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## **Molluscs in the Levantine Upper Palaeolithic: implications for modern human diets and subsistence behaviour**

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## **Chapter 7 • Discussion and Conclusion**

This thesis investigates the subsistence behaviour of early Upper Palaeolithic (including IUP and EUP) *Homo sapiens* based on the remains of molluscs and terrestrial animals recovered from the Ksâr 'Akil rockshelter in Lebanon. Specifically, I aimed to gain insight into the timing and intensity of shellfish exploitation in the Levantine early Upper Palaeolithic. To answer these questions, it was important to know (1) when early UP hunter-gatherers were using Ksâr 'Akil, (2) what marine and terrestrial resources were available in the surrounding landscape for EUP foragers to access, and (3) what the archaeological fauna assemblages (both molluscs and vertebrates) could tell us about how early Upper Palaeolithic foragers exploited those resources. In this chapter, I further discuss what influences that dietary choices may have had on human health and development and on population density. This is important, as increased population density is thought to influence human dispersal events and ties in with the debate surrounding early Upper Palaeolithic dispersals from the Levant into Europe. More specifically, this thesis addresses the following research questions:

- (1) When were early Upper Palaeolithic foragers using the Ksâr 'Akil rockshelter?
- (2) What do both the mollusc and vertebrate faunas from Ksâr 'Akil tell us about how early UP foragers exploited those resources, in terms of selection and frequency?
- (3) What role does shellfish exploitation play in early Upper Palaeolithic subsistence practices?
- (4) Are there differences between IUP and EUP subsistence strategies, and if so, how may they be explained?
- (5) Are there general inferences from the Ksâr 'Akil case study for wider debates about landscape use, human health, demography, and their potential relationships to human dispersals?

To pursue these research questions, I conducted zooarchaeological investigations combining optimal foraging theory using a diet breadth approach with nutritional ecology theory to evaluate subsistence practices and dietary adaptations of IUP and EUP groups. Specifically, I analysed mollusc assemblages to investigate shellfish use and consumption using a combination of zooarchaeological (including taphonomic), radiometric, and stable isotopic methods. These data were interpreted in the context of patterns and trends gleaned from the vertebrate faunal assemblage, using a diet breadth approach to evaluate the exploitation of both sets of animal food resources.

Below, I briefly summarise the results outlined in detail in the previous chapters, after which I discuss how these results contribute to addressing my research questions.

### **7.1 The Site of Ksar Akil and Its Vertebrate Assemblages**

Chapter 2 serves two purposes. First, it addresses the rationale behind choosing the site and the respective faunal assemblages studied in this thesis. Second, it provides zooarchaeological information (including the taphonomy and composition of the vertebrate fauna) to help contextualise the mollusc data discussed in Chapters 5 and 6. The Ksâr 'Akil faunal collections were selected for several reasons: (1) The site has played a central role in the Upper Palaeolithic dispersal debate because of its location in the Levantine Corridor (e.g., Bar-Yosef 1987) on the edge of Europe; (2) It is one of the few sites in the Levant with deeply stratified IUP and EUP deposits yielding rich mollusc and vertebrate assemblages; and (3) The IUP and EUP faunas had not been investigated from a zooarchaeological perspective and contained abundant small unidentifiable long bone shaft fragments. This indicates that there had not been a substantial excavation bias towards identifiable remains and/or that the collections had not suffered from post-excavation loss of 'uninteresting' (i.e., hard to identify) material. Analysing unidentifiable shaft fragments is important to determine skeletal element abundances and imperative to carry out in-depth taphonomic investigations needed to establish the extent to which the accumulation of bones has been biased by, for example, cortical surface weathering and carnivore ravaging. Such analyses are also critical for establishing the extent of human involvement evidenced by bone modifications such as cutmarks, impact fractures, and in some cases, burning.

Taphonomic investigations show that cortical bone surface preservation was sufficiently good to convey human and animal modifications and that the acid treatment prior to analysis did not substantially compromise the visibility of these modifications. The investigations further show

that carnivores contributed little to the formation of the IUP and EUP assemblages and that humans were the main contributor to the accumulation of these archaeological deposits.

In terms of NISP (Number of Identified Specimens) and relative abundance, the faunal composition shows that the onset of the Early Ahmarian (see Chapter 5) coincided with a shift towards a more even distribution of less-frequently obtained prey. This, in turn, suggests a general broadening of the human diet across various habitats and exploited faunal resources. From an optimal foraging perspective, using the broad-spectrum revolution hypothesis (Flannery 1969), such a broadening of the diet suggests an increase in dietary stress. This could be caused by an increase in population density or deterioration of environmental conditions resulting in a decrease in prey availability.

## **7.2 The Ksâr 'Akil chronology**

Chapter 3 presents a new chronology of the Ksâr 'Akil deposits and the implications of the age of specific technocomplexes and human fossils for understanding the timing and patterning of the early Upper Palaeolithic human colonisation of Europe. The new chronology was built on 16 AMS radiocarbon dates, which involved novel methodological approaches, partly developed in the framework of this thesis, to detect potentially compromised samples. The study employed rigorous evaluation of sample integrity and tested the validity of the chronology using four different independent data sets, namely amino acid racemization, geochemical characterization of all dated shells, oxygen isotope analyses, and Bayesian modelling.

Our proposed chronology is in line with previous age estimations by some scholars (e.g., Mellars and Tixier 1989) but deviates substantially from another recent chronology of the site (Douka et al. 2013). Douka et al. (2015) raised issues with how we constructed our Bayesian model and how we chose samples, although they stated that the  $^{14}\text{C}$  determinations themselves were not in question. Chapter 4 discusses the discrepancies between the two chronologies and proposes steps towards resolving the remaining questions. Douka et al.'s (2013) and our chronology provide age estimates that are approximately 3000–4000 radiocarbon years apart for both the IUP and EUP deposits, suggesting that either approach (or both) is subject to diagenetically or otherwise compromised samples. Douka et al.'s (2015) proposed alternative ways of modelling the data do not significantly alter our results, nor do their suggestions contribute to resolving why our radiocarbon data sets were so different. However, in the Supplementary Information from our original paper (Bosch et al. 2015a), we had already

narrowed down the potential sources of the differences between Douka et al.'s (2013) and our data sets to sampling strategy and/or pre-treatment method. It appears that the CarDS method used by Douka et al. (2013) does not in all instances eliminate all contamination, resulting in too young age estimations (see also Douka et al. 2011, 2013). Additionally, selecting beach-collected ornamental shells that show signs of diagenetic alterations—all samples used by Douka et al. (2013) are such beach-collected ornamental shells—for dating only serves to increase the risk of producing unreliable dates (see, for example, notes on the Columbelloidea and *Ostrea edulis* in Douka et al. 2013; see also Busschers et al. 2014; Stutz et al. 2015). AMS radiocarbon dating of shells is not without problems and is perhaps best avoided when other types of material (e.g., charcoal and bone) are available. Unfortunately, for Ksâr 'Akil there were no other organic materials available that could produce radiocarbon data. Moreover, one of the aims of this study was to date shellfish exploitation. Dating the shells of the exploited molluscs, therefore brought the 'dated event' (i.e., deposition of carbonates during the molluscs' life) as close as possible to the 'target event' (i.e., the time of shellfish exploitation). In sum, the best way forward is to select the best-preserved shells and find independent methods to determine whether a sample could be compromised.

