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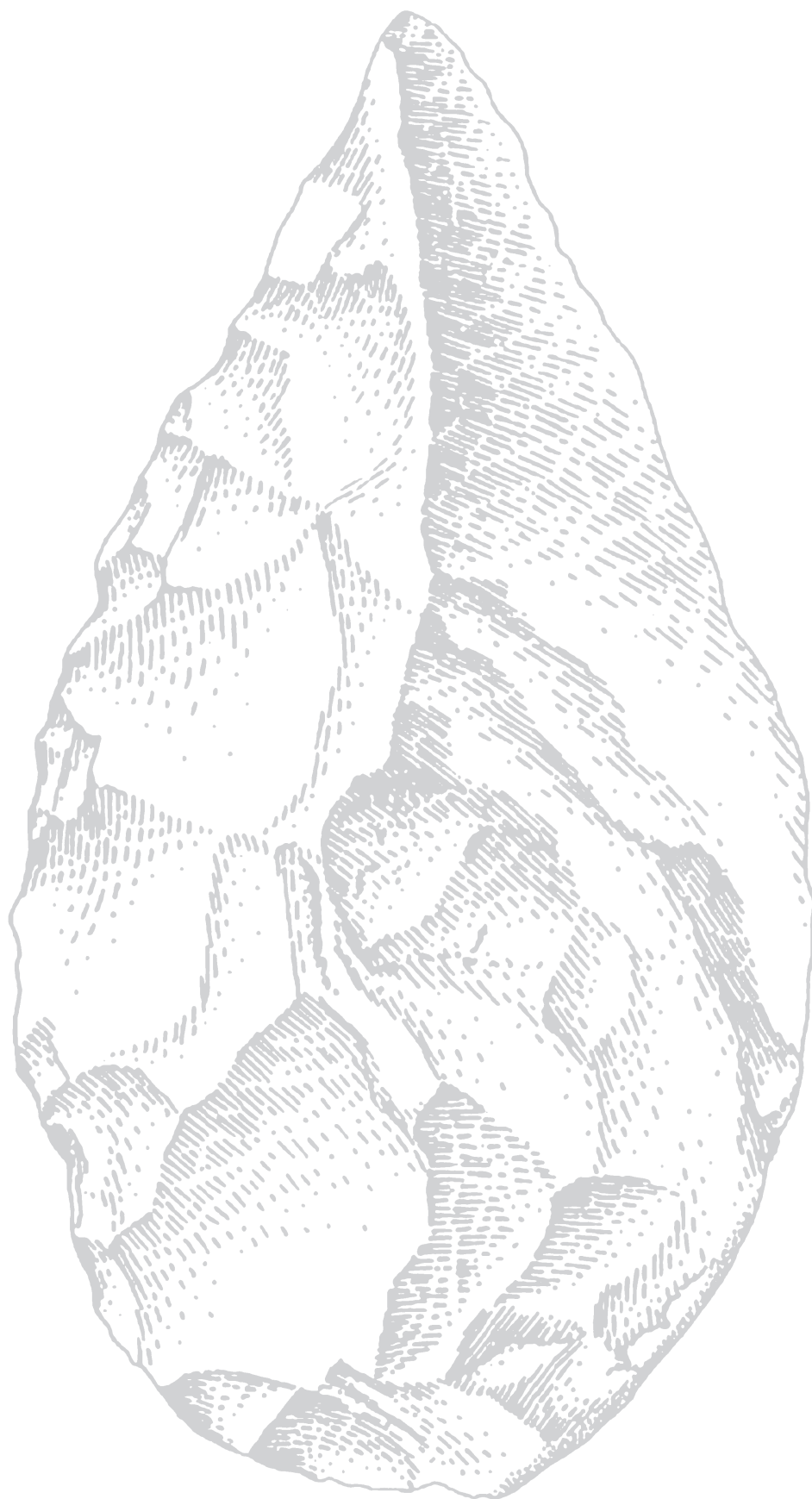
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Brief overview of zooarchaeological research within the framework of Middle Palaeolithic subsistence theories

Revisão sumária do percurso de investigação zooarqueológica no quadro teórico dos estudos de subsistência do Paleolítico Médio

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ABSTRACT: In the course of a general review of zooarchaeological studies, particular attention is given to the development of the thinking process associated with hominin dietary strategies. Since the dawn of archaeological studies animal bones were noticed and recovered in association with man-made tools. Since then, faunal remains have been discussed as the result of human dietary practices. However, the way such feeding activities were conducted has been the focus of an ongoing heated debate. Different subsistence strategies – i.e. Hunting vs Scavenging; Specialization vs Broad Spectrum; Inland vs Coastal Adaptation – have a strong impact on the image we create about our ancestors. Indeed, depending on the mode of acquisition and processing of faunal remains, hominins have been assessed on their cognitive abilities and, therefore, stamped as more, or less, evolved. More recently, new insights have been provided by the development of actualistic studies, highlighting the need to understand in detail the origin of the faunal accumulations. The formation of faunal assemblages in archaeological sites is not only dependent on anthropogenic activities. A myriad of other agents – ranging from natural events to a variety of mammal and bird predators – can also be responsible, or to provide strong inputs, to the formation of faunal accumulations. Therefore, it is imperative to first put faunal assemblages into a site-specific context, making use of a detailed taphonomic methodology, before conducting any kind of analysis and consequent interpretations.

KEY WORDS: Archaeological thought; Historiography; Zooarchaeology; Neanderthal; Taphonomy.

