V. K. TAYLOR · M. BELL

8. LAND MOLLUSCS

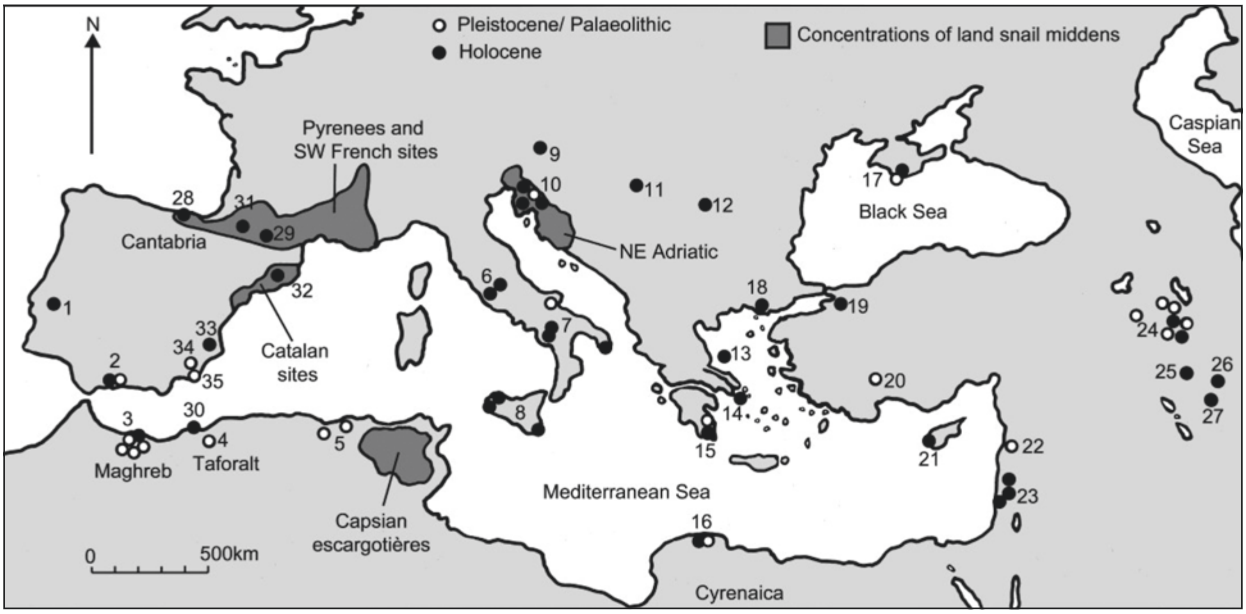
8.1 INTRODUCTION TO MEDITERRANEAN LAND MOLLUSC MIDDENS

The field of molluscan research in archaeology has been geographically somewhat patchy. Palaeoeconomic studies of land mollusc middens occur particularly in the Mediterranean, whilst palaeoenvironmental studies of land molluscs have been concentrated in Britain (Evans 1972) and in North America and Scandinavia; there has been a focus on marine mollusc middens with less emphasis on the contribution of land Mollusca (Claassen 1998; Andersen 2000). More recently there is a growing appreciation of the value of an integrated perspective and a growing range of ways in which Mollusca can contribute to archaeological research (Thomas 2015a; 2015b; Allen 2017).

Land snail middens are a widespread phenomenon occurring throughout Southern Europe, the Near East and North Africa (**fig. 8.1**; Lubell / Barton 2011), yet few have been excavated and recorded in detail (Lubell 2004b; Rabett et al. 2010). Some of the most well-known examples are located in North Africa, particularly in the Maghreb (Morocco, Tunisia and Algeria) and in Cyrenaica, Libya. The archaeology of these middens is mainly attributable to two cultural groups: the Iberomaurusian and the Capsian. Those belonging to the former are found in caves and rockshelters, often near the coast, and date to between c. 18,800 and 11,000 cal BP (Lubell / Sheppard / Jackes 1984; Lubell 1984; 2001). Those belonging to the Capsian tend to be open-air sites, are found further inland, mainly in Algeria and Tunisia, and are Holocene, dating between 11,000 and 7,000 cal BP (Morel 1974; Lubell / Hassan / Gautier / Ballais 1976; Lubell 2001). Key sites in North Africa include: the present mollusc study at Taforalt, also known as Grotte des Pigeons; Ifri n'Ammar (Moser 2000), Ifri Oudadane (Morales et al. 2013) and Taghit Haddouch (Hutterer / Linstädter / Eiwanger / Mikdad 2014) in Morocco; Tamar Hat (Saxon 1976) and Aïn Mistehiya (Lubell et al. 1975) in Algeria; and Haua Fteah in Libya (McBurney 1967; Hill et al. 2015).

After North Africa, the French Pyrenees has one of the highest concentrations of land snail middens. Important sites in the region include Grotte de Poeymaü and Mas d'Azil (Bahn 1983a; 1983b). Land snail middens can also be found in other European countries, such as Croatia, where Pupicina Cave has been investigated (Miracle 1995; 2001), and Italy (Bonizzoni / Bruni / Girod / Guglielmi 2009; Lubell et al. 1995). Middens are also found in Portugal and Spain. Some of the most well-known shell middens are in Spain. The Asturian middens along the Cantabrian coast (Aparicio et al. 2001; Lubell 2004a) are particularly known for their marine shell component but many also contain large numbers of land snail shells, as recorded at La Fragua Cave (Gutierrez-Zugasti 2011). Land snail middens can also be found outside of this region, such as at Nerja Cave in Andalucía (Auro Tortosa et al. 2002) and a chain of sites close to the east coast of Spain (Lloveras et al. 2011; Fernández-López de Pablo / Gómez Puche / Martínez-Ortí 2011).

In contexts where there are accumulations of shells without substantial middens, consideration must be given to whether the accumulation results from human activity or could be a natural death assemblage (Girod 2011). The latter will generally be characterised by a range of growth stages and species, many not edible, and the absence of associated anthropogenic artefacts. Assemblages derived from human consumption are generally of one edible species, or a narrow range of edible species, mostly fully grown, and they occur in specific contexts with cultural material. Examples are also often heat-affected.



1. The Muge middens
2. Nerja Cave
3. Ifri n'Ammar, Ifri-el-Baroud, Taghit Haddouch, Hassi Ouenzga
4. Taforalt
5. Afalou bou Rhumel, Tamar Hat
6. Grotta di Pozza, Grotta Continenza
7. Grotta della Madonna, Grotta Paglicci, Grotta di Latronico
8. Grotta dell'Uzzo, Grotta di Levanzo, Grotta Corrugi
9. Rosenburg
10. Pupićina Cave and other Istrian sites
11. Donja Branjevina
12. Foeni Salas
13. Cyclope Cave
14. Maroulas
15. Franchthi Cave
16. Haua Fteah
17. Lapsi VII
18. Hoça Çesma
19. Illipinar
20. Öküzini Cave
21. Kissonegra Mylouthkia
22. Ksar'Akil
23. Djebel Kafzeh, Hoyonim Cave, Erq el-Ahmar, Mugharet ez- Zuitina, Ein Gev
24. Asiab, Gerd Banahilk, Jarmo, Karim Shahir, Nemrik 9, Tepe Sarab, Shanidar Cave Layer B, Warwasi, Zawi Chemi Shanidar
25. Bestansur
26. Sheikh-e Abad
27. Jani
28. La Fragua
29. Mas d'Azil
30. Ifri Oudadane
31. Grotte de Poeymau
32. Balma del Gai
33. Arenal de la Virgen and Casa Corona
34. Algarrobo
35. Caballo

Fig. 8.1 Map of land mollusc middens of the Mediterranean and Near East. – (Drawn by J. Foster after Lubell 2004b with additions).

The earliest clearly defined land snail middens are Upper Palaeolithic in date, the best examples of which are those associated with the 'Epipalaeolithic' (Late Stone Age, LSA) Iberomaurusian culture in North Africa, such as at Taforalt, Ifri n'Ammar and Tamar Hat. The earliest substantial midden layers are c. 18,800 cal BP (Unit IV) at Tamar Hat (Saxon et al. 1974, 50; Hogue/Barton 2016). On two sites north of the Mediterranean, land mollusc use is attested in the Palaeolithic, the earliest at Cova de la Barriada c. 31,000-27,000 BP (Fernandez-Lopez de Pablo et al. 2014) and a later case at Nerja Cave in Southern Spain from c. 12,000 cal BP (Jorda/Avezuela/Aura/Martin-Escorza 2011). There is a notable increase, particularly north of the Mediterranean, in the number and distribution of land snail middens in the early Holocene, with the majority of sites being Mesolithic in date, such as the middens in Northern Spain and the Pyrenees. Le Fragua Cave in Spanish Cantabria contains a substantial midden estimated at 15,000 land snail shells, beginning c. 10,900 cal BP (Gutierrez Zugasti 2011). The Capsian middens in North Africa also date to the early Holocene; however, many extend into the Neolithic period, with land snail consumption continuing alongside early domestication at sites such as Ifri Oudadane (Morales et al. 2013). There is evidence for land snail consumption into the Neolithic, Roman and Hellenic periods in Libya, indicating that "eating of gastropods seems to have been a consistent feature of the coastal Cyrenaican sites through the Holocene" (Hunt et al. 2011, 24). A post-Neolithic midden has also been observed at Aounout, c. 1.5 km from Taforalt (Taylor 2014).

Smaller accumulations of land snails are also regularly found at archaeological sites in the Zagros Mountains (Eastern Iraq and Western Iran), with ongoing work in the region by the Central Zagros Archaeological Project continuing to produce evidence of small accumulations of *Helix salamonica* at Neolithic sites, including Bestansur, Sheikh-e Abad and Jani (Shillito 2013b; Iversen 2015). Recent work by Rabett et al. (2010) has highlighted the presence of a midden dominated by land snails in Hang Boi Cave (Fortune Teller's Cave) in Trang An Park in Vietnam. Exploitation of the Giant Land Snail (family Achatinidae) is also reported in the Middle Stone Age Bushman Rock Shelter in South Africa, where some were heat-affected (Badenhorst/Plug 2012), and there is also possible evidence for their consumption in Later Stone Age contexts in Kuumbi Cave, Zanzibar (Shipton et al. 2016). These sites push the known distribution well beyond the circum-Mediterranean. It seems likely that the distribution of evidence for land mollusc consumption will continue to expand as archaeologists become more aware of their potential contributions to the diet.

Consumption of a wide range of land mollusc species continues to this day in Mediterranean countries and beyond. We have purchased them as hot street food snacks in spicy broth near the project base at Saïdia and there are many pictures on the World Wide Web of them being sold as street food in Marrakech and elsewhere. Today, 10,000 tonnes of snails are harvested annually in Morocco for export, mainly to Spain (Independent 2011). In Europe, *Helix pomatia*, eaten as "*escargot*", is particularly well known and *Helix aspersa* (in the UK now designated *Cornu aspersum*, R. Anderson 2005) is similarly consumed. In Portugal *Theba pisana* is a traditional dish with some 4,000 tonnes being consumed annually.

8.2 RESEARCH QUESTIONS RAISED BY THE MIDDENS

In research terms, the land mollusc middens present questions similar to those of the coastal marine mollusc middens, such as those along the Atlantic seaboard of Europe (Milner/Craig/Bailey 2007), particularly in Denmark (Andersen 2000), and in many other parts of the world (Bailey/Hardy/Camara 2013). Where an accumulation of shells is found, the question must be asked: could they be a natural death assemblage, or one formed by people, or a combination of both? They may potentially provide evidence for environmental, climatic and dietary change. The quantities of shells can be enormous but their significance in the diet must be evaluated alongside other, sometimes less obvious, animal and plant resources (as reviewed in other chapters). Confronted with the question of how such large numbers of land snails could have been acquired, some writers have even advanced the highly questionable proposition that they were farmed in some way (Bahn 1983a; 1983b; Fernández-Armesto 2001). There is also the question of whether such a concentration of food debris is itself indicative of sedentary communities and whether there is evidence, in the form of periodic banding of the shells, or fluctuations in isotopic composition, for seasonality or year round exploitation of molluscan resources (cf. Katsi 2016). In the case of some examples of both Atlantic marine mollusc middens and Mediterranean land mollusc middens, theories of sedentism have been strengthened by the occurrence of human burials associated with the middens. The assumption is that burial is more likely to occur when settled populations identify with a specific place. The occurrence of large numbers of burials during the Iberomaurusian phase at Taforalt (Humphrey et al. 2012; **Chapter 15**) gives a particular significance to questions of seasonality and sedentism in this case.

