

**Sanctuary of Lot
at Deir 'Ain 'Abata in Jordan
Excavations 1988–2003**

Cover images

Front Cover

*View from inside Lot's Cave looking out to the lowest place on earth and the Dead Sea
(photo by K. D. Politis)*

Back Cover

*Detail of the central medallion in the mosaic pavement immediately below the altar
table in the chancel of the church. It reads: TELOS KALON = Good End
(photo by T. Springett)*

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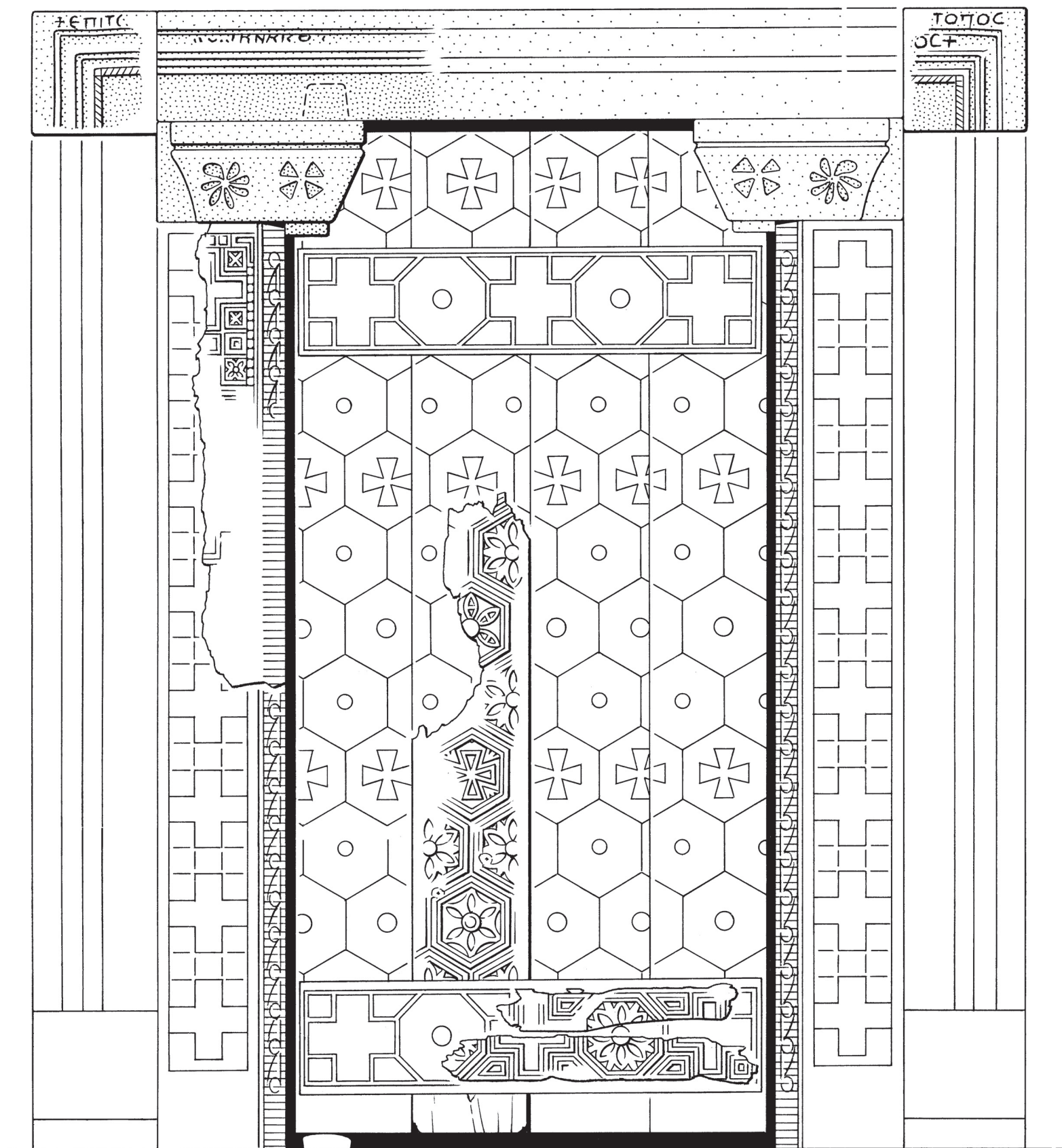
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Reconstruction of the main door to the church at Deir 'Ain 'Abata

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The Staff

The on-site excavation and conservation team consisted of Kate Da Costa, ceramic lamp specialist (1988); Helga Fiedler, Area A supervisor (1988); Jennifer Kiely, assistant supervisor (1988); Anthony Lowe, Area B supervisor (1988); Michael Rawlings, archaeologist (1988); Franz-Josef Reidel, excavation technician (1988); Robert Schick, Areas F.III, M and H.II supervisor (1988, 1992, 1994, 1995); Jodie Benton, Area F.I supervisor and objects registrar (1990); Ben Churcher, Area B.I supervisor (1990); Dawn Enright, assistant supervisor (1990); Peter Guest, assistant supervisor (1990); Alan Hills, objects photographer (1990); W. "Eddie" Moth site surveyor and Areas J, E.VII T.1, F.III supervisor (1990, 1992, 1993, 1994, 1996, 2003); Margaret O'Hea, glass specialist (1990); Ariadne Sakali, site assistant (1990); Hugh Strickland, assistant supervisor (1990); Jean Bradbury, illustrator (1991); Ray Bradbury, architect (1991); Yiannis Meimaris, epigrapher (1991, 1993, 1994, 1995, 1996); Thomas Muir, architect (1991); Olympia Theophanopoulou, archaeological conservator (1991); Jad Al-Younis, environmentalist and executive assistant (1991, 1992, 1994); Stefania Chlouveraki, archaeological and mosaic conservator (1992, 1993, 1994, 1995, 1996, 2001, 2002, 2003); Christopher Entwistle

(†) means recently deceased.

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The external academic readers were Fr. Michele Piccirillo (†) and T. Samuel N. Moorhead.

Konstantinos D. Politis,
London 2011



1995 excavation team on lower slope of Deir 'Ain 'Abata (TS)



1992 excavation team below Deir 'Ain 'Abata (TS)



1990 excavation team below Deir 'Ain 'Abata (TS)

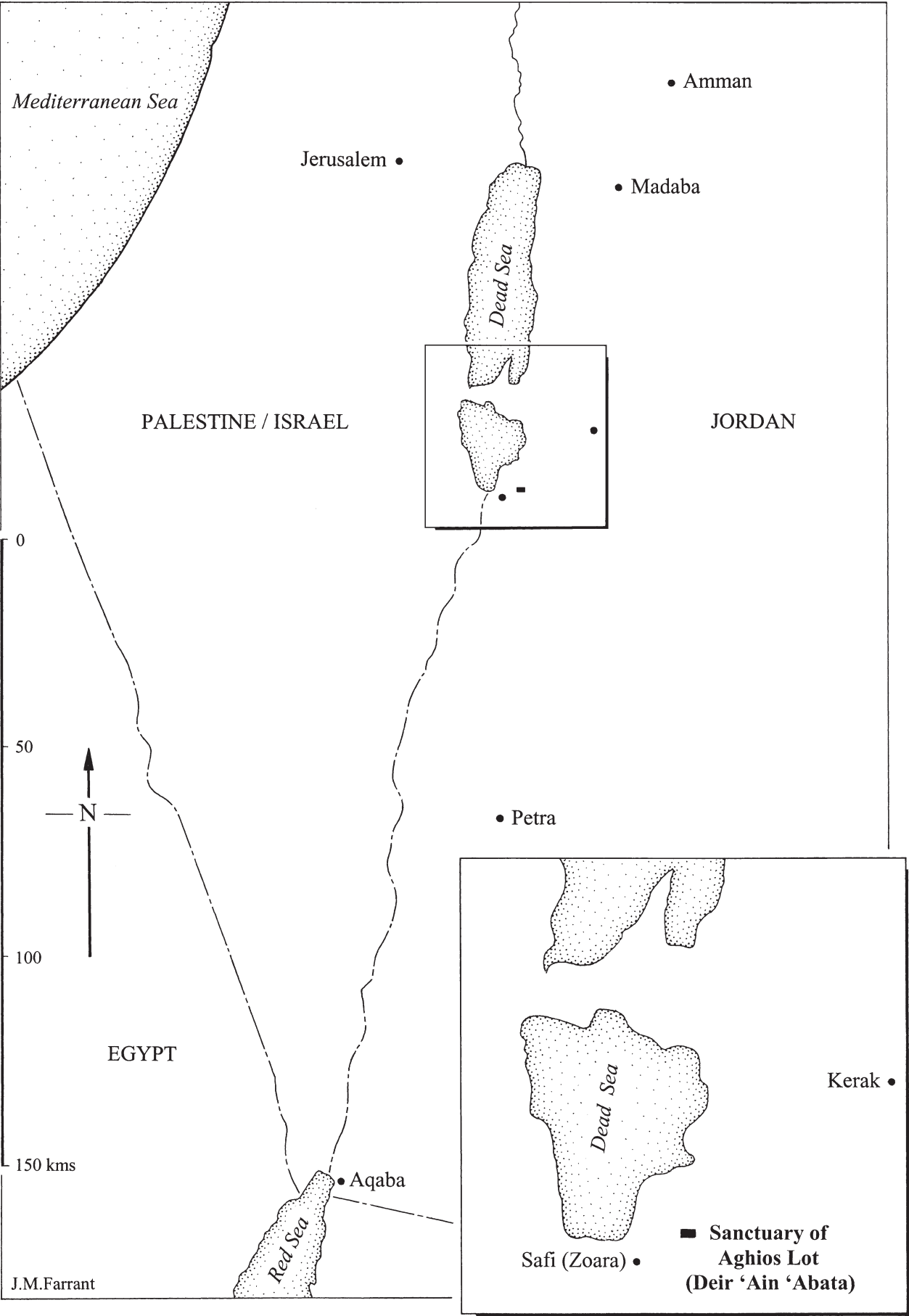


Figure 1: Location map

V.14a THE MAMMAL BONES

Mark Beech

The aim of the analysis of the mammal bones from Deir 'Ain 'Abata was primarily to investigate the economic basis of the site. The following questions were of interest: Was there any evidence to suggest the on-site husbandry of animals? Were sheep and goats kept primarily for their meat, milk and/or wool? What was the role of the other major and minor domesticates at the site? Did the presence of wild mammals within the assemblage suggest any reliance on hunting, which might have contributed towards resource provisioning? Was it possible to reconstruct, from the wild resources present, which environmental habitats were exploited within the locality's hinterland?

At a site-specific level, the following questions were of interest: Did the spatial distribution of bone material on the site reflect particular social practices, such as the organised disposal of particular rubbish in certain areas of the site? Did the occurrence of particular skeletal parts suggest the importation of joints of meat rather than of whole animals "on the hoof" to the site?

Finally, how did the overall results of the analysis of the Deir 'Ain 'Abata mammal bone assemblage match with the information provided in ancient documentary sources relating to monastic diet and economy of the region (e.g. Dembinska 1985; Hirschfeld 1990, 1992)?

Methods

On-site

All excavated occupation contexts at Deir 'Ain 'Abata were dry sieved using 5 mm mesh sieves. Although this was quite a time-consuming process during the excavation, it successfully produced huge quantities of well-preserved mammal, bird and fish bones. Skilled labourers from the nearby modern-day village of Safi assisted with this sieving programme, and rapidly became adept at picking out faunal material from the sieves. The author personally monitored this recovery process during the 1994, 1995 and 1996 field seasons, and checked that a sufficient level of consistency in recovery was being achieved.

Identification

The majority of the mammal bone assemblage was recorded by the author "in the field", during visits to Jordan in 1994, 1995 and 1996. Specimens which proved difficult to identify, or whose identification needed checking, were removed and taken to either Amman or the UK for subsequent evaluation. Various reference collections were used as an aid to identification, but primarily those housed in the then British Institute of Ancient History

and Archaeology (now Centre for British Research in the Levant), Amman, Jordan, and the Environmental Archaeology Unit at the University of York.

Attempts to differentiate between sheep and goat bones were only made on the following elements: horncore, humerus (distal only), metacarpal, tibia (distal only), astragalus, calcaneum, metatarsal, and third phalanges, using the morphological criteria of Boessneck et al. (1964). The lower third and fourth deciduous premolars (dP3 and dP4) of sheep and goat were identified following the method of Payne (1985). Further attempts were made biometrically to determine the presence of sheep and goats using the indices of Boessneck (1969) and Payne (1969).

The small mammal bones were identified with the assistance of Stephen Rowland (Department of Archaeology, University of York). Small mammals were only identified to genus or species level on the basis of mandibles or maxillae with at least two complete teeth. All other post-cranial bones were simply recorded as belonging to rodent. All specimens were examined using a binocular microscope, identifications being made with reference to Harrison and Bates (1991) using both morphological and metrical criteria.

Recording

Recording of the mammal bones was limited to a selected number of skeletal parts. This adopted a similar procedure to that suggested by Watson (1979) and Davis (1992). The following bones and parts were counted:

Horncore (if more than half of its circumference was present);

Maxilla and Mandible (if at least two teeth or teeth sockets were present);

Loose teeth: Loose mandibular deciduous and adult incisors (not attempting to distinguish between upper and lower in the case of pig); loose deciduous third milk molar; loose lower fourth permanent premolar; loose lower permanent first/second molar and third permanent molar. These teeth were only counted if more than half of their cusp was present;

Scapula (only if more than half of the glenoid was present);

Humerus, Radius and Metacarpal (only if more than half of the proximal or distal epiphysis was present);

Ulna (only if more than 50% of the proximal epiphysis was present);

Pelvis (only if more than half of the acetabulum was present);

Femur, Tibia and Metatarsal (only if more than half of the proximal or distal epiphysis was present);

Calcaneus (only if more than half of its proximal articulation was present);

Astragalus (only if more than half of the proximal or distal astragalus was complete);

First, second and third phalanges (only if more than half of the proximal articulation was present).

Sometimes fragments could only be assigned as belonging to a metapodial, where it was not absolutely certain that it could be identified as a metacarpal or metatarsal. Where only the medial or lateral distal trochlea of metapodials were included, these were counted as halves. All other anatomical elements not listed above, as well as unidentifiable long bone shaft fragments, ribs and vertebrae, were not counted and were excluded from further analysis.

Quantification

Regarding the quantification procedures, the quantities presented in Tables 1–5 and 12–14 are uncorrected NISP (number of identified specimens) counts following the recording procedure defined above. Where a more detailed examination of the anatomical representation data is carried out (Tables 7–10), modified counts are presented. These numbers represent the minimum number of elements (MNE) that may have occurred within that particular phase (combining both left- and right-sided bones).

A number of correction factors were used to equalise the data so that the relative occurrence of different elements might be broadly compared. In the case of sheep/goat, the number of deciduous and adult incisors was divided by three, the number of metapodial fragments was halved, and the counts for all phalanges were divided by four. In the case of pig, the number of deciduous and adult incisors was divided by three, the number of third and fourth metacarpals and metatarsals was divided by two, and the number of bones identified only as being 'metapodial' were divided by four, as were all pig phalanges. In the case of cattle, the number of adult incisors was divided by three, metapodials by two and phalanges by four.

Taphonomy

The degree of fragmentation of the mammal bone assemblage was recorded by registering whether each specimen was 'complete', 'more than half complete', 'half complete' or 'less than half complete'. The general condition of the bones was noted by recording if they were burnt or exhibited traces of carnivore or rodent gnawing. Butchery marks in the form of cutmarks or chops were noted where they occurred. Sometimes recording these marks was made difficult by the masking effect of burning, as well as concretions to the bone surface.

Ageing

Epiphyseal fusion data was noted for all the major species. Bones were treated as being unfused if the epiphysis was not completely joined to the diaphysis and there was not a smooth join with no trace of a line marking the epiphyseal junction. The number of newborn bones were noted, defined as bones which were small in size and porous in appearance. Grouping of the epiphyseal fusion data for the major domestic species follows the suggested ages of Silver (1969).

Sheep/goat dentition was recorded for mandibles with two or more recordable wear stages. In addition, the following loose mandibular teeth were recorded: fourth deciduous premolar (dP4), fourth permanent premolar (P4) and permanent third molar (M3). This loose teeth data was then proportionately allocated to the already aged mandibles. Wear stages were coded using the system of Payne (1973, 1987). The Deir 'Ain 'Abata ovicaprine dental data was then compared against the idealised exploitation models optimising for meat, milk and wool production of Payne (1973).

Pig dentition was recorded following the wear stage code system of Grant (1975, 1982) but grouping the results using age class definitions derived from Bull and Payne (1982).

Cattle dentition was similarly recorded using the wear stage code system of Grant (1975, 1982), but grouping the results into the suggested age classes of Halstead (1985).

Sex

In the case of sheep/goat an attempt was made to sex the pelvis using the morphological criteria of Boessneck et al. (1964), in particular the thickness of the margin of the acetabulum-pubis region.

Pig sexing data was derived from the presence/absence of canines in both mandibles and maxillae (including those where only the alveoli were present), as well as from the presence of loose canines.

Biometry

Bone measurements were taken following the criteria of von den Driesch (1976). However, a number of additional measurements were also taken. For the distal humerus, the measurement 'BT' (breadth of the distal trochlea measured on the anterior margins), and for the distal metacarpal and metatarsal, the measurement 'BFd' (breadth of the distal articulation measured on the anterior trochlea margins). These measurements follow those defined by Davis (1987: 37, Fig.1.13, measurements c-1 and d-1 on the humerus and a-1 on metapodials). For distal metapodials, the measurements 'a' and 'b' as defined by Boessneck (1969) and 'Wc' (width condyle) and 'Wt' (width trochlea) following Payne (1969) were also taken.

Dating

The phasing of the excavated loci is as follows:

I	Early Bronze Age (c. 3300–3000 BC)
II	Middle Bronze II (c. 2000–1500 BC)
III	Nabataean (1 st century BC to 1 st century AD)
IVa	Early Byzantine (5 th to 6 th century AD)
IVb	Early Byzantine (early 7 th century AD)
IVc	Umayyad (mid-7 th to early 8 th century AD)
V	Early Abbasid (mid-8 th to early 9 th century AD)

Note that certain loci were sometimes assigned to two or more phases, hence the grouping of some loci into broader phase groups (e.g. Phase II–III, IVa–b or IVb–V).

Results

Table 1 presents the overall results of analysis of the Deir ‘Ain ‘Abata mammal bone assemblage. Out of more than 30,000 animal bone fragments, 6935 (23%) were diagnostic fragments. The greater part of the assemblage belonged to Phase IVa–b, the early Byzantine period. Lesser quantities were recorded from the Umayyad and early Abbasid layers at the site, and even smaller amounts from the Bronze Age and Nabataean levels.

In terms of the spatial distribution of material across the site (Table 3), the Bronze Age material was confined to Area F.III (inside the cave) and the nearby Bronze Age cairn tombs (J.II, J.VIII, J.IX, J.XV and J.XVII). Most of the early Byzantine bones were retrieved from Areas A (the reservoir), B (the north-western corner of the monastery), H (buildings in the area west of the church and reservoir) and M (the refectory/buildings to the north-east of the church), whilst the Abbasid-period bones predominantly came from Area H.

Domestic mammals formed the majority of the assemblage with the following species being represented: sheep (*Ovis aries*), goat (*Capra hircus*), pig (*Sus domesticus*), cattle (*Bos taurus*), dog (*Canis familiaris*), equid (*Equus* sp.) and camel (*Camelus dromedarius*). Wild mammals were represented by: fallow deer (*Dama mesopotamica*), gazelle (*Gazella* sp.), fox (*Vulpes vulpes*), hare (*Lepus capensis*), black rat (*Rattus rattus*), spiny-tailed mouse (*Acomys* sp.) and short-tailed bandicoot rat (*Nesokia indica*).

General Preservation of the Mammal Bones

The fragmentation of the bones was similar throughout all the major periods with 54% of all bone fragments being less than half complete in Phases IVa–IVb, the early Byzantine period, as opposed to 59% in Phase V, the Abbasid period (Table 2). Generally the bones were very well preserved with little evidence of damage to their surfaces in the form of root action or severe weathering. The incidence of carnivore gnawing and rodent gnawing

was very low in all periods (Table 4); suggesting that the bones were fairly rapidly buried and that they were not subjected to prolonged exposure on the ground surface. Of some note was the fact that the majority of mammal bone fragments in all periods were burnt. In most cases the surface of the bone fragments was only slightly discoloured, indicating that they had been singed rather than directly burnt at the centre of a fire. Butchery traces in the form of cut and chop marks were recorded on cattle, sheep/goat, pig and fallow deer bones (Table 5). These are discussed in further detail below. There did not appear to be any major differences in preservation between different areas on the excavation. Overall, the assemblage was very homogenous in appearance. The similarity between deposits may also hint that many of the excavated loci represented organised secondary deposition from a similar primary source (the monastery kitchen/refectory?).

Early to Middle Bronze Age and Nabataean Periods

Only two mammal bone fragments were recovered from Early Bronze Age (EBA) (Phase I) levels at the site. Both were from Area F.III (inside the cave): a sheep/goat distal humerus fragment in Locus 12.1, and a rodent humerus fragment in Locus 35.2. Twenty-two fragments were recovered within Middle Bronze Age (MBA) (Phase II) levels at Deir ‘Ain ‘Abata. A rodent humerus occurred in Area F.III 13.19 (inside the cave). The remainder of the material consisted of various bones belonging to sheep/goat excavated from the various burial cairns in the vicinity of the site: J.II (six fragments from the external earth layer), J.VIII (one fragment), J.XIV (two fragments from the robbers spoil), J.XV (five fragments from Locus 15.3) and J.XVII (seven fragments).

A single sheep/goat fragment was recovered from the broadly dated MBA to Nabataean-period (Phase II–III) levels within Area F.III (inside the cave, Locus 13.9).

A total of eleven fragments occurred in Nabataean period (Phase III) levels at the site. These all occurred within Area F.III (inside the cave). Sheep/goat, pig and hare occurred in Locus 5.2, an unidentified rodent in Locus 13.3, and sheep/goat in Loci 13.9 and 20.3.

The Bronze Age and Nabataean material is too sparse to be very informative. Certainly the appearance of some of the ovicaprid bones was not dissimilar to that in later levels, and its dating should perhaps be treated with caution, particularly those layers from the various burial cairns. The excavated loci from these tombs largely represent external layers or robbing spoil layers connected with later intrusions by grave robbers. The bones present may, therefore, represent later Byzantine deposits that have spilled downslope and become mixed with Bronze Age deposits. The material found within the cave (F.III) was well stratified, however, and we can be sure that the EBA and Nabataean peoples visiting the cave kept sheep/goat

herds as did the later occupants of the site. The presence of four pig bone fragments in a Nabataean layer (Locus 5.2) within the cave, two of which were from very juvenile pigs, provides a hint that pig husbandry may have been carried out in the vicinity of the site. Such remains may simply represent food debris from initial settlement of the site, or another possibility is that the bones recovered stratified within the cave represent some kind of offering or veneration deposits associated with the religious importance of the site.

Early Byzantine, Umayyad and Early Abbasid Periods

Bones of sheep/goat dominated in the deposits from the early Byzantine, Umayyad and early Abbasid periods at Deir 'Ain 'Abata, followed by pig, then cattle. As there did not appear to be any major changes taking place in the representation of these major species at the site between these periods, further discussion will concentrate on summarising relevant information taking each species in turn.

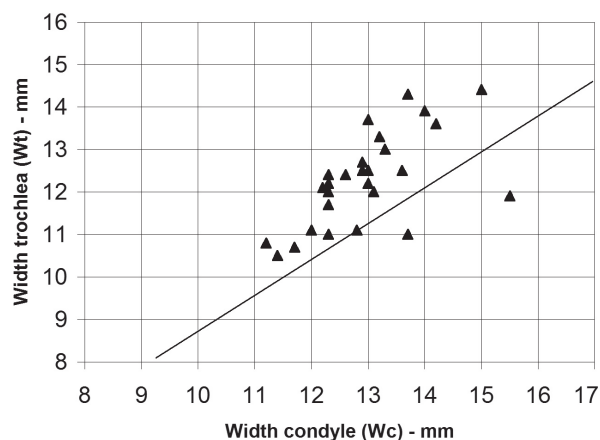
Major Species

Sheep/Goat (*Ovis aries*/*Capra hircus*)

Most of the ovicaprines could only be identified as belonging generally to the category 'sheep/goat'. Out of those bones where it was possible to identify sheep or goat separately (see above Methods: Identification), there were more sheep than goats. The ratio was 2.7:1 during the early Byzantine period (Phases IVa–b) and 4.7:1 during the early Abbasid period (Phase V). Metrical analysis of the ovicaprine distal metacarpals using the measurements defined by Boessneck (1969) confirms that the majority of ovicaprines were sheep (Table 6). An additional biometric analysis following the method of Payne (1969) also confirms this general picture (Graph 1), the majority of points falling above the line on the sheep side.

Anatomical representation data indicates that a broad range of elements were present at the site (Table 7). Certainly whole animals may have been brought to the site "on the hoof" for subsequent slaughter and consumption. There is, however, a significant over-representation of forelimb elements (scapula, humerus and radius) in proportion to hind limb elements, which is especially striking during the early Byzantine period (Phase IVa). This perhaps indicates the regular practice of direct provisioning to the site with shoulder joints of lamb and mutton.

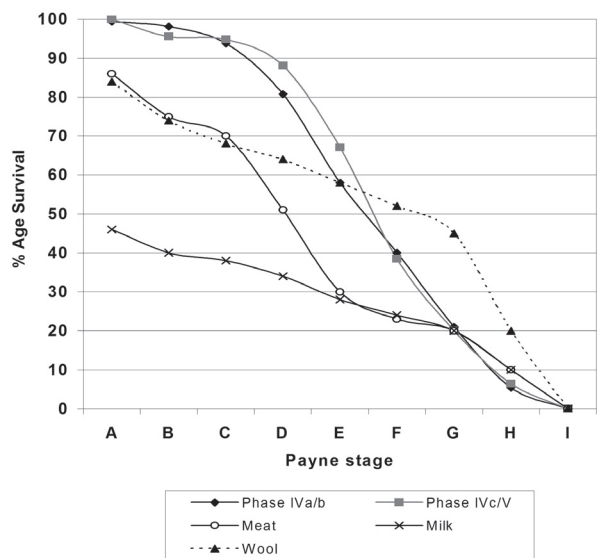
The ovicaprine butchery data recorded suggests that basic dismemberment of their carcasses was taking place at all the major joints. Many of the horncores had traces of having been chopped through or cut near to their base. Skulls were generally split in half, as witnessed by a number of chopped occipital condyle fragments. These also suggested that decapitation commonly took place by chopping through this part of the neck. Mandibles were



Graph 1: Distinguishing sheep vs. goat metacarpals using the method of Payne (1969). Note that most of the points fall above the line, on the sheep side

cut to remove them from the skulls. Although vertebrae and ribs were not recorded in detail during this present analysis it was noted that many of them had been chopped axially, suggesting that basic splitting of the carcasses was taking place. Most cuts and chops were concentrated in the zones immediately adjacent to the epiphyses of the major limb bones. These included the following areas: near the glenoid margins of the scapula, on the proximal and distal margins of the humerus, on the proximal and distal margins of the radius, around the acetabular margins of the pelvis, to the caput of the femur as well as to its distal articular margins, to the proximal anterior epiphysis of the tibia and to the anterior distal midshaft of the tibia. Oblique cuts and chops were occasionally observed to the lateral midshaft of calcanei. Medio-lateral cuts were also observed to the anterior midshaft of astragali, to the proximal anterior margins of metapodials, and very occasionally to the proximal margins of first phalanges.

Epiphyseal fusion data for ovicaprines suggests that the majority of animals were adult with only between 16.6–27% being killed younger than twenty-eight months during the different periods (Table 8). No clear changes were visible between the early Byzantine and Abbasid phases. A number of newborn ovicaprines were noted during the early Byzantine phases, perhaps hinting that animals may have been bred on or immediately adjacent to the site. Dental data broadly confirms this pattern, 19.2% being killed by the age of two years (Payne stage D) during the early Byzantine period (Phase IVa–b) as opposed to 12% during the Umayyad and early Abbasid periods (Phase IVc–V) (Table 9). A comparison of the ovicaprine mortality profiles reveals the similarity between the major periods at Deir 'Ain 'Abata (Graph 1). In terms of their comparison with Payne's idealised optimisation strategies for meat, milk or wool, the Deir 'Ain 'Abata data broadly follows the same shape as the meat curve; however, the significant number of old adult animals



Graph 2: Sheep/Goat dental mortality profiles at Deir 'Ain 'Abata compared against the idealised patterns of meat, milk and wool exploitation of Payne (1973)

also indicates that milk and wool may have been of some importance. It is interesting that the only hint of a difference between the major periods at Deir 'Ain 'Abata is the slightly higher number of older animals at Payne stages D and E (animals c. 1–3 years old) during the Umayyad/early Abbasid period. These may represent animals which, rather than being slaughtered at their optimum meat age, were retained until they were older in order to exploit their important secondary products: milk and wool.

The sparse sex data available for ovicaprids in the form of recordable pelves suggests that twice as many males as females were slaughtered (Table 10). This may, of course, be biased by taphonomic factors since more slender female pelves may not have survived so well as their male counterparts. This impression of predominantly males being killed is further reinforced by the fact that the majority of the horncores were large in size and strongly ridged, with a slight twist. These presumably represent rams that were surplus to breeding requirements and which were subsequently slaughtered.

