates were consumed during Late Prehistory (fig. 3): four gastropods (the limpet *Patella* sp., the periwinkle *Littorina littorea*, the abalone *Haliotis tuberculata*, and the thick top shell *Phorcus lineatus*), seven bivalves (the common mussel *Mytilus edulis*, the flat oyster *Ostrea edulis*, the common cockle *Cerastoderma edule*, the European clam *Ruditapes decussatus*, the piddock *Barnea candida*, the razor clam *Solen marginatus* and the peppery furrow shell *Scrobicularia plana*), one cirriped crustacean (the goose barnacle *Pollicipes pollicipes*), two decapod crustaceans (the crab *Xantho* sp. and the edible crab *Cancer pagurus*) and one echinoid (the violet sea urchin *Paracentrotus lividus*). These species would have been gathered during low tide in the intertidal zone. It is noteworthy that it is necessary for only one of these shells, namely the abalone, to enter the water.

3.1.2. Regional patterns in shellfish gathering

Each marine invertebrate is dependent on a biotope that presents specific characteristics with respect to the substrate, altitudinal position, wave exposure, temperature and physico-chemical properties of the water, such as salinity (Hayward and Ryland 1995). Marine invertebrates are distributed accordingly. Two elements specific to each species, the substrate and the altitudinal position, are taken into consideration in order to reconstruct the coastal environments exploited by humans (Mougne, 2015). Generally, **environments on the coasts of Western France during the Bronze Age and the Iron Age, in all the regions studied, were mainly rocky settings** (fig. 5). This substratum would have been selected on the basis of the easy location and access to the species living there. It should be noted that rocky coasts are more sheltered in Normandy and in some of the sites in Aquitaine. The detailed habitat reconstruction of each one of the 41 sites also shows regional specificities (fig. 6). Normandy, Brittany and Aquitaine are characterized by distinct malacological assemblages and selection modes. In Brittany, the limpet is the prevailing species and often represents 100% of consumed shellfish (Mougne and Dupont, 2020b). Inversely, this species is completely absent from the diet of the inhabitants of Normandy, who preferred common mussels. In Aquitaine, the spectrum differs greatly from one site to another, even among settlements of the same period. It is important to note that the early populations of this region do not seem to have focused on gathering a single species, unlike further north. Instead, often two or three species make up 90% of the malacological spectrum in several sites. Generally, in this region, the limpet and the peppery furrow shell are the most commonly consumed species. The flat oyster, the European clam, the common mussel and the common cockle are also present but in smaller quantities. Finally, in the Pays de la Loire, the number of sites is smaller and therefore no real tendencies emerge from the analysis. The results show that the inhabitants of Loire-Atlantique –geographically close but also similar to Breton environments– mainly consumed limpets, while the inhabitants of the Vendée sites near Aquitaine mostly ate peppery furrow shells.

Regional specificities can be clearly mapped out. In Normandy, Brittany and Aquitaine, these specificities differ in terms of species composition of the assemblages and their degree of selection.

3.1.3. Island and coastal continental sites

Throughout Late Prehistory, given the density and volume of shells found, island populations seem to have consumed shellfish and marine crustaceans in greater quantities than on the continent. However, this observation does not take into account unfavourable differential conservation in continental environments, due to more severe erosion and generally higher anthropogenic pressure. In island contexts, whatever the site and the chronological period, a single species, usually the limpet, dominates the spectrum, often making up 90% of consumed shellfish (table 1 n°14 to 19 and 21 to 27). Despite this, island populations consumed a higher diversity of species. Violet sea urchins and crabs are well represented in island settings (table 1 n°14, 16, 17, 19, 22, 25 and 26), whereas they were only rarely consumed on continental coasts (table 1 n° 20 and 29). The *Xantho* crab (table 1 n°17) and the goose barnacle (table 1 n°17, 22, 25 and 26) were only consumed on islands. On the continental coast, selection was more varied. In some sites, the inhabitants focused on the collection of a single species; sometimes they diversified their collection to include two or three taxa, which would make up 90% of the MNI. It should be noted that mussels, common cockles, peppery furrow shells, flat oysters and European clams are better represented on the continental coast (table 1 n°1 to 13, 32, 33, 36 to 41) than on the islands (fig. 6).

3.14. Coastal and hinterland sites

Evidence of consumption of marine shellfish in inland areas extends back to the Early Iron Age in Normandy on the Object'Ifs Sud site (table 1 site n°5). This trend increased from the end of the Iron Age onwards in Normandy and Aquitaine. It is likely that shellfish were also traded and consumed in central Brittany, although no discoveries have yet been made, which may be related to conservation issues. Only four species were transported to the hinterland, namely flat oysters, European clams, common mussels and common cockles. At sites located more than 50 km from the coast, only flat oysters and European clams have been recorded, such as at Les Gains (table 1 site n°41). In Normandy, mussels and cockles were consumed both on the coast and inland. In Aquitaine, continental coastal populations consumed a greater variety of species than in the hinterland where only oysters, mussels and European clams were consumed. The survival of each species out of the water varies, and some are more prone to spoilage than others. For transport and trade, humans selected marine invertebrate species that could be preserved for several days. Among them, the limpet and the oyster can be kept alive for at least fifteen days (Korringa, 1952). The survival time of the peppery furrow shell out of the water is much shorter, similar to that of the European clam, about four days. Therefore, the selection of these four taxa transported to and consumed in the hinterland is not merely due to practical constraints of preservation.

3.1.5. Diachronic evolution in shellfish gathering

Overall, Bronze Age populations seem to have concentrated mainly on collecting a single species for food purposes, while Iron Age populations diversified collecting strategies to include two or three species, particularly in Aquitaine.

On a regional level and **from a diachronic perspective, in Normandy and Brittany, the selected marine shells seem to be identical during the Bronze Age and the Iron Age (Dupont and Mougne, 2015)**. Inversely, in Poitou-Charentes, a change in dietary practices may be discerned between the Early Bronze Age and the late La Tène period. Indeed, the limpet, the mussel, and the peppery furrow shell were consumed throughout the Bronze and the Iron Ages whereas the flat oyster and the European clam only became part of the diet at

the end of the Iron Age.

3.1.6. Human marks and culinary uses

Two types of marks indicate culinary use, namely opening marks and traces of heating. They were observed on at least four species. Limpets bear traces of heating on the apex in two sites: Beg ar Loued (Bronze Age; table 1 n°14; 26 shells in 4572 in US 2500) and Rue Saint Nicolas (Iron Age; table 1 n°37; fig. 4; 4 shells in 337 in structure 20 survey 20). These traces could be linked to heating and cooking techniques. The limpets would have been placed with the apex turned towards the heat source, in order to heat the mollusc and to be able to consume it more or less grilled depending on exposure time. This practice is still current today on the French Atlantic coast, where shells are cooked on barbecues. Opening marks, namely notches or breaks on the edge of the shell, were observed on flat oysters on six Iron Age sites, at the ZAC Object'Ifs Sud (1 valve in 6), Boisanne (1 valve in 13), Rue Saint-Nicolas (194 valves in 391), 25 Cours Genêt (6 valves in 63), Grands Champs (58 valves in 388) and les Gains (2 valves in 5) (table 1 n°5, 28, 37, 38, 40 and 41). They are mainly located on the ventral edge (fig. 4). These small openings correspond to an action performed with a tool (fig. 4). Opening marks were also identified on European clams from several Iron Age sites; la Boisanne (2 valves in 5), Rue Saint-Nicolas (15 valves in 878) and the Grands Champs (1 valve in 41) (table 1 n°28, 37 and 40; fig. 4), in the form of notches or breaks on the edge of the shells. These marks may indicate the consumption of fresh shells. The remains of the claws of *Xantho* crabs and *Cancer Pagurus* bear traces of heating on several sites; Beg ar Loued, Mez-Notariou and Port-Blanc (table 1 n°14, 17 and 26).

It should be noted that shellfish preparations appear to be the same between the different regions included in this study and over time.

3.2. Artisanal activities

As well as being eaten, marine invertebrates were also used as raw material in various artisanal activities during late Prehistory, such as purple-dye making, ornament production and in architecture.

3.2.1. Dyeing

Two species of molluscs were used for obtaining purple dye on the French Atlantic coast, the dogwhelk *Nucella lapillus* and the oyster drill *Ocenebra erinaceus*. The selection of dogwhelks and oyster drills for extracting dye is clearly linked to their colouring qualities and accessibility (fig. 7), as *Nucella lapillus* could be collected from the mid part of the foreshore, whereas *Ocenebra erinaceus* is only present in the lower part of the foreshore zone (Poppe and Goto, 1991). Although the consumption of these species is also attested, several criteria indicate their use as dye (Dupont, 2013b), namely the presence of concentrations of dogwhelks and oyster drills systematically broken on the last whorl of spire. We applied a typology of fragmentation to demonstrate their systematic breakages (see Dupont, 2011). The shells are smaller (inferior to 20 mm) than those collected for food.

Until recently, this activity was only identified on French sites dating to after the Roman Conquest. Evidence of this use is restricted to Brittany in Late Prehistory and dates from at least the Iron Age, or even the Bronze Age. The assemblages identified in our study therefore provide the earliest evidence of dyeing in Western Gaul (Dupont, 2011, 2013b). Six pre-Roman sites in Brittany contain remains of dogwhelks and oyster drills used for dye production (for more details on the systematic breakage of the shells see Dupont, 2013a;

Dupont et al., 2013, 2018), indicating the use of *Nucella lapillus*, and to a lesser extent, *Ocenebra erinaceus*. For example at Port-Blanc (table 1 n°26), the extraction of dye appeared at the end of the Iron Age (Dupont et al., 2018, in press). More than 13 700 dogwhelks and 200 oyster drills have been studied. 98% of the specimens were broken on the last whorl. Intact individuals (2%) can be divided into two groups. Small ones (mean length = 16 mm) were excluded because they were too small to be broken individually. The second group concerned 31 larger (mean length = 21 mm), intact dogwhelks found in a single pit. They were broken and mixed with food waste (other marine molluscs, crabs, goose neck barnacles, marine fishes, birds and mammals).

Although purple-dye extraction is ascertained, particularly at the end of the Middle Iron Age, recent excavations provided huge quantities of shell fragments from the beginning of Antiquity (Dupont and Doyen, 2017). Based on currently available data, this activity seems to have been more sporadic on the French Atlantic seafront than in the Mediterranean zones. These results suggest a possible Mediterranean influence of this activity via maritime exchanges along the Atlantic coast (Dupont et al., in press).

3.2.2. Personal ornaments

Ten Bronze Age sites on the French Atlantic coast yielded ornamental pieces made from marine shell. However, no Iron Age site has yet yielded marine shell ornaments (fig. 8). A complete study was carried out on five of the ten Bronze Age sites (fig. 8 n°2, 4, 6, 7 and 10). For two other sites, study is in progress (fig. 8 n°8 and 9), while for the others (fig. 8 n°1, 3 and 5) no detailed analysis could be carried out due to sketchy descriptions at the time of discovery. Altogether, at least four shell species were used as raw materials: the cowrie *Trivia monacha*, the flat periwinkle *Littorina obtusata*, the tusk shell *Antalis* sp. and the cockle *Cerastoderma* sp. The shells were generally perforated by abrasion (cowrie and flat periwinkle), for example at Mez-Notariou (fig. 8 n°4) (Mougne and Dupont, 2020a). Tusk shell segments were shortened by sawing or bending, to widen the natural holes at their posterior ends, for example at La Vaurie (fig. 8 n°6) (Dupont and Le Merrer in Vacher, 2011, p. 200-234), and at ZAC du Clos Neuf (Mougne and Dupont in Le Saint Allain, 2013, p. 213-224). Cockle shells were also shaped to obtain discoidal beads, for example at Mas de Champ Redon (fig. 8 n°7) (Mougne et al., 2018) and La Villeneuve-du-Châtelot (fig. 8 n°10) (Mougne, 2020).

These ornaments are very heterogeneous from a geographic, chronological and morphological perspective. Two different types are present during the Bronze Age:

- a) the common type, a shell perforated by abrasion or shortened by sawing or bending, used in funerary (fig. 8 n°1, 2 and 3) and domestic contexts (fig. 8 n°4, 5 and 6) along the coast;
- b) a more elaborate type, consisting of discoidal beads, only found in funerary contexts in the hinterland (fig. 8 n°7, 8, 9 and 10).