RESUMO: Durante uma revisão geral da evolução do pensamento zooarqueológico, é dada especial atenção ao desenvolvimento do processo intelectual associado às estratégias de subsistência dos homínídeos. Desde os primórdios da prática arqueológica que os ossos de animais foram observados e recuperados em contexto de escavação e em associação com outros utensílios de origem antrópica. Os restos de fauna têm, desde então, sido apresentados como o resultado de práticas alimentares humanas. Contudo, o modo como tais actividades foram realizadas no passado tem sido o centro de um contínuo e aceso debate. Diferentes estratégias de subsistência – como Caça vs Necrofagia; Dieta Especializada vs Dieta de Largo Espectro; Adaptação ao Interior vs Adaptação Costeira – têm tido um forte impacto na imagem que criamos sobre

os nossos antepassados. O modo de aquisição e processamento de elementos faunísticos influenciam a forma como entendemos as suas capacidades cognitivas e, consequentemente, a forma como os consideramos mais, ou menos, evoluídos. Mais recentemente, novos dados têm vindo a ser fornecidos por variados estudos actualísticos que sublinham a necessidade de compreender de forma pormenorizada a origem das acumulações faunísticas. A formação destes conjuntos em contexto arqueológico não está apenas dependente de actividades antropogénicas. Uma pluralidade de outros agentes poderá também originar estas acumulações, ou contribuir significativamente para a sua formação, tais como eventos naturais ou a actividade de uma grande variedade de aves e mamíferos predadores. Assim sendo, torna-se imperativo que se proceda a uma contextualização do sítio arqueológico através de estudos tafonómicos detalhados antes da análise, e consequente interpretação, destes conjuntos faunísticos.

PALAVRAS-CHAVE: Pensamento arqueológico; Historiografia; Zooarqueologia; Neandertal; Tafonomia.

1. HOMININ LARGE GAME CONSUMPTION

Since the late 19th century the association of lithic tools and faunal remains in archaeological sites has been considered to reflect hominin subsistence behaviour, implying hunting and carcass-processing activities (Domínguez-Rodrigo 2002). According to Darwin (1871), such accomplishments – together with bipedalism and the abandonment of life in the trees – were indicative of a certain stage of hominization that separated humans from other apes. Further evidence of such humanized behaviours was later given by authors like Dart (1959), who argued for the primacy of meat-eating by early humans in many African sites. Such ideas were widespread, leading to the general acceptance of hunting as the main hominin subsistence strategy, which was later termed the *Hunting Hypothesis* (Domínguez-Rodrigo 2002; Stanford 1999).

The *Hunting Hypothesis* was well-received and popular among academics during the first part of the 20th century, reaching its peak with the *Man the Hunter* conference held in Chicago in 1966, where several ethnographic studies of recent hunting and gathering communities were presented (Lee – DeVore 1968). Hunting was perceived as the most efficient method to adapt to a myriad of environments, since the targeting of substantial herds of large herbivores guaranteed the sustenance of hunter-gatherer groups (Hart – Sussman 2005; Stanford 1999). However, in the 1970s, Glyn Isaac and colleagues (Isaac 1978; 1982; Isaac – Crader 1981) changed the focus from the hunting process *per se* to the hominin social cooperation that was seen as the real trait of progress and evolution.

The *Home Base / Food Sharing Hypothesis* argued that food resources other than meat were part of the diet, with women being generally responsible for procurement of plant foods whilst men were accountable for hunting activities. Furthermore, Isaac tackled issues like the role of non-anthropogenic factors (e.g. rivers, other carnivores) in the accumulation of archaeological material (Isaac 1983).

Such taphonomic concerns were extensively explored during the 1970s and 1980s within the frame of the *New Archaeology*, when several actualistic and experimental studies were conducted. This approach resulted in works highlighting the importance of non-cultural agents in the formation of archaeological assemblages. Amongst the most notable works is the one of Brain (1981), who demonstrated through detailed taphonomic analysis that the bone deposits interpreted by Dart (1959) as resulting from hominin hunting activities were, instead, due to predator-scavenger activities, and that humans were among the species preyed upon. Similarly, Binford's ethnographic work among the Nunamiut (Binford 1978) attempted to reconstruct the different agents and activities involved in the formation of bone accumulations through the body part representation patterns found in faunal assemblages. Binford compared modern hunter-gatherer and predator-scavenger assemblages with archaeological collections, concluding that several Lower Palaeolithic bone accumulations (e.g. in Olduvai Gorge Beds I and II, Swanscombe, Torralba and Klasies River Mouth) were in fact the result of carnivore kills with subsequent hominin scavenging intervention (Binford 1981; 1984; 1985; 1987). This resulted in

a dramatic shift in the interpretation of hominin subsistence behaviour with some authors rejecting early hominins as big game hunters (e.g. Binford 1981; 1985; Blumenschine 1986; 1992; Selvaggio 1998a; 1998b), but seeing them as purely scavengers relying on the carcasses from other carnivore kills in order to survive. Furthermore, Binford considered that hunting was only possible among Anatomical Modern Humans, an idea also shared at the time by researchers like Mellars and Stringer (1989) who considered that pre-modern humans lacked the physical, behavioural and technological ability for large game hunting.

In the 1990s, the gap between such opposing ideas – i.e. whether hominins were hunters or scavengers – started to narrow down. Some authors placed hominins back in their faunal community context (e.g. Stiner 1994), and included them in the wider carnivore guild (Stiner 2002) in order to better understand the interaction and competition of humans and other species for the resources available. Such approach has been producing evidence supporting both hunting and scavenging behaviours (Gaudzinski 1996). Moreover, zooarchaeological studies from several European Middle Palaeolithic sites have been advocating different, and frequently competing, Neanderthal subsistence behaviours. Specialised monospecific hunting of large and medium-sized game has been proposed for sites where a limited number of species is recorded, mainly focusing on herbivores like large bovids, horses and reindeer. Examples of such monospecific subsistence are found in sites like Wallertheim (Germany) (Gaudzinski 1996), Schöeningen (Germany) (Gaudzinski-Windheuser – Niven 2009), Mauran (France) (Farizy – David – Jaubert 1994) or La Borde (France) (Jaubert *et al.* 1990). Other sites demonstrate the exploitation of megafaunal species like the proboscideans from the Spanish sites of Torralba and Ambrona (Villa 1990; Villa *et al.* 2005) and Preresá (Yravedra *et al.* 2012), or the mammoths and woolly rhinoceros from La Cotte de St Brelade (Jersey) (Scott 1980; 1986; Smith 2015), and the Belgian sites of Goyet (Wißing *et al.* 2016) or Spy Cave (Weyrich *et al.* 2017), among others. Current archaeological evidence suggests that Neanderthals were successful hunters of large ungulates (e.g. Discamps – Jauber – Bachellerie 2011; Gaudzinski-Windheuser – Kindler 2012; Kindler – Smith – Wagner 2014; Rendu 2010). However, there is still some scepticism as to whether Neanderthals

