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GASTROPODS AND HUMANS IN THE LATE PALAEOLITHIC AND MESOLITHIC OF THE WESTERN MEDITERRANEAN BASIN

Guest Editors
DAVID LUBELL AND NICK BARTON

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Resource pressure and environmental change on the North African littoral: Epipalaeolithic to Roman gastropods from Cyrenaica, Libya

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A B S T R A C T

This paper discusses the marine and terrestrial shell on Epipalaeolithic to Classical-period sites in the Cyrenaican coastlands, northeast Libya, with particular reference to the Haufa Fteah, with parallel studies at a late-Roman farmstead and two small caves. Together they provide evidence for coastal and terrestrial environments and for the continued nutritional importance of gastropods to humans during the Holocene. Land snail evidence is consistent with regional vegetation in coastal Cyrenaica becoming increasingly open through the Holocene, as a result of some combination of climate change and human impact. Marine species suggest that the coastline near the Haufa had been rocky throughout the Holocene. At Hagat al-Gama, changing faunas provide evidence for sand encroachment onto a previously rocky shoreline in Hellenistic times. A biometric study of Osilinus turbinatus shows that in the archaeological sites these shells are systematically smaller than modern specimens, providing evidence for long-term dietary stress in the human populations around the Haufa Fteah, with particularly severe stress in parts of the Epipalaeolithic. A biometric study of Patella spp. provided evidence for size-selection, but also seems to show evidence for resource pressure. It is unlikely that variations in resource pressure seen in the mollusc biometrics are the result of climatic stress or natural ecological factors and explanations must be sought in society-environment dynamics.

1. Introduction

Molluscs are a key, but in the past often ignored, component of the diet of coastal populations in antiquity. Shoreline molluscs have the huge advantages of being highly predictable and straightforward to obtain in an uncertain world, and are good sources of protein, vitamins and minerals (e.g. Fa, 2008; Colonese et al., 2011). Shell also has a variety of other, non-food uses such as ornament (e.g. Bar-Yosef Mayer, 1997; Bar-Yosef Mayer et al., 2009; d’Errico et al.; 2009), tools (e.g. Szabo et al., 2007; Douka, 2011) and ritual (e.g. Pyatt et al., 2010) which may have profound behavioural implications. The Haufa Fteah (henceforth the Haufa), the main subject of this study, is one of the few prehistoric sites in the southern Mediterranean coastlands where mollusc use has been documented (Colonese et al., 2011), and thus has considerable importance in the understanding of the use of molluscs in this vast region.

The renewal of archaeological and geoarchaeological research at the Haufa by the Cyrenaica Prehistory Project (CPP) offers the chance to re-evaluate the seminal research of McBurney (1967) fifty years after his original excavation of the site. This work, although highly advanced at the time, pre-dated many key advances in archaeological theory and practice, so the renewed work aims to bring the huge body of data and the over one million finds from the original work into the modern arena by the application of modern science-based archaeological techniques (Barker et al., 2007).

Shells of the marine molluscs Patella caerulea and Osilinus turbinatus are known to be distributed throughout the Haufa sequence and to be food refuse (Emiliani et al., 1964, 1967; Klein and Scott, 1986). The distribution of marine molluscs at this site was dealt with briefly by Klein and Scott (1986) in their re-evaluation of the fauna from the cave, but their investigation was incomplete due to the original erratic recovery of mollusc shell by McBurney’s excavators, who worked under extremely difficult conditions, and the...
fact that much shell had been used by Emiliani and his co-workers in their pioneering oxygen isotope study (Emiliani et al., 1964, 1967). They remarked, however, the high incidence of Osilinus turbinatus in the lowest occupational levels of the cave. Hey (1967) noted that the land snails Rumina decollata, Helix melanostoma and Trochoidea cretica (as Helicella variabilis) are very common in the Epipalaeolithic to Neolithic layers in the cave, but are distributed throughout. He suggested that they were common in the later part of the sequence because they had been gathered and eaten by the people who had used the cave.

The renewed investigations show that marine and terrestrial molluscs are extremely common in the higher levels in the Haua and their occurrence in the Holocene layers (those documented sedimentologically by Hunt et al., 2010) is documented in this paper. McBurney (1967) and Higgs (1967) had depicted the human groups who used the Haua, as living in a ‘territory of fertility and vegetation’ (McBurney, 1967: 1) – a region with abundant game and other natural resources apparently readily available. This paper evaluates their idea, using material from the renewed excavations. It includes a study of marine and land molluscs from the Haua and another small prehistoric cave site, with a biometric study of the marine molluscs from these excavations and from other nearby sites to assess the Holocene environment of coastal Cyrenaica.

2. Study region

The province of Cyrenaica in northeast Libya (Fig. 1) has a predominantly rocky coastline today, with sandy beaches only developed close to the mouths of major wadis. Near the Haua, the coast also has low coastal platforms and some rugged limestone cliffs. The Wadi Bottamsa, the nearest wadi to the Haua, discharges into a small bay with a cobbly beach, and this is typical of all other wadis within 30 km of the Haua. Further to the East, sandy beaches are developed.

Behind the coast, the land rises through a series of escarpments into the Jebel Akhdar, a range of hills with a maximum elevation of 879 m asl. The mean annual rainfall near the crest of the Jebel Akhdar at Shahat (625 m) is 573 mm (http://www.globalbioclimates.org/station/li-shaha.htm). At el-Marj (329 m) to the west of the Haua, mean annual rainfall is 285 mm, and it is 311 mm at sea level at Derna, to the East (Sen and Eljadid, 1999).

