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Portmahomack on Tarbat Ness: Changing Ideologies in North-East Scotland, Sixth to Sixteenth Century AD

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Digest 7.1 SUMMARY REPORT ON ANIMAL BONES

KRISH SEETAH (OLA 7.3.1)

Method

The zooarchaeological investigation followed the system implemented by Bournemouth University, with all identifiable elements recorded (NISP: Number of Identifiable Specimens) and diagnostic zoning (amended from Dobney & Reilly 1988) used to calculate MNE (Minimum Number of Elements) from which MNI (Minimum Number of Individuals) was derived. Ageing of the assemblage employed a combination of Grant's (1982) tooth wear stages and fusion of proximal and distal epiphyses (Silver 1969). Metrical analysis followed von den Driesch (1976). Elements from sheep and goats were distinguished, where possible, based on criteria established for the post-cranial skeleton by Boessneck (1969) and teeth by Payne (1985) and Halstead et al (2002).

Identification of the domestic and wild component of the assemblage was undertaken with the aid of Schmid (1972) and Cohen & Serjeantsen (1996). The marine mammal component of the assemblage was identified with the help of Ericson & Storå (1999). Dr Chris Stimpson (Department of Archaeology, University of Cambridge) generously identified the avian bones. Zooarchaeological reference material from collections of the Grahame Clark, Zooarchaeology Lab, Department of Archaeology, University of Cambridge; the Zoology Museum, Cambridge and the specialist avian collection of the Natural History Museum housed at Thring, Hertfordshire, were also used in the analysis of this assemblage. Taphonomic criteria, including indications of butchery, pathology, gnawing activity and surface modifications as a result of weathering, were also recorded when evident.

The range of wild and domesticated species identified is summarised in Tables 3.6–3.8 in Chapter 3, pp 62–5.

Size and condition of assemblage

Following an initial assessment of the material, bones from 850 contexts were scanned, producing a total of 32,479 recorded fragments. Having identified the key components of the global assemblage that merited full analysis, a comprehensive zooarchaeological investigation was undertaken of material from both Sector 1 and 2. This resulted in a recorded sample of some 16,731 fragments from 855 [850] contexts, of which 11,763 (70%) were identifiable to element level, and a further 7,035 (42%) were identified to species. Some 8,862 bones were classed as having moderate to good preservation, whereas 3,445 were considered poor. Of the bones that underwent full analysis, 15,629 (93%) fragments were recorded from Sector 2.

Species represented

The assemblage as a whole was dominated by domestic species (Table D7.1.1).

Cattle were the most numerous species, accounting for 73% of the identifiable portion of the assemblage. They were also the most numerous in terms of MNI, with some 305 individual animals calculated from the MNE. Pig and sheep/goat were also recovered in representative numbers; however, their economic significance was apparently less important than cattle. The MNI count for the horse component of the whole assemblage was calculated to be nine individuals; six of these derive from Period 4. A large proportion of loose horse teeth recovered from Period 4 levels accounts for much of this, with sixty-four teeth recorded. Dog bones were recovered in greater numbers than horse; however, this is predominantly as a result of a near complete juvenile canid skeleton recovered from C1319 (Int 24).

The most abundant non-domesticates are red and roe deer; figures for red deer are inflated due to the presence of a relatively large number of antler fragments. The number of wolf finds (four individuals) is unusual, wolf finds being notoriously rare. The avian assemblage is markedly diverse. Sea birds are present in significant numbers. Geese were recorded in greater numbers than domestic chicken; however, this component included individuals from a range of species as opposed to domestic geese only. From the materials present it was not possible to refine the identification of the geese component to species level. One 'wader' was recorded and this was likely a grey heron (*Ardea cinerea*).

The marine mammal cohort showed a noteworthy level of diversity. Unfortunately, fragmentation – particularly of the largest whale species – and state of preservation made firm identification problematic. However, it was clear that large (minke whale sized), medium (porpoise sized) and small (dolphin sized) cetaceans, along with seals (common/harbour seal, *Phoca vitulina* and possibly grey seal, *Halichoerus grypus*, identified) were recovered.

Cattle: ageing, sexing and metrical data

Age

Both tooth wear and fusion data were used to establish an age range for cattle from this sub-assemblage. In total, it was possible to determine tooth wear stages from 100 individual mandibles; a significantly great number of fusion counts, 617 in total, were recorded. In combination, these data provide a reasonable estimate of the overall age profile of this sub-set. The tooth wear data strongly favours individuals classed as 'Adult' or 'Old Adult', with just three examples of sub-adult animals (estimated to be between 18 to 30 months old). Mandibular wear stages are calculated on the basis of permanent molars, this method is thus not ideal for identifying juvenile specimens. To deal with this, Grant's system includes the recording of deciduous and pre-molar teeth. At least ten juvenile cattle still retained the deciduous dentition, approximately 10% of the overall 'adult' component. This figure calls for caution in assuming that the cattle cohort is comprised principally of old adults. While this is in fact the case from the evidence we have, it must be noted that calves were also present, and in noteworthy numbers. The fusion data, which given that the greater sample size is likely to be providing a more complete age profile for the site, still shows 'Adult' and 'Old Adult' individuals in the majority. However, at least sixteen individuals died as sub-adults, under the age of 12 months, as evidence from the unfused distal radii count.

Sex

Unfortunately, due to the fragmentary nature of both the recovered horn cores and innominate bones it was not possible to determine the sex of any of the individual animals. The portion of horn core still attached to the cranium suggests that the horns themselves were not particularly large and could have potentially derived from either males or females. However, from the corpus of metrical data it was possible to extract two sub-sets denoting the size variation at the proximal joint of metacarpals (forty-seven individuals) and metatarsals (forty-four individuals). The results would seem to indicate two relatively clearly defined groups,

Table D7.1.1
NISP and MNI counts all species

Species	NISP	%NISP	MNI
Cow	5,124	72.8	305
Pig	721	10.2	71
Ovicaprid	355	5.0	28
Horse	199	2.8	9
Dog	270	3.8	9
Cat	11	0.15	2
Fox	33	0.47	4
Wolf	4	0.05	4
Hare	2	0.02	1
Cervid – no species assigned	2	0.02	2
Red deer	97	1.4	3
Roe deer	35	0.49	4
Otter	5	0.07	2
Birds	83	1.2	16
Chicken	20	0.3	3
Anser sp	34	0.5	8
Raven (*Corvus corax*)	2	0.03	1
Razorbill (*Alca torda*)	7	0.09	1
Lesser black-backed gull (*Larius cf fuscus*)	1	0.01	1
Cygnus sp	1	0.01	1
European shag (*Phalacrocorax aristotelis*)	11	0.2	2
Gannet (*Morus bassanus*)	1	0.01	1
Common redshank (*Tringa totanus*)	1	0.01	1
Eurasian curlew (*Numenius arquata*)	2	0.03	1
Western capercaillie (*Tetrao urogallus*)	2	0.03	1
'Wader'	1	0.01	1
Marine mammal (one unid'd)	94	1.3	9
Whale sized	15	0.2	2
Porpoise/dolphin sized	9	0.1	1
Seal	70	0.99	5
ULM	3,431	29.1 (Σ = 11763)	–
UMM	1,191	10.1 (Σ = 11763)	–
USM	1	0.008(Σ = 11763)	–
UUB	91	0.07 (Σ = 11763)	–
UUF	3	0.02 (Σ = 11763)	–
UUM	4,968	29.7 (Σ = 16731)	–

Key: USM, UMM & ULM = Unidentified Small, Medium and Large Mammal/UUB & UUF = Unidentified Bird and fish/UUM = Unidentified Fragment. NB: Species percentages are out of 7,035. These differ from the unidentified counts as these were calculated on the basis of element identification (for UMM & ULM) and total fragments (for UUM) (corresponding to Σ in brackets)

based on size of the proximal joint. From the metacarpal plot, it would appear that some 35 individuals, probably representing female animals, are distinguishable from a smaller, approximately 10 individuals, sample of male animals (two individuals fall between the main groupings). In contrast, the metatarsal evidence suggests the reverse, with a larger cohort of bigger, perhaps male, animals.

Stature

By using the greatest length measurement from the metacarpals and metatarsals (fifty-one in total) and Matolcsi's (1970) correction factor it was possible to estimate the average withers height of the sampled cattle, calculated as follows (after Matolcsi 1970):

Females: Metacarpal GL × 6.03/Metatarsal GL × 5.33

Males: Metacarpal GL × 6.33/Metatarsal GL × 5.62

As the sex of the individual animals was not known, each measurement was first calculated using the equation for estimating female stature, then male, then averaged. Overall, the withers height for individuals from the pooled data elicited an average stature of 1.1m for cattle at Portmahomack in Periods 2 and 3.

Body parts

Body part representation for cow suggest that all parts of the carcass are present. There is a bias towards cranial elements, but this might not be representative since there is a greater probability of these parts becoming fragmented.

Pig

Ageing of pig was again based on tooth wear and fusion data. Some fifty-five tooth wear stage records were taken, alongside 138 fusion counts. The majority of individuals were killed at between 18 to 30 months of age, indicating their use as meat animals. The pig cohort exhibits a classic cull-profile for this species, with a high number of young animals and a small number of older animals retained for regeneration of the population. Unfortunately, sexing was not possible for pigs as the majority of skull and pelvic elements were fragmented. Culling would have focused on sub-adult animals that are less likely to have developed sexually distinctive characteristics. No large canines were recovered that may have indicated large male animals. Because of the large number of unfused elements overall and the fact that bones such as the metacarpal and metatarsal are considered 'Middle' fusing (and therefore unlikely to have fused by the time the animals were slaughtered), metrical analysis was not assistive in determining sex. As with cattle, body part representation for pig indicates that all elements are present on site. Once again, there is an over emphasis of cranial bones and loose teeth, which is likely result taphonomic fragmentation.

Sheep/Goat

Tooth wear scores from twenty individuals were recorded, with a further 109 fusion records noted in order to estimate age at death for sheep/goat specimens. The cull patterns for S/G is in line with that observed for cattle, suggesting similar pressures on these species ie secondary products. This said, the S/G component reflects a preference towards goats. Where it was possible to identify that the specimen was clearly a sheep or a goat, in all instances – six in total – the individual artefact was noted as being derived from goat. Body part representation mimics the pattern observed for the other domesticates ie all body parts present, with an emphasis on cranial portions.

Butchery

Some 679 separate butchery records were noted on 224 individual bones from this assemblage, and good evidence was forthcoming on the sequence of tasks involved in the butchering process. One skull points to the mode of slaughter: pole-axing. This practice was common up to and including the modern period and is noted in the Tarbat assemblage from a skull demonstrating a slightly off-centred 'puncture' with associated circular and spiralling fracture marks. The fractured (but still attached) bone just above the circular indentation indicates that a punch point, with blunt force, was used rather than an actual cut.