specifically targeted megafauna and large ungulates, or if they simply scavenged from other carnivore kills or natural deaths (e.g. Burke 2004; Mellars 1996; Stiner 1994). Nonetheless, it is difficult to argue against the fact that scavenging hominins had to compete and fight over carcasses with other carnivores (Gaudzinski 2004).

Despite the manner of meat acquisition, Neanderthal consumption of large game has been widely accepted, and isotope analysis has been crucial in perpetuating such views (e.g. Wißing *et al.* 2016). The first carbon and nitrogen analyses carried out in the 1990s revealed Neanderthals as top meat consumers, clustering close to wolves and hyenas (Bocherens *et al.* 1991). However, and as later noted by Bocherens (2009), sample size was small (with only six samples fulfilling the necessary analysis criteria). Moreover, all samples were recovered from Neanderthal occupations relating to cold periods and to northern latitudes, with clear lack of evidence from sites in more southern positions (Hardy 2010). Nonetheless, isotope analyses made by Salazar-García *et al.* (2013) in Mediterranean sites showed similar results to those from cold environments, implying a predominant consumption of terrestrial resources. Ecker *et al.* (2013) support such conclusions through carbon and oxygen isotope analyses on Neanderthal tooth enamel samples from southern France, demonstrating a preference for large herbivore consumption.

However, the growing body of vegetal evidence has shown the inclusion of plant foods in pre-sapiens diets (Hardy – Moncel 2011; Hardy *et al.* 2012; 2013; 2016; Henry – Brooks – Piperino 2011; 2014; Weyrich *et al.* 2017). Nutshells from stone pine (*Pinus pinea*) were found in Gorham's Cave (Gibraltar) (Ward – Gale – Carruthers 2012), Gruta da Figueira Brava (Portugal) (Zilhão *et al.* 2020), and there is further evidence of consumption of pine nuts, moss and mushroom from Neanderthal teeth from El Sidrón Cave (Spain) (Weyrich *et al.* 2017). Other low ranked plants, like starches and grass seeds, were also consumed in several European Neanderthal sites (Henry – Brooks – Piperino 2014), and in the Near East such as Shanidar Cave (Iraq) (Henry – Brooks – Piperino 2011). In addition, there is rising evidence for the exploitation and consumption of small game and marine resources in the Middle Palaeolithic (e.g. Barton *et al.* 1999; Blasco – Fernández-Peris 2012a; 2012b; Blasco *et al.* 2016; Stiner 1994;

2005; Stringer *et al.* 2008; Zilhão *et al.* 2010; 2020);. Such research advances are therefore changing the traditional palaeodiet perceptions based exclusively on large game consumption and, instead, are becoming significantly more complex.

2. HOMININ BROAD DIETS

Formulations of broad spectrum diet theories had their origin in research related with food production and the dawn of domestication. In a well-known 1968 paper, Lewis Binford criticises Braidwood's nuclear zones theory (Braidwood 1960; 1963), which stated that food production was not an anthropogenic response to climate change but resulted from an increased cultural awareness of the environment, its resources and how to manipulate them. It was only in the terminal Pleistocene that hunter-gatherers had developed such a deep understanding of the flora and fauna of their living environments, with the direct consequence of domestication. Nevertheless, according to Binford (1968: 323), such cultural decision-making could not be confirmed, and it was impossible to test. Moreover, he argued that it was unlikely that prehistoric hunter-gatherer populations would change their long-term subsistence strategies unless there was considerable disequilibrium resulting from changes in the environment, forcing human groups to adapt to a new reality. Binford illustrated his theory by comparing the distribution of Mesolithic and Neolithic sites, which he argued was determined by environmental factors. Rising sea levels and other changes forced people to find new subsistence strategies, like heavy consumption of marine resources and the beginning of food production.

Binford's density disequilibrium model considered demographic increase as a possibility for hominin widening diets, but only in marginal areas and in very specific conditions. In most cases, population increase would only encourage "a regressive change in which a less complex cultural form is adapted" (Binford 1968: 331). Conversely, Flannery (1969) presented demographic expansion as a critical factor. Although the importance of climate change was not ignored, he did not consider environment as the main engine to changes in subsistence patterns. Instead, broader

diets were triggered by population pressure and disequilibrium towards resource carrying capacity, which forced mid-Upper Palaeolithic groups to use smaller size resources, more reliable and predictable in certain seasons of the year, like "fish, crabs, water turtles, molluscs, land snails, partridges and migratory water fowl" (Flannery 1969: 77). The increasingly broad spectrum exploitation from 20,000 years BC to about 6,000 BC was thus responsible for a change in mental attitudes, which started considering any resource as potential food. Flannery then argued that only after these developments would the first domestication be possible (Flannery 1969). Although such small resources would not be a substitute for specialised ungulate hunting, most of them could be storable, some were high in calories (like acorn and pistachio), and others provided important nutrients, like calcium from land snails, or vitamin A from mussels. Also, invertebrates and vegetal foods could easily be collected by women and children, which would complement men's ungulate hunting (Flannery 1969).

