Shellfish from the Bronze Age Site of Clos des Châtaigniers (Mathieu, Normandy, France)

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Summary

This article provides initial results on the use of shellfish by the inhabitants of Clos des Châtaigniers, Normandy (France) during the Late Bronze Age. The settlement is located at Mathieu, 10km from the coast. The French National Institute of Preventive Archaeological Research (INRAP) conducted excavations on this site in 2010, under the direction of David Giazzon. A semi-circular domestic enclosure from the end of the Late Bronze Age was discovered. The diet of the inhabitants of Mathieu was partly based on mussels, which were found in large quantities. These shells were collected at low tide on a rocky to muddy/rocky shore. They were then transported inland to be eaten fresh or processed. Other marine invertebrates were also present on this site. Some of them were collected with the mussels. In fact, they were mixed with or fixed to this bivalve. Many other small fragments of shells are present on the site and could have come from the stomach contents of fish.

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1. Introduction

This article presents the archaeomalacological study of the site of Clos des Châtaigniers, at Mathieu (Normandy, France). The interest of such a study is that it is one of the first on the Channel coast dated to the Bronze Age. In fact, for this period, there are few studies on the exploitation of shellfish by the coastal populations in France (Weydert 1994; Dupont 2008; 2011; 2013; Mougne in prep), and especially on the Channel coast (Mougne and Dupont 2012; Mougne and Dupont in press). The same applies to other European countries, where some studies have been undertaken (for example: McCormick *et al*. 1996; Prummel 2002; Minniti 2005; Theodoropoulou 2007; 2008; Çakirlar 2009; Marlasca Martín 2010; Law 2012).

Five objectives guide this study. The first is to characterise the marine invertebrates discovered on the site, then to establish whether their gathering was intentional (e.g. for human consumption) or accidental, in order to generate some data on the diet of the inhabitants. These data make it possible to define the environments exploited and the gathering methods used. The third objective tries to identify some culinary practices linked to the preparation and cooking of marine shells. Then, it seems interesting to carry out a spatial distribution of the shells within the settlement, in order to obtain information on the management of marine waste and on the possible presence of some preparation or consumption areas. The final objective aims at analysing a particular set of small fragments of shellfish, which could have originated from the stomach contents of aquatic animals.

2. Description of the Site

The Clos des Châtaigniers was excavated in 2010 by the French National Institute of Preventive Archaeological Research (INRAP), under the direction of David Giazzon (Giazzon 2013). This domestic settlement is located approximately 10km from the seashore, close to the River Dan, a tributary of the Orne. The archaeologists discovered a vast semi-circular structure, both pottery and radiocarbon dating assigning it to the Late

Bronze Age (Cal BC 1190-980, Cal BC 1000-840, Cal BC 1050-900, Cal BC 1020-900 and Cal BC 970-820). This enclosure consists of two joined ditches, with a V-shaped profile, reaching 1.6m to 2m in depth. This structure is open on its northern side and is associated with numerous structures, mostly post-holes, but also some pits and a large combustion structure. The archaeological material is not very abundant. A small amount of slag and some fragments of crucible seem to indicate an activity linked with metallurgy. This hypothesis is reinforced by the discovery of ceramic moulds in the ditch of the enclosure and also in some pits. Even fragmented, these remains indicate the making of swords, spearheads, chapes and possibly axes. Eight shell accumulations have been identified in the ditch of the enclosure (Figure 1).

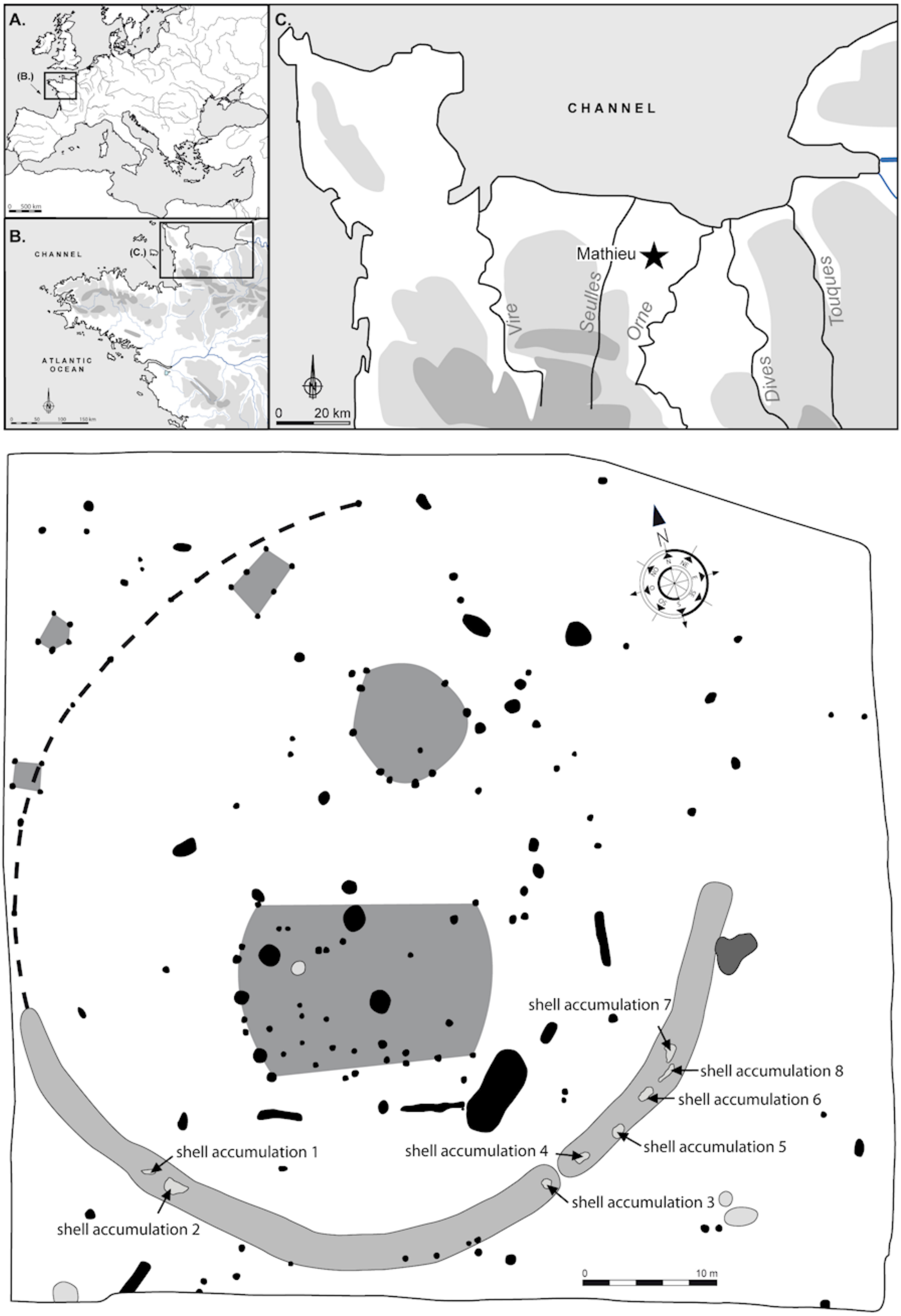

Figure 1: Location and map of the archaeological site of Clos des Châtaigniers at Mathieu. (Image credit: D. Giazzon, L. Quesnel, C. Mougne)

3. Methods

All the information and results presented here have been obtained from sedimentary samples (45 litres in total) collected during the excavation. Sieved with fine meshes (4 and 2 mm), these samples were sorted and studied at the Archaeosciences Laboratory of the University of Rennes. The identification of marine invertebrates (gastropods, bivalves and sea urchins) was carried out using the comparative collection from the same laboratory (comparative collection Gruet and Dupont, UMR 6566-CReAAH), and was confirmed using several reference works on marine biology (Tebble 1966; Poppe and Goto 1991; 1993; Hayward and Ryland1995; Quéro and Vayne 1998; Audibert and Delemarre 2009). The scientific names used for the identified marine molluscs correspond to the international standards of the CLEMAM (2013). Several counting methods were used to calculate the relative proportions of each species. The NISP (Number of Identified Specimens) corresponds to all the identified remains greater than 2mm. The MNI (Minimum Number of Individuals) was also used. For bivalves, an MNI was obtained after assigning valves to the left or right according to the position of the teeth, the ligament and the pallial sinus line (Dupont 2006a; McCarthy *et al*. 1999). For spiral gastropods, the MNI is linked to the presence of the peristome (Dupont 2006a). Finally, the remains of each species were weighed (in grams).