It is important to note that there is a clear differentiation between the species used for personal adornment and those intended for consumption during the Metal Ages, as it has already been observed for during the Mesolithic and the Neolithic (Dupont, 2019). Shells seem to have been gradually replaced by metal during the Bronze Age for making personal ornaments. The decrease in the use of shells for ornaments is probably linked to the use of more resistant raw materials, as well as to the possibility to create more complex shapes with metal.

3.2.3. Architecture and Decoration

The remains of marine invertebrates, particularly mollusc shells, were occasionally used as construction material. On the French Atlantic coast, two shell taxa, the limpet and the flat oyster, were reused as construction material during the Metal Ages. The physico-chemical properties of these two species are conducive to their use in the construction of walls and floors, as they are resistant to mechanical pressure, permeable and facilitate draining.

The Beg ar Loued site (table 1 n°14) on Molène Island yielded shells used in the construction of a building dated to the Early Bronze Age. These are essentially limpets *Patella* sp., added in large numbers to the filling (fig. 9, Dupont, 2012). This reuse is also documented at other archaeological sites in France, for instance on the Goulvars site (final La Tène) in Brittany (Hyvert and Le Bihan, 1990), or in the Scilly and Orkney Islands (Butcher, 1978; Clarke, 2003).

The use of the flat oyster is less common in the West of Gaul, in keeping with the fact that this taxon was not often consumed in this area and, consequently, there was not much waste to recycle. An example of recycling flat oysters is found at Rue Saint Nicolas (table 1 n°37; Iron Age) in Aquitaine (Mougne in Vacher, 2015). *Ostrea edulis* shells were used in the construction of a foundation just below the floor of the hearth (fig. 10). Oyster valves only covered the area circumscribed by the floor, arranged in a single layer, one beside the other, in a more or less orderly manner, with the inner side against the ground and the outer side in contact with the floor. A similar use of oyster shells was also observed in the foundations of two sites dated to the first century AD in Aquitaine, the Fâ in Barzan (Bardot-Cambot, 2013) and the Chapeau Rouge in Bordeaux (Chuniaud and Sireix, 2006), as well as a late Prehistoric site on the Mediterranean island of Martigues, dated to 150 BC (Brien-Poitevin, 1988).

Shells were occasionally used to decorate architectural elements, walls or floor coverings. At the Middle Bronze Age site of Mez-Notariou (table 1 n°17) in Brittany, fragments of the wall of an oven made from fired clay (Mougne and Dupont, 2020a) were decorated on their external side with prints of limpet shells and fingerprints (Le Bihan and Villard, 2010, p. 92-93) (fig. 11). These ovens would have been used for domestic or artisanal activities, such as firing ceramics. Most likely these limpets had been placed on the walls as decorative elements and were later detached from the surface. Unfortunately, these shells were not collected by archaeologists or have been lost. It should be noted that several limpet shells filled with terracotta were also observed in the Middle Bronze Age layers of the site (Le Bihan and Villard, 2010, p. 156).

4. Discussion

4.1. Regional specificities: environmental and cultural influences on food practices

Archaeological and ethnographic records suggest that there is a close link between exploited marine species and local availability, in other words gathering shellfish in the immediate vicinity of the site (Waselkov, 1987, p. 167). Beyond this general pattern, the relative proportions of consumed species reveal a somewhat more selective collection compared to the wider variety available around a site. The latter implies that cultural choices also came into play (Voigt, 1975, p. 96). Ethnographic examples show that some edible species, although available, were not consumed, either because their taste was not appreciated, or because they were not considered as a valued food, or they were deemed to be taboo by the group (Cipriani, 1966, p. 78; Aschmann, 1975).

4.1.1: Why did Normans prefer mussels and Bretons prefer limpets?

From an environmental point of view, during Late Prehistory the Norman coasts were probably more favourable to the development of mussel beds while the Breton coasts to limpets. This is linked to the fact that marine environments were more open in the north-western part of present-day France than in the Channel. However, the mussel was probably not the only abundantly available shellfish or edible marine resource. Almost all molluscs, decapod crustaceans and sea urchins found in the French Atlantic coast are edible. Nevertheless, not all of them were consumed. The choice of one species over another at the time of collection may have been governed by the diversity of available taxa, the abundance of a single species on the coast, but most probably by taste preferences or other cultural criteria that are difficult to assess from the archaeological record, such as taboos or external influences. In Normandy for example, no fish species appear to have been consumed. Mussels and common cockles and, more rarely, flat oysters and *Barnea candida* piddocks, were the only marine species consumed by these populations.

Accessibility could also come into play. The limpet can be collected by almost daily beachcombing of the upper foreshore. Breton populations would thus have selected a species that could be easily collected on a daily basis. Mussels are collected in the middle and low foreshore and require higher tidal coefficients. Norman populations therefore relied on a resource, the collection of which was more difficult and less regular. These choices could potentially result from the meals during which these shellfish were consumed. Breton shell middens, located in close proximity to the shore, could be the result of daily consumption, unlike Norman shell middens located farther from the coast that may have been consumed less regularly, perhaps during specific events such as feasts or ritual banquets.

4.1.2. The arrival of flat oysters and European clams at the end of the Iron Age: an environmental or cultural phenomenon?

The flat oyster and the European clam became a major part of the food spectrum of coastal populations at the end of the Iron Age (Mougne and Dupont, 2015). These two species seem to have been collected in small quantities for several centuries for environmental or social reasons, before appearing in the Late Iron Age diet, mainly in the Charente (Aquitaine) at rue Saint-Nicolas, 25 cours Genêt, Mortatambe and Grands Champs (table 1 n°37 to 40). The arrival of flat oysters is also observed to a lesser extent in Normandy at La Vignerie, in Brittany at La Boissanne and in Pays de La Loire at Moulin de Courtes (table 1 n°13, 28 and 32). This seems to be a multi-regional phenomenon taking place at the end of the Iron Age during the Late La Tène period.

The consumption of these two bivalves is most probably due to cultural factors. Indeed, their appearance seems to coincide initially, in the 1st century BC, with intensified exchanges between the local populations and the Roman traders and soldiers; then, in the 1st century AD, with the Roman conquest and the lasting settlement of Mediterranean populations in Gaul.

This innovation could therefore be the result of the influence of Mediterranean food customs, at first particularly visible in south-western France. The precocity of this phenomenon in Aquitaine, for example, can be explained by the links established between the Gallic Pictones and Santones and the Roman population. Contact between these populations was more widespread in Aquitaine than in north-western France (Lemaître et al., 2009). This could also

explain the rarity of the flat oyster and its later arrival in Breton and Norman diets especially during the Early Roman Empire. The early arrival of the flat oyster in French Mediterranean populations, geographically closer to Italy, seems to support our hypothesis (Bardot-Cambot, 2013). The consumption of this shellfish is attested in Provence as early as the 2nd century BC on the island site of Martigues (Brien-Poitevin, 1988). In Languedoc, it probably appeared c. 80 - 70 BC, for example in Lattes (Bardot-Cambot, 2013). The oyster is recorded in Aquitaine around 50 BC, for instance at the site of Rue Saint-Nicolas or at 25 cours Genêt (table 1 n°37 and 38). The consumption of the flat oyster will then greatly increase a few years later at the beginning of the Roman period (e.g.: Forest and Bardot, 2003; Dupont and Blondiau, 2006; Schneider and Lepetz, 2007; Bardot-Cambot, 2013; Mougne et al.; 2017; Mougne and Dupont, 2018 and 2020c).

The arrival of these two bivalves in the Late Iron Age diet of local communities might be due to environmental factors in this part of Aquitaine. Indeed, slight mudding of the coastline during this period could have favoured the increase of oysters and clams (Laporte *et al.* 2009). Inversely, these conditions might have resulted in the reduction of the number of limpets (fig. 6), as they are restricted to rocky environments and do not live on muddy substrates. These environmental changes could explain the abovementioned modifications in dietary practices, namely a reduction in the percentage of limpets and an increase in the percentage of oysters and clams at the end of the Iron Age, although only in some areas along the Aquitaine coast.

4.1.3. Daily or exceptional food?

The sites that produced larger shell assemblages are those located in island settings, such as the settlements of Beg ar Loued, Mez-Notariou or Port-Blanc (table 1 n°14, 17 and 26) in Brittany, that are similar to the Neolithic (Dupont, 2006b). The inhabitants of island sites probably consumed marine invertebrates on a daily basis. Continental coastal sites, located less than one kilometre from the coast, contain much smaller accumulations, such as at Dossen Rouz or the ZAC des Ormeaux (table 1 n°20 and 36). Nevertheless, it is more difficult to estimate the frequency of shellfish consumption by continental coastal settlements. Were they consumed on a daily basis or did shells play an occasional and probably a secondary role in the diet?

The issue of collective meals or "feasts" is particularly relevant for sites in the Caen Plain in Normandy dating to the Iron Age, located up to twenty kilometres inland, where in some cases important quantities of shellfish were found in pits or ditches (table 1 n°5 to 11) (fig. 12). Given the distance of these sites from the coast, it is unlikely that these remains represent daily consumption debris. Rather, they might indicate occasional, seasonal or even exceptional consumption, possibly linked to specific events giving rise to collective ritual meals (Dietler and Hayden, 2001) well documented for the Iron Age (Méniel, 2008, 2010). Large accumulations of shells in the Pays de la Loire and Aquitaine, located more than ten kilometres from the coast do not seem to represent daily consumption. The distance of these sites from the coast supports this hypothesis. Shellfish from the sites of 25 cours Genêt (table 1 n°38), the Grands Champs (table 1 n°40) or Les Gains (table 1 n°41) may have been transported as supplements, to introduce a more diversified diet, or for special events organised by a well-off part of the population in view of the objects discovered on the site and the high status of the settlement (Maguer, 2014; Landreau, in progress). The selection of species and sizes at these sites may also provide evidence of commercial links with the coast (Mougne and Dupont, 2015; Baudry et al., 2015; Mougne in Landreau, in progress).

These different case studies suggest that marine invertebrates played various roles in the diet. Most often, they were only consumed for their nutritional value, with a strong correlation between consumption rate and accessibility. Nevertheless, their consumption could also sometimes be dictated by social (selection of oyster and clams) or ritual events (collective meals or "feasts"). Seafood was valued differently by coastal communities, who were regular consumers, and by inland groups, who were more episodic or even exceptional consumers. A rare product from the coast probably held a special place on the table. The consumption of unusual food could also have held special significance for coastal residents, with respect to species such as abalone, sea urchins or goose barnacles, which were only collected during very high tides, only a few times a year.

4.2 Transport and trade of marine shellfish

The first evidence of the consumption of marine shellfish in the hinterland occurs during the Iron Age, up to 120 km from the coast. There is however no evidence of marine invertebrate consumption beyond 7 km from the coast during the Bronze Age. This image is consistent with what is known for the Neolithic on the French Atlantic coast, where consumption sites were situated no more than 5 km from the **coastline at the time of the occupation** (Dupont, 2006b). Therefore, the consumption of fresh seafood further inland began during the Iron Age, marking a considerable change in dietary habits. This phenomenon is related to socio-economic changes, the development of new activities and professions (Lepaumier et al. 2015) and the expansion of long-distance trade during this period (Buchsensschutz et al., 1993). It is due, among other things, to the establishment of a dense road network and the increased use of traditional waterways (Audouze and Buchsensschutz, 1989).

Nine settlements of this corpus are located more than 10 km from the current coastline (Normandy: Object'Ifs Sud (≈ 18 km), ZAC de la Maslière (≈ 16 km), Aire des Gens du Voyage (≈ 16 km), Honorine sites 3 and 5 (≈ 10 km); Aquitaine: 25 cours Genêts (≈ 40 km), Mortantambe (≈ 17 km), Les Grands Champs (≈ 42 km) and Les Gains (≈ 124 km). This raises questions concerning the transport and trade of seafood products (table 1 n°5, 6, 8, 9, 10, 38, 39, 40, 41).

From this period onwards, two types of dietary practices can be distinguished: coastal practices, which may or may not have involved the daily consumption of shellfish, and inland practices, which seem to have been more occasional or even exceptional.