With Malthusianism theories widely accepted, Flannery's Broad Spectrum Revolution was well received. Further support came from Mark Cohen's *The Food Crisis in Prehistory* (Cohen 1977) stating in favour of population pressure. Cohen also stressed that changes in the diet would impact on procurement efficiency. Therefore, smaller, lower energy and more labour-intensive resources would integrate the new diet patterns with the direct consequence of a significant increase in energy costs. As is well summarised by Christenson (1980: 36), the first consequence of population growth would be the intensification and specialisation of the high potential resources already explored. Once these started to decline, then diet diversification would occur incorporating animals giving less energy but with less cost input. However, overexploitation of these low rank resources would eventually occur and other low ranked foods, which are more labour intensive, would have to be included in the diets. These two types of low rank resources – with less and more cost input – were later zooarchaeologically defined by Mary Stiner and colleagues (Stiner *et al.* 1999; Stiner – Munro – Surovell 2000) as small slow prey (i.e. tortoises, shellfish) and small fast prey (i.e. lagomorphs, birds), respectively.

Archaeological evidence was soon provided by Clark and Straus (1986), who presented the Upper

Palaeolithic site of La Riera (Cantabria, Spain) as the perfect example of resource intensification, specialisation and diversification. They started by rejecting any significant environmental change during the cave's occupation and showing a progressive specialisation on red deer consumption through catastrophic mortality profiles suggesting herd hunting. Further intensification was noted through red deer bone breakage patterns that, at a certain stage in the stratigraphic sequence, started showing heavy exploitation of marrow and grease. Such intensification was supported by significant increase in new-born individuals, which was interpreted as a clear sign of red deer overexploitation. Concurrently, limpet shells were intensively consumed resulting in a size decline, indicating overexploitation. In addition, resource diversity was attested by an increase in the range of molluscs from different environments and the inclusion of marine species not previously exploited, like fish and sea urchins.

In the 1980s, archaeologists and anthropologists found support for their energy cost efficiency models in Behavioural Ecology and its Optimal Foraging Theory. The latter assumes that resources are selected so as to maximise the effort spent in collecting or hunting them. The ultimate goal is to define prey choice models in order to understand the rules used by foragers to enhance the efficiency of their resource selection (Zeder 2012 and references therein). Optimal Foraging Theory was embraced by the zooarchaeological community with a spotlight on the work of Mary Stiner and colleagues (Stiner 2001; Stiner – Munro 2002; Stiner – Munro – Surovell 2000). They ranked prey according to energy returns on the basis of small size prey's fast or slow locomotion. This ranking system allowed recognition of demographic pressure indicators and the identification of two distinct dietary change revolutions for the Mediterranean Basin: (1) from the Upper Palaeolithic to the Mesolithic, matching the time frame of Flannery's original conception of the Broad Spectrum Revolution; and (2) the transition from the Middle Palaeolithic to the Upper Palaeolithic, closely related with a renewed radiation of Anatomical Modern Humans from Africa into the Near East around 50–44,000 years BP (Stiner *et al.* 1999; Stiner – Kuhn 2006; Stiner – Munro 2011; Stiner – Munro – Starkovich.2012).

3. PUSHING BACK BROAD SPECTRUM DIET CHRONOLOGIES

Mary Stiner and colleagues have been pioneers in pushing back the notion of broad spectrum diets to late Neanderthal times. Increasing evidence has emerged mainly from the Mediterranean Basin, and faunal results obtained for sites in the Iberian Peninsula are extremely relevant.

In Portugal, indicators of wider Neanderthal diets were found in the first excavations of Gruta da Figueira Brava in the 1980s where a large variety of bird species was identified, together with several remains of rabbits, tortoises, marine mammals, marine molluscs and crabs (Antunes 2000, and papers therein). Nevertheless, such zooarchaeological research lacked detailed taphonomic studies, so it was difficult to assess if their presence was due to anthropogenic activity. Gruta Nova da Columbeira has a large collection of rabbit bones that seems to be due to human agency (Carvalho – Pereira – Manso 2018). The faunal assemblage also comprises tortoise remains, but according to Hockett and Haws (2009) it has not been confirmed that it was used as food. Conversely, a pilot study of the tortoise remains recovered from Gruta da Oliveira's layers 7 to 19, recovered a total of 3,394 bone fragments. Based on stratigraphic association with Mousterian industry, Neanderthal remains and an *in situ* hearth on layer 14, together with evidences of cut marks and preferential burning on the exterior part of the carapace, such tortoise remains were interpreted as the result of Neanderthal consumption (Nabais 2012).

A large tortoise assemblage accumulated by hominins was also recovered from the Middle Palaeolithic levels of Cova del Bolomor (Valencia, Spain) where, together with confirmed bird consumption, it was possible to clearly demonstrate Neanderthal use of small prey (Blasco 2008; Blasco – Fernández Peris 2009; 2012a; 2012b; Blasco – Fernández Peris – Rosell 2010). Similar evidence was found in Gibraltar caves. Dorothy Garrod's excavations in the early 20th century revealed a wide variety of species in Devil's Tower in stratigraphic association with Neanderthal human remains and Mousterian artefacts. Among the faunal assemblage, 25 mammal species were identified together with 33 bird species, including the currently extinct *Pinguinus impennis* (Linnaeus 1758), tortoise remains, fish and