The shells were then measured using a digital calliper graduated in millimetres (mm) (0.01) in accordance with the procedures described by Dupont (2006a). Some specific biometrical studies were also performed on the common mussel (*Mytilus edulis*). Shells found at the site are highly fragmented and consequently the whole length is not measurable. In fact, their fragile nature meant that the shells were found crushed as a result of the mechanical pressure exerted by the overlying sediments. Some authors highlight the fact that a good correlation exists between the height and the length of the shell (Buchanan 1985; Dupont 2006a, 86-87; Campbell 2013) and that it is therefore possible to reconstruct a mussel original size from measurements of shell height. However, mussels discovered at the Clos des Châtaigniers were so fragmented that shell height could not be measured. Therefore, a different method was employed, relying on a correlation established between original mussel size and a small part near the teeth (corresponding to the not pearly part, located just after the anterior adductor muscle scar; see Figure 4) (Mougne in prep). Through taphonomic analysis, modifications due to physical and chemical factors on the archaeomalacological material were identified (Claassen 1998; Dupont 2006a; Gutiérrez Zugasti 2008). The associated faunas in the thickness of the shell and in or on the shells were also observed and recorded (Hayward and Ryland 1995).

4. Results and Discussion

4.1. Faunal spectrum

Thirty species of marine shells (20 bivalves, 10 gastropods), one sea urchin and one crustacean were identified (Figure 2) at the site of Clos des Châtaigniers. Mussels (*Mytilus edulis*) represent the majority of marine shell remains in all three types of quantification used (98% of the NISP, 75% of the MNI and 94% of total weight) (Figure 3).

Figure 2. Identified Marine invertebrates at Clos des Châtaigniers (Image credit: C. Mougne)
1: *Mytilus edulis* (L = 35 mm), 2: *Acanthocardia tuberculata* (L = 51 mm), 3: *Cerastoderma edule* (L = 27 mm), 4: *Solen marginatus* (L = 16 mm), 5: *Scrobicularia plana* (L = 16 mm), 6: *Ruditapes decussatus* (L = 4 mm), 7: *Barnea candida* (L = 13 mm), 8: *Macoma balthica* (L = 18 mm), 9: *Donax vittatus* (L = 18 mm), 10: *Mactra* sp. (L = 18 mm), 11: *Spisula solida* (L = 33 mm), 12: *Spisula subtruncata* (L = 14 mm), 13: *Ostrea edulis* (L = 25 mm), 14: *Aequipecten opercularis* (L = 8 mm), 15: *Mimaclamys varia* (L = 10 mm), 16: *Corbula gibba* (L = 9 mm), 17: *Phaxas pellucidus* (L = 9 mm), 18: *Anomia ephippium* (L = 15 mm), 19: *Abra* sp. (L = 4 mm), 20:*Gari* sp. (L = 6 mm), 21: *Gibbula umbilicalis* (L = 13 mm), 22: *Littorina littorea* (L = 22 mm), 23: *Buccinum undatum* (L = 32 mm), 24:*Nucella lapillus* (L = 22 mm), 25: *Nassarius reticulatus* (L = 22 mm), 26: *Ocenebra erinaceus* (L = 34 mm), 27: *Bela powisiana* (L = 10 mm), 28: *Epitonium clathrus* (L = 10 mm), 29: *Lacuna pallidula* (L = 7 mm), 30: *Littorina obtusata* (L = 7 mm), 31: Test of urchin (L = 6 mm) 32: *Balanus* sp. (L = 11 mm).


Probably consumed species at Clos des Châtaigniers
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Probably unconsumed species at Clos des Châtaigniers
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The high percentage of NISP for this species is linked to high levels of fragmentation. As a consequence, the relation between the Number of Identified Specimens and the Minimum Number of Individuals (221752/1490) shows that, for a single mussel individual, 149 remains were counted. It is thus often difficult to obtain total lengths and to describe the collecting strategies. From these correlations between total length and a small part near the teeth, 214 total lengths (RV = 105; LV = 109) have been reconstructed. These measurements ranged between 27 and 65mm, with a mean of 43.5mm, corresponding to adult individuals (Figure 4).

Figure 3: Spectrum of the marine invertebrates at Clos des Châtaigniers

Latin name	Common name	NISP	MNI	Weight (g)
Bivalves				
Mytilus edulis	common mussel	221752	1490	6188.24
Ostrea edulis	flat oyster	33	4	5.81
Anomia ephippium	saddle oyster	1	1	0.18
Aequipecten opercularis	queen scallop	1	1	0.01
Mimachlamys varia	fan scallop	3	1	0.08
Solen marginatus	grooved razor shell	10	4	1.96
Phaxas pellucidus		7	5	0.04
Acanthocardia tuberculata		2	2	19.19
Acanthocardia sp.		115	3	16.48

Cerastoderma edule	common cockle	107	16	12.65
Cerastoderma sp.	cockle	186	8	110.47
Barnea candida		669	36	11.8
Donax vittatus	beam clam	1	1	0.36
Donax sp.	beam clam	275	25	4.64
Gari sp.		10	3	0.11
Macoma balthica		86	33	5.05
Mactra sp.		29	11	0.88
Spisula solida	Atlantic surf clam	1	1	2.21
Spisula subtruncata		1	1	0.03
*Spisul*a sp.		131	54	1.92
Scrobicularia plana	peppery furrow shell	149	4	4.09
Abra sp.		39	25	0.24
Corbula gibba		22	8	0.68
Ruditapes decussatus	European carpet clam	1	1	0.08
Cardiidae		22		0.71
Mactridae		891	7	5.83

Pectinidae		2		0.03
Semelidae		278		3.21
Tellinidae		188		1.8
Veneroida		549		4.51
Gastropods				
Littorina littorea	common periwinkle	336	123	123.78
Littorina obtusata	flat periwinkle	18	11	1.53
Littorina sp.		44	41	0.55
Lacuna pallidula	pale lacuna	1	1	0.12
Gibbula umbilicalis	flat top shell	16	13	6.54
Gibbula sp.	top shell	48	3	1.77
Buccinum undatum	common whelk	4	2	4.77
Nassarius reticulatus	netted dog whelk	27	5	5.21
Nassarius sp.		5	2	0.19
Nucella lapillus	dogwhelk	57	20	39.01
Ocenebra erinaceus	sting winkle	28	6	6.39
Bela powisiana		1	1	0.04

Epitonium clathrus	common wentletrap	1	1	0.1
Unspecified gastropods		19		1.12
Unspectified molluscs		15		0.22
Marine Molluscs total		**226181**	**1974**	**6594.63**
Balanus sp.	barnacle	35566	5927	187.39
Crustacean total		**35566**	**5927**	**187.39**
Unspecified urchin	urchin	2	1	0.03
Echinoderm total		**2**	**1**	**0.03**