The present natural vegetation of the Jebel Akhdar is degraded to various forms of maquis, garrigue and steppe by overgrazing. The backslope of the Jebel Akhdar escarpment slopes gently down to the Sahara. It receives less rainfall than the north-facing escarpments and is predominately steppe or steppe-desert today.

Cyrenaica has yielded traces of human activity from the Middle Pleistocene to the present day, with artifacts of Late Acheulean, Levallois, Levalloiso-Mousterian, Upper Palaeolithic, Epipalaeolithic and Neolithic type and outstanding Classical (Greek and Roman) and Medieval standing archaeology (McBurney, 1967; Barker et al., 2007, 2008, 2009, 2010). The outstanding archaeological site in Cyrenaica is the Haua (UTM 34S 00598300 3640732), which contains a (probably discontinuous) record from the Last Interglacial to the present day. The Haua is a huge cave, which opens onto an infilled doline. The site lies 1.5 km from the current coastline at 67 m asl and has commanding views of the coast.

The 14 m deep sequence in the Haua Fteah is rich in lithic artefacts, mammal bone and mollusc shell throughout (McBurney, 1967). Dating in the lower part of the sequence is inferential, based on the isotopic work of Emiliani (1964, 1967). The sequence starts with an elongate Levallois-based industry which McBurney (1967) called the ‘Pre-Aurignacian’. This most probably dates to parts of OIS 5 (the last Interglacial) (McBurney, 1967; Klein and Scott, 1986). Overlying this is a further Levallois-based industry which McBurney termed ‘Mousterian’, and which is likely to date to late OIS 5, OIS 4 and part of OIS 3 (McBurney, 1967; Klein and Scott, 1986). This industry is associated with two robust human mandibles thought by McBurney to be of Neanderthal type, but re-evaluated as Early Modern (Foley and Lahr, 1997; Hublin, 2000). These lower industries lie in fine-grained deposits which on visual inspection result from wash and shallow mudflow processes, with occasional episodes of pedogenesis and calcium carbonate induration. Some extremely large hearth-like features are present in the ‘Mousterian’. Following the ‘Mousterian’, there is a marked sedimentary change. In horizons characterized by breccias and associated with radiocarbon dates between ca. 40,000 and ca. 22,000 cal. BP is a blade-based industry termed ‘Dabban’ by McBurney (McBurney, 1967; Barker et al., 2009).

The layers above this, which are predominately breccias with some wash deposits, but with sometimes-abundant occupation debris, contain epipalaeolithic industries termed by McBurney (1967) ‘O’ranian’ (ca. 16,000–13,500 cal. BP: Barker et al., 2009) and ‘Libyco-Capsian’ (ca. 11,000–8000 cal. BP: Barker et al., 2009; Hunt et al., 2010). Wash deposits with some breccias above the ‘Libyco-Capsian’ contain artefacts termed Neolithic by McBurney (1967) and associated with dates of ca. 7800–6200 cal. BP (Barker et al., 2009; Hunt et al., 2010). The Classical to Modern period is associated with layers of charred animal dung, suggesting stabling of animals in the cave, and a series of mudflow and wash deposits, which may have resulted from cultivation in the doline outside (Hunt et al., 2010).

Compared with Southern Europe, or even compared with the Sahara and sub-Saharan Africa, knowledge of Holocene environmental change in the southern Mediterranean coastlands is relatively poor, and this is especially marked in northern Libya. Generally, over much of the Sahara, from Egypt and Sudan in the East to Chad in the West, the Early Holocene was comparatively humid after about 11,000 cal. BP, with rainfall decreasing with the 8100 cal. BP event, then gradual desiccation. The later Holocene, after about 7000 cal. BP, was marked by general desiccation (e.g. Kuper and Kropelin, 2006; Kuper, 2006; Watrin et al., 2009; Cremaschi et al., 2010; Mercuri, 2008; Mercuri et al., 2011).

In northwest Africa there is a different pattern, with rising precipitation and temperature a little before 11,000 cal. BP, then after about 7000 cal. BP falling temperature with stable or slightly rising precipitation leading to higher effective moisture in the later part of the Holocene (Cheddadi et al., 2009) but major swings in

![Fig. 1. The location of the Haua Fteah in Cyrenaica, Libya.](image-url)
temperature and rainfall in the later Holocene caused phases of fluvial activity and soil formation in both Morocco and Tunisia (Zielhofer et al., 2008). It is likely that these patterns of rising and falling precipitation were accompanied by changes in temperature and seasonality (Peyron et al., 2011), but evidence for this is not currently available in North Africa. While it is clear that in Tripolitania (northeast Libya) and the Fezzan (southeast Libya) the early Holocene was moist and the later Holocene was considerably drier (Gilbertson et al., 1994; Cremaschi et al., 2010), the Holocene in Cyrenaica has not been the subject of more than cursory investigation (e.g. Seddon et al., 1994; Hunt et al., 2002).

