I. DE GROOTE · L. T. HUMPHREY

16. THE HUMAN SKELETAL REMAINS: A PHYSICAL ANTHROPOLOGICAL ASSESSMENT

16.1 INTRODUCTION

The skeletal and dental remains of 14 individuals, including both primary and secondary burials, were recovered during the recent excavations in Sector 10 (Chapter 15). The present chapter will describe the analyses of the newly excavated skeletal and dental material and compare the adult individuals to the previously excavated sample (Ferembach 1962; Roche 1963).

16.2 STATURE ESTIMATION

Only three of the newly excavated skeletons retained long bones complete enough to permit measurements for stature estimation. Stature estimation regression formulae are affected by population affinity and it is therefore important to use a regression formula with a close biological affinity to the sample in question. In order to determine which of the stature estimation regressions would be the most suitable for this population from Northwest Africa, it was necessary to look for the populations for which regressions exist which had the most similar intra-limb index to the individuals in Northwest Africa (Ruff/Walker 1993; Zakrzewski 2003; Raxter et al. 2008) (tab. 16.1). The tibia-femur index and radius-humerus index of the Northwest Africans is most similar to those of the ancient Egyptians in Raxter et al. (2008); therefore, these regression equations for the different long bones were used to estimate stature. The combination of femur and tibia was used wherever possible, as they show the smallest estimation error, although the equations for the individual bones as well as radius and humerus were used where no femur or tibia was preserved.

Stature was estimated for Individual 5 (150 cm; range estimates: 147-157 cm), Individual 3 (177 cm; range estimates: 171-178 cm) and Individual 14 (156 cm; range estimates: 154-159 cm). Average stature for all the previously excavated Taforalt adults was estimated using measurements taken by IDG and using the Raxter et al. formula and was estimated at 166.6 cm (s. d. = 5.9 cm, n = 41). Males were on average 171.1 cm (s. d. = 3.8 cm, n = 13) and females 162.2 cm (s. d. = 6.9 cm, n = 10). There was a sample of 18 undetermined sex and for these stature was estimated at 165.9 cm (s. d. = 4.6 cm, n = 18). These means calculated using the Raxter et al. regressions are lower than those reported by Ferembach (1962) using a different regression formula. Nevertheless, the three newly excavated individuals for which stature could be assessed were well within the range of variation of the previously excavated Taforalt sample.

Comparisons were made with data from LSA/Upper Palaeolithic samples from Jebel Sahaba (Sudan) (male mean = 176.9 cm, female mean = 167.5 cm) (Anderson 1968), Grimaldi caves (Monaco) (male mean = 179.5 cm, female mean = 158.0 cm) and Moravian sites (male mean = 175.9 cm, female mean = 159.7 cm), and a collection of Late Upper Palaeolithic samples from Southern Europe (male mean = 165.3 cm, female mean = 152.4 cm) and Central Europe (male mean = 166.1 cm, female mean = 154.6 cm) (Formicola/Gi-

		Intra-limb Index	
Sample	Study	Tibia Max/Femur Max	Radius/Humerus
Egypt	Raxter et al. 2008	83.0-84.8	77.5-78.8
Modern Africans	Ruff/Walker 1993	82.8-85.8	76.4-78.7
Modern Europeans	Ruff/Walker 1993	78.4-83.1	72.9-74
Egypt	Zakrzewski 2003	83.8	78.3
This study		**83.48**	**78.04**

Tab. 16.1 Intra-limb bone length indices in present and previous studies.

annecchini 1999). Results demonstrate that the Taforalt individuals (total sample n = 45) were of comparable stature to other LSA/Upper Palaeolithic populations and that tall stature was the norm in this area in the Iberomaurusian. In other contemporaneous areas, for example in the Middle East and Europe, a reduction in stature was noted. Comparison with a small sample of early Holocene Capsian (n = 10) and Neolithic (n = 8) individuals, shows that it was not until the early Holocene that stature in the Maghreb reduced: average stature for the Capsian and Neolithic sample was 160.6 cm (s. d. = 5.9 cm, n = 10) and 156.9 cm (s. d. = 4.6 cm, n = 8) respectively.