### **7.3 Mollusc collection and taphonomy**

Moving to zooarchaeological investigations, Chapter 5 evaluates the integrity of the mollusc assemblage as well as potential biases (e.g., post-depositional processes, excavation, and collection bias). Although there is in some instances evidence of time averaging (i.e., the assemblages formed over an extended yet indeterminate amount of time), there is no tangible evidence for the actual mixing of deposits and/or archaeological materials either post-depositionally or post-excavation. Molluscs were used for several purposes. For example, they were utilised as tools, as seen in the examples of the retouched valve of a *Glycymeris* (Douka 2011) and another showing notches on both sides of the umbo, which was likely used as a container or for pouring (Bosch et al. 2015b). Molluscs were also used as a food resource, and perforated, beach-collected specimens were likely used as ornaments. The chapter especially focusses on the chronological patterns of change in the proportions of molluscs used as a food resource and as raw material for tools and ornaments. In general, topshells of the genus *Phorcus* and limpets comprising three taxa of patellids lack taphonomic damage indicative of post-mortem exposure to marine environments, suggesting that they were life collected. In addition, edge damage found on patellids is congruent with anthropogenic damage resulting from prying the

animals off the rocks. Furthermore, nearly all EUP *Phorcus* are devoid of their apex, which is evidence of a common practice to facilitate shellfish extraction by severing the ligament that attaches the animal to its shell.

In summary, the paper concludes that both *Phorcus* and *Patella* were consumed, and their shells were deposited at the site as food refuse. As for terrestrial taxa, *Helix pachya* demography reveals the sole presence of large adults. This selective rather than natural age profile, together with this taxon's frequent occurrence compared to other terrestrial taxa, suggest that *Helix pachya* was also consumed by the EUP and later Upper Palaeolithic occupants of Ksâr 'Akil. Finally, similar trends in morphometric analysis of both live- and beach-collected taxa suggested that average shell size variation was likely driven by environmental change affecting all measured taxa rather than by overharvesting of only the edible taxa by humans.

#### **7.4 Seasonality of shellfish exploitation**

Chapter 6 discusses the nature and timing of Upper Palaeolithic shellfish gathering at Ksâr 'Akil on the basis of results from oxygen isotope analysis of shells. Specifically, this chapter addresses when shellfish started to be habitually consumed at the site, what role shellfish played in past human subsistence strategies of people occupying Ksâr 'Akil, and whether any seasonal patterns of collection could be detected. The results indicate that shellfish exploitation was practiced from the second half of the IUP onwards. From the start of the EUP, this practice became more frequent and occurred throughout the year, albeit with a focus on the colder months. This indicates that coastal resources had a central, rather than a seasonally restricted supplementary, role in EUP foraging strategies. These data also provide better insight into the timing of site occupation, past hunter-gatherer mobility, and overall landscape use. The fact that the refuse of shellfish exploitation from all different seasons was recovered at the site implies that humans occupied the rockshelter at different times of the year, although not necessarily continuously. When these data were substantiated with evidence from other faunal categories, such as avian and micro- and macro-vertebrate assemblages, a general increase in the exploitation of different faunal resources and habitats from the EUP onwards becomes evident. In other words, our research indicates that EUP occupants of Ksâr 'Akil had a broader diet than their IUP forbearers.

## 7.5 Archaeological implications

Having summarised the different research projects carried out for this thesis, in the following section I discuss each of the research questions posed in the introduction and the archaeological implications of my research results.

### 7.5.1 When were early UP foragers using the Ksâr 'Akil rockshelter?

The chronology of the IUP and EUP assemblages at Ksâr 'Akil has broader implications for the debate surrounding early Upper Palaeolithic dispersals into Europe. The early Upper Palaeolithic of the Levant, including the IUP and EUP, is key in the debate over the timing of *Homo sapiens* dispersals into Europe. In light of the scarcity of early Upper Palaeolithic human remains in many parts of Europe, lithic assemblages are often used as proxies to track human dispersals through time and space (e.g., Mellars 1989, 2006; Bar-Yosef 1998, 2007; Davies 2001; Tostevin 2003; Hublin 2015). Such extrapolations should be treated with caution, especially when they are extended to other closely related assemblages, which are not associated with *Homo sapiens* remains, over a large geographical area. Nevertheless, several links were drawn between Levantine and European early Upper Palaeolithic technocomplexes based on similar lithic technologies (and sometimes also organic ones, such as split-based bone points and ornaments) (e.g., Mellars 1989; Davies 2001; Tostevin 2003; Zilhao 2006; Bar-Yosef 2007). The correlation of *Homo sapiens*-associated technocomplexes (e.g., the IUP/Emirian in the Levant) with similar technocomplexes (e.g., the Bohunician in Central Europe) allows tracking of potential dispersal routes in the archaeological record. Such archaeological data as well as genetic data suggest that the modern human colonisation of Europe happened in multiple dispersal episodes rather than in one large exodus (e.g., Davies 2001; Tostevin 2003; Reyes-Centeno et al. 2014, 2015; Hublin 2015).

Regarding the timing of early Upper Palaeolithic dispersals, on an interregional scale, similar Upper Palaeolithic lithic technocomplexes (e.g., IUP/Bohunician and Early Ahmarian/Proto-Aurignacian) first appear in the Levant, as Chapter 3 shows. However, on the basis of their proposed chronology, Douka et al. (2013) hypothesize that shell beads, and by proxy Upper Palaeolithic *Homo sapiens*, appeared first in Europe. These groups later moved into the Levant, which Douka (2013) describes as a 'cul-de-sac'.

Our new chronology for Ksâr 'Akil contributes to the debate on *Homo sapiens* dispersal patterns by providing age estimations for Upper Palaeolithic assemblages containing *Homo sapiens* fossils. Namely, IUP groups associated with the Ethelruda fossil in Layer XXV arrived at the site prior to 45.9 ka cal BP. Early Ahmarian groups, including those associated with the fossils of Egbert and a second individual in Layer XVII, were present between 43.3 ka cal BP and 40.0 ka cal BP.

Comparison of our age estimations with those of European *Homo sapiens* fossils places Ethelruda before the first occurrence of *Homo sapiens* in Europe. Similarly, Egbert's layer predates any known Aurignacian and other early Upper Palaeolithic *Homo sapiens* in Europe. Our data fit well with other early IUP and EUP Levantine sites, such as Boker Tachtit, Manot, Kebara (all Israel) and potentially Üçağızlı I (Turkey) (Marks 1983; Kuhn et al. 2009; Rebollo et al. 2011; Hershkovitz et al. 2015). The presence of both Upper Palaeolithic technocomplexes and *Homo sapiens* remains in the Levant prior to their occurrence in Europe indicates that *Homo sapiens* carrying an Upper Palaeolithic toolkit were present in the Levant before arriving in Europe. This contradicts Douka et al.'s (2013) hypothesis that Upper Palaeolithic *Homo sapiens* appeared first in Europe. In turn, this implies that the Levant served as a corridor for *Homo sapiens* dispersing out of Africa and into Europe rather than being a 'cul-de-sac' where *Homo sapiens* arrived after they dispersed into Europe.