4.2.1. Local exchange networks: the example of the Caen Plain in Normandy

The Caen Plain, where all the sites studied in Normandy are located, extends over approximately 40 km from north to south and 50 km from east to west. This micro-region comprises many archaeological sites dating to the middle and late La Tène. The latter are characterized by the almost systematic presence of marine shellfish, mainly *Mytilus edulis* and more rarely *Cerastoderma edule*, sometimes in large quantities. The settlements are located up to twenty kilometres from the coast along rivers (the Orne, the Seulles and the Dives). Estuaries and rivers would allow the circulation of marine products, and because of their proximity to such resources, they were certainly used as transport networks (Lepaumier et al. 2010 and 2015). Settlement sites comprise pits and ditches filled with mussel and cockle remains. Similar high concentrations of marine shellfish were also observed at other sites in

the Caen Plain. Unfortunately, no archaeomalacological study was possible, as the material was not retrieved. Nonetheless, there are several indications of the redistribution of mussels and cockles. The first relates to the selection of species as exchange often involved a limited number of malacological species. In the Caen Plain, only two species, the mussel and the cockle, were consumed in large quantities. The second indicator is shellfish calibration. Regardless of the studied site, mussels measure between 35 and 60 mm in 90 to 99% of cases and common cockles between 15 and 35 mm in length in 96% of cases (Mougne, 2015; Mougne et al., 2015). These metric data attest a precise calibration with the collection of only medium to large sized individuals that excluded small individuals of less than 20 mm in size (Gruet and Dupont, 2009, p. 561). These two species were therefore either chosen directly for their size at the time of collection, or collected in clusters before being immediately sorted where they had been collected. The third indicator of exchange is the scale of diffusion. To date, the Main Delle in Bourguébus site where marine invertebrates were found is furthest from the coast at about 20 kilometres inland (table 1 n°5, 6, 8, 9). In the current state of research, no Iron Age site from beyond this point has yielded seashells, which raises a number of questions. The nature of the substrate could be at issue, given that the soils of the Armorican Basin that surround the Caen Plain respectively to the west and east, are granitic and are therefore less favourable to shell preservation. According to available data, exchanges seem to be focussed in the Caen Plain that suggests the existence of a local exchange network. However, more malacological studies are required in this area to substantiate this hypothesis.

4.2.2. Regional exchange networks

At the end of the Iron Age in the Pays de la Loire and Aquitaine regions, four sites with marine shell remains were located several kilometres from the current coastline, namely 25 cours Genêt, Mortantambe, Grands Champs and Les Gains (table 1 n°38 to 41). All sites combined, four shellfish species were consumed in the hinterland in these two regions. These are flat oysters, European clams, common mussels and peppery furrow shells. The latter species can travel up estuaries for several kilometres and may therefore have been collected on the banks of the Charente River, near the Mortantambe site (table 1 n°39). As for the three other species, they may have been traded. It is noteworthy that small quantities of oysters and clams (four oysters and one clam) were transported to the Gains site, 120 km from the coast (table 1 n°41). These shellfish were probably consumed, as suggested by their size and the presence of opening marks, underlining the existence of a trade in shellfish over long distances. The absence of living organisms, such as barnacles attached to the shell, and the apparent size selection suggest that they were prepared before transportation. According to bibliographical references, oysters seem to have been consumed during the final La Tène at five other sites far from the coast: Court-Balent 1 in Saint-Pompain (Nillesse, 2001; Germinet, 2009), Les Genêts 1 in Fontenay-le-Comte (Nillesse, 1997; Germinet, 2009), Les Filasses in Le Langon (Mougne in Nillesse, 2018, p. 493-497), Le Moulin de Chez Bret in Jonzac (Dupont in Robin and Mortreuil, 2007, p. 162-192) and Rue de La Libération in Muron (Driard, 2016).

The rarity of shellfish consumption in the hinterland could imply that these products were reserved for a few individuals or high-ranking social groups. Trade networks, or even trade in molluscs and more generally in seafood probably existed to supply these inland sites. There is only one site in the corpus, Les Gains (table 1 n°41), located more than 100 km from the

coast, that yielded evidence of seashell consumption. This site comprised the remains of monumental buildings specific to Late Iron Age aristocratic settlements. People who consumed shellfish probably did not collect them themselves, given the distance between the site and the coast. There were probably trade networks that ensured the efficient transport of these products that required rapid packaging and transport so that the inhabitants could have access to fresh shellfish, although some might have been prepared (cooked, smoked or salted) before being transported. Were these resources delivered to the site through an organized distribution network?

Inland groups could have exchanged various products for marine resources such as salt, shellfish, crustaceans, sea urchins or fresh or prepared fish. Depending on the distance of the settlements to the coastline and the mode of transport used, the duration of the round trip could vary from a few minutes (50 m) to about six days (120 km).

The selection of only two marine taxa, the flat oyster and the European clam, for transport and consumption in the hinterland does not seem to be the result of a simple conservation technique. It could reflect a deliberate choice, either by coastal populations to focus their exchanges on a couple of species depending on available resources, or by inland communities for specific demands.

4.3. Funerary and ritual practices

Marine invertebrates also played a non-negligible role in the thought and belief systems of Bronze and Iron Age communities in this area. The remains of marine invertebrates have sometimes been identified as votive deposits, food offerings and the remnants of ritual or communal meals in at least three areas on the French Channel-Atlantic coastline; in Normandy during the Iron Age and on the Breton coast and in Aquitaine during the Late Prehistory. Each context is characterized by a specific assemblage of selected species or associated objects. It is therefore difficult to directly compare practices that seem to represent different symbolisms and rituals.

4.3.1 Normandy

In the Caen Plain in Normandy, a cluster of sites ([table 1 n°1 to 13](#)) within a radius of about fifteen kilometres have distinct features that do not match any utilitarian use ([Mougne et al., 2015](#)). These sites are dated to the late La Tène period and cover a period of 125 years (150 to 25 BC). In this small area located near the Channel coast, invertebrates seem to have played a non-negligible role in symbolic representations and practices at the end of the Iron Age. Some of these special contexts are presented here:

The first example illustrates the place of marine invertebrates in funerary meals. At the site of l'Etoile III, a deposit of shells was discovered in a tomb together with parts of a chariot ([Besnard-Vauterin, 2009](#)). Two metal chariot wheel treads were covered by shells over a thickness ranging from 5 cm to 20 cm ([Fig. 13-A](#)). Inside the treads, unburnt human remains, about 20 bones of domestic animals and a few pottery sherds were found. Unfortunately, this deposit could not be further studied.

The second example illustrates a religious deposit from the site of the Main Delle ([table 1 n°12](#)) ([Lefort, 2015](#)). It contained an iron ploughshare and 52 valves of marine shells, namely 48 rough cockles *Acanthocardia tuberculata* and four common cockles *Cerastoderma edule* ([Fig. 13-C](#)). The two identified species are morphologically rather similar and their selection

was clearly governed by common size and shape denominators. These shells do not constitute food remains, as marine organisms were observed inside some of the valves. They were thus collected dead on the beach, brought to the site and deposited intentionally with the ploughshare, as votive offerings, in an area devoid of any other archaeological material. The rough cockle *Acanthocardia* sp. seems to hold a special role in the symbolic sphere along the Atlantic coast, in other archaeological contexts dated from Prehistory to Roman times, and its presence in specific Late Prehistoric contexts is no coincidence (Dupont, 2019). This could be because in Normandy, as early as the Early Bronze Age, the bucarde is a symbolic place. Indeed, on the site of the ZAC Terres d'Avenir zones 1A and 1B in Blainville-sur-Orne (Calvados) (table 1 n°1), a tuberous cockle was placed on either side of the entrance to an enclosure (structure 40). This gesture could be ritual (Dupont in Ghesquière, 2019, p. 149-156).

The third example is a ritual deposit that does not appear to be food-related. In the settlement area of the ZAC Object'Ifs Sud site (table 1 n°5), marine shells were placed in a final La Tène deposit interpreted as votive. This deposit consists of 67 coins, as well as a fragment of a human skullcap, several pottery sherds and iron objects. It also includes animal bone, including one horse skull, and numerous marine shells (Le Goff et al., 2007). The sampling carried out in this deposit for archaeomalacological remains produced eight species of marine invertebrates: *Mytilus edulis*, *Cerastoderma edule*, *Barnea candida*, *Ostrea edulis*, *Solen marginatus*, *Spisula* sp., *Tritia reticulata* and *Abra* sp. The mussel is the best represented species with 206 individuals, whereas only four cockles were identified. The other species are each represented by a single specimen. The presence of these shells alongside the other items in the deposit suggests that they held a particular value as part of a votive practice (Le Goff et al., 2007). Two hypotheses can therefore be put forward. Firstly, the mussels may have been consumed before being deposited with the other elements. The marine shells, and particularly the mussels, may also have been deposited as food offerings, in the same way as the other species. In any case, the presence of marine fauna is of particular significance, as it is associated with votive rituals.

4.3.2. Brittany

In Brittany, during the Bronze Age, food offerings or the remains of meals made up of marine shells, crustaceans and sea urchins were discovered in funerary (tumuli, vaults) and ritual (sanctuaries, metal deposits) contexts.

Several burial mounds at Clohars-Carnoet in Douélan yielded batches of seashells, accompanied by fish and mammal remains (du Chatellier, 1889, p. 200 and 1907, p. 353). Numerous shells, mainly limpets, clams and oysters, were also observed in funerary chambers at Lestohan in Douarnenez (du Chatellier, 1907, p. 265). At Primel Trégastel in Plougasnou, limpet and mussel remains were placed in two tombs, near the head of the deceased in one case (du Chatellier, 1907, p. 81). However, these batches were discovered during early excavations, and were generally not retrieved for study. It is important to recall that the observed species of marine invertebrates were consumed during this period and the fact that they were associated with mammal and fish remains suggests that these marine shells may have been deposited as a funerary viaticum or the remains of a funerary meal.

Some deposits of metal objects dating to the Bronze Age have also been found with marine shells. None of the shell concentrations from discoveries dating back to the mid-twentieth century have been studied or even collected. However, the observations made by the

excavators indicate that marine shells were found alongside a deposit of Middle Bronze Age Breton type socketed axes on the island of Penfret in the Glénans at Fouesnant (Giot, 1975, p. 530; Pennors, 2004, p. 107). At Lestalia in Plomeur, a deposit of Late Bronze Age socketed axes was found inside a hearth filled with charcoal, baked clay and limpet shells (Le Roux and Briard, 1970). Finally, at Lividic in Plouneour-Trez, a Late Bronze Age metal deposit, consisting of decorated clasp bracelets, was found inside a concentration of limpets (Giot, 1967). These shell finds could be the remains of ritual meals or food offerings and appear to be directly linked to ritual deposits of metal objects. Finally, the site of Mez-Notariou in Ouessant (table 1 n°17), occupied from the Middle Bronze Age to the Roman period, has been identified as a ritual place, due to the selection and organisation of the animal bones found there (Méniel and Clavel, 2013). The discoveries include numerous remains of marine invertebrates with bones of terrestrial and marine mammals, birds and fish. Archaeomalacological study suggests that the remains of marine invertebrates come from food consumption during collective meals of a singular nature. Limpets are very abundant in this sector, estimated at around 300,000 specimens (Méniel and Clavel, 2013). Barnacles, sea urchins, edible crabs and *Xantho* crabs were also present but are relatively rare. In these two examples, the remains probably come from ritual meals, perhaps combined with food offerings in the case of the Mez-Notariou site (table 1 n°17).

4.3.1. Aquitaine

Two examples from Aquitaine were studied. The first is a Bronze Age site, located at La Vaurie, in the town of Périgny (table 1 n°33), which yielded the remains of a meal in a ritual context (Kerouanton et al., submitted). This deposit contains grooved razor shells that in view of their low fragmentation were laid out and rapidly buried in a circular enclosure straight after their consumption. The collection of grooved razor shells requires specific fishing techniques and concentrations of this species are rarely observed in archaeological contexts (fig. 13-B). The second is a site from the Early Iron Age at Rue Saint Nicolas in Andilly (table 1 n°37). An abalone shell, *Haliotis tuberculata*, was discovered beside a bronze ring of about 35 mm in diameter with a circular structure (Fig. 14). This type of deposit is currently unique for the Hallstatt period on the French Atlantic coast.

To sum up, the marine invertebrate species used in funerary and ritual practices vary in the three regions studied here.

Conclusions

Over the past decade, new archaeomalacological studies have been conducted for the Bronze Age (Law, 2012; Mougne et al., 2014a; Mougne, 2015; Dupont and Mougne, 2015; Mougne et al., 2018; Mougne, 2019; Mougne and Dupont, 2020a, 2020b; Kerouanton et al., submitted) and the Iron Age (Gonzalez Gomez de Agüero and Bejega Garcia, 2011; Dupont, 2013a; Mougne et al., 2013; Theodoropoulou, 2013; Angel Vincens and Hernandez-Gash, 2014; Angel Vincens et al., 2014; Bueno Serrano, 2014; Mougne et al., 2014b; Baudry et al., 2015; Bejega Garcia 2015; Dupont and Mougne, 2015; Mougne, 2015; Mougne and Dupont, 2015; Mougne et al., 2015; Dupont et al., 2018), reflecting the growing interest in the archaeomalacological approach in Europe. Syntheses are still rare and this paper represents the first such attempt for the Atlantic façade of France from the shell perspective.

