CHAPTER 9

INTERSITE VARIATION IN SIZE OF OYSTER SHELLS

INTRODUCTION

In the first part of this study of variation in oyster shells, samples have been compared on an **intra**site basis. However, as each site was examined, the sizes of shells in the samples were compared with those from other sites already considered. Not all sites or samples were used in the **inter**site comparisons but the evidence indicated that macroscopic differences were possibly characteristic of certain regions. These initial results are first presented on a site by site basis in this chapter. A wider selection of samples was then used to make comparisons to determine whether there was a greater similarity in sizes of shell within a region than in shells from other categories such as broad chronological period, urban versus rural site, or inland versus coastal site. These broader based comparisons have been carried out using only a fraction of the samples potentially available from the work already completed; and the analyses have been relatively unsophisticated; but it is believed that the numbers of samples and shells actually used are large enough to counteract the shortcomings of working without the assistance of a computer.

EVIDENCE FOR REGIONAL VARIATION IN OYSTER SIZE

A list of the sites in each region is given in Table 9.1. Figures 9.1 to 9.5 show the locations of the sites (with sample code numbers). Table 9.2 provides a breakdown of the samples, valves, dimensions and tests used for comparisons for each site. Most of the comparisons were carried out using the right valve maximum width measurement but the left valve maximum diameter measurement has been used in some instances as this allows comparisons between archaeological and modern (live) oysters. Two sample *t*-tests were the basis of most comparisons but the Kolmogorov-Smirnov test was used in addition to

or instead of the t-test in some instances, particularly with modern oysters for which only grouped size-frequencies were available.

Owslebury, Hampshire

Intrasite comparisons of size in shells from both Iron Age and Roman phases of occupation at Owslebury revealed no significant differences. However, intersite comparisons of size in Owslebury specimens with samples from archaeological and modern sites elsewhere in Wessex strongly suggested the location of the oyster beds from which the Owslebury oysters maybe derived.

Figures 9.6 and 9.7 show a matrix of two sample t-test results for comparisons between the Owslebury samples and those from Saxon sites in Southampton. They show that there is a marked similarity between the majority of the Owslebury shell samples and those from certain Southampton contexts such as 11151, 11275, possibly 242, and 667.

Figure 9.8 shows matrices of two sample t-test results of comparisons between the Owslebury oyster shell measurements and those of two samples of modern oysters from the West Solent; Sowley Ground and Newtown beds. The Owslebury samples were all significantly different from the modern Sowley Ground oysters but there was no significant difference between the Owslebury and Newtown bed oysters.

Figure 9.9 shows matrices of t-values for comparisons between Owslebury oyster shell measurements and those for samples from Newport Roman Villa on the Isle of Wight. There was no similarity in size of the shells from these sites.

Figures 9.10 and 9.11 show matrices of t-values for comparisons between oyster shell measurements of samples from Owslebury and from modern oysters from the Poole area: Poole Bay wild oysters, and relaid oysters from Wych Channel and South Deep within the Harbour. All the samples were significantly different. Some of the t-values were very high - up to 18.09.

Figures 9.12 and 9.13 give matrices of t-values for comparison of Owslebury oysters with samples from archaeological sites in Poole. Four of the Poole samples show a size relationship with those from Owslebury: PM 21.53, PM21.58, PM 21.501 and PM 21.504 (all from the Paradise Street site on the waterfront).

Figures 9.14 and 9.15 show t-values from t-tests comparing Owslebury with Greyhound Yard (Dorchester) oyster shells. All the comparisons showed a significant difference.

Figure 9.16 is a matrix of t-values for Owslebury versus Alington Avenue (Dorchester) oyster shells. The measurements of all samples show a statistically significant difference.

Figures 9.17 and 9.18 give results of comparisons between Owslebury and Ludgershall Castle oyster shell samples. All the samples were significantly different. Some of the t-values were high - up to 22.14.

Figure 9.19 shows t-values from comparison of samples from Owslebury with Salisbury (W139). All the samples were significantly different.

Figures 9.20, 9.21a and 9.21b are analyses of variance diagrams of Owslebury and other samples from Wessex. They show the relationship of the Owslebury/Newtown/Southampton/Poole group of samples with other groups with greater or lesser size characteristics from elsewhere in the region.