No significant changes were observed in the relative size of the ovicaprids between different periods (Table 11). Comparing the general size of the sheep and goats from Deir 'Ain 'Abata with those of the nearby site of Upper Zohar (Clark 1995), we can see that they fall within a similar size range. For example, the mean value of the greatest lateral length (GLL) of the astragalus at Deir 'Ain 'Abata (DAA) was 30.92 in Phase IVa, as opposed to 31.06 at Upper Zohar (UZ); the mean value of the proximal breadth (Bp) of metacarpals at DAA was 26.02, as opposed to 25.03 at UZ; and the mean values of the distal breadth (Bd) of the tibia was 28.86 at DAA and 28.1 at UZ.

Pig (*Sus domesticus*)

Pigs were regularly the second most abundant species, based on fragment counts, throughout the early Byzantine to early Abbasid periods (Table 1). It is presumed that the pigs at Deir 'Ain 'Abata were domestic, though this will be discussed in further detail below. Most of the pig bones came from Areas B.I (in Phase IVa, the north-western corner of the monastery) and M.II (in Phase IVa–b, outside of buildings to the north and east) (Table 3).

Anatomical representation data demonstrates that a wide range of body parts were present at the site (Table 12). This suggests that whole pigs were probably introduced to the site as whole live animals. However, relatively high numbers of forelimb elements (scapula and humerus) during the early Byzantine Phases IVa–b might also suggest the deliberate importation of shoulders of pork. The samples are relatively small though so this should be treated with caution as it may simply be due to taphonomic bias.

Traces of butchery cut and chop marks were noted on a number of the pig bones. These suggested basic dismembering of the carcass into smaller portions ready for consumption. Skulls were split open, and mandibles separated from the upper jaws probably to facilitate tongue removal. Cuts and chops were recorded adjacent to all the major joints including: to the neck of the scapula, the proximal and distal humerus, proximal radius and ulna, proximal and distal femur and tibia, distal astragalus, and to proximal and distal first phalanges.

The epiphyseal fusion data clearly shows that the majority of pigs at Deir 'Ain 'Abata were very young (Table 13). Between the early Byzantine Phases IVa and IVb, for example, somewhere between 61.2% and 88.5% of the animals were killed during their first year. A significant number of these were newborn judging from the size and porosity of their bones. This high proportion of juveniles did not appear to change in subsequent periods, although the sample size is unfortunately rather poor. The pig dental data confirms the picture that most animals were slaughtered during their first year, and indeed probably the majority during their first eight weeks, as they nearly all had unworn, barely erupted first molars (Table 14).

The sparse sex data available for pigs suggested that a broadly equal number of males and females were present at the site (Table 15). The sample sizes were poor however, and as the majority of the pigs represented are so young and the material so fragmentary, the situation remains unclear.

The few pig bones that could be measured are listed in Table 16. The size of these pigs falls within the size range recorded for the pigs at Upper Zohar (Clark 1995).

It is presumed that the pigs at Deir 'Ain 'Abata were domestic. The preservation of these mostly fragile young pig bones perhaps lessens the likelihood that they may

have been secondarily deposited at the site. Pig breeding could have been carried out within the enclosure of the monastery or in its immediate vicinity. Caution should perhaps be heeded though because, according to villagers from Safi, wild boar (*Sus scrofa*) does occur in the Ghor es-Safi region even to the present day. Tristram (1866) reports that swarms of wild boar were present in the thickets by the River Jordan and Dead Sea, extending even partly into the Judaeen desert region. It is, therefore, possible that some of the pig remains from Deir 'Ain 'Abata are from wild boar. However, the general size of the few more mature specimens within the sample, along with the presence of very juvenile individuals, leads the author to assume that they were probably domestic in origin.

Cattle (*Bos taurus*)

Only small amounts of cattle occurred in early Byzantine to early Abbasid layers at Deir 'Ain 'Abata. A range of anatomical elements was present indicating that whole animals may have been brought "on the hoof" to the site (Table 17). The sample size is unfortunately too poor to determine if any joint provisioning might have been practised to the site. A number of the cattle bones showed signs of cut and chop marks, indicating the regular dismemberment of carcasses at the following points: distal scapula, distal radius, proximal ulna, proximal metacarpal, proximal tibia, astragalus, proximal and distal metatarsal, distal first phalanx and proximal second phalanx.

The sparse epiphyseal fusion data (Table 18) demonstrated that most of the cattle were mature adults with only a small proportion of juveniles, although the sample size is too poor really to evaluate their importance successfully. The single recordable piece of dental information suggested that one individual was an old adult, as a permanent third molar was at Grant wear stage "h-j" (Grant 1975). This might have been from an old adult female retained for milking, or from an old male used for traction purposes, pulling a plough or a wagon. Unfortunately no sex data was available for cattle, so it is difficult to resolve the question of how the elderly cattle might have been utilised. The few cattle bones that could be measured are listed in Table 19. The two proximal metacarpal fragments were from quite small cattle, whilst the first phalanx was from a medium-sized animal, more similar in size to the cattle found at Upper Zohar (Clark 1995).

Minor Species

Anatomical representation data for the minor species is summarised in Table 20. Other information is discussed in the following sections.

Dog (*Canis familiaris*)

Four bones were identified as belonging to an immature dog in early Byzantine Phase IVb. These all came from the same locus within Area H.II (buildings in the area

west of the church, Locus 14.1). The similar appearance and relative size of these bones (an occipital condyle, humerus, pelvis-acetabulum and femur fragment) was compatible with them belonging to the same individual. The pelvis fragment was unfused and both the humerus and femur had unfused proximal and distal epiphyses. This suggests that the individual was probably only a few months old when it died and was buried in the deposits in Area H.II.

Equid (*Equus* sp.)

Three bone fragments could be attributed to equid. These were a mandibular second premolar (early Byzantine IVa, Area F.I 4.1), a mandibular third molar (early Byzantine IVb, Area F.I 1.11), and a proximal metacarpal fragment (early Abbasid, Area F.I 1.6). Both of the teeth were quite worn, and the metacarpal was of adult size.

It is interesting that all of these finds originate from the same area, i.e. F.I, the northern aisle of the basilica. They may provide an indication of the type of animals that were used by the monastic residents to transport goods and perhaps even to assist with the transport of stone for building work at the site (or for the removal of stone during robbing).

Unfortunately it was not possible to determine precisely whether these equid remains belonged to horse (*Equus caballus*), donkey (*Equus asinus*) or hybrid mules. The second premolar fragment was smallish in size and its occlusal surface seemed morphologically to be closest to donkey (*E. asinus*) (cf. Davis 1980). The other two fragments were of intermediate size.

Camel (*Camelus dromedarius*)

A single bone of camel was identified in the early Abbasid layers (Phase V) at Deir 'Ain 'Abata, from Area K.II 2.2. It was a proximal metacarpal fragment of an adult animal. No signs of butchery marks were observed on the fragment, although it was slightly burnt. Its general morphology appeared to match that of a dromedary rather than a bactrian camel (Steiger 1990: 69, Fig. 64). Camels may have been used to transport goods as well as pilgrims to Deir 'Ain 'Abata. The fact that the single bone found was burnt may indicate that they sometimes also ended up in the cooking pot.

Wild Species

Fallow deer (*Dama mesopotamica*)

A total of 16 fragments were identified as belonging to fallow deer. These all occurred in the early Byzantine levels at the site, Phases IVa–b. Fifteen fragments came from Phase IVa, Area B.I, Loci 9.1 (two distal scapulae), 17.7 (distal scapula), 18.1 (distal scapula), 18.3 (distal scapula), 18.5 (distal scapula), 18.8 (two distal humeri), 18.12 (two distal humeri), 19.1 (distal humerus), and 19.4 (astragalus). A single proximal radius fragment was identified in Phase IVa–b, Area M.II 5.11. All these

bones appeared to be from adult individuals. The few measurements which could be taken on these bones are listed in Table 21.

As nearly all of the *D. mesopotamica* bones belonged to the scapula, humerus and radius, it is possible that imported shoulder joints may have brought to the site (as in the case of the ovicaprine, see above). Mesopotamian fallow deer formerly occurred throughout the forested hills and mountain ranges of the northern Arabian peninsula (Harrison and Bates 1991: 206). Progressive deforestation and increased hunting have brought it close to extinction. Its occurrence at Deir 'Ain 'Abata confirms that occasional hunting was carried out in the more forested areas within the site's hinterland.

Gazelle (*Gazella* sp.)

Seven bones could be identified as belonging to gazelle (*Gazella* sp.). It was not possible to say to which species they belonged: *G. gazella*, *G. dorcas* or *G. subgutturosa*, as none of the anatomical elements represented were complete enough or particularly morphologically diagnostic. Unfortunately, no gazelle horncores were recovered that could have shed some light on this matter. The gazelle bones were located as follows: a single distal humerus fragment was identified in early Byzantine Phase IVa (Area B.I 6.2); five fragments in early Byzantine Phase IVaIVa–b (M.II 5.6 and 5.18, a metatarsal in each layer; M.II 5.15 and 5.18, a second phalanx in each layer; M.V 7.1, metatarsal); and finally, a single metatarsal fragment in early Abbasid Phase V (H.II 6.3). The measurements taken on gazelle bones are listed in Table 22.

The size of these seems close to that known for *G. gazella* (cf. Davis 1985). *G. dorcas* is normally much smaller than *G. gazella* and the larger *G. subgutturosa* normally inhabits the sands, gravel plains and limestone plateaux in Arabia (Harrison and Bates 1991: 204), an area mostly situated to the east of our region. If the Deir 'Ain 'Abata gazelles are in fact *G. gazella* then it is not entirely surprising. According to Lurie (1984), a population of about 4,000 individuals of *G. gazella* can be seen at the present day in Galilee, the Jordan Valley and in the Golan. However, as most of the gazelle bones represented at Deir 'Ain 'Abata consisted of metapodials it is possible that they may have been deliberately introduced to the site not in the form of whole animals but as feet still attached to skins, or represent waste elements from joints of meat.

Fox (*Vulpes* sp.)

A single fox bone was identified in early Byzantine Phase IVa. This was from Area B.I 19.6, and was a mandible from an adult individual. The mandible was assigned, on the basis of its size, as belonging to red fox (*Vulpes vulpes*) rather than the smaller Ruppell's sand fox (*V. rueppellii*) or Blanford's fox (*V. cana*) both of which are known to occur in the region at the present day (Harrison and Bates 1991).

The red fox is a very adaptable predator that inhabits a broad variety of habitats, and although it is predominantly nocturnal it can also be seen during the day. Foxes may have scavenged the domestic refuse dumps of the monastery, and may have also been attracted by the domestic poultry being reared within the vicinity of the monastic complex (see Ch. V.14c). A further possibility is that the fox was deliberately captured for its pelt, though this cannot be proven as no skinning cutmarks were visible to the mandible.

Cape hare (*Lepus capensis*)

Five hare fragments occurred in the early Byzantine layers. These all came from Area F.III (inside the cave and its entrance) from the following layers: Loci 15.6 (fourth metatarsal), 25.1 (femur and tibia), 25.4 (humerus) and 25.6 (humerus). Only one of these, the fourth metatarsal fragment, exhibited traces of burning to its surface. A single hare femur fragment was recovered from the early Abbasid layers in Area F.III 5.2. This was also burnt. Although no butchery traces were noted on any of the hare bones, the fact that some of them were burnt perhaps suggests that they may occasionally have been consumed by the site residents. It is also possible that hares may have taken advantage of the cave for concealment from predators and died naturally in the cave, prior to the construction of the shrine.

The cape hare is widely distributed throughout the region at the present day (Harrison and Bates 1991). Like the fox, it can occur in a wide variety of habitats where there is sufficient vegetation.

Small Mammals

Table 23 details the occurrence and anatomical representation of the small mammal remains found at Deir 'Ain 'Abata. As stated earlier in the methods section, only mandibles and maxillae with two or more teeth were identified to species. The recovery method used on the excavation, using 5 mm mesh dry sieving, may have missed many of the smaller rodents which might occur in the region. This should be noted when considering the present sample.

Black rat (*Rattus rattus*)

The identification of black rat, rather than brown rat (*Rattus norvegicus*), was confirmed by a number of measurements (Table 24). All the mandible length measurements fell within the typical size range of black rat (Harrison and Bates 1991: 245). Four bones from black rat occurred in early Byzantine Phase IVb. They were from F.III 25.3 (inside the cave), and from Area K.II (the refectory and water cistern/communal burial chamber), a single find in Locus 28.5 and two specimens in Locus 28.6. Both of these layers were fills inside the cistern. Two bones of black rat were present in the more broadly dated early Byzantine–early Abbasid Phase IVb–V. These

were also from Area K.II, but from Loci 19.1 and 19.3. Such finds undoubtedly illustrate how black rats would have taken advantage of the cistern to forage for food. It is worth noting that the majority of the black rat bones found at the nearby early Byzantine fort at Upper Zohar also came from a cistern (Croft 1995: 93).

Concerning the modern-day distribution of *Rattus rattus* in the region, it is reported as being locally abundant in Israel (Bodenheimer 1958) and the West Bank (Aharoni 1917), and has been noted from Safi and Moab in Jordan (Nehring 1901). Black rats are extremely adaptable and would certainly have been attracted to the monastic community at Deir 'Ain 'Abata, where the water supply network as well as the dumping of organic waste debris from food consumption would have encouraged their colonisation.

Spiny-tailed mouse (*Acomys* sp.)

A total of seven specimens were identified to the level of genus, *Acomys* sp., spiny-tailed mouse. The two species present within this genus in the region at the present day are the Egyptian spiny mouse (*Acomys caharinus*) and the golden spiny mouse (*Acomys russatus*) (Harrison and Bates 1991). The Egyptian spiny mouse (*A. caharinus*) is known at the present day from the West Bank and western Jordan (Allen 1915; Atallah 1978; Boye 1983; Harrison and Bates 1991; Qumsiyeh et al. 1986). Harrison and Bates (1991: 256) note that it is predominantly a nocturnal and crepuscular mammal that favours all kinds of rocky areas and is very capable of living in very arid steppe-desert. They also report that it lives in niches and crevices among boulders, and that it can occasionally be found in human habitations within Arabia. The golden spiny mouse (*A. russatus*) is known to occur at the present day within Jordan in Ghor es-Safi, Moab and Wadi el-Nasb, near Aqaba (Aharoni 1917). It is similarly found in rocky habitats but is confined to more arid zones (Shkolnik and Borut 1966; 1969). It is worth noting that Atallah (1970; 1978) recorded it both on steep rockslides in semi-arid areas near the Dead Sea, as well as along the edge of the basalt desert and in gardens around human habitation.

In the case of the material from Deir 'Ain 'Abata, it was possible to take a number of measurements on the lengths of the *Acomys* mandibles and tooth rows (Table 25). All these measurements unfortunately fall within the known range for both species (Harrison and Bates 1991: 256–7), with the exception of the mandible measuring 14 mm, which might possibly belong to the slightly smaller *A. russatus*.

Five bones of *Acomys* occurred in early Byzantine Phase IVb, from Area F.III (in the cave) and K.II (refectory and water cistern/communal burial chamber), Locus 28.5. Two bones were present in the early Abbasid layers of Phase V, from Area H.II (buildings in the area west of the church and reservoir), Locus 6.2.

Short-tailed bandicoot rat (*Nesokia indica*)

The distinctive morphology and size of the teeth permitted their identification to short-tailed bandicoot rat. It occurred in both early Byzantine Phase IVa–b (Area M.V 3.1—the north-east room) and in the early Byzantine to early Abbasid Phase IVb–V (Area K.II 19.2—the refectory and water cistern/communal burial chamber). The length of its mandibular tooth row in the latter case was 8.1 mm. This falls within the known size range (Harrison and Bates 1991: 259).

Modern-day occurrences of the short-tailed bandicoot rat (*Nesokia indica*) have been noted for the Ghor es-Safi region (Harrison and Bates 1991: 260) and it is also known from Moab (Aharoni 1917). It is reported as being a locally abundant rodent in suitable moist localities. Harrison (1959) reports that in Iraq “its holes and prodigious diggings are a frequent sight along the banks of irrigation channels and amongst camel thorn scrub near water”. Its typical diet of fleshy roots of *Alhagi mannifera* and *Typha elephantina*, as well as its propensity to damage crops of corn, barley, vegetables and fruit (Hoogstraal 1963; Al-Robaee 1977), may have made it an annoying pest for those involved in horticultural activities in the vicinity of Deir 'Ain 'Abata.

Discussion

The Economic Context

The Byzantine period was a period of great economic prosperity in Palestine (Avi-Yonah 1958; Piccirillo 1985). Agriculture reached its absolute peak during this period in terms of the amount of tillable land that was exploited (Patrich 1995b: 483). This transition to mass agricultural production is aptly demonstrated by the recently excavated agricultural estate to the north of Ashkelon. Here, the buildings included several large oil and wine-presses, two storey warehouses of a basilical plan for the storage of products, kilns for the production of jars in which oil and wine were exported, as well as ponds for the artificial breeding of fish (Patrich 1995b: 484). Other important factors which should be taken into consideration as part of this intensification process include the fact that, in the fifth and sixth centuries, soldier-settlers were given plots of land to cultivate, and tax reductions, besides their regular payments (Jones 1964: 649–54; 660–1).

The fifth century saw a period of great imperial as well as private investment of capital in the Holy Land, which explains the astonishing prosperity of Palestine during the Byzantine period. Apart from this obvious investment in the construction of churches and monasteries there was probably also a very significant input of capital from pilgrimages. A number of published itineraries and records of individual visits demonstrate that the number of pilgrimages grew continually from the fourth century onwards. Many of these pilgrims would have spent money on their personal

needs and it is known that inns were provided by public and private initiative (Avi-Yonah 1958: 45).

Investment in water management systems was also marked during the Byzantine period in some regions (e.g. Tell Hesban and Negev regions). In the Late Byzantine period this may go hand in hand with the beginnings of a shift towards stock production, as there is a period of inflation and population loss in the country as a whole (Department of Antiquities 1973: 41–2; Sauer 1980: 31–3).

Rural settlements in the Byzantine period could broadly be divided into Byzantine villages fortified by enclosures or built near military installations, agricultural villages, and agricultural monasteries where the monks, like the peasants of the nearby villages, lived by the exploitation of the land (Piccirillo 1985: 258). The Nessana papyri provide information on the variety of crops grown, which included wheat, barley, grapes, olives, figs and dates. Although these may mostly have been for local consumption, a series of *entagia* for requisitions of wheat and oil by the Arab governor in the late seventh century indicates that a surplus of crops beyond the needs of the local population may sometimes have been produced, but it may have been subject to taxation by the Byzantine government (Kraemer 1958: 175–9; Glucker 1987).

Byzantine–Umayyad–Abbasid Periods: Economic Transitions

The animal bone evidence from Deir ‘Ain ‘Abata provides no clear evidence of a sharp break in economic strategy with the onset of the Islamic period. The only hint of change is a possible intensification in ovicaprine husbandry towards exploiting milk and wool from their flocks, more 1–3-year-olds being retained to an older age (see discussion above on sheep/goat). However, it would be necessary to examine further larger faunal samples from the region to corroborate whether this is indeed a valid phenomenon, or simply due to the vagaries of the present sample under investigation.

The general picture perhaps confirms the idea that the Umayyads left the peasantry to continue to farm the fertile countryside (King 1992: 373). Archaeological surveys and excavations carried out in Hawran and al-Balqa demonstrate that farmland continued to be settled into the Umayyad period, prolonging the occupation of the same areas in Byzantine, Roman and earlier times (King 1992: 369). Indeed this pattern of Umayyad settlement upon Byzantine sites is extensively known throughout all of northern and western Jordan (King 1983).

Recent archaeological work has highlighted the waves of expansion of agriculture even into the arid desert-like conditions of the Negev during the Byzantine period (fifth–seventh centuries), followed by a second wave during the Umayyad period (seventh–eighth centuries) (Haiman

1995). This has been attributed to the following factors: imperial policy deliberately encouraging agricultural settlements on the frontier, as well as the gradual shift of semi-nomads from nomadism to spontaneous settlements, culminating in sedentarisation by the state.

A recent survey has also examined the archaeological evidence for Early Islamic occupation in the southern Negev and the Arabah, a region that Donald Whitcomb has referred to as Aila’s “hinterland”. This suggests that new settlements were established and flourished throughout the region during the eighth to tenth or eleventh centuries. Their economic base included large-scale agriculture using sophisticated irrigation systems and the introduction of new crops, copper and gold mining and production, stone quarrying, and the development of a road network used by merchants and pilgrims (Avner and Magness 1998).

In further support of this hypothesis of economic continuity from the Byzantine to Early Islamic period, excavations at Aqaba have uncovered significant portions of the ancient Nabataean, Roman, and Byzantine city of Aila, which flourished from the first century BC to the Early Islamic conquest (Parker 1997). Here it is clear that parts of the Byzantine settlement continued to be occupied even after construction of the new Islamic walled town in the mid-seventh century AD.

As Lancaster and Lancaster (1995: 121) have pointed out in their study of the history of Early Ottoman to present-day land use in north Karak, an assumption of decline from a surplus agriculture village-dwelling population incorporated into a central government, to a tribal population with a subsistence economy living through disorder and chaos because of a decline of power structures, is far too simplistic. Certain continuities in terms of social processes as well as continued participation in the wider regional economic and political sphere may be maintained.

Economic Use of the Major Domestic Species

The residents of Deir ‘Ain ‘Abata may very well have kept sheep/goat and pigs, if we accept the presence of very young individuals as being accidental deaths or the slaughtered by-product of husbandry strategies. In the case of cattle this is not so clear as the sample size is inadequate.

Were sheep and goat kept primarily for their meat, milk and/or wool? Comparison of the dental mortality profiles (Graph 2) with the idealised models of Payne (1973) indicates that meat was certainly an important concern, but the number of older animals present implies that milk and wool were also of crucial importance. Milk and cheese would have been important food items within the monastery. Wool production was undoubtedly also a significant economic activity. Documentary sources describe how among typical possessions owned by monks

were sheepskin capes and sheepskin rucksacks, which they took with them when they went out to seclude themselves in the desert (Hirschfeld 1992: 93; 96). It is reported that Rabbinic interdicts did not permit the breeding of “*small cattle*” (=sheep and goats) in certain areas of Palestine during this period (Sperber 1978: 45). This demonstrates that a great deal of breeding was going on and it is well known that the textile industry, with its heavy dependence on wool, was highly developed in Palestine at that time. Another Rabbinic edict by R. Yohanan (Bavli Hulin 84a) advises that: ‘he who wishes to become wealthy should devote himself to breeding small cattle’ (Sperber 1978: 46).

What was the role of the other major domesticates, pigs and cattle, at the site? Pigs would have provided meat and fat to the site residents, and judging from the butchery evidence they exploited almost all parts of the pig. Documentary evidence supports the idea that monasteries were involved in pig farming. It is reported by Moschus that one monastery near Phasael in the Jordan valley owned a pig farm (Hirschfeld 1992: 104). Citing documents by Moschus and Aetheria, Avi-Yonah (1958: 48) says that:

The monks of Mardes cultivated gardens near the Jordan; those near Mount Sinai grew fruit and vegetables for the benefit of pilgrims; *other monks and hermits engaged in pig breeding in the Jordan valley*, to the anger of the local Jewish inhabitants; many wove baskets from palm leaves, or made nets—occupations which went well with hymn singing and the contemplative life.

Interestingly, Avi-Yonah also mentions that:

Pinianus sold brush wood, collected in the desert, in the market of Jerusalem, Melania his wife *spun wool for sale*: in describing the Tabennesiotic monasteries, Palladius refers to the monks doing the work of tailors, copper-smiths, carpenters, *camel-drivers, fullers, pig-breeders*; the same story is told of the monks of Antioch and of some Palestinian anachoretes. However, the fact that the monasteries always needed donations shows that they were by no means self-supporting (Avi-Yonah 1958: 48–9).

This suggests that monasteries may have been involved in a whole range of economic activities. As pork seems to have been more expensive than beef during the period in question, it may have been economically profitable to maintain a pig farm. In the Edict of Diocletian, dated to AD 301, one Italian pound of beef cost eight denarii and of pork twelve denarii. In Tanhuma Balak 15, a text dated to about AD 303–304, it is reported that a pound of kosher meat (probably beef) costs eight maneh, whilst the same amount of pork costs ten maneh (Sperber 1974: 151–2).

Cows may have been kept within the monastery

primarily for their milk, although their meat would have also been consumed. One also has to consider that their hides may have been exploited, although no typical skinning cutmarks were observed on any of the Deir 'Ain 'Abata cattle bones. The larger oxen were probably retained for use as traction animals, to pull ploughs or wagons.

Dogs do not seem to have played a major role in the life of the monastery, judging from their relative scarcity at the site. Those fragments that did occur were probably all part of a single disturbed skeleton. The relatively low level of visible carnivore gnawing to the bone assemblage as a whole demonstrates how access to the area enclosed within the outer monastery wall may well have been restricted.

The equid remains found at Deir 'Ain 'Abata represent animals that were probably used as beasts of burden to transport goods and heavy items. It is reported that stables for the raising and tending of horses were identified in excavations at Byzantine Shivta and Rehovot (Patrich 1995b: 486). However, according to documentary sources, in the majority of cases traders owned large caravans of donkeys (Glucker 1987: 95).

Usually each monastery had its own deputy or steward. The job of this steward involved the purchase of food and various other items, including beasts of burden (Hirschfeld 1992: 74). Documentary sources report that the steward of the monastery of Euthymius purchased pack animals for the community (V. Euth. 18, 28. 13–14). An important role within the monastery would have been that of mule-driver, being in charge of the transport of goods and delivery of communications with the outside world. It is reported that Saba served as a mule-driver in his early days at the monastery of Theocristus (V. Sab. 8, 92. 13), and Moschus mentions the function of looking after the pack animals (Pratum 101, 2960B).

Camels were sometimes also used for the transportation of important goods. Amongst the papyrus documents found at Nessana in the Negev, there is an autographed letter from Moses, bishop of Aila, on the Red Sea, sending a money gift to two sanctuaries of the Negev through an Arab, ‘a Saracen’ bedouin camel rider (Kraemer 1958: 51).

Exploitation of Wild Species and the Local Environment

Hunting, primarily for fallow deer and gazelle, appears to have only played a minor part in overall resource provisioning at the site. Most Early Byzantine-period sites typically have relatively low numbers of wild species (see discussion below). All the wild mammals present at Deir 'Ain 'Abata could have originated from the local region, and indeed several of them may have accidentally died and found themselves incorporated into the site by entirely natural rather than anthropogenic causes, e.g. the small mammal remains. Foxes may have scavenged on the refuse dumps around the monastery, although they could

have been deliberately procured for their pelts. Hares were probably trapped for an occasional variation in diet.

Was it possible to reconstruct, from the wild resources present, which environmental habitats were exploited within the locality's hinterland? All the wild mammals recorded at Deir 'Ain 'Abata have modern-day distributions which overlap with the Ghor es-Safi region, the only possible exception being the fallow deer (*Dama mesopotamica*) which is practically facing extinction at the present day throughout its natural range (Harrison and Bates 1991: 207). This animal requires substantial forested areas and vegetation cover. Such areas are not available immediately adjacent to the site at the present day, however, the surrounding area might have been much more heavily wooded in the past.

Nineteenth-century travellers to the southern Ghor region, such as Irby, Mangles and Tristram, reported that both Wadi Karak and Wadi Hasa were permanent streams, abounding in fish, and that the waters were diverted by a system of small canals to irrigate arable patches deliberately cleared of thickets (Harlan 1988). The Ghor es-Safi area supported massive canebrakes near the shores of the Dead Sea where the underground water flow of the wadis kept the soil moist. It is noted that the extent of these canebrakes was so great that they were virtually impenetrable to men and domestic animals. Wild pigs abounded in the area, a fact that the author can personally confirm after his 1996 visit to an area located a couple of kilometres south of the Dead Sea. Nineteenth-century travellers also reported that the swine population supported a few leopards and the fact that jackals were common. These observers also registered the enormous numbers of pigeons and other birds nesting or roosting in the trees. They also commented upon the rich grass and pasture available, as well as on how the streams swarmed with fish (Harlan 1988: 126).

Based on the descriptions of the last century, above the Dead Sea the steep slopes of the Ghor would have been dotted with acacia trees and dwarf palms. The banks of the wadis would have been more stable than at the present day as they would have been more heavily wooded, the streams being bordered by dense stands of oleander and willow. As a whole the Ghor region would have been an attractive area for settlement and exploitation (Harlan 1988: 128).

Organising Rubbish—Cleaning by Burning?

Leaving aside for a moment the general economic and environmental context of Deir 'Ain 'Abata, let us consider the spatial distribution of bone material on the site and its social implications. A feature of the mammal bone assemblage throughout the whole site was its general homogeneity. This suggests that organised disposal of particular rubbish was not especially distinctive to certain areas. During the Early Byzantine Phases IVA–b most animal bones were dumped into Areas B, H and M.

In the Early Abbasid period, bones continued to be predominantly dumped into Area H.