3. Materials and methods

In the first CPP field season in 2007, McBurney’s original excavation trench was located and re-excavated to a depth of ~4 m. The sections were cleaned and bulk samples of 2 kg were taken for flotation and sieving from two sample columns through the Holocene deposits of the section on the west side of the excavation. The Holocene deposits are approximately the highest 2 m of the sequence (Barker et al., 2007). The layers are of Historic, Neolithic and Epipalaeolithic (Libyco–Capsian) age; their sedimentology and chronology are described in detail in Hunt et al. (2010). Their archaeological sequence is described in McBurney (1967) and for reference to this work, his layers are indicated, together with the contexts distinguished in the restudy, in Figs. 2 and 3. Broadly, the Libyco–Capsian is dated to 14,710–14,080 to 9680–9010 cal. BP (12,760–12,130 to 7730–7060 BC), but may extend higher. The base of the studied section is in the latter part of that timeframe. The Neolithic is dated to 7830–7680 to 6305–6210 cal. BP (5880–5730 to 4355–4260 BC) and the Historic-period on archaeological and radiocarbon grounds to the time after the Greek invasion of 621 BC (Hunt et al., 2010). The bulk samples were wet-sieved on 2 mm, 1 mm and 0.5 mm stainless steel sieves. The dried residues were then hand-sorted for molluscs, bones, lithics and other small finds. For this paper, counts from the two sample columns are aggregated, since the sampled contexts can be traced with confidence between the two columns.

A significant aspect of the CPP is the evaluation of past human activity in the Cyrenaican landscape. As part of this work, test excavations were made in a number of small caves. Dry-sieving the spoil from a test excavation of one small cave, CP1565 (UTM 34S 0598063 361095), yielded a well-stratified assemblage of marine molluscs together with an incised potsherds of late Roman age, probably 4th Century AD.

A second cave, Hagel al-Gama (CP2008: UTM 34S 0531356 3626074), was test-excavated in 2008. This small cave (7.3 m long, 7.6 m wide and about 7.0 m high) lies in a low cliff at the back of the present-day beach at about 21 m asl. It yielded a stratigraphy 1.2 m deep, with layers of Libyco–Capsian, Neolithic and Hellenistic age, on artefactual evidence (Barker et al., 2008, 190–196). Sieving and flotation of samples from these layers produced rather fragmented marine and terrestrial mollusc assemblages, plus extremely fragmented bones and numerous artefacts. The bones in the Libyco–Capsian layer were predominantly from a large form of ovicaprid, while in the Neolithic layer, the bones were predominantly from small (domesticated-sized) ovicaprids, together with occasional bovid, pig, and bird (Barker et al., 2008, 194–195).

Comparative live specimens were gathered on the rocky fore-shore northwest of the Haupa, where monospecific clusters of Osilinus turbinatus were observed at the water’s edge in a series of shallow rockpools. A four metre stretch of rockpool margin was selected and all Os. turbinatus specimens were gathered, measured and returned live. All limpets (Patella caerulea and Patella ferruginea) in the same general area of foreshore were measured in situ since it was impossible to detach them without damaging a large proportion of the shells, which would have made any measurements meaningless.

The molluscs were identified with the aid of a hand-lens and low-power microscope and notes made of the state of preservation. Taxonomy of land snails largely follows Brandt (1958, 1959), Wiktor (1983) and Zilch (1951): the marine molluscs could all be attributed to common Mediterranean species. Minimum number of individuals (MNI) counts were made by counting the apices of damaged and fragmentary specimens and adding this number to the number of whole specimens. In practice it was not possible to assign all archaeological specimens of Patella to species with complete confidence, so they are here recorded and discussed as Patella spp. The maximum basal diameter of complete specimens of Osilinus and Patella was measured and rounded to the nearest millimeter. Few specimens were visibly burnt. Most Osilinus specimens were whole, though some were rather friable and showed signs of surface disintegration. Many Patella specimens showed characteristic damage to their margins caused by an implement being used to remove the shells from their substrate, so the number available

Fig. 2. The sampled section in the Haupa Fneath, showing location of sampling columns and radiocarbon dates. Radiocarbon dates are in calibrated years BP.
for biometric study was rather limited and data have been aggregated to period.

4. Marine molluscs

The marine molluscs from the sample columns in the Haua are shown in Fig. 3. This is almost exclusively a rocky shore fauna, thus implying little change in the coastal environment as sea level rose over 30 m since the Libyco-Capsian. The seabed immediately offshore from the Haua is known to be very steep and rocky, so this is to be expected.

The marine molluscan fauna is dominated throughout the sampling column (60–100%) by Osilinus turbinatus, which is the commonest shoreline species now and by far the easiest to gather, as it is found in the intertidal area and in tidal pools and does not adhere strongly to its substrate. Osilinus is the only species found on one of the Roman sites (CP1565). The dominance of Osilinus may reflect dietary preference or ease of acquisition, since it is unlikely that other gatherable species were absent from the coast.

Modern Osilinus turbinatus from the foreshore have a mean maximum basal diameter of 25.7 mm (Table 1) and a range of 22–30 mm (Fig. 4). This is significantly larger than that of the 450 shells in the archaeological assemblages from the Roman sites or the Haua which have a mean basal diameter of 20 mm (Table 1). There is considerable variation between the various archaeological assemblages, with the size of the earliest Libyco–Capsian assemblage from the Haua (context 136) and the 4th Century Roman cave site CP1565 being particularly small (Fig. 4).

Patella spp., mostly Patella caerulea, are also relatively common, making up between 0 and 50% of marine shells in the assemblage (Fig. 3). Patella spp. are also intertidal but more difficult to gather than Osilinus because they are capable of clinging very tightly to the rocks, necessitating forceful removal unless the animals can be caught by surprise – a stealthy approach is needed to catch limpets with their adhesion to their resting scar relaxed.