To summarise the above information: Owslebury samples of oyster shells were compared with 49 other samples derived from archaeological sites and modern oyster beds in the Wessex region. On an intersite level the Owslebury oyster shells were found to bear a size relationship to only a few samples from Saxon Southampton, to modern oysters from the Newtown beds in the West Solent, and to some samples from the early medieval waterfront in Poole (Paradise Street). Thus

the Owslebury shells could only be matched for size with nine out of a possible forty-nine samples with which they were compared.

Discussion

The connection with the Southampton shells and the live oysters from the West Solent is of particular significance. The simple test used does not prove that the oysters from the archaeological sites were collected from the Newton beds, but it is an indication that this may be so. In an analysis carried out in parallel with this one, the remaining Southampton archaeological samples have been shown in similar extensive comparisons with material from all over Wessex to be closely related in their size characteristics only to modern oysters from the Sowley Ground in the West Solent. Additionally, oysters statistically indistinguishable in size from modern wild and relaid oysters in the Poole area can be detected in samples from archaeological excavations in Poole and Dorchester.

Certain anomalies need to be clarified. For example, the similarity between some of the Paradise Street samples and those from Owslebury and Newtown may be more apparent than real. The Poole shells could have originated in the West Solent - the same population as that exploited for the Owslebury shells. However, it is equally possible that a natural population of oysters with similar characteristics existed or exists nearer to Poole for which no sample has been obtained.

The small size of the Owslebury oyster shells compared with other samples is not due to their young age because a wide range of ages is found in all samples.

Newport Roman Villa, Isle of Wight

To see whether the large oyster shells from this site were significantly different in size from other archaeological samples obtained in Wessex and London, and from modern oysters from the region, two sample *t*-tests were carried out using the right valve

maximum width measurements. Sample 1 from Newport Roman Villa was a sub-sample from context 37 and Sample 2 was the remainder. The use of a simple test suggests that the oysters from Newport Roman Villa may not have originated in the creeks of the north coast of the Isle of Wight or the West Solent. The only archaeological and modern samples that are similar in size originate in the Poole area, specifically in the Bay rather than the Harbour.

For the comparisons archaeological samples were used from Alington Avenue (Dorchester); Guildhall House (London); Greyhound Yard (Dorchester); Ludgershall Castle (Andover); Moorgate-Coleman Street (London); Owslebury (near Winchester); Poole at Thames Street, Paradise Street and Shipwrights' Arms; Pudding Lane (London); Salisbury at Brown Street; and the Six Dials site in Southampton.

The present-day oyster specimens were obtained from the West Solent on the Sowley Ground and the Newtown Beds; natural beds of wild oysters in Poole Bay; and beds of relaid oysters in Poole Harbour in Wych Channel and South Deep.

Out of the 71 comparisons with Newport Sample 1, ten samples showed no significant difference in size. With sample 2 only eight samples showed no significant difference. The archaeological samples which were significantly different from the Newport samples have been omitted from Table 9.3 which gives the _t_- values obtained from the tests. _t_- values of 2 or less were considered to indicate that there was no significant difference in the sizes of shell in the samples.

There seemed to be no similarity, according to this very simple test, between the shells from Newport Roman Villa and nearby beds of oysters in the West Solent. Neither were the Newport shells like the archaeological ones from Southampton and Owslebury. There did seem to be a similarity, however, to the wild modern oysters from Poole Bay (but not the relaid ones within the Harbour). From Poole town, some of the Paradise Street samples, and from Hamworthy the sample from the Shipwrights' Arms site were like the Newport shells. Some of the

samples from the Greyhound Yard and Alington Avenue sites were also like the Newport shells in size.

Figure 9.22 shows that the oysters from Newport Roman Villa do not appear to be like the other samples from the Solent region. However, some of the archaeological samples from Poole are similar to modern Solent oysters. Figure 9.23 shows that the Newport oysters, in common with some archaeological samples from Poole and Dorchester are similar in size to wild oysters from Poole Bay.

Discussion

This preliminary work has not proved that Newport oysters came from Poole. Verification will entail re-examination of size distributions using the 'greatest diameter' measurement and submitting samples to comparison by the Kolmogorov-Smirnov test which is thought to be more reliable.