From an archaeological perspective, the success of some of these early dispersals seems short-lived. For example, the central European Bohunician lithic technocomplex shows similarities with the Levantine Emirian but is argued to have no continuation into the subsequent European Upper Palaeolithic record, i.e. Aurignacian and Gravettian (e.g., Svoboda and Bar-Yosef 2003). In contrast, the Levantine Ahmarian that shares many traits with the European Proto-Aurignacian appears to be long lived (i.e., including Early and Late Ahmarian, which lasts >20,000 years) in the Levant (for a summary, see Goring-Morris and Belfer-Cohen 2003). Moreover, the Proto-Aurignacian seems to have (at least partly) developed into a widespread Early Aurignacian tradition in Europe. Thus, the archaeological record is congruent with genetic and fossil data suggesting that some of these Upper Palaeolithic dispersal events had more long-term success than others. This raises the important question of which factors facilitate long-term human expansion, to which I return below.

### 7.5.2 What do faunal assemblages tell us about early Upper Palaeolithic foraging strategies at Ksâr 'Akil?

In this section, I discuss how the Ksâr 'Akil faunas, both molluscs and vertebrates, inform us about how early Upper Palaeolithic foragers exploited those resources. However, I first highlight some aspects of past human diets that the Ksâr 'Akil case study cannot shed light on. For example, the lack of preserved and/or recovered plant remains hinders our understanding of the role of plant foods in Ksâr 'Akil diets. Henry and her team (Plant Foods in Hominin Dietary Ecology Research Group, MPI EVA) have endeavoured to extract information about plant foods from excavated sediments at the site as well as from dental calculus preserved on Mesopotamic fallow deer dentitions; unfortunately, they have had little success. The initial loss of the site's human remains, Ethelruda (which has recently been rediscovered; Metni 1999; Yazbeck 2004), and up to now still lost Egbert and his contemporary, make it impossible to assess their diet through stable isotope analysis, dental macro/microwear or dental calculus analysis. Moreover, the Ksâr 'Akil vertebrate bones do not generally preserve collagen (based on tests run by Nehlich and Talamo, Department of Human Evolution, MPI-EVA), which suggests that stable isotopic investigations would have been unsuccessful even if the human fossils were available.

Nonetheless, both the vertebrate and mollusc collections are informative about early Upper Palaeolithic diets in terms of habitat and resource exploitation. On the basis of faunal remains found at the site, we presume that from the IUP onwards, forests, open woodland, steppe/grassland, and—contrary to the preceding MP—steep rocky terrain were terrestrial habitats regularly exploited by humans (Bosch 2015). Marine habitats, specifically the eulittoral ones, started to be exploited from the second half of the IUP, whereas evidence for exploitation of freshwater and potentially brackish water habitats first appears in the EUP. The EUP deposits witness a higher variety of bird remains from different habitats, including winter guests that often reside in sheltered shallow sea coasts, brackish estuaries, and lagoons (Kersten 1991). Oxygen isotope analysis on intertidal gastropods suggests that humans were present in winter, and therefore, Ksâr 'Akil's inhabitants might well have encountered these birds in brackish water environments. However, whether these bird species were consumed remains unclear, as no anthropogenic modifications on their bones have to date been identified. Thus, it seems that early Upper Palaeolithic foragers exploited a wealth of habitats in the vicinity of the site. The dominance of woodland species including the three species of deer (i.e., *Cervus elaphus*, *Dama mesopotamica*, and *Capreolus capreolus*) and wild boar (*Sus scrofa*) suggests that foragers were geared towards exploiting the Mediterranean woodland zone in which Ksâr 'Akil is located.

Judging from the vertebrates from square F4, the start of the IUP is signified by the discontinuation of Rhinoceros (cf. *Stephanorhinus kirchbergensis*) remains and the introduction of smaller-bodied mammals such as *Capra ibex*, *Gazella* cf. *gazella*, *Lepus* sp., *Vulpes vulpes*, and *Felis silvestris*. Throughout the early Upper Palaeolithic, vertebrate faunal composition stays largely the same and includes, aside from the above-mentioned taxa, *Cervus elaphus*, *Dama mesopotamica*, *Capreolus capreolus*, *Bos* sp., *Capra aegagrus*, *Gazella* cf. *dorcas*, *Sus scrofa*, *Testudo* sp., and various bird and carnivore taxa. *Dama mesopotamica* is the dominant species, and indices of taxonomic heterogeneity (H), evenness (e), and dominance (1/D) are similar (see Chapter 4). Thus, the number of exploited taxa does not change significantly across the studied assemblages, and moreover, the assemblages are neither heterogeneous nor dominated by a single species. However, faunal composition does change, especially between the IUP and EUP layers where a shift to a more evenly distributed occurrence of various less-common small-bodied taxa occurs. From an optimal foraging perspective, this suggests that hunter-gatherer subsistence strategies were not simply opportunistic. Although people were not specialising on a single species, overall, they seem to have focussed on targeting size three class animals (i.e., ~50–200 kg), and, to a lesser extent, size two class (i.e., ~20–50 kg) ungulates.

### **7.5.3 What role does shellfish exploitation play in early Upper Palaeolithic subsistence practices?**

The anecdotal occurrence of edible mollusc taxa in the IUP deposits at Ksâr 'Akil, including *Phorcus turbinatus*, *Patella* sp., and *Helix pachya*, suggests that mollusc exploitation was not regularly part of IUP foraging strategies. This changes during the EUP deposits, from which the remains of hundreds (n = 254) of edible molluscs were recovered. Due to the steep coastal morphology, potential sea level changes between these periods are not likely to have caused changes in availability of edible rocky shore molluscs. Therefore, the perceived increase in shellfish exploitation, is likely caused by a change in foraging behaviour. Moreover, mollusc remains recovered at Ksâr 'Akil probably only represent a fraction of the actual shellfish consumed by humans. Ethnographic examples suggest that shellfish are mostly eaten at the shore rather than transported to a site at least three kilometres from the shore (e.g., Meehan 1982; Claassen 1998). Bird and Bliege Bird (1997), however argue, based both on ethnographic observations and central place modelling predictions, that intertidal rocky shore molluscs are those most likely to be taken back to home bases. Oxygen isotope analyses on final growth increments of the most common edible taxon *Phorcus turbinatus* indicate that, during the EUP,

intertidal molluscs were gathered throughout the year, but with a focus on the colder months. In fact, this pattern is also evident in most of the overlying Upper Palaeolithic and Epipalaeolithic, albeit with perhaps a more restricted autumn-winter exploitation during the Atlitian (32.7–31.9 ka cal BP).