16.3 MOBILITY

Interpretation of measures of skeletal strength and robusticity allow for the assessment of mobility from the skeleton (Bridges/Martin/Solano 2000; Ruff 2000; Stock/Pfeiffer 2004). Several studies have highlighted the correlation between measures of cross-sectional strength and mobility patterns (Stock/Pfeiffer 2004; Stock 2006; Stock et al. 2011). Cross-sectional strength of the femur in particular is indicative of mobility (Trinkaus/Ruff 1999; Stock 2002). Here, shaft dimensions at 50 % of femoral length were used to calculate strength (DPROD) and shape (Ix/Iy). External dimensions (DPROD/L = "anteroposterior diameter at 50 % shaft length" × "mediolateral diameter at 50 % shaft length" / "femur length") suggest that males are more robust than females (males mean: 1.87 ± 0.21, females: 1.66 ± 1.9, t(14)2.109, p < 0.06) (**fig. 16.1a**). Measures of cross-sectional strength are however highly dependent upon the accurate standardisation to body size (Ruff 2000) and should be standardised to: (100 / [body mass × bone length]) resulting in the measure DPROD/LxBM = ([anteroposterior diameter at 50 % shaft length × mediolateral diameter at 50 % shaft length] × 100) / [body mass × femoral length]) (Stock/Shaw 2007). Results are quite different in this case (using measurements of length in millimetres and of weight in kilograms) and show the effect of body size correction on the male individuals (**fig. 16.1b**) who now appear less strong than the females but this difference is not statistically significant (males mean: 2.52 ± 0.21, females: 2.66 ± 0.27, t(13)-1.133, p = 0.278). In most contemporary cases, males are stronger than females (e. g. Stock/Pfeiffer 2004; Stock 2006; Stock et al. 2011).

The ratio of I_x (widest shaft diameter at 50 % shaft length) and I_y (diameter orthogonal to I_x) is used to compare bending strength in the long bones. Particularly in the femur, a more circular cross-section has been associated with a more sedentary lifestyle, whereas high shape ratios tend to be associated with high mobility (Carlson/Marchi 2014). The mean shape index of the individuals from Taforalt is indicative of high mobility levels but there are individuals with more circular shafts in the sample. The Taforalt sample (mean total sample: $I_x/I_y = 1.11$, s. d. = 0.11; males $I_x/I_y = 1.13$, s. d. = 0.11; females $I_x/I_y = 1.13$, s. d. = 0.11; undetermined sex $I_x/I_y = 1.09$, s. d. = 0.09) shows slightly lower shape ratios than a sample of Late Upper Palaeolithic individuals from Europe (mean $I_x/I_y = 1.32$, s. d. = 0.21) and a Neolithic sample from Italy (mean $I_x/I_y = 1.34$,