It is interesting to note, however, the presence of black burnished ware at Newport Roman Villa. This was manufactured in the Isle of Purbeck bordering Poole Harbour. It is at least feasible that oysters were collected near Poole and shipped back to the Isle with the pottery. Although in recent history it is known that oysters were relaid in creeks along the north coast of the Isle of Wight, and that natural beds exist in the East and West Solent, there is no evidence that oysters were relaid in creeks at the time the Newport midden was created (the close of the 1st century A.D. onwards) or that the deep sea beds had been discovered. On the other hand, in Poole Harbour, the Cleavel Point site where some black burnished ware was made, lay adjacent to South Deep where oysters thrive today, which was traversed by a causeway thought to be Roman in origin, and where any oysters would undoubtedly have been exposed to view at very low tides. Therefore it is possible to suggest that Poole oysters could have been exploited because their presence was so obvious and a method of transport was to hand.

Poole, Dorset

The distinctive size of the oysters seems to be a regional characteristic. Oysters which show no significant difference in size from these have been recorded from the Greyhound Yard and Alington Avenue sites in Dorchester, a few samples from the Six Dials site in Southampton and at Newport Roman Villa on the Isle of Wight. No comparable oyster shells have been found among the other sixty samples examined from sites in Wessex and London. The Poole oysters are different because they are larger than elsewhere. Daniel Defoe in 1724 wrote that "this place is famous for the best, and biggest Oysters in all this Part of England, ...'Tis observed more Pearl are found in Pool Oysters, and larger than in any other Oysters about England." The magnitude of the oysters produced in Poole is borne out by this research project but the pearls that Defoe mentions are probably just a product of his imagination. Commercially viable pearls are not found in the flat oyster (Ostrea edulis L.). In Great Britain only the freshwater mussel (Margaritifera margaritifera (L.)) creates valuable pearls.

Ower Farm, Isle of Purbeck

The Ower midden oysters were compared with modern oysters from natural beds in Poole Bay and relaid beds from South Deep and Wych Channel which are the locations nearest to Ower Farm. Only oysters from SP01 (1310) were recovered in sufficient numbers for statistical comparisons with other samples. The midden oysters were also compared with samples from archaeological sites at Poole and Hamworthy on the Harbour's edge, at Lodge Farm near Wimborne to the north of Poole, and at Corfe Castle on the Isle of Purbeck (and the closest site to Ower Farm).

Figure 9.24 gives the results of Kolmogorov-Smirnov tests and shows that the sizes recorded for the Ower midden oysters were different from the those recorded for both modern and archaeological shells from Poole. It was suspected that there would be a similarity between the 12th/13th century Ower midden oysters and samples of similar date

such as those from Paradise Street (radiocarbon dated 1095 ± 108 A.D.) and the upper layers of the Shipwrights' Arms deposit in Hamworthy (radiocarbon date 1075 ± 90 A.D.). However, Kolmogorov-Smirnoff tests revealed a significant difference in the sizes of shells. The mean maximum diameter of the Ower shells was 70.1 ± 14.8mm which was much smaller than the other Poole samples. There was **no** significant difference in size of oysters in comparisons with the 14th/15th century sample from Lodge Farm and the 17th and post-17th-century samples from Corfe Castle. Ower Farm oysters do not share the characteristics of modern relaid oysters from South Deep. Regularly-fished oysters from deeper channels or out in the Bay would probably be larger, older and better-shaped - like the archaeological shells from Poole.

Corfe Castle, Isle of Purbeck

The Corfe Castle oyster shells were compared with modern wild oysters from Poole Bay; with Poole Bay oysters that had been relaid for fattening in the Harbour at Wych Channel and South Deep; and with shells from archaeological sites in Poole and Hamworthy.

The basic measurement data used in the comparisons for the Poole oysters are given in Table 9. The results of the two sample *t*-tests are shown in Table 9.5. Numbers in **bold** indicate no significant difference between the samples compared. In the *t*-tests between grouped samples from Corfe Castle and wild modern oysters from Poole Bay, six out of ten comparisons showed no significant difference in size. The remaining four comparisons yielded *t*-values that were only just over the figure of 2 which would be considered the critical number at 0.05 level of confidence. The *t*-values obtained in comparisons of Corfe shells with modern relaid oysters from the Harbour were all well over the value of 2. A significant difference in the sizes of shells in these samples was demonstrated.

