OYSTERS AND OTHER MARINE SHELLS FROM ELMS FARM, HEYBRIDGE, ESSEX

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INTRODUCTION

Oyster and other marine molluscs shells were recovered from the site of a late Iron Age and Roman settlement on the western periphery of Heybridge, to the northwest of Maldon, at the head of the Blackwater estuary (TL 847 082) in Essex. These shells were examined to determine how significant the exploitation of marine and riverine resources had been to the economy of the settlement, and to establish the importance of the river as a communication route for the inhabitants.

METHODS

The shell was recovered from the site by hand retrieval and through wet sieving of bulk samples. Where large dumps of shell were present, samples were taken and an estimate made of the percentage of shell removed. It was then carefully washed and species identified and counted. Oysters (*Ostrea edulis* L.) were sorted into left and right valves, measurable and unmeasurable shells. The criteria for selection for measurement were the presence of the hinge or ligament scar, the adductor muscle scar, and at least two thirds of the shell intact. The numbers of oyster valves and other marine mollusc shells were recorded by context and by feature. Abundance by phase was also calculated.

The criterion for inclusion of a sample for analysis was a minimum number of at least thirty measurable individuals of either left or right valves. Measurements of length and width in millimetres were recorded for oysters from nine contexts in which an adequate number of shells remained in relatively good condition. The oyster shells from five of these were selected for more detailed examination. Evidence for infesting or encrusting epibiont organisms and various descriptive characters were recorded on a presence or absence basis for each shell. The methods are described in full in Winder (1992). The percentage of shells in each sample that was affected by each type of infestation was calculated, as was the frequency of descriptive characters.

Comparisons of size and size distribution in oyster samples were carried out by the parametric two sample *t*-test (Blalock 1972, 219-241; Bailey 1959, 33-42) and the non-parametric Mann Whitney test (Blalock 1972, 255-262; Bailey 1959, 153-160) on an intrasite basis between the oyster samples from the nine suitable contexts. These samples were also compared on an intersite basis with samples from other Roman sites and from modern oyster beds.

The percentage frequencies of the various types of infestation evidence in each sample were used to make comparisons between the Elms Farm oysters and samples of Roman oysters from elsewhere in Britain using Principal Component Analysis (PCA) (Morrison 1967; Johnston 1978; Shennan 1988).

The descriptive features of the shells are collated as an aid to determining whether the oysters have been farmed.

RESULTS

Samples
A list of the contexts from which oysters and other marine molluscs were recovered is given in Table 1. This provides the contexts containing shells in numerical order, the feature number, feature type, number of shells, and comments on wear.

Table 2 provides the same information as Table 1 above but arranged by feature number. Table 3 presents the percentage frequencies of the different species of shell (as a total of all contexts in each feature). Table 4 shows the final listing of contexts with shell with feature number, feature type, area of site and phase. In this table, fifteen contexts which had been listed at the assessment stage have been excluded and nine new contexts have been added.

Marine molluscs were recovered from one hundred and eight contexts located within seventy-five features (of which one hundred and three contexts from sixty-one features were finally used - presumably because of possible contamination from earlier or later deposits).

Spatial distribution
How were these contexts distributed spatially across the site, and what was the proportional representation of shell in the different localities? The total weight of recovered oyster shell was 291,483g. Oyster shells were recovered from Areas E, H, I, J, K, L, M, N, P and W. The distribution by weight in these areas varied. Areas E, W, P, H and L each contributed less than 5% of the total shell. Most shell was recovered from Area I (57.9%), with 14.6% from Area J, 9.9% from Area N, 9.6% from Area M and 5.3% from Area K. Tables 5 and 6.

Of the areas from which **most** shell was recovered, Areas I and J are in the centre of settlement, each with different character. Areas N, M and K are in the southern outer zone with regular plots dominated by pitting. Southern and south-western locations, I, J and K are clustered not only around the road coming from the south-west and the river crossing but also around the Temple complex.

Of the areas yielding **few** shells, Area E is in the northern outer zone which possibly represents domestic occupation within plots. Area W is the hinterland, essentially the immediate agricultural landscape. Areas P and L are in the southern outer zone with its regular plots dominated by pitting. Area H is in the centre of settlement where each area has a different character.

The percentage distribution of oyster shell by weight across the site therefore shows a concentration in the south-west near the junction of the south-west path from the River Chelmer with tracks 3 and 4 and the centre of settlement. There is also a concentration in the southern outer zone. It should be noted that very few shells were recovered from Area H which is designated as a potential market area that has been cleared and surfaced.

The oyster shells which have been selected for analysis were all retrieved from pits which were located in areas H, J, K, M and N.

Temporal distribution
Tables 7 and 8 show how the contexts containing oyster shell were distributed through time. The greatest weight of oyster shell (56.1%) was recovered from contexts attributed to phase IIIB , with 16.2% in phase IV contexts, 9.6% in contexts assigned to phase IV-V, and 9.3% in phase V contexts. Each of the other phases contributed less than 4% of shell by weight. Not only is there an apparent decrease in abundance through time but the area of the site over

which oyster shells are recovered is contracted through time. Whilst in Period III twenty-eight contexts with shell are scattered over six areas, by Period VI ten contexts with shell are distributed over just three areas.