The study of marine invertebrates is part of a broader research on dietary marine resources on the French Channel-Atlantic seaboard. Coastal biodiversity in this area is diversified, in terms of animals and plants, and provides a wide variety of dietary resources, such as salt, fish, molluscs, crustaceans, sea urchins, mammals, marine birds, but also marine plants. The regional syntheses included in this study show that the inhabitants of these areas engaged a close contact with the coastal environment. The identifiable marine products consumed in Normandy and in Aquitaine mainly consist of molluscs (Dupont, 2006a and 2009; Mougne 2015; Mougne and Dupont 2015; Mougne et al., 2013, 2014a and 2015) and salt (Carpentier et al., 2006; Landreau et al., 2009). In Brittany, populations seem to have included a wider diversity of marine faunal resources in their diet, mainly molluscs (Mougne et al., 2014b; Dupont and Mougne, 2015; Dupont et al., 2018; Mougne, 2019; Mougne and Dupont, 2020a and 2020b), but also crustaceans (Dupont, 2013a; Mougne, 2015; Dupont et al., 2018), echinoderms (Mougne et al., 2014b; Mougne, 2015), fish (Clavel, 2010; Dréano, 2011; Dréano et al., 2013; Méniel and Clavel, 2013; Dréano, 2019), birds (Méniel, 2010; Baudry, 2018) and marine mammals (Méniel and Clavel, 2013; Baudry, 2018), as well as important quantities of salt (Daire, 2003; Daire et al., 2015a). The subsistence of the inhabitants of Brittany, both on the islands and in the continent, was intricately linked to the coastal zone, particularly from the end of the Iron Age onwards. The diversity of exploited species indicates an excellent knowledge of the diversity of ocean resources.

This strong dependence on marine resources does not imply that coastal populations lived in isolation. Many inland sites, as well as some coastal ones, clearly served as exchange centres (Daire et al., 2015a; Le Bihan et al., 2015; Daire and Baudry, 2018). For example, Italian products, such as oil or wine, were consumed at some coastal Iron Age sites. The development of some activities is probably due to remote influences and certain aspects of the effects of Romanisation are clearly visible, in particular the consumption of the flat oyster or the European clam. Some early attempts at production of purple-dye seem to have been realised on a small scale and under an indirect Mediterranean influence coming from the sea (Dupont, 2013a and 2013b; Dupont et al., 2018). At the beginning of Antiquity, this activity shows a clear intensification with the presence of huge quantities on archaeological sites (Dupont and Doyen, 2017). We know that producing dye from shells is a complex process that requires thousands of *Nucella lapillus* specimens. The final product was highly valued, and it is possible that some of these coastal settlements played an influential role in the networks of this period, such as those transporting seafood to high-ranking people far from the seashore.

From an economic point of view, shells are included in several activities, but our synthesis also underlines their importance in the symbolic sphere. Late Prehistoric populations made a clear distinction between species used for personal ornaments and those intended for consumption, as already observed for the Palaeolithic, Mesolithic and Neolithic (Dupont, 2006b and 2019). It should be noted that shells seem to have been progressively replaced by metals for ornamental purposes as early as the end of the Neolithic period, as metal is more resistant and can be used for creating more complex shapes. In addition to the discoveries of the remains of marine invertebrates, the role of these animals in daily life and in the beliefs of coastal populations is manifested through other lines of evidence, such as the presence of sea urchins and unperforated fossil shells in some tombs (Demnard and Néraudeau, 2001; Gomez de Soto, 2002), or by the shapes and decorations of Iron Age granite stelae reminiscent of the

sea urchin (Daire, 2005).

The study of marine invertebrates (molluscs, crustaceans and echinoderms) remains from late Prehistoric sites is relatively new on the French Channel-Atlantic coast. However, and in spite of the fragmentary state of most shell assemblages, the first results shed light on how marine resources were used, thanks to the robust methodology applied. First, as part of the subsistence economy. Marine invertebrates were widely consumed in coastal areas but they were also transported and exchanged further inland, albeit a more limited variety of species. Furthermore, the use of marine invertebrates in funerary and ritual practices, but also in artisanal activities such as dyeing, in personal adornment, or in architecture, underline the importance of these marine animals for Prehistoric communities. The diversity of activities put forward by this study opens up new areas of study for the Bronze Age and the Iron Age.

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Figure captions

N°	Site	Town	Chronology	Geography	Occupation	Studies
Normandy						
1	ZAC Terres d'Avenir	Blanville-sur-Orne	EBA	M	domestic	Dupont in Ghesquière, 2019, p. 149-156
2	Les Vallons de Luc	Luc-sur-Mer	EBA	M	domestic	Mougne and Dupont in Marcigny, 2012, p. 70-79
3	ZAC du Clos Neuf	Démouville	MBA	M	funerary	Mougne and Dupont in Le Saint Allain, 2013, p. 213-224
4	Le Clos des Châtaigniers	Mathieu	LBA	M	domestic	Mougne and Dupont in Giazzon, 2013, p. 55-81; Mougne <i>et al.</i> , 2014
5	ZAC d'Object'Ifs Sud	Ifs	LBA à PA	M	domestic/ritual	Mougne <i>et al.</i> , 2015 ; Mougne 2015
6	ZAC de la Maslière	Bretteville-sur-Odon	MLT/ LLT	M	domestic	Mougne in Besnard-Vauterin, 2017, p. 222-239
7	Le Bougon	Graye-sur-Mer	MLT/ LLT	M	domestic	Mougne in Besnard-Vauterin, 2015, p. 90-105
8	Aire des Gens du Voyage	Cormelles-le-Royal	MLT/ LLT	M	domestic	Mougne <i>et al.</i> , 2013, 2015 ; Mougne 2015
9	Honorine site 3	Ranville-Hérouvillette	MLT/ LLT	M	domestic	Mougne in Giraud, 2020, p. 598-629
10	Honorine site 5	Ranville-Hérouvillette	MLT/ LLT	M	domestic	Mougne in Giraud, in progress
11	Le Clos de l'Épinette	Creully	LLT	M	domestic	Mougne <i>et al.</i> , 2015 ; Mougne 2015
12	La Main Delle	Bourguébus	LLT	M	domestic/ritual	Mougne in Lefort, 2015, p. 232-243
13	La Vignerie	Dives-sur-Mer	LLT	M	domestic/prod. of sea salt	Carpentier <i>et al.</i> , 2006 ; Dupont 2006
Brittany						
14	Beg ar Loued	Île-Molène	EBA	I	domestic	Mougne 2019 ; Paillet and Nicolas, 2019
15	Tariec Vraz	Landéda	EBA	I	domestic	Dupont in Paillet and Sparfel, 2008, p. 25-26
16	Kemenez 22 bis	Le Conquet	EBA	I	domestic	Mougne and Dupont in Gandois, 2017, p. 62-90
17	Mez-Notariou	Ouessant	MBA et H	I	domestic/ritual	Le Bihan and Villard, 2010 ; Mougne and Dupont, 2020a
18	Balanec	Le Conquet	LBA	I	domestic	Mougne, 2015
19	Litri 1	Le Conquet	LBA	I	domestic	Mougne and Dupont in Gandois, 2017, p. 62-90
20	Dossen Rouz	Locquémeau-Trédrez	MLT	M	domestic/prod. of sea salt	Daire, 2011 ; Mougne and Dupont 2011 ; Mougne <i>et al.</i> , 2014
21	Triélen	Le Conquet	MLT	I	domestic/prod. of sea salt	Dupont in Paillet <i>et al.</i> , 2004, p. 21-22
22	AC3 de l'Anse de l'Aber braz	Sein	MLT à LLT	I	domestic	Dupont and Digard in Dutouquet 2019, p. 35-49
23	Roc'h Santec	Santec	MLT à LLT	I	domestic	Mougne in Olmos Benloch, 2015b, p. 83-91 ; Marchand <i>et al.</i> , 2020
24	Roc'h Louet	Pleubian	MLT à LLT	I	domestic	Mougne <i>et al.</i> in Olmos Benloch, 2015a, p. 3-13
25	Sterflant	Hoedic	MLT à LLT	I	domestic/prod. of sea salt	Mougne and Dupont in Daire <i>et al.</i> , 2015b, p. 41-61
26	Port-Blanc	Hoedic	MLT à LLT	I	domestic/prod. of sea salt	Daire and Baudry, 2018 ; Dupont <i>et al.</i> , 2018
27	Les Moutons	Fouesnant	LLT	I	domestic/prod. of sea salt	Daire and Hamon, 2013 ; Dupont, 2013
28	Le Boisanne	Plouër-sur-Rance	LLT	M	domestic	Mougne, 2015
29	Le Yaudet	Ploulec'h	LLT	M	domestic	Campbell, 2007 ; Cunliffe and Galliou, 2005
Pays de la Loire						
30	Les Batardières 2	Saint-Vincent-sur-Jard	EBA	M	domestic	Large <i>et al.</i> , 2015
31	ZA du Pladreau	Piriac-sur-Mer	LLT	M	domestic	Dupont and Gruet in Hervé, 2007, p. 202-256
32	Le Moulin des Courtes	Les Moutiers-en-Retz	LLT	M	domestic	Dupont in Robin and Mortreuil, 2007, p. 162-192
Aquitaine						
33	La Vaurie	Périgny	CAM/ EBA à H	M	domestic/funerary/ritual	Dupont and Le Merrer in Vacher, 2011, p. 200-234
34	18 Passe de l'Écuissière	Dolus d'Oléron	EBA	I	domestic	Mougne, 2015 ; Laroche <i>et al.</i> , 2018
35	Le Mas de Champ Redon	Luxé	EBA	M	funerary	Mougne <i>et al.</i> in Audé, 2013, p. 62-96 ; Mougne <i>et al.</i> , 2018
36	ZAC des Ormeaux	Angoulins	ELT à LLT	M	domestic/prod. of sea salt	Dupont in Maguer <i>et al.</i> , 2009
37	Rue Saint-Nicolas	Andilly	H à LLT	M	domestic /ritual	Mougne in Vacher, 2015, p. 157-196
38	25 cours Genêt	Saintes	LLT	M	domestic	Mougne in Landreau, in progress
39	Mortantambe	Cabariot	LLT	M	domestic	Gruet, 1998
40	Les Grands Champs	Coulon	LLT	M	domestic	Mougne and Dupont, 2015 ; Mougne and Dupont in Maguer, Pelletier, 2020, p. 213-230
41	Les Gains	Saint-Georges-lès-Baillargeaux	LLT	M	domestic	Mougne and Dupont in Maguer, 2014, p. 241-246 ; Baudry <i>et al.</i> , 2015