Fig. 8.2 Mollusc sample column (red outline) through the Grey Series and the top 0.9 m of the Yellow Series; the artefact column (with 'L-units') is under excavation to the left and outlined in blue.

8.3 INVESTIGATIONS AT TAFORALT

The monograph on Taforalt by Roche (1963) included a table of mollusc identification but only recording presence/absence of species in each of the main recognised *Niveaux*, without any further quantification.

Thus, there were minimal data on this, one of the main components of the Iberomaurusian midden. 15 terrestrial species were recorded, of which 10 were present in all geographic zones of the top two of Roche's three excavation units (i. e. "*Niveaux I-V*", see **Chapter 2** for correct interpretation). The others were mostly confined to the upper unit or to single lower *Niveaux*. Three freshwater species were also identified and seven marine species (see **Section 13.2**).

During the recent field investigation, sampling of the mollusc column was undertaken in 2009 by Ingrid Brack and Martin Bell and in 2010 by the authors of this chapter. Small scale, detailed sampling was done of the standing section left by previous excavations. A 20 cm wide mollusc column (MMC – master mollusc column) was excavated in Square A23 of Sector 8. The mollusc column was located 1 m to the right of the column excavated by J. Hogue (the L-units) for lithics and other artefacts, as shown in **figure 8.2**. The adjacent placement of these columns enables some stratigraphic linkage between columns (**Chapter 2**) and allows radiocarbon data obtained from the lithic column to be applied to the mollusc column (cf. **Chapter 4**). Samples were taken following natural stratigraphy where possible, with arbitrary spits being used where there was a thick unit with no evident stratigraphic subdivision. The instability of the loose section prevented the excavation of a continuous column over the two excavation seasons and, in 2010, a new column was sited 20 cm to the right (when facing the section, inwards in the cave) of the 2009 column. The Yellow Series deposits had not previously been excavated in a vertical face as far back (laterally, towards the cave wall) as the Grey Series, preventing excavation of the column in a continuous straight line without significant disturbance of the remaining section. During the early excavations of the Morocco Caves Project, a c. 1 m^2 section of the Yellow Series at a 90° angle to the exposed face of the Grey Series, directly below the mollusc column, was prepared and recorded; this section was cleaned and used for the Yellow Series part of the mollusc column.

The Grey Series formed the local interval from 0 (top) -3.9 m and from this samples MMC 1-106 were taken. The sequence was continuous but a gap of 29 numbers (from 51 to 79 unused) was left between the two seasons, so the total number of samples in the GS was 77. **Figure 8.3** shows a small area of the Grey Series with shells (some calcined), stones (some heat-fractured), lithic chips and bones. Only the upper parts of the Yellow Series sediments were sampled from depth 3.9 m to 4.8 m, producing samples 107-130 which were considered to correspond to the Iberomaurusian activity. There was no sampling for Mollusca below the Iberomaurusian levels, which were considered to be beyond the remit of the Cemeteries and Sedentism Project. The total number of samples in the whole (composite) MMC column was thus 101.

In the field, a minimum of 2 litres of sediment was taken from each MMC unit where possible, in order to try to recover the 100 molluscs per sample recommended by Evans (1972) for molluscan analysis. Large molluscs visible in the section were removed separately during excavation, in order to prevent further fragmentation during processing. Sub-samples were taken from each bulk sample, one for specialist phytolith analysis (**Chapter 7**) and one for particle size analysis.

Earlier reports on the present molluscan study at Taforalt may be found in Taylor et al. (2011), Taylor (2014) and Taylor / Bell (2017). The present final report includes revisions as to species nomenclature and a refined chronology and interpretation.

8.4 SIEVING AND SORTING STRATEGY

One litre of sediment was sieved (after the hand-removal of rocks larger than 5 cm) at the excavation base in Morocco. The sediment was dispersed in water and flot fractions were repeatedly decanted onto a 0.5 mm

Fig. 8.3 Taforalt cave molluscs, horizontal view of Grey Series sediments with *in situ* mollusc shells, an example lower in the photograph blackened and degraded by fire; lithic debitage is also present. – Scale division 10 cm.

sieve until no further shells floated. The sink fraction was then washed using a hose spray with multiple easily controllable settings onto a nest of sieves of 4 mm, 2 mm, 1 mm and 0.5 mm mesh. The dusty midden sediments were easy to disaggregate and clean in this way (**fig. 8.4**). The fractions were then dried and bagged ready for transport to the laboratory.

All fractions of each sample were fully sorted using a binocular microscope at the University of Reading. The material removed was quantified by count (shown on the graphs in **figs 8.5-8.6**) and weight, excepting charcoal which has only been quantified by weight due to variable fragmentation. Molluscs are quantified using the NRE (non-repetitive element) method of MNI (Minimum Number of Individuals) quantification (Giovas 2009). The NRE selected is the apex; however, other diagnostic fragments were also removed (but not quantified) to aid species identification.

Materials recovered from the mollusc column samples (including: mollusc apices; charcoal; animal bone fragments; percentage burnt and unburnt bone; microfauna (vertebrate); and lithics, mostly microdebitage) are shown in **figure 8.5**. A total of 37,980 animal bones were recovered (mostly tiny fragments), 91 % of which came from the Grey Series. Of those, 65 % were burnt, which is much higher than the 22 % from the Yellow Series which showed signs of burning. A piece of decorated bone was recovered from MMC85 (c. 14,244-14,545 cal BP) in the Grey Series. Two segments of *Dentalium* shell bead were also recovered,

Fig. 8.4 Washed and sieved sample with mollusc shells, bone, lithics, etc. – Scale division 1 cm.

one in Sample MMC81 in the Grey Series, the other in MMC118 in the Yellow Series. Sorting of the flots also revealed the presence of numerous, well preserved, charred plant macrofossils, which have been analysed by Jacob Morales (**Chapter 6**). This corrects the previous work of Ward (2007), who reported an absence of seeds in samples from Sector 8, something which he interpreted as most likely being a result of a lack of seed consumption in the Iberomaurusian period.

Figure 8.6 compares mollusc occurrence with two measures of particle size in the column, both after stones larger than 5 cm had been removed. It shows the proportion of 1 litre samples less and more than 0.5 mm in size and the weight of the 4 mm fraction. The Yellow Series shows three distinct stony horizons and a further increase in stone content to its top. Dating led to the identification of a significant erosion phase in the Yellow Series above MMC109 and the increased stone, lithic, bone and microfaunal evidence is above this. **Figure 8.6** highlights the less stony nature of the Grey Series above c. MMC46 (see also **fig. 8.2**). There is also a less pronounced decline in particles larger than 0.5 mm from bottom to top of the Grey Series. Decreased stoniness above c. MMC46 may be a contributory factor to increased mollusc numbers but it is not likely to be the whole explanation since the increase in molluscs occurs earlier, from c. MMC84.

Figures 8.5 and **8.6** demonstrate very clearly the contrast between the Yellow Series sediments, with far smaller and declining numbers of Mollusca between the base at 20,882-21,436 cal BP and the Grey Series boundary. The micro-vertebrates also decline upwards in the Yellow Series although in this case peak numbers are at the boundary and continue into the lowest Grey Series samples. Charcoal occurrence is very low in the Yellow Series and animal bone and chert low, compared to the Grey Series. There is evidence of an

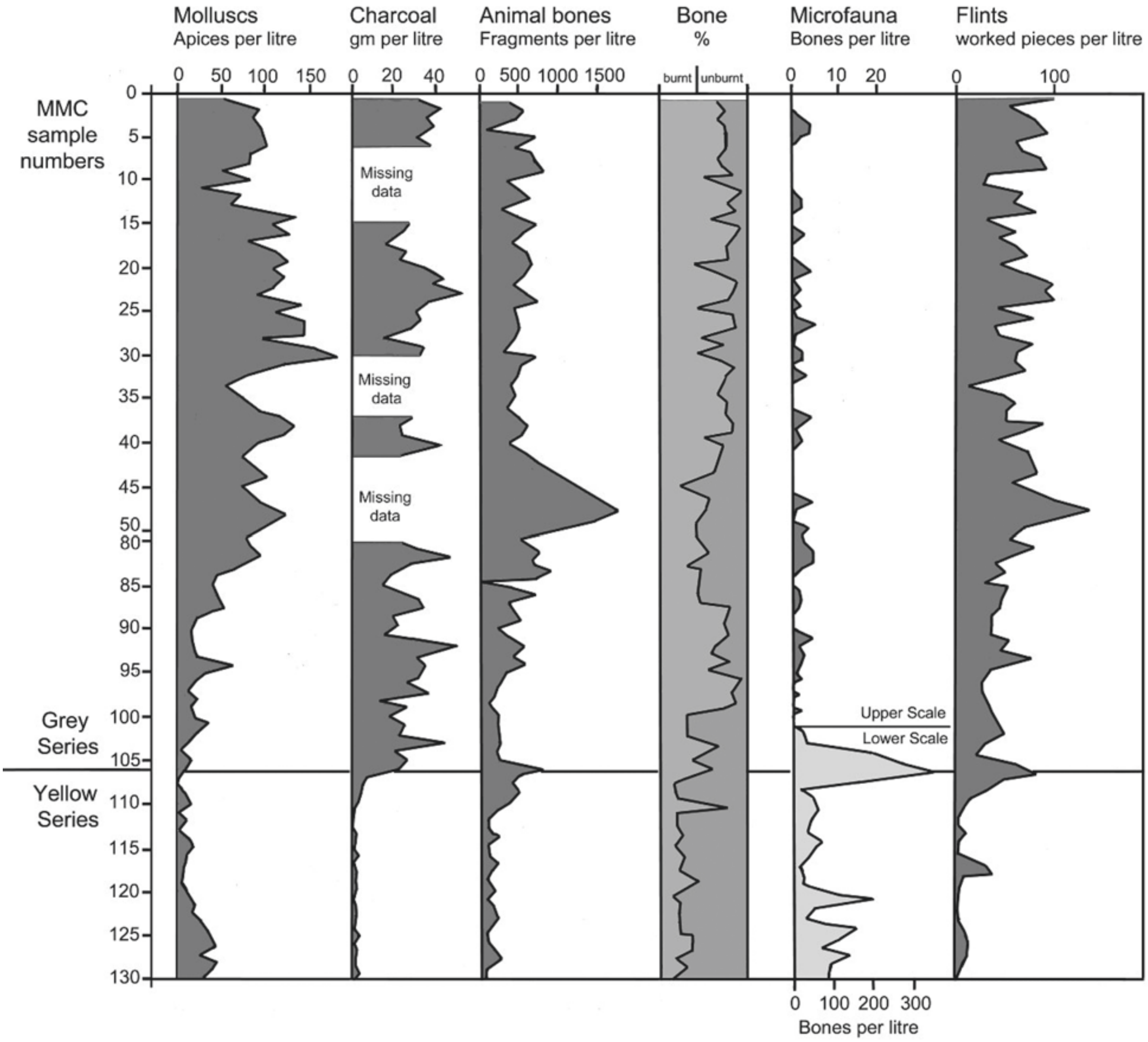


Fig. 8.5 The results of sieving the mollusc column samples in the MMC sequence, showing the occurrence of: Mollusca; charcoal; animal bone (mostly fragments); percentage of bone (burnt and unburnt); micro-vertebrates; and lithics (mostly microdebitage). – (Drawn by J. Foster).

hiatus between Yellow Series Y1 and Y2 (at c. MMC110) at or just before c. 15,180-15,615 cal BP. Each of the categories of material picked out of the samples increases at the very top of the Yellow Series.