As mentioned in the introduction, the exploitation of shellfish and other aquatic resources is thought to have been important at several key points in hominin evolution, for example, during early hominin encephalization (e.g., Cunnane and Crawford 2014; Joordens et al. 2014; Kyriacou et al. 2016) and as a fall-back food resource in lean times (e.g., Meehan 1977; Waselkov 1987; Prendergast et al. 2016). The exploitation of coastal habitats has played a somewhat prominent role in debates concerning the development of inter-group behaviour (e.g., Marean 2014, 2015; see also Lahr et al. 2016 for a similar discussion involving lake shores), and the predictable availability of intertidal molluscs has been argued to facilitate dispersals along coastal routes (e.g., Stringer et al. 2000; Mannino and Thomas 2002; Finlayson 2005; Mellars 2006; Fa 2008). Furthermore, incorporation of shellfish into the diet is sometimes seen as evidence of intensified use of resources, and in turn, is considered an indicator of reduced residential mobility and/or population pressure (e.g., Stiner 2001, 2009; Steele and Klein 2013; Marean 2014). In the following sections, I discuss how the Ksâr 'Akil data may or may not contribute to these debates. Naturally, the Ksâr 'Akil data set cannot contribute to the discussion of early hominin brain development. However, at the end of this section, I discuss the implications and potential health benefits of introducing shellfish to the diet from a nutritional ecology perspective, including those for foetal and child brain development

#### *7.5.3.1 A fall-back resource in lean times*

Ethnographic studies have shown that intertidal marine molluscs may be used as fall-back food resources in lean times (e.g., Meehan 1977; Waselkov 1987) due to the ease of access and their year-round availability (e.g., Shackleton and van Andel 1986; Kyriacou et al., 2014; Marean, 2014; Jerardino, 2016). Several studies have investigated the seasonality of shellfish exploitation to test this archaeologically (e.g., Shackleton 1973; Mannino et al. 2007, 2014; Colonese et al. 2009; Prendergast et al. 2016). The rationale behind these studies is that shellfish, as a low-ranking foodstuff, were only gathered if hunting of more profitable prey failed. For example, for the eastern Mediterranean, Prendergast et al. (2016) have compared the timing of terrestrial faunal exploitation with that of shellfish. They found that during the Epipalaeolithic Capsian and Neolithic periods at Haua Fteah (Libya), most of the recovered shellfish were gathered in winter, whereas terrestrial fauna exploitation predominantly occurred in summer. This led Prendergast

et al. (2016) to suggest that, during the Capsian and Neolithic, shellfish were indeed relied upon during times of the year when terrestrial fauna might have been sparse.

For Ksâr 'Akil, investigations on the seasonality of terrestrial fauna exploitation are in progress. Therefore, patterns in shellfish exploitation and hunting strategies of terrestrial animals can at present not be compared. However, our oxygen isotope data suggest that, although EUP shellfish exploitation seems to have been more prominent during the colder half of the year, shellfish collection occurred throughout the year. This suggests that shellfish played a more central role in human foraging strategies rather than a restricted seasonal one.

#### 7.5.3.2 Overharvesting

Shellfish exploited at Ksâr 'Akil are predictably found on the intertidal rocky shores they inhabit. Like any slow-moving animal (e.g., tortoise), they are at risk of being overexploited, resulting in diminishing populations and an easily depleted food source (e.g., Stiner et al. 2000; Mannino and Thomas 2002; Fa 2008; Steele and Klein 2013). The importance of shellfish gathering at Ksâr 'Akil steadily increased from the IUP to the Epipalaeolithic; therefore, the potential of overharvesting needs to be explored. Humans tend to select the larger specimens of a species to maximize net return rates, as is, for example, evident from the mortality profile of the terrestrial snail *Helix pachya*, which at Ksâr 'Akil consists entirely of mature individuals in the top 10% of their size range across all deposits. If molluscs were overharvested, this would result in a decrease of average shell size. Several studies have employed morphometrics on intertidal molluscs to ascertain whether taxa were overharvested (e.g., Mannino and Thomas 2002 and references therein; Steele and Klein 2013), although size change can also be triggered by other factors such as changes in environmental conditions or coastal morphology. Among the marine taxa at Ksâr 'Akil, *Phorcus turbinatus* was most frequently exploited. Although there is a small increase in the frequency of all three *Patella* species in Layers XVII and XVI, there were not sufficient numbers of well-preserved specimens available to include them in the study of overharvesting.

The results of our oxygen isotope study suggest that sea surface temperatures became colder towards the Epipalaeolithic. Additionally, no significant changes in taxonomic diversity of molluscs could be detected across assemblages. This suggests that the temperature change remained within the temperature tolerance of the various taxa, and their populations as a whole were not majorly affected by the temperature change. Alternatively, various taxa adapted to these changing temperatures with similar success. It further indicates that no edible mollusc was

exploited in larger quantities than others which would result in a decrease in relative abundance for that taxon (e.g., Yesner 1987).

To investigate potential overharvesting, I compared changes in the dimensions of life collected *Phorcus turbinatus* with those of the two most abundant beach-collected taxa, namely *Tritia (Nassarius) gibbosula* and *Columbella rustica*— the hypothesis being that if *Phorcus turbinatus* was overharvested they would show an observable decrease in average shell size, which would not necessarily be evident in the beach-collected taxa (as collecting already dead, beached specimens would not affect the average shell size of the living populations). If, however, a potential decline in shell size was caused by deteriorating environmental conditions, the expectation would be that both life- as well as beach-collected taxa would be affected in similar ways, as taxonomic composition did not significantly change. Results showed that not only did *Phorcus turbinatus* shell size increase significantly from the EUP to Upper Palaeolithic, similar significant increases were also recorded for both *Columbella rustica* and *Tritia gibbosula*. Thus, despite the steady increase in importance of shellfish gathering from the IUP to the Epipalaeolithic, there is no evidence for long-term overharvesting of these coastal resources. In terms of foraging behaviour this suggests that shellfish were an occasional supplement to the diet, but contrary to other sites, they were exploited throughout the year.

#### 7.5.3.3 Intergroup behaviour: hyperprosociality

The exploitation of coastal habitats has been key in debates surrounding the development of modern human inter-group behaviour during the Southern African late MSA (e.g., Marean 2014, 2015). Marean (2014) hypothesises that consistent use of coastal habitats gave rise to the need to defend these territories, which likely led to inter-group conflict. This, in turn, would have stimulated intra-group cooperative behaviours and so-called hyperprosociality (*sensu* Richerson and Boyd 2008). Marean (2015) argues that this hyperprosociality is one of the trademarks unique to modern humans. Marean's hypothesis assumes reliance on intertidal marine resources and, therefore, a central role of the coastal zone in hunter-gatherer mobility. From this, questions have arisen as to what the definition of coastal adaptation is, what the systematic utilisation of coastal resources entails, and whether dependence of coastal habitats appeared gradually or abrupt (e.g., Jerardino 2016).

Marean (2014) argues that in order to speak of full coastal adaptation the exploitation of coastal habitats should be a central part of subsistence and mobility strategies and marine foods should form a substantial part of the diet. For example, in terms of shellfish gathering, it has been suggested for the oceanic South African coast that collecting species from the lower intertidal

may require planning and adept knowledge of the tidal cycle (e.g., Marean 2014; Jerardino 2016). Selection of these lower intertidal taxa, therefore, would represent a full-fledged premeditated adaptation to coastal subsistence (Jerardino 2016). Below I explore whether we observe similar patterns in the eastern Mediterranean and if we can speak of coastal adaptation with regard to the year-round shellfish gathering evidenced from Ksâr 'Akil.