The majority of cutting took place with smaller blades *at* joints rather than chopping *through* the joints with cleavers or axes. This suggests a more refined approach to the butchery, as well as the likelihood that while regular and repetitive, it was not an 'everyday' task. The carcass was portioned into the main units ie shoulder and upper forelimb, leg and upper hind limbs, with the central rib cage and vertebrae left as one unit. Cleavers were used for bone breaking and sectioning of specific parts of carcass only, once it had been broken down into these main units. This subsequent activity took place on large tables or 'blocks'. Evidence for the above derives from a very clear sequence noted on the rib heads and vertebrae. Chop marks were recorded that demonstrated that rib heads and vertebrae were separated, whilst they were still joined, by using a cleaver. This took place on a block as the cut marks were delivered from above, straight down, travelling from the internal surface of the animal (ventral) to the back (dorsal). Thus, the person performing the butchery was standing over the carcass and chopping straight down. An alternative method to achieve the same separation of ribs and vertebrae would be to chop down along the spine. However, this would have resulted in cut marks travelling from the posterior of the animal to the anterior (tail to head); this was not the case.

Considering the overwhelming predominance of cattle on this site, it comes as no surprise that the majority of cut marks were recorded on this species. The butchery data were highly informative, indicating that a variety of implements were in use, ranging from fine blades to cleavers. The evidence from detailed microscopic analysis of the surface of the marks themselves would suggest that some of these blades potentially included steel technology.

Cut marks were also noted on both fur-bearing (otter) and game (red and roe deer) species. The highest occurrence of butchery relative to the number of specimens was recorded on marine mammals from all size categories.

Pathologies and non-metric anomalies

Pathological changes were noted on some seventeen individual elements. These were predominately associated with traction use on cattle distal limb bones, with five examples of eburnation (hardening) noted. A pig mandible showed evidence of an abscess. This was likely the cause of death as no healing of the abscess had occurred. Another infectious pathology was noted on the ulna of a pig, marked by the presence of a festule (tubular bone tract) to release pus. A non-metric anomaly was noted on a lower third molar that demonstrated a missing third cusp; this was not pathological.

Variations over time

Domesticates (see Chapter 3, Table 3.6, p 62)

Variations over time are subject to distortions due to the different sample sizes from Periods 1–4. Using the raw data of NISP, cattle dominate throughout, but there is a slight increase from Period 1–3, and subsequent decrease in Period 4. This is matched by a reduction in numbers of pig, and an increase in the numbers of ovicaprids in later periods. The raw data of the MNI count show a greater level of variability by period, with a pronounced dip in cattle from Period 2 to 3, and subsequent rise in Period 4. However, when these raw data are represented as a proportion of the overall MNI, ie as percentages, these fluctuations are generally evened out, although the main trend of an overall increase in cattle and sheep, at the expense of pig, remains consistent and would appear to corroborate the fragment count data (OLA 7.3.1.1, Graph 11, p 25).

The horse component of the overall assemblage shows a marked increase in Period 4, then accounting for nearly 10% of the assemblage.

Age variation in cattle by period

Some 103 MWS (Mandible Wear Stage) stages were calculated from mandibles recovered

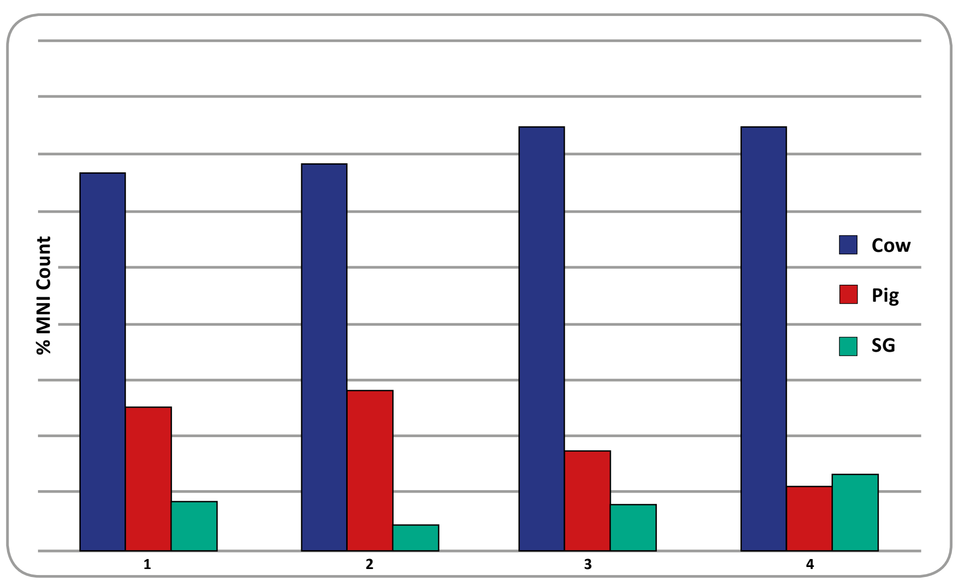

Illustration D7.1.1
Proportions of main domestic species by period (%MNI)

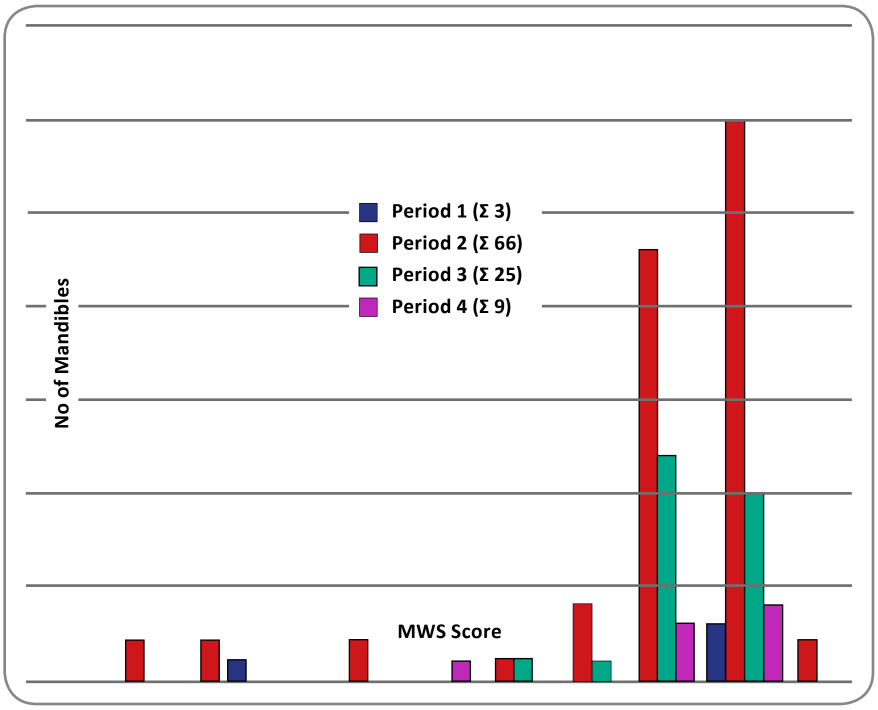

Illustration D7.1.2
MWS calculation by Period

from the four periods. In addition, a further 608 fusion data points were also assessed to investigate cull patterns over time. The overall trend of a predominance of animals falling into the 'Adult' and 'Old Adult' category, is maintained through the four periods (OLA 7.3.1.1, graph 12, p 26). However, there are some fluctuations. It would appear that there is greater proportion of younger animals being culled in Periods 2 and 3. Period 2 evidences a trend towards the culling of animals in the 'Old Adult' class, Period 3 shows a decline in this category and a greater number of 'Adult' animals. Of the eleven juvenile mandibles that were noted as having the deciduous premolar present, none were recovered from Period 1, six derived from Period 2, with a further three from Period 3, and two noted from Period 4. Although these figures are small, they would seem to suggest a greater representation of calves in Period 2 and a decline in Period 3. However, this may also be a reflection of the sample size.

The fusion data (OLA 7.3.1.1, Graph 14, p 29) would seem to indicate a general increase in the culling of younger animals in later periods. The variation is subtle but does represent a noticeable pattern. By presenting the percentages of the collated data, rather than raw counts, graphs 12 and 13 take variations in sample size into account. Thus, the fluctuations observed from one period to the next are not merely a consequence of sample size bias, although this will no doubt have had an impact.

Conclusions

The clear and overwhelming bias towards domestic species indicates focused management resulting in reliable meat stocks as well as, and perhaps more importantly, consistent exploitation of secondary products. There can be little doubt of the economic significance of cattle. Both the fragment count and MNI calculation reinforce this point. It is generally considered that sheep supersede cattle as the most significant economic species during the medieval period, sheep (but not goat) becoming important as providers of wool. Tarbat apparently bucks this trend. The cohort of sheep/goat finds supports this: all examples from the 'S/G' category that could be definitively identified were goat.

The mortality profile of cattle provides a clear indication that animals were generally raised to old age (with evidence for 'senile' animals also indicated by the tooth wear profile). The sexual data is somewhat contradictory – the metacarpals seem to indicate a predominance of female animals and the metatarsals favour male, but the overall pattern points towards adult individuals. This firmly points towards secondary product exploitation, and while cattle would no doubt have provided significant quantities of meat, it would appear that they were slaughtered after a long working life. Linking the metrical data with the incidences of pathology, it may be suggested that traction was an important aspect of animal management. The metacarpal data is indicative of dairying; this is further reinforced by the presence of a sizeable component of juvenile animals, accounting for a NISP of 49 and MNI of seven individuals.

The presence of all elements, including head and distal foot bones, would indicate that the animals were either brought in on-the-hoof and/or raised locally. The fact that this pattern

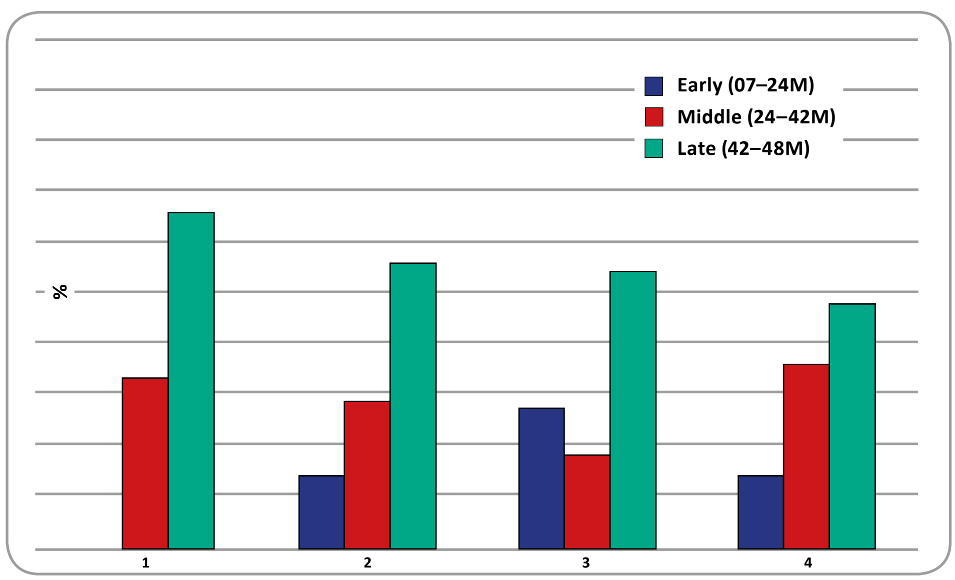

Illustration D7.1.3
Fusion data (% unfused) for cattle by Period

is repeated for all species would reinforce the notion of husbandry and management in situ. Furthermore, as the metrical data shows very little variation between individual animals, this could indicate that the animals themselves were drawn from a relatively restricted geographic region, a factor that isotopic analysis could certainly shed light on.