Family	Species
MOLLUSCS	
Gastropods	
Buccinidae	<i>Buccinum undatum</i> Linnaeus, 1758
Calliostomatidae	<i>Calliostoma zizyphinum</i> (Linnaeus, 1758)
Cerithiidae	<i>Bittium reticulatum</i> (da Costa, 1778)
Ellobiidae	<i>Myosotella myosotis</i> (Draparnaud, 1801)
Epitoniidae	<i>Epitonium clathrus</i> (Linnaeus, 1758)
Fissurellidae	<i>Ermarginula rosea</i> Bell, 1824
	<i>Diodora gibberula</i> (Lamarck, 1822)
	<i>Diodora graeca</i> (Linnaeus, 1758)
Haliotidae	<i>Haliotis tuberculata tuberculata</i> Linnaeus, 1758
Hydrobiidae	<i>Ecrobia ventrosa</i> (Montagu, 1803)
	<i>Peringia ulvae</i> (Pennant, 1777)
Lepetidae	<i>Lepeta caeca</i> (O.F. Müller, 1776)
Littorinidae	<i>Lacuna pallidula</i> (da Costa, 1778)
	<i>Lacuna parva</i> (da Costa, 1778)
	<i>Lacuna vincta</i> (Montagu, 1803)
	<i>Littorina compressa</i> Jeffreys, 1865
	<i>Littorina littorea</i> (Linnaeus, 1758)
	<i>Littorina obtusata</i> (Linnaeus, 1758)
	<i>Littorina saxatilis</i> (Olivi, 1792)
	<i>Melarhapha neritoides</i> (Linnaeus, 1758)
Mangeliidae	<i>Bela powisiana</i> (Dautzenberg, 1887)
	<i>Mangelia costata</i> (Pennant, 1777)
Muricidae	<i>Nucella lapillus</i> (Linnaeus, 1758)
	<i>Ocenebra erinaceus</i> (Linnaeus, 1758)
Nassariidae	<i>Tritia incrassata</i> (Strøm, 1768)
	<i>Tritia pygmaea</i> (Lamarck, 1822)
	<i>Tritia reticulata</i> (Linnaeus, 1758)
Naticidae	<i>Euspira nitida</i> (Donovan, 1804)
Patellidae	<i>Patella aspera</i> Röding, 1798
	<i>Patella depressa</i> Pennant, 1777
	<i>Patella pellucida</i> Linnaeus, 1758
	<i>Patella ulyssiponensis</i> Gmelin, 1791
<i>Patella vulgata</i> Linnaeus, 1758	
Phasianellidae	<i>Tricolia pullus</i> (Linnaeus, 1758)
Pyramidellidae	<i>Eulimella</i> Forbes & M'Andrew, 1846
Rissoidae	<i>Cingula trifasciata</i> (J. Adams, 1800)
	<i>Manzonis crassa</i> (Kanmacher, 1798)
	<i>Onoba semicostata</i> (Montagu, 1803)
	<i>Rissoa parva</i> (da Costa, 1778)
Triviidae	<i>Trivia monacha</i> (da Costa, 1778)
Trochidae	<i>Gibbula magus</i> (Linnaeus, 1758)
	<i>Jujubinus exasperatus</i> (Pennant, 1777)
	<i>Phorcus lineatus</i> (da Costa, 1778)
	<i>Steromphala cineraria</i> (Linnaeus, 1758)
	<i>Steromphala pennanti</i> (Philippi, 1846)
	<i>Steromphala umbilicalis</i> (da Costa, 1778)

Bivalves	
Anomiidae	<i>Anomia ehippium</i> Linnaeus, 1758
Cardiidae	<i>Acanthocardia echinata</i> (Linnaeus, 1758)
	<i>Acanthocardia tuberculata</i> (Linnaeus, 1758)
	<i>Cerastoderma edule</i> (Linnaeus, 1758)
	<i>Laevicardium crassum</i> (Gmelin, 1791)
	<i>Parvicardium minimum</i> (Philippi, 1836)
<i>Parvicardium scabrum</i> (Philippi, 1844)	
Corbulidae	<i>Corbula gibba</i> (Olivi, 1792)
Donacidae	<i>Donax vittatus</i> (da Costa, 1778)
Glycymerididae	<i>Glycymeris glycymeris</i> (Linnaeus, 1758)
Hiatellidae	<i>Hiatella arctica</i> (Linnaeus, 1767)
Lasaeidae	<i>Lasaea adansoni</i> (Gmelin, 1791)
	<i>Lasaea rubra</i> (Montagu, 1803)
Lucinidae	<i>Loripes orbiculatus</i> Poli, 1795
	<i>Lucinella divaricata</i> (Linnaeus, 1758)
Mactridae	<i>Lutraria</i> Lamarck, 1799
	<i>Mactra glauca</i> Born, 1778
	<i>Mactra stultorum</i> (Linnaeus, 1758)
	<i>Spisula solida</i> (Linnaeus, 1758)
	<i>Spisula subtruncata</i> (da Costa, 1778)
Myidae	<i>Mya</i> Linnaeus, 1758
Mytilidae	<i>Modiolus</i> Lamarck, 1799
	<i>Mytilus edulis</i> Linnaeus, 1758
Noetiidae	<i>Striarca lactea</i> (Linnaeus, 1758)
Nuculidae	<i>Nucula nucleus</i> (Linnaeus, 1758)
Ostreidae	<i>Ostrea edulis</i> Linnaeus, 1758
Pectinidae	<i>Aequipecten opercularis</i> (Linnaeus, 1758)
	<i>Mimachlamys varia</i> (Linnaeus, 1758)
	<i>Pecten maximus</i> (Linnaeus, 1758)
Pharidae	<i>Ensis</i> Schumacher, 1817
	<i>Phaxas pellucidus</i> (Pennant, 1777)
Pholadidae	<i>Pholas dactylus</i> Linnaeus, 1758
	<i>Barnea candida</i> (Linnaeus, 1758)
Psammobiidae	<i>Gari</i> Schumacher, 1817
Semelidae	<i>Abra alba</i> (W. Wood, 1802)
	<i>Abra segmentum</i> (Recluz, 1843)
	<i>Scrobicularia plana</i> (da Costa, 1778)
Solenidae	<i>Solen marginatus</i> Pulteney, 1799
Tellinidae	<i>Limecola balthica</i> (Linnaeus, 1758)
Veneridae	<i>Callista chione</i> (Linnaeus, 1758)
	<i>Chamelea striatula</i> (da Costa, 1778)
	<i>Dosinia</i> Scopoli, 1777
	<i>Gouldia minima</i> (Montagu, 1803)
	<i>Irus irus</i> (Linnaeus, 1758)
	<i>Polittapes aureus</i> (Gmelin, 1791)
	<i>Ruditapes decussatus</i> (Linnaeus, 1758)
	<i>Venus verrucosa</i> Linnaeus, 1758

Scaphopods	
Dentaliidae	<i>Antalis vulgaris</i> (da Costa, 1778)
	<i>Antalis novemcostata</i> (Lamarck, 1818)
Cephalopods	
Sepiidae	<i>Sepia officinalis</i> Linnaeus, 1758
Polyplacophors	
Chitonidae	<i>Chiton</i> Linnaeus, 1758
ARTHROPODES (CRUSTACEANS)	
Cirripedia	
Balanidae	<i>Balanus crenatus</i> Bruguière, 1789
	<i>Perforatus perforatus</i> (Bruguière, 1789)
	<i>Semibalanus balanoides</i> (Linnaeus, 1767)
Chthamalidae	<i>Chthamalus montagui</i> Southward, 1976
	<i>Chthamalus stellatus</i> (Poli, 1791)
Verrucidae	<i>Verruca stroemia</i> (O.F. Müller, 1776)
Pollicipedidae	<i>Pollicipes pollicipes</i> (Gmelin, 1790)
Malacostraca	
Cancriidae	<i>Cancer pagurus</i> Linnaeus, 1758
Eriphiidae	<i>Eriphia verrucosa</i> (Forskäl, 1775)
Grapsidae	<i>Pachygrapsus</i> Randall, 1840
Majidae	<i>Maja squinado</i> (Herbst, 1788)
Portunidae	<i>Carcinus maenas</i> (Linnaeus, 1758)
	<i>Necora puber</i> (Linnaeus, 1767)
Xanthidae	<i>Xantho</i> Leach, 1814
ECHINODERMS	
Echinoids	
Parechinidae	<i>Paracentrotus lividus</i> (Lamarck, 1816)

Table 2: List of marine invertebrate species identified at the 41 sites (Worms, 5 december)

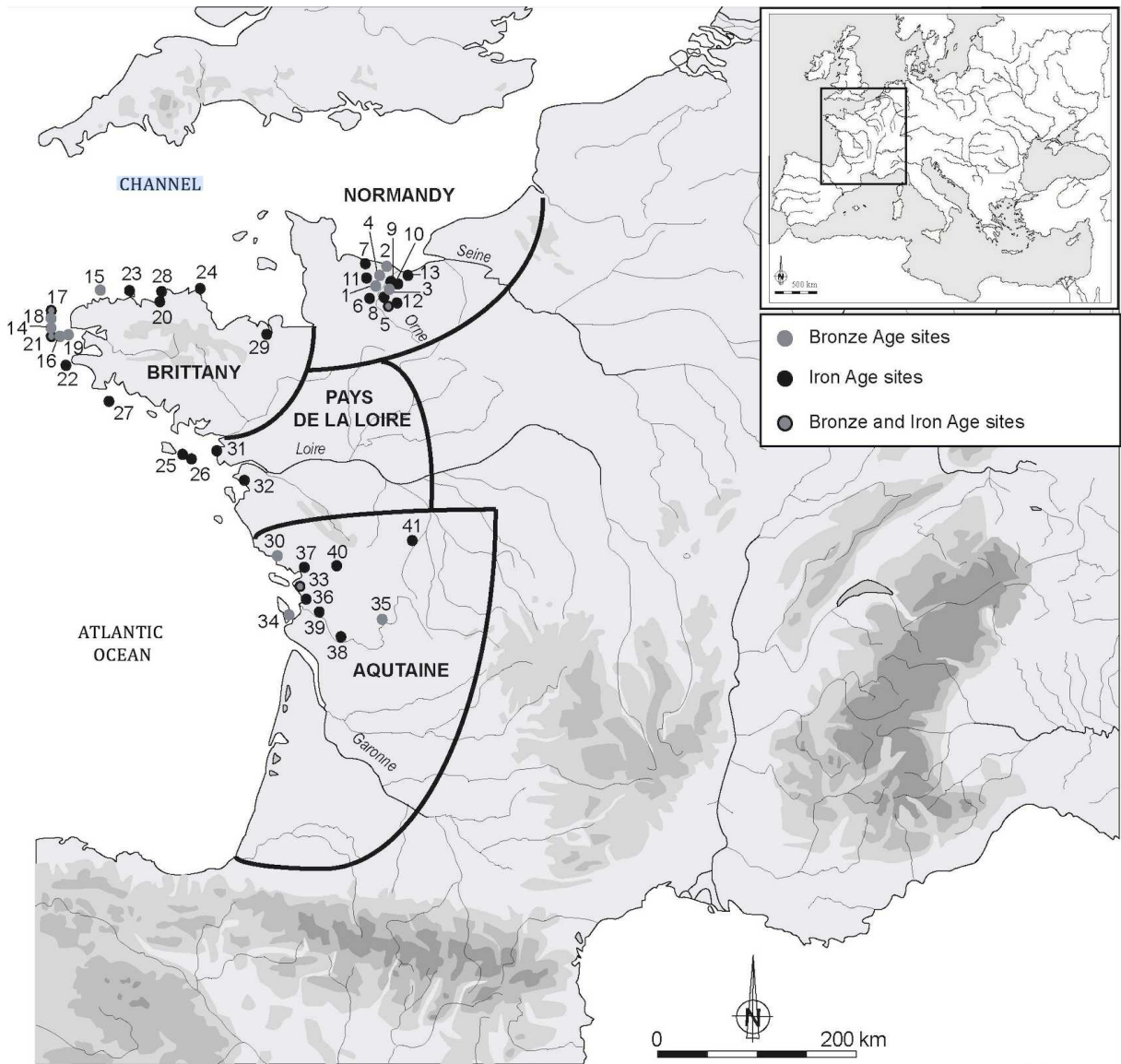


Figure 1: Map of the sites included in this study (for numbers refer to table 1) (CAD C. Mougne and L. Quesnel)