The modern Patella have a mean maximum basal diameter of 20.1 mm and a range of 7–35 mm (Table 2). Very few archaeological specimens of Patella survived whole in the Haua, so the archaeological data for contexts is aggregated to allow the productions of size histograms in Fig. 5. The mean sizes of the archaeological specimens from the Haua and from the Roman Villa CP1592 are considerably greater in size than the modern specimens, ranging between 23.8 mm in HF136 and 27.7 mm in HF130 (Table 2). Specimens larger than those logged during the study of modern specimens can be found in the Neolithic assemblages from contexts 130 and 131 and from Epipalaeolithic context 135. The largest specimen, from context 130, had a maximum basal diameter of 45 mm. Compared with the modern assemblage, the size histograms from all the archaeological assemblages contain what are disproportionately large numbers of sizeable specimens (Fig. 5), suggesting continuing strong selection for large specimens by the people using the Haua.

**Table 1**

| Biometric data for Osilinus from contexts at the Haua Fteah, two Roman sites and a modern comparative population. |
|---|---|---|---|---|---|---|---|---|---|
| Modern | CP1592 | CP1585 | HF127 | HF129 | HF130 | HF131 | HF132 | HF134 | HF135 | HF136 |
| Count | 52 | 42 | 28 | 1 | 24 | 81 | 11 | 3 | 16 | 38 | 31 |
| Mean | 25.7 | 20.8 | 18.9 | 16.0 | 20.4 | 20.1 | 20.3 | 22.3 | 22.0 | 19.9 | 18.0 |
| Largest | 30.0 | 27.0 | 24.0 | 16.0 | 24.0 | 28.0 | 23.0 | 24.0 | 25.0 | 25.0 | 23.0 |
| Smallest | 22.0 | 15.0 | 15.0 | 16.0 | 17.0 | 14.0 | 17.0 | 21.0 | 16.0 | 14.0 | 12.0 |
There is a clear relationship between the size and abundance of *Osilinus* and *Patella* which can be read in terms of dietary stress. Early in the Libyco-Capsian levels studied here, in context 136, the mean sizes of *Osilinus* (18.0) and *Patella* (23.8 mm) are small (Tables 1 and 2) and the size of assemblage is relatively large (Fig. 3), suggesting that there was food scarcity and that molluscs were an important and intensively used resource. This point is reinforced by the comparatively large numbers of the edible land snail *Helix melanostoma* in this layer (Fig. 3). Resource pressure seems to have declined through the Libyco-Capsian, as the mean size of *Osilinus* and *Patella* specimens rise and the numbers of *Helix melanostoma* decline. Although resource pressure rose again in the Neolithic, both in terms of specimens consumed and the decline in mean size of specimens, and was again apparent in the late Roman assemblages, it never again seems to have reached the levels of context 136.

The other marine species from the sample column - *Hexaplex trunculus*, *Conus mediterraneus* and *Bittium reticulatum* - are all species typical of shallow subtidal environments. *Hexaplex* is edible and the specimens were all unburnt fragments derived from the body whorl, being generally less than a centimeter across and probably from rather small individuals. Their presence, if these were live specimens brought to the cave, probably indicates diving or trapping and it is likely that smashing of the shells would have

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**Table 2**

Biometric data for *Patella* spp. from contexts from the Haua and from a modern comparative collection.

<table>
<thead>
<tr>
<th></th>
<th>Modern</th>
<th>CP1592</th>
<th>HF130</th>
<th>HF131</th>
<th>HF135</th>
<th>HF136</th>
</tr>
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<tr>
<td>Count</td>
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<td>9</td>
<td>15</td>
<td>20</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Mean</td>
<td>20.1</td>
<td>24.7</td>
<td>27.7</td>
<td>25.8</td>
<td>25.8</td>
<td>23.8</td>
</tr>
<tr>
<td>Largest</td>
<td>35</td>
<td>35</td>
<td>45</td>
<td>38</td>
<td>36</td>
<td>29</td>
</tr>
<tr>
<td>Smallest</td>
<td>7</td>
<td>16</td>
<td>11</td>
<td>13</td>
<td>16</td>
<td>18</td>
</tr>
</tbody>
</table>

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![Fig. 4. The percentage distribution of size-classes of Osilinus turbinatus in Holocene levels in the Haua Fteah and in comparative Roman-period and modern assemblages.](image-url)
been needed to access their flesh (Ruscillo, 2005; and see also Meehan, 1982). The other species are perhaps unlikely to reflect food use. The Conus specimens were whole, but also small (none as much as 2 cm in total length) and the Bittium specimens were also rather small. Conus spp. were sometimes collected for ornamental or other non-nutritional purposes in antiquity (e.g. Bar-Yosef Mayer, 1997; Vanhaeren and d’Errico, 2006; Hunt and el-Rishi, 2010). Bittium are very small shells which live on seaweed and are sometimes brought with the weed onto archaeological sites, perhaps for making pallets (Colonese and Wilkens, 2005).