The oyster shells which were measured and examined in detail were from the early Roman period (phase IIIB) - later 1st to mid 2nd century AD; mid-Roman period (phase IV) - later 2nd to mid 3rd century AD; late Roman (phase V) - later 3rd to mid 4th century AD; and latest Roman to early Saxon (phase VI) - late 4th to 5th century AD.

Abundance

The numbers of shells of each species of marine mollusc for each feature for the whole site are presented in Table 9. A total of 6637 oyster shells (*Ostrea eduli*s L.) were recorded. The actual number of oysters on site was greater than this because some samples represent just a fraction of the deposit. There were also 69 *Buccinum undatum* L. (whelks), 14 *Tapes sp* (carpet shell valves), 96 *Mytlius edulis* L. (mussel valves), 7 *Cerastoderma edule* (L.) (cockle valves) and 3 *Littorina littorea* (L.) (periwinkles).

Mussels were mostly found in Period III deposits (76 shells, 80% of total) in the four areas E, I, K and L. Very small numbers were found in Period IV and V deposits (4% and 3% respectively) also in Area K. Five percent of mussels were retrieved from Period IV - V in Area N.

Mussels commonly occur from high in the intertidal zone to depths of a few fathoms attached by byssus threads to rocks and other hard objects within sheltered harbours and estuaries as well as rocky shores of the open coast (Tebble 1966). They are predominantly estuarine and large commercial beds are all situated in areas subject to reduced salinity (Graham 1956). In suitable estuaries, where there are large areas of stony or gravelly bottom exposed between tide marks, mussels may form very large banks or scars. Some beds are never uncovered by the tide but these rarely extend beyond the immediate sublittoral zone. Mussels can be gathered by hand, by raking in submerged pools and channels, and by dredging.

Whelks were mostly found in deposits dating to Periods IV and IV - V (6% and 57% respectively) in Areas N, M and J. Only 1.4% whelks belonged to Period III in Area I, while 10% of whelks were attributed to Period V in Areas K and M.

Whelks live in the low inter-tidal zone down to deep water in estuaries and open seas on a variety of sea bottoms but with a preference for mud mixed with sand and shells. They are found all round our coasts, but whelk fishing is only locally important today on the east and south coasts. In the sea the whelk meat grows white and fils the shell while in estuaries and rivers the flesh is darker and may be poor quality (Hancock 1967). Whelks are usually caught using baited pots but sometimes in east coast estuaries by 'trotting' where baited lines are laid across the tide for about six hours and then hauled in.

The numbers of oyster shells in the nine contexts selected for size comparisons is given in Table 10.

Size

At the assessment stage eleven contexts were thought to contain enough measurable shells to enable the samples to be used in comparisons of size. These contexts were 4801, 4844, 5144, 5214, 5393, 10891, 11139, 13813, 15152, 15515 and 16213. However, contexts 13813 and 16213 actually had too few measurable shells and were therefore excluded from the analyses. Descriptive size statistics for the nine selected oyster samples for left valve maximum width (LVMW), left valve maximum length (LVML), right valve maximum width (RVMW) and right valve maximum length (RVML) are given in Table 11.

Taking the left valve maximum width, mean size varied from 77.5mm to 86.2mm with standard deviations between 7.7 and 8.6mm. The smallest oyster shell was 56mm and the largest 105mm in width. The greatest range in size was 48mm in context 10891, and the smallest range was 35 in context 4844.

It should be noted that the range of sizes in the samples varies with time. The Early Roman (IIIB) range is 39mm, mid Roman (IV) is 39.8mm, mid-late Roman(IV-V) is 47.5mm, late Roman (V) is 43mm, and latest Roman/early Saxon (VI) is 38mm. This indicates a greater range of sizes in samples from mid-late Roman (IV-V) and late Roman (V) than from the other phases. This greater range in size is associated with a rise in average size in the mid-late Roman (IV-V) from 80mm - 84 mm followed by a decrease in average size (84 - 75 mm) in the late Roman phase (V). This may be due to the inclusion of larger 'pied du cheval' type oysters.

Reference to Figure 3 of intrasite comparisons of size in samples from selected contexts will show that these size differences are statistically significant. See below under **Intrasite comparisons**.

The implications of a decrease in average size and greater range of sizes might be less selectivity in collection; over-fishing causing a reduction in the numbers of oysters in the preferred size range; or a change of collection method.

Intrasite comparisons

Matrices of the results of the intrasite comparisons of size by two sample *t*-test (assuming unequal variances) and Mann Whitney test, using left valve maximum widths are presented in context order in Figure 1, by area in Figure 2, and by phase in Figure 3.

There is no significant difference between contexts 4801 (phase IV), 4844 (IV), 5144 (IIIB) and 5214 (VI) and between most of these and contexts 15152 (V) (bar 5144) and 15515 (IV). In this group of samples the mean left valve maximum width (LVMW) measurements are all 80mm or less.

Context 5393 (IV) is not significantly different from context 10891 (IV-V). Context 11139 (IV-V) is not significantly different from context 15515 (IV). In this group of samples the mean LVMW measurements are all greater than 80mm.