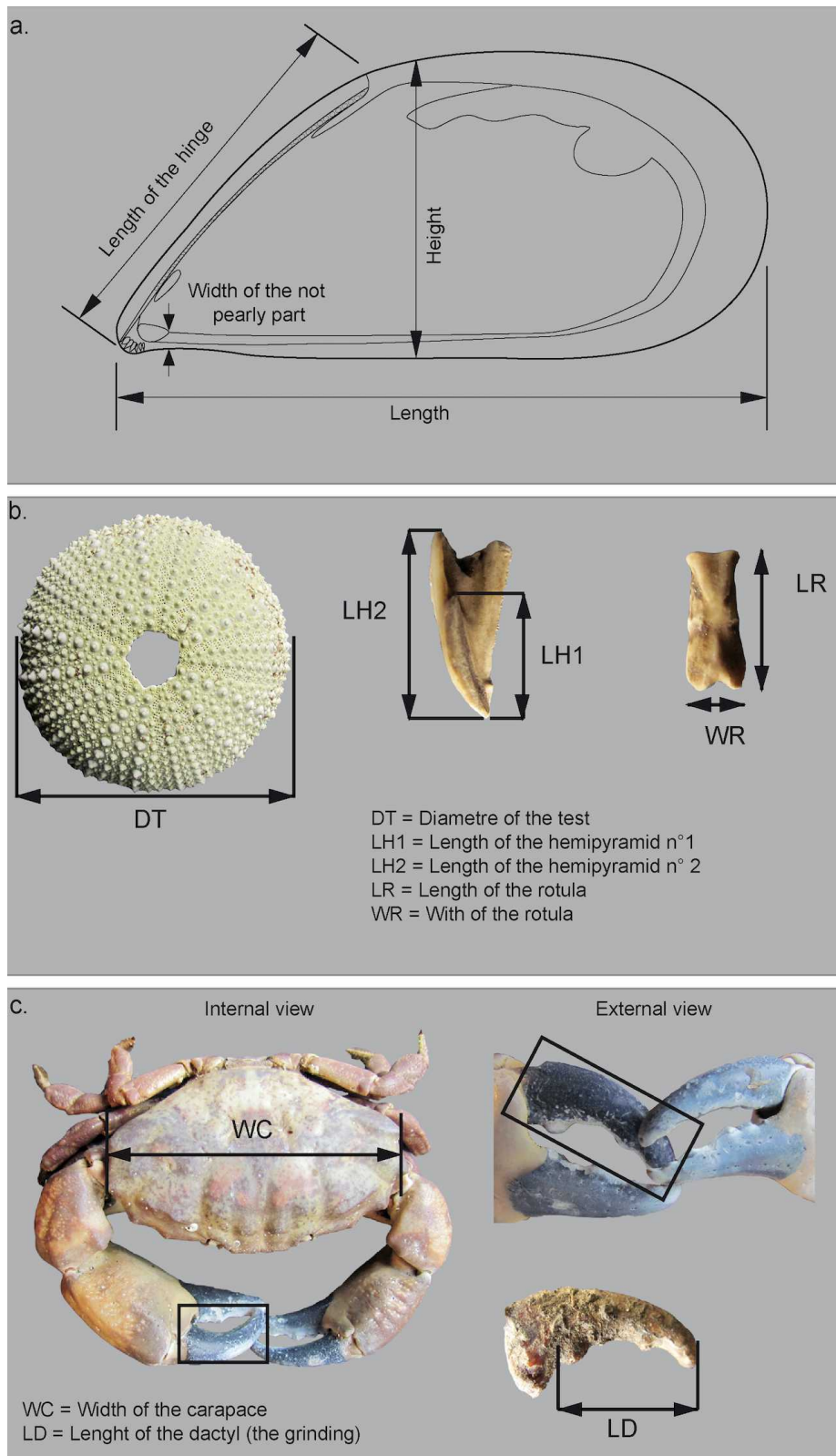


Figure 2: Size reconstruction of marine invertebrates based on fragments (Photo and CAD C.

Mougne)

a: Measurements of the common mussel shells *Mytilus edulis*

b: Measurements of purple sea urchin tests *Paracentrotus lividus*

c: Measurements of the Xantho crab *Xantho* sp.



Figure 3: Marine invertebrate species consumed during Late Prehistory on the French Channel/Atlantic seaboard (photo C. Mougne)

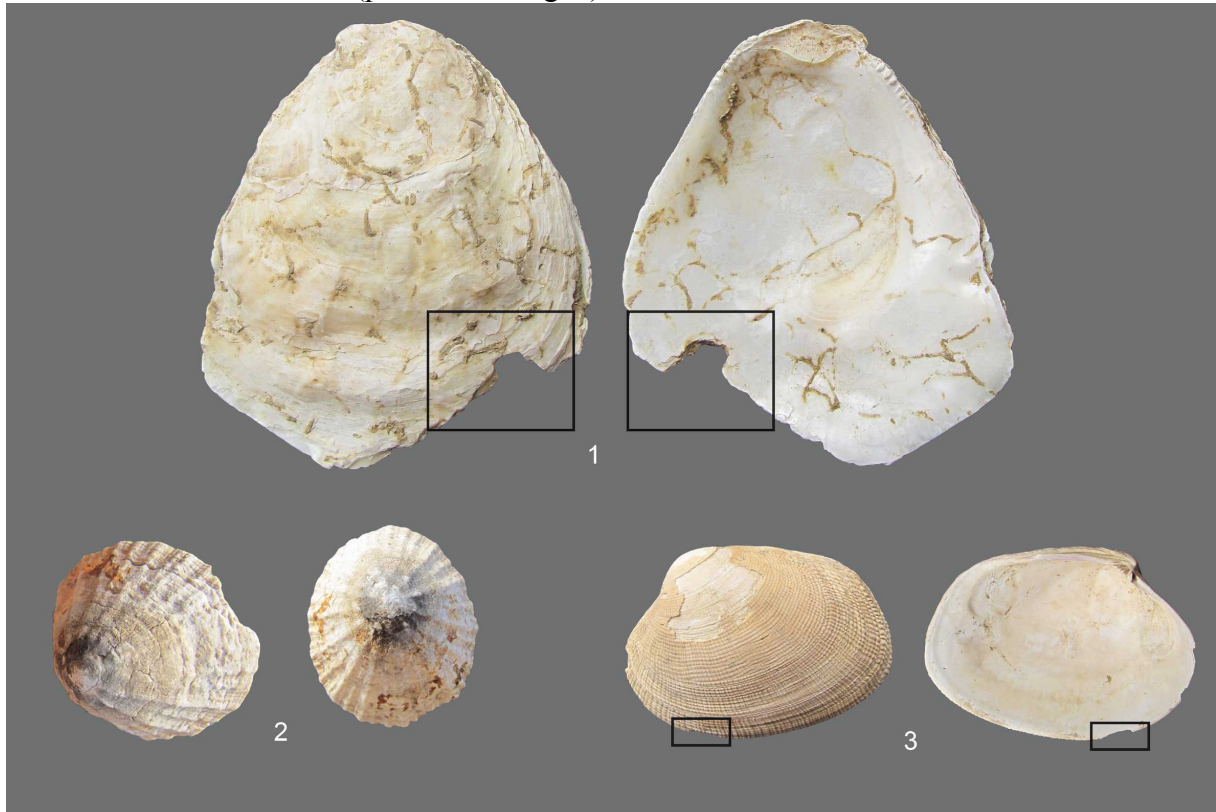


Figure 4: Opening and heating marks on marine shells (photo C. Mougne)

1: the European flat oyster *Ostrea edulis* (length = 85 mm) with opening mark, specimen found at Coulon (n^o ...).

2: the limpet *Patella* sp. (length = 36 mm) with heating mark, specimen found at Molène (n^o ...).

3: the European clam *Ruditapes decussatus* (length = 42 mm) with opening mark, specimen found at Coulon (n^o ...).

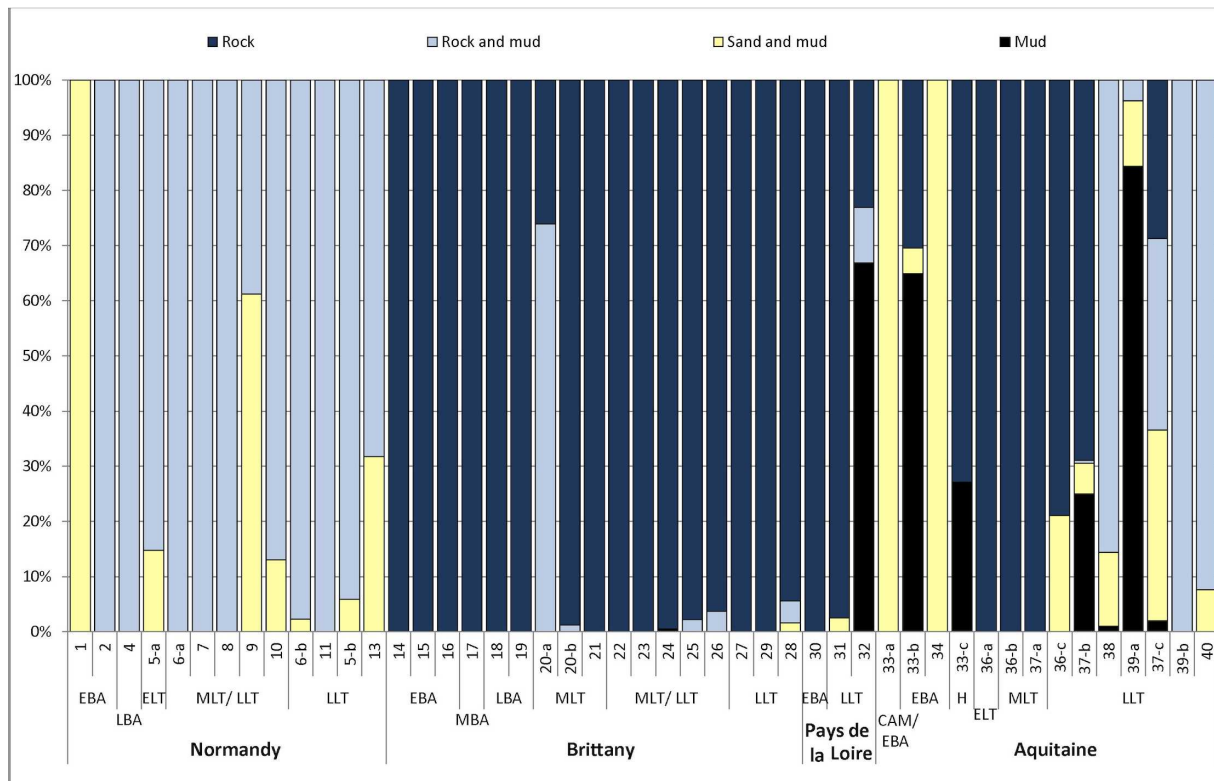


Figure 5: Distribution of the original substrata of the marine invertebrates for the units of the corpus with at least 50 individuals (MNI = Minimum Number of Individuals).

1	ZAC Terres d'Avenir (MNI = 136)	24	Roc'h Louet (MNI = 421)
2	Les Vallons du Luc (MNI = 55)	25	Sterflant (MNI = 6095)
4	Clos du Châtaigniers (MNI = 1490)	26	Port-Blanc (MNI = 93314)
5-a	ZAC Object'Ifs Sud (MNI = 217)	27	Les Moutons (MNI = 352)
6-a	ZAC de la Maslière (MNI = 241)	28	Le Boissanne (MNI = 198)
7	Le Bougon (MNI = 2596)	29	Le Yaudet (MNI = 53)
8	Aire des Gens du Voyage (MNI = 2937)	30	Les Batardières 2 (MNI = 98)
9	Honorine site 3 (MNI = 2904)	31	ZA du Pladreau (MNI = 1056)
10	Honorine site 5 (MNI = 3671)	32	Le Moulin des Courtes (MNI = 675)
6-b	ZAC de la Maslière (MNI = 404)	33-a	La Vaurie (CAM/EBA)(MNI = 686)
11	Le Clos de l'Épinette (MNI = 1300)	33-b	La Vaurie (MNI = 728)
5-b	ZAC Object'Ifs Sud (MNI = 1520)	34	18 passe de l'Écuissière (MNI = 277)
13	La Vignerie (MNI= 148)	33-c	La Vaurie (MNI = 125)
14	Beg ar Loued (MNI = 12154)	36-a	ZAC des Ormeaux (MNI= 123)
15	Tariec vraz (MNI = 91)	36-b	ZAC des Ormeaux (MNI = 128)
16	Kemenez 22 bis (MNI = 9818)	37-a	Rue Saint Nicolas (180-120 BC) (MNI = 3907)
17	Mez-Notariou (MNI = 32763)	36-c	ZAC des Ormeaux (MNI = 1961)
18	Balanec (MNI = 1428)	37-b	Rue Saint Nicolas (120-60 BC) (MNI = 7957)
19	Litri 1 (MNI = 346)	38	25 cours Genêt (100-60/30 BC) (MNI = 238)
20-a	Dossen Rouz (MLT 1)(MNI= 307)	39-a	Mortantambe (D2a)(MNI = 528)
20-b	Dossen Rouz (MLT 2)(MNI= 5057)	37-c	Rue Saint Nicolas (60-30 BC) (MNI = 1176)
21	Triélen (MNI = 428)	39-b	Mortantambe (D2b)(MNI = 195)
22	AC3 de l'Anse de l'Aber braz (MNI = 1845)	40	Les Grands Champs (MNI = 276)
23	Roc'h Santec (MNI = 265)		