Something that was very curious concerning the overall condition of the mammal bone assemblage was the fact that most of the bones were burnt, or rather lightly singed. This marked occurrence of burning was also observed during the analysis of the bird and fish bone assemblages (see Ch. V.14b and V.14c). It is difficult to explain all these burnt bones as simply representing barbecued bones resulting from over cooking. It seems more plausible that something has happened to the material once it had been initially discarded; a likely explanation is perhaps that periodic burning of rubbish took place to clean and reduce the mass of organic debris being produced by the occupants and visitors to the site.

It is likely that beside every monastery there would have been a refuse heap. The writings of Anthony mention such a heap near the monastery of Choziba (V. Geor. 12, 108. 5). This waste may, of course, have been collected for secondary use as manure in the monastery garden, or have been taken to adjacent cultivated areas. If this refuse got unmanageable then perhaps burning may have been used to reduce its bulk and to get rid of unpleasant odours. Burning may have also assisted the preparation of suitable waste for manuring.

Site Provisioning—Pilgrim Gifts?

The over-representation of certain skeletal elements at Deir 'Ain 'Abata is of considerable note. In the case of the ovicaprines (and possibly also pig) it seems that the upper parts of the forelimb were a favoured joint. This is very interesting as a similar phenomenon was remarked upon by Gillian Clark for the ovicaprines at the nearby Early Byzantine fort of Upper Zohar. She observed that:

Some prime meat (specifically lamb/mutton) was brought into the site as joints. This phenomenon may be seen most clearly in the North-east Tower, the Cistern and the Southern Internal Division, where the bones of the upper parts of the limbs are predominant. This import of meat is, it must be emphasised, limited to sheep/goat. For cattle one appears to be faced with a totally different situation: the majority of the material is from the limb extremities and, to a lesser extent, the head. There is a scarcity of fragments of bones of all other parts of the skeleton (Clark 1995: 59).

The cattle remains from Deir 'Ain 'Abata, although few in number, perhaps also reflect this general trend. The bulk of the cattle bone could also be described as belonging to heads and extremities, i.e. primary butchery waste.

Concerning the possible import of food items to this type of site, it is worth noting that Theodore of Petra reports that a woman regularly donated food to the monastery of

Theodosius, and that later a whole village regularly sent food supplies to the monastery (V. Theod. 78, 19–24 and 80, 24–27). Monasteries were clearly not completely self-sufficient and had to rely on outside donations.

Reconstructing Life in an Early Byzantine Monastery and the Diet of the Monks

Institutionally and architecturally the monastery of Deir 'Ain 'Abata was probably of *coenobium* type, i.e. the monks would live and work together, and meet daily with each other in the church and in the dining room. Architecturally the *coenobium* was an enclosed monastery, with all its components confined within its walls (Patrich 1995b: 487). Cyril of Scythopolis provides a detailed account of the lives of typical monks in a *coenobium*, where a group of monks lived a communal life in an enclosed complex, working, praying and eating together according to a fixed schedule. It is reported that:

They would spend the five days from Monday to Friday in their cells, living on bread and water and dates, without lamps, heat or cooked food. On Saturday they would bring their handiwork of rope and baskets to the coenobium, where they would receive Communion on Saturday and Sunday, partake of cooked food and a little wine, and return to their cells on Sunday evening with their week's supply of bread, water, dates, and palm-blades for their handiwork (Chitty 1966: 90).

Studies on the Byzantine monasteries of the Judaeen desert have suggested that one of the main sources of livelihood for the monks was the gathering of edible wild plants. Written sources mention three types of plants which were gathered systematically by the monks: salt bush (*Atriplex* sp.), caper (*Capparis* sp.) and a plant named 'manouthion' (?tumble thistle), which as well as being edible could be used as kindling material (Hirschfeld 1990: 26–7). Other plants which are mentioned include 'melagria' (*Asphodelus microcarpus*) and wild onions (sea squill, *Urginea maritima*). Surplus plant material may of course have also been used as animal fodder. Certainly the Byzantine monks and hermits of the Judaeen desert seem to have made the maximum use of the natural resources immediately available to them. Hirschfeld (1990) speculates that their familiarity with the available plants and largely vegetarian diet contributed towards their frugal, but well-balanced diet. Certainly some of the monks lived extremely long lives, e.g. John Hesychastes of the monastery of Mar Saba, died at the age of 104; Cyriac of the monastery of Chariton, died aged 107, and Euthymius, founder of the monastery of Khan el-Ahmar, died aged 97.

The monks did not just rely on gathered plants though, they would also have tended small garden

plots within or adjacent to the monastery, as well as perhaps nearby agricultural fields, which may have been collectively worked. One of the ancient sources mentions the admission of George to the monastery of Choziba, as described by Anthony, and says that one of the recluses, a man already advanced in asceticism, was entrusted with the care of the so-called "new garden" and was given George as a helper (V. Geor. 4, 99, 1–5). In one of Moschus's stories, the gardener of the monastery of Marda is mentioned as being in charge of a garden near the shore of the Dead Sea (Pratum 158, 3025D).

The great expansion caused by the growing number of pilgrims visiting the holy places near the Jordan River during the Byzantine period meant that many monasteries in the region became stopping-off points on the pilgrimage route, functioning almost like modern-day motorway service stations. A staff of monks would have been attached to the church to serve the pilgrims, and a small monastery built to house them nearby (Hirschfeld 1992: 16). This willingness to house guests and provide hospitality is clearly demonstrated by the conversion of the monastery of Choziba at the end of the fifth century from a *laura* (reclusive monastery) into a *coenobium* (communal monastery), which even allowed female visitors (Hirschfeld, 1992: 16).

What other food-related jobs were there within the monastery? Other documentary sources mention certain monks being in charge of baking bread, caring for the sick, receiving guests and administering the monastery. Usually each monastery had its own deputy or steward. The job of this steward involved the purchase of food and various other items, e.g. it is reported that the steward of the Great Laura arranged for the transportation of wheat (purchased in Transjordan) from the Dead Sea coast to the monastery (V. Sab. 80, 186, 15–17). Stewards also organised the provisioning of raw materials such as palm fronds and canes to the monks, for basket and rope making.

The job of cook is often mentioned in the ancient sources (V. Sab. 40, 130, 30, and 48, 138, 11; V. John Hes. 6, 205). Other food-related jobs within the monastery which are mentioned include those of storeroom keeper and baker (V. Cyr. 7, 226, 23). Younger, stronger monks would have had a daily routine of going out of the monastery to collect wood to bring in as fuel. They undoubtedly would also have collected some of the edible wild plants previously mentioned. Cyril describes a scene where the monks were sitting outside the monastery gate chatting as they washed the edible 'saltbushes' (V. Euth. 56, 77, 14–15).

On the basis of the ancient documentary sources it would appear that a monk's staple diet was bread (V. Char. 16, 28, 17). This even seemed to be true for visiting guests, as 400 Armenian pilgrims received pieces of bread, wine and oil on their arrival at the *laura* of Euthymius

(V. Euth. 17, 27. 20). As mentioned previously, wheat was transported to the monasteries, which depended on this imported grain to make their bread. Supplies may also have been occasionally donated by devout Christian communities, for example, Cyril reports that the people of Madaba, who venerated Sabas, contributed wheat and kidney beans to the Great Laura and his other monasteries (V. Sab. 45, 136. 4).

Vegetables eaten by the monks were served both raw and cooked. It is reported that pulses were a staple and that vegetables such as lupine, peas and cooked pumpkins were consumed (Hirschfeld 1992: 86). Other food included carobs and dates.

The Judean desert monks supposedly abstained from meat and probably also from fish (according to Hirschfeld 1992: 88). The rules attributed to Maruta state that the monks “*shall not eat meat in their monasteries*” (Vööbus 1960, 148, no. 2); however, some of the Egyptian monks occasionally ate meat and fish on holidays (Dembinska 1985: 435–6). Sources suggest that meat and fish were only eaten by sick monks (Pratum 65, 2916A). Fish is described as being a food for the ill in the monastery of Abba Seridos in southern Palestine (Doroth. 11, 140. 9–10). Hirschfeld speculates that it may have not been forbidden to the monks but simply that it was too scarce to be part of the diet of poorer communities. It is interesting to note that in the biography of the post-Byzantine monk Stephen Sabaïtes, pickled fish is mentioned as a delicacy that would only be offered to visitors on rare occasions when it was available (V. Steph. Sab. 40, 520B).

How can we reconcile the contradictory picture derived from the documentary sources with that obtained from our archaeological data? The sources seem to describe the monks as being largely vegetarian, and although we know that the monks at Deir ‘Ain ‘Abata did consume a certain amount of cereals, legumes and fruits (see Ch. V.15b), the faunal assemblages clearly demonstrate that considerable quantities of meat, fish, poultry and eggs were regularly consumed (see Chs V.14b, V.14c and V.17). Therefore, does the meat and fish present at Deir ‘Ain ‘Abata largely represent food brought to the monastery as offerings, or food prepared for visiting pilgrims, rather than for the monks themselves? Sources suggest that eggs, fish and even meat were given only in exceptional cases to ailing monks (Pratum 65, 2916A). Hirschfeld (1992: 91) speculates that animal products such as cheese, honey and eggs were not available as a general rule in the monasteries and that, therefore, they must have been received from the local villagers. Once received, a feast would be held and the offerings consumed (V. Sab. 13, 96. 18 and 15, 99. 3). Might the food waste at Deir ‘Ain ‘Abata represent the remnants of such feasts? Does the richness of the diet of the residents of Deir ‘Ain ‘Abata, therefore, provide an inkling of the high status of this site?

Deir ‘Ain ‘Abata in Context—A Regional Appraisal

Unfortunately, comparatively few contemporaneous Early Byzantine and Early Islamic period sites have been systematically excavated, sieved and have had their faunal remains analysed from this region. For the Byzantine period, most work has been done on isolated churches, so comparatively little bio-archaeological data is available for studying the dynamics of the Byzantine economy.

Table 26 presents a list of those sites where it was possible to obtain quantitative information of some kind. Data concerning Iron Age and Roman-period sites in the region was also included for comparative purposes. These amounted to a total of fifteen different localities. The distinguishing feature of most of the Byzantine sites was a predominance of sheep/goat, followed by cattle then pig, the only exceptions being Late Byzantine/Early Islamic Bet She’an, Late Roman/Early Byzantine Umm Qais, Early Byzantine Upper Zohar, and all the Early Byzantine phases to Early Abbasid layers at Deir ‘Ain ‘Abata. At these sites, pig was second most frequent after sheep/goat, followed by cattle. The majority of these bone assemblages were quite small and only three Byzantine assemblages (excluding Deir ‘Ain ‘Abata) had more than 1,000 identifiable fragments. These were: Bab-el-Hawa (Raphael and Lernau 1996), Pella (Tell al-Husn) (Rielly 1993) and Upper Zohar (Clark 1995).

The relationship between the proportions of the major domestic species can be seen more clearly in Fig. 834. Interestingly, Deir ‘Ain ‘Abata (points 7–11) and Upper Zohar (point 26) are the closest sites geographically and this is also reflected in the similarity of their relative proportions of the major domestic species. The two extreme outliers in Fig. 834 represent the early–mid Roman site of Mons Claudianus (point 17) located in the eastern desert of Egypt, and Late Roman Umm Qais (point 24), located in northern Jordan close to the Syrian border. At both these sites there was a very high proportion of pig bones that may have been provisioned into the site in the case of the former, or hunted/bred in the latter case. Bones of camel occurred in low numbers on all sites, except for at the Roman-period site of Mons Claudianus, where there was also a very high number of equid bones. This special site, because of its location, was provisioned almost completely from outside by camels and donkeys/mules (Hamilton-Dyer 2001). Generally speaking though, equids are infrequent on most sites. Dogs and cats were also only present in low numbers. Fallow deer and gazelle were the more regularly exploited species amongst the wild mammals. Roe deer, badger, fox, some sort of mustelid and cape hare were slightly less common.

As we can see, our knowledge of animal husbandry during the Early Byzantine period is fairly limited. If we consider only the three larger Early Byzantine assemblages, then the following more detailed comments can be made.

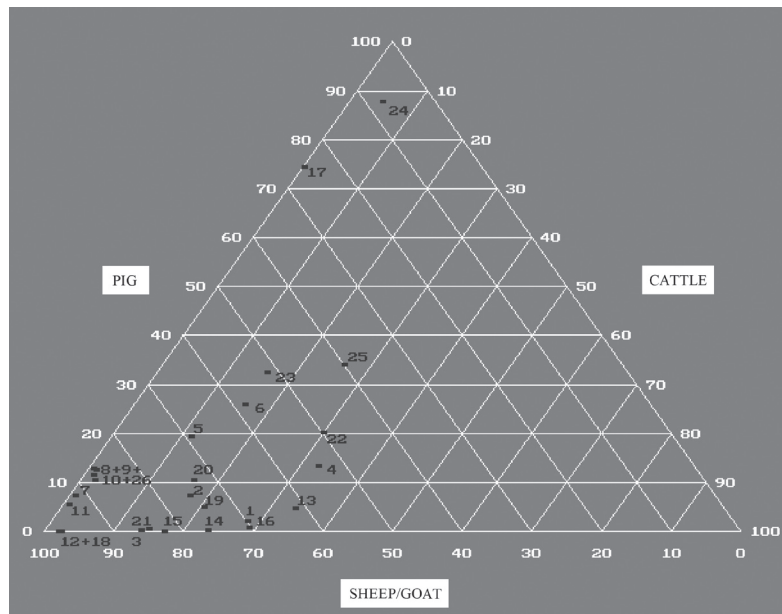


Figure 834: Comparison of relative percentages of the major domestic species at Iron Age, Roman, Byzantine and Early Islamic sites in the region. For an index of the numbered points see Table 26. Percentages are based on fragment counts/NISP values

Bab-el-Hawa is located on the north-eastern edge of the Quneitra Valley in the Golan Heights. It is reported that the inhabitants mostly used their flocks for milk and wool rather than for meat (Raphael and Lerna 1996: 107). The size of the sheep/goat fell within the range identified for Deir 'Ain 'Abata. A relatively high number of immature (unfused) cattle bones found here suggest that the occupants of the site consumed young cattle. The pigs were identified as belonging to wild boar. Cutmarks on some of the donkey bones suggests that they may occasionally have been eaten.

Pella (Tell al-Husn) is located at the eastern end of the Wadi Jirm, just a few kilometres east of the northern Jordan Valley near modern-day al-Masharia. During the Byzantine phase (Area XXXIV) at the site, all that can be said is that there was a clear predominance of sheep/goat bones and a good representation of cattle and chicken (Rielly 1993). It is suggested here that the pigs are domestic rather than wild in form, and that the equid bones are mostly donkey-sized.

The Early Byzantine fort of Upper Zohar is located just a few kilometres south-west of Deir 'Ain 'Abata. The site appears to have a number of similar characteristics with Deir 'Ain 'Abata. We have already noted the remarkable similarity in the proportions of the major domestic species at the two sites. There is also the matter of the preference for prime upper joints of lamb/mutton at both sites (Clark 1995: 59). Sheep seemed to be more common than goats at the site. Some of the sheep/goat died when young but many animals died over a wide variety of ages, some being quite old. The peak age at which they died was between 2–3 years in the large sample retrieved from the cistern at

Upper Zohar. Many of the pigs died at a young age, not surviving beyond the end of their second year. Some neonatal pig bones were present. Cattle were killed at any age from one and a half years of age upward (Clark 1995). This broadly matches the situation at Deir 'Ain 'Abata. Sheep/goats were obviously a critical component of diet at both sites, and would have provided the bulk of the meat requirement. Many animals would have been raised primarily for their secondary products (milk and wool), although ultimately they may also have been eaten. As Clark quite rightly says, with regard to Upper Zohar, it is “not clear whether the flock/herd was the responsibility of any permanent occupants of the fort, or whether it was maintained in the vicinity by a rural group practising pastoralism.” (Clark 1995: 59). We could say the same for

the occupants of the monastery. Certainly the similarity between the two sites perhaps strengthens the case for the latter hypothesis, both sites interacting with the local community of the region.

Additional qualitative information concerning animal husbandry during the Early Byzantine period is available from Geraty and LaBianca (1985), Gutwein (1981) and Piccirillo (1985). Some work has been carried out on the edge of the Jordanian highland on Mount Nebo. Preliminary archaeobotanical and archaeozoological analyses carried out at Tell Hesban indicate that the economy of some villages was based primarily on agriculture (principally wheat, barley, vineyards and olive groves) and only secondarily on the grazing of sheep and goats, or raising of domestic animals. It is reported that the main types of animals at Tell Hesban were sheep and goats, followed by cattle and other domestic animals, with hunted animals being represented by gazelle and partridge (Piccirillo 1985: 259).

The phase of intensive food production during the Byzantine period is clearly demonstrated by the increase in the number of sites and population in some regions. For the Tell Hesban area it has been suggested that sheep and goat meat scarcity may have been a direct consequence of turning most available pasture into cropland (Geraty and LaBianca 1985). In this particular region it is suggested that this was compensated for by the consumption of large quantities of poultry, pig and fish. This noticeable prominence of meats from barnyard animals, such as pigs and poultry, is interesting to note as such meats can be produced without requiring cultivated land to be returned for use as pasture. The lack of integration of crop and stock

production must have been a problem. Most crops grown in the region were directly for human consumption, leaving sheep and goats to forage on seasonally scarce natural pastures, as well as on the stubble remaining following the cereal harvest (cf. Grigg 1974: 125). In the Negev, local environmental conditions meant that agriculture was primarily based on the cultivation of barley with vineyards of secondary importance.

Local caravan routes crossing the region meant that inter-regional commerce played an important role. Sheep and goat breeding similarly would have played a vital role (Gutwein 1981). Water necessary for human consumption, as well as for their domestic animals, would have been provided from local water springs or streams, as well as by large public water reservoirs and private cisterns. The spring adjacent to Deir 'Ain 'Abata may have fulfilled a similar function for local grazing animals.

Conclusion

The mammal bone assemblage from Deir 'Ain 'Abata has provided a valuable insight into the life, environment and economy of an important Early Byzantine monastery in the Holy Land. The site represents one of the first of its type to be thoroughly investigated by environmental archaeologists. Interesting contradictions arise between the documentary sources that provide accounts of monastic diet and the daily life of monks. Certainly the idealised impression of vegetarian, predominantly bread-eating, monks that one obtains from reading the various sources seems not to be true in the case of all monasteries. At Deir 'Ain 'Abata the variety of food items available to the resident and visiting community was quite astonishing. It varied from mutton to pork, to occasionally beef, and the various dairy products associated with sheep/goats and cattle. Hunted game like fallow deer and gazelle were very occasionally consumed and would have helped to provide an element of variety to daily diet. Poultry, mostly chickens and eggs, exotic imported marine fish from the Red Sea and Egypt, as well as cereals, legumes and fruits

would have also featured in their diet (see Ch. V.14b, V.14c V.15b and V.17).

Current hypotheses concerning Byzantine monastic diet in the region (e.g. Hirschfeld 1990, 1992) may have to be amended to take into account this new data. Perhaps the documentary sources, and archaeologists considering these, have previously over-stressed the asceticism of the monastic way of life (simple vegetarian diet, retreat to the desert, etc.). The overall analysis of the faunal assemblages from Deir 'Ain 'Abata suggests that the residents of the monastery were more like their counterparts in the Egyptian monasteries where, according to documentary sources, both meat and fish were occasionally eaten (Dembinska 1985). The system of food procurement during the Byzantine period was probably very complex. Clearly interactions were taking place at different levels. Whilst some goods were being traded over long distances (e.g. the fish), others were only traded shorter distances from local rural communities.

Future work might profitably concentrate on understanding some of these smaller, more rural, Byzantine sites of lower status. Too much research in the past has concentrated on churches and prestigious buildings such as forts. Importation of joints of meat to sites clearly means that there has to be a producer somewhere who is supplying the market. One must also consider the factor of the site being an important pilgrim site. Visiting pilgrims may have brought gifts of food to the monastery. Certainly the organised preparation of food to feed all the visitors to the monastery would have formed a regular component of daily life at Deir 'Ain 'Abata.

Finally, the lack of any clear break or change in the economy of the site once the Byzantine period is over and the Umayyad, then Abbasid periods arrive, is very interesting. It appears to confirm the general picture emerging from other archaeological sources that, in many places, there was subsequently a smooth transition. The Umayyads, it appears, left the peasantry to continue to farm the fertile countryside (King 1992: 373).

The periods and dates for all the phases are presented in Table 1 and are the same in all the following tables.

Table 1: Quantification of the mammalian fauna from Deir 'Ain 'Abata
N.B.: based on uncorrected NISP totals of diagnostic fragments (see methods section above)

Phase	I	II	II–III	III	IVa	IVa–b	IVb	IVb–V	V	Total
Period	Early Bronze I	Mid Bronze II	Early/Mid Bronze I–II	Nabataean	Early Byzantine	Early Byzantine	Early Byzantine	Early Byzantine/Early Abbasid	Early Abbasid	
Date	3300–3000 BC	2000–1500 BC	3300–1500 BC	1 st c. BC–1 st c. AD	5 th –6 th c. AD	5 th –early 7 th c. AD	early 7 th c. AD	early 7 th –early 9 th c. AD	mid 8 th –early 9 th c. AD	
Sheep/Goat (<i>Ovis/Capra</i>)		16	1	5	2295	1391	604.5	338.5	360.5	5011.5
Sheep (<i>Ovis aries</i>)	1	5			443	120	113	56	42	780.0
Goat (<i>Capra hircus</i>)					167	53	26	19	9	274.0
Pig (<i>Sus domesticus</i>)				4	231	234	90	55	24	638.0
Cattle (<i>Bos taurus</i>)					31	12	18	7	4	72.0
Dog (<i>Canis familiaris</i>)							4			4.0
Equid (<i>Equus</i> sp.)					1		1		1	3.0
Camel (<i>Camelus dromedarius</i>)									1	1.0
Fallow Deer (<i>Dama mesopotamica</i>)					15	1				16.0
Gazelle (<i>Gazella</i> sp.)					1	5			1	7.0
Fox (<i>Vulpes vulpes</i>)					1					1.0
Hare (<i>Lepus capensis</i>)				1			6		1	8.0
Black Rat (<i>Rattus rattus</i>)							4	2		6.0
Spiny-tailed Mouse (<i>Acomys</i> sp.)							5		2	7.0
Short-tailed Bandicoot Rat (<i>Nesokia indica</i>)						1		1		2.0
Unidentified rodent	1	1		1		1	58	29	14	105.0
Total	2	22	1	11	3185	1818	929.5	507.5	459.5	6935.5

Table 2: Degree of fragmentation of the mammal bones at Deir 'Ain 'Abata
N.B.: based on uncorrected NISP totals of diagnostic fragments (see methods section above)

Phase	I	II	II–III	III	IVa	IVa–b	IVb	IVb–V	V	Total
Complete		4			1371	570	305	192	121	2563
More than half complete		6		4	39	173	141	25	55	443
Half complete		2		1	4	54	43	4	14	122
Less than half complete	2	10	1	6	1771	1021	440.5	286.5	269.5	3807.5
Total	2	22	1	11	3185	1818	929.5	507.5	459.5	6935.5

Table 3: Quantification of the mammalian fauna from different excavation areas at Deir ‘Ain ‘Abata.
N.B.: based on uncorrected NISP totals of diagnostic fragments (see methods section above).

Phase	I	II		II–III		III	IVa			IVa–b			IVb			IVb–V				V				Total						
		F	F	J	F		F	A	B	F	H	K	M	A	F	H	K	A	F	H	K	M								
Area																														
Sheep/Goat (<i>Ovis/Capra</i>)				16	1	5	7	2264.5	9	13.5	1	1391	31	6	517.5	50	265	3	30	40.5	1	32	205	36.5	86	5011.5				
Sheep (<i>Ovis aries</i>)	1		5				1	437		5		120	16	1	92	4	47		6	3		3	21	6	12	780				
Goat (<i>Capra hircus</i>)								167				53	6		17	3	17		1	1		1	5	2	1	274				
Pig (<i>Sus domesticus</i>)						4		227	3		1	234	5	1	78	6	37	1	15	2		5	11	3	5	638				
Cattle (<i>Bos taurus</i>)								31				12			16	2	5			2			1	1	2	72				
Dog (<i>Canis familiaris</i>)															4											4				
Equid (<i>Equus</i> sp.)									1					1								1				3				
Camel (<i>Camelus dromedarius</i>)																								1		1				
Fallow Deer (<i>Dama mesopotamica</i>)								15				1														16				
Gazelle (<i>Gazella</i> sp.)								1				5											1			7				
Fox (<i>Vulpes vulpes</i>)								1																		1				
Hare (<i>Lepus capensis</i>)						1									6							1				8				
Black Rat (<i>Rattus rattus</i>)														1	3					2						6				
Spiny-tailed Mouse (<i>Acomys</i> sp.)														4	1								2			7				
Short-tailed Bandicoot Rat (<i>Nesokia indica</i>)												1								1						2				
Unidentified rodent	1	1				1						1		27		31		3								105				
Total	2	1	21	1	11	2	8	3143.5	13	19	2	1818	58	47	725	100	371	7	52	77.5	1	52	246	54.5	106	6935.5				

Table 4: Preservation of the mammal bones at Deir 'Ain 'Abata
N.B.: based on uncorrected NISP totals of diagnostic fragments (see methods section above)

Phase	I	II	II–III	III	IVa	IVa–b	IVb	IVb–V	V	Total
Burnt	1	16	1	5	3064.5	597.5	116	396.5	125	4322.5
Burnt and carnivore gnawed					11			1	3	15
Burnt and rodent gnawed				2		1	1	3	2	9
Carnivore gnawed						5	10		4	19
Rodent gnawed					1			1		2
None recorded	1	6		4	108.5	1214.5	802.5	106	325.5	2568
Total	2	22	1	11	3185	1818	929.5	507.5	459.5	6935.5

Table 5: Type of butchery marks to the major species at Deir 'Ain 'Abata
N.B.: based on uncorrected NISP totals of diagnostic fragments (see methods section above)

Phase		I	II	II–III	III	IVa	IVa–b	IVb	IVb–V	V	Total
Cattle	None					24	12	13	6	2	57
	Cut					3		1			4
	Chop					4		4	1	2	11
	% Cut/Chop	0	0	0	0	22.6	0	27.8	14.3	50	
Sheep/Goat	None	1	21	1	4	2647	1483	711.5	383.5	396.5	5648.5
	Cut					124.5	34	8	10	6	182.5
	Chop				1	126.5	43	24	20	9	223.5
	Cut & Chop					7	4				11
	% Cut/Chop	0	0	0	20	8.9	5.2	4.3	7.3	3.6	
Pig	None				4	210	224	86	52	23	599
	Cut					9	8	1	1	1	20
	Chop					10	3	3	2		18
	Cut and Chop						1				1
	% Cut/Chop	0	0	0	0	8.3	5.1	4.4	5.4	4.2	
Fallow Deer	None					8	1				9
	Cut					1					1
	Chop					6					6
	% Cut/Chop	0	0	0	0	46.7	0	0	0	0	

Table 6: Identification of Sheep/Goat at Deir 'Ain 'Abata using the biometric method of Boessneck (1969) on ovicaprid metacarpals (measurement A / measurement B × 100)
N.B.: Boessneck (1969, 355) states that the index for sheep was always over 63 in Ovis and was usually equal or less than 63 for Capra

Phase \ Measurement	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
IVa	1		1	2		1	1		2	2	2	3	2	1			1
IVa–b		1		2					1	3	3	2	2		1	1	
IVb			1				1						1	2		1	
V			1									1		1			

Table 7: Sheep/Goat anatomical representation at Deir ‘Ain ‘Abata

N.B.: based on corrected NISP counts

** = count divided by two, *** = count divided by three, **** = count divided by four. See methods section above for explanation

Phase	I	II	II–III	III	IVa	IVa–b	IVb	IVb–V	V	Total
Horncore					54	34	50	22	13	173
Occipital condyle					53	16	10	15	13	107
Maxilla					35	14	35	20	4	108
Mandible				1	110	62	69	34	19	295
Deciduous incisor ***						2.7	0.67		1	4.37
4 th deciduous premolar					2	13	9		3	27
Adult incisor ***				0.33	0.33	54.3	8.3	2	5.3	70.56
4 th permanent premolar					29	21	23	7	11	91
3 rd permanent molar					52	22	57	15	3	149
Scapula (glenoid)		1			169	69	21	13	22	295
Humerus, proximal					122	42	4	5	6	179
Humerus, distal	1	2		2	253	113	20	11	23	425
Radius, proximal					138	84	17	31	13	283
Radius, distal		2			135	62	21	27	12	259
Ulna					73	67	6	20	10	176
Metacarpal, proximal		1		1	126	69	42	12	16	267
Metacarpal, distal					50	37	14	3	7	111
Pelvis (acetabulum)		1			2	54	46	7	25	135
Femur, proximal		1			45	32	16	13	5	112
Femur, distal			1		43	15	11	8	6	84
Tibia, proximal		1			39	26	1	7	5	79
Tibia, distal		1			74	22	18	8	6	129
Calcaneum		2			4	19	16	2	6	49
Astragalus		9			72	32	22		14	149
Metatarsal, proximal					149	42	33	30	17	271
Metatarsal, distal					120	34	13	27	18	212
Metapodial, proximal **					3					3
Metapodial, distal **					50.5	23.5	9.25	4.75	7.25	95.25
1 st phalanx ****					91	34.5	17.25	7	12.5	162.3
2 nd phalanx ****					66.75	24.75	8.25	4	8.75	112.5
3 rd phalanx ****					59.25	28.25	6.5	4.5	4	102.5