With cattle kept in significant numbers, but apparently for secondary products, and sheep/goat mimicking the pattern for cattle, it would appear that pig was the main meat provider. While this is not in itself a surprise, what is interesting is that despite the wealth of primary animal resources clearly evident from this site, meat does not appear to be the main concern. The fact that pig bones are more common than sheep/goat serves to reduce the importance of the latter; traction, diary products, meat and leather were derived from cattle; pigs were kept in relatively small numbers, and this actually serves to deemphasise the key resource that pigs provide: meat. This is further supported by the fact that pig numbers fall slightly through time. The fact that sheep/goat were apparently kept in smaller numbers than pig perhaps suggests that they were of marginal importance, or were ecologically unsuitable.

Of the wild species present, the finds are likely indicating species either trapped or actively hunted for specific products. The finds of capercaillie would almost certainly have made their way into the assemblage via hunting, given the type of woodland – dense coniferous – that it favours. This is also likely to have been the case for the other wild species, especially otter and wolf, given their habitats and habits, which are unlikely to bring them into contact with man. However, the significance of environment is most clearly contextualised from the perspective of marine mammals. The presence of such a diverse range of marine mammals gives some indication of the extent of resource exploitation, and specifically, the fact that this was evidently tied closely to available local resources.

There is clear evidence of a range of specialist implements in use for butchering, along with refined and systematic cutting practices. The tools used were predominantly knives – potentially with steel cutting edges – cleavers appear to have been reserved for chopping against a block. The repetitive, and consistent, manner in which the skulls of cattle were processed suggests both a high degree of skill and clear 'guidelines' for the types of butchery required. Thus, in this instance there is lucid evidence for the *outcome* of carcass processing (size of portion per body part) to have been clearly defined from the outset of butchering.

The diverse range of species, including food and (traditionally) non-food domesticates, that had occurrences of butchery is revealing. Skinning marks noted on otter, as well as antler removal 'chops' noted on red deer, indicate a diverse range of practices associated with activities not directly related to meat exploitation. Particularly revealing in this regard was the relatively high frequency of cut marks registered from marine mammals. Although the level of fragmentation, which, incidentally, was as a result of processing, was too great to construct detailed sequences, it was clear that heavy, repetitive and systematic exploitation of a range of marine species was undertaken. This exploitation was for meat as well as blubber.

The confusing matter with regard to craft specialisation is the fact that, whilst present in the assemblage, the numbers of elements with marks indicative of skinning, horn working and antler processing are relatively small. This suggests that the skills for these tasks were present within the monastic community, but employed on an ad hoc basis. Alternatively, and more likely, is that, as yet, the excavations have not revealed the main dumpsites. One would not, for example, expect to find skinning waste close to a tanner.

The assemblage had a relatively large number of 'neonatal' animals. Only two were recorded from Period 1, although this is likely a result of small sample size. Periods 2, 3 and 4 elicited thrity (nineteen neonates), twenty-five (twelve neonates) and twenty (nine neonates) juveniles respectively. These values, and those for the juveniles that could be categorised on the basis of MWS and Fusion, show a decline through time. Though small, the trend is an important one. It may indicate a change in husbandry or indeed, a transition in craft exploitation. The finds of juvenile bones certainly support the presence of vellum processing. In fact, the majority of juvenile cattle bones are neonatal, falling into an age range between 185 and 255 days (Prummel 1987). A few examples are older, based on tooth eruption, but overwhelmingly, the cattle are very young individuals. These numbers do not of themselves equate with book production. Gameson (1992) suggests that at least thirty individual animals would need to be slaughtered to produce one 246mm × 170mm volume with 200 folios. This figure is dwarfed when one considers the number of animals, 1,545, required to produce the three volumes of the *Codex Amiatinus* (see Chapter 5.6, p 210). It is likely that the assemblage recovered to date represents predominantly food waste, and only to a lesser extent waste from craft.

References

Boessneck, J 1969 'Osteological differences between sheep (*Ovis aries*) and goat (*Capra hircus*)', *in* Brothwell D & Higgs E S (eds) *Science in Archaeology*, 2nd edn, 331–58. London: Thames & Hudson.

Cohen, A & Serjeantson, D 1996 *A manual for the identification of bird bones from archaeological sites, revised edition*. London: Archetype Publications Ltd.

Dobney, K & Reilly, K 1988 'A method for recording archaeological animal bones: the use of diagnostic zones', *Circaea* 5(2): 79–96.

Ervynck, A 1997 'Following the rule? Fish and meat consumption in Monastic Communities in Flanders (Belgium)', *in* De Boe, G & Verhaeghe, F *Environment and Subsistence in Medieval Europe. Papers of the Medieval Europe Brugge 1997 conference*. Vol 9. Zellik: IAP Rapporten 9.

Gameson, R 1992 'The cost of the Codex Amiatinus', *Notes and Queries* 39(1): 2–9.

Grant, A, 1982 'The use of tooth wear as a guide to the age of domestic animals', *in* Wilson, B, Grigson, C & Payne, S (eds) *Ageing and sexing animal bones from archaeological* sites, 91–108. Oxford: Archaeopress.

Halstead, P, Collins, P & Isaakidou, V 2002 'Sorting the sheep from the goats: morphological distinctions between the mandibles and mandibular teeth of adult *ovis* and *capra*', *Journal of Archaeological Science* 29: 545–53.

Langdon, J 1984 'Horse hauling: a revolution in vehicle transport in the Twelfth- and Thirteenth-Century England?', *Past and Present* 103: 37–66.

Matolcsi, J 1970 'Historische Erforschung der Körpergrösse des Rindes auf Grund von ungarischem Knochenmaterial', *Zeitschrift für Tierzüchtung und Züchtungsbiologie* 87: 89–137.

Mettler, J 1986 *Basic butchering of livestock and game*. Vermont: Storey Books.

Payne, S 1985 'Morphological distinction between the mandibular teeth of young sheep *Ovis* and goats *Capra*', *Journal of Archaeological Science* 12: 139–47.

Prummel, W 1987 'Atlas for the identification of foetal skeletal elements of cattle, horse, sheep and pig. Part 2', *Archaeozoologia* 1(2): 11–42.

Schmid, E 1972 *Atlas of animal bones*. Amsterdam: Elsevier.

Silver I A 1969 'The ageing of domestic animals', *in* Brothwell D R & Higgs E (eds) *Science in Archaeology*, 2nd edn, 283–301. London: Thames & Hudson.

von den Driesch, A 1976 'A guide to the measurement of animal bones from archaeological sites', *Peabody Museum Bulletin* 1. Cambridge Massachusetts: Harvard University.

Digest 7.2 FISH BONE

MATILDA HOLMES

Introduction

The fish bone assemblage comprises a few small samples from Period 1 to 3 features and a considerable assemblage from the midden and other Period 4 features (Table D7.2.1). Although the earlier sample is small, its contrast with that of the later phase makes it worthy of consideration.

Method

Bones were identified using the author's reference collection and other resources as required, they were recorded using the York system (Harland et al 2003), where only the most diagnostic elements are identified. Condition of the assemblage was recorded (following Lyman 1994, 355), as was evidence for other taphonomic factors such as butchery, gnawing, burning and working. Measurements were taken where the bone was complete enough (Morales & Rosenlund 1979). Information on the ecology of species was taken from Fishbase (Froese & Pauly 2000).

Both hand-collected and sieved samples (sieved to 1mm) were recorded.

Taphonomy and condition

The bones were generally in good condition (Table D7.2.2), with a small number able to be refitted from smaller fragments. A high proportion of Period 1 to 3 bones were burnt (63%), suggesting they were subject to different processing than those of the later phase, of which only a few fragments (2%) were burnt. Five bones from Period 4 had been gnawed.

Butchery and fragmentation

Butchery marks were only observed on Period 4 bones. Very few vertebrae included the lateral or dorsal spines, even in the sieved samples there were very few spinous processes (25% of the total number of ribs, rays and spinous processes and vertebrae), which suggests that these were removed at an earlier stage in processing. While this could be a matter of taphonomy, occasional butchery marks were observed on cod vertebrae, largely in the axial direction on the lateral aspect of vertebrae (Illus D7.2.1), but also, more rarely, as transverse chops and cuts. A similar cut mark was observed on a haddock caudal vertebra, in a transverse direction. Although not obvious from the bagged assemblage, the site record notes a number of articulated vertebrae that would have been deposited intact, as part of a butchery process.

Other butchery included a cod vomer that had a knife cut to the dorsal aspect and an articular from a gadidae spp with holes pierced in it (Illus D7.2.2), possibly resulting from hanging the fish or removing a fishing

Table D7.2.1
Number of fish bones identified to species and/or anatomy by feature type

Feature	1 or 2	2	2 or 3	3	4
Culvert		1	3	3	
Gulley					34
Hollow					278
Layer					5
Pit					31
Post-hole					27
Road				1	
Scoop					9
Shell Midden					1,125
Spread	2	1			297
Well		1			
Total	2	3	3	4	1,806

Illustration D7.2.1
Two illustrations of butchery occurring on cod vertebrae

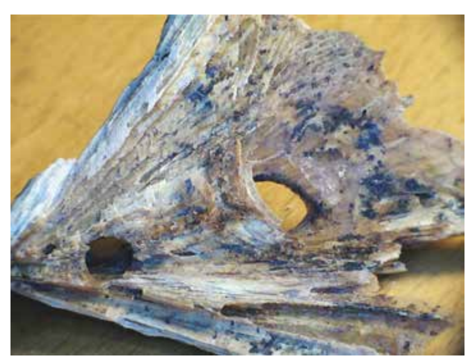

Illustration D7.2.2
Holes pierced in a gadidae articular fragment

Table D7.2.2
Condition and taphonomic factors affecting the fishbone assemblage

Condition	1 or 2	2	2 or 3	3	4
Fresh					1
Good	1	1	1	1	1102
Fair	1	1	2	3	680
Poor		1			23
Very poor					
Total	2	3	3	4	1806
Burnt	2	1	2		32
Gnawed					5
Refit			1 = 2		14 = 33

hook – the size of the hole is consistent with hooks recovered on site (C Spall pers comm).

When the skull elements present were compared with those from sites of known function (Barrett et al 1999, 372, fig 378), they are consistent with the results from sites where fish were being cured and exported (Illus D7.2.3; Table D7.2.3). And this, combined with the location of butchery marks and presence of filleted vertebrae, suggests that the cod assemblage from Period 4 was consistent with the waste left following preservation previously recorded at Robert's Haven, Caithness, and St Boniface, Orkney (Barrett et al 1999, 371; Barrett et al 2008, 852). The haddock assemblage included greater numbers of cleithra, which are more commonly recorded on sites where whole fish were consumed. However, this is also a phenomenon that has been observed on other sites and related to the unusually robust cleithrum of the haddock, creating a bias in favour of preservation of this element (Barrett et al 1999, 373). Haddock, too, may be the result of preservation or curing waste, particularly given the low numbers of supracleithra.

Period 1 to 3 (sixth–eleventh century)

This assemblage, although small, included freshwater or marine char, oceanic cod and horse mackerel (Table D7.2.4). Char are present in deep glacial lochs in Scotland, and could have been caught in the highland lochs Morie or Glass *c* 26 miles away by land, or Loch Ness, *c* 30 miles away by sea (National Library of Scotland 2012). However, all three species are available in coastal waters or further out at sea. The increase of cod in the eighth to ninth century is consistent with the increase in cod fishing in the Viking Age period (ninth to eleventh centuries) (Barrett et al 2000, 151; Barrett et al 2004, 624).