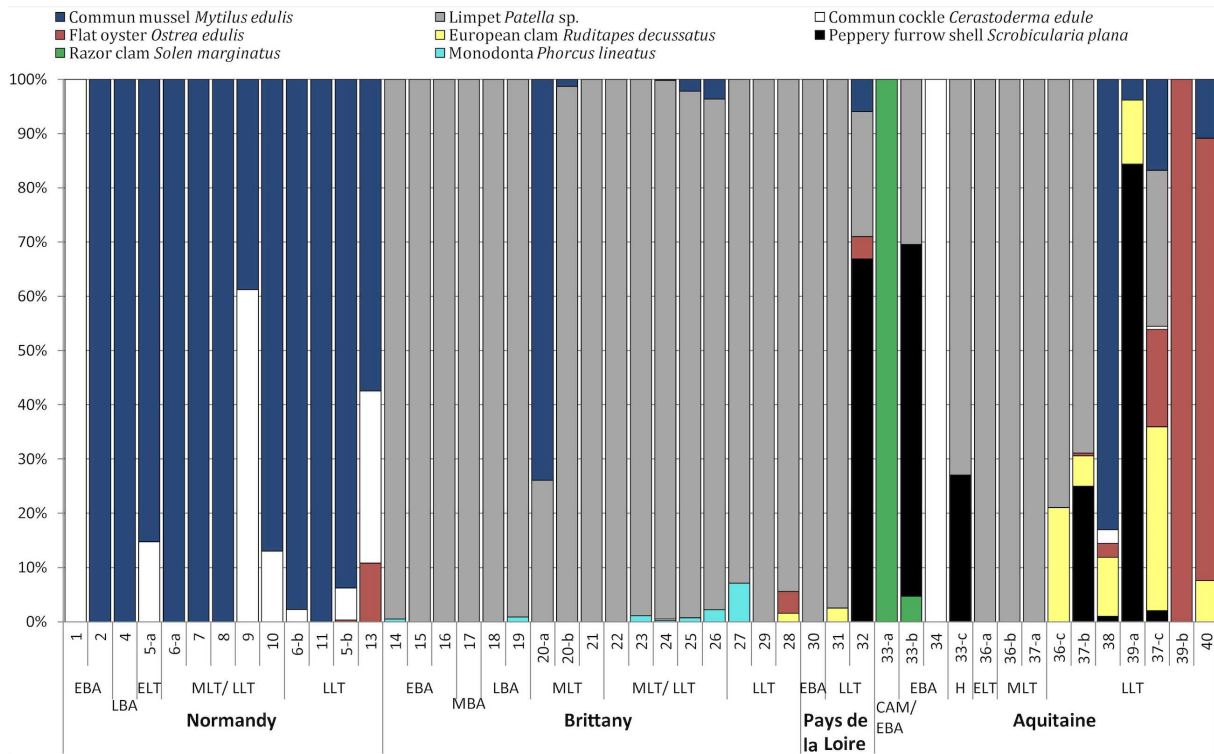


Figure 6: Distribution of marine invertebrates consumed during Late Prehistory on the French Channel/Atlantic seaboard (for the units of the corpus with at least 50 individuals; MNI = Minimum Number of Individuals)

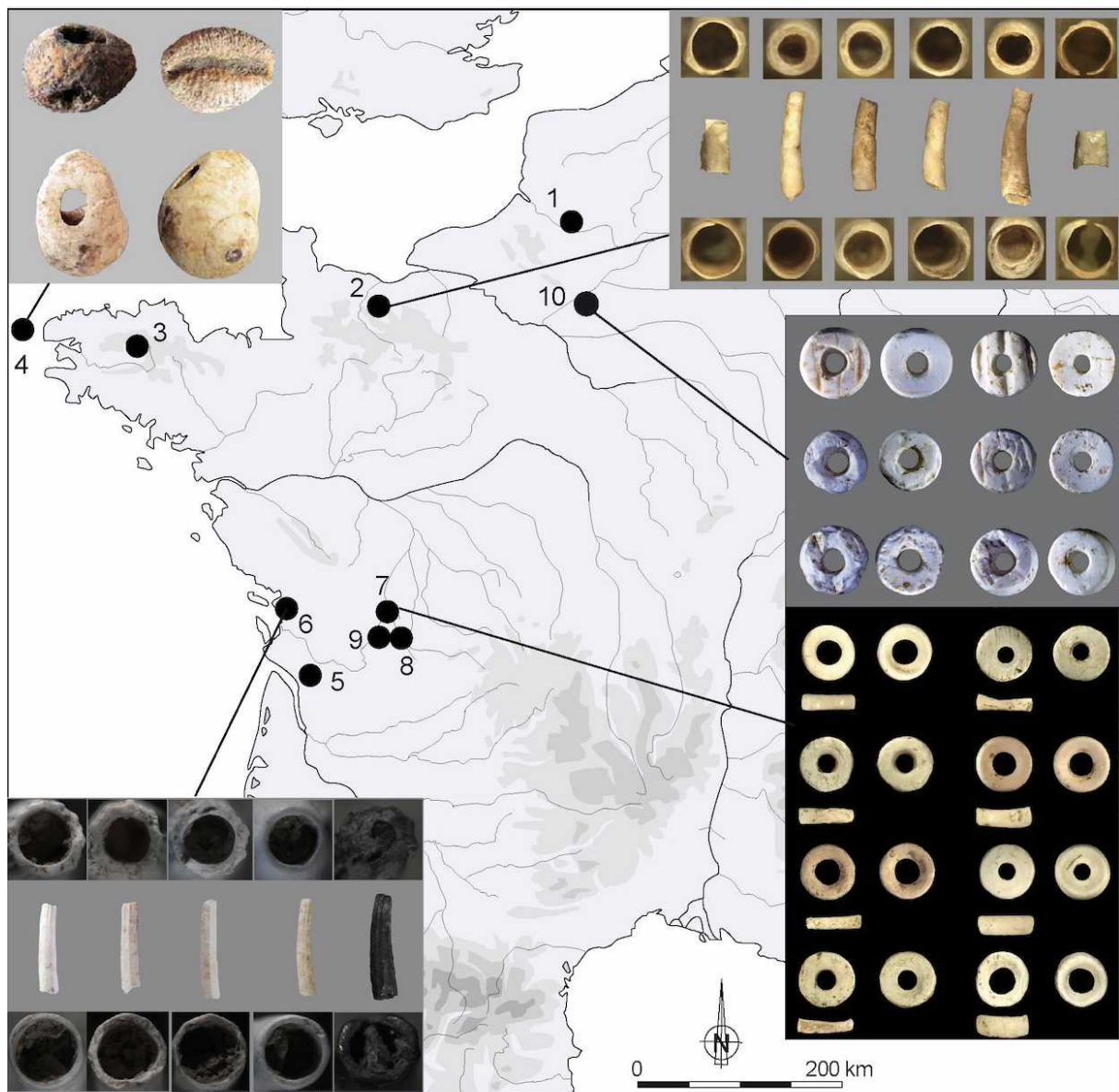
(C = Campaniforme ; EBA = Early Bronze Age ; MBA = Middle Bronze Age ; LBA = Late Bronze Age ; H = Hallstatt ; ELT = Early La Tène period ; MLT = Middle La Tène period ; LLT = Late La Tène periode)

1	ZAC Terres d’Avenir (MNI = 136)	24	Roc’h Louet (MNI = 421)
2	Les Vallons du Luc (MNI = 55)	25	Sterflant (MNI = 6095)
4	Clos du Châtaigniers (MNI = 1490)	26	Port-Blanc (MNI = 93314)
5-a	ZAC Object’Ifs Sud (MNI = 217)	27	Les Moutons (MNI = 352)
6-a	ZAC de la Maslière (MNI = 241)	28	Le Boisanne (MNI = 198)
7	Le Bougon (MNI = 2596)	29	Le Yaudet (MNI = 53)
8	Aire des Gens du Voyage (MNI = 2937)	30	Les Batardières 2 (MNI = 98)
9	Honorine site 3 (MNI = 2904)	31	ZA du Pladreau (MNI = 1056)
10	Honorine site 5 (MNI = 3671)	32	Le Moulin des Courtes (MNI = 675)
6-b	ZAC de la Maslière (MNI = 404)	33-a	La Vaurie (CAM/EBA)(MNI = 686)
11	Le Clos de l’Epinette (MNI = 1300)	33-b	La Vaurie (MNI = 728)
5-b	ZAC Object’Ifs Sud (MNI = 1520)	34	18 passe de l’Ecuissière (MNI = 277)
13	La Vignerie (MNI= 148)	33-c	La Vaurie (MNI = 125)
14	Beg ar Loued (MNI = 12154)	36-a	ZAC des Ormeaux (MNI= 123)
15	Tariec vraz (MNI = 91)	36-b	ZAC des Ormeaux (MNI = 128)
16	Kemenez 22 bis (MNI = 9818)	37-a	Rue Saint Nicolas (180-120 BC) (MNI = 3907)
17	Mez-Notariou (MNI = 32763)	36-c	ZAC des Ormeaux (MNI = 1961)
18	Balanec (MNI = 1428)	37-b	Rue Saint Nicolas (120-60 BC) (MNI = 7957)

19	Litri 1 (MNI = 346)	38	25 cours Genêt (100-60/30 BC) (MNI = 238)
20-a	Dossen Rouz (MLT 1)(MNI= 307)	39-a	Mortantambe (D2a)(MNI = 528)
20-b	Dossen Rouz (MLT 2)(MNI= 5057)	37-c	Rue Saint Nicolas (60-30 BC) (MNI = 1176)
21	Triélen (MNI = 428)	39-b	Mortantambe (D2b)(MNI = 195)
22	AC3 de l'Anse de l'Aber braz (MNI = 1845)	40	Les Grands Champs (MNI = 276)
23	Roc'h Santec (MNI = 265)		



Figure 7: Gastropod species used for their dyeing properties (photo C. Mougne)
 1: the dogwhelk *Nucella lapillus* (length = 32 mm); 2: the European sting winkle *Ocenebra erinaceus* (length = 39 mm).



- 1 : Chaussée-Tirancourt
- 2 : Zac du Clos Neuf (Démouville)
- 3 : Reuniou 1 Nord (Berrien)
- 4 : Mez Notariou (Ouessant)
- 5 : Le Palut (Saint-Léger)

- 6 : La Vaurie (Périgny)
- 7 : Le Mas de Champ Redon (Luxé)
- 8 : Les Renardières (Les Pins)
- 9 : Perrats (Agris)
- 10 : Le Villeneuve-le-Chatelôt

Figure 8: Distribution map of sites dating to Late Prehistory with personal ornaments in marine shell tests linked to the French Channel/Atlantic coast (photo and CAD C. Mougne, C. Dupont).



Figure 9: Fill between walls almost exclusively made up of limpets at the site of Beg ar Loued on the island of Molène (Finistère) dated to the Early Bronze Age (from Dupont 2012:)

fig.1).

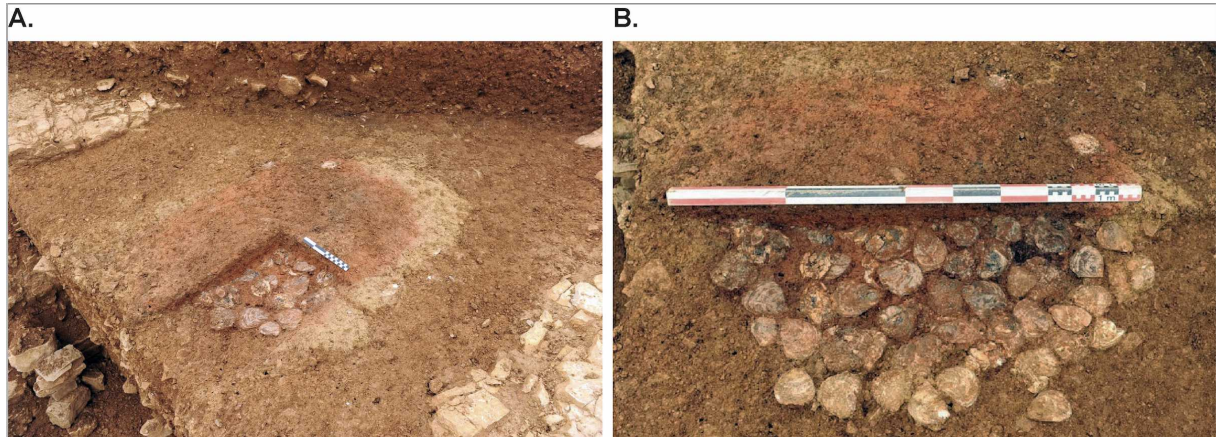


Figure 10: A. General view, B. details of oyster shells used for an oven floor in enclosure B, structure 280 dated La Tène D2b (60-30 BC), St Nicolas Street in Andilly, Charente-Maritime (photo. S. Vacher, Inrap) (from Vacher, 2015: fig.337).



Figure 11: A fragment of oven wall with traces of limpet shells in the Middle Bronze levels of the Mez-Notariou site on the island of Ouessant in Brittany (from Le Bihan 2011: 33).