Figure 2, with comparisons of size of samples arranged by Area of site, shows that the samples within each area are not uniform in size and size distribution. Some samples from the same Area are significantly different in size and others are not. Similarly, between different Areas of the site, there are generally no clearly indicated similarities or differences. The samples in Areas K and N which are all significantly different in size from each other form the exception.

Figure 3, with comparisons of size of samples arranged by phase, shows that the samples within each phase may be significantly different from each other. Between phases there are also significant differences which reflect the changes in mean size at each phase - as discussed above in **Size**. The Early Roman sample is significantly different from 25% of Mid Roman samples, 50% of Mid to Late Roman samples, and 100% of Late Roman samples. The Mid Roman samples are significantly different in 75% of comparisons with Mid to Late Roman samples, 50% of Late Roman samples and 25% of Latest Roman to Early Saxon samples. Mid to Late Roman samples are significantly different in all comparisons with Late Roman and Latest Roman to Early Saxon samples.]

These tests therefore indicate that there is a significant increase in size, and range of size, in oysters from Early Roman to Mid to Late Roman and a subsequent decrease in size and range through to the Latest Roman/Early Saxon phase.

Intersite comparisons of size with other Roman sites

Comparisons were made of Elms Farm oysters with other Roman sites. The sizes of shells in the nine selected samples (4801, 4844, 5144, 5214, 5393, 10891,11139, 15152 and 15515) were compared with thirty-seven samples from thirteen other Roman sites, mostly from southern England. Comparisons were made by two sample *t*- and Mann Whitney tests. These sites include Shapwick (Winder 2000a), Greyhound Yard (Winder 1993a), Alington Avenue (Winder 2000b), Halstock Roman Villa (Winder 1993b) in Dorset; The Brooks (Winder 2000c) and Owslebury (Winder 1988) near Winchester in Hampshire; Newport Roman Villa (Winder 1989a) on the Isle of Wight; Pudding Lane (Winder 1984, 1985a) in London; North Shoebury (Winder 1993c) and Colchester (Winder 1993c) in Essex; Tort Hill (Winder 1999) in Cambridgeshire and the Shires (Monckton and Winder 1992) in Leicester. The size data for all these Roman sites is summarised in Table 12.

The matrices of results from these tests are shown in Figure 4 (context order), Figure 5 (phase order) and Figure 6 (area order). The results of these comparisons are difficult to interpret. The results have been divided into groups depending on the ratio of significantly different sample comparisons to non-significantly different comparisons.The first group comprises results of comparisons between Elms Farm oyster samples and other Roman samples between which there is a statistically significant difference in size for all samples. The last group comprises results of comparisons where there is no statistically significant difference in size for seven out of the nine Elms Farm samples. Whether the Elms Farm oysters are considered by context, phase or area, there appears to be no clear pattern of similarity or difference based on samples from different geographical locations. Many Elms Farm oysters show no significant difference from south coast or Essex oysters.

The Elms Farm oysters are not significantly different in size and size distribution from many of the other samples. This mean that the null hypothesis, that the two samples are derived from the same population, cannot be rejected. It is possible that contexts 4801, 5144 and possibly 15515 share common size characteristics which are distinct from those of contexts 5393 and 10891. For example, contexts 5393 and 10891 are both significantly different from all the North Shoebury and Colchester samples while contexts 15515 and 5144 show no significant difference from 5 out of 6 of the same set of samples; and context 4801 is not significantly different from 3 of the 6 samples.

Intersite comparisons of size with modern samples

Table 13 gives a summary of the size data relating to samples from modern oyster populations. Figure 7 shows that in comparisons with oyster samples from locations in the Rivers Roach and Colne (MAFF 1960's) - no Blackwater data is available - and from the Colchester Oyster Feast (Colchester Museum 1971), the Elms Farm oysters from contexts 5144, 5393, 10891, 11139, 15515 were all significantly different from the modern samples. Contexts 4801, 4844 and 5214 were not significantly different from the modern relaid East coast samples and the modern wild oysters from the South coast in Poole Bay . The modern Colne, Roach and Colchester samples were all native oysters. The modern Poole Bay oysters were natural and unsorted except by dredge bag mesh size. The mean size of the Solent oysters was smaller and the Poole Harbour oysters were larger than the Elms Farm contexts 4801, 4844 and 5214.

Infestation

Infestation evidence was recorded in only five contexts in which the shells were considered to be in better condition. These contexts were 4801, 5144, 5393, 10891 and 15515. Evidence was recorded of the burrows of the marine polychaete worm *Polydora ciliata*, borings of the sponge *Cliona celata*, boreholes made by gastropod molluscs such as *Ocenebra erinacea* and *Nucella lapillus,* and encrusting barnacles, Bryozoa and sand tubes made by Sabellid worms. Full details of these organisms can be found in Winder 1993c.

Table 14 presents the infestation data as percentage frequency of evidence for epibiont infestation or encrustation recorded in the samples of oyster shell from Elms Farm and other Roman sites. Principal component analysis was used to compare Elms Farm oysters with all available Roman sites (Figure 8), and with other nearby Roman sites at Colchester and North Shoebury (Figure 9).

Figure 8 is a scatter gram of the results of a PCA of infestation in Elms Farm oysters and samples of Roman oysters from elsewhere. The diagram shows two groups basically representing oysters from the east coast on the right and from the south coast on the left. Samples from sites in Cambridge, Essex and London (plus the Shires in Leicester) are arranged in a group to the right of the diagram while samples from Dorset, Hampshire and the Isle of Wight are grouped on the left.