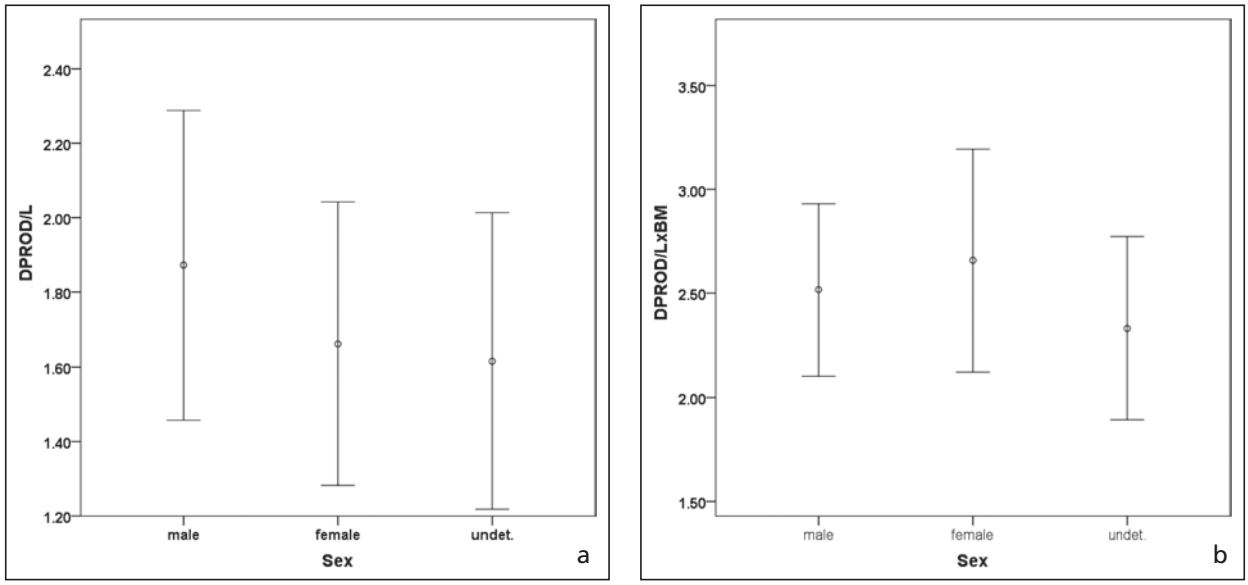

Fig. 16.1 Femoral robusticity (means ± 2σ): **a** corrected for bone length only; **b** corrected for bone length and body mass; see text for full formulae.

s. d. = 0.20) (Carlson/Marchi 2014) but slightly higher ratios than in an Iron Age series (mean $I_x/I_y = 1.03$, s. d. = 0.14) (Carlson/Marchi 2014). In conclusion, cross-sectional measures of femoral robusticity and shape are suggestive of moderate levels of terrestrial mobility in the individuals at Taforalt.

16.4 DENTAL ANTHROPOLOGY

Teeth are sensitive to fluctuations in diet, pathogenic load, physiological stress, oral hygiene, food preparation, non-dietary use of the teeth, and fluoride intake (Larsen 1999). Diseases and abnormalities of teeth are therefore indicative of individuals' interaction with their environment. In the case of Taforalt, teeth are also indicative of cultural behaviour. The following conditions were recorded in all teeth: attrition, caries presence, and tooth loss (including evulsion). In addition, the mandibles and maxillae were observed for evidence of abscesses and alveolar resorption. Of the recently excavated adult sample, Individuals 1, 3, 5, 10, 13 and 14 retained sufficient teeth for study. The extant teeth and supporting structures provide evidence for overall poor oral health for the sample and the widespread practice of evulsion of the upper central incisors.

Attrition

Attrition was recorded using the Smith system (1984) for incisors, canines and premolars, and the Scott system (1979) for occlusal wear in molars. Angle of the attrition facet was not considered in this study.
Left and right are not considered independently. Upper and lower dentitions have been noted to vary (Hillson 2001) and, therefore, upper and lower attrition rates are considered separately. Mean attrition of each observed tooth was calculated for six adult individuals in the newly excavated sample. Mean attrition rate for each tooth type is also reported for the subsamples of young adults, middle adults and old adults of the total Taforalt (Roche excavation) sample for which attrition could be recorded. The sample was divided into three

broad age categories because attrition is age progressive, which can also be observed in figure 16.2. Where possible, age estimation was carried out using pubic symphysis morphology (Todd 1920; Brooks/Suchey 1990), auricular surface morphology (Lovejoy et al. 1985), ectocranial suture closure (Meindl/Lovejoy 1985), and sternal rib end changes (İşcan et al. 1984). Based on these observations, the sample was divided into three age categories – young adult, middle adult, old adult – and an undetermined category.
Individual 5 of the new sample has the lowest attrition rates. Individuals 1 and 14 exhibit slightly more advanced dental wear than Individual 5 and are both considered to be young adults. Individual 13 has more advanced dental wear than Individual 14 but exhibits a similar stage of skeletal development and is considered to be a young adult. Individuals 3 and 10 are middle adults.