Period 4 (thirteenth–fifteenth century)

The increase in fish bone evidence from this phase comes exclusively from marine fish (Table D7.2.4). The majority of the assemblage derives from large numbers of cod and haddock, but includes various demersal species living on or near the ocean floor ie flatfish (plaice, halibut and, possibly, dab), conger eel, halibut, haddock and saithe, all of which could be caught from close to the shoreline. Other species are benthopelagic and can be caught at all depths, such as herring, cod and pollack. All these fish occupy littoral zones and can be found within the range of the continental shelf, so could be caught from the shore or with a small boat keeping close to the coast. Herring, cod, conger eel, halibut, haddock and saithe may be caught further out to sea.

The increase in gadid family species (ie cod, saithe, pollack and haddock) has been observed in assemblages from northern Scotland in the medieval period (Barrett et al 1999, 356), which is consistent with the findings from Portmahomack. This reflects the intensification of the fish trade in both Scotland and Europe at that time (Barrett et al 1999; Barrett 2008).

A small number of measurements were available for cod and haddock bones, which were used to estimate the total length of fish (using equations in Jones 1991). The results for cod (Illus D7.2.4) were compared with those given for a number of medieval northern Scottish sites (Barrett et al 1999, 361, fig 364), those from Portmahomack lying within the range for larger fish. No such comparanda were available for haddock, but they were similarly in the larger range of samples given

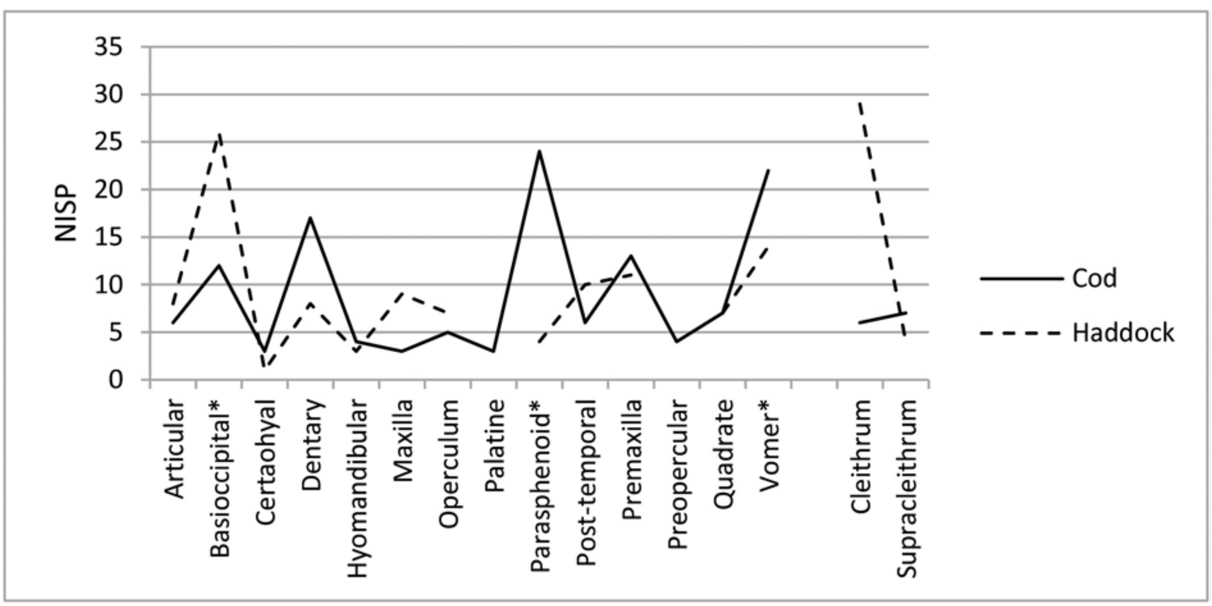

Illustration D7.2.3
Proportion of elements recorded for the cod and haddock assemblages in Period 4 (number of mid-line fragments doubled). Based on the greater likelihood of cleithrum and supracleithrum to be kept with the fish following preservation (after Barrett et al 1999).

Table D7.2.3
Anatomical elements recorded for the Period 4 fishbone assemblage (NISP)

Element/species	Cod	Pollack	Saithe	Haddock	Herring	Gurnard	Conger	Halibut	Flatfish	?Dab	Plaice
Articular	6			8							
Basioccipital	6			13							
Certaohyal	3			1							
Cleithrum	6			29							
Dentary	17	1		8			1				
Hyomandibular	4			3							
Maxilla	3			9							
Operculum	5			7							
Otolith	1			8							
Palatine	3										
Parasphenoid	12		1	2		1					
Posttemporal	6			10							
Premaxilla	13			11							
Preoperculum	4									1	1
Quadrate	7			7							
Supracleithrum	7			4							
Vomer	11			7							
Abdominal vertebrae	323	2		164			42				
Caudal vertebrae	403	17		434	2		91		1		7
Vertebrae	12						4				
Ultimate vertebrae				5							
1st Anal Pterygiophore								1			
Total	**853**	**20**	**1**	**730**	**2**	**1**	**138**	**1**	**1**	**1**	**8**

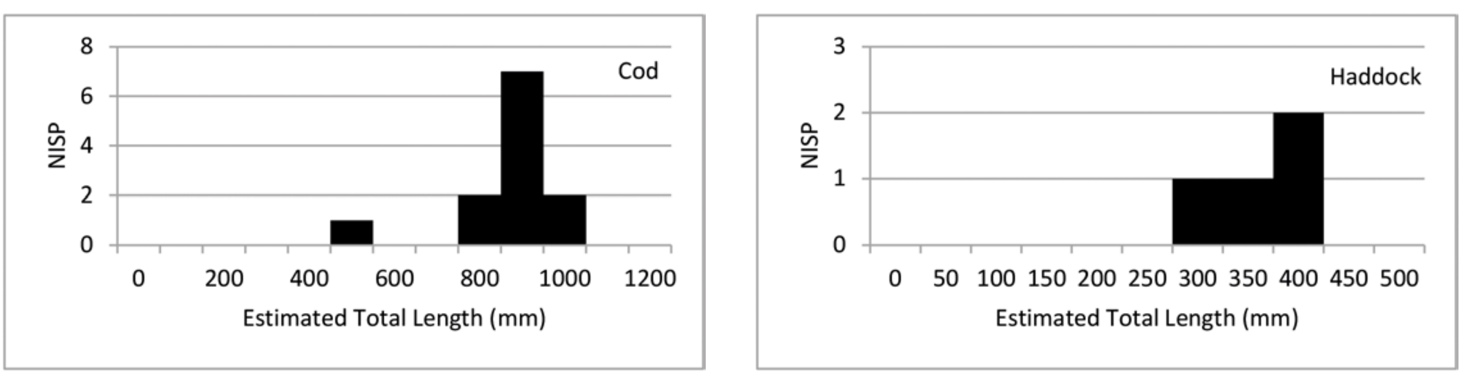

Illustration D7.2.4
Estimated total length of cod and haddock from the Period 4 assemblage. Based on dentary measurements, following equations by Jones 1991

by Jones (1991, 155, fig 157). The life cycle of cod suggest that larger fish are more likely to live in deeper waters, and the size of cod from Portmahomack are consistent with those suggested by Barrett et al (1999, 363) to be large enough to have required deep sea fishing.

Summary

Although not a vast sample size, the fish bone assemblage from Portmahomack has allowed some comments to be made regarding the nature of fish exploitation from the sixth to fifteenth centuries, of which relatively little is known in this area of the British Isles. The earliest phases were typified by a very small number of fish bones, suggesting that nearby lochs may have been fished, or, more likely, that the closer, more easily accessible marine resources were taken advantage of. The evidence from isotope studies on the human bone at the site suggest that only negligible amounts of marine resources were eaten by the inhabitants of the site in this phase. This is consistent with the low numbers of fish bones recovered on the site, the members of the monastery possibly focusing their attentions towards more land-based food sources.

Following a hiatus between the eleventh and thirteenth centuries, there was evidence for an intensification of the utilisation of marine stocks to have taken place in the intervening period. This is not surprising, as the phenomenon has been recognised on English sites from *c* AD 1000, and those from further north in both Scotland and Europe as occurring on Viking Age sites from *c* AD 900. The diversity of species suggests that both coastal and deep-sea waters were exploited, requiring some considerable expenditure of time and skill. Furthermore, the implications from metrical analysis suggest that larger fish were targeted, requiring the use of deep-sea fishing methods.

The combination of butchery marks and anatomical representation further implies that the deposits of cod and haddock resulted from a preservation process, where fish were beheaded and vertebrae removed on site, and then smoked or salted with the cleithra and/or supracleithra intact, to be traded further afield or supplied to another location.

Table D7.2.4
Species representation (NISP) of hand-collected material and that from samples

Species	1 or 2	2	2 or 3	3	4
Char	2	1	2	1	
Horse Mackerel	1				
Gadidae	1				46
Small Gadidae					1
Cod			1	3	853
Herring					2
Conger					138
Gurnard					1
Haddock					730
Pollack					20
Saithe					1
?Dab					1
Halibut					1
Plaice					8
Flatfish					1
Total	**4**	**1**	**3**	**4**	**1803**

References

Barrett, J, Beukens, R & Nicholson, R 2000 'Diet and ethnicity during the Viking colonization of northern Scotland: evidence from fish bones and stable carbon isotopes', *Antiquity* 75: 145–54.

Barrett, J, Nicholson, R & Ceron-Carrasco, R 1999 'Archaeo-icthyological evidence for longterm socioeconomic trends in northern Scotland: 3500 BC to AD 1500', *Journal of Archaeological Science* 26: 353–88.

Barrett, J H 2008 'Cod bones and commerce: the medieval fishing revoloution', *Current Archaeology* 221: 20–5.

Barrett, J H, Johnstone, C, Harland, J, Van Neer, W, Ervynck, A, Makowiecki, D, Heinrich, D, Hufthammer, A, Enghoff, I, Amundson, C, Christiansen, J, Jones, A, Locker, A, Hamilton-Dyer, S, Jonsson, L, Lougas, L, Roberts, C & Richards, M 2008 'Detecting the medieval cod trade: a new method and first results', *Journal of Archaeological Science* 35: 850–61.

Barrett, J H, Locker, A & Roberts, C 2004 'Dark Age Economics' revisited: the English fish bone evidence AD 600–1600', *Antiquity* 78: 618–36.

Froese, R & Pauly, D 2000 *Fish Base 2000: Concepts, Design and Data Sources*. Penang: The World Fish Center.

Harland, J, Barrett, J H, Carrott, J, Dobney, K & Jaques, D 2003 'The York System: An integrated zooarchaeological database for research and teaching', *Internet Archaeology* 13.

Jones, A 1991 *The fish remains from Freswick Links, Caithness*. Unpublished thesis, University of York.

Lyman, L 1994 *Vertebrate Taphonomy.* Cambridge: Cambridge University Press.

Morales, A & Rosenlund, K 1979 *Fish Bone Measurements. An Attempt to Standardize the Measuring of Fish Bones from Archaeological Sites.* Copenhagen: Steenstrupia.