Clear patterns in fragmentation of shells can be seen in Fig. 3, with the most fragmented assemblage being from context 136. These probably reflect some sort of taphonomic factors. Fragmentation is unlikely to reflect sediment acidity, given the lack of corrosion features on the shells and the high limestone content in most layers. Crushing of shells during sediment compaction is possible, but the layers with large proportions of fragmented shells are not systematically different from those with few (Hunt et al., 2010), and fragmentation affects the marine species (which are thick-shelled) far more than it does the much more fragile-seeming land snails. It is difficult to extract the flesh of Osilinus from the shell unless it is cooked, so it is possible that fragmentation reflects efforts to extract mollusc flesh from uncooked shells. Some present-day hunter-gatherer groups break shells in order to extract their flesh (Meehan, 1982). Trampling is also a possibility, but it is painful to walk barefoot over mollusc shells. It is interesting to note that context 136, identified above as the layer reflecting the highest resource pressure, and perhaps human presence, also has very high levels of fragmentation. Layer 133, which also has relatively high levels of fragmentation, is identified by Hunt et al. (2010) as an in situ occupation horizon, but mollusc counts are low for this context.

Marine molluscs were very sparse at Haglet el-Gama (Fig. 6), and dominated by the rocky shore species Patella caerulea and Osilinus turbinatus. Cerastoderma glaucum and an unidentified...
bivalve species are present in the Hellenistic layer, perhaps reflecting a change in coastal geography with the encroachment of beach sands — today rocky shorelines are present to the west of the cave, but to the east there is a wide sandy beach. The fauna is very fragmented and about a quarter of fragments in the Neolithic and Libyco—Capsian layers show signs of burning. No marine shells were recovered intact from the Libyco—Capsian level. Only five *Patella* were recovered whole from the Neolithic layer — these had a mean maximum basal diameter of 21.8 mm and a range of 18–25 mm. In the Hellenistic layer, three *Osilinus*, of 13, 19 and 27 mm basal diameter, and *Patella* specimens of 23 and 33 mm maximum basal diameter were recovered. The small number of marine molluscs in each of the layers is surprising, given the proximity of the cave to the modern shoreline — in the Libyco—Capsian only 5.6% of the assemblage is marine; this falls to 3.4% in the Neolithic layer then rises to 37.5% in the Hellenistic layer. The shoreline geometry would appear to be consistent with a low-angle slope to the seabed offshore and thus with the sea being relatively distant in the earlier periods. The low figures for marine taxa in the earlier layers are probably consistent with the sea being relatively distant until the Hellenistic period, and thus foraging around the cave concentrated on locally-available terrestrial species.

5. Terrestrial molluscs

The land snail assemblages from the Ha'au mostly contain rather few specimens per sample and are low in diversity (Fig. 3). The relatively large Epipalaeolithic context 136 contains *Helix melanostoma* and *Trochoidea cretica*. In Cyrenaica, these species are found in coastal garrigue, *Juniperus-Pistacia* scrub and Mediterranean mixed woodland (Fig. 7), where they aestivate amongst the roots of shrubs, especially *Ceratonia siliqua* (Carob) (Hill and Hill, 2010: 83–84), but
Both species are sizeable – *Helix melanostoma* is the largest land snail present in Cyrenaica - and their presence in this interval (Fig. 3) which would have inhibited vegetation growth. Alternatively, surface wash could have brought the specimens into the cave.

Higher in the Epipalaeolithic part of the cave fill, assemblages become smaller but slightly more diverse, with *Helix melanostoma*, *Trochoidea cretica*, *Eobania* sp., *Rumina decollata* and *Caracollina lenticulina*. Most of these species are also edible, but *Rumina decollata* is carnivorous, so may have been colonising carrion. Alternately the assemblages could result from surface wash from the doline outside. Specimens throughout were too fragmentary for biometric study, so these conflicting hypotheses cannot be tested in this way. The molluscs from these contexts have the aspect of assemblages from modern juniper scrub near the Haua (Fig. 6) and this chimes with the work of Morales (2010: Table 2), who identified in Capsian contexts a variety of plant remains typical of Mediterranean woodland, including *Quercus*, *Juniperus*, *Myrtus* and *Cupressus*, together with taxa typical of maquis and grassland environments such as *Cistus*, *Galium* and Poaceae. *Caracollina lenticulina*, which appears only in the latest Capsian context 132, is known only from inland maquis sites (Fig. 6) and this may reflect a drier environment at this time.

During the Neolithic, *Helix melanostoma* and *Trochoidea cretica* become minor components of the assemblages and *Eobania* sp., *Rumina decollata*, *Trochoidea aff. pyramidata* and *Barcania* sp. are present. Although some of these are large enough to have been food items, not all are – *Trochoidea aff. pyramidata* and *Barcania* sp. for instance. *Barcania* (Clausiliidae) in Tripolitania are rupestral and some specimens were noted living on the cave walls in the Haua and on rock outcrops in Cyrene as well as in scrubby vegetation, so it is quite likely that some specimens fell from the roof of the cave. It is quite possible that many land mollusc specimens were introduced into the cave from the doline outside by the shallow wash which gave rise to a major component of these horizons (Hunt et al., 2010), but it is also possible that the larger specimens represent food waste. This assemblage would be typically found in coastal scrub or fairly heavily-grazed rather open Juniper scrub near the Haua today (Fig. 6; Hunt, 2009) and this is consistent with the spectrum of plant species identified from charcoal which includes taxa such as *Rhus*, *Juniperus*, *Pistacia*, *Ephedra* and *Suadea* (Cartwright and Hunt, 2008).