Evulsion

The practice of tooth evulsion is characteristic across the Maghreb from the Iberomaurusian through to the Neolithic (Briggs 1955; Humphrey/Bocaege 2008). Evulsion is the voluntary removal of teeth during the life of the individual and can be distinguished from tooth loss caused by disease or accidental loss based on the recurrence of particular patterns within a population (Briggs 1955; Mariotti et al. 2002; Bonfiglioli et al. 2004; Balzeau/Badawi-Fayad 2005; Humphrey/Bocaege 2008). Evulsion of the upper incisors is often accompanied by compensation of the mandibular anterior teeth, which emerge into the space provided by the lack of the upper incisors forming a characteristic arch (Marchand 1936; Ferembach 1962). A recent study by the authors (De Groote/Humphrey 2016) considered the prevalence and pattern of evulsion in the Maghreb region and showed that there was an almost universal pattern for both central upper incisors to be removed in the Iberomaurusian. By the early Holocene there is a tendency for all four central incisors to be removed. This pattern becomes more varied and evulsion becomes less prevalent in males during the Capsian. With the onset of the Neolithic in the region, the prevalence of evulsion is dramatically reduced and eventually disappears (Humphrey/Bocaege 2008). Although evulsion effects the biomechanics of the oral apparatus (Balzeau/Badawi-Fayad 2005) and the occlusion of the other teeth (Marchand 1936), it is not believed to be linked directly to oral pathology.
Only three of the Sector 10 individuals could be included in the evulsion analyses due to poor preservation of the maxillary region in other crania. Both Individuals 5 and 3 had experienced evulsion but no teeth were removed from Individual 10. Individual 5 had undergone removal of both upper central incisors. Individual 3 had undergone evulsion of the upper left central incisor but the right side of the maxilla was too poorly preserved to determine whether any teeth had been removed. Individual 13 had extensive damage to the anterior upper alveolar region but its morphology suggests that it experienced evulsion of the central incisors. For the whole Taforalt assemblage it was possible to observe evulsion in 34 individuals. Of these, 76.9 % of males (10/13), all females (10/10) and all unsexed individuals had evulsion. For those individuals for which it could be assessed, the most prevalent pattern was the removal of both left and right central incisors (n = 14/20). Only one individual from Taforalt (Taforalt VIII-2) presented evulsion of the lower central incisors in addition to the upper incisors.

Oral Pathologies

Caries is caused by intra-oral microbial activity associated with the consumption of processed carbohydrate-rich plant foods (Hillson 2008). Caries were recorded using Hillson's (2001) categories. Discoloration of the