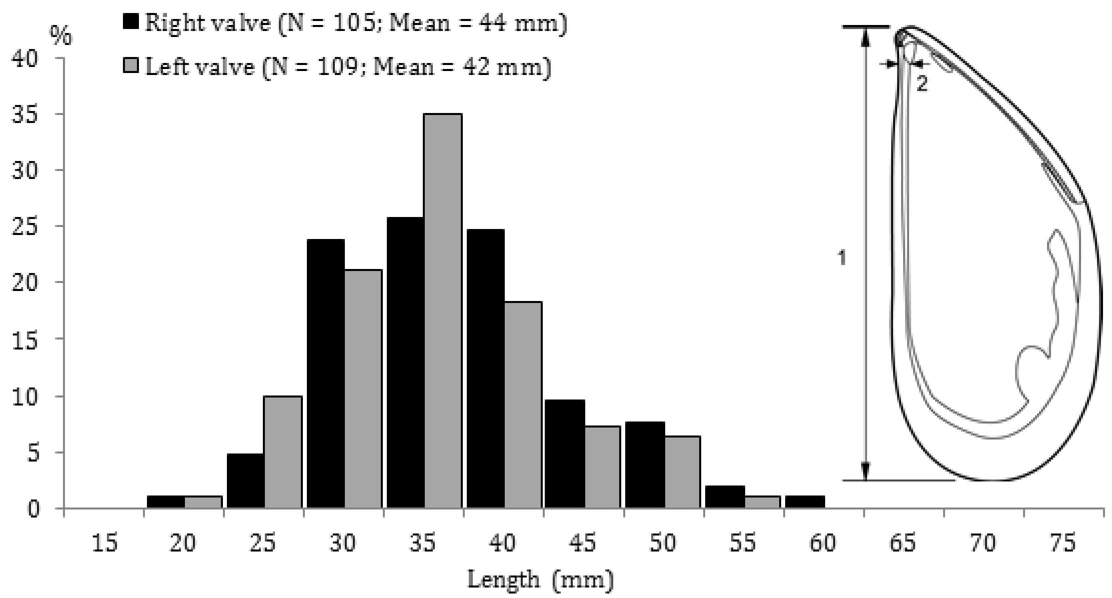

Figure 4: Distribution of reconstructed length (1) classes (mm) of *Mytilus edulis*, from a small part near the teeth (2). (N = number of valves) (Image credit (mussel): L. Quesnel)

Seven other identified marine shells are edible and may have been part of the diet of the inhabitants of Clos des Châtaigniers: *Littorina littorea, Barnea candida, Macoma balthica, Donax* sp., *Abra* sp., *Spisula* sp. and *Cerastoderma* sp. (Figure 3). Nonetheless, the shells of these bivalves measured less than 20mm, a size typically rejected as being too small for human consumption. Thus the presence of these six species does not appear to be linked to human diet. The dogwhelk (*Nucella lapillus*) is represented by 20 medium-sized individuals (between 20 and 40mm). Half of them, however, show marks of marine worms of *Polydora*-type in their internal shell. These taphonomic modifications show that specimens of dogwhelk arrived dead and empty, without flesh, to the site. Twenty-one other species (*Anomia ephippium, Ostrea edulis, Solen marginatus, Acanthocardia tuberculata, Scrobicularia plana, Spisula solida, Buccinum undatum, Aequipecten opercularis, Mimachlamys varia, Ruditapes decussatus, Gari* sp., *Phaxas pellucidus, Lacuna pallidula, Littorina obtusata, Bela powisiana, Nassarius reticulatus, Epitonium clathrus, Corbula gibba, Ocenebra erinaceus, Mactra* sp. and *Gibbula* sp.) are represented by only 1 to 13 individuals (Figure 3). The small quantities of these marine invertebrates are unlikely to indicate intentional collecting for human consumption. In addition, some of these species are small in size and evidence shows that deposited specimens were already dead when they arrived at the site. Only one fragment of sea urchin, species unidentified, was found (Figure 2, 31). Finally, some barnacles, belonging to the order of Cirripedia crustaceans, were observed (Figure 2, 32) and probably brought to the site during the transport of the mussels.

In summary, the size and quantity of mussel remains show that this shellfish was consumed by past inhabitants. However, the consumption of the other thirty-one identified marine invertebrates cannot be proved because of their presence in small quantities (Figure 3), small sizes and/or observed taphonomic modifications.

4.2. Gathering area

The site of Clos des Châtaigniers is located 10km from the Channel coast. The gathering strategies reflected the values attributed to each species (e.g. flavour), and other environmental parameters such as accessibility and abundance at the seashore. The inhabitants seem to have exploited mainly rocky to muddy/rocky shores (84% of the MNI of marine shells) (Figure 5). This is evidenced by the numerical dominance of the mussel, the most frequently consumed shellfish on the site, which lives in the intertidal zone, down to 10m in depth along the coast. Mussel gathering is quite straightforward since these are readily visible and can be collected by hand or with a tool to cut the byssus, in clusters or individually. Mussels can be consumed all year round but are fleshier during the reproductive period, between March and October (Poppe and Goto 1993). Those mussels living in sandy to muddy/sandy shore substrates were more rarely exploited (11% of the MNI) (Figure 5). It is interesting to note that the spectrum of species coming only from sandy to muddy/sandy environment mostly consists of small individuals, with a shell size smaller than 20mm (*Donax* sp., *Spisula* sp., *Abra* sp., *Macoma balthica*).

Figure 5: Tide range and substrates of the marine species (shaded cell = potential presence; + = present; (+) = more rarely present; after Dupont 2006a).

Species	Substrate	Tidal range			
		Intertidal			Eulittoral
		High tide level	Middle tide level	Low tide level	
Littorina obtusata	rocky		+		
Nucella lapillus	rocky		+	+	
Gibbula umbilicalis	rocky		+	(+)	
Aequipecten opercularis	rocky			(+)	+
Barnea candida	rocky			+	+
Mimachlamys varia	rocky			+	+
Lacuna pallidula	rocky			+	+
Ocenebra erinaceus	rocky			+	+
Littorina littorea	rocky to muddy-rocky	+	+	+	(+)
Mytilus edulis	rocky to muddy-rocky		+	+	+
Ostrea edulis	rocky to muddy-rocky			+	+
Anomia ephippium	rocky to muddy-rocky			+	+
Donax sp.	sandy		+	+	+

Acanthocardia tuberculata				(+)	+
Spisula solida				+	+
Spisula sp.				+	+
Donax vittatus				+	+
Mactra sp.				+	+
Bela powisiana				+	+
Spisula subtruncata					+
Corbula gibba					+
Macoma balthica			(+)	+	+
Ruditapes decussatus			+	+	+
Nassarius reticulatus			+	+	+
Cerastoderma edule			+	+	+
Abra sp.	sandy to muddy-sandy		+	+	+
Gari sp.				+	+
Buccinum undatum				+	+
Solen marginatus				+	+
Phaxas pellucidus				(+)	+

Epitonium clathrus					+
Scrobicularia plana	muddy	(+)	+	+	(+)