Table 8: Sheep/Goat epiphyseal fusion at Deir 'Ain 'Abata
N.B.: based on uncorrected NISP totals of diagnostic fragments (see methods section). Percentage of unfused includes newborns.
Fus = Fused, New = Newborn, Unf = Unfused, cum % = cumulative percentage of unfused bones
P = Proximal, D = Distal

Phase	IVa			IVa–b			IVb			IVb–V			V		
6–10 months	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf
Scapula	146		11	48		17	20		1	11		2	18		1
D. Humerus	196	6	46	59		15	17		2	11			19		3
P. Radius	129	4	5	61		7	17			26	1	2	12		
Pelvis				44	3	4	32		2	3			24		
	cum % 13.3			cum % 17.8			cum % 5.5			cum % 8.9			cum % 5.2		
13–28 months	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf
D. Metacarpus	35		12	21		14	10		4	2		1	3		3
D. Tibia	39		33	10		7	15		3	4		4	4		2
D. Metatarsus	79		37	27	1	7	10		3	18		9	14		4
D. Metapodial	12		74	11		34.5	9		9.5			9.5	1		13.5
P. Phalanx 1	265		65	97		41	53		16	22		6	37		13
P. Phalanx 2	232		32	80		19	31		2	16			31		4
	cum % 22.3			cum % 27.0			cum % 16.6			cum % 23.4			cum % 21.1		
30–36 months	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf
P. Ulna	33		38	10		23	3		2	7		13	2		3
P. Femur	17		25	6		23	5		11	2		11	3		2
P. Calcaneum	2		2	5		13	6		9			2	2		2
	cum % 24.8			cum % 32.3			cum % 22.1			cum % 33.2			cum % 22.9		
36–42 months	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf
P. Humerus	22	6	88	3		32	1		3	1		4	1		5
D. Radius	35	4	96	10		46	6		15	8	1	18	1		11
D. Femur	7		29			10	6		5	4		3	1		2
P. Tibia	10		25	4		14			1	1		3	1		4
	cum % 33.6			cum % 40.0			cum % 26.9			cum % 39.7			cum % 29.4		

Table 9: Sheep/Goat tooth eruption/wear at Deir 'Ain 'Abata
N.B.: based on mandibles with two or more recordable wear stages plus proportionally allocated loose mandibular teeth (dP4, P4 and M3)
* = for explanation of codes see Payne (1987)

Payne stage	Definition	Phase Suggested Age	IVa	IVa–b	IVb	IVb–V	V
A	dP4 still unworn	0–2 months	0	2	0	0	0
B	dP4 in wear, M1 unworn	2–6 months	0.5	3	1	1	2
C	M1 in wear, M2 unworn	6–12 months	5	5.5	4.5	0.5	0
D	M2 in wear, M3 unworn	1–2 years	20	15	10.5	1.5	3
E	M3 in wear, posterior cusp unworn	2–3 years	27	20.1	32.7	7.6	6.5
F	posterior cusp of M3 in wear, M3 pre-”11G” *	3–4 years	31.5	5.6	25.7	8.6	10.5
G	M3 = “11G”, M2 = “9A” *	4–6 years	27.8	13.1	27	7.1	5.2
H	M3 = “11G”, M2 post-”9A” *	6–8 years	19.8	12.8	21.9	4.4	4.7
I	M3 post-”11G” *	8–10 years	3.3	5.8	8.4	0.4	3.7
Total			134.9	82.9	131.7	31.1	35.6

Table 10: Sheep/Goat sex data at Deir 'Ain 'Abata
N.B.: based on morphological criteria of pelvis described by Boessneck et al. (1964)

Element	Phase	IVa	IVa-b	IVb	IVb-V	V	Total
Pelvis	Male	2	13	10	1	1	27
	Female		7	4		1	12

Table 11: Sheep/Goat measurement data at Deir 'Ain 'Abata

Scapula (GLP-mm)	25	26	27	28	29	30	31	32	33	34	35	36	37	38	N	Mean	Std. Dev.	Variance
IVa				2	5	2	2	4	3	7	5	7	8	2	47	34.17	2.94	8.66
IVa-b							1	2		2	3	3	2	2	15	35.56	2.08	4.33
IVb					1					1	2	3	1		8	35.14	2.55	6.50
IVb-V					1			1		1			1		4	33.53	3.55	12.63
V					1									1	2			
Humerus (BT-mm)	25	26	27	28	29	30	31	32	33	34	35	36	37	38	N	Mean	Std. Dev.	Variance
IVa				2	3	5	8	4	6	2			1	2	33	32.18	2.50	6.25
IVa-b					1	1	2	1	1						6	31.38	1.22	1.49
IVb				2		1	1			2					6	31.25	2.94	8.65
IVb-V						1			1						2			
V							1		1						2			
Radius (Bp-mm)	25	26	27	28	29	30	31	32	33	34	35	36	37	38	N	Mean	Std. Dev.	Variance
IVa				1	5	4	2	5	8	4	4	5	4		42	33.28	2.64	6.97
IVa-b	1	2	2			1	2		4	4	3	1			20	32.15	3.46	11.99
IVb				1		1			1				1		4	32.33	4.07	16.53
IVb-V						2	2		1	3	2				10	33.06	2.07	4.30
V						2	1	1			1				5	32.06	2.00	4.00
Metacarpal (Bp-mm)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	N	Mean	Std. Dev.	Variance
II	1														1			
III					1										1			
IVa			1	5	9	13	10	11	6	1					56	26.02	1.63	2.64
IVa-b			3	1	1	8	7	4		1					25	25.73	1.73	3.00
IVb	1		1	2	3	5	8	2		1					23	25.55	1.98	3.93
IVb-V		1		1	1	2	1								6	24.33	1.90	3.62
V				2		2	2	2	1						9	25.93	1.65	2.73
Metacarpal (BFd-mm)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	N	Mean	Std. Dev.	Variance
IVa							2	2	7	7	3	1			22	28.92	1.17	1.37
IVa-b						1			4						5	28.00	1.33	1.77
IVb								1	4	2		1			8	28.85	1.15	1.33
IVb-V												1			1			
Tibia (Bd-mm)	20	21	22	23	24	25	26	27	28	29	30	31	32	33	N	Mean	Std. Dev.	Variance
II								1							1			
IVa						1	3	4	3	7	5	1		1	25	28.86	1.71	2.92
IVa-b						1	3	2		1					7	26.89	1.34	1.80
IVb				1				2		1	4	1			9	28.86	2.54	6.44
IVb-V						1				1					2			
V								2	1		1				4	28.83	1.42	2.00

Table 11 continued

Astragalus (GLL–mm)	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	N	Mean	Std. Dev.	Variance
II						1			2								3	29.27	1.81	3.29
IVa				1	3	2	1	8	4	7	6	7	3				42	30.92	2.38	5.68
IVa–b	1					1	3	3	3	3	1	1	2	1			19	30.43	3.00	9.01
IVb						1	1	1	2	3	6						14	31.18	1.61	2.61
V					1					1	3					1	6	32.05	3.62	13.12
Calcaneum (GL–mm)	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	N	Mean	Std. Dev.	Variance
II							1										1			
IVa				1	1			2		1	2	2			2	1	12	61.97	3.83	14.74
IVa–b															1		1			
IVb								1	1					1			3	61.83	2.93	8.56
IVb–V	1							1									2			
V								1									1			

Metatarsal (Bp–mm)	16	17	18	19	20	21	22	23	24	25	N	Mean	Std. Dev.	Variance
IVa		2		1	10	12	20	19	5	1	70	22.21	1.45	2.09
IVa–b	1			3	6	3		7	3		23	21.72	1.95	3.80
IVb					3	4	5	5	1	1	19	22.42	1.36	1.84
IVb–V			1	1		2	2	1			7	21.39	1.64	2.69
V			1		1	1	4	1	1		9	22.04	1.83	3.35

Metatarsal (BFd–mm)	23	24	25	26	27	28	29	30	N	Mean	Std. Dev.	Variance
IVa	1	4	6	11	16	8	3		49	26.91	1.44	2.06
IVa–b		1	2	5	1	3			12	26.73	1.28	1.63
IVb			2	1	3			1	7	27.20	1.73	2.99
IVb–V	1		1	3	3				8	26.34	1.47	2.15
V				1		2			3	27.87	1.27	1.62
Phalanx 1 (Bp–mm)	10	11	12	13	14	15	16	17	N	Mean	Std. Dev.	Variance
IVa		4	49	92	62	26	2	1	236	13.68	0.95	0.90
IVa–b	3	5	20	31	24	4	1		88	13.40	1.04	1.07
IVb		5	11	10	10	2	1		39	13.38	1.27	1.61
IVb–V		1	3	5	5	2	1		17	13.73	1.17	1.36
V		1	6	13	4	3			27	13.65	0.88	0.77

Table 12: Pig anatomical representation at Deir 'Ain 'Abata

N.B.: based on corrected NISP counts

** = count divided by two, *** = count divided by three, **** = count divided by four. See methods section for explanation

Element \ Phase	I	II	II–III	III	IVa	IVa–b	IVb	IVb–V	V	Total
Occipital condyle					3	7	3	1		14
Maxilla					21	19	9	9	1	59
Mandible					23	17	15	10	5	70
Deciduous incisor ***				0.33		1.33				1.66
4 th deciduous premolar						9	4	2		15
Adult incisor ***						2.33				2.33
Lower canine						3	2			5
4 th permanent premolar						2				2
Scapula (glenoid)				1	22	17	5	3	2	50
Humerus, proximal					11	8	8	2	1	30
Humerus, distal					20	24	10	3	4	61
Radius, proximal				1	7	10	4	3		25
Radius, distal					5	7	4	2		18
Ulna					9	9	2	3	3	26
3 rd + 4 th metacarpal, proximal **					3.5	10.5	1.5	0.5		16
3 rd + 4 th metacarpal, distal **					6.5	9	1	1.5		18
Pelvis (Acetabulum)				1	1	3	2			7
Femur, proximal					4	1	6	4		15
Femur, distal					7	3	2	3		15
Tibia, proximal					7	5	9		1	22
Tibia, distal					7	13	9	2	3	34
Calcaneum						4	3		2	9
Astragalus					4	1	2	1	1	9
3 rd + 4 th metatarsal, proximal **					1	3	1.5	1		6.5
3 rd + 4 th metatarsal, distal **					2.5	1	0.5	1.5		5.5
Metapodial, proximal ****										0
Metapodial, distal ****					3.25	1.5		0.25		5
1 st phalanx ****					6.25	4.5	0.25	0.25		11.25
2 nd phalanx ****					4	3.25	0.75	0.25	0.25	8.5
3 rd phalanx ****					3.75	2.75	0.5	0.5	0.25	7.75

Table 13: Pig epiphyseal fusion at Deir 'Ain 'Abata

N.B.: based on uncorrected NISP totals of diagnostic fragments (see methods section)
Fus = fused, New = newborn, Unf = unfused, cum % = cumulative percentage of unfused bones, P = Proximal, D. = Distal
Percentage of unfused includes newborns.

Phase	IVa			IVa–b			IVb			IVb–V			V		
0–12 months	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf
Scapula	6		16	3	1	13		2	3		2	1		1	1
D. Humerus	8	5	6		4	18	1	6	3		1	2	1	2	1
P. Radius	4	3		3	1	6	1	2	1	1	1	1			
Pelvis	1					3	1		1						
	cum % 61.2			cum % 88.5			cum % 85.7			cum % 88.9			cum % 83.3		
24 months	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf
D. Tibia	1		6	1	1	11		7	2			2			3
D. Metacarpal	1		6		3	15	2					2			
D. Metatarsal			3			2			1			2			
D. Metapodial			13	1		5						1			
P. Phalanx 1	14		10	1		17	1					1			
P. Phalanx 2	13		3	5		8	1		2	1			1		
	cum % 59.7			cum % 88.5			cum % 81.1			cum % 88.9			cum % 80.0		
24–30 months	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf
P. Calcaneum						4			3						1
	cum % 59.7			cum % 88.9			cum % 82.5			cum % 88.9			cum % 81.8		
36–42 months	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf	Fus	New	Unf
P. Humerus		5	6		4	4		6	2		1	1			1
D. Radius		3			1	6		2	2		2				
P. Ulna		3	6			8		2			1	2			2
P. Femur			2		1			3	3		1	3			
D. Femur			7		1	1		2	1		1	1			
P. Tibia			6		1	2		7	2						1
	cum % 69.4			cum % 91.0			cum % 90.3			cum % 93.5			cum % 86.7		

Table 14: Pig tooth eruption/wear at Deir 'Ain 'Abata

N.B.: based on mandibles with two or more recordable wear stages plus proportionally allocated loose mandibular teeth (dP4, P4 and M3)
* = age class definition adapted from Bull and Payne (1982), wear stage codes from Grant (1975)

Age class	Definition	Phase	IVa	IVa–b	IVb	IVb–V	V
		Suggested Age					
A	dP4 unworn	few weeks	2	6	3	1	
B	dP4 in wear, M1 unworn	up to 8 weeks	5	10	7	1	1
C	M1 in wear, P4 unworn	9–14 months	2	1	1	1	
D	M2 in wear, P4 unworn	15–18 months					
E	P4 in wear, M3 unworn	19–26 months		1			
F	M3 in early wear (“a–b”) *	27–36 months					
G	M1 heavily worn (“j–n”), M3 in moderate wear (“c+”) *	36 months					
Total			9	18	11	3	1

Table 15: Pig sex data at Deir ‘Ain ‘Abata

Element	Phase	IVa	IVa–b	IVb	IVb–V	V	Total
Maxilla	Male		1				1
Mandible	Male			2			2
	Female			1			1
Canine	Male			1			1
	Female		3	1			4
Total Male		0	1	3	0	0	4
Total Female		0	3	2	0	0	5

Table 16: Pig measurement data at Deir ‘Ain ‘Abata

Phase	Area	Locus	Element	GLP	BG	SLC	Bd	BT	Bp	SD	Dd	GLl	GLm	GL	Notes
III	F.3	5.2	Scapula			6.8									Immature
IVa	B.1	10.1	Scapula	38.4	23.0	20.9									
IVa	B.1	18.2	Scapula	32.7	22.3										
IVa	B.1	18.2	Scapula	32.7	22.3										
IVa–b	M.2	5.11	Scapula			9.8									
IVa–b	M.2	5.15	Scapula			8.8									
IVa–b	M.2	5.15	Scapula			9.8									
IVa–b	M.2	5.2	Scapula			10.4									
IVa–b	M.2	5.2	Scapula			13.5									
IVa–b	M.2	5.9	Scapula			11.7									
IVa–b	M.2	5.9	Scapula			11.3									
IVa–b	M.2	13.4	Scapula	31.5	21.9	20.2									
IVb	H.2	7.1	Scapula			14.3									
IVb–V	H.2	12.1	Scapula			12.0									
IVb–V	K.2	20.2	Scapula			13.1									
V	F.3	6.1	Scapula			9.0									
IVa	B.1	5.1	Humerus				36.4								
IVa	B.1	6.1	Humerus				37.1								
IVa	B.1	6.1	Humerus				39.0	33.6							
IVa	B.1	6.1	Humerus				39.0	33.6							
IVa	B.1	6.1	Humerus					37.1							
IVa	B.1	9.1	Humerus				37.5								
IVa	B.1	18.3	Humerus					32.3							
IVa	B.1	10.1	Radius						26.7	0.0					0
IVa	B.1	18.5	Radius						24.7	0.0					0
IVa	B.1	18.5	Radius						27.1	0.0					0
IVa–b	M.2	5.2	Radius						26.5	0.0					0
IVa–b	M.2	5.18	Radius						26.3	0.0					0
IVb	H.2	14.1	Radius						0.0	7.4					Immature
IVb–V	A.1	4.2	Radius						25.5	0.0					0
IVb–V	H.2	10.3	Radius						0.0	4.6					Neonatal
IVa	B.1	17.4	Tibia					28.2			25.2				
V	H.2	6.3	Tibia							7.2					Immature

Table 16 continued

Phase	Area	Locus	Element	GLP	BG	SLC	Bd	BT	Bp	SD	Dd	GLI	GLm	GL	Notes
IVa	B.1	18.1	Astragalus				19.8					36.8	34.5		
IVa	B.1	18.1	Astragalus				24.3					40.7	38.0		
IVa–b	M.2	5.6	Astragalus				20.2					36.0	34.0		
IVb	H.2	7.1	Astragalus				18.5					33.9			
IVb/V	H.2	10.2	Astragalus									39.1			
IVa	B.1	8.1	1 st phalanx						15.9	11.5				32.8	
IVa	B.1	17.7	1 st phalanx						15.2	12.7				33.1	
IVa	B.1	17.8	1 st phalanx						15.0	11.8				30.4	
IVa	B.1	18.1	1 st phalanx						17.1	13.5				38.5	
IVa	B.1	18.3	1 st phalanx						14.8	11.4				33.9	
IVa	B.1	18.5	1 st phalanx						15.6	12.3				33.8	
IVa–b	M.2	5.13	1 st phalanx						14.0						

Table 17: Cattle anatomical representation at Deir ‘Ain ‘Abata

N.B.: based on corrected NISP counts
** = count divided by two, *** = count divided by three, **** = count divided by four. See methods section for explanation

Element \ Phase	I	II	II–III	III	IVa	IVa–b	IVb	IVb–V	V	Total
Maxilla					1					1
Mandible						2				2
Adult incisor ***					0.33	0.67	0.33			1.33
4 th permanent premolar						1				1
3 rd permanent molar						1				1
Scapula (glenoid)							1		1	2
Humerus, proximal										0
Humerus, distal										0
Radius, proximal							1			1
Radius, distal					1					1
Ulna					1		1			2
Metacarpal, proximal					3		2			5
Metacarpal, distal							1			1
Pelvis (acetabulum)										
Femur, proximal							1	1		2
Femur, distal					1	1				2
Tibia, proximal									1	1
Tibia, distal					1	1	1			3
Calcaneum							1			1
Astragalus						2	1			3
Metatarsal, proximal					1		2	1		4
Metatarsal, distal					3	1	3	1		8
Metapodial, proximal **					0.5				1	1.5
Metapodial, distal **								0.5		0.5
1 st phalanx****					1.5		0.25	0.25		2
2 nd phalanx ****					1.5		0.25	0.5		2.25
3 rd phalanx ****					1.25	0.25	0.25			1.75

Table 18: Cattle epiphyseal fusion at Deir 'Ain 'Abata
N.B.: based on uncorrected NISP totals of diagnostic fragments (see methods section)
Fus = fused, Unf = unfused. cum % = cumulative percentage of unfused bones, P = proximal, D. = distal

Element \ Phase	IVa		IVa-b		IVb		IVb-V		V	
	Fus	Unf	Fus	Unf	Fus	Unf	Fus	Unf	Fus	Unf
7-18 months										
Scapula					1				1	
D. Humerus										
P. Radius					1					
Pelvis										
P. 1 st phalanx	1	4			1			1		
P. 2 nd phalanx		6			1			2		
	cum % 90.9		cum % 0.0		cum % 0.0		cum % 100.0		cum % 0.0	
24-36 months	Fus	Unf	Fus	Unf	Fus	Unf	Fus	Unf	Fus	Unf
D. Metacarpus					1					
D. Tibia		1		1		1				
D. Metatarsus		1		1	2	1		1		
D. Metapodium								1	1	1
	cum % 92.3		cum % 100.0		cum % 22.2		cum % 100.0		cum % 33.3	
36-42 months	Fus	Unf	Fus	Unf	Fus	Unf	Fus	Unf	Fus	Unf
P. Calcaneum						1				
	cum %	92.3	cum %	100.0	cum %	30.0	cum %	100.0	cum %	33.3
42-48 months	Fus	Unf	Fus	Unf	Fus	Unf	Fus	Unf	Fus	Unf
P. Humerus										
D. Radius		1								
P. Ulna		1								
P. Femur					1			1		
D. Femur				1						
P. Tibia										
	cum % 93.3		cum % 100.0		cum % 27.3		cum % 100.0		cum % 33.3	

Table 19: Cattle measurement data at Deir 'Ain 'Abata

Phase	Area	Locus	Element	GL	Bp	SD
IVa	B.1	9.1	Metacarpal		46.8	
IVa	B.1	10.1	Metacarpal		47.3	
IVb	H.2	14.4	Metatarsal			24.6
IVa	B.1	10.1	1 st phalanx	63.7	28.6	22.4

Table 20: Anatomical representation of other mammal species at Deir ‘Ain ‘Abata

N.B.: based on corrected NISP counts
** = count divided by two, **** = count divided by four
See methods section for explanation

Taxon	Phase		I	II	II–III	III	IVa	IVa–b	IVb	IVb–V	V	Total
	Element											
Dog	Occipital condyle								1			1
	Humerus, proximal								1			1
	Humerus, distal								1			1
	Pelvis (acetabulum)								1			1
	Femur, proximal								1			1
	Femur, distal								1			1
Equid	Permanent premolar						1					1
	3 rd permanent molar								1			1
	Metacarpal, proximal										1	1
	Metacarpal, distal											0
Camel	Metacarpal, proximal										1	1
	Metacarpal, distal											0
Fallow Deer	Scapula (glenoid)						9					9
	Humerus, proximal											0
	Humerus, distal						5					5
	Radius, proximal							1				1
	Radius, distal											0
	Astragalus						1					1
Gazelle	Humerus, proximal											0
	Humerus, distal						1					1
	Metatarsal, proximal											0
	Metatarsal, distal							3			1	4
	2 nd phalanx ****							0.5				0.5
Fox	Mandible						1					1
Hare	Humerus, proximal											0
	Humerus, distal								3			3
	Femur, proximal					1			1		1	3
	Femur, distal								1			1
	Tibia, proximal								1			1
	Tibia, distal											0
	4 th metatarsal, proximal **								0.25			0.25
	4 th metatarsal, distal **								0.25			0.25

Table 21: Fallow deer (Dama mesopotamica) measurement data at Deir ‘Ain ‘Abata

Phase	Area	Locus	Element	GLP (mm)	BG (mm)	Bd (mm)	BT (mm)
IVa	B.I	18.1	scapula		26.2		
IVa	B.I	18.5	scapula		24.0		
IVa	B.I	19.8	scapula	39.8	25.2		
IVa	B.I	18.5	scapula		24.7		
IVa	B.I	19.1	humerus				30.4
IVa	B.I	18.12	humerus				31.0
IVa	B.I	19.4	astragalus			20.0	

Table 22: *Gazelle* (*Gazella sp.*) measurement data at Deir 'Ain 'Abata

Phase	Area	Locus	Element	BFd (mm)
IVa–b	M.II	5.6	metatarsal	23.1
IVa–b	M.II	5.18	metatarsal	21.6
IVa–b	M.V	7.1	metatarsal	21.5
V	M.V	6.3	metatarsal	22.1

Table 23: Anatomical representation of small mammal species at Deir 'Ain 'Abata

Taxon			I	II	II–III	III	IVa	IVa–b	IVb	IVb–V	V	Total
	Phase	Element										
Black Rat		Mandible							2	2		4
Spiny-tailed Mouse		Maxilla							1			1
		Mandible							4		2	6
Short-tailed Bandicoot Rat		Maxilla								1		1
		Mandible						1				1
Unidentified rodent		Maxilla							1			1
		Mandible				1			5	5		11
		Adult Incisor							3	3	1	7
		Scapula (glenoid)							1			1
		Humerus, proximal							5	4		9
		Humerus, distal	1	1					3	5	1	11
		Radius, proximal							1			1
		Radius, distal							1			1
		Ulna							1	1	1	3
		Pelvis (acetabulum)							9	3	2	14
		Femur, proximal						1	18	6	5	30
		Femur, distal						1	17	5	3	26
		Tibia, proximal							13	6	1	20
		Tibia, distal							14	6	3	23

Table 24: *Black rat* (*Rattus rattus*) measurement data at Deir 'Ain 'Abata

Phase	Area	Locus	Mandible length (mm)	Tooth row length (mm)
IVb–V	K.II	19.1		6.3
IVb	K.II	28.5	22.0	6.0
IVb	K.II	28.6	19.5	6.2

Table 25: *Spiny-tailed mouse* (*Acomys sp.*) measurement data at Deir 'Ain 'Abata

Phase	Area	Locus	Mandible length (mm)	Tooth row length (mm)
IVb	F.III	25.3	17.0	
IVb	F.III	25.3	17.0	
IVb	F.III	25.3	14.0	4.4
IVb	F.III	25.5	20.0	4.5
V	H.II	6.2	18.0	
V	H.II	6.2	16.1	4.8

Table 26: A comparison of Iron Age, Roman, Byzantine and Early Islamic faunal assemblages from the region

Explanation of codes: N = total number of fragments, S/G = sheep/goat (Ovis aries/Capra hircus), P = pig (Sus domesticus/scrofa*), C = cattle (Bos taurus), CA = camel (Camelus dromedarius), HO = horse (Equus caballus), AS = donkey (Equus asinus), D = dog (Canis familiaris), C = cat (Felis sp.), FD = fallow deer (Dama mesopotamica), RD = roe deer (Capreolus capreolus), G = gazelle (Gazelle sp.), B = badger (Meles meles), F = fox (Vulpes sp.), M = mustelid (Mustelidae), H = cape hare (Lepus capensis)
P = present, F = few, FF = frequent, FFF = very frequent

Code	Site Name	Date	N	S/G	P	C	CA	HO	EQ	AS	D	C	FD	RD	G	B	F	M	H	Reference
1	Bab-el-Hawa	Iron Age	350	214	6*	87		P		P			5	33	5					Raphael & Lernaü 1996
2	Bab-el-Hawa	Byzantine (4 th –7 th c. AD)	3200	2147	213*	496		56		136	65		12	30	43	1		1		Raphael & Lernaü 1996
3	Beersheba	Iron Age	1228	1010	3	164				24	13		8		6					Hellwing 1984
4	Bet She'an	Byzantine	?	FFF	F	FF	P		P		P				P					Manor et al. 1996
5	Bet She'an	Late Byzantine–Early Islamic	?	FFF	FF	F	F		F		P		?P							Manor et al. 1996
6	Bet She'an	Umayyad	?	FFF	FF	F	P		P		?FF									Manor et al. 1996
7	Deir 'Ain 'Abata	Early Byzantine - Phase IVa	3185	2905	231	31			1				15		1		1			Beech & Prance, this vol.
8	Deir 'Ain 'Abata	Early Byzantine - Phase IVa–b	1816	1564	234	12							1		5					Beech & Prance, this vol.
9	Deir 'Ain 'Abata	Early Byzantine - Phase IVb	863	744	90	18			1		4							6		Beech & Prance, this vol.
10	Deir 'Ain 'Abata	Early Byzantine/Early Abbasid Phase IVb–V	476	414	55	7														Beech & Prance, this vol.
11	Deir 'Ain 'Abata	Early Abbasid - Phase V	444	412	24	4	1		1						1				1	Beech & Prance, this vol.
12	El-Lejjun	Early Byzantine (late 4 th –early 6 th c. AD)	78	74		2	1				1									Toplyn 1987
13	El-Lejjun	Late Byzantine (early–mid 6 th c. AD)	73	40	3	22	1		1	5	1									Toplyn 1987
	En Boqeq	Late Roman/Byzantine	?	FFF	FF	F														Gichon 1993
14	Hirbet el-Msas	Iron Age	619	441	1	137				14	5		11		10					Tchernov & Drori 1983
15	Jemmeh	Late Roman/Byzantine	23	19		4														Wapnish & Hesse 1979
16	Kh. Faris	Iron Age–Early Islamic	314	205	2	85	10		3	1	3	5								Rielly, 1989
17	Mons Claudianus	Early/Mid Roman (late 1 st –mid 3 rd c. AD)	5471	477	1405	6	424		2897		150	7			16		85	4		Hamilton-Dyer, 2001
18	Nahal Mitnan	Early Islamic	46	45		1														Horwitz 1995
19	Pella (Tell al-Husn)	Late Hellenistic/Early Roman (Area XXXIV)	276	202	14	56			1	2					1					Rielly 1993
20	Pella (Tell al-Husn)	Byzantine (Area XXXIV)	1507	1049	150	234	12		23	19	11		4		5					Rielly 1993
21	Pella (Wadi al-Khandaq)	Abbasid (late 8 th –9 th c. AD) (Area XXXIX)	869	711	5	125	1		2	8	12	2	1		2					Rielly 1993
22	Umm Qais	Hellenistic (Area 40)	352	169	69	102	2		3						7					Rielly, forthcoming
23	Umm Qais	Early Roman (Area 44, all)	445	211	132	65	1		29		1				6					Rielly, forthcoming
24	Umm Qais	Late Roman (Area 41, 2)	840	61	732	40			4		3									Rielly, forthcoming
25	Umm Qais	Late Roman/Byzantine (Area 44, all)	591	200	178	147	8		26		1	3								Rielly, forthcoming
26	Upper Zohar	Early Byzantine	5624	4583	671	64	248		14		2		1		31				10	Clark 1995

V.14b THE FISH BONES

Mark Beech and Claire Prance

The aim of the analysis of fish vertebrate remains from Deir 'Ain 'Abata was to examine the exploitation and role of fish within a Byzantine monastic community in Palestine and included identifying the origin of the fish. Also, were the fish freshwater species caught locally, or did they represent imported marine species from the Mediterranean or Red Seas? Did the skeletal parts of fish found suggest anything about how they might have arrived at the site, and how they were subsequently processed for consumption? Did biometric data reconstructing the original lengths of the ancient fish suggest that particular sizes were deliberately targeted or selected at their source?