All intertidal rocky shore species consumed at Ksâr 'Akil have slightly different preferences regarding their microhabitat. For example, *Phorcus turbinatus* is less tolerant to salinity and temperature changes than *Phorcus articulatus* (Schifano and Censi 1983; Menzies et al. 1992). As a result, *Phorcus turbinatus* favours the lower and mid-intertidal zone that is regularly flushed out by marine tidal water, whereas *Phorcus articulatus* tends to forage in rock pools higher on the shoreline (e.g., Menzies et al. 1992; Mannino et al. 2008; Prendergast et al. 2013). Regarding the Patellidae, *Patella rustica* prefers vertical walls and steep surfaces in the upper eulittoral zone (e.g., Lima et al. 2006), whereas *Patella caerulea* frequents relatively horizontal surfaces in the lower parts of the eulittoral zone (e.g., Bannister 1975). Lastly, *Patella ulyssiponensis* prefers pools and crevasses in the low- (to mid-) intertidal zone (Firth and Crowe 2008).

Therefore, does the abundance of *Phorcus turbinatus*, favouring the lower tidal zone, among the exploited taxa signify a similar premeditated coastal foraging strategy, as has been argued for prehistoric humans collecting the South African lower intertidal taxa?

The eastern Mediterranean intertidal zone is much narrower (10–20 cm) than the South African oceanic coast (>1metre). As a result, niche partitioning in the case of Mediterranean rocky shore molluscs does not reach the same extent as oceanic molluscs (e.g., Fa 2008), and all five taxa are often found in close proximity. Moreover, in rock pools that are frequently affected by wave action, one can often find both species of *Phorcus* in the same rock pool. On days with calm seas, most of the taxa in question can easily be collected even when the tide is not fully low due to the generally low tidal action. Thus, the abundance of *Phorcus turbinatus*, favouring the lower tidal zone, across the Ksâr 'Akil sequence does not necessarily suggest that Upper Palaeolithic hunter-gatherers inhabiting the site were fully adapted coastal foragers. This is confirmed by the lack of evidence for overharvesting.

According to Marean's (2014) criteria, no full coastal adaptation can be identified at Ksâr 'Akil. In terms of systematic utilisation of coastal resources, however, the seasonality data derived from oxygen isotope analysis suggest that during most of the Upper Palaeolithic, including the EUP, shellfish were exploited throughout the year. This suggests that coastal habitats were regularly included in subsistence strategies.

Another question is whether dependence of coastal foraging happened gradually or abruptly. With regard to Ksâr 'Akil and the eastern Mediterranean, note that regular visits of coastal habitats are not the same as a dependence on coastal habitats. However, it seems that during the IUP, the hunter-gatherers using Ksâr 'Akil made trips to the coast, but mainly to collect beached shells as raw material for tools and ornaments. Although it can of course not be excluded that during these trips shellfish were consumed at the coast, they were only rarely taken back to the rockshelter. From the EUP onwards, shellfish exploitation increased gradually. Year-round exploitation of shellfish further suggests that, although there seems to be an emphasis on collecting during the colder part of the year, exploitation of coastal habitats was not a seasonally restricted activity. Thus, these habitats were frequented increasingly often, and intertidal molluscs likely played a central role in hunter-gatherer subsistence.

#### *7.5.3.4 Facilitating coastal route dispersals*

The richness and predictability of coastal resources are also seen by some as an argument in favour of *Homo sapiens* dispersals along coastal routes (e.g., Stringer et al. 2000; Finlayson 2005; Mellars 2006). In unknown terrain, hunting terrestrial fauna might prove difficult, whereas marine molluscs are generally abundantly available on intertidal rocky shores. However, Fa (2008) argues that the low tidal amplitude of the eastern Mediterranean shores, due to the reduced zonations, would have supported fewer edible littoral molluscs than, for example, the shores of the western Mediterranean or South Africa. He further argues that, therefore, shellfish communities in the eastern Mediterranean would be rapidly depleted. This, in turn, would necessitate moving to a new coastal patch and thereby increase hunter-gatherer mobility. Similarly, Mannino and Thomas (2002) suggest that localised over-exploitation and patch depletion of intertidal rocky-shore molluscs would have resulted in increased residential mobility (*sensu* Binford 1980) if large-scale human dispersals along coastal routes were the result of many small-scale dispersal events and if subsistence practices relied substantially on exploiting coastal resources. In these scenarios, the availability of edible shellfish would influence human mobility and dispersals, although short-term local over-exploitation would not necessarily be evident in the archaeological record, as humans would be passing through rapidly and might not have had a long-term impact on mollusc communities (Fa 2008).

Dispersal patterns are better explained from a multi-site perspective; however, Ksâr 'Akil is often mentioned in the early Upper Palaeolithic dispersal debate. The site's location on the eastern Mediterranean coast with its low carrying capacity does fit the scenarios proposed by Fa (2008) and Mannino and Thomas (2002). Additionally, the lack of evidence of overexploitation in

the (early) Upper Palaeolithic may be explained by Fa's (2008) hypothesis of people quickly passing through. However, the intensity of site occupation and the diversity in the archaeological material culture suggest that Ksâr 'Akil was used as residential base rather than an ephemeral short-term camp.

#### *7.5.3.5 Population pressure: reduced residential mobility*

Contrary to the coastal dispersal hypothesis, evidence for the intensified use of coastal resources is often considered an indicator of reduced residential mobility and of population pressure (e.g., Stiner 2001, 2009; Steele and Klein 2013; Marean 2014). Based on optimal foraging theory, the broad-spectrum revolution hypothesis (Flannery 1969) suggests that increased population density can be seen in the archaeological record by a diversification in exploited faunal taxa. For the eastern Mediterranean, for example, increased dietary breadth, and especially the inclusion of small-bodied fast-moving taxa, has been documented for the Upper Palaeolithic (e.g., Stiner et al. 1999; Stiner 2001; 2010). Incorporation of shellfish into the diet arguably would have allowed for higher population densities (e.g., Stiner 2001) or would have sustained smaller groups for a longer time (e.g., Finlayson et al. 2006; Fa 2008; Prendergast et al. 2016).

Hunter-gatherer foraging strategies are highly variable (e.g., Kelly 1995), but they are generally grouped into two overarching strategies: (1) residential mobility in which a group's camp is moved to a new location when resources run low (i.e., resulting in frequent residential moves); and (2) logistical mobility with a central multipurpose camp to which resources are moved from a multitude of short-term camps that are close to key resources (i.e., resulting in less frequent residential moves) (Binford 1980). Residential mobility patterns are sometimes suggested to involve seasonal moves and follow an annual circular pattern (e.g., Binford 1980). They are found in a variety of environments from the arctic steppe to tropical forests (Gamble 1986; Kelly 1995) and are thought to be relatively stable because the seasonal moves would avoid overexploitation and resource depletion (see, e.g., Lieberman 1993). Logistical mobility patterns, however, are less common in modern hunter-gatherers (Kelly 1995) and more unstable in most environments due to the risk of resource depletion (Lieberman 1993). To evaluate this in the southern Levant, Lieberman (1993) conducted seasonality studies using seasonal bands in gazelle dental cementum. Results indicated the use of seasonally restricted sites, which he considers indicative of residential mobility, for most of the Upper Palaeolithic (with the exception of the Natufian). He argues that hunter-gatherer logistical mobility is only possible through trade with non-hunter-gatherers or in extremely rich environments such as what he calls 'marine' habitats or sites located in proximity to multiple exploitable habitats.