4.3. From gathering to consumption

After being gathered, the shells were then transported to the site of Clos des Châtaigniers. Transport may have either been by boat, given that the River Orne was navigable during protohistory, or by land. The return trip would have taken at least a half-day. The large number of barnacles (5,927 specimens) and small shells found in shell deposits seem to indicate that the preparation of the shells was probably done on the site. The barnacles were probably attached to the mussels and transported with them. It is likely that some of the barnacles detached from the mussels during the preparation or preservation phases. Traces of burning are evident on some mussels, representing on average 87% of NISP of the mussels. These marks are perhaps related to cooking methods or secondary activities occurring after consumption. Archaeological studies of burnt shell remains are not numerous in the archaeological literature. For this reason, we undertook research on the methods of cooking mussels and their effects on the shell, as described in the ethnohistorical literature, in order to gain some information (Waselkov 1987). Mussels can be cooked by placing them in the heart of a fire, in a steam oven (Best 1924, 417; Greengo 1952, 77; Duguet 1995, 367; Kroeber and Barrett 1960, 113; Meehan 1977, 366; Waselkov 1987, 101-2), placing them on hot stones (Terrell 1967, 44; Oberg 1973, 67) or roasting them around fires (Waselkov 1987, 101). Other hypotheses could also explain the high rate of burned archaeological mussels. After the mussels had been eaten, the shells could have been thrown into a fire. The shells could also have been used eventually to maintain the fire, or even to put it out. This activity could reflect hygienic and/or marine waste management strategies. Nevertheless, it is difficult to select one of these possibilities given the lack of available bibliographical references. However, experimentation on shell material could make it possible to identify specific criteria for each type of cooking method, as has already been undertaken for bones (Costamagno *et al*. 2010; Lebon 2010; Zazzo 2010). The results obtained would provide some real answers regarding cooking methods and heat treatments and seems a promising area for future studies.

The collected shellfish were either eaten directly or processed for later consumption. There are several different ways to preserve mussel flesh: it can be dried in the sun (with or without the shell), smoked and stored in jars, in baskets or strung on suspension lines and later rehydrated and boiled (Gifford 1939, 315; Greengo 1952, 77-78; Stewart 1943, 60; Kroeber and Barrett 1960, 113; Oberg 1973, 67; Aschmann 1975, 46; Best 1924, 417; Waselkov 1987, 106-7).

Previous research demonstrated, through experimental archaeology, that it was possible to dry a very large number of mussels in a relatively short period of time, with minimum effort, and using simple technology (Henshilwood *et al*. 1994). The most effective experiments in terms of time/calories related to the cooking and drying of mussel flesh inside the shell. Once cooked and dried, the flesh can be easily removed from the shell in only two or three seconds, so that fewer people and less time are needed to process large quantities of mussels. This method also reduces the need for firewood, since the mussels are cooked within around seven minutes. This technique eliminates the need for drying frames or posts and suspended lines, and minimises labour input (Henshilwood *et al*. 1994).

Finally, the dehydrated shellfish were generally later plunged into fresh water, and then boiled (Gifford 1939, 315; Swanton 1946, 378; Greengo 1952, 77-78; Kroeber and Barrett 1960, 113). For example, some North American populations living close to the sea in temperate areas kept dried shellfish all year round, either for exchange or for their own consumption (Greengo 1952, 78-80; Oberg 1973, 67-75). Nevertheless, we lack the archaeological data (organic residues in pottery, artefacts linked with preservation such as baskets, etc.) to state definitely that such a preservation technique was used at the site of Clos des Châtaigniers.

4.4. Spatial distribution of archaeological remains

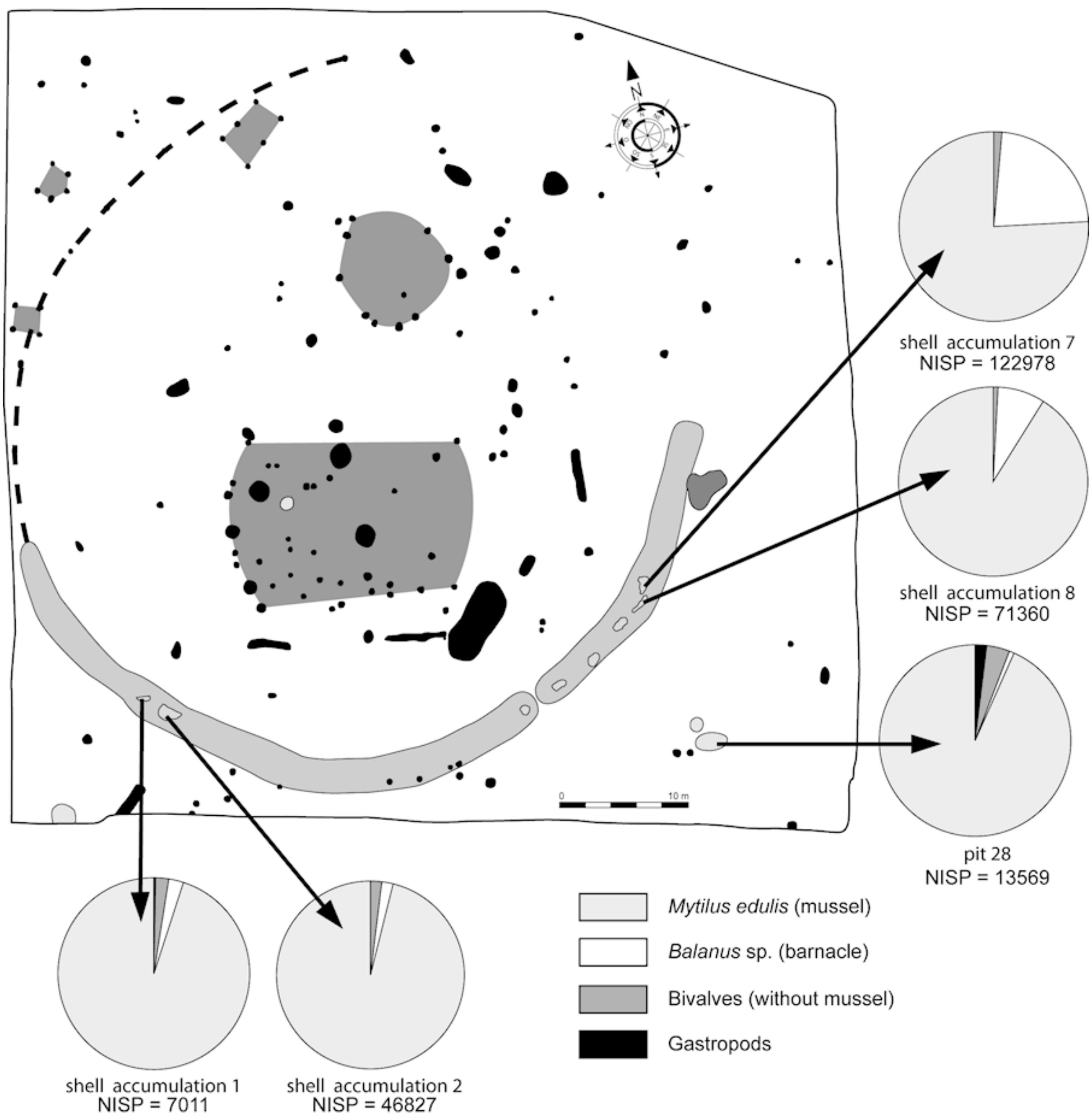

Figure 6: Spatial distribution of the marine invertebrates from the percentage of the NISP. (Image credit: D. Giazzon, L. Quesnel, C. Mougne)

The distribution of the shell accumulations seems to be confined to specific areas within the enclosure. Shells have only been found inside the ditch of this enclosure and in a single outside pit (F28) (Figure 1 and Figure 6). Four sedimentary samples have been extracted from inside this ditch (accumulations 1, 2, 7 and 8) and one in pit 28 (Figure 6). The quantification used for this distribution is the NISP expressed as a percentage. Inside the pit, accumulations and the percentage of mussel NISP are quite similar, demonstrating that this mussel was consumed in different parts of the site (Figure 6). The distribution of *Balanus* sp., however, shows an important difference. Barnacles represent between 1 and 2% of the NISP in pit 28 and in accumulations 1 and 2, as opposed to 8.5% in accumulation 8 and 23% in accumulation 7 (Figure 6). These barnacles, found in large quantities, might have become detached when the mussels were prepared or cooked, as previously mentioned. Considering the large quantities of barnacles, the preparation, cleaning and cooking of this shellfish could have taken place at the site, and perhaps in an area close to accumulations 7 and 8 (Figure 6).