In the Grey Series, micro-vertebrates were only present in very low numbers (note the change of scale on **fig. 8.5**) whereas the classes of artefact were much more abundant in the Grey Series than in the Yellow Series. Mollusc numbers are low (<50) below MMC84 in the Grey Series but above this they increase with a peak between MMC50-14. Charcoal shows a moderate increase up the Grey Series profile, as does chert, and, together with the molluscan results, might be interpreted in terms of increasing intensity of activity. Interestingly the peak of animal bone fragments occurs at the base of the molluscan peak which might be interpreted in terms of a shift from vertebrate to molluscan exploitation.

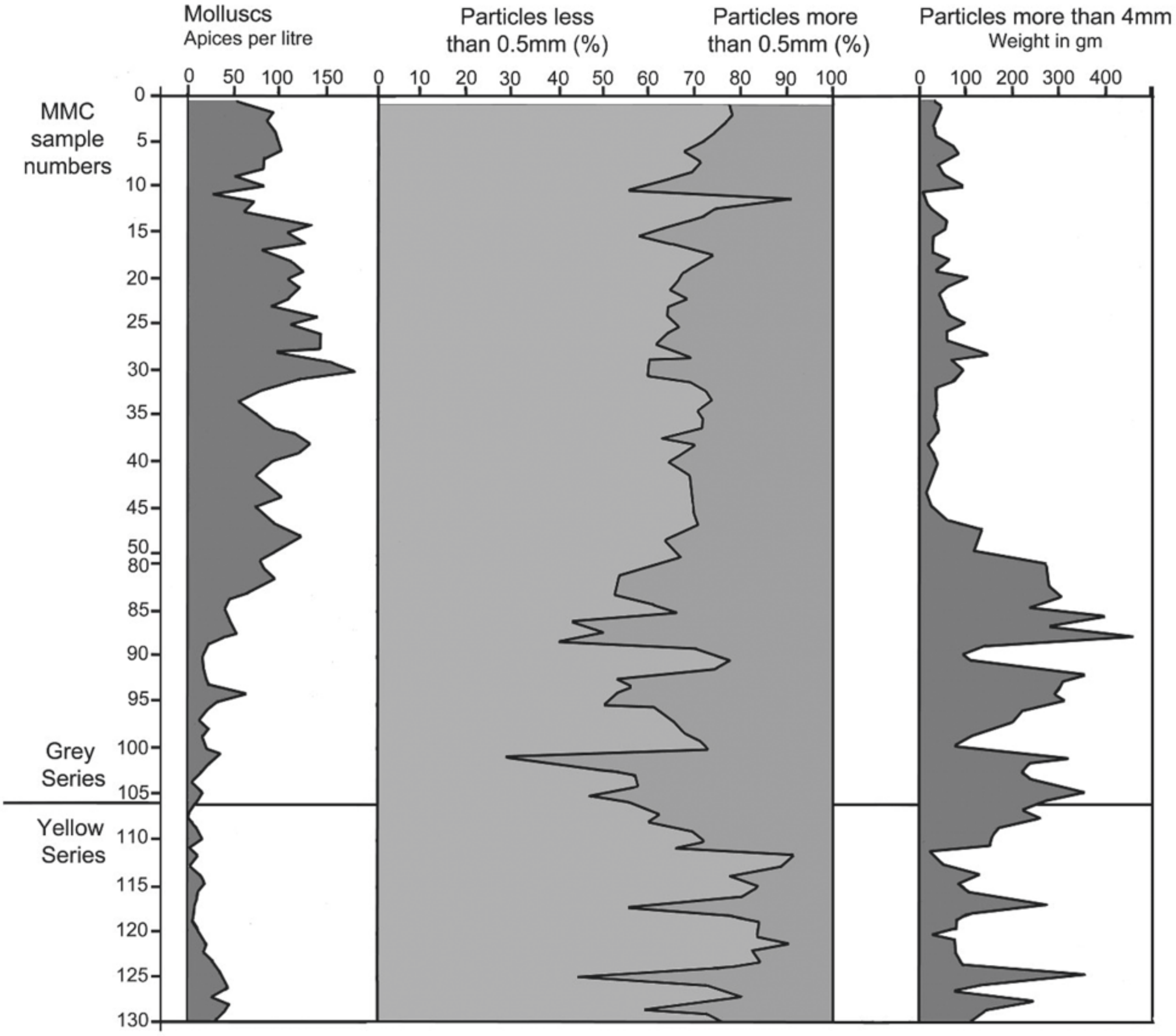


Fig. 8.6 Mollusc occurrence compared to measures of particle size in the column: percentage of sediment less and more than 0.5 mm; weight of particles larger than 4 mm. – (Drawn by J. Foster).

8.5 SPECIES IDENTIFICATION AND TAXONOMIC ISSUES

When studying archaeological molluscan material from sites in well documented areas such as Britain and much of Europe, it is possible to refer to published guides which outline key identification features and some information as to the habitat and distribution of the relevant species (Kerney/Cameron 1979; Welter-Schultes 2012a). North Africa has been widely recognised as having an interesting and diverse malacofauna with many endemic species (Pond/Chapuis/Romer/Baker 1938). However, there has been a lack of recent systematic work, except in relation to individual species. Most of the work was done by French malacologists in the late 19th and early 20th centuries, such as J.-R. Bourguignat, who had a tendency to split species based on characteristics which might be more appropriate to identification of sub-species (Dance 1970). The result is that there are many synonymous species, taxonomic descriptions are limited and there is very limited information about the ecological context from which specimens were collected. Some molluscan collection was

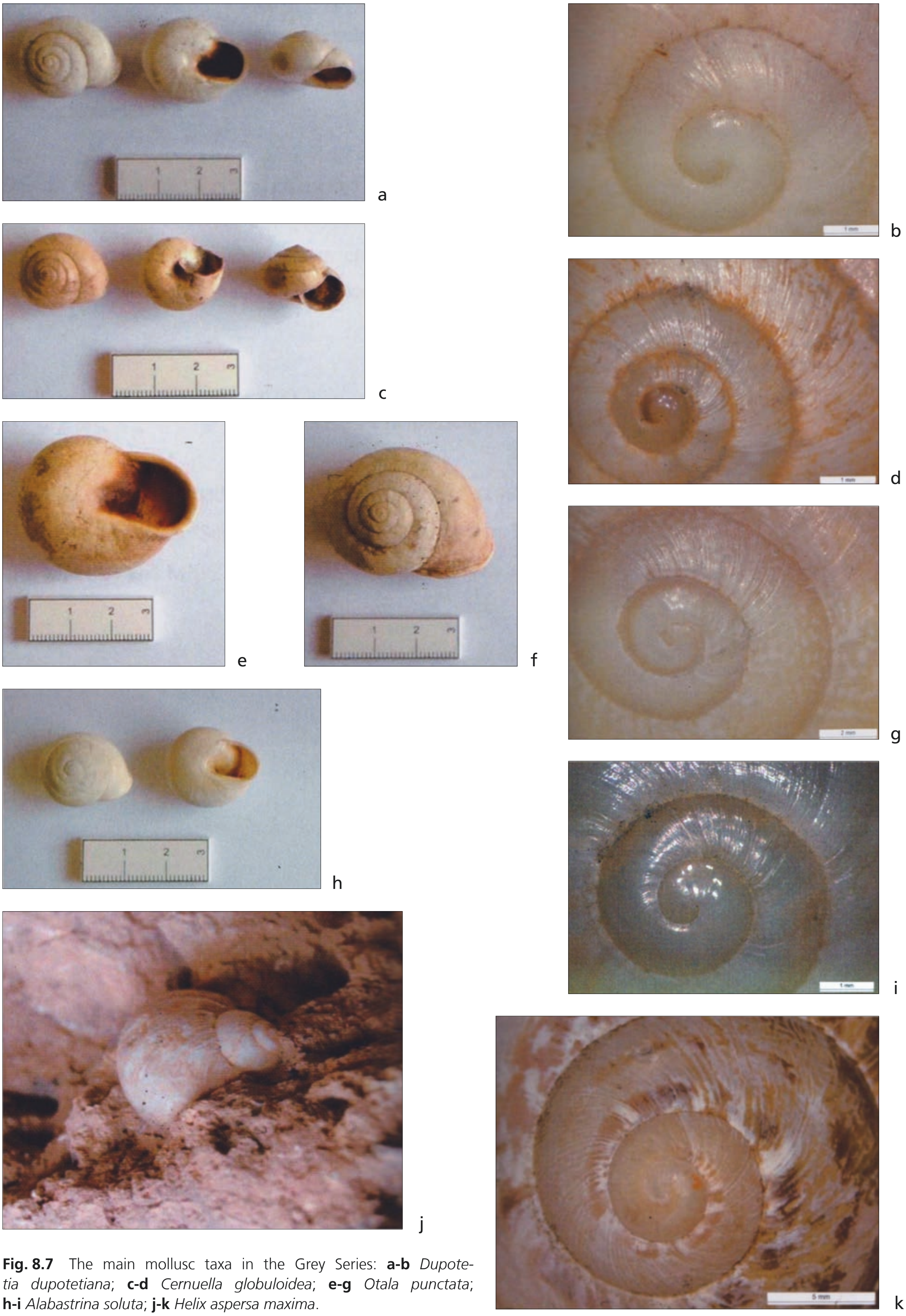


Fig. 8.7 The main mollusc taxa in the Grey Series: **a-b** *Dupotetia dupotetiana*; **c-d** *Cernuella globuloidea*; **e-g** *Otala punctata*; **h-i** *Alabastrina soluta*; **j-k** *Helix aspersa maxima*.

done in the Taforalt area by Capt. P. Martel (Pallary 1920a; 1920b) and also as part of a more recent study of the Mollusca of Morocco by Dr. Mary Seddon and Dr. David Holyoak, the material from which is housed in the National Museum of Wales and has been consulted as part of the present study (Holyoak/Seddon 1986). Recent publications which provide species inventories for Morocco include Rour/Chahlaoui/Van Goethem (2002) on terrestrial species and the Ramdani et al. (1987) inventory of freshwater Mollusca. Despite this and other recent work on individual taxa (cf. Hutterer/Greve/Haase 2010; Abbes/Nouira/Neubert 2011), not unfortunately key components of the Taforalt assemblage, there remain considerable problems of taxonomy and large scale revision of the molluscan species of the Maghreb is very much needed. These taxonomic problems mean that it is necessary to describe and illustrate each of the taxa which formed the main components of the Taforalt midden; more detailed descriptions including those of species present in low numbers are contained in Taylor (2014). Images of each of the main species can be found in **figure 8.7**.

Dupotetia dupotetiana **(Terver 1839)** (fig. 8.7a-b)

H. 13-17 mm × W. 22-25 mm. Shell globular, of varying height, with convex spire and strong, everted lip. Dextrally coiled. Moderately thick and strong shell with moderate suture and wide aperture (2/3 of width). Umbilicus closed in adults and open in juveniles. One clear tooth on basal lip, 2/3 of distance from column. Colour white or brown-banded with fine radial ribs and very slight spiral grooves.
Taxonomy is particularly confused for this species and there is evidently a large amount of synonymy within this genus. Possibly the same species as the *Otala tigri* (Marès 1857) in the land snail midden layers at Taghit Haddouch (Hutterer/Mikdad/Ripken 2011; Hutterer/Linstädter/Eiwanger/Mikdad 2014). No published information on habitat preference. Abundant today on the plains north of the Beni Snassen (see below).