The Historic-period assemblages, probably from the last few centuries BC (Hunt et al., 2010), are generally lower in diversity than most of those from earlier horizons. Most assemblages contain *Helix melanostoma* and *Trochoidea cretica*. *Granopupa granum*, which occurs for the first time, is an inconspicuous shallow burrower in leaf litter in scrub or other semi-sheltered habitats (e.g. Giusti et al., 1995). At face value the assemblages are consistent with the continuation of coastal juniper scrub outside the cave. In the Historic period, however, the predominant depositional mechanism had changed from wash to small mudflows resulting from the erosion of cultivated land outside the cave (Hunt et al., 2010). Pollen analyses from wadi fills of coeval age suggest small-scale cultivation of a predominantly wooded wadi landscape (Hunt et al., 2002). It is suggested that mudflows following the initial cultivation would have brought into the cave landsnails which had lived in the vegetation before cultivation started, such as *Granopupa*, but the larger species could be food waste.

The prehistoric land mollusc assemblages from Hagfet el-Gama are relatively large but are low in diversity (Fig. 7). It is likely, given the geomorphology of the cave (surface wash is extremely unlikely), that the shells of the larger species – *Helix melanostoma*, *Eobania* sp., *Trochoidea cretica* and *Rumina decollata* – reflect food waste. *Barcania* is rupestral and the specimens, as at the Haua, were quite possibly living in the cave. *Parmacella oliveri* is a burrowing slug, found typically on bare soil under large rocks (Seddon et al., 1994), so was possibly living in the cave or could have been brought into the cave with the land snails if they were gathered in an aestivated condition from among the roots of bushes. The large change in numbers between layers masks the relative stability of the assemblages, although *Trochoidea cretica* becomes more common and *Eobania* sp. becomes rarer through time (Table 3). If this does not reflect a shift in gathering preference, it may reflect a gradual degradation of the environment through time, thus reinforcing suggestions of generally degrading Holocene environments at the Haua and suggesting that this is a general pattern.

## 6. Discussion

The marine molluscs from the Haua provide evidence for relatively unchanged local coastal environments, although at Hagfet el-Gama there is a suggestion of shoreline change, with shallow soft-bottom environments unequivocally present only in the Hellenic. Naturally, statements of this kind must be qualified by the possibility that ancient foragers were simply ignoring opportunities provided by molluscs in certain habitats (see for instance Shackleton and van Andel, 1986; Shackleton (1988a,b); Mannino et al., 2007), but the steep offshore topography near the Haua is incompatible with widespread shallow water with soft bottom during phases of low sea. There is a suggestion from the land snails at both the Haua and at Hagfet el-Gama that terrestrial ecologies changed subtly in response to climate and/or human impact. The molluscs also provide an interesting perspective on resource use and nutritional stress, and by implication along much of the enormous reaches of the North African littoral and interior, where resources were sufficiently difficult to extract that molluscs were an attractive supplement to diet over vast areas (for instance Lubell et al., 1975; Mulazzani et al., 2010).

In the earlier Libyco–Capsian, probably some time around or after 10,000 cal. BP, it might appear that resource stress was sufficient to cause significant ‘over-gathering’ of *Osilinus turbinatus* on the rocky coast near to the Haua, causing a noteworthy diminution in mean size of the gathered assemblage, relative to the unpressed modern assemblage. At the same time, size selection of *Patella* spp. was less marked than in higher levels, again suggesting resource pressure, and *Helix melanostoma* and other landsnails were most probably a part of the mollusc component of the diet.

Similar conclusions of ‘over-gathering’ of molluscs leading to changes in mean size of assemblages have been made in the past (e.g. Cabral and da Silva, 2003; Prummel, 2005; Mannino and Thomas, 2010), although Claassen (1998) and Campbell (2008) counsel that ecological factors and changes in gathering strategy can also cause size change in mollusc assemblages. In the case of

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<tr>
<td><em>Helix melanostoma</em></td>
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<td><em>Trochoidea cretica</em></td>
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<td><em>Eobania</em> sp.</td>
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the Haua, however, the open and relatively simple coastal location of the mollusc faunas suggests that ecological factors were most likely minimised, while the likely time-averaging of assemblages is likely to have smoothed the monthly size variations of gathered populations reported by Lasiak (1991, 1992).

It is probable from the palaeobotanical and vertebrate bone evidence (Higgs, 1967; Klein and Scott, 1986; Morales, 2010) that this resource stress occurred in a fairly benign open Mediterranean woodland landscape, with relatively abundant plant and vertebrate resources likely to have been available — McBurney's (1967: 1) 'territory of fertility and vegetation'. This might be taken to suggest that the human population was not able to efficiently regulate its size relative to resource availability at this point, perhaps because of the rapid temperature and rainfall changes which must have occurred at the beginning of the Holocene.

At the end of the Libyco–Capsian, perhaps just before 8000 cal. BP (Hunt et al., 2010 Table 1) it might appear from the appearance of Caracolina lenticulina that the landscape may have become more arid and open, but the use of Helix melanostoma seems to have diminished and the mean size of Osilinus and Patella specimens increased. The size distribution of Osilinus in the late Libyco–Capsian context 133 is the nearest to the unstressed modern assemblage of any encountered in this study. It can be hypothesized that human use of the cave and of its surrounding landscape had diminished considerably by this time, perhaps because the population-resource balance had stabilized during the more predictable early Holocene. Alternatively, there may have been a dietary shift away from molluscs, or the population using the cave may have declined in size. It is perhaps coincidental that the 8.2 ka event appears close in time to the end of the Libyco–Capsian, but it is also conceivable that this climatic shock contributed to the initiation of the cultural and subsistence developments of the Neolithic at the Haua.