Figure 7: Traces of burning on left valves of mussels (*Mytilus edulis*) in the shell accumulation no.7. (Image credit: C. Mougne)

Burnt shell remains represent 60% of the total NISP and 87% of mussel NISP (Figure 7). The distribution of these remains is, however, heterogeneous at the site. The percentage of burnt mussel remains is significantly higher in the ditch of the enclosure (between 35 and 88% of the NISP) than at pit 28 (1.5% of the NISP) (Figure 8). This seems to indicate either a spatial organisation of the burnt mussel remains or differential treatment of the shells during or after their cooking.

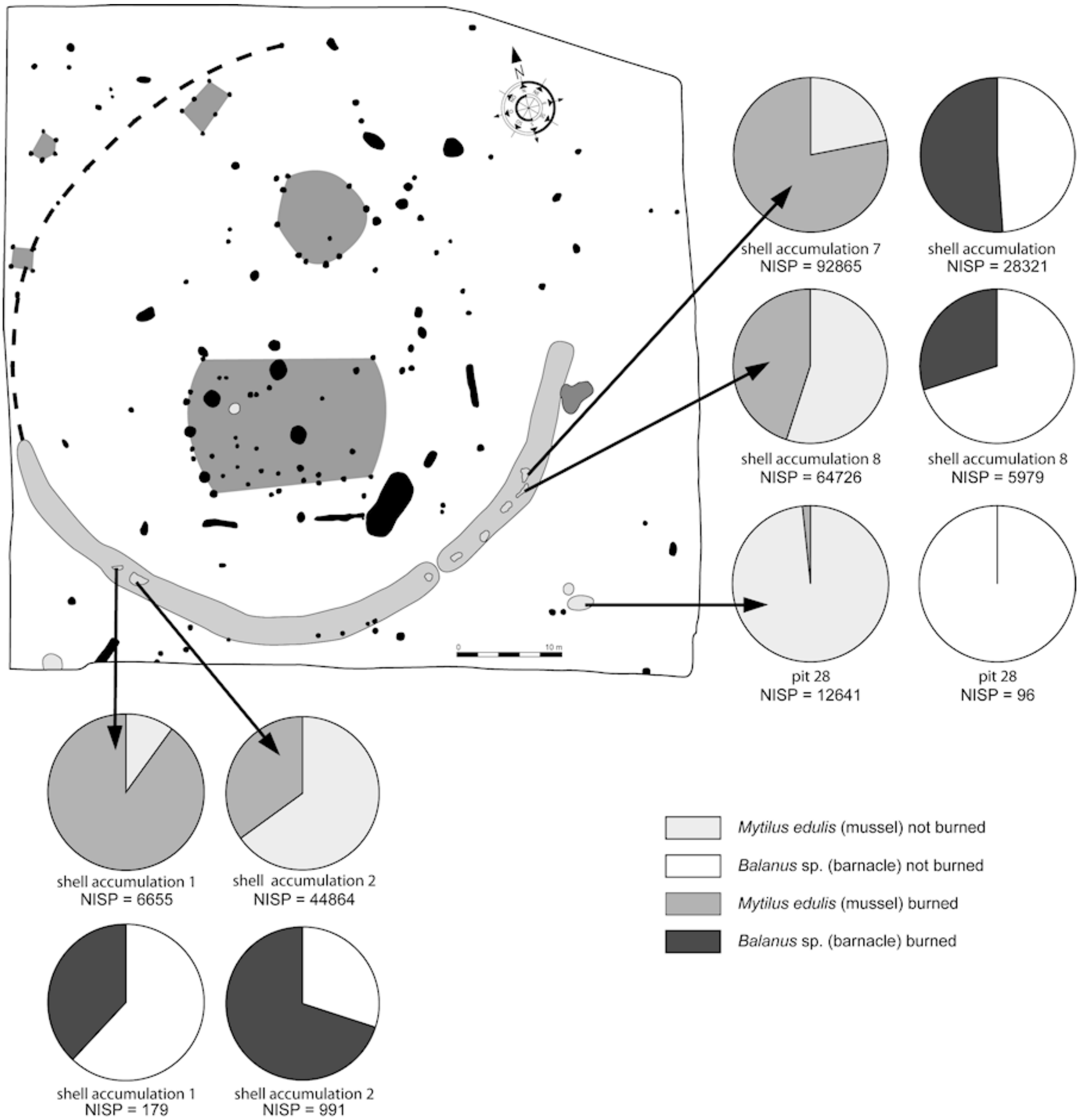

Figure 8: Spectrum of the burned or unburned remains of mussels and barnacles by shell accumulations in percentage of the NISP. (Image credit: D. Giazzon, L. Quesnel, C. Mougne)

4.5. The presence of marine shells as an indicator of the consumption of fish?

Numerous small marine shells (smaller than 11mm) have been found at the site. These remains are not burnt, unlike the great majority of mussels with which they were mixed in the ditch of the enclosure and in the pit (Figure 9). These shells do not seem to have been consumed by past humans (see section 4.1). In order to understand the origin of these shell fragments, they have been compared with other remains from modern mussel-beds. Bronze Age populations could have accidentally transported these small shell remains fixed to and mixed with collected mussels. Mussels originating from four modern-day coastal areas (Sangette, Nord-Pas-de-Calais; Saint-Honorine-des-Pertes, Basse-Normandie; Quiberon, Brittany and Lérat, Pays-de-La-Loire) located at the Channel and Atlantic coasts have been collected. These mussels were cleaned in a strainer and associated shell remains compared with archaeological remains. Fragment sizes in modern mussels vary (between 2 and 20mm) and these fragments show rounded outlines caused by marine erosion. By contrast, the sizes of archaeological remains identified at Clos des Châtaigniers are more uniform (between 5 and 10mm), and show angular and regular breaks.

Figure 9: Shell remains in accumulation no.7. (Image credit: C. Mougne)

Identified shell species (*Barnea candida, Donax* sp., *Macoma balthica, Spisula* sp. and *Abra* sp.) and those fragmented shells measuring between 5 and 10mm could correspond to residues from the stomach contents of fish. The fish would have been gutted and the entrails discarded by the inhabitants, together with any shellfish remains. Several fish species eaten by humans have a diet that includes shellfish, such as European eel (*Anguilla anguilla*), conger (*Conger conger*), plaice (*Glyptocephalus cynoglossus*), Ballan wrasse (*Labrus bergylta*), haddock (*Melanogrammus aeglefinus*), hake (*Merluccius merluccius*), sole (*Solea solea*), gilthead bream (*Sparus aurata*), turbot (*Psetta maxima*), pollack (*Pollachius pollachius*) or dogfish (*Scyliorhinus* sp.) (Figure 10) (Muus *et al*. 2005; Teletchea 2009). One should bear in mind that the presence of such remains could also result from the accumulation of dead aquatic birds or from faecal waste (Erlandson and Moss 2001; Van Leeuwen 2012). Thus, shell remains could also originate from animal stomach contents. It is important to note here that remains of three unidentified fish and one bird have been discovered at Clos des Châtaigniers.