molluscs (Garrod *et al.* 1928). The Mousterian layers contained mussels and different species of limpets from both Atlantic and Mediterranean environments (Colonese *et al.* 2011). Marine resources were also found in recent excavations of Middle Palaeolithic levels of Gorham's Cave. They consist of rocky intertidal molluscs, such as limpets, mussels and topshells whose exploitation patterns seemed to have remained the same during Middle and Upper Palaeolithic times (Fa 2008). According to Stringer *et al.* (2008) marine mammals were also recovered from levels associated with Mousterian industry, as well as birds and rabbits with human gnawing marks. Currant and colleagues (Currant – Fernández-Jalvo – Price 2012) identified a long list of mammal remains, reinforcing the large number of rabbits present in the assemblage. Vanguard Cave shows a similar faunal composition, where terrestrial mammals shared the Mousterian levels with marine resources, including dolphins, seals, marine birds, fish, crabs and molluscs (Colonese *et al.* 2011; Currant *et al.* 2012; Stringer *et al.* 2008). Most shells coincided with the spread of ashes from two underlying hearths; they were burnt or showed some sign of heating (Barton *et al.* 1999). Cueva de los Aviones (Murcia, Spain) has also a Neanderthal occupation associated with bone remains of horse, deer, ibex, rabbit, tortoise and marine molluscs (Zilhão *et al.* 2010). Among the latter, rocky species are the most abundant (mainly top snail, mussel and limpet) and seaweed was also identified, essentially *Jania rubens* (Montes Bernárdez 1989).

Although there is vast evidence of marine resources in hominin diets, only in 2001 was their relevance truly considered by Erlandson. Until then, marine resources were generally seen as less productive for hominin exploitation due to their small size, costly processing and unreliability (Erlandson 2001). They were also associated with women and children's work in most ethnographic societies (Meehan 1983; Siegfried – Hockey 1985), which contradicted the established idea of male-dominated hunting as the central force of subsistence. Moreover, a diet based on shellfish is high in protein but low in fat, and Noli and Avery (1988) considered it to have severe health consequences.

However, it seems from ethnographic studies that many sea foods are storable and seasonally predictable (like salmon going up-stream) (Mannino – Thomas 2002); shellfish is a predictable resource and

has significant nutritional benefits due to richness in protein and vitamins D and E (Fa 2008); its collection is an easy and low-risk activity and many recent hunter-gatherers indicate that daily subsistence is based on resources like plants and small game, and not on medium to large game hunting (Bicho – Haws 2008). Furthermore, sea level today is at its highest point and most hominin coastal evidence is probably destroyed or submerged (Bailey – Flemming 2008; Bicho – Haws 2008; Colonese *et al.* 2011; Erlandson 2001). Recently, Mousterian artefacts were found eroding from a creek bank 18m below sea level, close to Cherbourg, France (Flemming 1998, *apud* Erlandson 2001: 327), and intact bone-bearing deposits in underwater caves near Gibraltar have been investigated (Erlandson – Fitzpatrick 2006). Finally, plate tectonics have also played a significant role and, according to Bailey and Flemming (2008), the Mediterranean region is in a main potential tectonic uplift zone, which helped preserve some of its archaeological deposits above present sea-level.

4. CONSTRAINTS OF NEANDERTHAL CURRENT BROAD SUBSISTENCE MODELS

Although there is increased evidence of wider hominin diets in earlier time periods, it seems that the most recent and accepted broad spectrum theories are still largely dependent on demographic pressure as the main engine for small size resource consumption. This is the trend even after ethnography has shown that small resources, like shellfish, should be ranked in higher positions since they are reliable, predictable, and not at all marginal or difficult alternatives in moments of crisis (Bicho – Haws 2008). Ethnography has also demonstrated that people are willing to walk long distances in order to collect their favourite molluscs. Once they reach intertidal zones, they often prefer some species above others that contain more meat. A good example is the Anbarra community in north Australia, where the consumption of the tapestry shell is preferred over the brown mussel that provides more energy (Meehan 1983). Hence, hunter-gatherers are subjected to the resources existing in their living environment, but they also have the free will to choose other resources that are not necessarily the most fit in terms of energy returns, but they can simply taste better.

Another difficulty with broad spectrum diets relates to the amount of clear evidence for small game consumption, in which marine resources play an important role. Researchers working in Gibraltar were among the first to claim marine resources as highly important in hominin diets (Finlayson 2008; Stringer *et al.* 2008), an argument later followed by Cortéz-Sánchez *et al.* (2011) for the Bajondillo Cave, in Málaga (Spain). Both teams have shown Neanderthal's systematic use of seafood, and coastal adaptation through comparisons with the dense shellfish remains recovered from Middle Stone Age South African sites, like Sea Harvest (Volman 1978), Hoedjiespunt (Kyriacou *et al.* 2015; Will *et al.* 2013), Klasies River (Langejans *et al.* 2012; Thackeray 1988), Ysterfontein 1 (Klein *et al.* 2004), Pinnacle Point 13B (Jerardino – Marean 2010; Marean *et al.* 2007) or Blombos Cave (Langejans *et al.* 2012). In spite of the similarities in timeframe, such comparisons were not considered valid by Klein and Steele (2008: E115), who argued that Spanish caves did not have sufficient evidence for extensive shellfish exploitation. Marean (2014) further considers that the small amounts of molluscs are sparsely distributed and only found in thin lenses from large sedimentary deposits, not meeting the definition of a shell midden. Moreover, no definition of “systematic use” is given, revealing no understanding of the consequences of such behaviour.

Two problems arise from these criticisms: (1) the definition of a shell midden, and (2) the clear identification of a hunter-gatherer group's systematic coastal use. Shell middens were first designated in Danish as *køkkenmødding*, which means kitchen midden, referring to the food waste of people living by the sea and using its resources (Speed 1969). This is the generally accepted shell midden definition, but it is extremely broad and subjective. There were several attempts of better defining it, like Andersen (2007) who defines a shell midden as a cultural deposit in which at least 50% of the volume is made of shells forming a continuous horizon with a minimum of 10m². If a site fails on this number, then it should be considered as a shell bearing site. Other researchers tried to create shell midden typologies, such as Widmer (1989, *apud* Claassen 1998: 11) who distinguished between (a) shell midden sites, (b) shell middens, (c) shell bearing midden sites, and (d) shell bearing habitation sites, based on the distinction between site and deposit. Another

categorisation is the one from Dupont (2006: 41), who establishes three types of shell middens according to morphology and volume: (1) *Amas coquiller*, a mound bigger than 2m³; (2) *Dépôt coquiller*, a mound smaller than 2m³; and (3) *Lit coquiller*, a horizontal shell layer. The lack of an accepted definition led Balbo *et al.* (2011) to propose a broad description of shell midden as an “intentional anthropogenic shell accumulation”, so it can include all chronologies, geography, sizes and shapes. In the light of this recent definition, the above-mentioned Spanish caves would be accepted as shell middens, as well as their South African counterparts.