As mentioned above, Ksâr 'Akil was likely used as a residential camp, and during the EUP, people frequented the site in all seasons. Lieberman (1993) suggests this pattern could be indicative of a logistical mobility strategy (Binford 1980), characterized by extended habitation episodes spanning multiple seasons, but in theory could also signify a residential mobility strategy, involving multiple short-term visits throughout the year rather than a few seasonally restricted ones. This pattern could also be caused by multiple groups visiting the site in different seasons. The absence of evidence for overexploitation of marine molluscs may be indicative of multiple short-term stays. However, EUP foragers using Ksâr 'Akil were not dependent on coastal resources alone. The eastern Mediterranean woodland zone is rich in a variety of floral and faunal resources (e.g., Danin 1992). In summary, although it is hard, if not impossible, to make any statements on regional mobility patterns based on seasonality of exploitation of a single site, the Ksâr 'Akil microhabitat appears extremely rich, especially when compared with other sites in the region (e.g., Mt. Carmel and Negev sites). This may explain why seasonality patterns are different here than in other parts of the Levant and why a radiating mobility strategy may have been sustainable in this instance.

#### *7.5.3.6 Shellfish exploitation and human health*

From the EUP onwards, shellfish were used regularly as a dietary supplement throughout the year. The contribution of shellfish to past hominin diets has been considered marginal for most of the Palaeolithic (e.g., Erlandson 1988; Erlandson and Moss 2001; Colonese et al. 2011; Clark and Kandel 2013; Jerardino 2015). This is certainly true for Ksâr 'Akil when considering an optimal foraging model, which primarily considers the caloric value and energy intake of foodstuffs (see also Stiner 2001, 2010). However, nutritional ecology theory suggests that the dietary implications of including shellfish in the diet are perhaps more influential in terms of micro (essential) nutrients (e.g., vitamins and minerals) than in terms of macro (protein) nutrients.

Hockett and Haws (2003; Haws and Hockett 2004) argue that diversification of foods would result in a more varied and nutritious diet. One way of doing this is to incorporate shellfish rich in essential nutrients into the diet, whereas another way would be to increase consumption of terrestrial-based animal organs and/or to eat more and diverse plant foods.

Nutritional ecology theory is about quality of the diet, not the quantity of food; therefore, the presence of low quantities of shellfish, as is evident at Ksâr 'Akil, is informative about their dietary nutritional value. Shellfish are rich in several nutrients (e.g., vitamins A, B12, C, D, E, iron, folate, omega-3 fatty acids, potassium, calcium), which are needed for several biological systems to operate properly, if for example, the immune system (vitamin A), blood formation and oxygen

transport (B12 and iron), bone mineralisation (D and calcium), collagen synthesis and wound healing (C), the nervous system (B12 and E), heart function (potassium), muscle and body growth (A and E), vision (A), and brain function (B12, E, folate, and omega-3 fatty acids). Folate and omega-3 fatty acids are thought to be especially important in foetal and infant brain development (e.g., Brenna and Carlson, 2014; Cunnane and Crawford 2014).

Changing the currency of the foraging model from energy to essential nutrients opens up a new area of exploration in human dietary studies. For example, it is known that especially pregnant women and children require more omega-3 fatty acids and higher-quality nutrition in general. However, Parkington (2003) has argued that prehistoric women are more likely to have had access to nutritionally rich aquatic resources rather than terrestrial ones such as organ meat and brains (see also Claassen 1998). This is because the latter tissues decay quickly, and most would probably have been eaten immediately by the hunters. Among modern hunter-gatherers, shellfish are mainly gathered by women and children, providing them access to the much-needed essential nutrients (e.g., Meehan 1982). From a nutritional ecology perspective, this access to nutritionally rich resources and their inferred benefits to personal and population health, could have contributed to the EUP population increase (Hockett and Haws 2003), which in turn, could have facilitated human dispersals into Europe (see section 7.5.5). Furthermore, access to these foods could have given shellfish-eating groups a key advantage in competition with others exploiting similar geographic regions and environments who solely subsisted on terrestrial resources.

#### **7.5.4 Are there differences between IUP and EUP subsistence strategies, and if so, how may they be explained?**

At Ksâr 'Akil, no dietary diversification is evident in the IUP. Similar to the MP, faunal exploitation in the IUP is dominated by few species, namely *Dama mesopotamica*, *Capra aegagrus*, and *Sus scrofa*. Moreover, shellfish exploitation seems to have occurred in low quantities only in the later stages of the IUP, i.e., from Layer XXII onwards. However, there is no evidence that these taxa were exploited from the start of the IUP, i.e., contemporary to the *Homo sapiens* fossil named Ethelruda from Layer XXV prior to 45.9 ka cal BP.

Landscape use changed slightly with the onset of the EUP. This is evident from an increase in the exploitation of coastal habitats and steep rocky terrain between 43.3 and 40.0 ka cal BP, dates which are associated with the skeleton of Egbert and his contemporary in Layer XVII. In

turn, subsistence strategies broadened with the inclusion of new taxa, e.g., intertidal marine molluscs (*Patella rustica*, *Patella caerulea*, *Patella ulyssiponensis*, *Phorcus articulatus*) and higher frequencies of terrestrial molluscs (*Helix pachya*), small to medium ungulates such as Nubian Ibex (*Capra ibex*), and a larger gazelle (*Gazella* cf. *gazella*), as well as more evenly represented small mammals among the less common taxa (see Chapter 2).

Shellfish were exploited year-round, suggesting that these resources were eaten regularly, albeit likely in small quantities, and not only during the winter when other resources might be sparse. Even when consumed solely as a dietary supplement, rather than representing the bulk of the diet, shellfish provide an array of essential nutrients to the diet. Thus, from a nutritional ecology perspective, EUP diets at Ksâr 'Akil are likely more balanced and nutrient rich than diets during the IUP. This perceived improvement in dietary health may have triggered lower interbirth intervals, a decrease in child mortality, and in turn, may have contributed to the observed increase in population density in the EUP.

#### **7.5.5 Are there general inferences from the Ksâr 'Akil case study for wider debates about landscape use, human health, demography, and their potential relationships to Upper Palaeolithic dispersals?**

Not much is known about the seasonality of shellfish exploitation for the eastern Mediterranean Palaeolithic. However, there are an increasing number of regional sites that attest to shellfish consumption during the Palaeolithic. It is important to note that, although there is no evidence for shellfish exploitation prior to the IUP at Ksâr 'Akil, such evidence does exist at other Eastern Mediterranean sites (e.g., Colonese et al. 2011) and in the 'pre-Aurignacian' deposits at Haua Fteah in Libya (Klein and Scott 1986; Barker et al. 2012; Hill et al. 2015).