Figure 10: Examples of fishes present in Normandy nowadays, consumed by men and who have a diet based partially on marine shells (+: consumption of marine shellfish; Muus *et al*. 2005; Teletchea 2009).

Latin name	Common name	Marine shell consumed
Anguilla anguilla	European eel	+
Conger conger	European conger	+
Cyclopterus lumpus	Lumpfish	+
Diplodus sargus	Sargo	+
Diplodus vulgaris		+
Gadus morhua	Atlantic cod	+
Glyptocephalus cynoglossus	Plaice	bivalves
Hypotremata sp.	Ray	mostly mussels
Labrus bergylta	Ballan wrasse	+
Limanda limanda	Common dab	gastropods and bivalves
Melanogrammus aeglefinus	Haddock	+
Merluccius merluccius	European hake	+
Microstomus kitt	Lemon sole	mussels
Molva molva	Common ling	+
Pagellus erythrinus	Common pandora	+

Pagrus pagrus	Red porgy	+
Pegusa lascaris	Sand sole	+
Platychthys flesus	European flounder	mussels
Pleuronectes platessa	European plaice	bivalves with thin shells
Pollachius pollachius	Pollack	+
Psetta maxima	Turbot	bivalves
Scyliorhinus canicula	Small-spotted catshark	+
Scyliorhinus stellaris	Nursehound	+
Scorpaena scrofa	Red scorpionfish	+
Solea solea	Common sole	bivalves with thin shells
Sparus aurata	Gilt-head bream	mostly bivalves
Trisopterus luscus	Pouting	small bivalves

Analysis of bivalves other than mussels allowed us to understand the distribution of these small shells within the settlement (Figure 11). Pit 28 is unique, with a strong presence of Semelidae (44% of the NISP) while Tellinacea is almost absent (3% of the NISP). The distribution of Tellinacea, Pholadidae, Mactridae and Cardiidae is uniform in the ditch of the enclosure. By contrast, Semelidae are totally absent from accumulation 1. This distribution could potentially correspond to the preparation of fish or birds that have different diets.

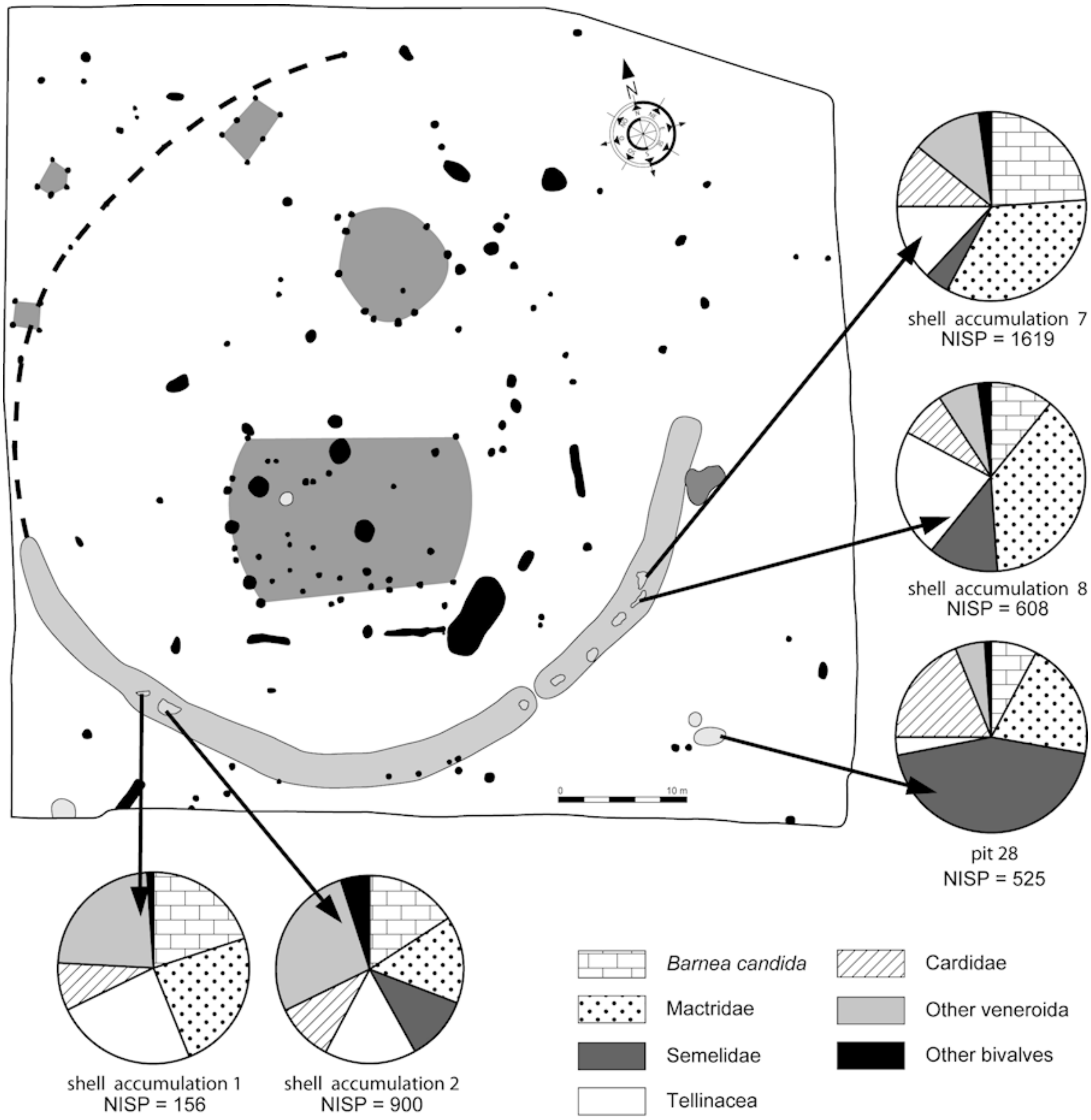

Figure 11. Spectrum of the bivalve remains (excepted the mussels) by shell accumulations. (Image credit: D. Giazzon, L. Quesnel, C. Mougne)

Figure 11: Spectrum of the bivalve remains (excepted the mussels) by shell accumulations			
Order	**Family**	**Genus**	**Species**
Veneroida	Pholadidae	*Barnea*	*candida*
	Mactridae	*Spisula*	sp.
		Mactra	sp.
	Semelidae	*Abra*	sp.
		Scrobicularia	*plana*
	Tellinacea	*Donax*	sp.
		Macoma	*balthica*
	Cardiidae	*Cerastoderma*	sp.
		Acanthocardia	sp.

Theodoropoulou (2007, 178) points out that, on some archaeological sites, small-sized marine shells could originate from stomach contents of mammals and aquatic birds or fish. However, she highlights the fact that it is very difficult to establish such an origin given the lack of reference studies. Van Neer and Pieters (1997) mentioned that, in a 15th-century coastal village in Belgium, remains of plaice (*Pleuronectes platessa*, 130 individuals) have been discovered in association with bean clam shells (*Donax vittatus*), interpreted as the stomach contents of these fish. Likewise, in waste areas of the medieval castle of Boves (Somme), all the identified marine shells (8 at species level and 9 at genus level) originate from the preparation of fish used in human diet (Dupont 2005).