The left hand group in Figure 8 is characterised by relatively high levels of *Polydora hoplura* associated with low levels of barnacles, as typified by the extreme left sample from Shapwick context 210 with 16.2% *Polydora hoplura* and 0% barnacles. The right hand group is characterised by absence of *Polydora hoplura* and high levels of barnacles as illustrated by the case of North Shoebury context 917 on the extreme right with no *Polydora hoplura* and 25.8% barnacles.

The results of the Principal Component Analysis shown as a scatter gram in Figure 9, of the Elms Farm oyster samples and samples from nearby Roman sites, clearly separates out the groups on the basis of their infestation characteristics. On the left, or negative side of the PC1 axis, lie the North Shoebury and Colchester samples while the Elms Farm samples are on the right or positive side of the PC1 axis.

On a regional scale therefore Elms Farm oysters share the infestation characters common with other East coast oysters but on a local scale show differentiation from nearby sites. This is a finer indication of local source. In comparison with the Elms Farm samples, the Colchester oysters have a fairly high percentage of *Polydora ciliata* (68.6%) and slightly higher levels of *Cliona celata* (2.7%) but lower levels of barnacles (0.3%), and Bryozoa (0.9%). On the other hand, North Shoebury samples are characterised by high percentages of *Polydora ciliata* (up to 89.6%), high levels of barnacles (up to 25.8%) and Bryozoa (up to 15.1%), with low levels of *Cliona celata* (maximum 1.4%) and the presence of sand tubes in one sample (Shoe299). Sand tubes were also noted in the Elms Farm samples (0.9% in 10891) but all differed from oysters at the other two sites in the presence of boreholes (0.6% to 3.9%). Clearly, the individual combinations of infestation evidence indicate different habitat characteristics of different oyster beds.

Descriptive characters

Twelve descriptive characters were recorded for oyster shells in the five contexts selected for more detailed recording (4801, 5144, 5393, 10891 & 15515). These included relative thickness and weight; chambering and chalky deposits; degree of wear; natural colour or post-burial staining; attachment of adult or spat oysters; irregularity of shape; man-made notches or cuts; and the presence of a ligament. Table 15 presents the frequencies with which these characters were recorded in the samples.

Shells from context 4801 show the greatest degree of variation, exhibiting the highest percentages of both thin and thick shells, chambering, wear and flakiness, attached oysters and ligament survival. Shells from context 5393 show much more uniformity in general features with the lowest percentage of thin, thick, heavy and chambered shells together with few chalky deposits and attached oysters.

Chambering and chalky deposits were recorded in all samples; generally these two features are closely associated - as is the case in four of the samples. In context 4801, however, chalky deposits were less important than chambers. The formation of chambers and chalky deposits is related to a need to reduce, or alter the shape of, the internal volume of the shell cavity between the two valves in response to a sudden reduction in meat volume. The animal is surrounded by an enveloping structure called the mantle which is responsible for shell formation and must remain in contact with the shell at all times. When subjected to rapid changes in salinity (usually an increase) or when depleted after spawning, the animal shrinks. A very thin-walled partition is often laid down internally, very rapidly trapping fluids and sediments, to form a chamber. Or a pad of micro crystalline structure is formed to similarly alter internal shape. Chambers and chalky deposits can therefore be an indicator of either shallow water conditions (as in creeks and tidal inlets) where evaporation increases salinity, or breeding activity.

All the samples had irregular shaped shells (ranging from 12.6% in 10891 to 4.9% in 5144). Irregularity in oyster shell shape is a response to growth in restrictive physical conditions such as settlement on a rough substrate and/or overcrowding caused by many oysters competing for space. Shape can therefore be a guide as to whether the oyster sample was derived from a natural population where irregularity may be common, or whether the oysters have been farmed where they are separated and spread out on the sea bed and thus achieve a more regular shape. It should be noted that the absence of irregularity cannot necessarily be taken to imply that the oysters were relaid since repeated dredging on a natural bed can produce the same effect.

Cut marks were present in low numbers in all but context 4802. Cuts and notches are thought to be caused during the opening of oysters and the removal of meat. Cuts suggest that the oysters were being eaten alive, or a least opened while alive.

The ligament survived in some specimens from each context, with the highest proportion from 4801 which was also characterised by highest levels of wear and flakiness. This probably indicates that the wear has probably been mechanically produced in some samples as well as resulting from the breakdown of the organic component of the shell.

All the samples included shells to which other oysters were attached (2.4% in 5144 to 8.9% in 4801). The presence of small spat, or more mature oysters, attached to an oyster shell is an indication firstly that the population from which it is derived is actively propagating; and secondly that the population is likely to be natural or wild. Oyster farming practices would divide or separate off attached oysters before marketing; and oysters relaid for fattening are most frequently in locations not conducive to breeding.