Concerning the systematic use of marine resources, it implies a designed subsistence strategy that would intercept the coast at determined periods of the year, sometimes shifting between inland and littoral, or even remaining at the coast all year (Marean 2014). Consequently, a sporadic use of the coast is not a systematic use. Primates (e.g. Russon *et al.* 2014) and other animals (Erlandson – Moss 2001) consume marine resources, but that does not mean they are coastal adapted or that they do it systematically. It should also be cautioned that ethnographic studies have shown that systematic use of coastal resources generally result in highly sedentary behaviour with consequent population increase, highest levels of complexity, high technological developments and levels of conflict (Marean 2014).

So how can we identify systematic coastal resource use? Since many animals eat marine resources and are capable of forming small shell heaps, the first step is to clearly define the agent of accumulation. Coastal sites can also contain shell accumulations due to natural activities, like storms or sea high tides. It is fundamental to recognise stratigraphic association between bone/shell remains and well-dated lithic industry or other features, and to identify bone/shell surface modifications (like burning), patterns of mechanical fracture and any other visible taphonomic processes. Another valuable contribution is to report shell densities in comparison to the volume of sediment excavated. Although there are no magic numbers, they will give a feel for the intensity of shell accumulation. The cultural use of shells (i.e. as beads or as containers for ochre) can also be a good indicator of systematic use. A final approach is the use of scientific methods. Isotope analysis on hominin remains can easily tell if they

were consuming marine resources, and isotope analyses on shells give precious information on seasonality, as well as permitting environmental reconstruction and discussion on hominin mobility strategies.

Systematic use of marine resources does not imply abandonment of terrestrial foods. However, the contribution of both types of resources should be analysed in detail. It is fundamental to study animal categories individually but also in an integrated manner, so that their contribution to hominin diets and consequent food provisioning strategies can be compared and contrasted in any possible way (e.g. type of environment, animal size, type of animal locomotion). Marine and terrestrial resources should also be assessed from a site formation process perspective through taphonomy, in order to confirm their use and accumulation by hominins.

5. FORMATION OF FAUNAL ASSEMBLAGES

Hominin behaviour is one of many potential agents of bone accumulation and modification. Associations of stone tools and faunal remains are still generally accepted as sufficient to infer on hominin meat-procurement and consumption. However, such perception has been criticised since the 1980s by several authors (e.g. Bailey 1983; 2007; Marshall 1989) who argue that the finds should be put into site specific context, bearing in mind the environment of the deposition and all possible site formation processes. Consequently, all zooarchaeological analyses should have as their primary concern the use of an explicit and detailed taphonomic methodology, considering all different scenarios regarding bone assemblage formation.

Several natural causes can be responsible for bone accumulation. Assemblages can be formed by natural deaths: whether catastrophic, and therefore concerning several animals; or due to the normal death of an individual. For the first scenario, Conybeare and Haynes (1984) studied mortality profiles caused by mass death events, such as flash floods. The resulting faunal assemblages are characterised by the presence of several species inhabiting the area at the time the floods occurred; there should be variation in terms of sex and age-structure, since there was no specific animal targeting and the whole population was

indifferently killed. Haynes (1988) further refers that such events would produce an important opportunity for countless predators. However, low carnivore marks would be found since predators-scavengers would not feed intensively on each of them since there are plenty available. Natural fires can also decimate a population, as it is reported for tortoise populations in South Africa (Avery *et al.* 2004), France and Spain (Couturier *et al.* 2014). Assemblages resulting from such events feature individuals of all sexes and ages, with skeletons still in articulation exhibiting completely charred bones. Conversely, each animal can reach the end of its life due to many other causes related to the general health of each individual – disease, old age, hibernation, among others –, and are thus the opposite of the catastrophic scenario. In such cases it is expected to find more restricted age structures with preference for very old or very young animals, and absence of prime-age individuals that are generally more resilient. Males and females should be equally represented, and predator-scavenger and hominin bone modifications may overlap (Conybeare – Haynes 1984). Additionally, accidental deaths due to natural traps (such as pitfalls) should also be considered. Some excellent examples are the ones provided by leporid remains recovered from the French caves of Coudoulous II (Cochard 2004), Igue des Rameaux (Cochard 2004), Régourdou (Pelletier *et al.* 2015), Igue du Gral (Castel *et al.* 2014) and Coulet des Roches (Pelletier *et al.* 2020). The taphonomic signature of such remains revealed high completeness of the bones showing low degree of bone surface modification, mostly related with natural phenomena or post-mortem events, as well as mortality profiles compatible with a natural living population structure.

Archaeological material can also be naturally transported by physical action due to run-off, aeolian, fluvial or tidal processes resulting in accumulations of derived position and thus forming secondary deposits. Archaeological materials are expected to be found following an orientation aligned with the direction of the movement flow; lighter elements (e.g. vertebrae) tend to travel longer distances than denser elements (e.g. teeth) that are generally accumulated in lag deposits; and transported elements can show rounding of the edges, with different degrees of erosion associated with the distance travelled, i.e. short distances corresponding to low rounding degrees, and vice-versa

(Auguste 1995; Stopp 1997). Due to its secondary deposition, faunal remains with anthropogenic and/or predator-scavenger surface modifications relate to events performed elsewhere other than the location where they were recovered. Therefore, such behaviours should be interpreted with caution since they cannot necessarily provide information on subsistence on the locale where faunal remains were found. Additionally, when digging in cave environments, one should also consider vertical movements. These are frequently produced by (a) accumulations close to cave walls, (b) roof collapses, and (c) sediment slide through cave cracks and fissures that can result in hourglass-shaped accumulations (such as the one found in layers 26 and 27 from the Middle Palaeolithic site of Gruta da Oliveira (e.g. Deschamps – Zilhão 2018).