Otala punctata **(Muller 1774)** (fig. 8.7e-g)

H. c. 22 mm × W. c. 38 mm. Large, slightly depressed, globular shell with strong, reflected lip. Protoconch smooth with no sculpturing. Dextrally coiled. Thick, strong shell with moderate suture which is deeper in the later stages, from around 1.5 whorls. Last whorl deeply descending by aperture. Aperture almost half the width of the shell. Umbilicus closed in fully adult shell, open in juveniles. Thickening around lip with callus close to columellar area, approximately half way along lower lip. Lip is strong and thickened, especially on lower side, and everted on upper side. Shell grey-brown in colour with some indistinct bands (c. 2-5) interrupted by small, white irregularly shaped marks. In early growth stages irregular, fine, radial ribs are visible. In later growth stages the shell has a more irregular, puckered appearance. Distinguishable from closely related *Otala lactea* by larger overall size, less distinct bands and more puckered surface sculpture on later whorls.
Hutterer/Mikdad/Ripken (2011) state that specimens of *Otala punctata* from Taghit Haddouch are likely to be the same species as similar specimens found at Taforalt. Favours cultivated coastal plains, gardens, dry wasteland and areas around rocks and walls (Welter-Schultes 2012a, 624).

Alabastrina soluta **(Michaud 1833)** (fig. 8.7h-i)

H. c. 12-14 mm × W. 20-22.mm. Globular, convex shell with smoothed profile and alabaster-like appearance. Juvenile far more keeled at margin. Dextrally coiled. Moderately thick shell with shallow suture, particularly in early whorls, and rounded aperture (around half width of shell). Closed umbilicus in fully adult shell, open in juveniles. Slight thickening on right side of basal aperture, 4/5 of distance from columellar. Shell entirely white or light brown with dark brown bands. The numbers of this species are likely to be an underestimation of the total count, as the apical whorl can appear similar to that of *Dupotetia dupotetiana* in highly fragmented, archaeological specimens.

It should be noted that all individuals identifiable as *Alabastrina* sp. will be referred to in the text as *Alabastrina soluta* for ease of description but it is acknowledged that we may be dealing with more than one species, particularly if the name *Alabastrina alabastrites*, which was previously assigned to this species (Taylor et al. 2011), does indeed belong to a white-shelled variant as stated by Hutterer/Mikdad/Ripken (2011). Very abundant today in the immediate vicinity of Taforalt and Moulouya River. Terver (1839) frequently observed *Alabastrina soluta* on rocks and cactus plants in Morocco.

***Helix aspersa* var *maxima* (Taylor 1913)** (fig. 8.7j-k)

H. c. 38 mm × W. c. 34-40 mm. Tall, wide shell with 4-5 whorls and large, oval aperture (greater than half the width of the whole shell, c. 25 mm × c. 25 mm). Dextrally coiled. Moderately thick shell with deep, clear suture and closed umbilicus. Lip is strong and reinforced at the base of aperture. 4-5 interrupted, brown, bands are visible in addition to a distinctive wrinkled surface sculpture.

Helix aspersa has been widely dispersed by people over time but has a Mediterranean origin. It can live in a wide variety of habitats including gardens, parks, dunes, woods, rocks, shrubs, light woods, etc. (Kerney/Cameron 1979; Welter-Schultes 2012a). *Helix aspersa* var *maxima* is a large variety of *Helix aspersa* endemic to North Africa (Taylor 1913). In the UK nomenclatural list, *H. aspersa* is now designated as *Cornu aspersum* (R. Anderson 2005).

***Cernuella globuloidea* (Terver 1839)** (fig. 8.7c-d)

H. c. 15 mm × W. c. 20 mm. Globular shell with conical spire. Very tightly coiled, bulbous apex, darker in colour than body whorls. Dextrally coiled. Thin walled shell with open umbilicus (c. 2 mm) and circular aperture, slightly less than half width of body. Suture is pronounced at apex, becoming clear in later growth stages. Lip is weakly developed with some thickening on the inside. Shell pale brown with one prominent band (sometimes 2) and several weaker, thinner bands which are less prominent and more interrupted. Surface sculpturing comprises very fine radial ribs from early growth stages. Sculpture more irregular and slightly puckered in later growth stages.

Infrequent in Epipalaeolithic deposits at Taghit Haddouch (Hutterer/Mikdad/Ripken 2011). Recorded by Terver (1839) on spiny shrubs and bushes in Morocco. Not found during modern mollusc study.

8.6 DATES FOR THE MOLLUSC COLUMN

A radiocarbon dating sequence relevant to the mollusc column (S8-MMC) is provided in **table 8.1**, which shows the mollusc column and other units which can be correlated with reasonable confidence to specific MMC samples, or groups of samples. This provides dates for 15 horizons within the mollusc sequence. The

MMC	Unit	^{14}C date	Lab No.	Cal BP modelled range 95.4 % range
4	L2	10,680 ± 45	OxA-24111	12,611-12,725
c. 9	L3	10,870 ± 45	OxA-23404	12,700-12,817
c. 14	L4	11,165 ± 45	OxA-24112	12,804-13,045
20-24	L6	11,540 ± 50	OxA-24113	13,280-13,467
25-30	L8 (top)	11,445 ± 50	OxA-23406	13,200-13,354
46	L15	11,890 ± 55	OxA-23409	13,590-13,780
88-91	L25	12,405 ± 55	OxA-23410	14,244-14,545
97-106	L28	13,060 ± 65	OxA-23411	15,339-15,902
106	c. L29	12,605 ± 55	OxA-24109	14,734-14,970
107	Y1 (top)	12,200 ± 55	OxA-22786	13,853-14,788
110	Y1 (base)	12,850 ± 50	OxA-22788	15,180-15,615
111	Y2spit1	14,005 ± 60	OxA-16267	16,745-17,214
119	Y2spit4/5	15,790 ± 60	OxA-16269	18,886-19,236
125	Y3	16,285 ± 65	OxA-16270	19,514-19,993
126-130	Y4spit2	17,515 ± 75	OxA-16273	20,882-21,436

Tab. 8.1 Relationship between: the mollusc samples (MMC); the units (L) in one of the more substantial excavated columns in the Grey Series (or, in one case, a close equivalent) and stratigraphic units in the Yellow Series (Y); and correlated radiocarbon dates (the radiocarbon dates and calibrations (adjusted in a Bayesian model) follow **Chapter 4**).

actual number of dated samples published by Barton et al. (2013) was 40 and 16 dates have been assayed subsequently, making a total of 56 for the Sector 8 sequence; however, only some dated samples could be tied to particular mollusc samples, due to the extremely variable nature of the Grey Series deposits which have lenses, patches and pockets of sediment. The radiocarbon dates and calibration follow the revised model developed in 2018 (cf. **Chapter 4**). The modelled dates have been followed precisely except that, in the present chapter, a date of 14,830-15,190 cal BP has been taken as the Yellow Series – Grey Series boundary (Barton et al. 2013). Other dates given in the text follow **table 8.1**, and have not been rounded, to facilitate ready comparison of table and text.

The earliest modelled date at the base of the mollusc column, at the top of Unit S8-Y4spit2, is c. 20,882-21,436 cal BP. The transition from the Yellow to Grey Series takes place 14,830-15,190 cal BP. Near the top of the surviving Grey Series and the mollusc column sample, MMC4 corresponds to a modelled date of c. 12,611-12,725 cal BP. Thus the mollusc column spans a period c. 6,200 years, during which this part of the Yellow Series sediment accumulated, and c. 2,300 years for the Grey Series sediment. Overall, the mollusc column spans c. 8,500 years.

8.7 RESULTS OF MOLLUSC ANALYSIS

The results, from the sequence of 101 samples over a depth interval of 4.8 m, are shown in **table 8.2** and **figure 8.8**, and will be described from the earliest to the latest samples. **Figure 8.8** also demarcates 5 Molluscan Assemblage Zones (MAZ-1 to MAZ-5), and in the case of MAZ-1, 3 sub-zones, into which the sequence has been divided.

Sample no.	*Cernuella globuloidaea*	*Alabastrina soluta*	*Dupotetia dupotetiana*	*Dupotetia* type	*Otala punctata*	Hygromidae sp.	*Leonia mamillaris*	*Ferussacia* sp.	*Helix aspersa*	Unidentified terrestrial	Other molluscs		Total
1	9	4	29	3	8	-	-	-	-	-			53
2	5	2	52	21	8	-	-	-	-	1	*Vitrea contracta* *Rumina* sp.	1 1	91
3	10	-	57	5	15	-	-	-	-	-		-	87
4	4	1	66	13	10	-	-	-	-	2	*Vitrea contracta*	2	98
5	2	-	68	7	22	-	-	-	-	-		-	99
6	3	-	70	16	12	-	-	-	-	1		-	102
7	3	1	47	4	28	-	-	-	-	-		-	83
8	1	-	44	18	19	-	-	-	-	-		-	82
9	-	1	20	20	8	-	-	-	2	-		-	51
10	1	-	47	3	33	-	-	-	-	-		-	84
11	-	1	18	5	6	-	-	-	-	-		-	30
12	1	-	53	12	6	-	-	-	-	-		-	72
13	-	-	38	7	16	-	-	-	-	-		-	61
14	1	-	99	14	23	-	-	-	-	-		-	137
15	1	2	74	11	20	-	-	-	-	-		-	108
16	-	3	73	21	30	-	-	-	-	-		-	127
17	-	-	58	17	12	-	-	-	-	-		-	87
18	1	2	67	22	23	-	-	-	-	-		-	115
19	1	1	82	18	24	-	-	-	-	-		-	126
20	-	4	65	2	33	-	-	-	2	-		-	106
21	-	-	82	17	23	-	-	-	-	-		-	122
22	1	2	72	14	23	-	-	-	-	-		-	112
23	1	1	58	17	16	-	-	-	-	-		-	93
24	3	-	79	15	42	-	-	-	-	-	*Carychium tridentatum*	1	140
25	-	3	90	5	18	-	-	-	1	-		-	117
26	10	-	105	20	9	-	-	-	-	-		-	144
27	9	4	87	20	24	-	-	-	1	-		-	145
28	1	-	78	9	11	-	-	-	-	-		-	99
29	7	-	86	29	36	-	-	-	-	-		-	158
30	1	1	135	6	33	-	-	-	-	-		-	176
31	5	3	59	23	32	-	-	-	-	-		-	122
32	1	4	46	12	19	-	-	-	-	-		-	82
33	-	3	33	12	9	-	-	-	-	-		-	57
35	-	3	49	12	9	-	-	-	-	1		-	74
36	2	1	51	21	20	-	-	-	1	-		-	96
37	4	2	91	14	5	-	-	-	-	-		-	116
38	6	6	76	24	21	-	-	-	-	-		-	133
39	6	5	68	16	24	-	-	-	1	-		-	120
40	1	1	58	21	13	-	-	-	-	-		-	94
41	1	3	43	20	12	-	-	-	-	-		-	79
44	4	1	71	16	10	-	-	-	-	-		-	102
45	1	1	56	6	9	-	-	-	-	-	*Carychium minimum* Unid freshwater	1 1	75
47	-	4	77	9	6	-	-	-	-	-	Unid freshwater	1	97

Tab. 8.2 Molluscs in each MMC unit.