The Deir 'Ain 'Abata fish bone assemblage represents the richest and largest assemblage so far analysed from this region and thus provides a unique insight into the importance of fish as a significant resource in Byzantine monastic life.

Material and Methods

All excavated loci were dry sieved on site during the excavation using 5 mm gauge mesh sieves. This enabled a good and consistent level of recovery of fish bones throughout all excavated deposits.

Identifications were made using the comparative osteological reference collections of modern Arabian Gulf fish and of north-west European marine and freshwater fish species, both held at the University of York. A third, private collection, was also briefly consulted in Jerusalem.

The method used for recording the bones was a modification of Leach (1986). Nine diagnostic elements were recorded: the maxilla, premaxilla, dentary and articular, which are all paired bones and form the jaws of the fish; the hyomandibular, quadrate and post-temporal, again all paired bones which form a set at the rear of the neurocranium and attach the head elements to the axial skeleton. Further elements which were counted included the distinctive pharyngeal elements of parrotfish (*Scaridae*), the paired upper pharyngeals as well as the single, broader lower pharyngeal. These nine diagnostic elements were selected because they generally survive well, are distinctive and are easily recognisable. For the majority of elements these differences were pronounced enough to enable distinction between different families of fish. Vertebrae were recorded as being abdominal or caudal. It was often more difficult to identify these, particularly for some of the perciform fish.

The identification of each fragment was determined by a thorough comparison of all of the visible morphological characteristics such as ridging, articular surface shapes and

the angles of certain parts of each element. Only when a convincing match was found between archaeological and comparative material was the taxonomic group of the fragment recorded. If, after this process, a match could not be found, the fragment was recorded as being unidentified. Most fragments were only recorded to the level of family, largely because the reference collections being used were not complete enough to cover all possible genera and species occurring in the region. In the case of the parrotfish family (*Scaridae*), it appeared that several genera were present based on comparisons made with the excellent illustrations and morphological descriptions provided in Bellwood (1994). For other important families, however, morphological criteria could not generally be used beyond the level of family or genus. Taxonomic descriptions follow Fishbase98 (Froese and Pauly 1998), except where published identifications differ, in which case they are retained in their original format.

Diagnostic elements were recorded using a diagnostic zone approach, using a modified version of the system suggested by Barrett (1995). Each of the diagnostic elements had up to five diagnostic zones. For hyomandibular fragments and parrotfish pharyngeals further suitable zones were established (Figs 835 and 836). For each element one of the zones was determined as being the most characteristic; generally these were the articular surfaces. These important zones are marked on each of the diagnostic zone diagrams with arrows. An element fragment was only recorded if 50% of this specific zone was present. Although this meant that a number of fragments ended up not being recorded, it ensured that no element was recorded twice.

The completeness of each fragment was recorded by making a rough estimate of the percentage present as being 20, 40, 60, 80 or 100% complete. The texture of all fragments was categorised as either 'poor' if the fragment was very flaky and crumbled easily when handled, 'medium' if the fragment had a dulled but more solid appearance, and 'good' if the bone was quite shiny and not in the least crumbly. The presence of burning was noted for all fragments, which were also examined for traces of either rodent or carnivore gnawing marks. Butchery was noted as being absent or present with knife cutmarks, chop marks, or both knife and chop marks.

Size estimations were carried out by comparing the archaeological bone fragments with their respective counterparts in the modern reference collection, for which original total length measurements are known. The following size group categories were used: 'tiny' (0–

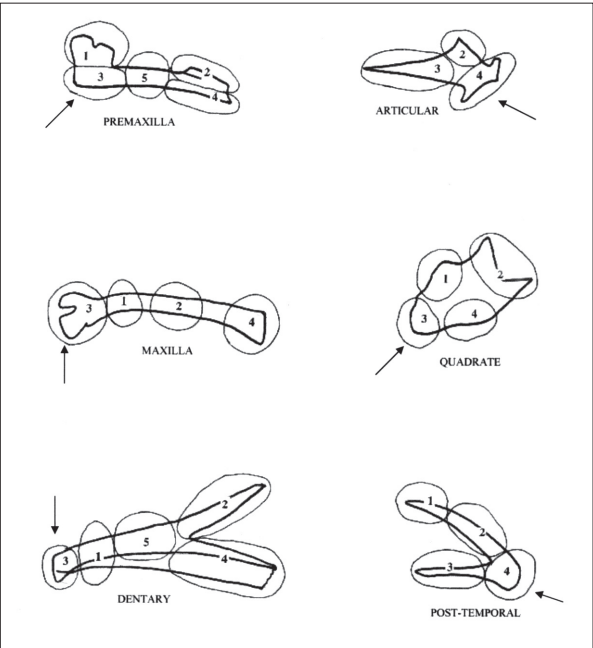


Figure 835: Diagnostic elements showing the zones recorded (after Barrett 1995). Arrows mark the key zone which had to be more than 50% complete for the element to be recorded. In the case of the articular, quadrate and post-temporal these zones were utilised for all fish families. In the case of the dentary, maxilla and premaxilla, these were used for all families except for parrotfish (Scaridae) and emperors (Lethrinidae), see Fig. 836

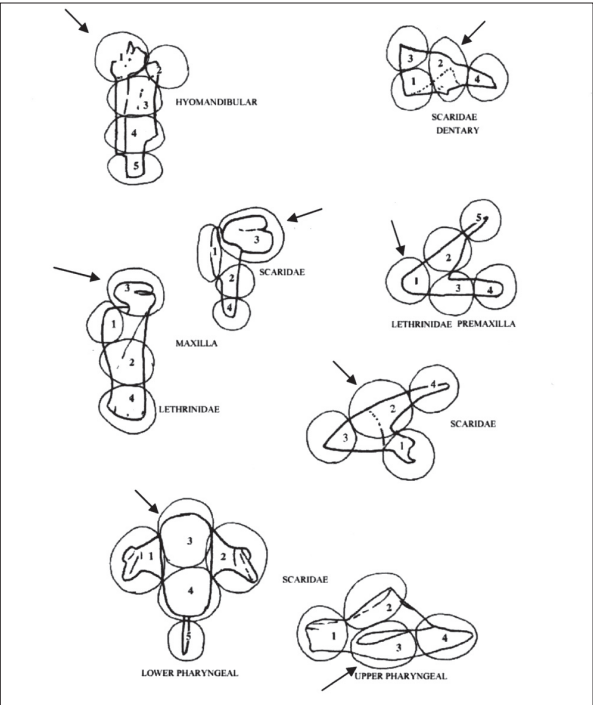


Figure 836: Diagnostic elements showing the zones recorded for emperors (Lethrinidae) and parrotfish (Scaridae). Arrows mark the key zone(s) which had to be more than 50% complete for the element to be recorded. The hyomandibular zones were utilised for all fish families

15 cm), 'small' (15–30 cm), 'medium' (30–50 cm), 'large' (50–80 cm) and 'extra large' (80–100 cm).

Measurements were also taken on grouper (*Serranidae*) dentaries, premaxillae and quadrates, following those

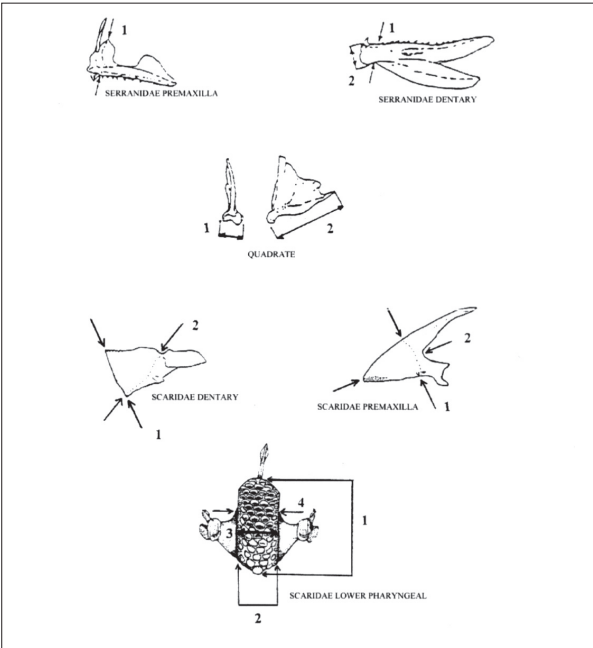


Figure 837: Bone measurement taken on grouper (*Serranidae*) elements (after Desse and Desse-Berset 1996a)
- premaxilla, dentary and quadrate (top)
Bone measurements taken on parrotfish (*Scaridae*) elements (after Beech 1997)
- premaxilla, dentary and lower pharyngeal (bottom)

defined by Desse and Desse-Berset (1996) (Fig. 837). A number of bone measurements were also taken on parrotfish dentaries, premaxillae and lower pharyngeals (Fig. 837), following those defined by Beech (1997). In the case of dentary measurements, there were sufficient measurements to compare the Deir 'Ain 'Abata specimens directly with modern parrotfish and grouper data, and to use the derived linear regression formulas calculated by Beech (1997) to calculate the original lengths of the ancient fish more precisely.

Vertebrae were divided following Wheeler and Jones (1989) into abdominal vertebrae (with no fused haemal spine) and caudal vertebrae (with definite fused haemal spines). First vertebrae were recorded separately from the other abdominal vertebrae. Vertebrae were only recorded if they were more than 50% complete and if they were well preserved ('medium' or 'good' condition). All vertebrae not fulfilling these criteria were included with the non-diagnostic elements as the non-identified fraction of the assemblage. These non-diagnostic fragments were simply counted. The majority of these fragments consisted of fin spines and tiny unidentifiable bone fragments.

All quantities represented in the tables of results can, therefore, be considered as representing the minimum numbers of elements based on the diagnostic zone counts described above. Minimum numbers of individuals was calculated using the highest value of a right or left-hand-side element recorded for each family, within the particular site phase and area.

Results

A total of 4710 fish bone fragments were recovered during the excavation, out of which 1490 (31.6%) were identified to at least the level of family. A good proportion of these ($n = 678$, 45.5%) were also recorded further to genus level (Table 1). The material within the assemblage was fairly homogeneous across the different areas of the site in terms of its general condition, as well as in terms of the fish families and genera represented. The majority of the recorded material was recovered from levels in the site dating to between the fifth and seventh centuries AD, the Early Byzantine era. From these phases of occupation the vast majority of material was recovered from the three main areas of the site, the refectory (K.II) and two rubbish deposits outside of the main buildings (B.I and M.II) (Table 2). The refectory area appears to have been used consistently throughout the occupation of the site.

Preservation

The preservation of fish bones was fairly even across the whole site, most material being in a quite good condition. The average completeness of the bones across each phase and area of the site varied between 40% and 80%. The average texture of most fragments within the assemblage was 'medium', being of a slightly flaky or crumbly appearance, although some of the material was quite well preserved.

A number of taphonomic factors, including different physical and chemical processes, may have affected the fish remains since they were originally deposited on the site. Differential preservation may have played an important role in the structuring of the assemblage.

It has been remarked on elsewhere that variation in the robustness of elements may exist between different fish families and also between species of the same family, as well as between different elements of the skeleton (Wheeler and Jones 1989). Bones of a lower density are more likely to break and deteriorate when exposed to taphonomic processes (Jones 1989). One of the main families represented at Deir 'Ain 'Abata are the groupers, whose skeletons are generally very robust and usually preserve well in archaeological deposits (Desse and Desse-Berset 1996). Parrotfish also tend to have quite hard and robust bones, particularly the dentary, premaxilla and pharyngeal elements, which are similarly well represented at Deir 'Ain 'Abata.

Gnawing

Traces of gnawing on bones on archaeological sites may provide evidence of the presence of scavenging carnivores and/or rodents. Only five examples of gnawed fish bone fragments were recorded during this study. These were from Areas B.I (Phase IVa, Locus 16.5), K.II (Phase IVb, Loci 28.3 and 28.5) and M.II (Phase IVa-b, Loci 5.15

and 5.19). All of these gnawing marks were ascribed to rodents on the basis of the morphology of the teeth marks visible on the surface of the bone fragments. All of these specimens came from areas where one might reasonably expect to find rodent activity, i.e. from the refectory area and the rubbish dumps around the site. Although the low observed incidence of gnawing may also be partly due to the surface condition of the bones, the flaky nature of the material making it very hard to detect any clear teeth marks, it may also be due to the fact that rubbish was fairly rapidly buried and was thus not exposed for prolonged periods on the ground surface. The lack of more typical carnivore marks (cf. the mammal bones from the site, Ch. V.14a) hints that scavengers such as dogs and cats may not have been tolerated within the confines of the monastery.

Burning

A high percentage of the fish bones showed traces of having been burnt (89.5%), and the levels of burning appeared to be fairly consistent between different areas of the site (Table 3). Many of the bone fragments had a slightly greyish appearance suggestive of having been lightly singed. No clear evidence was found for a change in the proportions of burnt bones during the different phases of occupation. Burning of the bones could have resulted from cooking activities such as grilling and roasting or to various post-depositional factors, such as the deliberate burning of rubbish and food debris. Area B.I produced bone fragments exhibiting varying degrees of burning, ranging from blackened and charred to grey-white material. As Nicholson has recently stated, "...completely calcined bone (grey or white) would not be expected in a cooking accident..." (Nicholson 1995: 63). This, together with the fact that other animal bones from the site are heavily burnt (see Ch. V.14a and V.14c), suggests that perhaps refuse was being periodically burnt to reduce the piles of organic waste within the monastery. Another possible explanation might be that bone debris might have been tossed into fires for use as fuel.

Butchery

Butchery processes, when recognised, may provide evidence of fish processing techniques used at the site during its occupation, but butchery marks were comparatively rare. Only five fragments exhibited traces of cutmarks and these are detailed as follows:

- Phase IVa (Area B.I 9.1), jack/trevally (*Carangidae*), quadrate, from a medium-sized individual.
- Phase IVa-b (Area M.II 5.14 and 5.15), grouper (*Serranidae*), post-temporal, and parrotfish (*Scaridae*: cf. *Scarus* sp.), premaxilla, from medium and large-sized individuals respectively.
- Phase IVb (Area K.II 28.3), parrotfish (*Scaridae*), dentary, from a large individual.

• Phase IVb–c (Area K.II 19.3), grouper (*Serranidae*), abdominal vertebra, from an extra large-sized individual.

The relative scarcity of butchery marks is not altogether surprising. Preservation factors may have reduced the amount of observable cut and chop marks to the bones. More likely, however, is the fact that the techniques of processing and cooking the fish were unlikely to damage the bones. Knife marks on skeletal elements of fish are not normally expected since they tend to be filleted, which would involve removing the meat of the fish from the whole skeleton without contact between blade and bone, if it could be avoided, due to the possibility of blunting the knife (Wheeler and Jones 1989). The few traces of cutmarks observed to the Deir 'Ain 'Abata fish predominantly come from bones in the skull, suggesting that some larger individuals may have been partially butchered to facilitate cooking. Their heads would have been removed and subsequently their trunks would have been split laterally. Many of the other fish may, of course, have been cooked whole, the consumer separating edible versus non-edible components on the dining table, prior to their disposal.

Anatomical Representation

There is a relatively even distribution of anatomical elements between different fish families through the different site periods (Table 4). Both skull elements and vertebrae were well represented for all the major species. There did not appear to be any special deposits with particular dumps of certain elements indicating obvious areas of the site used specifically for fish processing. This perhaps indicates that the fish were largely brought whole onto the site. Minimum number of individual (MNI) counts were calculated for the three major fish families (groupers, emperors and parrotfish) represented at the site (Tables 5–7). These were done for each phase and site area to check if there were any interesting concentrations of particular fish elements being dumped in a particular location. Again, no clear pattern was visible, both skull and trunk elements being broadly represented, with larger samples being present in Phases IVa (Area B), IVa–b (Area M), and IVb–c (Area K).

Families Represented

The variety of fish exploited during the occupation of the site remains approximately constant through all periods with possibly a hint of a slight decline in diversity towards the latter half of the seventh century AD, in Phase V (Table 1). This decline is not statistically significant, however. A total of fifteen fish families were represented within the Deir 'Ain 'Abata assemblage. The more commonly occurring families included the groupers (*Serranidae*), jacks and trevallies (*Carangidae*), grunts (*Haemulidae*), emperors (*Lethrinidae*), seabreams (*Sparidae*), parrotfish (*Scaridae*) and tuna/mackerel (*Scombridae*). Less common

groups and families represented included sharks, rays and skates (*Chondrichthyes*), sea catfish (*Ariidae*), snooks (*Centropomidae*), dolphinfish (*Coryphaenidae*), snappers (*Lutjanidae*), mullets (*Mugilidae*), goatfish (*Mullidae*), and barracudas (*Sphyraenidae*). Snooks (*Centropomidae*) were the only freshwater family represented within the assemblage. It is possible that one or two other freshwater species may be present but overlooked during the analysis, as the comparative modern osteological collections used did not encompass all possible freshwater species present within this region. What is clear, however, is the fact that the assemblage as a whole was almost entirely dominated by imported marine fish. Table 8 summarises the size categories of all the fish remains represented at the site. Most of the fish were from medium- (52%) or large-sized individuals (35%), with just a small number of very large- (1%) and small-sized (12%) fish. Let us now consider each of the main families represented, in taxonomic sequence.

Sharks, rays and skates (*Chondrichthyes*)

Sharks, rays and skates were represented by three calcified vertebral centra. These all came from Phase IVa–b, Area M.V 7.1 and 8.1. They could all have come from the same individual, in that they were of a comparable size and similar appearance. Judging from the diameter of the centra, these vertebrae must originally have come from a very large shark.

Sea catfish (*Ariidae*: *Arius* sp.)

Five vertebrae were recorded as belonging to sea catfish. Abdominal vertebrae were present in Phases IVa (Area F.I 4.1) and IVc (Area K.II 24.3). Caudal vertebrae occurred in Phases IVa–b (Area M.II 5.7) and IVb–c (Area K.II 19.2 and 19.4). These all came from large fish, except for the small individual represented in Phase IVa–b.

Snook (*Centropomidae*: cf. *Lates niloticus*)

A single bone from a snook was tentatively identified as belonging to Nile perch (cf. *Lates niloticus*). This came from Phase IVa (Area B.I 18.3), and was a caudal vertebra from a medium-sized fish. As no modern reference material was available to the authors, comparisons could only be made with already published photographs of Nile perch bones (e.g. Lernau 1986–7: 233, Pl. IV; Lernau and Lernau 1992). The morphology of the vertebra appeared to closely match those depicted in Lernau 1986–7.

Groupers (*Serranidae*)

A total of 266 bones were identified as belonging to groupers, accounting for 18% of the total number of identified fragments. The combined MNI for groupers from all periods was twenty-six. All diagnostic elements (cranial and trunk) were recorded within the major phases and areas of the site. The majority of the bones recorded as *Serranidae* appeared to belong to the genus *Epinephelus* on the basis of their general size and morphology. Other genera such as *Aethaloperca* (redmouth grouper) and *Cephapholis* (hind) were also apparently present, in

smaller numbers. A substantial proportion (c. 37%) of the fish were from large- to extra large-sized fish, but most (c. 45%) were from medium-sized individuals. Table 9 details the bone measurements which it was possible to take on the more complete premaxillae, dentaries and quadrates.

Jacks and trevallies (*Carangidae*)

Thirteen bones were recorded as being from jacks and trevallies. They represent approximately 1% of the identified fraction of the assemblage. The combined MNI for this family was five. Elements represented included maxilla, dentary, quadrate and hyomandibular as well as vertebrae. Individuals represented varied from small- to large-sized fish.

Dolphinfish (*Coryphaenidae*)

A single articular fragment was identified as belonging to a dolphinfish. This came from Phase IVb (Area K.II 28.4). It came from a large-sized individual.

Snappers (*Lutjanidae*: *Lutjanus* sp.)

One dentary fragment was recorded as belonging to snapper (*Lutjanus* sp.). This was from Phase IVb–c (Area K.II 19.6). It came from a large-sized individual.

Grunts (*Haemulidae*, incl. *Plectorhinchus* sp.)

Ten bones were identified as belonging to grunts, representing approximately 1% of the identified fragments. Out of these, seven fragments could be identified only as belonging to *Haemulidae*. Bones represented included the maxilla, dentary and articular. Three other bones (a maxilla, hyomandibular and first abdominal vertebra) could tentatively be identified further to genus level, to *Plectorhinchus* sp. (sweetlips). The combined MNI for this family was five. Individuals represented varied from small- to large-sized fish.

Emperors (*Lethrinidae*: *Lethrinus* sp.)

A total of 129 bones were recorded as belonging to emperors, representing 9% of the identified bones. The combined MNI for this family was twenty-one. All diagnostic elements (cranial and trunk) were recorded within the major phases and areas of the site. Individuals represented varied from small- to large-sized fish.

Seabreams (*Sparidae*, incl. *Rhabdosargus* sp.)

A total of sixty-one bones were recorded as belonging to seabreams. This represents 4% of the identified fragments. MNI for this family was eleven. Elements recorded included the premaxilla, dentary, hyomandibular and post-temporal as well as vertebrae. Most bones could only be recorded to family level, but in the case of premaxillae and dentaries, it was clear that the genus *Rhabdosargus* (goldlined/haffara seabream) was present. Individuals represented varied from small- to large-sized fish.

Mulletts (*Mugilidae*)

A single mullet bone was recorded in Phase IVb–c (Area K.II 19.6). This was a hyomandibular fragment from a small-sized individual.

Goatfish (*Mullidae*)

One hyomandibular fragment was identified as belonging to a goatfish. This came from Phase IVa (Area B.I 5.1), and was from a small-sized individual.

Parrotfish (*Scaridae*, incl. *Cetoscarus* sp., *Chlorurus* sp., *Hipposcarus* sp. and *Scarus* sp.) (Fig. 838).

A total of 907 bones were identified as belonging to parrotfish. This represents 61% of the total identified fraction of the assemblage. The combined MNI for this family was 104. All diagnostic elements (cranial and trunk) were recorded within the major phases and areas of the site. The majority of these elements could only be identified to the level of family (*Scaridae*). A more detailed examination of two elements, the premaxilla and dentary, suggested that a number of genera were probably present. Although it was not possible to compare these specimens directly with osteological reference material, comparisons were made with the excellent illustrations and morphological descriptions provided in Bellwood (1994). Most of the premaxillae and dentaries examined appeared to belong to the genus *Scarus*, but a number of other genera were also present, including: *Cetoscarus* (bicolour parrotfish), *Chlorurus* ("parrotfish"), and *Hipposcarus* (perhaps *Hipposcarus harid*, the candelamoa parrotfish, which is the only species occurring in the Red Sea within that particular

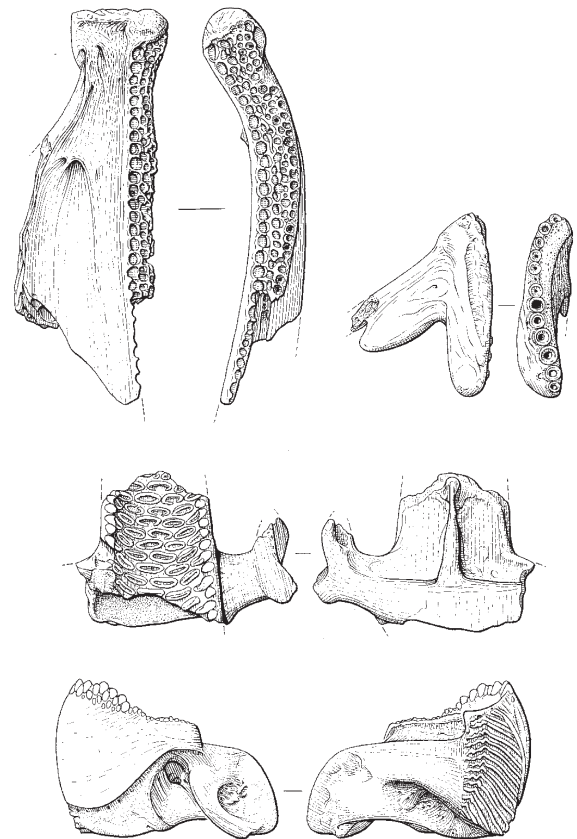


Figure 838: Commonly represented fish elements at Deir 'Ain 'Abata: *Serranidae*: *Epinephelus* sp. - grouper dentary (top left); *Lethrinidae*: *Lethrinus* sp. - emperor dentary (top right); *Scaridae*: parrotfish pharyngeal (middle); parrotfish dentary (bottom)

genus). Most of the parrotfish were from medium- and large-sized individuals (c. 57% and 33% respectively); small-sized individuals were less frequent (9%). Two extremely large individuals were retrieved from the same archaeological layer (Phase IVa-b, Area M.II 5.18), one a dentary of *Scarus* sp., the other a premaxilla of *Hipposcarus* sp. These must have been from fish which would have been about 80–90 cm in length. Table 10 details the bone measurements which it was possible to take on the more complete premaxillae, dentaries, quadrates and pharyngeal bones.

Barracudas (*Sphyraenidae*: *Sphyraena* sp.)

Two bones were recorded as belonging to barracuda. These were both caudal vertebra and came from Phase IVa (Area B.I 18.1 and 18.6). One was from a small-sized specimen, whilst the other was from a large-sized individual.

Tunas and mackerel (*Scombridae*)

A total of eighty-nine bones were recorded for tuna and mackerel. This represents approximately 6% of the identified fragments. The combined MNI for this family was eleven. Out of the ninety bones, only three were cranial elements (an articular and quadrate fragment in Phase IVa–b, Area M.I 5.14 and 5.18; and a maxilla fragment in Phase IVb, Area K.II 28.4). The other eighty-six bones recorded were all vertebrae. The majority of the scombrid bones could only be identified to the level of family, *Scombridae*, though some fragments could be recognised as belonging to the genera *Euthynnus* and *Thunnus* (twenty caudal vertebrae and a quadrate as well as twenty-one caudal vertebrae, respectively). Individuals represented varied from small- to large-sized fish.

Discussion

Zoogeography and Habitat:

Origin of the Deir 'Ain 'Abata Fish

Table 11 summarises the zoogeographic information for the fish represented at Deir 'Ain 'Abata. Fourteen out of the fifteen recorded families are marine dwelling fish which occur at the present day in the Mediterranean and/or Red Seas. Some of these fish, e.g. the sea catfish (*Arius* sp.), redmouth grouper (*Aethaloperca* sp.), hind (*Cephalopholis* sp.), snapper (*Lutjanus* sp.), emperor (*Lethrinus* sp.), goldlined/haffara seabream (*Rhabdosargus* sp.), and the various genera of parrotfish represented (*Cetoscarus*, *Chlorurus*, *Hipposcarus* and *Scarus*) only occur in the Red Sea at the present time. The only parrotfish species known to inhabit the Mediterranean Sea is *Sparisoma cretense* (Whitehead et al. 1986).

In May 1996, some of the material from Deir 'Ain 'Abata was taken to Jerusalem and compared with several examples of this species in Lernau's osteological collection. None of the material was found to match with *Sparisoma cretense*. Interpretation of the origin of the remainder of the

fish represented was more problematic as they may have come from either the Mediterranean or Red Seas. What was interesting was the presence of the freshwater species, Nile perch (*Lates niloticus*). This has now been discovered on a number of sites in the region (Lernau 1986–7; Lernau and Lernau 1992; Lernau 1995). These fish inhabit Africa at the present time and are widespread throughout Ethiopia and within the river Nile area. Although the fish may have been caught in Egypt and transported up to Deir 'Ain 'Abata, it has also been suggested that Nile perch may have inhabited coastal rivers in Israel during historical times (Lernau 1986–7).

Table 11 also summarises the habitat data for the fish present at Deir 'Ain 'Abata. The majority of them were probably caught in coastal waters, generally on or near coral reefs. The larger sharks, dolphinfish and tuna may have been caught in a variety of coastal waters. At certain times of year they can all be easily caught near the surface. The sea catfish, Nile perch, and mullet may have been caught in coastal rivers, although sea catfish and mullets occur more regularly in marine habitats.

Certain trends can be seen when comparing the families recorded from Deir 'Ain 'Abata with those caught using modern fishing techniques within the Red Sea. Sheppard et al. (1992) confirm that the majority of fish caught in the Red Sea are associated with the abundant reef environments in the region. Hook and line methods of fishing on the reefs produce catches rich in the following families: groupers (*Serranidae*), snappers (*Lutjanidae*), emperors (*Lethrinidae*) and seabreams (*Sparidae*). In contrast they report that baited net and trap methods are used to catch parrotfish (*Scaridae*), rabbitfish (*Siganidae*) and mullets (*Mugilidae*) (Sheppard et al. 1992). All of these families (except rabbitfish) are present within the Deir 'Ain 'Abata assemblage. Nets and traps are also used to capture fish which feed on the sandy bottom amongst the reefs, with *Hipposcarus* sp., *Scarus* sp., *Epinephelus* sp. and *Lethrinus* sp. being the most abundantly caught species (Sheppard et al. 1992). Not surprisingly these were also some of the most abundantly recorded fish within the Deir 'Ain 'Abata assemblage.