The site of Üçağızlı I in southeastern Turkey is very similar in terms of material culture and richness of deposits (e.g., Kuhn et al. 2001, 2009) to both the IUP and EUP occupations at Ksâr 'Akil. Similarly, exploitation of coastal resources is also quite similar. For example, at the onset of the IUP, the Üçağızlı I mollusc assemblage comprises almost exclusively beach-collected marine shells, which were probably used as raw material for tools and ornaments. Shellfish gathering for subsistence purposes is first recorded in the second half of the IUP deposits, and at both sites, shellfish exploitation becomes more frequent from the EUP onwards (Stiner 2010).

The dietary diversification during the EUP at both sites could be explained by an increase in population density in the eastern Mediterranean forest zone in which both sites are situated. Bar-

Yosef (1978) sees a similar increase in sites with EUP or Early Ahmarian lithic artefacts and sites more frequently located in semi-arid environments when compared to the IUP. He argues that this pattern testifies to the improved adaptive strategies of the Early Ahmarians compared with people in preceding periods.

As mentioned in the introduction, many scholars have argued that, at the onset of the Upper Palaeolithic, parts of Eurasia saw an increase in population density. The EUP shows increasing population density both in the Levant (e.g., Bar-Yosef 1987; Goring-Morris and Belfer-Cohen 2003) and Europe (e.g., Bocquet-Appel et al. 2000; Lahr and Foley 2003; Davies 2007; Mellars and French 2011). From the EUP onwards, *Homo sapiens* dispersed into Europe in steadily rising numbers. What were the underlying factors that facilitated this process?

Factors that are thought to play key roles in human dispersals are (high) mobility, (high) population density, and changing (either improving or deteriorating) or instable environmental conditions (e.g., Shennan 2001; Henrich 2004; Powell et al. 2009; Grove et al. 2015). Both improving and deteriorating environmental conditions may trigger population movements into new territories (i.e., dispersal). Conceivably, groups move away from their original territory and inhabit new (more favourable) ones in deteriorating conditions. This would result in lower population densities in the original territory. Inversely, favourable environmental conditions may allow for population increase and the need for additional territory (i.e., range expansion), resulting in increasing population density in both the original as well as the new territory. For range expansion to be successful, sufficient population density needs to be maintained to ensure long-term occupation of and connectivity within increased territory (e.g., Powell et al. 2009).

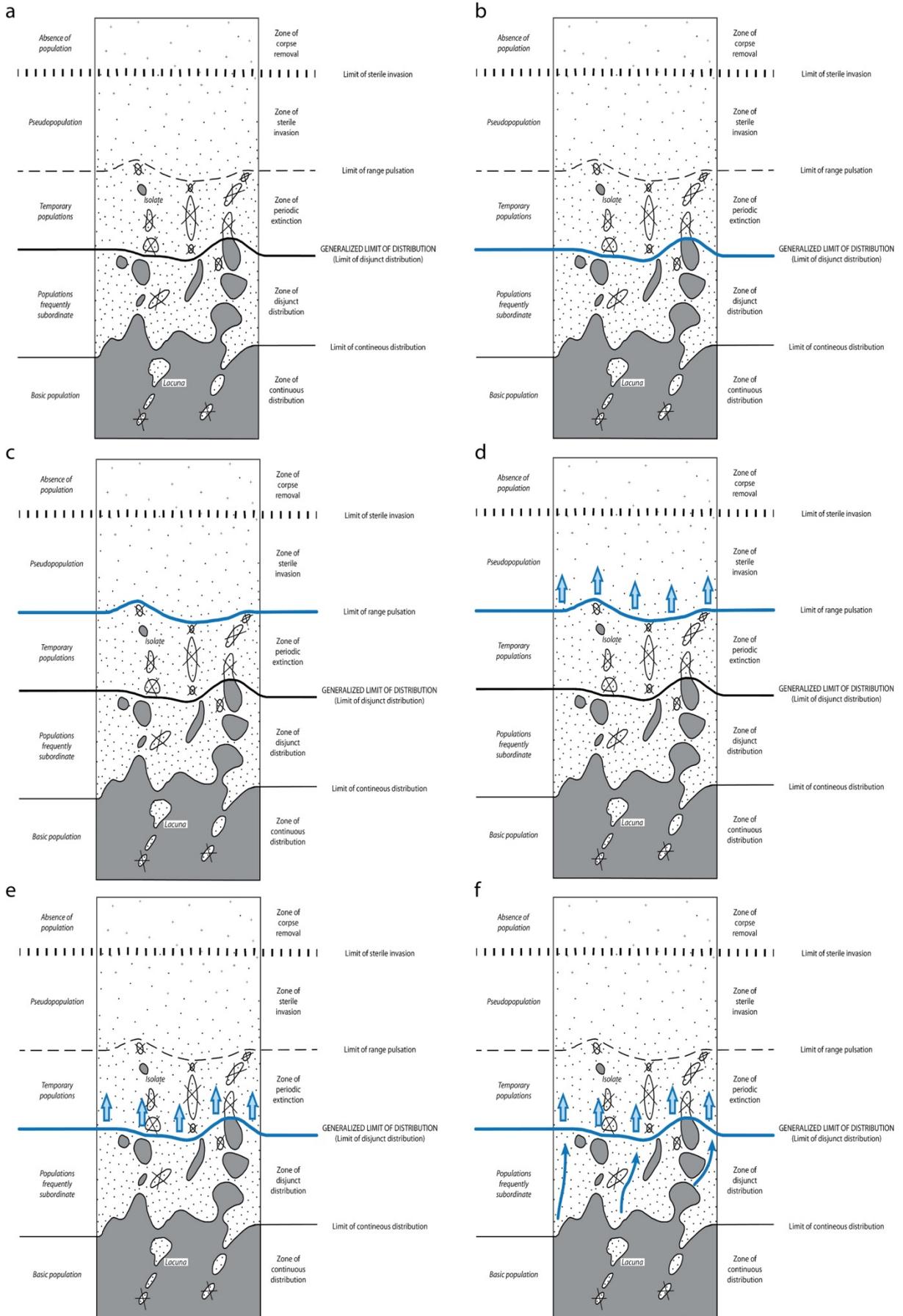
Gorodkov's (1986) ecological model of a species range is a useful framework to consider dispersal mechanisms (see Fig. 7.1a). He describes the distribution of a species as a gradual transition from optimal zones with high populations (zone of continuous distribution; Fig. 7.1b) to less densely populated minimal zones (zone of insular distribution; Fig. 7.1c), to a zone where populations suffer from isolation and periodic die-offs under extreme conditions (zone of periodic extinction), and finally a zone of sterile invasion. Gorodkov (1986) argues that range expansion can be achieved through several mechanisms: (1) expansion of the optimal zone or the zone of continuous distribution (Fig. 7.1e), for example, by climate improvement to more ambient conditions or by behavioural adaptations that help cope with habitats previously regarded as suboptimal (Fig. 7.1 d); (2) highly mobile taxa can have an apparent continuous presence in the zone of periodic extinction by compensating for partial die-offs by immigration from more favourable regions (i.e., the zone of continuous distribution; Fig. 7.1f).