Sample no.	*Cernuella globuloidaea*	*Alabastrina soluta*	*Dupotetia dupotetiana*	*Dupotetia* type	*Otala punctata*	Hygromidae sp.	*Leonia mamillaris*	*Ferussacia* sp.	*Helix aspersa*	Unidentified terrestrial	Other molluscs		Total
48	-	7	96	5	15	-	-	-	-	-		-	123
50	3	9	56	6	18	-	-	-	1	-		-	93
80	15	5	46	2	11	-	-	-	-	1	*Galba truncatula*	1	81
81	32	1	44	5	-	-	-	-	-	1		-	83
82	40	-	46	4	4	-	-	1	-	-	*Ceciloides* sp. *Galba truncatula* *Bithynia tentaculata*	1 1 1	98
83	22	-	36	-	4	-	-	-	-	-		-	62
84	24	1	21	1	-	-	-	-	1	-		-	48
85	23	-	18	-	2	-	-	-	-	-	*Amnicola pycnolena*	1	44
86	23	-	21	-	3	-	-	-	-	-		-	47
87	19	-	31	-	3	-	-	-	-	1		-	54
88	28	1	10	-	2	-	-	1	-	-	*Carychium tridentatum*	1	43
89	14	-	7	-	-	-	-	1	-	-		-	22
90	10	-	10	-	-	-	-	-	-	-	*Carychium minimum*	1	21
91	15	-	5	-	1	-	-	-	-	-	*Bithynia tentaculata*	1	22
92	10	1	7	-	2	-	-	-	1	-		-	21
93	17	-	4	-	1	-	-	-	-	-	*Carychium minimum*	1	23
94	35	-	16	2	7	-	-	-	-	1	Succineidae	1	62
95	14	-	11	-	7	-	-	-	1	-		-	33
96	13	-	6	-	1	-	-	-	-	1	*Bithynia tentaculata*	1	22
97	8	-	5	-	-	-	-	-	-	-	*Carychium tridentatum* *Bithynia tentaculata*	2 1	16
98	9	-	7	-	1	-	-	-	-	-	*Carychium minimum* Unid freshwater *Amnicola pycnolena*	1 1 1	20
99	5	-	7	-	1	-	-	-	-	1	*Carychium minimum*	1	15
100	5	-	7	-	7	-	-	-	-	0		1	19
101	11	1	9	1	5	-	-	-	-	4	*Candidula submeridionalis* *Carychium tridentatum* *Galba truncatula*	1 1 1	34
102	5	-	13	-	3	-	-	-	-	2	*Carychium minimum* *Acanthinula aculeata*	2 1	26
103	4	-	6	2	1	-	-	-	-	-	*Carychium minimum* *Bithynia tentaculata*	1 1	15
104	1	-	2	-	2	-	-	-	-	-	*Carychium tridentatum* *Bithynia tentaculata*	1 1	7
105	5	-	5	-	3	-	-	2		-	*Carychium tridentatum*	1	16
106	4	-	1	-	-	-	-	-	-	3	*Candidula submeridionalis* *Carychium tridentatum*	2 1	11
107	-	-	-	-	-	-	-	-	-	1	*Vertigo* sp. *Galba truncatula*	1 1	3
108	-	-	-	-	-	-	-	-	-	-	*Pyramidula pusilla* *Vitrina* sp.	1 1	2
109	-	-	-	-	1	5	1	-	-	1	*Galba truncatula*	1	9

Tab. 8.2 (continued)

Sample no.	*Cernuella globuloidaea*	*Alabastrina soluta*	*Dupotetia dupotetiana*	*Dupotetia* type	*Otala punctata*	Hygromidae sp.	*Leonia mamillaris*	*Ferussacia* sp.	*Helix aspersa*	Unidentified terrestrial	Other molluscs		Total
110	-	1	-	-	1	-	4	-	-	5	Succineidae *Ceciloides* sp. *Galba truncatula*	1 1 1	14
111	-	-	-	-	1	-	1	2	-	-		-	4
112	-	1	-	-	-	2	1	-	1	-	*Galba truncatula* *Bithynia tentaculata*	2 1	8
113	-	1	-	-	-	-	-	2	-	-	*Candidula submeridionalis* *Galba truncatula*	1 1	5
114	-	-	-	-	-	2	1	1	6	1		-	11
115	1	-	-	-	-	-	2	7	2	2	*Vitrina* sp. Unid freshwater	1 1	16
116	-	-	2	-	-	1	-	3	-	2	*Carychium minimum* *Carychium tridentatum* *Vitrina* sp. *Galba truncatula*	1 1 2 1	13
117	1	-	2	-	-	1	2	1	-	4		-	11
118	-	-	-	-	-	2	-	2	1	-	Succineidae *Vitrina* sp.	1 2	8
119	-	3	-	-	1	-	-	2	2	-	*Vitrina* sp.	1	9
120	-	1	-	-	2	1	3	1	-	4	*Vitrea contracta*	1	13
121	-	2	-	-	1	5	1	1	1	-	*Chrondina* sp. *Vitrina* sp. *Galba truncatula*	1 5 5	22
122	-	4	-	-	1	3	0	2	1	-	*Vitrina* sp. *Galba truncatula*	2 7	20
123	-	3	-	-	3	6	1	6	-	7	*Candidula submeridionalis* *Vitrea contracta*	1 1	28
124	-	1	-	-	2	2	-	7	1	17	*Vitrea contracta* *Pupilla* sp. *Galba truncatula*	3 1 1	35
125	-	-	-	-	-	3	2	5	4	7	*Vitrea contracta* *Vertigo* sp. *Carychium tridentatum*	6 1 1	29
126	1	2	-	-	2	8	6	7	1	13	*Merdigera obscura* *Vitrina* sp.	1 3	44
127	-	-	-	-	-	5	7	4	-	8	*Candidula submeridionalis* *Pupilla* sp.	1 1	26
128	1	1	1	-	2	4	15	7	1	13		-	45
129	-	1	-	-	1	1	13	7	1	8		-	33
130	1	1	-	-	2	1	9	7	2	6	*Vitrea contracta* *Vertigo* sp. *Galba truncatula*	1 1 1	31
Total	525	119	3335	625	904	52	69	79	36	119		109	5972

Tab. 8.2 (continued)

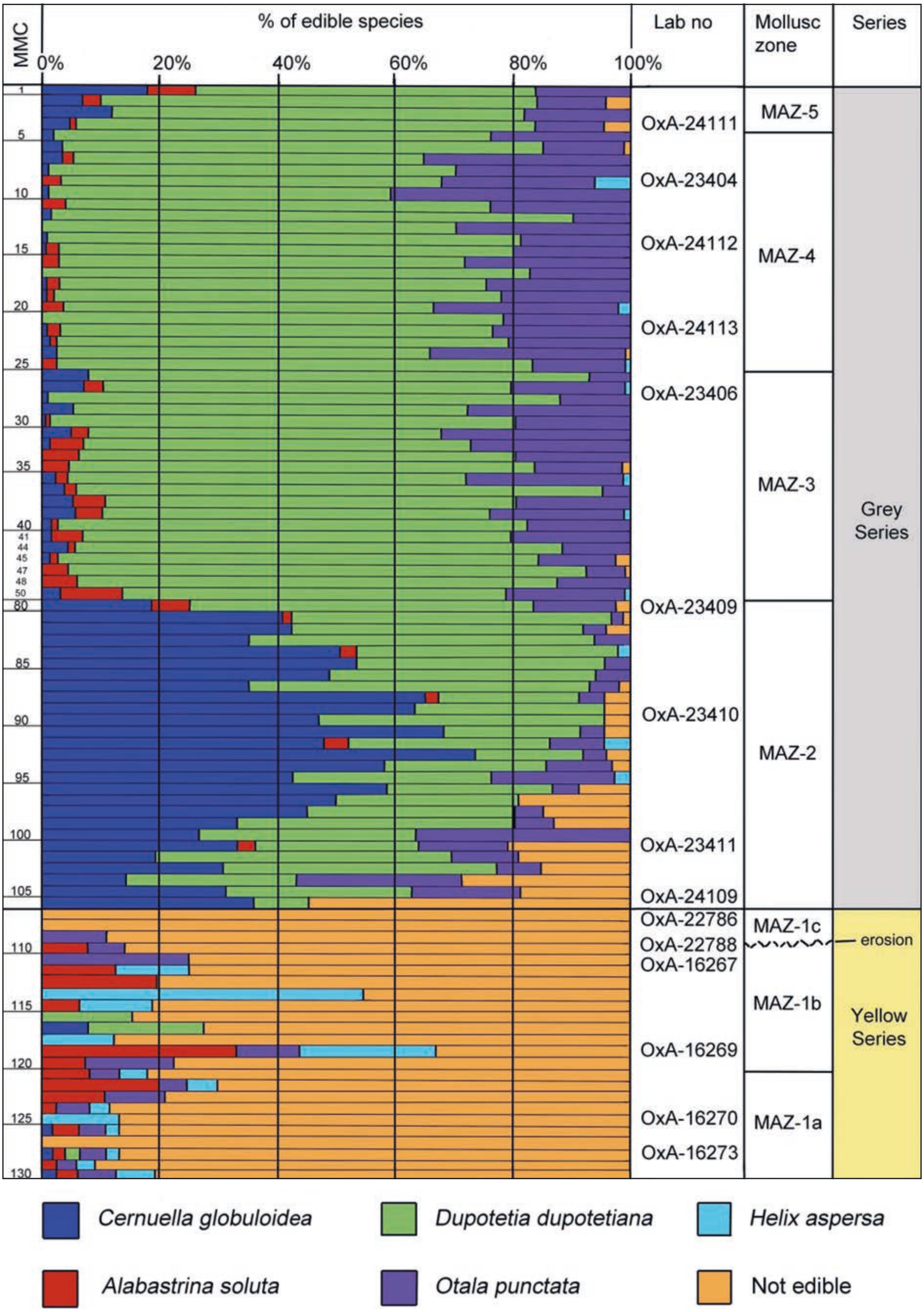


Fig. 8.8 Taforalt mollusc diagram, showing percentages of species, edible and not edible, in relation to the sequence of mollusc samples (MMC); dates to the right are extrapolated across from ties to the adjacent artefact column ('L-units'); date values are given as modelled ages in **tab. 8.1**; the diagram also shows the Molluscan Assemblage Zones (MAZ). – (Drawn by J. Foster, modified).

Yellow Series

(MAZ-1) Mollusc numbers in the Yellow Series are low, no sample producing more than 44. The bottom 8 samples (MAZ-1a) were more productive in terms of the range of species and numbers than those above in the Yellow Series. This might imply an environment which was a little more favourable, perhaps more humid, for molluscan life. Alternatively it could be an artefact of more rapid sedimentation above MMC121, although stoniness does not increase. The Yellow Series deposits were more natural, in terms of their formation processes, than the largely anthropogenic Grey Series. They are also nearly all dominated by mollusc species which are regarded as inedible, that is to say they are neither known to have been eaten nor, by virtue of their tiny size, likely to have been eaten. Those species which are present in any numbers, *Leonia mamillaris*, *Ferussacia* sp., *Vitrea contracta* and *Vitrina* sp., are all frequent in rather rocky, dry and sometimes disturbed areas. The Yellow Series material was more fragmentary than that above, creating problems of identification. There are several unidentified family Hygromidae and other unidentified terrestrial species which limits ecological interpretation. A small number of freshwater taxa are present in the Yellow Series, especially *Galba truncatula* particularly in MMC121-2; this, being a semi-terrestrial species, implies no more than small wet patches within the cave. The presence of 79 ostracods in the Yellow Series may also be consistent with wet areas in the cave, though they have not been identified. A single example of *Bythnia tentaculata*, which is mainly found in larger waterbodies, is perhaps more likely to have been introduced with material from elsewhere.

Notwithstanding the dominance of inedible species in all but two Yellow Series samples, there are small numbers of the species which overwhelmingly dominate the Grey Series midden above, and for this reason are candidates for species which were eaten, given that lithic artefacts, and other material of anthropogenic origin, are also well represented in this upper part of the Yellow Series. Although mollusc numbers were very low between MMC121 and 108 (MAZ1b), the species which may have been eaten comprised a higher proportion than in the lower part of the column. Three of these were present in about half of the Yellow Series samples and were present in the low 20s from the Yellow Series as a whole: *Alabastrina soluta*, *Helix aspersa*, *Otala punctata*. The other two are present in just 3 or 4 samples being represented by just 4 or 5 individuals in the Yellow Series as a whole: *Dupotetia dupotetiana* and *Cernuella globuloidea.* In the Yellow Series as a whole, species which may have been eaten account for only 17 % of the Mollusca. Mollusc numbers are very low in the upper samples of the Yellow Series and the top two have only inedible species (MAZ-1c).

It should also be noted that some molluscs were also observed much lower in the Taforalt sequence but have not been analysed because they were beyond the remit of the present project. Individual large shells of *Otala punctata* were observed in the Taforalt Calcareous Group sediments Unit R26 dated c. 90-95,000 BP (**fig. 8.9**), although here there were no concentrations of shells and only scattered worked lithics and charcoal (S. Collcutt, pers. comm.). More significant were concentrations of land molluscs in ashy hearth deposits in the Lower Laminated Group Unit R22 which is dated to c. 80-82,000 BP (Clark-Balzan et al. 2012; Barton et al. 2015). This layer also contained perforated shell beads of the marine mollusc *Nassarius gibbosulus* which is regarded as among the earliest evidence of human symbolic behaviour worldwide (Bouzouggar et al. 2007; D'Errico et al. 2009).