DISCUSSION AND CONCLUSIONS

The importance of shellfish to the settlement at Elms Farm, Heybridge

It is appropriate to now discuss the significance of the marine mollusc remains at the Roman village at Elms Farm near Heybridge in the light of the evidence provided by the oyster and other shells recovered there. The Essex coast is famous for its oysters (Benham 1993). The River Blackwater, and the town of Maldon are especially renowned for their oyster production and trade (Benham 1993; Yonge 1960, 152-153; Philpots 1890, 390-400). The Roman village at Heybridge is close to these places with their long association with the oyster industry; and is just 400 metres from a tributary of the River Blackwater, the River Chelmer, to which it is linked by a pathway. It is therefore ideally situated to exploit a nearby abundance of oysters.

It was initially proposed in the interim report that oysters and shellfish could not have held an important role in the diet and economy of the community because there were too few shells recovered from such a wide area occupied over such a long time *'This lack of evidence for coastal trade is part of a wider absence of indicators for the role of marine and riverine resources in the settlement's economy. Most obvious is the rarity of marine molluscs; only half a dozen or so features and deposits yielded more than the occasional shell, while only one excavated feature contained a significant deposit of mussels*' (Atkinson and Preston 1998, 108).

This idea needs to be re-examined now that the marine molluscs have been studied in detail. First of all, nearly 7,000 oyster shells were actually excavated from this site. This is an underestimate of the number of shells actually present because excavations did not extend over the whole site, and larger deposits of shells were sub sampled. In comparison with quantities of oyster shells recovered from thirteen other Roman sites, numbers vary from 10,810 valves at the Greyhound Yard Roman town site in Dorset, to just 383 valves from the Roman road at Tort Hill in Cambridgeshire; so the Elms Farm shells represent a not inconsiderable amount of oysters. In any terms, with 6637 oyster shells, marine molluscs cannot be called 'rare' at this site.

Secondly, it is erroneous to claim that '*only half a dozen or so features and deposits yielded more than the occasional shell'.* Marine molluscs were recovered from one hundred and eight contexts located within seventy-five features (of which 103 contexts from 61 features were finally used). Thirty-seven contexts had more than 20 shells, 14 contexts had more than 100 shells. The condition of the shells tended to be poor and only 9 contexts were selected for detailed analysis on the basis that they were sufficiently intact for measurements to be made and evidence for infestation to be recorded. Regarding mussel shells, it should be noted that this type of marine mollusc rarely survives intact in archaeological deposits and is usually found in a comminuted state or even as a blue, almost fibrous, layer. All shells are likely to be adversely affected by the harsh acidic gravel conditions (which were noted as a cause of poor survival in fish bones in Atkinson and Preston 1998, 108) to the point where they might be totally destroyed.

The number of shells to be found on a site will have depended on various factors, apart from soil conditions and post-deposition treatment. The main consideration would be the balance pertaining in the community between production, consumption, processing and trade. Only coastal or estuarine sites may be areas of shellfish production. The settlements may fish oysters for home consumption, in which case all shells could potentially be disposed on site.

The settlement may trade inland all, or just surplus stocks, to the local or wider hinterland so that potentially only a fraction of oysters fished could be disposed on site. The numbers of shells on site could therefore be small in relation to the quantity of shellfish actually being handled by a community that was heavily dependant economically on shell fishing.

Large deposits may occur in waterfront locations where the community relied to a large extent, maybe seasonally, on shellfish in the diet, as in Mesolithic shell middens (Mellars 1978) and the Ertebolle culture in Denmark (Andersen and Johansen 1986). Huge dumps of shell can result from marine mollusc processing, usually where the meat is removed from the shells and preserved, for example the oyster middens on which the early medieval town of Poole in Dorset is built (Winder 1992), and the large 12th century shell midden on the south side of Poole Harbour at Ower Farm which was generated when cockles were pickled for a nearby monastery (Winder 1991). Waterfront trading of oysters is thought to have been responsible for the substantial dump of oyster shells beneath the Roman open-work Thames-side piers uncovered beneath Pudding Lane in London (Winder 1984, 1985a). These are all special instances and not typical of the quantities of shell usually recovered during excavations whether of coastal or inland sites.

The habit of recycling oyster and other shells may also account for large dumps on sites, or for the absence of large dumps. For example, ditches are often backfilled with shells as in Saxon Hamwic (Winder 1998), and the Billingsgate excavations in London revealed the way oysters had been used to infill behind waterfront revetments (ref). Floor surfaces and pathways have also been constructed mainly from shell (Six Dials: Winder 1985b, 1986 and 1997; Corfe Castle: Winder 1989b). Conversely, recycling may involve the destruction of shells so that few shells are evident on site. Examples of this are the use of shells for mortar between stonework - especially in arches, for making lime, poultry grit, shell-tempered pottery, and particularly in Roman times for medicines and cosmetics (Radcliffe 1931; Masefield 1899; Haman 1893; Nealey 1931; Roughly 1923; Swanton 1898). In other cases oyster shells are spread on fields as fertiliser (calcium neutralising acid soils which cause the shells to delaminate and disintegrate), or - most importantly in oyster production areas - they are put back on the sea bed as the preferred substrate for oyster spat settlement.

The point being made here is that the absence of enormous numbers of oyster shells, from a site which is in a prime location for oyster fishing, is not necessarily an indication that there was no fishing industry.