Comparisons of Corfe oysters with archaeological shells from excavations in Poole at Thames Street (PM9) showed a significant

difference in size in all cases. The sizes of The Paradise Street oyster shells (PM21) were shown to be like the Corfe Castle shells. In twenty-three of thirty comparisons the t-values were under 2; in five of the thirty just over 2; and in two of the thirty just over 3. A significant difference was demonstrated between the Corfe Castle shells and those from the Shipwrights' Arms in Hamworthy (PM SHIP).

Therefore, on the basis of size distribution of shells and using two sample t-tests, a similarity was demonstrated between the Corfe Castle oysters, the wild oysters from Poole Bay and the majority of samples from the midden beneath Paradise Street.

The t-test is a very simple one and basically compares the means of samples. A more advanced test for the "goodness of fit" of distributions between samples is the Kolmogorov-Smirnov test. This test was carried out on a limited scale and confirmed the findings of the t-tests. Details are not included in this report.

Discussion

Comparisons with modern oysters revealed a similarity in size between the Corfe oysters and the oysters from the wild or natural beds in Poole Bay but no similarity with present day relaid oysters from the Harbour. The archaeological oysters from the Thames Street site on the former Poole waterfront, and from the Shipwrights' Arms site on the Hamworthy side of the water were significantly different in size from the Corfe shells. However, there was no significant difference between most of the Corfe and Paradise Street samples, possibly indicating a common origin. The size comparisons indicate that the Corfe oysters came from Poole Bay.

Lodge Farm, near Kingston Lacey, Dorset

Since the shells from the two Lodge Farm samples can be considered similar in size, only the shells from the larger sample - context 122 - were compared with grouped samples from the excavations at Corfe

Castle on the Isle of Purbeck (Winder 1989a). The results are presented in Table 9.6.

These results are not straightforward to interpret. First of all, it had been demonstrated that there was no significant difference in size between the Corfe Castle samples. Looking at the t-test results of the comparison of Lodge Farm context 122 with the Corfe Castle samples, all the t-values were below 2. This would seem to indicate that there was no difference in the sizes of oyster shells from the two sites. However, the Smirnov test indicates that both Corfe 4 and 5 are in fact significantly different from Lodge Farm context 122.

Previous work on the Corfe Castle oyster shells showed that they all shared their size characteristics with modern oysters from Poole Bay and with some of the archaeological samples from the Paradise Street excavations in Poole (Winder 1989a; forthcoming b). Therefore, by logical inference, the two Lodge Farm samples of oyster shells probably were collected from Poole Bay.

All the Corfe Castle samples showed a comparatively even spread of sizes and ages over a wider range than that exhibited by the Lodge Farm shells. This indicates a more extreme case of the lack of selection found in context 192. However, not all the oyster shells at Corfe were food remains. Empty shells were introduced to the site for building purposes and this would undoubtedly have affected the nature of the samples.

Greyhound Yard, Dorchester

The sizes of the shells in the five groups from the Greyhound Yard were compared with measurements of both modern and archaeological samples of oysters from the Poole region to see if any similarities could be detected. The t-test results from these comparisons are shown in Table 9.7.

In the matrix of two sample t-test results in Table 9.7 it can be seen that most of the t-values obtained in the comparisons of Greyhound Yard grouped samples with archaeological and modern samples from Poole are in excess of 2, indicating a significant difference in the samples. Some of the t-values are quite high, such as 11.15 for the Group 5/PM 21.502 (Paradise Street excavation) comparison. There are, however, several notable exceptions to this pattern.

The sizes of oysters in Groups 1 to 4 are not significantly different from the PM 9 (Thames Street excavation) shells. Additionally, Group 1 and Group 5 show no significant difference from the samples of modern oysters recovered by dredging from the Wych Channel and South Deep beds of relaid oysters within Poole Harbour. The samples of modern oysters from Poole Bay were dredged from a natural/wild bed. Previous tests have shown a significant difference in size between the wild Poole Bay oysters and the relaid Poole Harbour ones. Tests have also illustrated the similarity between the majority of the archaeological shells from Poole waterfront sites and the wild Poole Bay form. Therefore, as most of the Greyhound shells are dissimilar in size to the Poole archaeological shells, then by inference the Greyhound shells are not alike in size to the Poole Bay wild specimens either.