The long-term success of dispersal into the zone of sterile invasion, which was previously outside of the taxon's range, depends on the capability of a species to disperse and make immediate use of any favourable change in climatic or biotic situations for extending its range. In this light, Gorodkov (1986) suggests that the limit of range pulsation may be pushed forward by adaptation (physical or social) of a species to cope with harsher environmental conditions than before. Grove (2016; Grove et al. 2015) argues that in the past many major dispersal events were preceded by episodes of instable climatic conditions. These created the need for a higher level of climatic tolerance, or in other words, the ability to adapt to a variety of habitats and environmental conditions. This increased adaptability would consequently be expressed in dispersal events in subsequent stable climatic conditions.

The observed intensification of habitat exploitation at Ksâr 'Akil but also the broader regional expansion into semi-arid environments as highlighted by Bar-Yosef (1987) could be indicative of the increasing adaptability of EUP hunter-gatherers. However, it is unclear how useful some of these traits were to groups dispersing into central and eastern Europe where foods such as edible terrestrial molluscs were available and steep rocky terrain as well as riverine and lake environments may have been encountered; coastal zones are clearly absent. Even if all adaptations were not useful in new environments, increased population density in the optimal zone may push forward the boundaries of this zone and would instigate dispersals into less amiable territories such as the zone of periodic extinction (Fig. 7.1f).

In addition, although in ecological terms the general limit of a species' range is placed at the limit of the zone of discontinuous distribution, from an archaeological perspective, one might consider exploiting the edge of the zone of periodic extinction because temporary occupation might leave archaeological remains. Thus, population pressure resulting in more dispersals into the zone of periodic extinction would increase archaeological visibility in this zone. Although periodic extinctions would still occur, they would appear to be (falsely) continuous to archaeologists because of the timescales they are forced to work with.

Figure 7.1 (next page): (a) Ecological model of a species range redrawn after Gorodkov (1986) and Roebroeks (2006). (b) The maximum extent of the zone of continuous distribution (blue). (c) The maximum extent of the zone of insular distribution. (d) Range expansion where environmental change and/or human adaptation enables survival in habitats previously beyond the species range. (e) Range expansion where environmental change and/or human adaptation enables dispersals into the discontinuous zone without changing the limits of this zone. (f) Range expansion fuelled by increased population density in the zone of continuous distribution.



Therefore, taking the Ksâr 'Akil data as an example, the observed regular shellfish consumption and increased diet breadth would add a range of essential nutrients to the diet. The intake of these resources would result in healthier populations with greater reproductive success and ultimately contribute to population increase. Higher population density, in turn, could fuel dispersals that are either successful due to the increased adaptability of EUP groups to a higher variety of environments or a series of less successful dispersals which leave a multitude of ephemeral sites resembling a zone of continuous distribution in the archaeological record. These possible outcomes raise several important questions for future research. For example: Is there evidence for populating the central and eastern European landscape with dispersing groups coming from the Levant? What is the longevity of early Upper Palaeolithic groups settling in Europe? How can we gain better insight on the scale of increasing population density during the EUP in the eastern Mediterranean woodland zone? Were the foraging strategies employed in the Levantine EUP also used in European inland sites?

## **7.6 Future research: mobility, dispersals, and shell beads**

The discussions above stimulate a number of potential avenues for future studies. Such research would contribute to a better understanding of early Upper Palaeolithic *Homo sapiens* population dynamics in the Levant as well as of early Upper Palaeolithic dispersals into Europe and the mechanisms driving and/or aiding them.

To broaden our knowledge on seasonal activities during the IUP and EUP at Ksâr 'Akil and to provide a better view on the full extent of site occupation and the timing of resource exploitation, the seasonality of the terrestrial fauna should be investigated to complement the seasonality signal provided by the molluscs. Similarly, on a larger scale, to better grasp mobility strategies and population dynamics in eastern Mediterranean EUP, more data are needed on the seasonal patterns of shellfish exploitation from other sites. Ksâr 'Akil is the first site for which such a seasonality study of EUP molluscs has been undertaken. Similar investigations, for example, on the mollusc assemblages of Üçağızlı I, would serve to reinforce or complement the Ksâr 'Akil data set. Such data should be compared with seasonality data from other Levantine sites, which would allow for an evaluation of a wide array of subsistence and mobility strategies of past hunter-gatherers on a broader regional scale (e.g., Lieberman 1993). This, in turn, may help us gain better insight into the scale of increasing population density in the Levant during the EUP.

Another way to look at EUP dispersals is through the use of shells as personal ornaments. This type of symbolic behaviour is argued to be important in maintaining contact over long distances and may inform us about contacts between Levantine and European groups. Gamble (1998) argues that objects with symbolic meaning and the ability to transfer the properties of people to objects are key in negotiating extended and/or global networks. In this framework, socially imbued objects are needed to overcome the problems of stretching social systems to the point where people are no longer in direct contact (i.e., extended and global networks) to identify distant relatives and/or 'comparative strangers'.

Richerson and Boyd (2008) suggest that one of the most striking features of human sociality is the symbolic marking of group boundaries. This can be done through seemingly arbitrary things such as clothing, hairstyle, speech, and ornamentation (see also Hodder 1977). These symbolic markers convey common beliefs and norms within a group (e.g., ethnic or ethnolinguistic groups), but they can also convey the position of an individual within a group, such as gender, status, profession, or provenance (e.g., Vanhaeren and d'Errico 2006; d'Errico and Stringer 2011). While a large part of the material culture might be symbolically imbued, beads are one of the few archaeological objects whose function is exclusively symbolic. Using the Aurignacian as a case study, Vanhaeren and d'Errico (2006) have shown that shell beads can be used to identify and track cultural diversity in the archaeological record.

The shell bead assemblages of such sites as Ksâr 'Akil, Üçağızlı I, and Manot (Stiner et al. 2013; Hershkovitz et al. 2015) could be used to study diversity in bead working in the Levantine region. They could also be used to compare the Levantine materials with those from Europe in terms of uniformity and diversity of raw materials, technological processes, morphology, and use wear, as well as ecological context of beads. In this context, the reported Mediterranean shell found in the early Upper Palaeolithic of Kostenki 14 (Sinitsyn 2015), deep in the Eastern European mainland is highly interesting.

Coming back to the Gorodkov model, studying shell ornaments may shed light on distinguishing between an overall range expansion versus an increased frequency of occupation in the discontinuous zone (see Fig 7.1). If the Levantine and European early Upper Palaeolithic are related, one would expect to see similarities in manufacture processes and modes of use. In distant groups without continuous contact (into the zone of periodic extinction), one could expect aesthetic appearance to show standardisation so that new arrivals may be identified as like-minded or belonging to the same meta-group. In populations that are in regular contact (range expansion), one may expect beads to reflect more similarities in manufacture processes and more

individual variation and invention among the end-products to convey personality and style within a larger group.