The information provided from fishing practices in the Red Sea today suggest that during the Roman-Byzantine period fishing was carried out in small boats using hooks and lines as well as small nets and traps mostly over the reefs and in the areas between them. Evidence of fishing nets used during this period has been excavated at the coastal site of Abu Sha'ar in Egypt. The nets were made from flax and the mesh holes ranged from 1.27 to 7 cm. Fish hooks made from copper have also been found there (Wendrich and Van Neer 1994). The similarity of the Deir 'Ain 'Abata fish bone assemblage with that of Abu Sha'ar suggests that similar fishing methods may have been utilised. Some of the larger groupers (*Serranidae*) and parrotfish (*Scaridae*)

might have been caught using spears, although hand-lines with hooks and basket traps could also have been used (Sheppard et al. 1992). The lack of very small fish, less than 15 cm in length, can be explained by a number of factors. Obviously very small fish bones may have been missed by the on-site recovery procedures. It seems strange though, that during the whole excavation no smaller-sized fish were recovered. Another point to consider is the mesh size of the fishing nets found at Abu Sha'ar. These were possibly very typical of the nets used by fishermen along the Red Sea coast at the time. It is possible that the fishermen were selecting to catch only the medium to larger size of fish required for sale and transportation to inland sites and distant markets.

Organised Importation of Fish

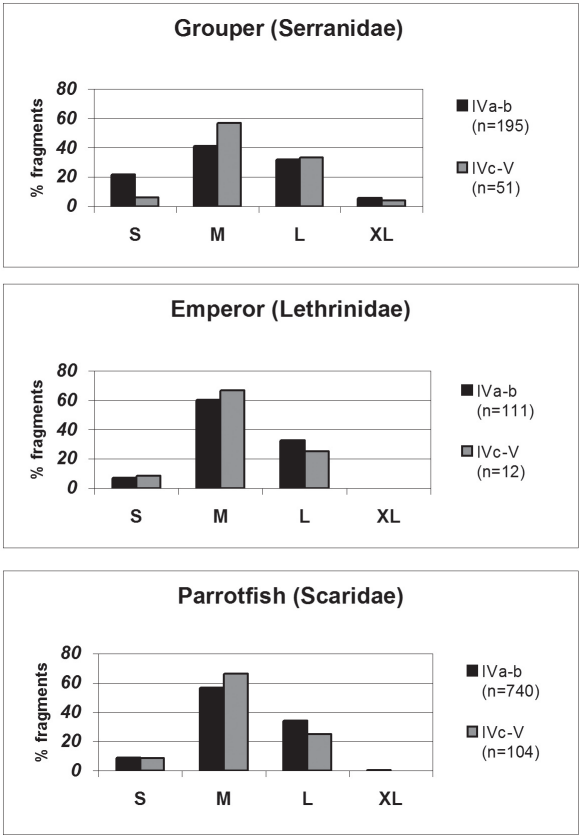
It is clear that most of the fish were probably brought to the site whole or relatively complete, judging from the presence of both cranial and trunk elements for the typical families represented. Only in the case of the sharks, sea catfish, Nile perch and barracuda were they represented by vertebrae alone. As the journey time from the sea would have been considerable, it is presumed that the fish were probably imported to the site in a dried form.

An important aspect to consider when discussing the role of fish at Deir 'Ain 'Abata is the geographical location of the site, close to the shores of the Dead Sea. The Dead Sea was used during the period in question as a supply of salt for the area (Broshi 1986). Other supplies of salt were located at Sodom. It is very probable that the salt from these locations was traded along many of the well-established routes throughout Palestine and further afield. Since salt is an excellent preservative and aids the drying process, it would be a reasonable suggestion that on return journeys from coastal regions the salt caravans carried large quantities of dried and cured fish, possibly even preserved in brine (Lernau 1986). Cotton et al. (1996) give evidence of salteries for the preservation of fish using salt along the Mediterranean coast. This evidence suggests the likelihood that the transport and use of salt was primarily as a preservative for fish and other food products. Aila (present-day Aqaba) is the most likely destination for this salt trade. Aila was a very important port during the Byzantine period, allowing trade by sea with India and also areas of the Mediterranean (Gutwein 1981). It was also a halfway point for traders who were travelling from Arabia to Syria and had to pass through Palestine. These travellers were principally spice traders. These caravans frequently passed through Palestine and thus trade routes were established with many roads built to connect important towns (Gutwein 1981).

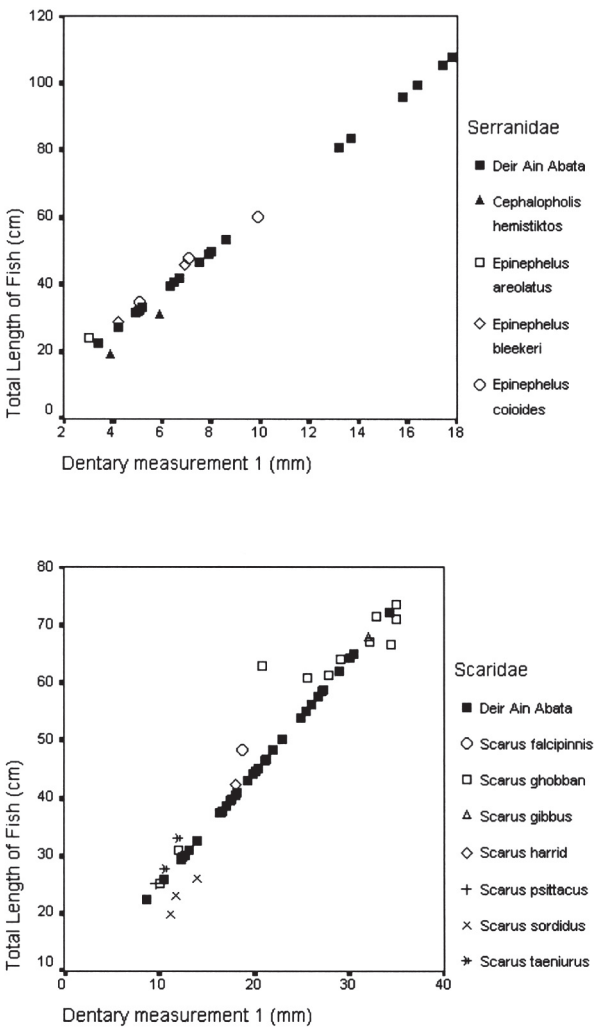
It would be quite possible that these routes provided the necessary access for traders from the Deir 'Ain 'Abata region to the Red Sea and thus a source of marine fish.

Deir 'Ain 'Abata is situated very close to a network of these routes. Trajan's Road was a major route which leads south to Aila, the Wadi Sirhan-Characmoba route leads from Qalat al-Hasa to the Syrian desert and eventually Persia, and in the local area is the Characmoba (present-day Karak) track connecting towns in the south-eastern Dead Sea area (Gutwein 1981). Deir 'Ain 'Abata is thus situated in a very accessible region for trade with the coast. Also in this area was the important administrative centre of Zoara which was a possible centre for trade in various goods (Gutwein 1981).

Evidence of trade also exists between Palestine and Egypt. During the earlier parts of the Byzantine era, fish are known to have been exported from Egypt in a dried form, preserved in salt and loaded in baskets (Sperber 1976; Lernau 1986-7). This evidence might explain the presence within the Deir 'Ain 'Abata assemblage of Nile perch (*Lates niloticus*). This species, along with Nile catfish (*Clarias gariepinus*), has been found on a number of excavations in the region including Upper Zohar, En Boqeq and Tamara (Lernau 1995; Lernau 1986). Today, the Nile catfish inhabits the Jordan river system and Mediterranean coastal rivers. The Nile perch, however, is limited to Africa and we are unsure of its distribution in



Graph 1: Graph illustrating grouper (Serranidae), emperor (Lethrinidae) and parrotfish (Scaridae) size category data for the early Byzantine (Phases IVa-b) vs. early Islamic (Phase IVc-V) periods at Deir 'Ain 'Abata. S = small (15-30 cm), M = medium (30-50 cm), L = large (50-80 cm), XL = extra large (80-100 cm)



Graph 2: (Top) Size reconstruction of groupers (*Serranidae*) and (Bottom) parrotfish (*Scaridae*). The graphs illustrate dentary measurement 1 (see Fig. 3) plotted against TL – the total length of the fish. The Deir 'Ain 'Abata measurements are plotted using the derived regression formulas of Beech (1997) based on modern parrotfish and grouper skeletons

the past (Lernau 1995). Both species may have inhabited local river systems in Palestine, or may have been traded from Egypt (Lernau 1986–7). Such a trade might account for other Red Sea or Mediterranean species being brought to the site.

Another possible explanation for the import of dried fish to the site is that they may have been brought by pilgrims. During the Byzantine era pilgrims were regular visitors to the monasteries of Palestine and carried offerings with them (Gutwein 1981). These were either a direct monetary donation to the monastery or were in the form of gifts, possibly food or wine (Gutwein 1981; Hunt 1982). A network of established pilgrim routes is also known to have existed connecting the biblical sites throughout Palestine. These routes stretched as far as Mount Sinai in what was southern Palestine (Gutwein 1981).

The three most frequently recorded families of fish within the assemblage were parrotfish (*Scaridae*), groupers

(*Serranidae*) and emperors (*Lethrinidae*). Graph 1 summarises the size estimation data for these three families. The fish mostly fall into the medium size category (from 30–50 cm in length), with quite a substantial number also appearing in the large size category (from 50–80 cm in length). None of the fish were estimated to be of a size smaller than 15 cm in length. This perhaps confirms that predominantly medium- to larger-sized fish were selected for export at their source.

Parrotfish and grouper bone measurement data was also analysed using a single regression method, utilising the derived regression formulas created by Beech (1997) on modern parrotfish and grouper skeletons (Graph 2). These graphs confirm the picture obtained from the estimated size categories, i.e. that the majority of the fish were of medium size, with a few large and extra large fish present. In the case of the grouper measurements, there appeared to be two distinct groups of fish, medium-sized fish ranging from 20–50 cm in length and then a group of extra large fish ranging from 80–110 cm in length. These size groups may reflect the presence of the smaller sized genus *Cephalopholis* as opposed to the much larger *Epinephelus* genus.

Regional Context

Many Roman-Byzantine sites are found within the study region but at the time when this study was carried out, few had published animal bone assemblages, let alone analyses of fish bone assemblages. The few exceptions to this are listed as follows:

Site Name	Site Code	Location	Date	Reference
City of David	COD	Near Jerusalem, Israel	Iron Age-Byzantine	Lernau and Lernau 1992
Temple Mount	TM	Jerusalem, Israel	Iron-Age-Byzantine	Lernau and Lernau 1989
En Boqeq	EB	W shore Dead Sea, Israel	Roman-Byzantine	Lernau 1986
Tamara	TAM	NE Negev, Israel	Roman-Byzantine	Lernau 1986
Upper Zohar	UZ	Jordan Valley, Israel	Early Byzantine	Lernau 1995
Deir 'Ain 'Abata	DAA	Jordan Valley, Jordan	Early Byzantine	Beech and Prance, Ch. V.14b, this volume
Abu Sha'ar	ABS	Red Sea, Egypt	Late Roman	Wendrich and Van Neer 1994
Mons Claudianus	MC	Eastern desert, Egypt	Roman	Hamilton-Dyer 2001

The site codes refer to those used in Table 12 below, which presents comparable data on the fish assemblages from these other, broadly contemporary, archaeological sites. Each is briefly discussed in turn.

Excavations in the City of David, Jerusalem, on layers dating from the Iron Age to Byzantine period, recovered 240 fish remains using dry sieving techniques (Lernau and Lernau 1992). A total of 215 bones were identified, amongst which fifteen fish families were recognised. The most common fish represented were Nile catfish, Nile perch, white grouper, gilthead seabream and flat-headed grey mullet. Less frequent were sharks/rays, wahrindi, meagre, mouth breeders and tuna/mackerel. Lernau and Lernau (1992) decided that the marine families identified were all from the Mediterranean rather than the Red Sea. Their decision seems to have been largely based on the closer proximity of Jerusalem to the Mediterranean rather than Red Sea. As for the freshwater fish represented at the site, they suggested that the Nile catfish and mouth-breeders may have been caught in the River Yarkon to the west of Jerusalem or from the River Jordan to the east. A mouth-breeder (*Tilapia*) is depicted on the Madaba mosaic map swimming in the River Jordan just above the entrance to the Dead Sea. Other freshwater fish which were present, like the wahrindi and Nile perch, inhabit the Nile at the present day although, as mentioned above, the latter species may once have inhabited larger coastal rivers in the region (Lernau 1986–7).

The Temple Mount excavations, also in Jerusalem, recovered a total of forty-seven bones from Iron Age to Byzantine period layers, again dry sieving being employed (Lernau and Lernau 1989). Seven families were recognised. The most common fish represented were Nile catfish, Nile perch, grouper, mouth-breeder and mullet, with seabream and meagre also present.

The Roman-Byzantine castellum at En Boqeq is situated in a semi-desert area, near a small spring, on the western edge of the Dead Sea. The site was built about AD 340 and continued to be occupied through the Roman-Byzantine period until the Arab conquest around AD 635. Dry sieving was employed on the excavation using a 3–5 mm mesh. A total of 360 bones were recovered from nine different families. The most common fish represented were Nile catfish, groupers, mouth-breeders, mullet and parrotfish, with carp, seabreams (dentex), emperors and meagre also present (Lernau 1986).

Tamara is located further south in the hilly region of the north-eastern Negev, about 39 km south-west of En Boqeq. Tamara was built about AD 270 and, like En Boqeq, continued to be occupied through the Roman-Byzantine period until the Arab conquest around AD 635. Dry sieving was employed on the excavation using a 3–5 mm mesh. A total of 351 bones were recovered from eleven families. The most common fish represented were Nile catfish, groupers, seabreams, emperors, mouth-breeders, mullet, parrotfish and tuna, with scorpionfish, seabream (dentex), meagre and wrasse also present (Lernau 1986).

Lernau (1986) concluded, in discussing the origin

of the fish present at En Boqeq and Tamara, that there were four groups present. Most of the fish originated from the Red Sea (43% of the En Boqeq bones 56% of the Tamara bones) with only smaller amounts being from the Mediterranean Sea (25% of the En Boqeq bones and 8% of the Tamara bones). One group of fish may have come from either the Red or Mediterranean Seas (18% of the bones at both sites). The final group was that of freshwater fish probably coming from the River Jordan (37% of the bones at En Boqeq and 17% at Tamara).

Upper Zohar is an early Byzantine fort in Israel located on the hill of Rosh Zohar, near the southern end of the Dead Sea. It represents the closest site geographically to Deir 'Ain 'Abata. All occupation layers were dry sieved during the excavation using a c. 5 mm mesh. A total of 2325 fish bones were recovered, out of which 726 could be identified to family level and a proportion of these to genus and species (Lernau 1995). Sixteen different families were recognised, the most common fish represented being mullet and parrotfish, followed by Nile catfish, grouper, seabream and mouth-breeders. Sharks/rays, carp, merluccid hake, scorpionfish, Nile perch, temperate bass, jack/trevally, emperor, meagre and triggerfish were also present. Lernau (1995) concluded, as at En Boqeq and Tamara, that most of the fish originated from the Red Sea, and that the strategic location of the site meant that the fish were likely to have been brought by caravans passing through the region from the south.

The site of Abu Sha'ar is situated on the Egyptian Red Sea coast (Wendrich and Van Neer 1994). It is a late Roman fort, dating from the fourth to sixth centuries AD, which was reused as a Christian monastic complex from the late fourth to late seventh centuries AD. Over 4000 bones were recovered from the site and were identified by Wendrich and Van Neer (1994). Remarkably, during the excavation, traces were also recovered of fishing gear in the form of net fragments and hooks. A total of seventeen families were represented, all of them marine and originating from the local Red Sea area. The most common fish present were groupers, emperors and parrotfish, followed by jack/trevallies, grunts, seabream, mullet and triggerfish. Other fish represented included requiem sharks, sawfish, needlefish, squirrel/soldierfish, snapper, barracuda, wrasse, surgeonfish and rabbitfish.

The Roman settlement of Mons Claudianus is located in the mountainous eastern desert of Egypt. Occupation at the site dated from the early second to third century AD. Its purpose was for the quarrying of stone for export to Italy and elsewhere in the empire. As the site was very isolated, being about 120 km from Luxor and 50 km from the Red Sea coast, this meant that all food had to be provisioned into the site either from the Nile or the Red Sea. Analysis of the fish assemblage from Mons Claudianus has demonstrated that a wide variety of marine

and freshwater fish were imported to the site (Hamilton-Dyer 2001). Over 5000 fish remains were recovered by hand and at least 3000 more from sieved samples. At least twenty family groups were represented and over thirty different species. The majority of these were from marine fish, only six families being freshwater fish (elephant-snout fish, carp, bayad, Nile catfish, wahrindi and mouth-breeders). Most common amongst the marine fish were parrotfish together with groupers and emperors. Sharks, jacks/trevallies, snappers, seabreams, surgeon/unicornfish and triggerfish were also common. Other fish represented at Mons Claudianus included mojarra, goatfish, mullet, barracuda and wrasse. It is reported that both head bones and vertebrae were recovered from most fish, implying that they were probably transported whole to the site (Hamilton-Dyer 2001).

It is clear that the Deir 'Ain 'Abata fish assemblage has a very similar pattern and abundance of fish to these other sites. Parrotfish and groupers appear to have been a popular food item also at the nearby sites of Upper Zohar and the two castella of En Boqeq and Tamara. These sites, along with Deir 'Ain 'Abata, all seem to have been provisioned primarily with marine fish coming from the Red Sea. The similarity between the Deir 'Ain 'Abata fish assemblages with those from the nearby sites of En Boqeq, Tamara and Upper Zohar may hint that the fish found at these sites could have been purchased from a similar source. This might have been a local market which was supplied with fish from the coast, or by a large amount of fish bought directly to the area by a trader or their representatives. Deir 'Ain 'Abata was located adjacent to a number of key trade routes and roads leading through the area, and would have taken advantage of passing commercial traders to provision the inhabitants of the monastery as well as to feed hungry visiting pilgrims.

Contradictions in the Documentary Sources: Food for Sick Monks or Pilgrim Feasts?

Written accounts suggest that life for the monks was very simple and ordered (Jones 1989). Rules were devised for each part of everyday life, which included their diet. These documents suggest that the diet consumed within a typical monastery of this period was as plain and simple as the rest of the monks' lives. Bread made from wheat was the staple foodstuff. Other permitted items in their diet included fruit, vegetables, herbs, wine and oil, all of which had to be gathered by the monks either from the surrounding area or from gardens cultivated within the monastery walls (Hirschfeld 1990). Many of these items were eaten raw in salads with oil and vinegar (Dembinska 1985). Meat and fish were strictly forbidden as suitable food for consumption by monks living in such establishments, except during period of illness (Hirschfeld 1992). Therefore, how does one explain the presence of the

significant quantities of fish remains at Deir 'Ain 'Abata?

The Christian monks, and/or the pilgrims staying at the monastery, certainly did enjoy a life which involved the consumption of a very varied diet rich in meat, fish and other animal products (see Ch. V.14a and V.14c). The question then arises of how the provisioning of the monastery with such products might have been organised. There is written evidence, such as the papyri from Nessana, of the purchase of fish by monasteries at this time (Gutwein 1981), however, it is difficult to interpret exactly for which population within the monastery the fish was destined. One possibility is that the monastery had a subsidiary population who consumed such foodstuffs. This is certainly feasible. Monasteries were known to have been the centre of local life in these remote areas and often had a large lay population associated with them. The monastery was the provider of food, stability and education for these people and in return the lay population were agricultural workers for the monastery (Hirschfeld 1992; Gutwein 1981). It is possible that such a lay population tended the cereal crops and reared the domestic animals on the site itself. Any surplus produce might then be traded at local markets or further afield. Fish may have been one of the items bought in return for the sale of these crops. It seems likely, though, that the purchase of more scarce food resources, such as marine fish, would have been too expensive for many poor people to consume (Hirschfeld 1992).

Clearly a key group of people associated with the monastery at Deir 'Ain 'Abata would have been pilgrims. During the early Byzantine period, interest in Christianity, especially within the Holy Land, soared. Monasteries thrived on the new-found source of income (Hirschfeld 1992). The monastery may have become a regular resting place for pilgrims providing accommodation and food. In return for providing hospitality, the monastery would receive a gift of money or food from pilgrims, allowing the purchase of further food for the guests and other inhabitants of the monastery. The writings of many of the visiting pilgrims to Palestine suggest that monasteries were very wealthy establishments with silver and silk adornments (Hunt 1982). It would be a reasonable assumption that the inhabitants of these monasteries certainly relished their wealth and power within the community. Many monasteries also profited from the sale of holy relics to their visiting guests, enhancing the biblical theme (Hunt 1982). Fish were of course an important symbol of early Christianity and so it is perhaps not entirely surprising that it may have become one of the key food items that richer pilgrims may have consumed.

Conclusion

With reference to the original aims of this analysis, the following conclusions can be drawn. The majority of the fish families represented at Deir 'Ain 'Abata were

from marine rather than freshwater fish. These came predominantly from Red Sea rather than Mediterranean Sea sources. A striking feature of the Deir 'Ain 'Abata fish bone assemblage is its similarity with fish remains from comparative sites that also have their origins in the Red Sea. Some freshwater fish may have been caught in local rivers but they comprise an insignificant part of the total assemblage.

A range of cranial and axial elements were represented for all the major fish families (parrotfish, groupers and emperors) with no clear bias towards particular elements. This evidence suggests that the fish were mostly transported to the site whole. Due to the distance involved in the transportation of goods from the Red Sea to Deir 'Ain 'Abata, approximately 180 km, it is presumed that the fish were transported in some sort of preserved form, which may have involved the use of salt. The fish caught and transported were of a consistently medium to large size, suggesting some degree of selection or standardisation of the imported goods. The fish may have been dried at their source and then transported in bundles.

Little evidence of butchery was found on the fish bones, suggesting that care was taken when filleting the fish. Some larger fish had their heads removed and may have had their trunks split laterally. Most fish were probably cooked whole or were eaten in the preserved state in which they arrived. The spatial distribution of the fish remains was fairly even for most areas of the site, as were

the proportions of burnt to non-burnt fragments. An even distribution of all elements was also recorded across the site. This indicates that no particular areas of the site were regularly used for the on-site processing of fish. However, fish remains were found in the refectory area continuously through the main site phases. During the fifth to seventh centuries AD two rubbish dumps were used to dispose of the food remains from the monastery. It is possible that burning of these middens took place to manage this refuse. It is generally known that monks paid particular attention to details of hygiene within their living space (Jones 1989). During later periods, after the seventh century AD when the rubbish dumps ceased to be used, the monastery was occupied by people other than the monks who were perhaps not so conscious of hygiene matters.

Although documentary evidence seems to suggest that fish was not regularly consumed within monasteries at the time, archaeological evidence contradicts this and proves that the inhabitants of Deir 'Ain 'Abata clearly did enjoy a diet rich in meat and fish (see Ch. V.14a and V.14c). Fish may have been brought to the site either by pilgrims, as gifts or offerings to the monastery, or they may have been regularly acquired by the monks of the monastery who traded goods at local markets in order to feed themselves and the swelling ranks of visiting pilgrims. This latter hypothesis, perhaps, seems more likely considering the similarity of the Deir 'Ain 'Abata fish remains with those assemblages from adjacent sites in the region.

Table 1: Quantification of the fish bones at Deir ‘Ain ‘Abata
Figures in brackets represent sub-totals for genera and species which are included in the respective overall family counts

Family	Genus/Species	Common Name	III	IVa	IVa–b	IVb	IVb–c	IVc	IVc–V	V	Total
Chondrichthyes		Sharks, rays, etc.			3						3
Ariidae	<i>Arius</i> sp.	Sea catfish		1	1		2	1			5
Centropomidae	cf. <i>Lates niloticus</i>	Snook (?Nile perch)		1							1
Serranidae	?mostly cf. <i>Epinephelus</i> sp.	Grouper		70	87	38	20	34	5	12	266
	cf. <i>Aethaloperca</i> sp.	Redmouth grouper			[2]						[2]
	cf. <i>Cephalopholis</i> sp.	Hind		[8]	[2]	[1]	[2]	[2]			[15]
Carangidae		Jacks/Trevallies		6	3	4					13
Coryphaenidae		Dolphinfish				1					1
Lutjanidae	<i>Lutjanus</i> sp.	Snapper					1				1
Haemulidae		G grunt		5	3	1				1	10
	<i>Plectorhinchus</i> sp.	Sweetlips		[1]	[1]	[1]					[3]
Lethrinidae	<i>Lethrinus</i> sp.	Emperor		30	35	46	6	4		8	129
Sparidae		Seabream		24	11	22	2	1	1		61
	<i>Rhabdosargus</i> sp.	Goldlined/Haffara seabream			[2]	[9]			[1]		[12]
Mugilidae		Mullet					1				1
Mullidae		Goatfish		1							1
Scaridae		Parrotfish	1	268	319	153	62	64	8	32	907
	cf. <i>Cetoscarus</i> sp.	Bicolour parrotfish		[1]							[1]
	cf. <i>Chlorurus</i> sp.	“Parrotfish”			[6]	[1]	[1]	[1]			[9]
	cf. <i>Hipposcarus</i> sp.	Candelamoa parrotfish		[2]	[7]		[1]	[1]			[11]
	cf. <i>Scarus</i> sp.	Parrotfish		[3]	[16]		[2]	[1]		[1]	[23]
Sphyraenidae	<i>Sphyraena</i> sp.	Barracuda		2							2
Scombridae		Tuna/Mackerel		47	24	8	6	4			89
	<i>Euthynnus</i> sp.	Kawakawa/Little tunny		[8]	[5]	[3]	[2]	[2]			[20]
	<i>Thunnus</i> sp.	Albacore/Tuna		[17]	[3]	[2]					[22]
Total (diagnostic)			1	455	486	273	100	108	14	53	1490
Total (non-diagnostic)			4	480	1507	677	167	259	28	98	3220
Grand Total			5	935	1993	950	267	367	42	151	4710

Table 2: Quantification of the distribution of fish bones at Deir ‘Ain ‘Abata
I = identified (diagnostic fragments), U = unidentified (non-diagnostic fragments)

Phase Area	III		IVa		IVa–b		IVb		IVb–c		IVc		IVc–V		V		Total
	I	U	I	U	I	U	I	U	I	U	I	U	I	U	I	U	
B.I			417	448													865
F.I			16	7			1	4							1	3	32
F.II									10	14							24
F.III	1	4	0	1			0	1			1	3			2	5	18
H.II			1	2			50	39			8	9	13	26	13	10	171
K.II			21	22			222	633	90	153	99	247	1	2	31	69	1590
M.I															1	3	4
M.II					464	1475											1939
M.III															5	8	13
M.V						22	32										54
Total	1	4	455	480	486	1507	273	677	100	167	108	259	14	28	53	98	4710

Table 3: Quantification of the burnt fish bones at Deir 'Ain 'Abata
B = burnt, 0 = unburnt

Phase Area	III		IVa		IVa-b		IVb		IVb-c		IVc		IVc-V		V	
	B	0	B	0	B	0	B	0	B	0	B	0	B	0	B	0
B.I			416	1												
E.I			16	0			1	0							1	0
E.II									10							
E.III		1									1	0			2	0
H.II			1				50				8	0	13	0	13	0
K.II			17	4			188	34	67	23	54	45	1	0	23	8
M.I															1	0
M.II					424	40										
M.III															5	0
M.V					21	1										

Table 4: Quantification of the anatomical representation of the Deir 'Ain 'Abata fish

Family	Genus/Species	Common Name	Phase Element	III	IVa	IVa-b	IVb	IVb-c	IVc	IVc-V	V	Total
Chondrichthyes		Sharks, rays, etc.	Caudal vertebra			3						3
Ariidae	<i>Arius</i> sp.	Sea catfish	Abdominal vertebra		1				1			2
			Caudal vertebra			1		2				3
Centropomidae	cf. <i>Lates niloticus</i>	Snook (?Nile perch)	Caudal vertebra		1							1
Serranidae	?mostly cf. <i>Epinephelus</i> sp.	Grouper	Premaxilla		5	5	1		1		1	13
			Maxilla		6	7	3	1	3			20
			Dentary		4	4	3	1	1		2	15
			Articular		1	7	2		3		1	14
			Quadrate			10	1		2	1	1	15
			Hyomandibular		1	4	1	1	1			8
			Posttemporal			7	3				1	11
			First abdominal vertebra		1		1		1			3
			Abdominal vertebra		15	14	7	9	5	3	4	57
			Caudal vertebra		29	25	15	6	15	1	2	93
Serranidae	cf. <i>Aethaloperca</i> sp.	Redmouth grouper	Premaxilla			1						1
			Dentary			1						1
Serranidae	cf. <i>Cephalopholis</i> sp.	Hind	Premaxilla		1			1				2
			Dentary		3		1		1			5
			Articular			1						1
			Quadrate		2	1		1	1			5
			Hyomandibular		1							1
			Abdominal vertebra		1							1
Carangidae		Jacks/ Trevallies	Maxilla		1	1						2
			Dentary			1						1
			Quadrate		2	1						3
			Hyomandibular		1		4					5
			Caudal vertebra		2							2
Coryphaenidae		Dolphinfish	Articular				1					1
Lutjanidae	<i>Lutjanus</i> sp.	Snapper	Dentary					1				1
Haemulidae		Grunt	Maxilla		3	1						4
			Dentary			1						1
			Articular		1						1	2
Haemulidae	<i>Plectorhinchus</i> sp.	Sweetlips	Maxilla		1							1
			Hyomandibular			1						1
			First abdominal vertebra				1					1
Lethrinidae	<i>Lethrinus</i> sp.	Emperor	Premaxilla		2	4	5		1			12
			Maxilla		3	6	2	1	1		1	14
			Dentary		3	4	8	2				17
			Articular		1	9	6	1				17
			Quadrate		1		5	1			1	8
			Hyomandibular			1	5					6
			Posttemporal			3						3
			First abdominal vertebra				1					1
			Abdominal vertebra		3	1	4				3	11
			Caudal vertebra		17	7	10	1	2		3	40