Grey Series

The onset of the Grey Series occurs c. 14,830-15,190 cal BP (Barton et al. 2013) and it is essentially an anthropogenic midden. The contrast with the Yellow Series is very marked on the mollusc diagram. MAZ-2

Fig. 8.9 *Otala punctata* in the much older Middle Stone Age (Calcareous Group) sediments (for comparison with LSA examples).

covers MMC-106-80. In the Grey Series, with the single exception of the lowest sample, where there was some intermixing of Yellow Series sediment, the vast majority of the species are those which are considered to have been eaten. The numbers of inedible species declines steadily and above MMC87 there are just a few patchy occurrences. Despite the marked change in species composition, it is notable that the bottom few samples of the Grey Series are characterised by very low mollusc numbers and in this respect the base has some similarity to the underlying Yellow Series. Mollusc numbers steadily increase upwards as do animal bones and lithics (**fig. 8.5**).

Below MMC82 there are, on average, 30 shells per sample and, above this, 88 shells per sample. At about the same point, MMC80, there is a marked change in the assemblage. From MMC107 up to MMC80, thus from 13,853-14,788 to 13,590-13,780 cal BP, there is the steady decline of inedible species and steady increase in overall mollusc numbers already noted. In this zone the predominant species is *Cernuella globuloidea* which peaks at c. 60 % around 14,244-14,545 cal BP. In this zone the second most important species is *Dupotetia dupotetiana* at around 20-40 %. There is a smaller proportion of *Otala punctata*, and the occasional presence of *Alabastrina soluta* and *Helix aspersa*.

Above MMC80 (MAZ-3) the assemblage is overwhelmingly dominated by *Dupotetia dupotetiana* at between 80-55 %. *Otala punctata* is the second most important species at around 20 %.

Otala punctata proportions show some interesting fluctuations through MAZ-3 and MAZ-4 with c. 15 peaks. Some are restricted to one sample (e. g. MMC24, MMC33), others cover as many as 3 samples

(MMC29-31). Peaks are separated by lower proportions, some of one sample duration, others of up to 12 samples (MMC81-93).

Alabastrina soluta, which was infrequent below, is consistently present between 5-10 % between MMC-80 and 31 but is less frequent above this. *Cernuella globuloidea*, which had dominated the assemblage below MMC-80, is present in most samples until MMC-26 but at low percentages up to c. 15 %. Between MMC-26 and 7 (MAZ-4), it is even less frequent. *Helix aspersa* has only patchy occurrence in this zone and there is patchy occurrence of inedible species.

Near the top of the column a change occurs from c. MMC7 (MAZ-5). *Cernuella globuloidea* steadily increases up to 18 %, in the very top sample there is an increase of *Alabastrina soluta* and there are more non-edible species near the top.

8.8 BURNING, TAPHONOMY AND SHELL MODIFICATION

Evidence for burning on shells is rare in the Yellow Series and frequent in the Grey Series. An estimated 60 % of all shells in the Grey Series show some contact with heat. It is not evident whether burning occurred from direct contact with fire during cooking, or took place after consumed shells were discarded. Shells exposed to heat were dark grey to white in colour, with those most affected being significantly weakened (**fig. 8.3**). Those which had been exposed to the highest temperatures had a powdery texture and were extremely fragile and crumbled to dust. Burning is much less frequent in the larger fractions, with the 4 mm fraction containing no burnt apices. This suggests that burning weakened the shell structure and contributed to higher fragmentation rates. Although it is unclear how much shell material has been lost through burning, this does seem to suggest that the total apical count for the Grey Series may be an underestimation of the original numbers of shells collected. An additional factor contributing to shell fragmentation will have been trampling by people, and possibly at times animals, within the cave.

Hutterer/Mikdad/Ripken (2011; 2014) have recorded intentional perforation marks on a large percentage of land snail shells from Neolithic midden sites in northeast Morocco. This has led to the development of the hypothesis that these perforations were made with lithic tools in order to break a vacuum in the apical portion of the shell which allows the flesh to be easily removed through sucking (Hutterer/Linstädter/Eiwanger/Mikdad 2014). A small number of complete *Dupotetia dupotetiana* shells from Taforalt also show breakages near the apex which are similar in appearance to the Hutterer et al. specimens. Two modern shells of this species were punctured using lithic tools to provide a comparison for the archaeological material. The experimental puncture marks are smaller in size and have sharper edges than the archaeological perforations. These results have been discussed with Hutterer (pers. comm.) who believes that the shells from Taforalt are unlikely to have been intentionally perforated, based on the irregularity of puncture marks and the LSA date of the deposits, almost all shells with more convincing perforations being found in Neolithic contexts at other sites. The current hypothesis is therefore that land snails at Taforalt were not intentionally perforated before consumption.

8.9 INTERPRETATION

A key research question is whether the accumulation of molluscs at Taforalt is natural or anthropogenic in origin. The first criterion indicating anthropogenic accumulation is the presence of shells of a sufficient size to be eaten. This is somewhat more subjective because the shells are mostly so fragmentary, with the result that the size cannot be evaluated metrically. However, the overall impression given by the assemblage (including many whole, unstratified shells fallen at the base of the old section scree, eroding since the 1950s) is that the vast majority of apices derive from more or less fully grown adult shells. As a second criterion, if collected for consumption, we would expect to see a bias towards edible species with ratios between edible and non-edible species being much higher than in a natural assemblage. These criteria are met clearly by the Grey Series samples, and much less convincingly in the Yellow Series. A third criterion would be the association of adult shells with demonstrable anthropogenic refuse such as charcoal, charred plant remains, worked cherts, animal bone, etc. Again the criterion is met very fully by the Grey Series and arguably also by the Yellow Series, where worked lithics and bone were present in the samples (**fig. 8.5**), although in lower numbers than in the Grey Series. Frequent burning of shells could also be a fourth criterion; however, land snail preparation techniques may, or may not, have always resulted in contact with fire. In the Grey Series 60 % of the shells were affected by fire, but this was rare in the Yellow Series.

Four main species dominate the Grey Series deposits at Taforalt: *Dupotetia dupotetiana*, *Otala punctata*, *Alabastrina soluta* and *Cernuella globuloidea*. These four species are classified as 'edible' on the basis of the criteria outlined above. *Helix aspersa* occurs in lower numbers but will also be classified as an edible species due to its large size and its popularity as a food source today (Arrébola Burgos/Álvarez Halcón 2001). *Rumina paviae* is large enough for consumption; however, it occurs in such low numbers that it seems unlikely to have been consumed in the past and is not considered to be an edible species (Lubell et al. 2004a). All other species identified have been classified as 'non-edible' due to their small size and infrequency. Analysis shows that the Grey Series is dominated by edible species (99 %) which is markedly different to the Yellow Series, where they only account for 17 % of the total molluscs recovered.

In **figure 8.5**, the high volume of edible molluscs (of anthropogenic origin) in the Grey Series is clearly mirrored in the plots for the animal bone and the worked chert. Samples from this part of the section show consistently higher levels of debris indicative of human occupation than those from the Yellow Series, all the more so because the dating evidence shows the Grey Series was deposited c. 10 times more quickly than the Yellow Series. The micro-vertebrate data shows the reverse trend with much higher numbers in the Yellow Series. The presence of micro-vertebrate remains is often indicative of lower intensity human activity, thus strengthening the hypothesis that the Grey Series represents a period of intensive, or sustained, use of the site by people.

As regards the transition from the Yellow to the Grey Series, the steady decline in non-edible species at the base of the Grey Series and the low numbers of shells in the first seven samples of the Grey Series demonstrate some degree of continuity or perhaps mixing. However, the two series are separated by two samples with no edible species but larger numbers of lithics, bone and microfauna. Of the species present, only *Otala punctata* occurs in similar proportions in the Yellow Series and the lower part (MAZ-2) of the Grey Series. The proportions of the other four species are markedly different as between the Yellow and Grey Series. That is most likely to be explained by an environmental change but, since they were collected, we cannot exclude a human behavioural explanation.

Otala punctata accounts for 16 % of all apices in the Grey Series and 5 % in the Yellow Series. For much of the Grey Series *O. punctata* is present in relatively low numbers in comparison with *Dupotetia dupotetiana*. Fluctuating peaks in the abundance of *Otala punctata* may represent targeted selection of this species, perhaps during times of abundance, either at specific times of the year, or during years which are favourable to population growth, possibly due to fluctuations in the local climate and environment. Although the overall numbers of *Otala punctata* are notably less than *Dupotetia dupotetiana*, it is important to note that, from a nutritional perspective, *Otala punctata* contains more protein per individual due to its significantly larger size, something which may partly account for the lower numbers. It also seems likely that behavioural differences make it easier to collect larger numbers of *Dupotetia dupotetiana* as discussed below in connection with the modern molluscan survey.

Alabastrina soluta, having been the main edible species in most Yellow Series samples, is only occasionally present in the lower part of the Grey Series (MAZ-2). It increases above MMC80, at which point *Cernuella globuloidea* shows a dramatic reduction. A notable increase in the use of *Otala punctata* and *Dupotetia dupotetiana* can also be seen at this point. Perhaps *A. soluta* was not previously favoured due to its small size but, during this transitional period, people were turning to different molluscan resources to mitigate the decline of a previously favoured species as a result of environmental changes.

Helix aspersa is one of the best known edible snails, as it is commonly eaten in many countries today. It occurs very sporadically in small numbers with no visible patterns in use, suggesting that it was an occasional, possibly seasonal, resource which was infrequently used, probably in a similar manner to *Alabastrina soluta*. In terms of distribution throughout the sequence, *Helix aspersa* actually shows the reverse pattern of the other edible species in that it is more prevalent in the Yellow Series, where it accounts for 5 % of the total molluscs, than in the Grey Series where it only accounts for less than 1 % of the total. The higher numbers in the Yellow Series may represent a larger population in the area during this period, or may represent early consumption of molluscs, as its large size means that it has greater nutritional value relative to the other smaller species such as *Cernuella globuloidea* and *Alabastrina soluta*.

8.10 MODERN MOLLUSCAN STUDY

As part of this study, a limited modern ecological study was carried out of the molluscs living within c. 0.5 km of the cave and in a transect down the Moulouya River, the latter as part of a joint investigation with Joshua Hogue into the availability of molluscan resources and raw materials for lithic production. The area around the Moulouya River was selected as it is the largest water course in northeast Morocco (Linstädter/Zielhofer 2010) and was considered to have provided an obvious routeway from Taforalt to the coast in the past. Roche (1963, 153) recorded the presence of a variety of marine molluscan species in the Grey Series layers, including *Ostrea*, *Cardium* and *Columbella*; A. Freyne (**Chapter 13.2**), counting 384 shells mentioned by Roche, has identified further marine molluscs from the recent excavations of Sectors 8 and 10. This indicates either periodic visits to the coast by the occupants of Grotte des Pigeons, possibly as part of a strategy of seasonal mobility, or trade/exchange links which enabled them to obtain marine shells. Our recent sampling took place in May, during which time the weather was dry with high temperatures, particularly at the lower elevations in the Moulouya valley. Weather in the area in May is characterised by average high temperatures of 25°C and a monthly average 24 mm of rain spread over 7 days (www.worldwideweather.com). Since the focus of this research was on the larger edible species, modern molluscan sampling concentrated on these, so that small species are likely to be greatly under represented. The full results of the modern molluscan study are given in Taylor (2014).