Oyster evidence for an Iron Age to Roman transition

It is relevant at this stage to discuss in general what is known about oyster exploitation in the Roman period. It is quite clear that the arrival of the Romans in Britain created a widespread demand for, and exploitation of, this particular marine resource which had been largely neglected in the preceding Iron Age. It is not known why this should have been the case. It is possible that climatic conditions in the Iron Age were unfavourable for oyster breeding; or maybe oysters were abundant but not a preferred food source. We only know that oyster shells have seldom been excavated from British Iron Age sites and Heybridge is no exception. Only 0.09% by weight of oyster shell was recovered from four contexts in the late pre-Roman Iron Age and transition to early Roman phases (II and II-III). However, 56% of the oyster shells for the whole site were retrieved from eleven phase IIIB contexts (late 1st to mid 2nd century A.D.) This sudden influx of oysters must surely mark the appearance of Romans on the scene. They were widespread over the site in pits, trenches, spreads and layers. [An exception to the general absence of Iron Age oysters is found at Owslebury, Hampshire occupied from the 3rd century B.C. until the 4th century A.D. (Winder 1988). Here, 6% of the oysters were recovered between the 3rd century B.C. and the early 1st century A.D].

The Roman passion for oysters

The Romans had a well established passion for oysters long before the conquest of Britain. Large natural oyster populations around our coasts would have been obvious to the invaders and eagerly fished. Sallust wrote in 50 B.C. 'The poor Britons - there is some good in them after all - they produce an oyster'. Elsewhere it is noted that 'British oysters were first brought to the notice of Roman gourmets in the time of Agrippa (A.D. 78)' (Philpots 1897, 45; Juvenal Satire 4, 139). There was indisputably a huge trade in oysters across Britain while the Romans were here (Marsden 1980). Oysters were not only eaten by the elite living in villas and palaces but also by common soldiers at fortress sites (Davies 1971). Oyster shells are found on Roman sites at the coast like Richborough in Kent (Bushe-Fox 1949; Cunliffe 1968) and Newport Roman Villa on the Isle of Wight (Winder 1989a) as well as far inland at Housesteads on Hadrian's Wall (Birley 19--NB can't locate this reference yet because I've packed all my books for the move)) and the Shires in Leicester(Monckton and Winder 1992). This means that an efficient system was in operation to collect the live fresh oysters and transport them rapidly, sometimes over hundreds of miles.

Were the Elms Farm oysters farmed or wild?

Evidence was sought in the shells to distinguish between oysters from wild or natural beds (Winder 1993c: Model 1, 283-285; Model 2, 285-288) as opposed to cultivated or relaid ones (Winder 1993c: Model 4, 289-292). Oysters from natural beds would be expected to have irregular shapes, adhesion between individuals, oyster spat attached, and a wide range of sizes and ages. In intertidal beds a slow growth rate leading, in some instances, to the phenomenon of 'stunting' might also be expected in oysters spending regular periods of time out of the water. A few 'stunters' were recorded in the Elms Farm samples.

Relaying of young oysters from natural beds were they have bred into new places, which enhance the fattening up of the meat, is the first stage in oyster cultivation or farming. Fattening grounds tend to be in enclosed harbours, estuaries and creeks. The characteristics of samples of relaid oysters might be a restricted age and size range because of cropping at a specific age. Warm, shallow nutrient-rich waters may lead to higher levels of infestation. Where muddy substrates have been consolidated with broken shells. twigs and branches prior to relaying, such shram might be incorporated in the developing shells of the relaid oysters. Shape of shells would be less distorted because individual oysters would have been separated. Spat and attached oysters would be rare.

The Heybridge oysters provided only evidence to suggest that they were fished from natural beds either by hand collection in the intertidal zone or by dredging inshore shallow waters.

Roman oyster cultivation methods

It is often stated that the Romans introduced oyster cultivation to Britain but no evidence has been put forward to support this idea. It is very unlikely that they would have imported the system that they practised in Italy; and it probably would have been unnecessary to do so. From the late Roman writer Ausonius we learn that in the fourth century A.D. oysters were brought from Brindisium in the south of the country to the neighbourhood of Puteoli north of Naples and there fattened in the Lucrine Lake (Lago Lucrino) - which is connected by a narrow channel to the Mediterranean - to supply the markets of Rome.

Maybe it was in order to counteract the problem of poor condition in the well-travelled oyster, that the Romans devised an ingenious system for fattening up oysters. Oysters live naturally on hard substrates. In soft sands and muds they are liable to sink or suffocate. Pliny wrote ' The first person who formed artificial oyster beds was Sergius Orata, who established them at Baiae, in the time of L. Crassus the orator, just before the Marsic War'. The flooded inlet of Baiae was underlain by volcanic muds. We know from engraved glass vessels how the oysters were farmed (Gunther 1897; Yonge 1960, 148-151). Trellis-like wooden platforms were constructed to project from the shore like piers. From these supports, thick and loosely-twisted ropes, called *pergolari*, were suspended. Oysters sent up from Brindisium were inserted between the strands of these ropes. In this way, the spent oysters could take advantage of the nutrient-rich waters in order to flesh out whilst avoiding all danger of sinking in the soft sea bed. The ropes could be hauled up as the oysters were required to meet market demands. The point made here is that the system was invented to overcome the problem that oysters could not naturally have survived relaying in this type of location.