The predator-scavenger scenario refers to faunal accumulations due to carnivore/raptor feeding behaviours. It is marked by extensive evidence of predator-scavenger modifications, such as gnawing, pitting, punctures, edge crenulations, scores, digestion; mostly confined to the meatiest areas of the bones indicating primary access to the carcass; and should be present in most skeletal elements and species found on site (e.g. Binford 1981; Brain 1981). Most frequently, such accumulations are due to the activity of hyenids, canids and felids that show different accumulation characteristics (Auguste 1995). For example, faunal assemblages formed by hyenas are marked by the lack of long bone epiphyses, mainly the proximal ends of humeri and tibiae, the distal radii and both ends of the femuri which are frequently chewed off (e.g. Bunn 1986; Cruz-Urbe 1991; Pickering 2002). In addition, the presence of juvenile hyena bones, as well as some cannibalistic hyena behaviour, are accepted as evidence of hyena dens (e.g. Diedrich 2011; Pickering 2002). Adding to previous studies (e.g. Haynes 1982; 1983; Mondini 2000; 2004; Mondini – Sebastian Muñoz 2007), extensive experimental work has been carried out in the last decade on carnivore/raptor bone accumulations focusing, not only on bone surface modification, but also on skeletal part representation patterns (e.g. Arilla *et al.* 2019; Camarós *et al.* 2017; Lloveras – Moreno García - Nadal 2009; Mallye *et al.* 2012; Rodríguez-Hidalgo *et al.* 2020; Sanchis *et al.* 2014; Stiner – Munro – San. 2012). Such studies have been essential in the separation of faunal accumulations by very different

predators – from larger animals (like lions and hyenas) to smaller species (lynx, eagles, badgers and several others).

Finally, the hominin scenario shows anthropic accumulation of faunal remains as direct result of subsistence behaviour on site. In such instances, it is expected to find anthropogenic marks (like incisions and intentional burning) on bones and shells demonstrating primary access to the carcass, i.e. modifications on the meatiest parts (Domínguez-Rodríguez 1999; 2003). There should be numerous hominin modifications distributed across most elements and species, whereas carnivore marks should be limited and restricted to elements with low bearing meat. Whenever both signatures are present, the carnivore marks should overlie hominin modifications (Binford 1981). However, it should be borne in mind that humans can produce modifications similar to carnivores. Hence, it is important to separate them neatly, especially when considering tooth marks (Fernández-Jalvo – Andrews 2011; Saladié *et al.* 2013).

6. RECENT RESEARCH AND CLOSING REMARKS

It is now clear that to fully understand the role hominins played in faunal accumulations, they have to be put into site-specific and palaeoenvironmental contexts in which it can be determined who was the agent responsible for the formation of faunal assemblages. This has been made easier in the last years considering the large amount of actualistic studies providing detailed insight into the patterns and signatures created by several specific agents of accumulation in the archaeological record (e.g. see the extensive work of Lluís Lloveras researching on rabbit bone accumulators).

The review of the ongoing debates regarding hominin diets has shown that both hunting and scavenging subsistence strategies might have been concurrently performed since there is no archaeological evidence disproving any of the models, but rather suggests that they may have complemented each other. Such food procurement models were certainly part of a larger behavioural framework that included subsistence and environmental adaptive strategies depending on the geographical setting that was being explored.

Such a notion has been recently demonstrated by the results provided from the last fieldwork seasons (2010-2013) in Gruta da Figueira Brava, in Portugal. Zilhão *et al.* (2020) established that Last Interglacial Iberian Neanderthals exploited the full range of ecosystems present in their ecotonal environment. Fishing and seafood harvesting were accomplished systematically, and were complemented with mammal and bird hunting, as well as fruit collection. The observed diversity of food resources consumed in Gruta da Figueira Brava by Neanderthals is higher than that found at nearby Mesolithic sites dated to between 7500 and 9000 years ago. During the phases of more intensive occupation, the Figueira Brava mollusc accumulations are as dense as in those Mesolithic sites, in which isotope analysis of human bone reflects a diet that was of up to 50% of marine origin. Additionally, in Gruta da Oliveira, in an inland setting, it was tortoises that had a paramount role in the Neanderthals' exploitation of small game. Large size individuals seem to have been preferentially targeted, indicating a predilection for adult animals. The consumption of tortoises may have had an impact on the local population, as possibly suggested by the decrease in size and in number of remains from the older to the most recent occupations (Nabais – Zilhão 2019).

The most recent results from these two Portuguese Neanderthal caves agree with the growing corpus of Eurasian literature that challenges previous interpretations of Neanderthal preferential targeting of large and medium ungulates. In the Mediterranean Basin, and the Iberian Peninsula in particular, it is clear that Neanderthals had a broad spectrum subsistence where all kinds of animal food resources were procured and included in the diet. Neanderthal exploitation encompassed all ungulate sizes (from very large, e.g., rhinoceros, to small, e.g. ibex) and extended to slow and quick moving small vertebrates (like tortoises and birds, respectively), and to several aquatic animals (aquatic birds, fishes, several molluscs and crabs).