The Area around Taforalt

In 2010 and 2012, molluscs were collected from the area directly surrounding Taforalt Cave. Many of the species found in the archaeological layers could be found directly around the cave. Most common were *Ala-*

Fig. 8.10 Contexts in which modern molluscs can be collected today: **a-b** *Dupotetia dupotetiana* resting or aestivating on plant stems in May in the Moulouya River Valley 20 km NW of Taforalt; **c** *Alabastrina soluta* clustered on the shaded part of a rock; **d-e** *Alabastrina soluta* in micro-caves close to Taforalt cave entrance.

bastrina soluta and *Leonia mammillaris*. *Alabastrina soluta* could be found attached to the numerous prickly pear plants (*Opuntia ficus-indica,* an introduced species) which grow around the site, within crevices in the limestone and, as shown in **figure 8.10d-e**, within small holes in the rock which appear to have been formed over the centuries by dissolution by the snails themselves. The name given to this species is suggestive of this habit of limestone dissolution. The process of limestone dissolution has been described in other Mediterranean contexts by Danin (1996) and in the Mendips, UK, by Stanton (1986). *Otala punctata*, another edible species, was also present in the Zegzel Valley in the form of empty shells on the rocky slopes around

Taforalt and as live, aestivating juveniles within piles of limestone boulders at Grotte du Chameau. The lack of live individuals at Taforalt is presumed to be related to their preference for aestivating out of sight within limestone crevices, as observed at Grotte du Chameau. The remaining edible species from the Grey Series, *Dupotetia dupotetiana* and *Cernuella globuloidea*, were not found in the area directly surrounding the cave. A range of non-edible species were also found in the area. Large numbers of *Leonia mammillaris* shells were found around Taforalt, something which is not unexpected given its preference for rocky habitats, although live individuals were not found. *Rumina* sp. occurs more frequently in the modern environment than in the archaeological deposits. Of the other species recorded in the area, *Mauronapaeus* sp., *Sphincterochila corrugata* (Pallary 1920a; 1920b; called *Albea corrugata* by Rour/Chahlaoui/Van Goethem 2002) and a number of small Helicidae do not appear to be present in the archaeological layers, which may suggest that the habitat and distribution of these species has changed over time.

The Moulouya River Environs

Many of the edible species found in the archaeological deposits at Taforalt could be found along the Moulouya River, which forms the western border of the Triffa Plain, a semi-arid plain to the north of the Beni Snassen. The sampled sites are in river valley and coastal lowland locations, well below Taforalt cave which is at 720 masl. Most interesting is *Dupotetia dupotetiana*. Despite being the most commonly occurring species in the Grey Series, it was not found, either living or as shells, in the area directly surrounding Taforalt during any of the excavation seasons. Widening the research area to include the Moulouya River showed that *Dupotetia dupotetiana* occurred very widely in the area. It is possible that the past distribution of this species included the area around Taforalt.

Of particular interest is one sample site (MOU 5, N34.57040, W002.32482) on the bank of the Moulouya, approximately 20 km NW of Taforalt, where there were a variety of small shrubs and bushes on which were extremely large numbers of *Dupotetia dupotetiana* and a smaller number of *Sphincterochila* sp., as shown in **figure 8.10a-b**. All the molluscs were attached to the stems of plants, either individually, or in clusters of up to 25. On the eroding section of a dry river bed at MOU7 N34.49359, W002.40467, *Dupotetia dupotetiana* was found on shrubby vegetation and sometimes on limestone rocks but *Alabastrina soluta* was only found on the rocks. The relative locations of both are shown in **figure 8.10c**, with *Alabastrina soluta* clustering on the shaded side of a rock. As at other sample locations, the type of vegetation occupied does not seem to be important, with almost the entire range of bushes containing molluscs. Research by Giokas/Pafilis/Valakos (2005) in Greece observed similar, tight clusters of the Clausilidae, *Albinaria caerula*, during aestivation and concluded that "clustering may offer an effective isolation from environmental conditions, since in this way the exposed total surface area is decreased and a more humid micro-environment obtained, resulting in a lower water vapour pressure gradient to the environment and, therefore, a lower rate of water loss" (Giokas/Pafilis/Valakos 2005, 20). Rizner/Vukosavljević/Miracle (2009), describing Adriatic sites, also suggest that snails could have been collected during periods of inactivity.

This is the first time this clustering behaviour has been documented for *Dupotetia dupotetiana*, something which has important consequences for our understanding of resource procurement strategies in the LSA. At MOU 5, rough estimations calculated each bush to contain approximately 100 snails. With over 20 bushes in the direct area, this would enable a small group of people to collect 2,000 snails in a short period of time, in an area a few metres across.

Helix aspersa is known to dig just below the surface of the soil to protect itself during adverse conditions (Potts 1975). Hunt et al. (2011) suggest that this behaviour of hibernating and aestivating in groups within the soil, under specific plants, could also have provided an easy way in which people could have collected this species in the past. There may also be other species which display such clustering behaviour which could have facilitated their collection.

Edible species occur along the Moulouya River today which are not present in the archaeological record at Taforalt, including *Sphincterochila* sp., which is commonly found in *escargotières* in the Maghreb, particularly in Algeria (Pond 1938; Lubell / Hassan / Gautier / Ballais 1976; Fernández-López de Pablo / Gómez Puche / Martínez-Ortí 2011; Saafi / Aouadi / Dupont / Belhouchet 2013). At the site of Taghit Haddouch, this species accounts for 68.7 % of the total shells recovered, making it the most commonly consumed species during the 'Epipalaeolithic' and Early Neolithic (Hutterer / Mikdad / Ripken 2011). It is likely that the distribution of this species changed over time due to the climatic changes of the early Holocene. The occupation of Taghit Haddouch is considerably later than that at Taforalt, with the earliest deposits from the site dated to 9,717 ± 105 cal BP (Hutterer / Mikdad / Ripken 2011, 59). Also absent from the archaeological record is *Theba pisana* and other related *Theba* species which occur widely in the coastal habitats of Northeast Morocco today (Hutterer / Greve / Haase 2010). The most likely explanation for their absence from Taforalt is again the distance from their preferred coastal habitats to the site. The distance from the site to the modern day coastline is 40 km.

8.11 PALAEOENVIRONMENTAL AND PALAEOCLIMATIC IMPLICATIONS

Since the evidence for human collection of molluscs is so strong, and the numbers of those too small to eat are so few, it is difficult to attribute changes within the sequence to palaeoecological factors, such as environmental or climatic changes. If such evidence is to be identified, it is likely to emerge from a multi-proxy approach involving comparisons between several sources to palaeoenvironmental evidence. Even so, it is important that changes of possible environmental origin are identified to facilitate comparison with the other sources. Comparisons are made on a hemispheric scale with the Greenland ice core GISP 2 (Grootes et al. 1993). Fortunately there is also a more local marine core record from the west Mediterranean, particularly a site in the Alboran Sea c. 150 km NNW of Taforalt (Cacho et al. 2001) which indicates significant regional differences between the west Mediterranean and Greenland palaeoclimatic records.

In the Yellow Series, mollusc numbers are rather higher in MAZ-1a at the base of the sequence declining to low levels just before 18,886-19,236 cal BP. This could suggest slightly more favourable conditions for mollusc life in MAZ-1a, between 20,894-18,882 and 19,514-19,993 cal BP, and less favourable conditions in MAZ-1b, between the last date and c. 15,000 cal BP, particularly very low numbers immediately below the last date in MAZ-1c. Other evidence suggests the probability of an hiatus at the top of Y2 between MMC111 and MMC110 (**Chapter 2**). The small numbers of species considered to be non-edible, and thus more straightforward to interpret ecologically, do not indicate any marked changes in the Yellow Series. The species which are most consistently present (*Leonia mamillaris*, *Vitrina* and *Ferussacia* sp.) are present through MAZ-1a and MAZ-1b and the first two in MAZ-1c. There is a wider range of non-edible species in MAZ-1a. Most notable is the occurrence of *Galba truncatula* through the Yellow Series, indicative perhaps of wet patches or pools. This may also be indicated by the unidentified ostracods from Yellow Series samples; there is also one example of *Bithynia tentaculata* which is more indicative of moving water. The limited evidence for water may be supported by the banded nature of the Yellow Series indicating deposition in water. *Leonia mammillaris* is commonly found in the Yellow Series. Today, this species favours shrub vegetation and pine woods (Welter-Schultes 2012a) and is common around the cave at Taforalt. It is absent in the lower Grey Series. The non-edible species in the Yellow Series are very much what might be expected in an area of rocks and caves and provides little indication of regional climate.

The boundary between the Yellow Series and the Grey Series at c. 14,830-15,190 cal BP corresponds broadly to the boundary between Greenland Stadial 2 and the last Greenland Interstadial. In North Africa, that marks the transition from more arid conditions to a more humid phase (Limondin-Lozouet/Haddoumi/Lefèvre/Salel 2013). The development of the Grey Series midden might therefore be seen as related to more favourable environmental conditions. That may be reflected in the steady increase in mollusc numbers through the lower part of the Grey Series, perhaps through vegetation succession to favourable ecological communities. It might also reflect increasing intensity, or duration, of human activity. It should be noted that, despite the very marked sedimentary change from the Yellow to the Grey Series, in the lower third of the latter there are still scattered occurrences of the freshwater taxa present in the Yellow Series, which could suggest some continued, but reduced, freshwater input to the cave. The presence of *Carychium minimum* in MAZ-2 may also reflect the presence of wet areas and the presence of a few *Carychium tridentatum* also points to relatively humid vegetated areas, or litter within rubble (Welter-Schultes 2012a, 87). The predominance of *Cernuella globuloidea* in the lower part of the Grey Series (MAZ-2) is followed by its marked decline c. 13,590-13,780 cal BP, at a time when mollusc numbers were high (**fig. 8.5**). MAZ-2 probably corresponds to the first part of the Greenland Interstadial (GI-1e) up to the transition at c. 13,828-13,555 later in the Interstadial (GI-1c). In hemispheric terms GI-1e was the warmest part of the Interstadial. However, in the Alboran Sea record, higher temperatures are indicated in GI-1c (Cacho et al. 2001).

In the succeeding MAZ-3 there are greatly increased proportions of the predominant species *Dupotetia dupotetiana* and *Otala punctata*. These changes could be due to over exploitation of *Cernuella,* or some other cause, but seem more likely to be a result of an environmental change. As to the nature of any change, there is unfortunately little evidence for the ecological preferences of the affected species. Each of them and their relatives are generally found in rather dry rocky places. In Iberia *Otala* is found in rocks and walls in coastal plains and the survey of modern mollusca showed that this species occurs around the cave today. *Dupotetia dupotetiana*, the overwhelmingly predominant species in the upper Grey Series MAZ-3 to MAZ-5), was not found around the cave today but occurred in abundance on scrubby vegetation in the much lower-lying Moulouya River valley and Triffa Plain to the northwest. This could indicate that people were travelling to lower slopes to collect it. However, given the numbers of shells involved, it is more likely that the distribution of this species has changed over time due to the climatic fluctuations of the late Pleistocene and Holocene. A further possible factor is the effect of human communities on the environment since the period of cave occupation. For instance, in Iberia burning has been shown to exert a major influence on molluscan communities (Bros/Moreno-Rueda/Santos 2011). At Taforalt itself, the effects of faunal agents, and in this case recent landscape management, are also very evident in the vegetational contrasts between a large fenced area grazed by reintroduced *Ammotragus* and the rest of the Beni Snassen Ecopark outside the fenced area. Today the coastal lowlands are generally drier with no rainfall in mid-summer and hotter than the hills where Taforalt is located. Drier conditions at the time of cave occupation do not seem particularly likely, given the abundance of resources suggested by the Grey Series midden. Possibly more relevant is an association with scrubby vegetation and perhaps at least periodically damper conditions found today in the lowland close to the river, where the densest concentrations of molluscs were found today. Comparable microenvironments may perhaps have been present at higher elevations during the period of occupation.

MAZ-4 is marked by a further reduction of *Cernuella globuloidea* and a further increase in the predominance of *Dupotetia dupotetiana*. This occurs at c. 13,280-13,467 cal BP, corresponding approximately to the onset of declining temperatures in the Alboran Sea record (Cacho et al. 2001). The final change at the top of the sequence, to MAZ-5, is marked by a steady increase in *Cernuella globuloidea*, *Alabastrina soluta* and some non-edible species. An absence of ecological knowledge of the species involved makes interpretation difficult, although it seems probable that these final changes around 12,611-12,725 cal BP may relate to the Greenland Stadial (GS-1) with the lowest temperatures in both the Greenland and Alboran Sea records at about this time. Wood charcoals from the top of the sequence, nearer the cave entrance (**Chapter 5**), indicate the onset of a significant cool damp period with dates within Greenland Stadial 1.