Table 4 continued

Family	Genus/Species	Common Name	<div>Phase Element</div>	III	IVa	IVa–b	IVb	IVb–c	IVc	IVc–V	V	Total	
Sparidae		Seabream	Premaxilla				2					2	
			Hyomandibular		1	2	1					4	
			Posttemporal				1					1	
			Abdominal vertebra		8	1	3					12	
			Caudal vertebra		15	6	6	2	1			30	
Sparidae	<i>Rhabdosargus</i> sp.	Goldlined/ Haffara seabream	Premaxilla			1	5			1		7	
			Dentary			1	4					5	
Mugilidae		Mullet	Hyomandibular					1				1	
Mullidae		Goatfish	Hyomandibular		1							1	
Scaridae		Parrotfish	Premaxilla		15	9	3	2	2			31	
			Maxilla		4	12	3		2			21	
			Dentary	1	9	16	11	1	3	2	1	44	
			Articular		4	11	2		1			18	
			Quadrate		3	13	2	1	1		1	21	
			Hyomandibular		7	18	6	4	5		1	41	
			Upper pharyngeal		31	55	26	17	19	1	8	157	
			Lower pharyngeal		17	16	16	7	5	1		62	
			Posttemporal		1	1						2	
			First abdominal vertebra		6	6						12	
			Abdominal vertebra		23	25	15	4	4	1	5	77	
			Caudal vertebra		142	108	68	22	19	3	15	377	
	cf. <i>Cetoscarus</i> sp.	Bicolour parrotfish	Premaxilla		1							1	
	cf. <i>Chlorurus</i> sp.	“Parrotfish”	Premaxilla			3			1			4	
			Dentary			3	1	1				5	
	cf. <i>Hipposcarus</i> sp.	Candelamoa parrotfish	Premaxilla		2	5			1			8	
			Dentary			2		1				3	
	cf. <i>Scarus</i> sp.	Parrotfish	Premaxilla			8							8
			Maxilla			3						3	
			Dentary		3	5		2	1		1	12	
Sphyracnidae	<i>Sphyracna</i> sp.	Barracuda	Caudal vertebra		2							2	
Scombridae		Tuna/ Mackerel	Maxilla				1					1	
			Articular			1						1	
			First abdominal vertebra		1							1	
			Abdominal vertebra		4	4		1	1			10	
			Caudal vertebra		17	11	2	3	1			34	
	<i>Euthynnus</i> sp.	Kawakawa/ Little tunny	Caudal vertebra		8	5	3	2	2			20	
	<i>Thunnus</i> sp.	Albacore/ Tuna	Quadrate			1						1	
Caudal vertebra				17	2	2					21		
Total				1	455	486	273	100	108	14	53	1490	

Table 5: Quantification of grouper (Serranidae) diagnostic elements at Deir ‘Ain ‘Abata
PMX=premaxilla, MX=maxilla, DE=dentary, AR=articular, QU=quadrate, HYO=hyomandibular, POT=post-temporal, AVT1=1st abdominal vertebra, AVT=abdominal vertebra, CVT=caudal vertebra

Phase	Area	PMX	MX	DEN	AR	QU	HYO	POT	AVT1	AVT	CVT	Highest MNI
IVa	B	1/2	3/3	3/3	0/1	1/1	1/1		1	(14)	(26)	3
	F	1/1								(1)	(1)	1
	H											0
	K	0/1		0/1						(1)	(2)	1
IVa–b	M	1/5	4/3	4/1	2/6	3/8	4/0	2/5		(14)	(25)	8
IVb	F											0
	H			1/0							(2)	1
	K	1/0	2/1	0/3	1/1	1/0	0/1	2/1	1	(7)	(13)	3
IVb-c	F	1/0								(4)		1
	K		0/1	1/0		0/1	1/0			(5)	(6)	1
IVc	F									(1)		0
	H	0/1							1	(1)	(1)	1
	K		2/1	1/1	1/2	1/2	0/1			(3)	(14)	2
IVc–V	H					1/0				(2)	(1)	1
	K									(1)		0
V	F											0
	H	1/0								(3)		1
	K			1/1	0/1			1/0		(1)	(2)	1
	M					1/0						1

Paired figures represent number of left and right examples of that particular element, e.g. 1/1 = 1 left and 1 right. Figures in brackets (vertebra counts) are not included in MNI estimates, except in the case of first abdominal vertebrae. Highest MNI counts are the highest left or right sided element occurring within a particular site phase and excavation area.

Table 6: Quantification of emperor (Lethrinidae) diagnostic elements at Deir ‘Ain ‘Abata
PMX=premaxilla, MX=maxilla, DE=dentary, AR=articular, QU=quadrate, HYO=hyomandibular, POT=post-temporal, AVT1=1st abdominal vertebra, AVT=abdominal vertebra, CVT=caudal vertebra

Phase	Area	PMX	MX	DEN	AR	QU	HYO	POT	AVT1	AVT	CVT	Highest MNI
IVa	B	1/0	0/3	0/3	1/0					(2)	(16)	3
	F	1/0								(1)		1
	H											0
	K					0/1					(1)	1
IVa–b	M	2/2	3/3	2/2	4/5		1/0	2/1		(1)	(7)	5
IVb	F											0
	H	1/0			0/1							1
	K	3/1	0/2	5/3	3/2	2/3	2/3		1	(4)	(10)	5
IVb-c	F											0
	K		0/1	1/1	0/1	0/1					(1)	1
IVc	F											0
	H										(1)	1
	K	0/1	1/0								(1)	1
IVc–V	H											0
	K											0
V	F											0
	H											0
	K		0/1			1/0				(3)	(2)	1
	M										(1)	1

Paired figures represent number of left and right examples of that particular element, e.g. 1/1 = 1 left and 1 right. Figures in brackets (vertebra counts) are not included in MNI estimates, except in the case of first abdominal vertebrae. Highest MNI counts are the highest left or right sided element occurring within a particular site phase and excavation area.

Table 7: Quantification of parrotfish (Scaridae) diagnostic elements at Deir 'Ain 'Abata

PMX=premaxilla, MX=maxilla, DE=dentary, AR=articular, QU=quadrate, HYO=hyomandibular, UPH = upper pharyngeal, LPH=lower pharyngeal, POT=post-temporal, AVT1=1st abdominal vertebra, AVT=abdominal vertebra, CVT=caudal vertebra

Phase	Area	PMX	MX	DEN	AR	QU	HYO	UPH	LPH	POT	AVT1	AVT	CVT	Highest MNI
III	F			0/1										1
IVa	B	6/6	0/3	5/6	1/3	2/1	3/3	19/11	13	0/1	6	(21)	(137)	19
	F	2/1					0/1	1/0	1				(3)	2
	H			0/1										1
	K	3/0	0/1						3			(2)	(2)	3
IVa-b	M	13/12	7/8	13/13	5/6	6/7	7/11	32/23	16	0/1	6	(25)	(108)	32
IVb	F			1/0										1
	H			2/2		1/0	0/1	7/3	8			(5)	(11)	7
	K	1/2	1/2	5/2	1/1	1/0	2/3	8/8	8			(10)	(57)	8
IVb-c	F							1/1					(3)	1
	K	0/2		2/3		1/0	3/1	8/7	7			(4)	(19)	8
IVc	F													0
	H	0/1											(1)	1
	K	2/1	0/2	1/3	0/1	0/1	4/1	11/8	5			(4)	(18)	11
IVc-V	H			1/1				1/0	1			(1)	(3)	1
	K													0
V	F						0/1	1/0					(1)	1
	H			2/0		0/1		2/0				(1)	(3)	2
	K							4/1				(2)	(9)	4
	M											(2)	(2)	1

Paired figures represent number of left and right examples of that particular element, e.g. 1/1 = 1 left and 1 right. Figures in brackets (vertebra counts) are not included in MNI estimates, except in the case of first abdominal vertebrae. Highest MNI counts are the highest left or right sided element occurring within a particular site phase and excavation area.

Table 8: Size of the Deir 'Ain 'Abata fish

Phase	Family	Common Name	S	M	L	XL
IVa–b	Chondrichthyes	Sharks, rays, etc.				3
IVa	Ariidae	Sea catfish			1	
IVa–b			1			
IVb–c					2	
IVc					1	
IVa	Centropomidae	Snook		1		
IVa	Serranidae	Grouper	13	27	28	2
IVa–b			21	33	25	8
IVb			8	20	9	1
IVb–c			2	12	4	2
IVc			3	21	10	
IVc–V				1	4	
V				7	3	2
IVa	Carangidae	Jacks/Trevallies	1	2	3	
IVa–b			1		2	
IVb			1	3		
IVb	Coryphaenidae	Dolphinfish			1	
IVb–c	Lutjanidae	Snapper			1	
IVa	Haemulidae	Grunt	2		3	
IVa–b			1	1	1	
IVb					1	
V				1		
IVa	Lethrinidae	Emperor	3	18	9	
IVa–b			3	19	13	
IVb			2	30	14	
IVb–c				5	1	
IVc			1	2	1	
V				6	2	
IVa	Sparidae	Seabream	5	15	4	
IVa–b			4	6	1	
IVb			19	3		
IVb–c				1	1	
IVc			1			
IVc–V				1		
IVb–c	Mugilidae	Mullet	1			
IVa	Mullidae	Goatfish	1			
III	Scaridae	Parrotfish			1	
IVa			22	155	91	
IVa–b			26	162	129	2
IVb			18	103	32	
IVb–c			8	34	20	
IVc			9	43	12	
IVc–V				6	2	
V				20	12	
IVa	Sphyraenidae	Barracuda	1		1	
IVa	Scombridae	Tuna/Mackerel	4	4	39	
IVa–b			2	3	19	
IVb				4	4	
IVb–c				2	4	
IVc					3	

Based on comparisons with modern comparative specimens of known length.
S = small (15–30 cm),
M = medium (30–50 cm),
L = large (50–80 cm),
XL = extra large (80–100 cm)

Table 9: Measurements taken on grouper (Serranidae) bones

Phase	Area	Locus	PMX 1	DEN 1	DEN 2	QU 1	QU 2
IVa	B.I	9.1		7.9	9.9		
	B.I	10.1		3.4		6.3	
	B.I	12.3		15.8			
	B.I	18.1		8.0	10.1		
	B.I	18.1		13.7			
	B.I	18.3				8.4	24.2
	B.I	18.5		5.1	6.0		
	B.I	19.1		4.9	6.6		
	F.I	4.1		17.8			
IVa–b	F.I	13.1		17.4			
	M.II	5.6				4.0	
	M.II	5.6				10.0	
	M.II	5.9	20.4				
	M.II	5.15	13.3	5.2	6.7	5.8	18.8
	M.II	5.15	19.0			6.9	
	M.II	5.15				8.2	
	M.II	5.17				5.8	
	M.II	5.18		5.0	6.2	6.4	
	M.II	5.19	12.4			3.3	
	M.II	5.19	18.5			8.5	
	M.II	5.20				13.7	
	M.III	1.1				6.0	
IVb	H.II	14.1		6.3	8.0		
	K.II	28.1/3				4.4	
	K.II	28.4	11.5	4.2	5.3		
	K.II	28.4		7.5	9.0		
	K.II	28.4		13.2	16.1		
IVb–c	K.II	19.2		16.4	8.9		
	K.II	19.3				4.2	
IVc	K.II	24.2				5.8	
	K.II	24.2				6.4	
	K.II	24.2				8.0	
	K.II	24.3		6.5	8.1		
	K.II	36.2		6.7	7.8		
IVc–V	H.II	10.2				4.5	14.6
V	K.II	25.1		6.5	7.7		
	K.II	45.2	18.5	8.6	10.9		

PM = premaxilla, DEN = dentary, QU = quadrate.
See Fig. 837 for definition of measurements.

Table 10: Measurements taken on parrotfish (Scaridae) bones

Phase	Area	Locus	PMX 1	PMX 2	DEN 1	DEN 2	QU 1	QU 2	LPH 1	LPH 2	LPH 3	LPH 4
III	F.III	5.2			24.2	28.0						
IVa	B.I	5.1	28.4	24.1								
	B.I	6.1										22.8
	B.I	9.1	30.8	27.4								
	B.I	12.3	14.9	17.6								
	B.I	12.3	26.4	32.5								
	B.I	18.1	15.9	13.7	12.3							11.8
	B.I	18.1	25.8	32.5					36.1	22.3	21.3	19.7
	B.I	18.2			25.4	25.5			24.6	16.0	13.9	13.9
	B.I	18.3	15.5	19.3		28.0				14.0	12.8	12.8
	B.I	18.3	16.4	14.5								
	B.I	18.5			29.0	28.5						
	B.I	18.7								18.9	17.3	17.1
	B.I	18.8			26.7							
	B.I	19.4							21.7	12.4	11.5	10.9
	B.I	19.10					8.5					
	H.II	15.1			22.0	23.5						
	K.II	45.2	22.0	23.5								
	K.II	45.2	27.0	30.9								
	K.II	45.2		26.4						21.0	20.0	18.4
IVa-b	M.II	5.1	21.4		27.3				19.2	11.4	10.0	9.0
	M.II	5.2								13.5	13.2	
	M.II	5.5								18.0	17.2	16.8
	M.II	5.6					7.4					
	M.II	5.7		14.4								
	M.II	5.9			12.5	16.1	5.5					
	M.II	5.11	22.6	32.4								
	M.II	5.14	12.9	11.4			4.1					
	M.II	5.14	17.3	15.0			7.5					
	M.II	5.14	19.0	15.0			9.0					
	M.II	5.14	21.4	28.5								
	M.II	5.15	15.4		16.6	17.8	5.8					
	M.II	5.15	16.4	14.2	17.0	20.2	6.1					
	M.II	5.15	18.3	23.5	19.3	19.6	6.5					
	M.II	5.15			19.3	21.4	7.4					
	M.II	5.15			19.8	20.6	7.8					
	M.II	5.15			20.1	22.9						
	M.II	5.15			21.1	23.2						
	M.II	5.15			21.2							
	M.II	5.15			24.9	21.7						
	M.II	5.15			27.2	28.5						
	M.II	5.15			30.5	25.1						
	M.II	5.18	15.2	19.5	12.7	18.5	6.4				11.6	10.5
	M.II	5.18	18.9	16.4	13.1	18.2	6.9				12.9	
	M.II	5.18	20.1	24.6	18.2	21.4	9.0					
	M.II	5.18	29.3	33.4	27.3	23.5						
	M.II	5.18			34.2	34.7						
	M.II	5.19	18.0	22.7	23.0	24.0						
	M.II	5.20	20.7							11.8	11.0	9.8
	M.II	5.20								15.5	14.0	12.3

Table 10 continued

Phase	Area	Locus	PMX 1	PMX 2	DEN 1	DEN 2	QU 1	QU 2	LPH 1	LPH 2	LPH 3	LPH 4
IVa–b	M.II	13.2									17.0	
	M.II	13.4	28.2									
	M.V	3.3							38.0	23.7	23.2	23.0
	M.V	8.1		22.7								
IVb	F.I	2.1			30.1	28.0						
	F.I	4.1	20.6	24.2								
	H.II	14.1			17.6	16.4						
	H.II	14.2								17.9	14.7	14.2
	H.II	14.4			20.4	22.5	16.3			13.8	11.6	
	H.II	14.4							28.5	18.2	16.5	16.5
	H.II	14.7			18.0	16.2			21.2	13.4	11.5	11.3
	K.II	28.5							21.2	12.4	11.4	10.1
	K.II	28.7								13.0	12.3	11.4
	K.II	28.1 or 3										12.6
	K.II	28.1 or 3							15.8	16.0	14.4	14.3
	K.II	28.1 or 3							23.4	13.8	11.9	10.5
	K.II	28.3			8.7	10.3						
	K.II	28.3			16.4	17.3						
	K.II	28.4	35.4	24.5	10.5	14.3			32.6	18.9	16.7	15.5
	K.II	56.1					8.5					
IVb–c	K.II	19.2	14.3	13.0			6.9				11.5	10.0
	K.II	19.2									13.6	12.5
	K.II	19.2							24.2	15.9	14.9	12.5
	K.II	19.3								19.5	16.5	
	K.II	19.3							22.3	13.7	10.6	10.4
	K.II	19.4			26.0	22.9						
	K.II	19.6			16.5	16.4			27.4		14.6	13.3
	K.II	57.1							22.2	12.1	11.5	10.3
IVc	H.II	8.2	12.6	11.2								
	K.II	24.2	14.3	10.4	17.5	18.7	7.0					
	K.II	24.2	31.3	28.5								
	K.II	36.2							23.5	13.6	11.9	10.5
	K.II	36.3			14.0					14.9	11.6	11.5
	K.II	36.3							25.9	15.6	13.7	13.0
IVc–V	H.II	10.1								20.6	18.2	

PM = premaxilla, DEN = dentary, QU = quadrate, LPH = lower pharyngeal.

See Fig. 837 for definition of measurements.

Table 11: Zoogeography and habitat preferences of the fish represented at Deir 'Ain 'Abata

Family	Genus/Species	Common Name	Source	Habitat
Chondrichthyes		Sharks, rays, etc.	Mediterranean / Red Sea	Marine
Ariidae	<i>Arius</i> sp.	Sea catfish	Red Sea	Marine (mostly) - demersal; occasionally freshwater
Centropomidae	cf. <i>Lates niloticus</i>	Snook (?Nile perch)	Africa (widespread in Ethiopian region, common in Nile)	Freshwater - demersal; prefers sandy bottoms but also found in rocky to muddy bottoms
Serranidae	?mostly cf. <i>Epinephelus</i> sp.	Grouper	Mediterranean / Red Sea	Marine - mostly reef-associated; bottom-dwelling predators
	cf. <i>Aethaloperca</i> sp.	Redmouth grouper	Red Sea	Marine - reef associated; usually seen in or near caves and holes in the reef
	cf. <i>Cephalopholis</i> sp.	Hind	Red Sea	Marine - reef-associated: in the Red Sea, it is often found on patchy open reef areas
Carangidae		Jacks/Trevallies	Mediterranean / Red Sea	Marine (mostly); rarely brackish
Coryphaenidae		Dolphinfish	Mediterranean / Red Sea	Marine - migratory; inhabits surface waters
Lutjanidae	<i>Lutjanus</i> sp.	Snapper	Red Sea	Marine; rarely estuarine. Some species do enter freshwater for feeding
Haemulidae		Grunt	Mediterranean / Red Sea	Marine (mostly), some brackish; rarely freshwater
	<i>Plectorhinchus</i> sp.	Sweetlips	Mediterranean / Red Sea	Marine (mostly)
Lethrinidae	<i>Lethrinus</i> sp.	Emperor	Red Sea	Marine - reef associated; bottom-feeding, carnivorous, coastal fish
Sparidae		Seabream	Mediterranean / Red Sea	Marine (mostly); very rare in fresh- and brackish water
	<i>Rhabdosargus</i> sp.	Goldlined/ Haffara seabream	Red Sea	Marine - reef associated; shallow waters nr. coral reefs and over mud-sandy bottoms
Mugilidae		Mullet	Mediterranean / Red Sea	Marine (mostly) - coastal and brackish water. Some in freshwater
Mullidae		Goatfish	Mediterranean / Red Sea	Marine; rarely in brackish waters
Scaridae		Parrotfish	? mostly Red Sea, as = no <i>Sparisoma cretense</i>	Marine - reef associated
	cf. <i>Cetoscarus</i> sp.	Bicolour parrotfish	Red Sea	Marine - reef associated; occurs in clear lagoon and seaward reefs
	cf. <i>Chlorurus</i> sp.	“Parrotfish”	Red Sea	Marine - reef associated; over corals
	cf. <i>Hipposcarus</i> sp.	Candelamoa parrotfish	Red Sea	Marine - reef associated; coastal regions associated with coral reefs and reef flats
	cf. <i>Scarus</i> sp.	Parrotfish	Red Sea	Marine - reef associated
Sphyraenidae	<i>Sphyraena</i> sp.	Barracuda	Mediterranean / Red Sea	Marine (mostly) - coastal and brackish water. Some in freshwater
Scombridae		Tuna/Mackerel	Mediterranean / Red Sea	Marine - many are migratory and pelagic
	<i>Euthynnus</i> sp.	Kawakawa/Little tunny	Mediterranean / Red Sea	Marine - pelagic
	<i>Thunnus</i> sp.	Albacore/Tuna	Mediterranean / Red Sea	Marine - pelagic

Based on information provided in FishBase98 (Froese and Pauly 1998).

Table 12: Representation of fish remains at other Roman-Byzantine sites in the region

Family	Genus/Species	Common Name	Site Code							
			COD	TM	EB	TAM	UZ	DAA	ABS	MC
Chondrichthyes		Sharks, rays, etc.	*				*	*	*	***
Carcharhinidae		Requiem shark							*	
Pristidae		Sawfish							*	
Mormyridae		Elephant-snout fish								*
Cyprinidae		Carp			*		*			*
	<i>Labeo</i> sp.	Carp								*
Bagridae	<i>Bagrus</i> sp.	Bayad								*
Clariidae	<i>Clarias gariepinus</i>	Nile catfish	**	***	***	***	**			*
Ariidae	<i>Arius</i> sp.	Sea catfish						*		
Mochokidae	<i>Synodontis schall</i>	Wahrindi	*							*
Merlucciidae		Merluccid hake					*			
Belonidae		Needlefish							*	
Holocentridae		Squirrelfish/Soldierfish							*	
Scorpaenidae		Scorpionfish				*	*			
Centropomidae	<i>Lates niloticus</i>	Nile perch	***	****			*	?	*	
Percichthyidae	<i>Dicentrarchus labrax</i>	Temperate bass					*			
Serranidae		Grouper		****	***	***	**	***	****	****
	cf. <i>Aethaloperca</i> sp.	Redmouth grouper						*		
	cf. <i>Cephalopholis</i> sp.	Hind						**		
	<i>Epinephelus aeneus</i>	White grouper	**		*	**	*			
	cf. <i>Epinephelus</i> sp.	Grouper						**		
	cf. <i>Epinephelus microdon</i>	Camouflage grouper								*
	cf. <i>Epinephelus summana</i>	Summan grouper								*
	cf. <i>Plectropomus</i> sp.	Coralgrouper								*
Carangidae		Jack/Trevally					*	*	**	***
	<i>Trachurus trachurus</i>	Atlantic horse-mackerel					*			
Coryphaenidae		Dolphinfish						*		
Lutjanidae	<i>Lutjanus</i> sp.	Snapper						*	*	***
Gerreidae		Mojarra								*
Haemulidae		Grunt						*	**	
	<i>Plectorhinchus</i> sp.	Sweetlips						*		
Sparidae		Seabream		*			**	**	***	***
	<i>Acanthopagrus</i> sp.	Seabream								*
	<i>Argyrops</i> sp.	Soldierbream								*
	<i>Argyrops</i> cf. <i>filamentosus</i>	Soldierbream								*
	<i>Dentex</i> sp.	Dentex			*	*				
	<i>Pagrus</i> sp.	Seabream					*			
	<i>Rhabdosargus</i> sp.	Goldlined/Haffara seabream						**		*
	<i>Sparus aurata</i>	Gilthead seabream	****			**				
Lethrinidae	<i>Lethrinus</i> sp.	Emperor			*	**	*	***	****	****
	cf. <i>Lethrinus mahsena</i>	Sky emperor								*
	<i>Lethrinus nebulosus</i>	Spangled emperor								*
	<i>Lethrinus variegatus</i>	Slender emperor								*
Sciaenidae	<i>Argyrosomus regius</i>	Meagre	*	*	*	*	*			
Mullidae		Goatfish								*
Cichlidae	(Tribe = <i>Tiliapini</i>)	Mouth-breeder	*	**	***	**	**			*

Table 12 continued

Family	Genus/Species	Common Name	Site Code							
Mugilidae		Mullet	**	**			**	*	**	*
	<i>Liza</i> sp.	Thin-lipped grey mullet					***			
	<i>Mugil</i> sp.	Mullet			***	***				
	<i>Mugil cephalus</i>	Flat-headed grey mullet	*				*			
Sphyraenidae	<i>Sphyraena</i> sp.	Barracuda						*	*	*
Labridae	<i>Labrus</i> sp.	Wrasse				*			*	*
	<i>Cheilinus lunulatus</i>	Broomtail wrasse								*
	<i>Cheilinus</i> cf. <i>undulatus</i>	Humphead wrasse								*
Scaridae		Parrotfish			****	****	***	****	****	****
	cf. <i>Cetoscarus</i> sp.	Bicolour parrotfish						*		
	cf. <i>Chlorurus</i> sp.	“Parrotfish”						*		
	<i>Hipposcarus harid</i>	Longnose parrotfish								*
	cf. <i>Hipposcarus</i> sp.	Candelamoa parrotfish						**		
	<i>Scarus ghobban</i>	Blue-barred parrotfish								**
	cf. <i>Scarus</i> sp.	Parrotfish					**	***		
Acanthuridae		Surgeonfish							*	***
	<i>Naso</i> cf. <i>liveratus</i>	Orangespine unicornfish								*
	<i>Naso</i> cf. <i>unicornis</i>	Bluespine unicornfish								*
Siganidae		Rabbitfish							*	
Scombridae		Tuna/Mackerel	*					**		
	<i>Auxis</i> sp.	Bullet/Frigate Tuna				**				
	<i>Euthynnus</i> sp.	Tuna				*		**		
	<i>Euthynnus alleteratus</i>	Little Tunny	*							
	<i>Sarda sarda</i>	Atlantic bonito				*				
	<i>Thunnus</i> sp.	Albacore/Tuna						**		
Balistidae		Triggerfish					*		**	***
	cf. <i>Abalistes stellaris</i>	Starry triggerfish								*

For explanation of site codes see text “Regional Context” above.
* = present, ** = few, *** = common, **** = frequent

V.14c THE BIRD BONES

Kevin Rielly and Mark Beech

The aim of the analysis of bird bones from Deir 'Ain 'Abata was primarily to investigate the role played by domestic fowl at the site. Was there any evidence to suggest the on-site breeding of fowl? Were domestic fowl retained largely for their eggs or meat? Was hunting of wildfowl practised and if so, which environmental habitats in the surrounding area were exploited?

An extensive sieving strategy produced a very large quantity of bird bones arising from all but the earliest occupation phases, and in particular from the Byzantine deposits (see Table 1). The site phases are as follows:-

I	Early Bronze Age (c. 3300–3000 BC)
II	Middle Bronze II (c. 2000–1500 BC)
III	Nabataean (1 st century BC–1 st century AD)
IVa	Early Byzantine (5 th –6 th century AD)
IVb	Early Byzantine (early 7 th century AD)
IVc	Umayyad (mid-7 th to early 8 th century AD)
V	Early Abbasid (mid-8 th to early 9 th century AD)

Methods

Various reference collections were used as an aid to identification, including those of the Environmental Archaeology Unit at the University of York, the Museum of London Environmental and Finds Department, as well as the Natural History Museum at Tring. Problems associated with the identification of particular species are mentioned within the relevant sections.

A full record of the chicken bones was limited to particular skeletal parts, these including each of the limb bones, though excluding the extremities. Recorded elements included the following: scapula, coracoid, and carpometacarpus (only those fragments with more than 50% complete proximal epiphysis), humerus, femur, tibiotarsus and tarsometatarsus (only those fragments with more than 50% complete distal epiphysis).

Notes were taken concerning species, part, side, state of fusion, state (fragmentation and preservation), butchery, size and sex data, i.e. tarsometatarsii spur and also presence of medullary bone (after Driver 1982). The recording of medullary bone was limited to femurs, and where complete bones occurred these were snapped in half to check for its presence/absence. The non-chicken bones received similar attention, with no limitation concerning skeletal part.

In order to gain a full record of the quantities of bones recovered, counts were made of the total numbers of bones found within each deposit (see totals given in Table 1).

Results

State of the Bone

Throughout these deposits the bird bones were generally very well preserved and only minimally fragmented. A relatively large proportion of bones were gnawed, these occurring in approximately similar proportions throughout the spatial and temporal units. Of some interest is the high proportion of burnt bones, being well over 75% of the bones in some areas, and in particular Areas K in Phases IVa, IVb, IVb–c, IVc and V, and Area M in Phase IVa–b. This latter area provided an assemblage of 1373 fragments, out of which 1096 (79.8%) were burnt. This high level of burning also occurs consistently amongst other classes of finds within these loci (e.g. mammal and fish bones, see Ch. V.14a). This may indicate that the general burning *in situ* of rubbish regularly took place at the site.