In order to answer this type of interrogation more precisely, it would be interesting to propose some criteria for the identification of aquatic animals from their stomach contents, through the development of studies and bibliographical research on the diet of these faunas. The results could demonstrate the consumption of other aquatic animals, whose skeletal remains were not preserved, marine shells being the only indicators of their initial presence.

5. Conclusion

In conclusion, the archaeomalacological study shows that the shell remains discovered at Clos des Châtaigniers represent mainly food waste. Despite the size and the diversity of the samples, mussels seem to have been the only shellfish to have really played a role in the diet of local inhabitants during the Bronze Age. The choice of this shellfish can be explained as a result of easy access and abundance at the coastline of Normandy. Other marine invertebrates may have been brought to the site during the transport of mussels or represent the collection of empty shells. The study also reveals the consumption of other marine animals such as fish or birds, whose stomach contents contained small amounts of shells. The site is characterised by high numbers of mussels with medium to large sizes. Gathered in a rocky or muddy/rocky environment, they were then transported 10km inland. The absence of small-sized specimens of mussels might indicate prior selection during collection at the seashore. This sorting would reduce the number of mussels to be transported, thus less effort was required. The presence of numerous barnacles may signify that the mussels were washed and prepared at the site of Clos des Châtaigniers. The high ratio of burnt mussel remains at the site could be associated with a particular cooking method or the management of marine waste.

The presence of common mussels (*Mytilus edulis*) is frequent in protohistorical sites in Normandy (Dupont 2006b; Mougne and Dupont 2012; Mougne *et al*. 2013; Mougne in prep). Therefore, the consumption of mussels at the site of Clos des Châtaigniers is not an isolated phenomenon but corresponds to an activity practiced in Normandy during the Bronze and Iron Ages.

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Bibliography

Aschmann, H. 1975 'Culturally determined recognition of food resource in the coastal zone', *Geoscience and Man* **12**, 43-47.

Audibert, C. and Delemarre, J.-L. 2009 *Guide des coquillages de France, Atlantique et Manche*, Paris: Belin.

Best, E. 1924 *The Māori (2 volumes): Memoirs of the Polynesian Society*, Wellington: Harry H. Tombs.

Buchanan, W.F. 1985 'Middens and mussels: an archaeological enquiry', *South African Journal of Sciences* **81**, 15–16.

Çakirlar, C. 2009 *Mollusk shells in Troia, Yenibademli, and Ulucak: an archaeomalacological approach to the environment and economy of the Aegean*, Brit. Archaeol. Rep. Int. Ser. 2051, Oxford: Archaeopress.

Campbell, G.E. 2013 'Size prediction in archaeomalacology: the common mussel, *Mytilus edulis* L., as an example', *Archaeological and Anthropological Sciences.* http://dx.doi.org/10.1007/s12520-013-0155-2

Claassen, C. 1998 *Shells*, Cambridge Manuals in Archaeology, Cambridge: Cambridge University Press.

CLEMAM 2013 'Checklist of European marine mollusca', http://www.mnhn.fr/base/malaco.html Last accessed 15 November 2013.

Costamagno S., Théry-Parisot I., Kuntz D., Bon Fr., Mensan R. 2010 'Impact taphonomique d'une combustion prolongée sur des ossements utilisés comme combustible' in Théry-Parisot I., Chabal L., and Costamagno S. (eds) *Taphonomie de la combustion des résidus organiques et des structures de combustion en contexte archéologique*, Actes de la table ronde, 27-29 mai 2008, CEPAM, P@lethnologie 2. 173-187. http://www.palethnologie.org/category/2010-2/

Duguet, J. 1995 'L'origine des mots chaudrée, éclade et terée', *Roccafortis: Bulletin de la Société de Géographie de Rochefort* 3e série, **2(16)**, 362-67.

Dupont, C. 2005 'L'étude des coquillages de Boves ou la description des contenus stomacaux de poissons (Somme)', Unpublished report.

Dupont, C. 2006a *La malacofaune de sites mésolithiques et néolithiques de la façade atlantique de la France: Contribution à l'économie et à l'identité culturelle des groupes concernés*, Brit. Archaeol. Rep. Int. Ser. **1571**, Oxford: Archaeopress.

Dupont, C. 2006b 'Etude archéozoologique: la faune marine, coquillages et crustacés de la phase 3' in V. Carpentier, E. Ghesquiere and C. Marcigny (eds) *Grains de sel. Sel et salines du littoral bas-normand (Préhistoire – XIXe siècle), entre Archéologie et Histoire*, CeRAA/Amarai. 111-16.

Dupont, C. 2008 'La malacofaune marine de Tariec vraz (Landéda, Finistère)' in Y. Pailler and Y. Sparfel (eds)*Rapport de sondage d'urgence sur un site de l'âge du Bronze ancien, Ile Tariec vraz en Landéda (Finistère)*, SRA Bretagne, Rennes. 25-26.

Dupont, C. 2011 'Les données malacologique: du dépôt alimentaire à la parure' in S. Vacher (ed) *Le complexe cultuel à enclos fossoyés de La Vaurie à Périgny, Rapport final d'opération INRAP*, Unpublished report, SRA Poitou-Charentes, Poitiers. 200-34.

Dupont, C. 2013 'Le petit lot de coquilles de la structure de combustion' in J.-M. Large (ed) *Les Batardières 2 (Saint-Vincent-sur-Jard, Vendée)*, Unpublished report, Rapport de fouille programmée en cours.

Erlandson, J. M. and Moss M.L. 2001 'Shellfish feeders, carrion eaters, and the archaeology of aquatic adaptations', *American Antiquity* **66(3)**, 413-32. http://dx.doi.org/10.2307/2694242

Giazzon D. (ed) 2013 *Une semi enceinte du Bronze final III, Mathieu, Calvados, Le Clos des Châtaigniers*, Rapport de fouille de l'Institut national de recherches archéologiques préventives (INRAP), Caen: Service Régional de l'Archéologie de Basse-Normandie, inédit.

Gifford, E.W. 1939 'The Coast Yuki', *Anthropos* **34**, 292-375.

Greengo, R.E. 1952 'Shellfish foods of the California Indians', *Kroeber Anthropological Society Papers* **7**, 3-114.

Gutiérrez Zugasti, F.I. 2008 'Análisis tafonómico en arqueomalacología: el ejemplo de los concheros de la región cantábrica', *Krei* **10**, 53-74.

Hayward, P.J. and Ryland, J.S. 1995 *Handbook of the Marine Fauna of North-West Europe*, Oxford: Oxford University Press.

Henshilwood, C., Nilssen, P. and Parkington, J. 1994 'Mussel drying and food atorage in the Late Holocene, SW Cape, South Africa', *Journal of Field Archaeology* **21(1)**, 103-9. http://dx.doi.org/10.1179/jfa.1994.21.1.103

Kroeber, A.L. and Barrett S.A. 1960 *Fishing among the Indians of Northwestern California* , University of California Anthropological Records 21(1).

Law, M. 2012 'Shellfish and coastal exploitation' in Niall Sharples, 'The Beaker-period and Early Bronze Age settlement at Sligeanach, Cill Donnain' in M.P. Pearson (ed) *From Machair to Moutains: Archaeological survey and excavation in South Uist*, Oxford: Oxbow Books. 247-59

Lebon, M. 2010 'Caractérisation des ossements chauffés en contexte archéologique – Étude comparative de matériel moderne et fossile par spectroscopie infrarouge' in Théry-Parisot I., Chabal L., and Costamagno S. (eds) *Taphonomie de la combustion des résidus organiques et des structures de combustion en contexte archéologique*, Actes de la table ronde, 27-29 mai 2008, CEPAM, P@lethnologie 2. 149-162. http://www.palethnologie.org/2010-12-lebon/

Marlasca Martín, R. 2010 'El consumo de moluscos marinos por los primeros pobladores de las pitiusas (La Mola, Formentera, Islas Baleares)', *Férvedes* **6**, 131-37.