8.12 MOLLUSCS AND DIET

In cases such as this, it is instructive to consider the dietary contribution of the food resources represented (Hosfield 2016); these would be approximate calculations concerning the importance of molluscs in the Iberomaurusian diet. Inevitably this involves some assumptions concerning the number of molluscs in the cave, their nutritional value and the typical size of hunter-gatherer groups sharing the resource. The volume of the Grey Series, including the full stone content, can be roughly calculated from the cross sections in Roche (1963) and, despite some doubts as to the accuracy of sections and subdivisions, the volume can be calculated (see **Chapter 2**) as at least 1750 m³. A key assumption is that the number of mollusc shells found in the mollusc column is representative of the Grey Series as a whole. It is assumed that the lower 1/3 of the midden, where mollusc numbers are lower, and the upper 2/3, where they are more numerous, were represented in similar proportions over the area of the cave. The average sample size was 0.2 × 0.2 × 0.05 m so 1 m³ is equivalent to the volume of 500 samples. In the bottom third of the Grey Series (formed between c. 15,000 and 13,590-13,780 cal BP) there was an average of 30 shells per sample, multiplied by 500 = 15,000 shells per m³. This estimate is reasonably close to the 25,000 figure given by Lubell et al. (1975) for other sites. Multiplied by the volume of sediment 583 m³, this gives an estimate of 8.74 million in the lower third of the midden. In the upper two-thirds of the Grey Series (formed between horizons dated to 13,590-13,780 and 12,611-12,725 cal BP), there was an average of 88 shells per sample, multiplied by 500 = 44,000 per m³; the overall volume of sediment 1167 m³ would give a total of 51 million shells in the upper two-thirds. The overall hypothetical number of shells in the Grey Series as a whole could be 60 million.

The lower third of the midden accumulated over c. 1321 years and contains 8.74 million shells which is 6616 shells per year or 18 per day. The upper two-thirds of the midden accumulated over 1,048 years and contains 51 million shells which is 48,644 per year or 133 per day.

As regards the nutritional value of snails, 100 gm of snail flesh yields about 85 calories and 17 grams of protein (United States Department of Agriculture 2017). If we assume a typical weight for a snail of 10 gm (*Helix aspersa* ranges from 7-15 gm) then one snail is equivalent to 8.5 calories and 1.7 gm of protein. The adult daily requirement of calories for a hunter-gatherer is generally thought to be c. 3000 calories (Kious 2002).

In terms of protein, the generally recommended intake is 0.8 gm per kg of body weight, so for a 60 kg individual that is c. 50 gm of protein per day but for more highly active hunter-gatherers is likely to have been significantly higher, such that we will work with a figure of 80 gm of protein.

In the lower one third of the midden, molluscs could have provided about 153 (18 × 8.5) calories per day, 5 % of the daily calorific requirement of one person and, in terms of protein, 30.6 gm which is 38 % of adult daily protein requirement. In the upper two-thirds of the midden, molluscs could have provided about 1130 calories (133x 8.5) which is 38 % of the daily calorific requirement of one person and, in terms of protein, 226 gram (133 × 1.7) which is the protein requirement of almost 3 people.

However, it is of course likely that the molluscs would have been consumed, not by one person but by several. It is also absolutely clear from the wide range of food remains in the midden that Mollusca were by no means the only, or even main, food resource (cf. **Chapter 18**). If we assume an Iberomaurusian band of 10 people, then in the lower third of the midden each one could only derive less than 0.5 % of their calorific requirements and 3.8 % of their daily protein requirements from molluscs.

Alternatively, if we assumed that Mollusca were consumed only periodically rather than on a daily basis, then for 10 % of the diet of 10 people 350 shells a day would be required. The shells in the lower part of the midden would have been sufficient to contribute about 10 % of the daily calories to the group's diet on about 19 days of the year, and the molluscs in the upper part on about 139 days.

Such calculations are both mechanistic and averaging and we must not lose sight of the fact that molluscs could have been a particularly important and predictable source of food at times when other sources were scarce, a particularly challenging period for hunter-gatherers, for instance, is early spring. The calculations do suggest that Mollusca are likely to have been especially important for their protein contribution. Nor should we forget the other nutritional elements such as vitamins, which have not been quantified; molluscs are for instance a valuable source of trace elements.

Also notable is the evidence of a marked intensification in the use of molluscan resources from MMC84 shortly before 13,590-13,780 cal BP, when there is the most marked change in the composition of the molluscan assemblage within the Grey Series. Mollusc numbers increase before the decrease in stone content, so the change may not reflect changing particle size. This might point to increasing reliance on molluscan resources, or the increasing duration, or intensity, of occupation.

Each and every one of the assumptions made could of course be significantly in error. However, even within reasonable margins of error, these rough calculations do carry certain implications. It is improbable that molluscs made up a major proportion of the diet through the year, and despite the vast numbers of shells present, which might give the impression of resource abundance, the molluscs alone were certainly not sufficient to allow the site to be occupied all year round. The wide range of other foods present, particularly the important evidence for the use of plant resources (Humphrey et al. 2014; **Chapter 6**) could have provided the basis for permanent occupation.

It may also be misleading to think of molluscs mainly in terms of their nutritional contribution. Today Mediterranean land mollusc consumption is particularly associated with festivals and special gatherings at certain times of year. Examples are snail festivals at Caragol, Spain, in May, Graffignano, Italy, in August, and Digoin, France, in August, at which vast quantities of snails are consumed (Taylor 2014). In Crete recent snail gathering is particularly associated with festivals before Easter and in mid-August (N. Galanidou, pers. comm.); these Cretan festivals occur at times when snails are particularly abundant and easily gathered. Such evidence demonstrates that snails should not just be seen as everyday items of diet, or something to be consumed when other resources are scarce. Indeed, the ethnohistorical evidence identifies them as a delicacy and a food of particular social significance by virtue of its association, however created, with special events. Miracle (1995) identified the molluscan evidence from Pupicina Cave in terms of feasting associated with burial, and, given the numbers of burials at Taforalt associated with the Grey Series, that may be a pertinent factor here.

8.13 MOLLUSC COOKING

It has often been suggested that molluscs were prepared by cooking (Lubell et al. 1975; Bar 1977; Bahn 1983a; 1983b; Heller 2009). That possibility is strengthened by the abundance of charred plant material and heat-fractured rocks at Taforalt, where up to 60 % of Grey Series shells were heat-affected. Today the most commonly employed method for cooking snails is immersing them in boiling water (Arrébola Burgos et al. 2001) which loosens the muscles and enables the flesh to be easily removed from the shell, a method which Lubell et al. (1975) believe was used by prehistoric North African communities. They may have used skins or baskets as containers within which water could be boiled using heated rocks, often called 'pot boilers'. Another possibility is that snails were cooked directly by placing them in the fire bed or onto stones heated in the fire (Bonizonni et al. 2009; Heller 2009; Matteson 1959; Pond/Chapuis/Romer/Baker 1938), or into pits lined with heated rocks, a technique for cooking a range of foods which is widely attested through ethnographic studies (Linderman 1962; Wandsnider 1997; Meehan 1982). Experiments in cookery of *Helix aspersa maxima* at Reading University have shown that these molluscs can be very rapidly cooked in boiling water by adding hot rocks to a container, although those roasted on hot rocks were, to modern taste at least, more palatable (**fig. 8.11**).

8.14 CONCLUSIONS

Analysis demonstrates that the vast majority (c. 99 %) of molluscs in the Grey Series, which accumulated from c. 14,734-14,970 cal BP to 12,611-12,725 cal BP, were anthropogenic in origin. This conclusion is based on the narrow range of species, the large shell size, the lack of very small species and particularly the association with large volumes of anthropogenic material such as charcoal, charred plants, chert tools, animal bone and heat-fractured stone. The base of the mollusc column, within the Yellow Series, is dated to c. 20,882-21,436 cal BP. This is slightly later than the unmodelled date for the start of the Iberomaurusian at Taforalt which is 22,912-23,459 cal BP (in Sector 9, cf. **Chapter 4**). Between here and the transition to the Grey Series at c. 14,830-15,190 cal BP, the sequence was more indicative of natural accumulation, with greater species diversity, more small species, more freshwater shells and less frequent burning. Infrequent shells of large, edible species were, however, still present in the Yellow Series which suggests that land snails were consumed during this period but in much smaller numbers.

Much earlier in the Taforalt sequence, the occurrence has been noted of concentrations of land molluscs in ashy hearth deposits in the Lower Laminated Group Unit R22 which is dated c. 80-82,000 BP. From this it may be concluded that the use of land molluscan resources began in a small scale way by about 80,000 BP, that they became more consistently used after the last glacial maximum, and that they saw major intensification with the onset of midden formation c. 14,830-15,190 cal BP and further intensification after 14,244-14,545 cal BP.

As regards wider comparisons, the earliest substantial land mollusc midden is at Tamar Hat from 18,000 cal BP (Saxon et al. 1974; Hogue/Barton 2016), some three millennia before the Taforalt Grey Series. Evidence for small scale land mollusc exploitation has recently been reported from Cova de la Barriada, Spain from 32,000-26,000 cal BP (Fernández-López de Pablo 2014). Giant African land snails were exploited in South Africa in the Middle Stone Age as reported by Badenhorst and Plug (2012). Marine mollusc exploitation is attested somewhat earlier from 164,000 BP at Pinnacle Point, South Africa (Marean 2007). Whilst Taforalt is not the earliest site with evidence for mollusc exploitation, it is certainly among a rather small group of early sites with evidence for such exploitation and it appears to be unique in providing a discontinuous record of mollusc exploitation over some 67,000 years from c. 80,000 to c. 15,000 cal BP followed by a seemingly continuous record over some 2,300 years between c. 15,000 and 12,611-12,725 cal BP. Thus, in total, mollusc use at Taforalt spans much of the last glaciation.

Fig. 8.11 Experiments in land mollusc cookery at Reading University, showing (**a**) roasting of *Helix aspersa maxima* (and two *Cepaea*) on hot rocks, and (**b-c**) calcined remains of snails in hearth.

Confronted with the numbers of shells on some sites, some writers have flirted with the notion that land molluscs were farmed (Bahn 1983a; 1983b; Fernández-Armesto 2001) but without any convincing evidence in support of this idea. It may be more realistic to think in terms of non-analogue ecological communities in the late glacial, and on other sites in the early Holocene, creating particularly favourable conditions for molluscan life round parts of the Mediterranean. Nor can we exclude the possibility that people contributed in some ways to the creation of niches in which these Mollusca flourished. In a similar and reciprocal way, Mollusca, combined with a diversity of other resources, created niches with a broad spectrum of resources in which some human groups became more sedentary. Although land snails were clearly an important part of the Iberomaurusian diet, particularly from the onset of the Grey Series, there is no evidence to suggest they were ever a staple food as has sometimes been suggested. Indeed, it was suggested above that a significant aspect of the molluscan contribution might have been social in the context of special events, perhaps funerals. All Grey Series samples contained large quantities of animal bone, which was frequently burnt, as were many molluscs; there was also a wide range of charred plants. It is therefore clear that, from the onset of the Grey Series at c. 14,830-15,190 cal BP, the diet was very varied and included a range of plants, animals, and molluscs. On the basis of the mollusc column evidence these do not appear to have been consumed in quantity in the earlier Iberomaurusian period represented by the Yellow Series from 20,882-21,436 cal BP to 14,830-15,190 cal BP. The apparent intensification represented by the Grey Series would seem to represent a particularly noteworthy manifestation of a broad spectrum revolution which seems to have occurred in the Middle East and more widely in the late glacial and initial Holocene. However, in the Taforalt case, broadening was in the context of ameliorating environmental conditions rather than the deteriorating conditions represented on Middle Eastern sites where Flannery (1969) first identified the phenomenon (see **Chapter 18**).