Discussion

From the above information it is possible to suggest that oysters from Group 1 and Group 5 of the Greyhound Yard shells are similar in size to the present-day relaid oysters found within Poole Harbour in the deeper channels. The oysters from Thames Street share this similarity.

The oysters from the remaining Groups 2 to 4 do not seem to relate to either Poole Bay wild, Poole Harbour relaid or the majority of shells from archaeological excavations in Poole. Most of the oyster shells from Old Poole have been shown in previous tests to resemble the Poole Bay wild specimens. The Thames Street and Shipwright's Arms samples are unlike any known modern oyster samples. As it is unlikely

that the Thames Street and Shipwright's Arms shells came from outside the Poole region, another bed within the Harbour, for which no specimens are available as yet, may have been the one exploited.

That the Greyhound Yard Group 1 shells should be like the Harbour specimens, the Thames Street and the Shipwright's Arms samples seems contradictory. This anomaly needs further consideration. In addition to this, since Group 5 and Group 1 have been shown as significantly different, it is surprising that they should both show no significant difference from the Poole Harbour samples. This might imply that Group 1 and Group 5 oyster shells are not really different in any other character but size. An examination of other features of the samples might clarify this point.

Alington Avenue, Dorchester

The grouped samples from this site were also compared with samples from a series of other archaeological sites and samples obtained from living populations of wild and relaid oysters from south coast origins. Figures 9.25 and 9.26 show the results of these two sample t-tests in the form of a matrix in which the three Alington Avenue samples are compared with each other and seventy other samples, giving the actual t-values obtained.

Figures 9.27 and 9.28 are also matrices of the t-test results using symbols instead of actual values. It should be noted that where the t-value obtained is only just over the limit of 2, there may be reason for considering these as borderline results in which the samples could be more alike than different.

The Alington Avenue grouped samples from phases 30, 40 and 50 are not significantly different from each other. Neither are they significantly different from most of the oyster shells examined to date from the Greyhound Yard excavations in Dorchester, although the samples from the early medieval phases (Grey EM, Grey EM2 and Grey 22) show a slight difference. The Alington Avenue shells show no significant

difference in their size characteristics from the oyster shells found on the Thames Street site (PM 9), Shipwright's Arms site (PM Ship) and at least two samples from the Paradise Street site (PM 21.53, PM 21.ran) - all excavations in Poole. There was no significant difference in size from the shells from Newport Roman Villa site on the Isle of Wight (Newport 1) or from context 896 on the Stoner Motors site in Southampton. These archaeological samples cover a wide range of dates. The similarities exist despite differences in date. Finally the Alington Avenue oyster shell measurements were compared with those from samples of modern live oysters from locations in the Solent and Poole area. There is no significaqnt difference in size between the Alington shells and those from beds of wild oysters in Poole Bay.

There was a significant difference in size between oyster shells from Alington Avenue and all other sites including Ludgershall Castle near Andover; some of the Paradise Street samples from Poole; Pudding Lane excavations in London; Guildhall House and Moorgate/Coleman Street in London; Six Dials in Southampton; Owslebury near Winchester; Salisbury W139; Newtown and Sowley Ground natural beds in the West Solent; and beds of relaid oysters in Poole Harbour at South Deep and Wych Channel.

An analysis of variance was carried out using MINTAB program. The diagram printed out and reproduced in Figures 9.29, 9.30 and 9.31 (because of its length it had to be split into three parts) presents the relationships between the size characteristics of the different samples in a way which is easier to comprehend. The order in which the samples are presented is not relevant.