The 8.2 event appears to have had a major cultural impact over great areas of North Africa. As at the Haua, the 'Mesolithic' gave way to the Neolithic in the Central Sahara at the arid 8.2 event (Cremaschi et al., 2010). The advance of domesticates and 'Neolithic' cultural markers did not, however, extend right across North Africa at this time. Thus, in the Télidiène Basin in Eastern Algeria at Kef Zoura D and Ain Mistehayia, land snail evidence points to significant aridification during the 8.2 event (Jackes and Lubell, 2008) and at these sites and Site 12 (Aioun Beriche), this coincides with marked technological change in which Typical Capsian industries give way to Upper Capsian lithic assemblages (Jackes and Lubell, 2008; Lubell, 2009).

It is likely that in Cyrenaica, as in the Fezzan (Cremaschi et al., 2010; Mercuri et al., 2011) and Eastern Algeria (Jackes and Lubell, 2008) the 8.2 ka event provides a watershed between a moister Early Holocene and a drier later Holocene, but that in all of these regions the period immediately after the event was not dramatically drier than the period before it. The landsnail and charcoal evidence at the Haua are consistent with a Neolithic landscape that was relatively open scrubland, but the land snail assemblages do not point to comprehensive aridification. It is possible that the change in vegetation is the result of degradation by domestic ovicaprines, which appear at this time (Klein and Scott, 1986). The marine mollusc assemblages might be taken to suggest intermediate levels of resource stress. Selection for large size is particularly noticeable in Patella spp. in the Neolithic. Perhaps people were relatively well-adjusted to and stable in their environment. This may be because they had widened their resource base with herding of ovicaprines (Higgs, 1967). There is little evidence, so far, for Neolithic cultivation of cereals at the Haua apart from sparse cereal pollen grains (D. Simpson pers. comm., 2011), although this cannot be ruled out. Neolithic activity in the Haua seems to have ended shortly after 6300–6600 cal. BP (Hunt et al., 2010), about the same time that Upper Capsian activity seems to have ended in Eastern Algeria (Jackes and Lubell, 2008) — although there is a later phase of activity, of uncertain cultural affinities, in some Eastern Algerian sites ca. 5500–5700 cal. BP, associated with relatively humid conditions (Lubell, 2009). It may be hypothesized that in Cyrenaica and Eastern Algeria the abandonment of sites was a response to aridification, since at this time desiccation was increasingly evident in the Eastern Sahara (Kuper and Kropelin, 2006), although the final drying of the Central Sahara was probably later (Cremaschi and Zerboni, 2009).

The Haua appears to have been used for stock-keeping from the start of the Classical Period and cultivation appears to have started in the doline outside the cave (Hunt et al., 2010). The terrestrial taxa probably diminished at this time because Cyrenaican species tend to be highly intolerant of ploughing and indeed are absent from arable fields close to the Haua. It is possible that shells from the previous scrubland were available to be transported into the cave, but the change in the species represented would indicate that this was not the case and that the specimens of Helix melanostoma and Trochoidea cretica reflect food waste. The absence of Eobania sp. from the (admittedly very small) assemblages may point to further landscape degradation by this time. Numbers of marine taxa are low at this time, but the use of Osilinus turbinatus and Patella spp. continues. The two Roman-period marine mollusc assemblages from nearby sites, both reflect food stress and this is particularly marked for the 4th Century AD assemblage from CP1565. This is perhaps surprising, given the prosperity evident in Roman Libya (e.g. Barker et al., 1996).

No dating evidence other than the artefacts is available for the levels at Hafjet al-Gama. It is clear from the simplicity and shallowness of the stratification that the site was used only occasionally and empheremically compared with the much more extended (albeit likely seasonal) use of the Haua — perhaps activity of a logistic mobility type. The presence of Eobania sp. in the Libyco–Capsian layer might be taken to suggest that this layer is broadly time-equivalent to the higher Libyco–Capsian layers in the Haua, as this species is not present in the basal context 136, but this remains to be tested by radiocarbon dating. What is clear from this site is that land snails — Helix melanostoma, Trochoidea cretica, Ruminia decollata and Eobania sp. - were part of the diet of Libyco–Capsian, Neolithic and Hellenic-period people, as it is likely that large numbers of land molluscs entered the site by natural causes, for geomorphological reasons and because the typical signs of small mammal predation (Hunt, 1993) are absent. A corollary is that many specimens of these large species in the higher levels at the Haua may also be food waste, in spite of the wider taphonomic possibilities at this site. The partial replacement of Eobania sp. by Trochoidea cretica (Table 3) may reflect degradation of the environment between the Libyco–Capsian and the Hellenistic period, as at the Haua (if it does not reflect changes in gathering strategy) but the lack of secure dating and low resolution of the study preclude more definite conclusions. The very low number of whole marine molluscs precludes any attempt at biometric work, but the impression is that the marine specimens were all rather small.

As with the prehistoric Cyrenaican sites discussed here, at Franchthi, Greece (Farrand, 2001), the Grotta dell’Uzzo, Sicily (Compagnoni, 1991; Mannino et al., 2007), the Grotta della Serratura, Italy (Colonese and Wilkens, 2005; Colonese et al., 2011), land snails were an important component of the Mesolithic/Epipalaeolithic mollusc resource. Significant land snail use had, however, ended in the final Magdalenian at Nerja Cave, Spain (Aura Tortosa et al., 2002; Jordà et al., 2010, 2011), after the Early Mesolithic at the Grotta dell’Uzzo, and declined in significance through the Mesolithic at the Grotta della Serratura. In the Capsian escargotières of Southern Tunisia and Eastern Algeria,
which are far from the coast, landsnails were the only molluscs used (Lubell et al., 1975; Lubell, 2004). At none of these sites, even the Tunisian and Algerian escargotières (Lubell, 2004), were the landsnails the dominant source of protein during the Mesolithic/Epipalaeolithic.