National Library of Scotland 2012 'Bathymetrical Survey of the Fresh-Water Lochs of Scotland, 1897–1909', *http://maps.nls.uk/bathymetric/index.html* [Accessed March 2012].

Digest 7.3 SHELLFISH

MATILDA HOLMES

Introduction

Shellfish were abundant in the middens of Period 4 associated with the lay settlement, and because of this, a sampling programme was undertaken whereby a few shells were kept for identification, but the majority were weighed and discarded. Shells from earlier deposits (Periods 1 and 2) relating to the early Christian monastery were all kept, and originated from a variety of features (Table D7.3.1). Because of the Period 4 sampling strategy, and bias introduced by the likelihood that only the biggest or most representative shells were kept back for identification, no measurements were taken on the Period 4 material.

Method

Shells were weighed and identified to family or species where possible (following Crothers 2003). Condition of the shells was recorded, as well as their completeness. Taphonomic processes affecting the assemblage were also noted, including burning, butchery, gnawing, perforations, encrustations and abrasion (Claassen 1998, 54–9). Measurements were taken following guidelines by Claassen (1998, 109–10) and bivalves were sided where possible.

Both hand-collected and sieved samples were recorded.

Taphonomy and condition

Shells were in fair condition, although highly fragmentary. Encrustations and perforations caused by parasites were common on whelk shells, oysters and, less often, winkles (Table D7.3.2). A large number of shells (crab and winkle) from Period 4 deposits showed signs of burning, and one winkle shell, also from this period, bore numerous cut marks.

Periods 1 to 2 (sixth–ninth century)

Shellfish from these periods came from discrete features, with a concentration of whelks in and around pit F325 in Int 14. Winkles were recorded further to the south, from features within Int 24 associated with the vellum yard. Limpets, oysters and cockles were less commonly recorded (Table D7.3.3).

With the exception of two flat winkles (*Littorina obtusata* or *Littorina fabalis*), the rest were identified as the common or edible winkle (*Littorina littorea*), both of these species inhabit the middle and lower shore areas. Although it has been suggested that winkles were roasted to be used as lime in the vellum production process, there was no evidence of burning on the shells in this assemblage. However, this may not be

Table D7.3.2
Condition and taphonomic factors affecting the shellfish assemblage

Condition	1 or 2	2	2 or 3
Excellent			
Good	3	6	16
Fair	31	87	
Poor		16	
Very Poor			
Total	34	109	16
Burnt		6%	81%
Butchery			6%
Encrustation	3%	11%	
Perforation	3%	11%	6%
Refit		1 = 4	

Table D7.3.1
Number of shells identified to species by feature type

Feature	1 or 2	2	2 or 3
Culvert		13	
Ditch		3	
Dump		8	
Floor		1	
Hollow			1
Layer	11		
Pit		23	1
Shell Midden			13
Spread	23	61	1
Total Number	34	109	16
Total Weight (g)	4.2	22.5	36 860.6*

* Period 4 weight includes discarded sample from the midden

Table D7.3.3
Shellfish recorded to species from hand collected and sampled deposits

Phase	1 or 2		2		4*	
Species	Number	Weight	Number	Weight	Number	Weight
Winkle	21		72	2.2	1	23817
Flat Winkle			2			
Whelk			30	18.2		
Common Whelk			1			
Cockle	1	0.1				
Limpet	3	0.1	3	0.5	1	7097
Oyster	9	4	1	1.6	1	1.6
Crab					13	–
Mussel						5945
Total	34	4.2	109	22.5	16	36890.6

* Number of fragments from Period 4 comes from a sample kept back from the middens. Weights include all midden shells including those later discarded

surprising, as those winkles that had been roasted and crushed would not survive well in the archaeological record.

Although the use of dog whelks (*Nucella lapillus*) for the production of purple pigment has been documented as occurring in Anglo-Saxon Britain, little direct evidence has been forthcoming (Biggam 2006, 2). Unfortunately, despite their association with manuscript production at this site, the only whelk shell complete enough to be identified to species was that of the common whelk (*Buccinum undatum*), which are distinct from the dog whelk. Common whelks are found on the lower shore and could be easily exploited.

Native British oysters (*Ostrea edulis*) were present and could have been picked from freshwater, estuarine or marine beds. Cockles and limpets are also common finds on the middle and lower shoreline.

Period 4 (thirteenth–fifteenth century)

As with the earlier period, winkles dominated the Period 4 assemblage by weight (Table D7.3.3), and given their small size compared to the other common shellfish, suggests the intensive exploitation of this species. Mussels and limpets were also recorded in significant numbers from the middens, along with a small number of crab claws and oyster shells. It is likely that these species formed part of the diet and they could have been easily gathered from the shore.

Summary

The sheer quantity of shellfish remains in the Period 4 middens suggests intensive exploitation. Although it is possible that shellfish were exported from the site, it is most likely that the accumulations of shells derive from animals eaten by the inhabitants of the settlement.

Despite the results of isotope analysis on the human remains of the earlier Periods 1 and 2 indicating that there was no intensive exploitation of shellfish for food, it is possible some were occasionally eaten, resulting in the significant deposit of winkles. There was no direct evidence for the use of shells for craft purposes – the winkles were not burnt or otherwise processed, and the whelks were not of the correct species to produce pigment.

References

Biggam, C 2006 'Whelks and purple dye in Anglo-Saxon England', *The Archaeomalacology Group Newsletter* 9: 1–2.

Claassen, C 1998 *Shells*. Cambridge: Cambridge University Press.

Crothers, J 2003 'Rocky shore snails as material for projects (with a key for their identification)', *Field Studies* 10: 601–34.

Digest 7.4 SUMMARY REPORT ON PLANT AND INSECT REMAINS

ALLAN HALL and HARRY KENWARD (formerly University of York) (OLA 7.4.1)

A wide variety of samples was collected during excavations at Portmahomack over the period 2004–11, including spot finds of charcoal and uncharred wood, and other charred and waterlogged plant material. Some samples were processed by wet-sieving by FAS for recovery of charred remains; and some further samples of whole sediment containing material preserved primarily by anoxic waterlogging were processed by the author and by others. In some cases, the material offers insight into fuel use at and importation and use of materials from the hinterland to the site, whilst in others, aspects of the past environment of the inhabitants of the site at Portmahomack have been addressed through studies of plant and insect remains.

For samples of charcoal and other charred remains treated as spot finds or residues/flots from sieving, the quantity of material submitted was weighed to the nearest gram as a rough guide to the quantity present. In some cases, material was sieved to remove fine debris before being examined under the low-power binocular microscope. Charcoal was identified by examining transverse sections, either from the original surface or by creating freshly broken surfaces. where necessary. For waterlogged wood, thin sections in one or more of three planes were taken with a razor blade and examined using a transmission microscope.

Some samples in which the bulk of the preservation was by anoxic waterlogging had been disaggregated by staff at Headland Archaeology during an early phase of assessment and the authors received 'flots' from paraffin flotation. Some other material had been examined at this stage by Headland Archaeology and their comments are, where relevant, subsumed into this account (OLA 7.4.2).

Lastly, a group of samples from the channel/'millpond' in Sector 2 was processed (by ARH) using one of the two series of column samples obtained by FAS. These were in the form of cling-film wrapped slices, each of about 200–330g in weight. They were disaggregated and sieved following the general procedures of Kenward et al (1980) (with the use of sodium carbonate and boiling for some of the early processed samples, though this was not found very effective in facilitating disaggregation). The wet residues were then checked (by ARH) for macroscopic plant remains, which were recorded semi-quantitatively on a four-point scale of abundance (from 1 – one or a few items per kg of original sediment to 4 – very abundant or a major component of the deposit), along with all other components of the samples. Representative insect remains observed during this stage were picked out for examination (by HKK) with paraffin flotation (again following the methodology of Kenward et al (1980)) used in one case.

Detailed comments on the material examined are presented in OLA 7.4.1 Table 1, where the order and grouping of samples follows the narrative below. Note that the deposits from the stream channel/'millpond' are treated separately (OLA 7.4.1 Table 2) since their dating stretches from Period 0 to 2.2+.

Period 0 Fill of charcoal pit/kiln F573

C3536

The material in the two samples examined was primarily charred birch roundwood (up to about 35mm in diameter). The observation that much of the material in Sample 24/8538 comprised bark with tarry deposits on outside surfaces is perhaps consistent with the idea that this material was deliberately made charcoal, since tars would tend to be concentrated in the enclosed environment of a charcoal clamp. But this also raises the possibility that pitch was being produced by this kiln as a primary product or a by-product to the charcoal.

Period 1 Fill of ditch F129

C1325, C1337 and C1345

The series of samples from this feature were notable for their content of charred cereal remains, with both grains and chaff fragments represented, evidently discarded into the ditch rather than being burnt there. The presence of grains and rachis (ear stalk) fragments of rye, barley and free-threshing wheat might be considered to imply bulk processing of cereals nearby: charring having occurred either during the crop drying phase of processing or during a conflagration of a storage context, whilst an origin in waste from threshing is perhaps unlikely, given the paucity of weed seeds. The presence of charred debris which may have arrived in turves is perhaps the key to this material – it may have been burnt debris from a straw and turf roof (though the absence of cereal culm material might argue against that, in which case one might invoke a crop within a turf-roofed and/or walled building, both of which were destroyed by fire).

Period 1 Fills of hearth F535

C3305, C3406, C3467, C3473, C3499, C3500, C3502 and C3528

Plant material surviving in charred form in the deposits associated with this hearth primarily comprised the coarse woody material from the basal parts of heather plants, sometimes with twig fragments from the upper parts, identified with certainty in most of the samples. There were also some charred rhizome fragments, presumably from surface-cut turves – perhaps from the organic litter layer from which the heather had been pulled. Likewise, the record of fragments of burnt peat in three samples also points to peat turves, or to the same kind of surface-deposited organic matter from an area of heathland or moorland. The traces of barley grains in four samples might represent material from straw, or accidental burning of grain intended for food, in the hearth. Charred hazel nutshell was present in two samples in this group.

Two samples from a deposit identified as a dump of spent fuel, adjacent to the hearth (C3467 and C3528), yielded a very similar range of remains. Charred hazel nutshell and traces of barley grains were noted in one sample within this group.

Period 1 Samples from gulley F436, well F527 and cistern F530

C2224, C3227 and C3570

Three samples fell outside of these Phase 1 context groups. Two consisted of willow stems (details in OLA 7.4.1 Table 1), whilst the organic content of a sample from C3227, the fill of a stone-lined cistern, appeared to be mainly burnt peat, or perhaps surface-cut heathland/moorland turves.

Period 2 Building material from buildings/structures

C1030, C1866, C1872, C1916 and C2704

Sixteen samples from five contexts from layers of 'primary burning' relating to the destruction of Period 2 Phase 2 buildings by fire were examined and were, not surprisingly, dominated by wood charcoal (principally of oak, present in thirteen samples). There were also numerous records of hazel charcoal, mostly from roundwood, typically from stems about 15mm in diameter and therefore, presumably, most likely to be from wattle (they would be rather slender for roof purlins, for example) though a less formal brushwood layer within a roof is possible). There were remains of heather in many samples, sometimes in the form of small leafy shoot or twig fragments, in other cases as coarser root/basal twig material.