Oysters in Roman Britain

Picture then the situation in Britain. Extensive, hitherto unexploited, natural oyster beds lay on firm sea bed substrates not only in deeper open water but also in sheltered bays and harbours, estuaries, rivers, creeks and inlets all around these shores. (Oyster beds would have been far more common than they are today. Over-exploitation, disease, alien competing species and adverse climate have combined over the last century or so to decimate British oyster stocks). These populations of wild oysters would have been easily accessible and plentiful. It is clear that, at least initially, supply could have met demand, as shown by the huge numbers of oyster shells recovered from most, if not all, Roman sites in Britain. Even if stocks had begun to dwindle because of over fishing the beds, then the cultivation techniques practised in Italy would have been unnecessary and inappropriate over here.

An examination of nearly 40,000 shells, together with artefacts and structures from 13 Roman sites in Great Britain has failed to provide firm evidence for any direct cultivation or farming (i.e. relaying) of oysters. The only indication that some kind of stock improvement may have been attempted is that shells found on the Roman Thames waterfront beneath Pudding Lane in London changed from predominantly irregular shapes with a lot of infestation in the 1st century A.D. to more regular shaped cleaner ones in the 2nd century A.D. (Winder 1984, 1985). However, other explanations for this can be proposed. It might be that supplies were obtained from a different source where shell characteristics were different, or that extensive dredging on the same oyster bed had split up the naturally-occurring clumps of oysters and spread out the individual oysters which were then able to achieve their full growth potential without restrictions.

The source of the Elms Farm shellfish

There is no evidence to prove that marine as well as estuarine shellfish were being exploited at Elms farm. All the marine mollusc species could have grown in either fully marine or brackish conditions. Oysters and mussels both have a preference for reduced salinity. The frequency of long oyster shells and elongated ligament scars suggest growth on relatively softer or muddier grounds. Similarly the occurrence of chambers and chalky deposits may indicate shallower waters where salinity can rapidly change. These features point to shallower estuarine locations for the oyster beds rather than deeper open sea beds.

Comparisons of size and infestation characters with samples from other Roman sites indicate that the Elms Farm samples are typical of the east coast type of oyster (c.f. south coast type of oyster) but are distinct from other Roman oysters found at North Shoebury and Colchester. This suggests that oysters from each of these three Essex sites came from different locations.

In comparisons of size and infestation of Elms Farm oysters with modern oyster populations the results are equivocal.

The most likely scenario for Heybridge is that oysters were collected locally in the Blackwater. Oysters are not confined to fully marine conditions (35 parts per 1,000 salinity) and can breed and thrive far upstream to a minimum of 23 parts per 1,000 salinity. In 1867 the upper reaches of the Blackwater owned by the Fish and Oyster Breeding Company were considered suitable for both breeding and fattening oysters but, at that time, shelly cultch had to be placed on the mud.

Oysters fishing methods

Collection could have been by hand at low tide; the area in the upper Blackwater available for oysters in the late 19th century is known to have included acres of ebb-dry fore shore between the low water mark of neap and low water mark of spring tides. Fishing for oysters may have also taken place from boats using some kind of dredge for which activity there is plentiful documentation in the 19th and 20th centuries but not earlier. A relatively local account of oyster fishing and its associated equipment can be found in *The Colchester Oyster Fishery: Its antiquity and position, method of working and the quality and safety of its products* (Laver 1916). The oysters could then be ferried by boat and/or cart to a marketing point such as the supposed market area in Heybridge village centre from which they could be transported far and wide.

Oysters transportation

Initially perhaps the live oysters would be carried just loose in sacks or baskets for movement from shore to market. However, greater distance and travel time would mean that the oysters had to be prevented from deteriorating or dying. There are records of live oysters being packed in wooden tubs and packed with snow to keep them cool as they travelled overland (Aldorovandi in Rydon 1968). Athenaeus wrote (Deipnosophists, 4, 8) 'when the Emperor Trajan was in Parthia at a distance of many days' journey from the sea, Apicius Coelius sent him fresh oysters, which he had kept so by a clever contrivance of his own'. This may have been the device of putting oysters in bags tightly packed with snow (Poli, in Philpots 1890). It is also possible that they were brought up in deep-welled boats around the coast.

Although Frere (1978) suggests that oysters in Roman Britain were transported alive in tanks of water, in the same way that fish were kept alive, this would not have been an effective system. There is a high shell to meat ratio, i.e. a lot of waste, in a relatively low-cost commodity. Transport in tanks of water would be expensive and the numbers of oysters that could be carried this way would be limited. Additionally, it would have been difficult to maintain the quality of the salt water which would easily stagnate and kill the oysters.

Traditionally, live oysters have been packed tightly together, with the cupped left valve lowermost, in sacks, barrels or boxes so that the oysters have been prevented from opening their valves. This conserves the living animals in their own reservoirs of fluid. In cool conditions, well-packed oysters can survive at least ten days. Transport would be easier and costs would be far lower with oysters packed 'dry'.