McCarthy, A., Finlay, N. and McClean, O. 1999 'Marine molluscan remains' in P. Woodman, C. Peter, L. Anderson and N. Finlay (eds) *Excavations at Ferriter's Cove, 1983-95: last foragers, first farmers in the Dingle Peninsula*, Bray: Wordwell. 93-102.

McCormick, F., Gibbons, M., McCormac, F. and Moore, J. 1996 'Bronze Age to medieval coastal shell middens near Ballyconneely, Co. Galway', *The Journal of Irish Archaeology* **7**, 77-84.

Meehan, B. 1977 'Hunters by the seashore', *Journal of Human Evolution* **6(4)**, 363-70. http://dx.doi.org/10.1016/S0047-2484(77)80005-5

Minniti, C. 2005 'Shells at the Bronze Age settlement of Coppa Nevigata (Apulia, Italy)', in D. Bar-Yosef Mayer (ed) *Archaeomalacology: Molluscs in Former Environments of Human Behaviour*, 9th ICAZ Conference, Durham 2002, Oxford: Oxbow Books. 71-81.

Mougne, C. in prep *Exploitation des invertébrés marins (mollusques, crustacés et oursins) durant la Protohistoire sur le territoire littoral et continental de la façade atlantique et de la Manche de la France*, PhD thesis, University of Rennes 1.

Mougne, C. and Dupont C. 2012 'Indices de consommation de coquillages marins au Bronze ancien sur le site Les Vallons de Luc à Luc-sur-Mer (Calvados)' in C. Marcigny (ed) *Luc-sur-Mer (Calvados), 'Les vallons de Luc'. Habitats et parcellaire de l'âge du Bronze ancien*, Unpublished report, Rapport de fouille de l'Institut national de recherches archéologiques préventives (INRAP), Caen: Service Régional de l'Archéologie de Basse-Normandie, inédit. 70-79.

Mougne, C., Dupont, C., Lepaumier, H. and Quesnel, L. 2013 'Exploitation of marine shells during the Late Iron Age: gathering territory, dietary choices and circulation networks. The example of Cormelles-le-Royal (Plain of Caen, Lower-Normandy, France)' in M.-Y. Daire C. Dupont, A. Baudry, C. Billard, J.M.Large, L. Lespez, E. Normand and C. Scarre (eds) *Ancient Maritime Communities and the Relationship between People and Environment along the European Atlantic Coasts/Anciens peuplements littoraux et relations Homme/milieu sur les côtes de l'Europe Atlantique, Proceedings of the HOMER 2011 Conference, Vannes (France)*, Brit. Archaeol. Rep. Int. Ser. **2570**, Oxford: Archaeopress. 527-34

Mougne, C. and Dupont, C. en collaboration avec Jahier, I., Le Goff, E., Lepaumier, H. and Quesnel, L. in press 'Les Gaulois et la pêche à pied en Plaine de Caen (Calvados): Pratiques alimentaires, économiques et cultuelles' in *Les Gaulois au fil de l'eau, Actes du 37e colloque international de l'AFEAF, 8-11 mai 2013*. Montpellier: Presses Universitaires des Lettres de Montpellier.

Muus, B.-J., Nielsen, J.-G., Dahlström, P. and Olesen Nyström, B. 2005 *Guide des poissons de mer et de pêche, biologie, pêche, importance économique*, Lausanne: Delachaux and Niestlé.

Oberg, K. 1973 *The Social Economy of the Tlingit Indians*, Seattle: University of Washington Press.

Poppe, T. and Goto, Y. 1991 *European Seashells: Polyplacophora, Caudofoveata, Solenogastra, Gasteropoda*, Germany: Verlag Christa Hemmen.

Poppe, T. and Goto, Y. 1993 *European Seashells: Scaphopoda, Bivalvia, Cephalopoda*, Germany: Verlag Christa Hemmen.

Prummel, W. 2002 'Molluscs from a Middle Bronze Age site and two Hellenistic sites in Thessaly, Greece' in D.E. Bar-Yosef Mayer (ed) *Archaeomalacology: Molluscs in Former Environments of Human Behaviour*, 9th ICAZ Conference, Durham 2002, Oxford: Oxbow Books. 107-21.

Quéro, J.-C., Vayne, J.-J. 1998 *Les fruits de la mer et plantes marines des pêches françaises*, Lausanne: Delachaux and Niestlé.

Stewart, O.C. 1943 *Notes on Pomo ethnogeography*, Berkeley and Los Angeles: University of California Press.

Swanton, J.R. 1946 *The Indians of the Southeastern United States*, Bureau of American Ethnology Bulletin 137, Washington, D.C.: Government Printing Office.

Tebble, N. 1966 *British Bivalve Seashells: a handbook for identification*, London: British Musuem.

Teletchea, F. 2009 *Guide des poissons de France, Côtes de l'Atlantique et de la Manche*, Paris: Belin.

Terrell, J. 1967 'Galatea Bay: the excavation of a beach-stream midden site on Ponui Island in the Hauraki Gulf, New Zealand', *Transactions of the Royal Society of New Zealand* **2(3)**, 31-70.

Theodoropoulou, T. 2007 *L'exploitation des ressources aquatiques en Egée septentrionale aux périodes pré- et protohistoriques*, Unpublished PhD Thesis, University of Paris I Panthéon-Sorbonne.

Theodoropoulou, T. 2008 'Stratégies de pêche en Egée septentrionale au Néolithique et à l'âge du Bronze: paramètres environnementaux et culturels' in P. Béarez, S. Grouard and B. Clavel (eds) *Archéologie du poisson, 30 ans d'archéo-ichtyologie au CNRS, Hommage aux travaux de Jean Desse et Nathalie Desse-Berset*, 28e rencontres internationales d'archéologie et d'histoire d'Antibes et 14e ICAZ Fish remains working group meeting, APDCA, Antibes. 347-58.

Van Leeuwen C.H.A. 2012 *Speeding up the snail's pace. Bird-mediated dispersal of aquatic organisms*, Unpublished PhD Thesis, Radboud University Nijmegen, Nijmegen, The Netherlands: Ponsen and Looijen, Netherlands Institute of Ecology.

Van Neer, W. and Pieters, M. 1997 'Evidence for processing of flatfish at Raversijde, a Late Medieval coastal site in Belgium' in M. Kokabi and J. Wahl (eds) *L'Homme et l'Animal*, Anthropozoologica, 7 ème Congrès ICAZ, MNHN. 579-86.

Waselkov, G.A. 1987 'Shellfish gathering and shell midden archaeology', *Advances in Archaeological Method and Theory* **10**, 93-210.

Weydert, N. 1994 'Le dépôt coquillier anthropique de la Place Jules-Verne: Un témoignage de l'âge du Bronze à Marseille, Etude malacologique et archéologique', *Préhistoire Anthropologie Méditerranéennes* **3**, 177-89.

Zazzo, A. 2010 'Géochimie isotopique des ossements brûlés: implications pour la reconstruction des régimes alimentaires et pour la datation par la méthode du radiocarbone' in Théry-Parisot I., Chabal L., and Costamagno S. (eds) *Taphonomie de la combustion des résidus organiques et des structures de combustion en contexte archéologique*, Actes de la table ronde, 27-29 mai 2008, CEPAM, P@lethnologie 2. 163-172. http://www.palethnologie.org/2010-13-zazzo/