This is consistent with the excavators' record of C2704, for example, as having 'contained burnt wattle and heather rope' and woven wattle, though none of this could be discerned directly from the samples as supplied. Some small charred peg-like structures in Sample 24/6773 may have been from roofing material – pegs might be used in the fixing of turves or other thatching material. The thatch seems most likely to have been of heather (perhaps with some cut turves as an underlay), since the grass or straw debris likely to represent cut reed or cereal stems do not seem to be present in the assemblages.

Period 2 Hearth fills associated with S9

C2468, C2777, C2786, C3196, C3198 and C3252

This group comprised material from hearths F445, F495 and F529, within the 'vellum-makers' yard' adjacent to S9. The two small samples from focal hearth F445 included charred (?)heather root/twig and some barley grains, whilst much the same material was recovered from refurbished focal hearth F495 (noted during excavation as 'containing frequent lenses of pure turf charcoal and occasional pockets of unburnt turf present as decayed brown silt'). Sample 24/3196, in particular, contained what appeared to be burnt peat/mor humus (the latter more likely from surface-cut turves than deeper-lying peat), with root/rhizome and sedge nutlets as further probable indicators of an origin in turves. From a sample from focal hearth F529, further burnt amorphous peat was recovered, along with heather twig and (?)heather basal twig/root fragments, as well as a single burnt spirorbid shell and charred and uncharred snails (spirorbids are discussed further in the next section). A second sample from another layer within the same hearth produced what might have been a tiny fragment of charred seaweed, as well as further (?)heather charcoal, but the bulk of the sample seemed to be unburnt mor humus, again consistent with the excavators' observations.

Period 2 Other deposits associated with S9

C1917, C2109, C2889, C3140 and C3171

The sample from C1917, a layer of ash and burnt shell, gave the strongest evidence in this group for material from the marine littoral. There were burnt marine shells, including periwinkle, as well as charred seaweed with frequent burnt spirorbid shells. The latter live mainly as epibionts on seaweed and are unavoidably imported with their substrate. They can serve as a proxy for seaweed, even when none is recorded in its own right. Closer identification of spirorbids is difficult, if not impossible, but their interpretation does not depend on knowing the species concerned. Similarly, a sample from C3140, recorded as a shell-rich sand, forming part of an earth and stone bank (F476), included further charred seaweed material along with marine shell, spirorbids, traces of foraminiferans (marine micro-fauna) and a few burnt snails, which included two *Hydrobia* cf *ulvae*, a species likely to have arrived with seaweed. The assemblage as a whole points to imported seaweed and shells, presumably burnt to produce a form of lime for processing skins (which process is also inferred from other evidence). A third sample rich in spirorbid shells was from C3171, an ashy dump; again, there were traces of burnt seaweed and some charred herbaceous material that may have originated in turves.

Quite different, yet still charred material was recovered from C2889, recorded as burnt structural material. Here, there was a sample comprising a mixture of what may have been burnt peat with charcoal, the latter including oak and (?)heather, with some fine charred herbaceous stems and fine charred moss stems, perhaps from burnt surface-cut turves. Another sample was of coarser charred herbaceous stems, perhaps from some large sedge-like plant such as bulrush or sea club-rush (*Scirpus lacustris/maritimus*) and most likely, material from a thatched roof.

The sample from C2109 was a chisel handle on which mineral-replaced wood was present; the wood may have been alder but was not conclusively identified (24/4716).

Period 2 Deposits associated with S7

C2295 and C3509

The sample from C2295 was material from a wooden structure, from which a willow twig provided a radiocarbon date. From C3509, the final backfill of a stone-lined culvert, F431, there was a single sample of very humic sand. Not surprisingly, as a final fill it probably bears no relation to the life and use of the culvert; the assemblage of plant remains was dominated by wood fragments and elder (*Sambucus nigra*) seeds, the former perhaps largely also from elder bushes. On the whole, the material gave the impression of inwashed terrestrial material, though fragments of caddis larval cases stood out as the exception to this. It is perhaps significant that the only beetles recorded were of terrestrial species, one of which, *Grynobius planus*, is a wood-borer and the only beetle associated with trees to have been found in any of the assemblages which yielded insect remains.

Period 2 Deposits associated with monastic boundary walls

C2584, C2677 and C2697

Four samples from C2584 were from charred remains of a hurdle and were from a variety of tree species: alder, birch, hazel, oak and an unidentified conifer, together, in one case, with traces of (?)heather root/basal twig. Generally, the charcoal seemed to have come from well-grown plants which perhaps – not surprisingly – implies management of woodland for poles suitable for hurdles (providing long straight specimens) rather than casual collection from unmanaged local woods. Charcoal from C2677, adjacent to F483 (collapsed burnt hurdle), included birch, hazel and oak, along with willow/poplar/aspen and, again, some fragment which were probably heather root/basal twig. The hurdle elements were again from well-grown stools. Lastly, a further selection of charcoal samples from a hurdle from C2697 contained alder, hazel, oak and willow/poplar/aspen as well as (?)heather. The quality of growth of the rods, as marked by their ring-widths, was not noted as especially good or bad, except in the case of material from one sample (Sample 24/2697), which was hazel, perhaps from a stem perhaps 100mm in diameter, and therefore perhaps a sail (upright) rather than a rod; here there were some tens of annual rings across the section, suggesting rather slow growth. It may be significant that a sample of this charcoal returned a radiocarbon date rather earlier than others for this phase.

Period 2 Enclosure ditch S16

C1401, C1404, C1405 and C1407

These deposits were the waterlogged fills from the basal sequence in the monastic enclosure ditch and had been examined previously by Mhairi Hastie at Headland Archaeology. Only 0.5l samples had been processed and the material examined by the present authors consisted of glass jars of 'residue' and some sorted remains. HKK makes the point that much larger samples (3–5kg) would undoubtedly have furnished rather more valuable information. The interpretative potential of these insect assemblages was very much limited by the small numbers of remains: few taxa were recovered, and it was not possible to make a reasonable judgment as to the relative importance of the various habitats suggested. The site is, of course, located in an area where many species common in more southerly locations might not be able to exist, restricting the potential range that might be recovered in any case (though this would not necessarily prevent the recovery of useful data from the insects, as it has proved possible in areas such as Iceland and Greenland, with extremely limited local faunas).

Those caveats notwithstanding, the ditch clearly contained water, at least intermittently, at the time the lowermost deposits (C1407) formed, for there were both plant and insect taxa requiring a body of standing water. The bulk of the biota, though, was of terrestrial origin, with the abundance of elder seeds (and with wood and twig fragments of this species, too), perhaps suggesting scrub overhanging the ditch. Consistent with such scrubby vegetation were the moderate numbers of fruits of rough chervil (*Chaerophyllum temulentum*), docks (*Rumex*) and stinging nettle (*Urtica dioica*). Amongst the insects there were some dung beetles, pointing to the presence of nearby livestock, or of extensive grazing land more generally. Perhaps the ditch formed the boundary to a field, with the elder scrub part of a hedge line. The presence of rough chervil so far north in the seventh–eighth centuries may be of some significance in terms of climatic change; this area is very much the northern limit for the species at the present time (Preston et al 2002, 456, as *C temulum*).

Much the same kind of assemblage of plant remains was seen in C1405, with very abundant elder seeds and many elder twig fragments. There were again some 'hedgerow' taxa, but also present here were traces of uncharred heather (twigs, shoots and flowers), the bog moss *Sphagnum* (leaves) and bog myrtle (*Myrica gale*). They must have originated in an area of heathland or bog, perhaps, for example, via imported materials for roofing. The presence of traces of arable weed seeds points to a further component from a quite different source. By contrast, the insect remains offered no evidence for human occupation in the vicinity, though as pointed out in the detailed narrative (OLA 7.4.1 Table 1), such taxa may be rare in deposits forming even quite close to occupation.

The theme of an elder twig/seed-rich assemblage continued into C1404, though with twigs of alder and willow also present. There was clearly a return to more permanently standing water at this time, evidenced by the insect remains – which included several aquatic taxa – and by the plants, amongst which were abundant water crowfoot (*Ranunculus* Subgenus *Batrachium*) achenes. Hedge/scrub communities were again indicated by the insects, as well as cultivated land, grazing land and waste places, but with none of the presumed occupation materials seen in the sample from C1405.

Finally, the uppermost fill in this sequence, C1401, was largely twiggy debris, including a substantial chunk of elder trunk wood and many elder seeds, along with abundant water crowfoot achenes (some of them finding their way onto the larval cases of caddis flies that lived in the ditch at the same time). Much the same kinds of habitats were represented, but there was a decline in overall numbers of taxa – and here the observation that some of the wood looked as though it had become somewhat decayed before burial may be of relevance. Perhaps the ditch was drying out more frequently, leading to some decay between phases of standing water (during which material was much better preserved).

Two other samples from this sequence were timber and twigs; not surprisingly, perhaps, they, too, were elder.

Period 2/3 Hearth fills in S1

C1082, C1086, C1141, C1142, C1527, C1615, and C1621

Material from focal hearth F65, S1, was represented by samples from six contexts (all those listed, apart from C1527). Wood ending up as fuel – whatever its original function – comprised alder, birch, hazel, Pomoideae (perhaps rowan or hawthorn, for example), oak, and willow/poplar/aspen, with hazel, oak, and willow/poplar/aspen being the most frequently recorded. Heather root/basal twig fragments were recorded in six samples, with other parts of heather plants noted in several of them: buds, flowers, twigs – presumably from cut or pulled heather brought as fuel or from recycled heather thatch, for example. There were occasional fragments of charred root/rhizome and herbaceous material which may have arrived with surface-cut turves (especially in Sample 11/4171, C1615, the principal surviving fill of the hearth). Oat and barley grains (but no wheat) were occasionally recorded too, and five samples (from three contexts) furnished charred hazel nutshell.

The single sample from C1527 (the fill of a stone-lined 'flue' serving the interior of S1), comprised remains of three charred barley grains from which a radiocarbon date in the ninth and tenth centuries was obtained.

Period 3 Fills from metal-workers' hearths

Material from hearth F148: C1412

The three small samples yielded remains of charcoal of oak and hazel, with, in one case, some heather root/basal twig and a little charred straw. Another sample produced a single oat grain.

Material from hearth F353: C1545 and C1815

The small sample was mainly oak charcoal.

From a deposit interpreted as a metalworkers' dump by hearths F148 and F353, an iron hook (24/4804) was recovered and mineral-replaced wood from its handle was examined, but could not be identified.

The last sample in this group was from C1724, a fill from a further hearth or firepit, F299. It comprised burnt (?)peat (or perhaps organic soil) and heather root/basal twig fragments.

Period 3 Fills of S5 ditch F3

C1009, C1010, C1018, C1126, C1127, C1128, C1130, C1132, C1135, C1136, C1137, C1140, C1141, C1147, C1148, C1149, C1150, C1151, C1153, C1154 and C1156

The earliest silting onto the basal sands was represented by a single sample from C1156 in which the ancient (charred) remains comprised traces of barley grains and (?)heather root/basal twig fragments.

This was followed by a slumping episode (C1150, C1151, C1153 and C1154) from which the thirteen mostly minuscule samples produced only scraps of charcoal (most of which was not identified any further, though there was some heather from two samples from C1150), traces of barley grains, and a few uncharred and presumably recent weed seeds.