Much greater mollusc biodiversity is evident in the North Mediterranean sites than in the Cyrenaic sites, reflecting the depau-perate Cyrenaic land snail faunas relative to Europe and the variety of coastal types evident in localities such as Franchthi Cave (Shackleton and van Andel, 1986), compared with the rather uniform rocky coastal geomorphology in Cyrenaica. The greater marine mollusc biodiversity in the North Mediterranean sites also points to a wider and more active spectrum of mollusc acquisition strategies at these sites, possibly for a wider range of purposes including bait for fishing and the manufacture of beads (Colonesi et al., 2011). There is no evidence for anything other than dietary use and relatively simple collection in the levels studied in these Cyrenaic sites. Only the relatively few Hexaplex trunculus specimens at the Haua point to diving or trapping as an acquisition strategy — all other molluscs would have been gathered with relatively little effort by the simple expedients of picking them up, digging shallowly for estivating land snails in the dry season, or in the case of the limpets, prising them from their resting scars. The low incidence of fish bones in the Historic and Neolithic, and their absence in the Libyco–Capsian levels, and total lack of marine mammal remains at the Haua (Klein and Scott, 1986) similarly points to a lack of engagement with the sea and marine resources and contrasts with sites such as Nerja Cave and the Grotta dell’Uzzo where sea fish, seals and dolphins were taken, in addition to the marine shell (Aura Tortosa et al., 2002; Mannino et al., 2007). Fishing of lagoonal species and collection of shallow-water brackish–lagoonal bivalves occurred at Hergla, Tunisia, but fully marine species were not taken (Mulazzani et al., 2010), so the lack of engagement with deep-water marine resources in Cyrenaica may have been part of a more general cultural attitude to the sea along parts of the North African littoral.

A good case was made by Shackleton (1988a,b) and Shackleton and van Andel (1986), for strong marine mollusc species selectivity among prehistoric populations at Franchthi, with rocky shore molluscs perhaps being taken as an adjunct to other activities at times. It is unclear whether this was the case in the Cyrenaic caves other than the size-selection for Potell a spp. — as noted above, virtually all the mollusc species on these sites can be collected extremely easily and therefore this could have been an activity largely relegated to those too young or infirm to participate in more energetic economic activity. In all the North Mediterranean and Cyrenaic sites (apart from the ephemeral occupation in CP1565), and even in the Tunisian and Algerian escargotières, it is clear that the molluscs were not the main component of the diet, as animal bones are frequent. In addition to changes caused by selection, changing dominance amongst marine mollusc ecological groupings during the periods considered here is seen at Franchthi and the Grotta della Serratura as sea level rise changed coastal configurations, but this is only slightly apparent at Hagfet al-Gama and not seen at the Haua.

Finally, the Cyrenaic sites provide good evidence for the continuation of the use of land and marine molluscs through the Epipalaeolithic/Neolithic transition and into Historic times, in spite of major shifts in subsistence strategy. This level of continuity at single sites is unusual: at Franchthi Shackleton (1988a,b) and Farrand (2001), and at Grotta dell’Uzzo Compagnoni (1991) and Mannino et al. (2007) documented continuity of use of marine and terrestrial molluscs from the Mesolithic into the Neolithic. But at many sites around the Mediterranean, the locus of human activity and patterns of subsistence seem to have changed radically with the beginning of farming.

7. Conclusion

This first systematic study of the land and marine molluscs from the Holocene levels in the Haua Pteah provides evidence that people were able to extract a stable assemblage of rocky shore molluscs through most of the Holocene. The intensity of use of these shoreline gastropods changed through time, and it is likely that the resource stress was sufficient to lead people also to eat several land snail species, the most prevalent at the Haua being Helix melanostoma. At Hagfet al-Gama, predominantly land snails were eaten during the rare times that people used the cave, most probably because it was further from the sea in the past. At this site the situation of the cave makes it very likely that Eobania sp., Trochoidea cretica, Rumina decollata and Rumina melanostoma were eaten. Eating of gastropods seems to have been a consistent feature of the coastal Cyrenaic sites through the Holocene.

The land snail evidence from the Haua and Hagfet al-Gama provides for the first time a view (albeit highly imperfect) of the earlier Holocene environments in Cyrenaica. It is possible that the landscape was becoming relatively well-vegetated with Mediterranean woodland from the start of the time considered here, about 10,000 cal. BP, but became more open and arid by the end of the Libyco–Capsian, just before 8000 cal. BP. In the Neolithic, the molluscan evidence suggests that the area was still relatively well-vegetated, albeit slightly more open in aspect as people expanded their resource-base through the adoption of herding. As they became better adjusted to their environment, pressure on mollusc populations declined. Even in Classical and Roman times, however, molluscs were still used for food and there was still marked stress on coastal mollusc populations close to the Haua, even in what became a Roman province known for its prosperity.

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A. M. Fattah, Grotta dell’Uzzo Compagnoni (1991) and Mannino et al. (2007) documented continuity of use of marine and terrestrial molluscs from the Mesolithic into the Neolithic. But at many sites around the Mediterranean, the locus of human activity and patterns of subsistence seem to have changed radically with the beginning of farming.

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