Figure 12: Concentrations of mussel remains and other marine shellfish at two Iron Age sites on the Caen Plain

A - In a ditch, located on the "Clos de l'EpINETTE" site, dating from the Late Iron Age (table 1 n°11) (photo I. Jahier);

B - In a pit at the "Aire des Gens du Voyage" site, dating from the Middle / Late La Tène period (table 1 n° 8) (photo D. Thiron).

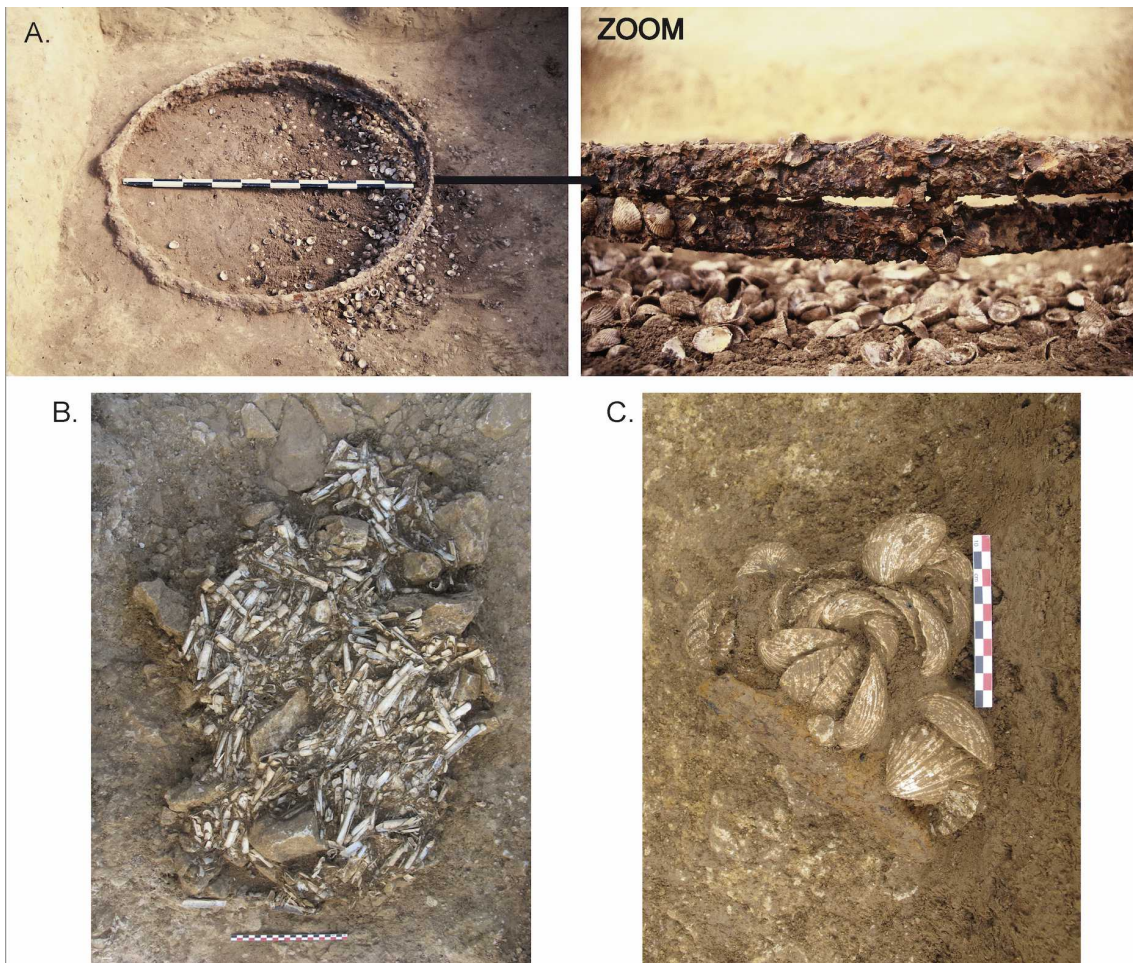


Figure 13: Funerary or ritual deposits on the French Channel/Atlantic seaboard

A - Tomb with chariot elements associated with a deposit of cockles located on the site of Etoile III (Mondeville, Calvados) dated to the Late La Tène (photo C.- C. Besnard Vauterin).

B - Deposit of razor clams *Solen marginatus* in a circular structure attributed to probable ritual functions (photo A. Baudry).

C - Marine shell deposit with a ploughshare at the site of Main Delle at Bourguébus dated to the Late La Tène (photo A. Lefort).

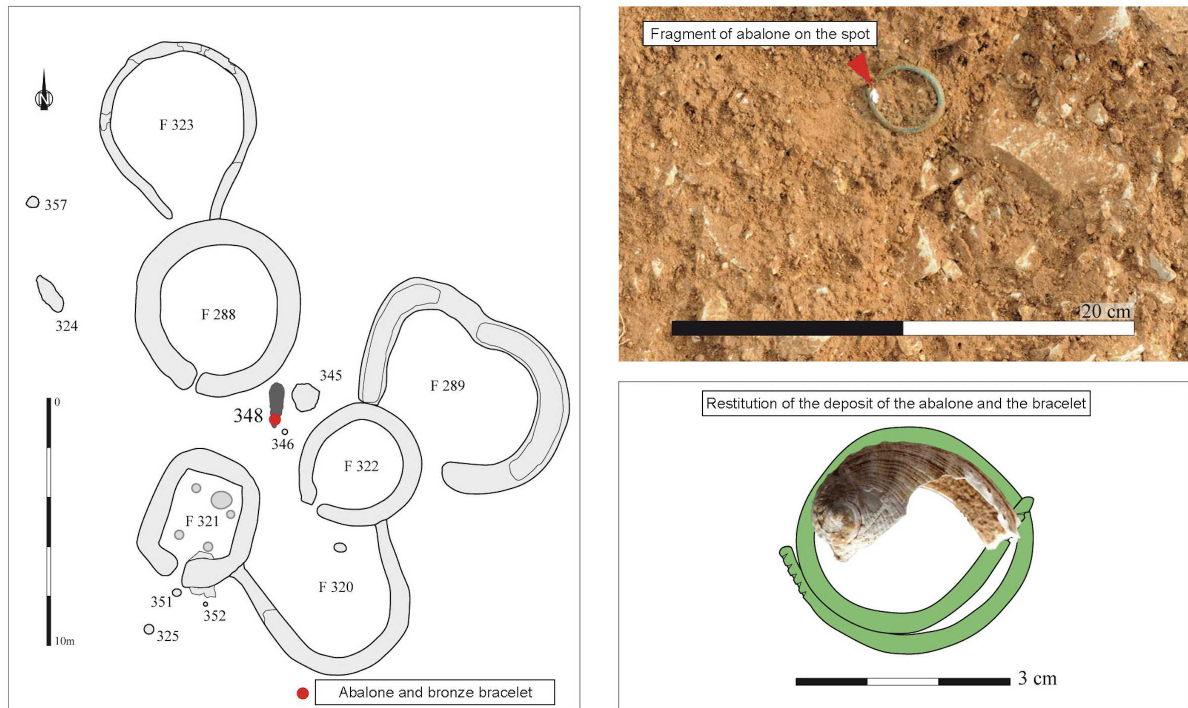


Figure 14: Abalone shell with a bronze ornament in pit 348, St Nicolas Street in Andilly, Charente-Maritime (photo and DAO S. Vacher et C. Mougne) (Vacher, 2015: fig.305).

Légendes des figures

Tableau 1 : Tableau des sites composant le corpus d'étude (pour la localisation se référer à la figure 1)

(M : Continent ; I : Île ; EBA = âge du Bronze ancien (2300/2200 à 1550 av. J.-C.) ; MBA = âge du Bronze moyen (1550 à 1300 av. J.-C.) ; LBA = âge du Bronze final (1350/1300 à 800 av. J.-C.) ; H = Hallstatt (800 à 450 av. J.-C.) ; ELT = La Tène ancienne (450 à 250 av. J.-C.) ; MLT = La Tène moyenne (250 à 150 av. J.-C.) ; LLT = La Tène finale (150 à 25 av. J.-C.) ; AA = période augustéenne (25 av. J.-C. à 15 ap. J.-C.))

Tableau 2 : Liste des espèces d'invertébrés marins identifiées sur les 41 sites protohistoriques (Worms, 5 décembre 2022)

Figure 1 : Carte des sites constituant le corpus d'étude (pour les numéros, se référer au tableau 1) (DAO C. Mougne et L. Quesnel).

Figure 2 : Reconstitution des tailles des invertébrés marins à partir des fragments (Photo et DAO C. Mougne).

a : Mesures des coquilles de moules communes *Mytilus edulis*

b : Mesures des tests de l'oursin violet *Paracentrotus lividus*

c : Mesures du crabe *Xantho Xantho* sp.

Figure 3 : Espèces d'invertébrés marins consommées durant la période protohistorique sur la façade Manche/Atlantique française (photo C. Mougne)

Figure 4 : Traces d'ouverture et de chauffage sur des coquillages marins (photo C. Mougne)

1 : l'huître plate européenne *Ostrea edulis* (longueur = 85 mm) avec une trace d'ouverture, découverte sur le site de Coulon.

2 : la patelle *Patella* sp. (longueur = 36 mm) avec une trace d'échauffement, découverte sur le site de Molène.

3 : la palourde européenne *Ruditapes decussatus* (longueur = 42 mm) avec une trace d'ouverture, découverte sur le site de Coulon.

Figure 5 : Distribution des substrats d'origine des invertébrés marins pour les corpus comportant au moins 50 individus (NMI = Nombre Minimum d'Individus).

Figure 6 : Distribution des invertébrés marins consommés au cours de la période protohistorique sur la façade Manche/Atlantique française (pour les unités du corpus comportant au moins 50 individus ; MNI = Minimum Number of Individuals).

(C = Campaniforme ; EBA = âge du Bronze ancien ; MBA = âge du Bronze moyen ; LBA = âge du Bronze final ; H = Hallstatt ; ELT = La Tène ancienne ; MLT = La Tène moyenne ; LLT = La Tène finale)

Figure 7 : Espèces de gastéropodes utilisées pour leurs propriétés tinctoriales (photo C. Mougne)

1 : le pourpre *Nucella lapillus* (longueur = 32 mm) ; 2 : le murex *Ocenebra erinaceus* (longueur = 39 mm).

Figure 8 : Carte de répartition des sites protohistoriques sur la façade Manche/Atlantique française possédant de la parure en coquille marin (Photo et DAO C. Mougne et C. Dupont).

Figure 9 : Remblai entre les murs presque exclusivement constitué de patelles sur le site de Beg ar Loued sur l'île de Molène (Finistère) daté du début de l'âge du bronze (Dupont, 2012 : fig.1).

Figure 10 : Vue générale, b. détails de coquilles d'huîtres utilisées pour un radier de four dans la structure 280, enclos B, daté de La Tène D2b (60-30 av. J.-C.) sur le site Rue Saint-Nicolas à Andilly (Charente-Maritime) (photo. S. Vacher, Inrap) (Vacher, 2015 : fig.337).

Figure 11 : Un fragment de paroi de four avec des empreintes de coquilles de patelles dans les niveaux de l'âge du Bronze moyen sur le site de Mez-Notariou sur l'île d'Ouessant (Bretagne) (Le Bihan 2011 : 33).

Figure 12 : Concentrations de restes de moules et autres coquillages marins sur deux sites de l'âge du Fer en Plaine de Caen

A - Dans un fossé, localisée sur le site du "Clos de l'Épinette" date de La Tène finale

(tableau 1 n°11) (photo I. Jahier);

B - Dans une fosse localisée sur le site de l'«Aire des Gens du Voyage» datée de La Tène Moyenne/ finale (tableau 1 n°8) (photo D. Thiron)

Figure 13 : Contextes funéraires et rituels protohistoriques sur la façade Manche/Atlantique française.

A - Tombe à éléments de chars associés à un dépôt de coques située sur le site de l'Etoile III (Mondeville, Calvados) datée de La Tène finale (photo C.- C. Besnard Vauterin).

B - Dépôt de couteaux *Solen marginatus* dans une structure circulaire attribuée à de probables fonctions rituelles (photo A. Baudry).

C - Dépôt de coquilles marines associé à un soc d'araire sur le site de la Main Delle à Bourguébus (Normandie) daté de La Tène finale (photo A. Lefort).

Figure 14 : Coquille d'ormeau associée à une parure en bronze dans la fosse 348, rue St Nicolas à Andilly, Charente-Maritime (photo et DAO S. Vacher et C. Mougne) (Vacher, 2015 : fig.305).