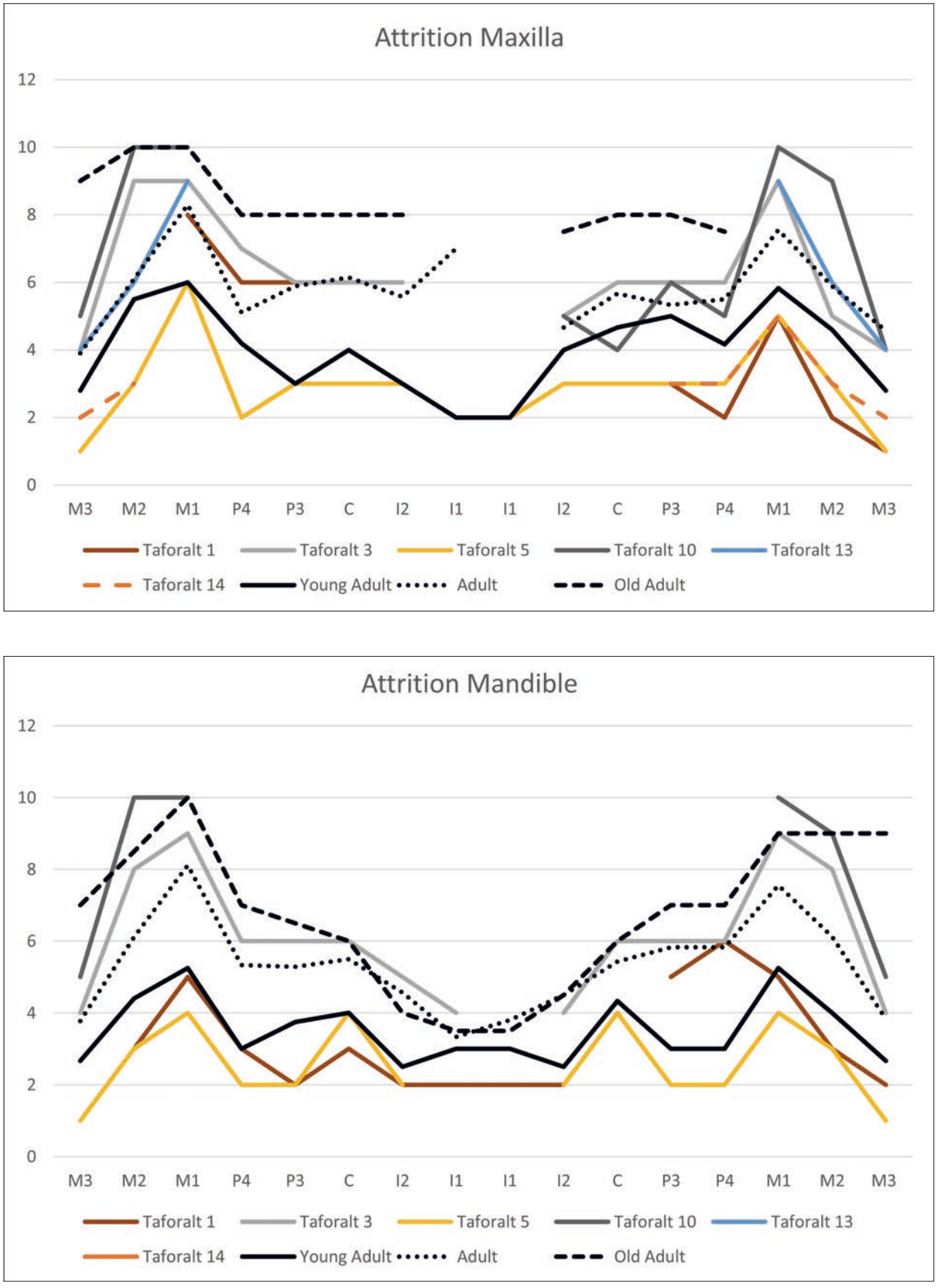

Fig. 16.2 Attrition rates for the newly excavated skeletons compared to those for the overall sample of young adults, middle adults and old adults; maxilla (above), mandible (below).

	Age									
Pathology #	Young Adult		Middle Adult		Old Adult		UD		Total	
	N	%	N	%	N	%	N	%	N	%
Observed teeth	132	100.0	228	100.0	55	100.0	257	100.0	672	100.0
Carious teeth	44	33.3	125	54.8	29	52.7	146	56.8	344	51.2
Abscess*	2	1.2	9	3.1	17	19.8	23	5.7	51	5.4
Alveolar resorption	75	56.8	155	68.0	28	50.9	138	53.7	396	58.9
Gross caries	0	0.0	9	7.2	8	27.6	11	7.5	28	8.1

Tab. 16.2 Numbers of observed teeth affected by caries, abscesses, and alveolar resorption.
Caries types as % of carious teeth.
* Abscess as % of observed sockets (including those with *ante mortem* tooth loss).

enamel was recorded and could be an early sign of caries formation (Hillson 2001) but, for these analyses, a carious lesion was only considered present when there was clear penetration in the enamel (score 3 or above). The number of lesions and locations was scored for each observed tooth. Only one surface (occlusal, mesial, distal, lingual or buccal) of the tooth had to be affected for caries to be considered present on the tooth site. Gross caries was determined present when a lesion affected more than one surface and the origin of the caries could no longer be determined (score 7 or 8). Caries rates are expressed here as the proportion of observed teeth. The reported caries rates are likely to be slightly inflated compared to other populations who do not practice evulsion because caries rarely affects the incisors.