A phase of burning came next. Here, the four samples from two contexts (C1148 and C1141) yielded three records of oak charcoal, one of hazel, and two examples of charred heather twigs, with two of (?)heather root/basal twigs. The presence of charred root/rhizome in the two samples from C1141, and of sedge nutlets in one of them, perhaps points to an origin in burnt surface-cut turves.

Deposits interpreted as originating from the erosion of the bank are next in the sequence. The fourteen samples (from C1132, C1135, C1136, C1140, C1147 and C1149) perhaps included material originally deposited in Period 2, since there were traces of (?)burnt peat and (?)charred seaweed across two of the contexts and (?)heather root/basal twig in five of the samples (representing four contexts). Some lesser clubmoss megaspores in a sample from C1140 might indicate material from unburnt turves if they are not inwashed from local damp short turf. Traces of barley grains were recorded from two samples from two contexts and tentatively from a third.

From a sand deposit laid prior to levelling, four samples (from C1127, C1128, C1130 and C1137, all equivalent layers) yielded between them no more than a few barley grains. And a little oak charcoal

The latest layers in the infill of the ditch were interpreted as relating to its final levelling (C1009, C1010, C1018 and C1126). Perhaps not surprisingly, there were few ancient remains (but quite a few records of uncharred – presumably recent – weed seeds) in the six small samples available: the remains were much the same as in deposits below, with three records of oak charcoal, two of (?) heather root/basal twig fragments and a single record of tentatively identified barley (two grains).

Period 3 Other deposits

The fill of a central pit in S5 (C1027) provided two samples. In one, the sediment was most likely burnt peat, with a little charcoal and charred (?)heather root/basal twig, charred heather flowers, some small barley and oat grains and a few wild radish (*Raphanus raphanistrum*) pod segments, the last a cornfield weed contaminant not easily winnowed or sieved from the crop. The other sample was a spot find of charcoal including a few oat and barley grains.

Channel/pool section (OLA 7.4.1 Table 2)

The sequence of more or less sandy detritus peat had been divided in the field into three contexts, a basal layer sandy gravel (C2332) grading into the lower half of the section, with a sharp change in colour between the lower context (C2310) and the upper (C2296) (though there was little to distinguish the two upper contexts lithologically when examined in the laboratory some years after excavation). Though labelled C2332, the lowermost sample has been assigned to C2310 here since it was indistinguishable in composition from the material immediately above it, other than having a higher sand content. Since the nature of the plant and invertebrate remains in the peat was not known from the outset, the division of samples into a series of thin slices collected in the field was respected during the present analyses, and they were not aggregated into larger units. In any case, the sediment proved rather intractable: even prolonged soaking or the use of mild alkaline chemicals did not readily assist in disaggregation, the peat remaining very coherent and requiring considerable manual intervention to reduce clast size and free the contained fossils. It is likely (especially given the sandy substrates across the site) that the peat had undergone a degree of natural drying and shrinkage during the centuries after deposition, which made it difficult to tease apart.

The commentary which follows is based on the more detailed sample-by-sample account in OLA 7.4.1 Table 2, and drawing on information in OLA 7.4.1 Table 6.

Period 0–1 C2310

The assemblages from the lowermost samples were dominated by plants of marsh and fen, primarily – in terms of identifiable matrix components – the hypnoid mosses *Drepanocladus* (whose identification to species is extremely challenging for fossil material where characters such as habit and colour are lacking), *Cratoneuron commutatum* (in Sample 24/49102, taken from the second, adjacent column, and examined to provide material for radiocarbon dating), and *Scorpidium scorpioides*. The other plant taxa persistently present or recorded in significant numbers, such as lesser spearwort (*Ranunculus flammula*), toad rush (*Juncus bufonius*) and spike-rush (*Eleocharis palustris*), augmented by the records for waterside insects, such as *Chaetarthria seminulum*, were also consistent with deposition in a shallow wet feature, with enough standing water to provide habitats for caddis flies and water beetles such as *Coelostoma orbiculare*, though with remains coming from organisms living in terrestrial habitats nearby. Indeed, in this latter category, beetles such as *Aphodius* (but also several other taxa) pointed to the presence of herbivore dung in the vicinity. Intriguingly, the records for charred and uncharred remains of heather, even in these lower deposits, suggests a very small component of occupation material may have been reaching the site of deposition, probably by wind-blow.

Period 2 C2296

Human influence is more markedly obvious in the upper context, where records for plants of disturbed places and weeds of cultivation, such as annual nettle (*Urtica urens*), docks (*Rumex*), fat hen (*Chenopodium album*), chickweed (*Stellaria media*), corn spurrey (*Spergula arvensis*) and wild radish (*Raphanus raphanistrum*) become established. Further records of heather, especially as charred fragments, together with scattered charred grains and chaff fragments of barley (*Hordeum*) point to material from occupation. Likewise, as low in the sequence as Sample 24/4872, there are indications in the beetle fauna for the presence of artificial habitats associated with human occupation (via *Falagria* or *Cordalia* sp and *Gyrohypnus ?angustatus*). At least four kinds of fly puparium were present in this assemblage, too, perhaps adding to the evidence that detritus from human occupation was present. It should be noted, though, that the only *strongly* synanthropic insect (from Sample 24/4868 from this context) was the spider beetle *Tipnus unicolor*, a species generally found in (by modern standards) damp old buildings. Though some of the wetland plant taxa from the earlier phase persist, and there are occasional records of waterside beetles, the moss flora is very depleted in the upper part of the peat and the taxa present are not those fen/marsh plants seen in Period 0–1. The insect fauna is increasingly dominated by terrestrial taxa, especially grazing land forms, though at the top of the sequence (Sample 24/4862) there are hints of a return to more marshy conditions (which also fostered better preservation and a large assemblage of both plants and insects).

Concluding remarks

Overall, the studies of plant remains have enabled us to confirm many of the field interpretations of the excavators: deposits thought to comprise or contain structural building material have generally yielded materials likely to have come from roofs and perhaps also walls, with imported heather persistently present in the assemblages. Whilst this may sometimes have arrived as cut material in its own right, the abundance of what are thought to be the coarser basal parts of the plant warn us that surface-cut turves from heather-dominated vegetation are a rich source of such material, and would also be likely to furnish the charred remains of roots/ rhizomes and small clasts of burnt peat seen in so many of the samples.

Evidence for plant foods at Portmahomack is very limited. Although cereal grains were quite frequently encountered, in some cases in moderately high concentrations, the grains were more usually scattered in ones or twos through many of the samples. Rachis fragments from samples from the Period 1 ditch (F129) have allowed us to show that free-threshing hexaploid wheat, barley and rye were all being exploited.

The records for wheat, with a single exception, and for rye, are all from Period 1 deposits, the later cereals being barley, with (occasionally) oats. Rye is perhaps the more likely crop to have been grown successfully so far north, so perhaps the wheat was imported, as suggested for the contemporaneous material from Hoddom, Dumfries and Galloway (Holden 2006, 152), though the presence of the rachis would perhaps be unexpected in a crop cleaned prior to shipping. Comparison with the Hoddom assemblages – which can only be tentative, given the very different nature of the depositional contexts between the sites – also reveals the very limited representation of oats at Portmahomack compared with the Dumfriesshire site, where 'tens of thousands of oats' (ibid 151) were recovered.

The insect assemblages reported here, though for the most part limited by sample size and/or quality of preservation, offer evidence (primarily through records of dung beetles and the chafer *Phyllopertha horticola*) for grazing land at various stages through the period of occupation of the site. Notable also are some elder-rich assemblages, which presumably reflect patches of scrub; these must have been close to the site of deposition in the case of the Period 2 monastic enclosure ditch (S16), and were perhaps boundary hedges, though elder seems unlikely to have been stockproof enough to serve to contain the livestock whose dung was apparently providing a substrate for *Aphodius* and *Geotrupes* dung beetles at the same time. That the elder represents phases of neglect or abandonment of certain areas might also need to be considered.

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References

Holden, T 2006 'The botanical evidence', *in* Lowe, C *Excavation at Hoddom, Dumfriesshire. An Early Ecclesiastical Site in South-West Scotland*, 150–5. Edinburgh: Society of Antiquaries of Scotland.

Kenward, H 2009 'Invertebrates in archaeology in the north of England', *English Heritage Research Department Report Series* 12/2009, 785 pp (http://services.english-heritage.org.uk/ResearchReportsPdfs/012_2009WEB.pdf).

Kenward, H K Hall, A R & Jones, A K G 1980 'A tested set of techniques for the extraction of plant and animal macro-fossils from waterlogged archaeologicaldeposits', *Science and Archaeology* 22: 3–15.

Kenward, H & Large, F 1998 'Recording the preservational condition of archaeological insect fossils', *Environmental Archaeology* 2: 49–60.

Kloet, G S & Hincks, W D 1964–77 *A Check List of British Insects*, 2nd edn. London: Royal Entomological Society.

Philp, E G 2006 'Vascular plants and the beetles associated with them', *in* Cooter, J & Barclay, M V L (eds) *A Coleopterist's Handbook*, 270–310. Orpington, Kent: The Amateur Entomologists' Society.

Preston, C D, Pearman, D A & Dines, T D (eds) 2002 *New Atlas of the British & Irish Flora*. Oxford: University Press.

Smith, A J E 1978 *The Moss Flora of Britain and Ireland*. Cambridge: Cambridge University Press.

Tutin, T G, Heywood, V H, Burges, N A, Moore, D M, Valentine, D H, Walters, S M & Webb, D A (eds) 1964–80 *Flora Europaea* 1–5. Cambridge: Cambridge University Press.

Digest 7.5 SUMMARY REPORT ON SOIL MICROMORPHOLOGY

CLAIRE ELLIS (for full report see OLA 7.5.1)

Method

Nine kubiena samples were taken from four selected locations in Sector 2. Each sample was prepared for thin section analysis by G McLeod at the Department of Environmental Science, University of Stirling, using the methods of Murphy (1986). Water was removed and replaced by acetone exchange and then impregnated under vacuum using polyester crystic resin and a catalyst. The blocks were cured for up to four weeks, sliced and bonded to glass and precision lapped to 30μm with a cover slip.

Samples were assessed using a MEIJI ML9200 polarizing microscope, following the principals of Bullock et al (1985), Courty et al (1989), Fitzpatrick (1993) and Stoops (2003). A range of magnifications (×40–×400) and constant light sources (plane polarized light – PPL, cross-polars – XPL, circular polarized light and oblique incident light – OIL) were used in the analysis. The summary results are given below and full descriptions in OLA 7.5.1.

Locations and objectives

The main objective of analysis was to characterise the nature of the sampled deposits and address specific questions as follows:

Location 1. Sample 24/8030. Taken from the layers stratified beneath the stones F577 assigned to the bridge (S7) and representing Period 0 to 1.

- Did the sediment accumulate in situ or was it imported?

Location 2. Samples 24/8033 and 8034. Taken from C3587, C3584, C3560 stratified beneath the Period 2 road (S13) and representing Period 0 to 1.

- Did the sediments accumulate naturally and in situ, or were they imported?
- What was the environment of accumulation?
- Was vegetation supported on the soils?

Location 3. Samples 24/6899 and 6898. Taken from C2294, C2292, clay silts in Module D2 accumulating in Period 2.