The confirmation of certain qualities in Neanderthal subsistence strategies, like (1) their adaptability to the varied resources available in the landscape, (2) their broad spectrum diets, (3) the hunting of small fast game, (4) the systematic use of marine resources, (5) the recurrent use of the same sites at different times of the year, have been considered by many researchers

as part of a modern behaviour package (e.g. Klein – Steele 2008; Marean 2014; Mellars 2007). That Neanderthals were endowed with symbolic thinking is revealed by the practice of personal ornamentation and burial (e.g. Hoffmann *et al.* 2018a; Vanhaeren *et al.* 2006; Zilhão *et al.* 2010), their controlled use of fire (e.g. Sorensen – Claud – Soressi 2018; Villa – Roebroeks 2014), complex lithic technology (e.g. d'Errico – Borgia – Ronchitelli 2012; Zilhão *et al.* 2015), extensive social networks (e.g. Villa – Roebroeks 2014) and production of art (e.g. Hoffmann *et al.* 2018b; Prévost *et al.* 2021;), all of which have been considered feature-specific of “modern humans”. Such seems to be also the case for Neanderthal lifeways and subsistence economy, adding support to the notion that Neanderthals were humans just like us.

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POLÍTICA EDITORIAL

A *Ophiussa* – Revista do Centro de Arqueologia da Universidade de Lisboa foi iniciada sob a direcção de Victor S. Gonçalves em 1996, tendo sido editado o volume 0. O volume 1 (2017) é uma edição impressa e digital da UNIARQ – Centro de Arqueologia da Universidade de Lisboa.

O principal objectivo desta revista é a publicação e divulgação de trabalhos com manifesto interesse, qualidade e rigor científico sobre temas de Pré-História e Arqueologia, sobretudo do território europeu e da bacia do Mediterrâneo.

A *Ophiussa* – Revista do Centro de Arqueologia da Universidade de Lisboa publicará um volume anual. A partir de 2018, os artigos submetidos serão sujeitos a um processo de avaliação por parte de revisores externos (peer review). O período de submissão de trabalhos decorrerá sempre no primeiro trimestre e a edição ocorrerá no último trimestre de cada ano.

A revista divide-se em duas secções: artigos científicos e resenhas bibliográficas. Excepcionalmente poderão ser aceites textos de carácter introdutório, no âmbito de homenagens ou divulgações específicas, que não serão submetidos à avaliação por pares. Isentas desta avaliação estão também as resenhas bibliográficas.

Todas as submissões serão avaliadas, em primeira instância, pela Coordenação Editorial, no que respeita ao seu conteúdo formal e à sua adequação face à política editorial e às normas de edição da revista. Os trabalhos que cumprirem estes requisitos serão posteriormente submetidos a um processo de avaliação por pares cega / *blind peer review* (mínimo de dois revisores). O Conselho Científico, constituído pela direcção da UNIARQ e por investigadores externos, acompanhará o processo de edição.

Esta etapa será concretizada por investigadores externos qualificados, sendo os respectivos pareceres entregues num período não superior a três meses. Os revisores procederão à avaliação de forma objectiva, tendo em vista a qualidade do conteúdo da revista; as suas críticas, sugestões e comentários serão, na medida do possível, construtivos, respeitando as capacidades intelectuais do(s) autor(es). Após a recepção dos pareceres, o(s) autor(es) tem um prazo máximo de um mês para proceder às alterações oportunas e reenviar o trabalho.

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Para mais informações: ophiussa@letras.ulisboa.pt

EDITORIAL POLICY

Ophiussa – Revista do Centro de Arqueologia da Universidade de Lisboa started in 1996, with the edition of volume 0. From 2017, this journal is a printed and digital edition of UNIARQ – Centro de Arqueologia da Universidade de Lisboa.

The main objective of this journal is the publication and dissemination of papers of interest, quality and scientific rigor concerning Prehistory and Archeology, mostly from Europe and the Mediterranean basin.

Ophiussa – Revista do Centro de Arqueologia da Universidade de Lisboa will publish an annual volume. From 2018, submitted articles will be subject to a peer-review evaluation process. The submission period will always occur in the first quarter of each year and the edition will occur in the last quarter.

The journal is divided into two sections: scientific articles and bibliographic reviews. Exceptionally, texts of an introductory nature may be accepted, in the context of specific tributes or divulgations, which will not be submitted to peer-review evaluation. Exemptions from this evaluation are also the bibliographic reviews.

All submissions will be considered, in the first instance, by the Editorial Board, regarding its formal content and adequacy in face of the editorial policy and the journal's editing standards. Papers that meet these requirements will subsequently be submitted to a blind peerreview process (minimum of two reviewers). The Scientific Council, constituted by the directors of UNIARQ and external researchers, will follow the editing process.

This stage will be carried out by qualified external researchers, and their feedback will be delivered within a period of no more than two months. The reviewers will carry out the evaluation in an objective manner, in view of the quality and content of the journal; their criticisms, suggestions and comments will be, as far as possible, constructive, respecting the intellectual abilities of the author(s). After receiving the feedback, the author(s) has a maximum period of one month to make the necessary changes and resubmit the work.

Acceptance or refusal of articles will have as sole factors of consideration their originality and scientific quality. The review process is confidential, with the anonymity of the evaluators and authors of the works being ensured, in the latter case up to the date of its publication.

Papers will only be accepted for publication as soon as the peer review process is completed. Texts that are not accepted will be returned to their authors. The content of the works is entirely the responsibility of the author(s) and does not express the position or opinion of the Scientific Council or Editorial Board. The Journal *Ophiussa* follows the guidelines established by the Committee on Publication Ethics (COPE, the Ethics Committee Publications): <https://publicationethics.org/>

The editorial process will be conducted objectively, impartially and anonymously. Errors or problems detected after publication will be investigated and, if proven, corrections, retractions and / or responses will be published. Contributions submitted for publication must be unpublished. Article submissions can not include any problem of forgery or plagiarism. In order to detect plagiarism, the URKUNDU platform will be used.

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