Periodontal disease is identified by alveolar resorption in skeletal material. It is assessed by measuring the distance between the alveolar margin and the cemento-enamel junction. If this distance is larger than 2 mm periodontal disease is assumed present (Hillson 1996). The distinction between abscesses, granulomas and cysts is difficult to make in an archaeological assemblage without x-ray observations (Hillson 1996; Nelson 2015). Thus, all periapical cavities are grouped here under the term abscess. Abscesses were recorded by direct naked-eye observation only and defined as present when there was a clear cavity in the alveolar bone and reported as the proportion of observable sockets.

Individual 1 had 24 observable sockets and no evidence of ante- or post-mortem tooth loss. Twelve of the 24 observed teeth were affected by caries (50 %) and four had alveolar resorption. This individual had no abscesses.

Individual 3 preserved 30 observable sockets with one socket affected by ante-mortem tooth loss due to evulsion. This resulted in 29 observable teeth. Caries affected 21 of these teeth (72 %) and nine had alveolar resorption over 2 mm. No abscess was recorded.

Individual 5 preserved 32 observable sockets of which two were affected by ante-mortem tooth loss due to evulsion. Seventeen of the teeth had at least one carious lesion (57 %) and nine teeth had alveolar resorption. There were no abscesses recorded.

Individual 10 retained 31 observable sites but only 19 preserved teeth because 12 teeth were lost post-mortem. Seventeen of the 19 teeth had signs of caries (89 %) and 11 sites had alveolar resorption over 2 mm (58 %). Two abscesses were visible.

Individual 13 retained seven observable teeth. Six of these teeth were affected by caries (85 %) and periodontal disease. The individual had no abscesses.

Individual 14 retained seven observable teeth of which three were affected by caries (42 %). There was no abscess recorded but three of the teeth showed alveolar resorption over 2 mm.

Caries rates for all age groups were high in the entire Taforalt sample, with 33 % of observed teeth for young adults, 55 % for middle adults and 53 % for old adults affected by caries (**tab. 16.2**). These results suggest that high caries frequencies may have been characteristic of the time-period represented by these

samples. Caries rates in our excavated sample were higher than the average for the site as a whole and for their age category. This observation will require further analyses when excavations continue to discern if this pattern is due to sampling bias or a true pattern.

16.5 DISCUSSION AND CONCLUSION

The skeletal and dental properties of the individuals from Sector 10 show good correspondence with the individuals excavated by Roche (Ferembach 1962). The presence of evulsion of the upper central incisors in most adults from the S10 sample reflects a pattern of dental modification that is characteristic of the Ibero-maurusian and occurs at other sites, such as Afalou in Algeria (De Groote/Humphrey 2016).

The overall results for Taforalt show high oral pathologies in the individuals from Taforalt exceeding those observed in many food producing populations. Charred macro-botanical remains from Taforalt (**Chapter 6**) suggest that the consumption of carbohydrate-rich wild plant foods, such as acorn and pine seeds, was a likely contributor to the poor oral health observed in these populations (Humphrey et al. 2014), and high attrition rates possibly due to the use of grindstones may have further contributed to the elevated caries rates. The frequent consumption of fermentable carbohydrates would have resulted in an oral environment well-suited to cariogenic bacteria. The increased reliance on carbohydrates with the onset of food production and their cariogenicity is well documented from both archaeological and historical samples. These results imply an early origin of virulent cariogenic microbiota, predating the onset of food production in Northwest Africa.

Post-cranial and archaeological evidence support moderate to high levels of terrestrial mobility for this sample, consistent with other populations exploiting wild food resources. The data presented here reveal that both a cariogenic diet and virulent caries causing oral microbiota predated the onset of the Neolithic in North West Africa but that the pathways to sedentism in this region may have differed from those observed elsewhere.