The Domestic Fowl (Chicken)

Identification

An attempt was made to differentiate chicken (*Gallus gallus*) from the smaller galliforms. This was seen to be important as the smaller chicken bones were clearly overlapping in size with the chukar partridge (*Alectoris chukar*) and the Black Francolin (*Francolinus francolinus*). Each of these species is known to exist in the Jordan Valley and adjacent steppe and desert regions (Hollom et al. 1988). While neither species was definitely identified, the range of sizes shown by a number of skeletal parts previously identified as chicken do appear to show a peak at the smaller end of the range, for example the case of the humerus in Graph 1. In addition, the characteristics known to differentiate pheasant (*Phasianus colchicus*), were also looked for. This bird is found today in the Jordan Valley. None were identified.

Overall it can be assumed that the vast majority of the galliform bones belong to chicken. However, a small proportion of partridge/francolin bones do appear to be present, while the identification process cannot categorically exclude the presence of pheasant.

Distribution and Use

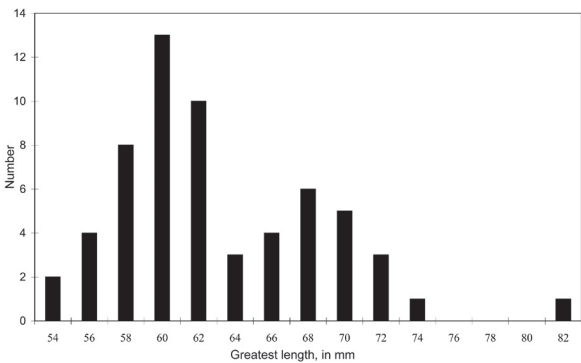
It can certainly be assumed that the chicken bones represent food waste. This is clearly confirmed by the plethora of butchery cuts (Table 3), which occur in all phases. The butchery and anatomical evidence (Table 2), indicates the possible sequence of events. Undoubtedly the bones represent the waste from entire birds, indicative, at the least, of the purchase of birds rather than joints (see age evidence below). It should be noted that the apparent

absence of phalanges is related to non-recording rather than non-recovery (see *Methods* above). The extensive butchery to the distal tibiotarsus (Table 3b) can be interpreted as a dressing cut, while cuts/chops to the humerus and femur are indicative of further carcass subdivision. This evidence suggests that it was common practice to joint the bird prior to cooking. This can be compared to the known Roman cooking practices (from Apicius) where recipes existed for whole birds as well as for joints. While the butchery evidence is rather slight in the later phases, it is perhaps significant that the heavier type of butchery, using the chopper, is absent from the Phase V chicken assemblage.

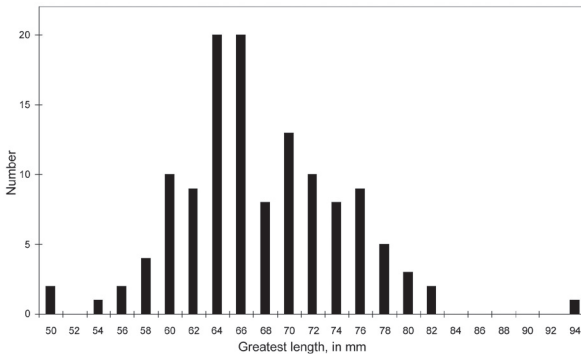
Regarding the age data (Table 4), it can be seen that a very large proportion of the birds were adult. This would point either to a preference for older meat or towards the importance of egg production. Certainly, significant quantities of eggshell were found in most phases, these principally identified as chicken (see Ch. V.16). Of interest was the recovery of a single very juvenile fragment from Phase IVa–b. This can be interpreted as infant mortality and, therefore, a clear indication of the on-site breeding of chickens. Given the aforementioned conclusion regarding the importance of egg production, it is perhaps surprising that this age group is so poorly represented. However, the fragility of the bones plus unlikely use of such young birds for their meat (and hence their non-inclusion in the general food waste dumps) probably act against their survival in the archaeological record.

With egg production, it is to be expected that there would be a far greater proportion of hens relative to cocks, the latter birds generally being culled prior to attaining adulthood. At this site, as mentioned, there is a very low proportion of immature birds. In addition the proportion of hens is certainly smaller than would be expected. The sex evidence is taken from the presence/absence of spurs on the tarsometatarsus (Table 5a) and of medullary bone (following Driver 1982), this confined to a study of the femurs (Table 5b). Medullary bone is essentially indicative of a hen in-lay and its presence/absence can be interpreted as female/male or female. Spurs provide more equivocal evidence as long as the analysis is limited to full scars, as rudimentary spurs can also occur on females (West 1982: 259). Further sex data is provided by the measurement data. Clear bimodal distributions can be seen in the distribution of the greatest length (following von den Driesch 1976) of humerii and tarsometatarsii (Graphs 1–2), the smaller peak interpreted as hens and the larger peak as cocks. The distribution of male and female birds amongst the tarsometatarsii is shown in Graph 3.

Within Graph 3 are included a number of bones interpreted as displaying ‘spur scars’. It is unclear whether these scars represent post-depositional damage to the spurs, or whether they represent the practice of burning off the spurs. Columella (8.1.3) described this practice, the



Graph 1: Chicken humerii for Phase IVa–b



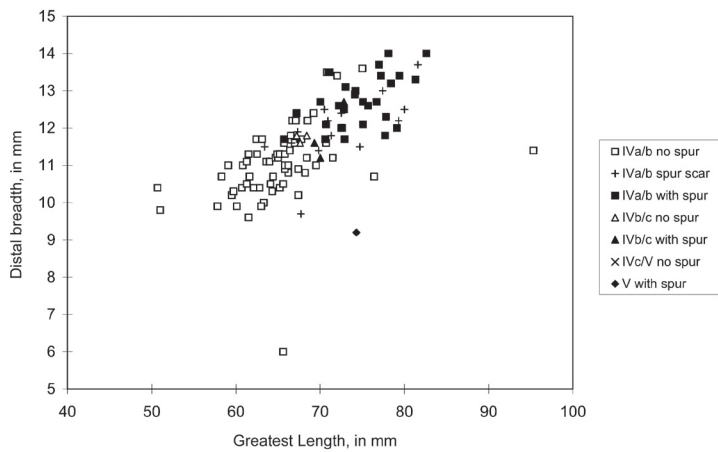
Graph 2: Chicken tarsometatarsii for Phase IVa–b

scar then being treated with potters clay until they healed. Birds treated in this way were erroneously referred to as capons (ibid.), true caponisation involving castration. It can, however, be assumed that this false caponisation had the desired affect, i.e. an increase in size and, therefore, of meat yield, by effectively removing the bird from competing with males (West 1982: 255). There is no clear evidence for true capons, though castration was carried out during the Roman period (ibid.). This could have been shown archaeologically by the presence of relatively large tarsometatarsii with true spur scars.

Overall, the birds present could include a few sub-adult birds (probably all males), and then a large quantity of older males, and a mixture of laying and non-laying females. This age and sex distribution pattern, apparently seen throughout the occupation period, though best demonstrated by the better represented Byzantine assemblages, is suggestive of the application of a relatively extensive exploitation strategy.

Size

A large quantity of bones were measurable, for example Table 6 shows the range of greatest length for the humerus, femur and tarsometatarsus. The range of sizes can certainly be linked to the distribution of sexes (see above and Graphs 1–3). Overall there would appear to be no obvious differences in size through time, the greater range shown in Phase IVa–b probably being related to the size of the sample rather than any real difference.



Graph 3: Chicken tarsometatarsii showing spurred and unspurred bones

Comparisons can be made with contemporary sites, such as late Roman/Byzantine Gadara, North Jordan (Rielly forthcoming), Abbasid Pella, Upper Jordan Valley (Rielly pers. comm.) and also Roman Mons Claudianus, in the eastern desert in Egypt (Hamilton-Dyer 2001: 280–1). Each of these sites provided a range of chicken sizes which were within those shown at this site. Of some interest is the recovery of particularly large hens, both at Deir ‘Ain ‘Abata and Mons Claudianus. Each site provided non-spurred tarsometatarsii with a greatest length exceeding 90 mm. It is to be wondered whether these sites exploited more than one type of chicken, a larger variety occurring infrequently amongst the ubiquitous small-sized chickens.

Other Birds

Identification

Various problems arose with regard to the identification of the other species shown in Table 1. These can be described under the following bird group headings.

Corncrake/Water rail: it was found (using the Natural History Museum reference collections at Tring) that certain bones appeared to resemble corncrake (*Crex crex*) more closely, while others were more similar to water rail (*Rallus aquaticus*). This distinction by skeletal part is very unlikely to represent the true situation, and thus it should be stressed that, while there is a high probability that both species are present, it is not possible to suggest which of the two is more abundant.

Doves: within this group there were a number of bones which conformed to rock dove (*Columba livia*) in size, others that appeared to be somewhat smaller, in one case smaller than collared dove (from Phase IVc), but in all cases they were larger than turtle dove (*Streptopilia turtur*). While more than one dove species may be present, it would seem probable that the majority belong to rock dove, possibly including a variety of wild/feral/domestic forms.

Perching birds (passerines): these can be divided essentially into thrush-sized and smaller. Within the

thrushes (*Turdidae*) it was possible to do a further subdivision into large and small, i.e. blackbird-sized and song thrush-sized. In two cases (both in Phase V) it was possible to identify particular species from each of these size groups: blackbird (*Turdus merula*) and song thrush (*Turdus philomelos*) respectively, this based on visible differences in shaft width. The smaller passerines appear to be lark/wagtail (*Alaudidae/Motacillidae*) in size (this group would also include the pipits). A further refinement was possible in just two cases, both from Phase V and both identified as large wagtail, i.e. pied/yellow wagtail (*Motacilla alba/cinerea*). These distinctions were based on the noted difference in length

of femur (for a similar-sized bird, this bone appears to be longer in the wagtails in comparison to larks), and also on a clear morphological difference between these two groups in the shape of the proximal humerus.

Ducks: this group contains a large number of species, most of which are very similar regarding both size and morphological characteristics. The exceptions are those at either end of the size range i.e. mallard (*Anas platyrhynchos*) and teal (*Anas crecca*). It is generally considered that the best policy concerning the other duck species is to use a general category of middle-sized ducks. The single specimen (from Phase V), is within the latter size category.

Sandgrouse: a small proportion of the bones identified to this group were similar in size to the pin-tailed grouse (*Pterocles alchata*), while others were clearly smaller. From this information it can perhaps be assumed that at least two species of sandgrouse are represented.

Finally, there is the possibility that certain of the small, and possibly large, galliform species have been misidentified (see above, Domestic Fowl, *Identification*).

Distribution and Use

With the likely exception of scops owl (*Otus scops*), each of these species can be classified as game birds. The range of species clearly shows the use of a variety of habitats (see Table 7), all of which would have been in fairly close proximity to the site. This includes the Lower Jordan Valley, which would have been ideal for the hunting of various water birds as well as perhaps the woodland species, also the desert areas to the south for sandgrouse, the nearby cliffs for pigeons, and then much of this general area for larks and wagtails. The present-day status of these birds is shown in Table 7. From this data it can perhaps be seen that hunting exploited year-round as well as seasonal resources.

Notably, the largest range of species were recovered from the earlier Byzantine and Abbasid levels (see Table 1). It is a general rule that the greater the sample size the greater the likelihood of a relatively larger species count. Thus the large species count amongst the relatively small

assemblage arising from the latest levels may be significant. There would appear to be some differences between the phase assemblages, which could perhaps be summarised as a decline in the exploitation of water birds in the latest levels (absence of corncrake and rail), but with an increase in the use of the more arid areas (presence of sandgrouse). Such changes could be related to availability (ease of capture rather than rarity or extinction) and/or preference. Again, these conclusions must be viewed with regard to the quantities of bones involved.

Overall it can perhaps be assumed that hunting for game birds provided only a very small proportion of the meat consumed at this site. It can be envisaged that such species may have been deemed expensive, either in expenditure of time or in monetary terms if purchased/traded.

Discussion

Overall the analysis of the bird bones from Deir 'Ain 'Abata suggests that the occupants of the site practised a relatively extensive exploitation strategy. Chickens were represented by a few sub-adult birds (probably all males), a large quantity of older males, and a mixture of laying and non-laying females. This suggests that both eggs and meat were important at the site. The presence of a single very juvenile fragment from Phase IVa–b may be interpreted as an infant mortality and, therefore, a clear indication of the on-site breeding of chickens. The anatomical representation data suggests that entire birds rather than joints were introduced to the site. Fowl may have been allowed to wander “free range” throughout the site and its surrounding area. The monastery may perhaps have been self reliant on its chickens and eggs. The slightly higher number of cockerels than might have been expected could be a result of a number of factors: cockerels may of course have been used for fighting purposes, or alternatively they could have been seen as representing more prestigious gifts from visiting pilgrims to the guardians of the monastery and shrine.

Comparing the Deir 'Ain 'Abata bird assemblage with other sites in the region is difficult as few sites

are published. What is a little surprising is the possible absence of chukar and quail, two species which would have been present in the vicinity. Both of these are found amongst the extensive Abbasid deposits at Aqaba. This latter site, like Deir 'Ain 'Abata, also produced corncrake. In general, the bird assemblages in broadly contemporary sites such as Aqaba, Pella (Byzantine Tel al-Husn and the Abbasid complex) and late Roman/Byzantine Gadara, are all largely composed of chicken with smaller numbers of partridge (all except Abbasid Pella) and rock/stock dove (except Gadara) (Rielly 1993 and forthcoming). It should be mentioned, however, that amongst these sites, only Aqaba and Abbasid Pella were sieved. The proportion of chicken amongst the sieved assemblages from Abbasid Aqaba and Pella is considerable, clearly suggesting that chicken provided a major part of the meat diet during this period. What is perhaps notable is that Pella is so limited in its range of bird species, especially when, unlike Deir 'Ain 'Abata and especially unlike Aqaba, it was situated within relatively easy reach of the water resources available in the Upper Jordan Valley. Yet corncrake, as mentioned, was found at Aqaba. It is interesting also that during the earlier periods at Pella, mainly Iron Age through to Byzantine, a wide range of ground and water game birds (although not in great numbers) were present. It should be noted that the doves represented at these sites may in fact be domestic, which would then leave partridge as the sole representative of game birds amongst the inland contemporary sites.

As few other Byzantine monastic communities have been investigated it is difficult to say whether the large proportion of chicken found within the early Byzantine layers at Deir 'Ain 'Abata relates explicitly to a particular type of monastic diet. Was such food intended for the priests and monks of the monastery or did the accumulation of food debris result largely from the food consumption of the lay people attached to the monastery, or both? Another possibility is that visiting pilgrims may have brought fowl to the site as gifts. Only the further analysis of material from other Byzantine religious and secular settlements in the region can hope to answer this question.

Table 1: Species representation

Phase	IVa	IVa/IVb	IVb	IVb/IVc	IVc	IVc/V	V
Domestic fowl	206	1339	556	145	73	158	168
Little grebe		1					
Duck (middle-sized)							1
Water rail		6	2				
Corncrake	3	19		2	1		
Sandgrouse							4
Rock dove		4			1		1
Scops owl		1					
Lark/Wagtail		3				1	1
Pied/Grey wagtail							1
Wagtail							1
Blackbird							1
Song thrush							1
Total (diagnostic)	209	1373	558	147	75	159	179
Total (unidentified/non-diagnostic)	93	4246	1335	455	286	367	364
GRAND TOTAL	302	5619	1893	602	361	526	543

N.B. Also present: Phase I and II–III (non-diagnostic) – 1 and 3 fragments respectively; Phase III – 6 chicken and 3 non-diagnostic fragments.

Table 2: Chicken anatomical representation

Phase	Skeletal part						
	coracoid	scapula	humerus	carpometacarpus	femur	tibiotarsus	tarsometatarsus
III	3	1	1		1		
IVa	36	18	27	22	33	43	27
IVa–b	280	220	135	193	135	174	202
IVb	124	74	57	51	76	90	84
IVb–c	31	22	16	18	16	21	21
IVc	21	12	10	5	9	10	6
IVc–V	35	20	18	15	22	22	26
V	33	21	25	12	12	37	28

Table 3: Chicken butchery
a) Distribution of butchery types

Phase	Butchery type		
	Knife cut	Chop marks	Cuts and Chops
IVa	11	4	0
IVa–b	86	36	4
IVb	28	13	2
IVb–c	15	2	0
IVc	2	0	0
IVc–V	10	5	0
V	14	0	0

b) Distribution by skeletal part

Phase	Skeletal part						
	coracoid	scapula	humerus	carpo- metacarpus	femur	tibio- tarsus	tarso- metatarsus
IVa			2,0,0			9,4,0	
IVa–b	4,1,0	1,0,0	26,3,0		8,18,0	33,12,4	14,2,0
IVb	4,0,0		10,2,1	1,0,0	0,2,0	11,9,1	2,0,0
IVb–c	0,1,0		2,0,0		3,0,0	10,1,0	
IVc		1,0,0				1,0,0	
IVc–V	0,2,0		3,0,0		4,1,0	3,2,0	
V			4,0,0		2,0,0	8,0,0	

Data sorted by butchery types, i.e. knife cut, chop marks, cuts and chops (see Table 3a)

Table 4: Chicken epiphyseal fusion data
a) Combined proximal end totals

Phase	Fused	Unfused	Fusing	V. Juvenile	% Fused
III	6	0	0	0	100.0
IVa	105	0	0	0	100.0
IVa–b	857	39	14	0	95.7
IVb	296	21	10	0	93.6
IVb–c	92	0	0	0	100.0
IVc	49	3	1	0	94.3
IVc–V	90	0	1	0	100.0
V	89	0	2	0	100.0

b) Combined distal end totals

Phase	Fused	Unfused	Fusing	V. Juvenile	% Fused
III	6	0	0	0	100.0
IVa	156	6	3	0	96.4
IVa–b	998	61	5	1	94.2
IVb	425	9	0	0	97.9
IVb–c	106	2	0	0	98.1
IVc	52	2	0	0	96.3
IVc–V	109	1	3	0	99.1
V	132	3	2	0	97.8

% Fused equals sum of fused and fusing/total epiphyses × 100.
Using all recorded skeletal parts

Table 5: Chicken sex data
a) Tarsometatarsus – presence/absence of spur

Phase	With spur	Without spur	% With spur
IVa	9	4	69.2
IVa–b	49	93	34.5
IVb	16	17	48.5
IVb–c	4	11	26.7
IVc	3	0	100.0
IVc–V	6	8	42.9
V	8	6	57.1

The recorded bones are all those with at least half of the distal epiphysis present and sufficient shaft to determine the presence/absence of spurs. % With spur taken as proportion of males.

b) Medullary bone

Phase	Presence	Absence	% Present
III	0	1	0.0
IVa	2	31	6.5
IVa–b	23	112	20.5
IVb	10	66	15.2
IVb–c	4	12	33.3
IVc	1	8	12.5
IVc–V	1	21	4.8
V	0	12	0.0

Data compiled from femurs only. Can assume that those with medullary bone are female, while those without are either male or female.

Table 6: Chicken limb bone length measurements
Greatest length (GL) after von den Driesch (1976).
All measurements in millimetres.

Part	Phase	Range	Mean	N
humerus	IVa–b	54.9–83.4	64.0	61
	IVb–c	58.5–70.8	64.2	7
	IVc–V	56.0–66.1	59.4	4
	V	56.2–70.4	62.4	6
femur	IVa–b	60.6–86.2	70.8	49
	IVb–c	70.1–75.5	72.9	5
	IVc–V	73.8	73.8	1
	V	70.4–77.1	74.2	3
tarsometatarsus	IVa–b	50.7–95.3	68.6	127
	IVb–c	67.2–78.5	70.5	7
	IVc–V	56.4–73.4	64.2	4
	V	62.7–74.5	69.9	4

Amalgamated Phases:- IVa–b including IVa, IVa–b and IVb; and IVb–c with IVb–c and IVc.
N is the number of measurable bones.

Table 7: Habitat distributions of recorded wild species/species groups

Species/ species groups	Habitat	Nesting	Status
Little grebe	Lakes and pools, sometimes densely vegetated.	Water (on heap of vegetation).	R/W
Duck (middle-sized)	Wetlands		W
Water rail	Dense aquatic vegetation, reed beds, overgrown ponds, ditches and river banks.	Reeds or sedges above shallow water	W
Corncrake	Meadows, lush vegetation and crops. Avoids standing water.	Nest concealed in grass or isolated tussocks.	M
Sandgrouse	Dry, rocky, semi-deserts, wadis and hillsides.	Nests on the ground.	R
Rock dove	Typically, pure forms occur in rocky upland areas and around sea cliffs but ferally occurs anywhere.	Crevices, caves among rocks.	R
Stock dove	Woodland and country with scattered trees, also on cliffs and sometimes in towns.	Nests in holes.	W
Scops owl	Trees near human habitation, plantations, oases, gardens etc.	Hole in tree or building, occasionally in old nest of other bird.	R
Lark/Wagtails	Ground-loving birds		
Pied wagtail/ Grey wagtail	Open flattish area with/without scattered vegetation, sometimes near water and often close to habitation.	Hole in wall, bridge, rock, banks, and near running water/cultivated areas.	W
Wagtail	(see above)		
Blackbird	Woodland, often deciduous, gardens, thickets, plantations, often near cultivation.	Dense bush or tree.	R/W
Song thrush	Woodland, often deciduous, shrubberies, plantations etc.	Bush or tree.	W

Information about habitat and nesting preferences after Hollom et al. (1988).
Status – R=resident, W=occurs in winter, M=spring and autumn migration.

ABBREVIATIONS AND JOURNALS

- AASOR
Annual of the American School of Oriental Research.
- ACO
E. Schwartz (ed.), *Acta Conciliorum Oecumenicorum*, vols 1-4, Berlin and Leipzig, 1924-40.
- ACOR
American Center of Oriental Research, Amman.
- ADAJ
Annual of the Department of Antiquities of Jordan, Amman.
- AJPA
American Journal of Physical Anthropology, New Jersey.
- ARAM
Aram, Periodical of the Aram Society for Syro-Mesopotamian Studies, Oxford.
- BAH
Bibliothèque Archéologique et Historique. Institut Français d'Archéologie du Proche Orient, Beirut-Damascus-Amman.
- BAR British Series
British Archaeological Reports. British Series, Oxford.
- BAR Int. Series
British Archaeological Reports. International Series, Oxford.
- BASOR
Bulletin of the American School of Oriental Research.
- BE
Bulletin Épigraphique in Revue des Études Grecques, Paris.
- BMCV
W. Wroth. *Catalogue of the Coins of the Vandals, Ostrogoths and Lombards and of the Empires of Thessalonica, Nicaea and Trebizond in the British Museum*, London: British Museum Press 1911.
- CAHL
G. C. Bottini, L. Di Segni, and E. Alliata (eds), *Christian Archaeology in the Holy Land: New Discoveries. Essays in Honour of Virgilio C. Corbo OFM*, Studium Biblicum Franciscanum Collectio Maior 36, Jerusalem 1990.
- CIG
A. Boeck (ed.), *Corpus Inscriptionum Graecarum*, Berlin 1828-77.
- DOP
Dumbarton Oaks Papers, Cambridge, MA. 1941-58; Washington, DC 1959-.
- EKBMM
Δελτίον του Ευρωπαϊκού Κέντρου Βυζαντινών και Μεταβυζαντινών Μνημείων. *Newsletter of the European Centre of Byzantine and Post-Byzantine Monuments*, Thessaloniki.
- HEO II, III
G. Fedalto (ed.), *Hierarchia Ecclesiastica Orientalis. Series episcoporum ecclesiarum christianarum orientalium*, vol. II. *Patriarchatus Alexandrinus, Antiochenus, Hierosolymitanus*, Padua 1988; vol. III. *Supplementum*, Padua 2006.
- IEJ
Israel Exploration Journal, Israel Exploration Society, Jerusalem.
- IFPO
Institut Français du Proche Orient, Beirut-Damascus-Amman.
- IG
Inscriptiones Graecae, Berlin 1873-.
- IGLS
Inscriptions Grecques et Latines de la Syrie, Paris 1929-.
- JECM V
The Joint Expedition to Caesarea Maritima, Excavation Reports, vol. V: C. M. Lehmann and K. G. Holum, *The Greek and Latin Inscriptions of Caesarea Maritima*, Boston 2000.
- JGS
Journal of Glass Studies, The Corning Museum of Glass, New York.
- JRA
Journal of Roman Archaeology, University of Michigan, Ann Arbor.
- LA
Liber Annuus, Studium Biblicum Franciscanum, Jerusalem.
- LGPN
P. M. Fraser and E. Matthews (eds), *A Lexicon of Greek Personal Names*, Oxford 1987-.
- LRBC
R. A. G. Carson, P. V. Hill and J. P. C. Kent, *Late Roman Bronze Coinage: A.D. 324-498*, London: Spink and Son 1978 (reprint).
- LSJ
H. G. Liddell and R. Scott, *A Greek-English Lexicon*, revised and augmented throughout by Sir H. S. Jones with the assistance of R. McKenzie, Oxford 1978, reprint of the new (9th) edn 1940; 1st edn 1843; P. G. W. Glare and A. A. Thompson, *Revised Supplement*, Oxford 1996.

MEC

P. Grierson and M. Blackburn, *Medieval European Coinage*, vol. 1, Cambridge University Press 1986.

Meletemata

Meletemata, Publications of the Research Centre for Greek and Roman Antiquity. The National Hellenic Research Foundation, Athens.

MIB

W. Hahn, *Moneta Imperii Byzantini*, vol. 1, Vienna: Austrian Academy of Sciences 1973.

NDIEC

New Documents Illustrating Early Christianity, The Ancient History Documentary Research Centre, Macquarie University, Alexandria and Marrickville 1981–.

Nessana 1

G. E. Kirk and C. B. Welles, 'The inscriptions', in H. D. Colt (ed.), *Excavations at Nessana (Auja Hafir, Palestine)*, vol. 1, London 1962, 131–97.

Nessana 3

C. J. Kraemer, Jr., *Excavations at Nessana*, vol. 3. Non-Literary Papyri, Princeton, NJ, 1958.

ODB

A. P. Kazhdan et alii (eds), *The Oxford Dictionary of Byzantium*, New York and Oxford 1991.

PAES IIIA

E. Littmann, D. Magie Jr. and D. R. Stuart, *Publications of the Princeton University Archaeological Expeditions to Syria in 1904–5 and 1909*, Division III. *Greek and Latin Inscriptions*, Section A. *Southern Syria*, Leyden 1921.

PEQ

Palestine Exploration Quarterly, Palestine Exploration Fund, London.

PG

J. P. Migne (ed.), *Patrologiae cursus completus. Series Graeca*, Paris 1857–66.

PLRE II

J. R. Martindale, *The Prosopography of the Later Roman Empire*, vol. II. (A.D. 395–527), Cambridge 1980.

QDAP

The Quarterly of the Department of Antiquities in Palestine, London.

Qedem

Qedem, Monographs of the Institute of Archaeology, The Hebrew University of Jerusalem.

RB

Revue Biblique, Paris.

RIC VIII

J. P. C. Kent, *The Roman Imperial Coinage VIII: The Family of Constantine I, AD 337–364*, London: Spink and Son 1981.

RIC X

J. P. C. Kent, *The Roman Imperial Coinage X: The Divided Empire and the Fall of the Western Parts, 395–491*, London: Spink and Son 1994.

SCI

Scripta Classica Israelica, Yearbook of the Israel Society for the Promotion of Classical Studies, Jerusalem.

SEG

Supplementum Epigraphicum Graecum, Leiden and Amsterdam 1923–.

SHAJ

Studies in the History and Archaeology of Jordan, Department of Antiquities, Amman.

ZDPV

Zeitschrift des Deutschen Palästina-Vereins, Wiesbaden.

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- Doroth.** = **Dorotheos of Gaza** in L. Regnault and D. J. de Préville, (1963). *Dorothee de Gaza: Oeuvres Spirituelles*. (Sources Chrétiennes 92). Paris: Éditions du Cerf.
- Jerome.** *Saint Jérôme, Lettres*, (vol. 9), J. Labourt (ed.) (1951). Paris: Les Belles Lettres.
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- Miracula** = **Antonius Chozebitae**, 'Miracula beatae virginis Mariae in Choziba', *Analecta Bollandiana* 7 (1888): 360–70.
- Prudentius.** 'Cathemerinon', in H. Isbell (ed. and transl. 1971), *The Last Poets of Imperial Rome*. Harmondsworth: Penguin, 153–77.
- Sulpicius Severus.** *Sulpice Sévère: Vie de St Martin (vols 1–3)*, (ed. J. Fontaine 1967–69). (Sources Chrétiennes 133–135). Paris: Cerf.
- V. Char.** = **Vita Charitonis** in G. Garitte (ed.) (1941). 'La vie prémétaphrastique de S. Chariton.' *Bulletin de l'Institut Historique Belge de Rome* 21: 16–46.
- V. Cyr.** = **Vita sancti Cyriaci**, by **Cyril of Scythopolis** E. Schwartz (ed.) (1939). *Kyrrillos von Skythopolis*. (Texte und Untersuchungen zur Geschichte der althristlichen Literatur 49/2). Leipzig, 222–35.
- V. Euth.** = **Vita sancti Euthymii**, by **Cyril of Scythopolis** in E. Schwartz (ed.) (1939) *Kyrrillos von Skythopolis*. (Texte und Untersuchungen zur Geschichte der althristlichen Literatur 49/2). Leipzig, 3–85.
- V. Geor.** = **Antonius Chozebitae**, **Vita sancti Georgii Chozibitae** in C. House (ed.) (1888), 'Vita sancti Georgii Chozibitae auctore Antonio Chozibita', *Analecta Bollandiana* 7: 95–144, 336–59.
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