- What was the mode and environment of sediment accumulation and/or deposition?
- What was the type and source of fuel(s) being utilized?

Location 4. Samples 24/8031 and 8032. Taken from C2353, C3633, the ultimate sand floor of the yard of S9 (the vellum workshop) immediately beneath the primary burning, representing the Period 2 to Period 3 interface. Samples 14/4291 and 4292 were also taken from the floor of S9 yard, but sampled in baulk.

- What was the mode and environment of sediment accumulation and/or deposition?

Results

Location 1 (under bridge) Sample 24/8030 Period 0–1

This sample comprises a coarse, quartz dune sand with very little organic or fine organo-mineral. The organic content is dominated by amorphous charred organic matter that occurs between and forms thin coats on some mineral grains. Organic coatings to mineral grains often occur in peats (FitzPatrick 1993) and it seems probable that some of the sand is derived from peat ash. The presence of a very few fungal spores/pollen grains replaced by goethite is also indicative of peat as the original source deposit.

Summary interpretation: Sample 24/8030 comprises a wind-blown sand that appears to have accumulated in situ with the addition of some sand grains from peat ash.

Location 2 (under road) Samples 24/8034 and 8033 (Illus D7.5.1) Period 0–1

All three contexts within Sample 24/8034 comprise natural coarse dune sand, which is peppered with thin, often irregular bands of ash. The majority of the ash laminations are less than 1mm thick, but the boundary between (C3584) and (C3583) is marked by a thicker wavy band up to 5mm thick. The ash is characterised by fragmented biogenic silica, mainly phytoliths but with very few diatoms, a few small woody charcoal fragments and charred contorted organic matter and a few mineral grains, mainly silt-sized but some coarse sand-sized. In places, the burnt organic matter retains a linear preferred orientation. The ash is derived from either a grass-rich damp turf, or more likely, a thin peat that had developed upon a silt/sand rich substrate. The environment of deposition of the contexts was dynamic with overall net accumulation of dune sand interspersed by very frequent and short lived phases of ash accumulation, all occurring as the result of aeolian processes (wind). There is no micromorphological evidence of the in situ growth of vegetation on these dune sands. The diffuse nature of the boundary (Sample 24/8033) from (C3583) into the overlying (C3560) indicates that there was no hiatus in sediment accumulation.

C3560 contains significantly more and larger clasts of charcoal and charred, contorted organic material than the

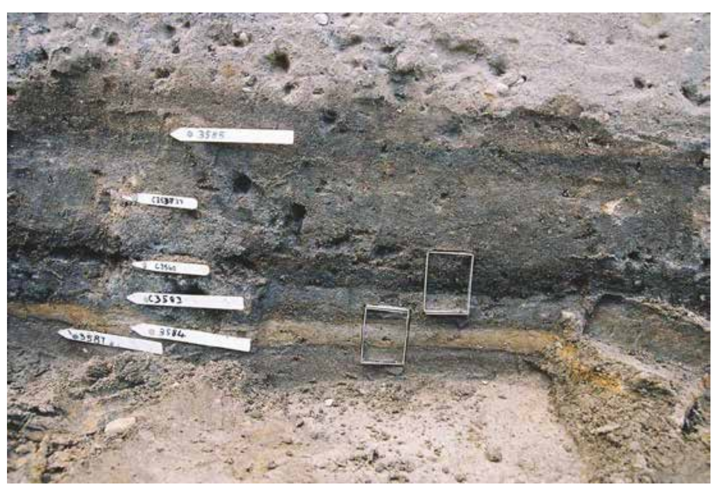

Illustration D7.5.1
Sequence beneath the road (S13) with kubiena boxes in place

Illustration D7.5.2
Sequence through and under the vellum workshop floor, showing locations of kubiena boxes

underlying (C3583). The source of the fuel of the ash present in the upper portion of (C3583) and (C3560) is also peat, and clearly a fire in which combustion was incomplete. However, the relative scarcity of ash rich in biogenic silica may also to be a function of the carrying capacity of the wind, ie it was too strong to deposit the finer ash. There are two fragments of slag, one within (C3583) and one within (C3560), hinting at the possibility that peat was being utilized to fuel a smelting furnace. The presence of very small fragments of bone, possible coprolite and a rounded clast of pottery suggests that the source of the ashy components of the deposits may have been a midden heap onto which domestic and industrial waste was being dumped.

Summary interpretation: Sample 24/8034, the lower deposit, comprises wind-blown sands that appear to have accumulated in situ, with the occasional influx of wind-blown ash from a nearby midden; the ash content increases up the profile. There is no evidence that vegetation was supported on the dune sands of Sample 24/8034 (C3584).

Location 3 (ashy silts associated with the vellum-working area) Samples 24/6899 and 6898 Period 2

Sample 24/6899 comprises two units, Unit 1 is a coarse sand with abundant ash, rich in charcoal and Unit 2 is a peat ash, rich in silt with some sand. Unit 2 is contained within Unit 1, although there are clasts of Unit 1, like material within Unit 2. The fabric of Unit 1 has been disturbed by the post-depositional activities of soil biota. It is likely that the lower portion of Unit 1 represents the accumulation of wind-blown sand and locally eroded coarse components of peat ash into a shallow hollow within the confines of an active settlement. Further erosion of a nearby midden is demonstrated by the presence of relatively large clasts of fine peat ash (Unit 2) and domestic waste, as indicated in the existence of rounded coprolite clasts (no bone is observed, so this coprolite is possible human), pottery [burnt clay] fragments and burnt and unburnt bone. The sediment within Sample 24/6898 is similar, but much richer in fine peat ash, with a relatively low sand content; it is essentially an ashy midden. The sediment has been subject to extensive post-depositional bioturbation, which has largely destroyed the original fabric. However, some of the largely mixed ash clasts are clearly rounded, indicating rolling across a surface, propelled by the wind.

Summary interpretation: see below.

Location 4 (floor of vellum workshop yard) Samples 24/8032 and 8031 (Illus D7.5.2) Period 2–3

The lowermost context (C2353) comprises a wind-blown sand with a small wind-blown ashy midden content. The sharp boundary into (C2109) reflects a sudden increase in the amount of ash incorporated into the sediment. The ash in Sample 24/8032 is dominated by clasts of charred amorphous organic material (partially combusted clasts of peat) while that in Sample 24/8031 is dominated by fine, well-combusted peat ash. As with many of the other deposits, (C2109) contains anthropic derived inclusions that indicate an ashy midden was being actively eroded and re-deposited as a band of dirty dune sand. Much of the bioturbation appears to be post-depositional in origin and reflects the high organic and nutrient rich nature of the midden material. The dark lens (C3633) within (C2109) comprises a mixture of fine, well combusted peat ash clasts and partially combusted peat ash clasts, mixed with the occasional fragment of bone (burnt and not burnt).

Samples 14/4292 and 4291

The deposit sampled in Sample 4292 is very similar to (C3633), comprising a mixture of fine, well-combusted peat ash and poorly combusted peat ash. This deposit contains the largest concentration of bone fragments of all the sampled contexts. The deposit has been extensively re-worked by soil biota. The basal portion of the deposit also contains more goethite pseudomorphs and goethite impregnations than any of the other sampled contexts, a probable consequence of the nature of this particular batch of peat. Sample 14/4291 comprises three irregular bands, the lower and upper band made up from a mixture of wind-blown dune sand, well-combusted and partially combusted peat ash and the central band is dominated by well-combusted peat ash. In this central band, there are very few clasts of sandstone cemented by iron (one oxidized and one metallic in OIL), which may have been the source rock of iron ore and used for the extraction of smelted iron. The central band appears to be a dump of mixed peat ash residue and midden material to which some sand has been incorporated, probably by aeolian processes.

The fuel

The dominant fuel utilized was a silty, moderately humified peat. Some of the ash clasts are dominated by biogenic silica, mainly phytoliths derived from grasses (in the broadest sense) with a few diatoms, the latter clearly indicating that the organic matter accumulated under damp conditions. The degree of humification of the organic matter within the peat was poor to moderate, as woody charcoal derived from small shrubs is clearly visible within some of the ash deposits. The clasts rich in biogenic silica and yellow in colour when observed in OIL are remnants of peat that has been subject to relatively high temperatures (>600°C), resulting in the combustion of nearly all of the organic matter (Simpson et al 2003). Within these clasts are occasional zones of vesicular biogenic silica, where the temperature has attained such a high level as to melt the silica. In contrast, the clasts dominated by charred and burnt organic matter have not been subject to such high temperatures and combustion is incomplete. One explanation of the micromophological evidence for contrasting burning temperatures of the peat is that the fuel was utilized for two purposes. Peat would have been burnt at a high temperature for 'industrial' use, such as the smelting of iron, whereas a lower temperature was necessary for domestic use.

In addition to the micromorphological evidence for high temperature burning of peat, such as that required in a smelting furnace, other evidence for metal working includes a couple fragments of slag (Sample 24/8033), clasts of possible native ore (Samples 24/4292, 4291 and 8032) and shards of magnetite (Sample 24/8031).

The peat generally appears to have developed on a substrate rich in silt-sized quartz. However, in Sample 24/8031 a few clasts of silt ash contain muscovite, indicating that at least some of the peat was removed directly from bedrock. The juxtaposition of clasts of peat ash derived from different temperature fires, along with the incorporation of bone fragments and rounded pottery fragments, suggests that many of the contexts originated as either wind-blown detritus from midden heaps or were spread as thin dumps of midden material and to which wind-blown sand was then naturally incorporated.

Summary interpretation, locations 3 and 4: The earlier contexts in both workshop locations comprise wind-blown sand mixed with peat ash. Generally, the ash midden material appears to have been incorporated into naturally accumulating dune sand by aeolian processes. Some deliberate spreading of ash midden may have occurred; wind-blown sand was then incorporated by natural aeolian processes.

The ash midden is derived from eroding midden heap(s), composed of the waste of domestic and 'industrial' activities. The dominant fuel type utilized was a poor to moderately humified peat. The peat ash occurs in two forms: a charcoal rich ash, dark brown to black in colour, derived from low temperature fires where combustion is often incomplete and a fine grey-brown granular-looking ash, dominated by phytoliths and diatoms derived from high temperature fires where the majority of the organic matter has been burnt off. The partially combusted ash is most probably derived from the domestic hearth. The fully combusted ash is likely to be derived from 'industrial' furnaces, probably associated with the smelting of ore.

References

Bullock, P, Fedoroff, N, Jongerius, A, Stoops, G, Tursina, T & Babel, U 1985 *Handbook for soil thin section description*. Wolverhampton: Waine Research Publications.

Courty, M A Goldberg, P & Macphail, R 1989 *Soils and Micromorphology in Archaeology*. Cambridge: Cambridge University Press.

FitzPatrick, E A 1993 *Soil microscopy and micro-morphology*. Chichester: John Wiley & Sons.

Murphy, C P 1986 *Thin section preparation of soils and sediments*. Berkhamsted: AB Academic Press.

Simpson, I A, Vésteinsson, O, Adderley, P & McGovern, T H 2003 'Fuel resource utilization in landscape settlement', *Journal of Archaeological Science* 30: 1401–20.

Stoops, G 2003 *Guidelines for analysis and description of soil and regolith thin sections*. Madison: Soil Science of America, Inc.