Evidence for trade of the Elms Farm oysters

Comparisons of both size and infestation yielded the interesting fact that 2nd century A.D. oysters from context 15515 at Heybridge were virtually identical to oysters of the same date from context 1728 at Pudding Lane in London. There is no significant difference in size using either non-parametric or parametric tests (*t*-value 0.05). This means that it is not possible to rule out that the two samples were derived from the same oyster bed. This in turn suggests the possibility that oysters fished near Heybridge were traded on to London. It has already been suggested that the supposed relative paucity of oyster shells at Heybridge might be the result of selling on of oysters to places such as Colchester and Chelmsford (Atkinson 1998, 108). This evidence suggests that oysters were traded further afield and introduces the idea that river and coastal transport may have been the logical way to get supplies to London.

How the oysters were eaten

At Elms Farm notches and cut marks were found on a few of the shells which shows that at least some oysters were opened while alive and possibly eaten raw. Some of the shells had a brown iridescence on the internal surface which is thought to be caused by burning, and other shells were blackened, both possible signs of cooking in the shell. If oysters are to be cooked, then roasting them in hot ashes or ovens causes the valves to open automatically as the animal is poached in its own liquor.

It can be assumed that when oysters have been transported some distance, whatever the mode of transport, that by the time the oysters reached their destination they were in poor condition. Despite the Romans extolling the virtues of fresh oysters, there are many recipes for oysters and other shell fish cooked in rich and spicy sauces which would have masked any delicate natural flavour, and disguised many a bad one (e.g. Apicius translation Flower and Rosenbaum 1958; Edwards 1984; Vehling 1977).

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JUST NOTES

Noting that the EF oysters are closely associated with some Pudding Lane samples and Shires. This might be indicative of shared Origin, trade even. Could this be used to suggest that Elms Farm was collection & trading point for oysters sent to London and the North. Check the dates/periods of the samples involved. Possibly all these are 2nd c so similar in date. No sig diff in size between EF15515 (0.05 t value) and PDN 1728 but sig diff between EF10891 and PDN 1728 (3.6 t value), and Shires EF 15515 (7.22) & EF 10891 (11.83) respect.

Elms Farm is a Roman Village situated in an unusual position close to low-lying boggy ground by the R. Chelmer close by the Blackwater.
Its location is enigmatic because it is not ideal agricultural land (check) and it is away from the major Roman roads- check!
However, its location makes sense if the major activity on site is the exploitation of the local oyster beds and the marketing of oysters to the local and wider hinterland.
There is a long established history of oyster fishing in the Blackwater. Discuss and provide references.
How does this idea of oyster exploitation tally with the evidence from the site?
A fair number of oyster shells were recovered.
How does this number of shells compare with the situation on other sites examined.
Lack of large numbers of shells on site would be expected if the live oysters were being sold on - either directly to markets or for relaying.
In what circumstances would you expect to see large numbers of shells on site?
Large middens from consumption.
Large middens from processing.
Recycling of shells for mortar, roads and other surfaces.
Laying on fields for fertiliser
Use for making lime.

What do the shell characteristics tell us about exploitation practices?
Were they collected or farmed?
In what kind of location were they likely to have originated?
Were the oyster beds at the head of the Blackwater or further afield - i.e. is there any indication that they were transported up river from other locations?
Is there any evidence to suggest that they were traded elsewhere - PCA infestation?

What was the relative importance of oysters to the community through time?
Oyster numbers declined after a peak. Oyster sizes changed with time as do the range of sizes - what could this mean in exploitation terms?
Peak numbers in the early phases of the site might show local consumption prior to an increase in out-trading the commodity.
Decline in numbers, together with larger size range, and larger average size followed by further reduction in numbers and decrease in size below original levels.
Could this be an effect of over fishing?
Why else could the numbers decline?
Reduction in village population?
Beds fished out?
Natural fluctuations in stocks related to weather etc.
Increase in no oysters exported.

Historical background to oyster cultivation in the area.
Early charter at Colchester referred to rights to dredge rather than to cultivation or farming practices which are assumed in 'Essex Gold' to have commenced in the 18th century (ref)

References to practices in the 18th/19th century in the Blackwater and at Maldon (see Philpots, Essex Gold, Robert Nield's book, Board of trade report, Yonge's 'Oysters'

References to other sites - why do you get a lot of shell on site and vice versa (e.g. Poole and Ower middens, Pudding Lane waterfront – the implications); consumption on site (Ower); processing on site (Poole Paradise Street); recycling on site Pudding Lane backfilling revetment, flooring; Corfe Castle paths, yards, mortar; disposal on site in deeper features (most sites); disposal off site on fields, poultry grit, shelly based fabric pottery, metal working?, cultch. Trading on of oysters live in the shells. Were there any artefacts like knives, dredge rings, pits associated?

Why is negative evidence dangerous when the geographical location of the site is enigmatic unless you take into consideration that it would have been ideally located to exploit oysters naturally breeding in the upper Blackwater and maybe the Chelmer. References to dredging young oysters for transfer elsewhere off the Essex coast where they would fatten.

What does the quantity of shell tell you about the exploitation of oysters at a site (e.g. what sort of numbers have been recovered at various sites - give examples with references and examine the statement in the interim report to discuss whether-it is really true that not much shell has been recovered from Elms Farm);

Source of oysters - exploitation of riverine hinterland?
Evidence from the size and infestation comparisons

Collected or cultivated - trade
Evidence from both descriptive characters and all size/infestation comparisons.

CHECK that discussion addresses the research objectives

STORY LINE