It is possible to see that the means for certain samples occur in closely related groups. The Alington Avenue samples are featured in Figure 9.31 (Aling 30, Aling 40 and Aling 50). Their means are in a tight group. Their relationship to the samples from the earlier phases of the Greyhound Yard (Grey erb, Grey lrb, Grey rbd, Grey arb) and to the modern wild oysters from Poole Bay (Poole 11 and Poole 17)

and those from Newport Roman Villa (Newport 1) can be seen in this figure. The shells share in common a large size with means between 76 and 85mm although they are not the largest shells recorded. Other groups of greater or smaller size can be distinguished such as those from Ludgershall Castle (Lud h14 etc) and Salisbury W139 (Salis 2, 3a and 5).

Discussion

The oyster shells from Alington Avenue are amongst the largest recorded in over 70 samples examined to date. The analyses carried out show that they share this large size with other archaeological samples from Dorchester and Poole. The common denominator of size appears to be regardless of date. The samples have been shown by two sample *t*-tests and analysis of variance to be alike. They are different from most other samples from sites in Wessex and London. This seems to suggest that common origin is the factor they share. The age structure and growth rates of the samples, where available, shows a similarity as well. These shells are not just big because they have attained a great age (although some are twelve years or more). The size can be attributed to excellent growth rate. The size, age and growth rate characteristics of the archaeological shells are shared by those of modern oysters from natural beds in Poole Bay. Therefore all the evidence available at the moment suggests that many of the oysters from archaeological deposits in Poole and Dorchester came from beds in Poole Bay. It was thought at one time that sizes of oysters might be related to climatic changes through time. There is nothing here to support that idea. It would seem that the high growth rate, and consequently the large size achieved, is typical of the Poole oyster. Relaid oysters within Poole Harbour are even bigger than those considered comparable with the Alington Avenue shells.

39 Brown Street, Salisbury, Wiltshire

In order to determine whether observed differences in size frequency of the right valve maximum width measurements of the oyster samples were significant in statistical terms, two sample *t*-tests between the

grouped Salisbury samples, and between Salisbury and seventy other samples of archaeological and modern derivation, were made (see Figure 9.32 which shows results indicating no significant difference in size of samples). There is no significant difference in the size characteristics of the three Salisbury grouped samples. They show a similarity in size to oysters from Ludgershall Castle near Andover and to one sample from the Saxon Six Dials site in Southampton. In all other comparisons the Salisbury shells are significantly different in size.

The analysis of variance of the sizes in the samples was used to depict the relationship between them (see Figure 9.33). The three Salisbury samples are shown at the bottom of the diagram (Salis 2, Salis 3a and Salis 5) as a distinct group of smaller than normal size.

Discussion

The size of oyster shells is governed by several factors including age and growth rate. Although the range of ages varied from sample to sample, with the greatest range from 1 - 9 years in Salis 5, there was a marked peak of abundance at 3 years in all of them. The combination of size and age information was used to calculate absolute growth rate which was virtually identical in all three Salisbury samples. However, Figure 9.34 shows how the growth curve obtained, e.g. for Salis 5, compares with ones drawn for oyster shell samples obtained elsewhere. The absolute growth rate was appreciably lower than that recorded for oysters from the Alington Avenue site in Dorchester but not quite so low as for Cross Street, Wokingham shells.

The various analyses carried out on the size characteristics of the oyster shells highlights how small the shells are, and that they share this smallness with oyster shells from excavations at Ludgershall Castle and one atypical sample from Saxon Southampton. They were much smaller than sixty-two other samples with which they were compared. An examination of the ages of oysters demonstrated

that size could be partly attributed to young age. By looking at the growth rate curves, size could also be seen to have been affected by slow growth.

Reading Abbey Wharf, Berkshire

Each period sample was compared with the others from Reading Abbey Wharf by using the standard error of difference to determine whether there was statistically any significant difference in sizes. No significant difference was found between the samples. When the mean size and standard deviation of the Reading samples of oyster shell were compared with those obtained for other archaeological and modern samples, a close relationship was found between the Reading samples and those from Ludgershall Castle near Andover; Cross Street, Wokingham; and Brown Street, Salisbury. The shells from the more northern part of Wessex are much smaller than those originating on the South coast in, for example, the Poole or Southampton localities.

Discussion

The average size of the oysters was small. The absolute growth rates determined for samples from periods 4, 5 and 7 were virtually identical. They were also similar to the rates demonstrated for oyster shell samples from Brown Street, Salisbury. The growth rate of oysters from period 6 at Reading is much lower than the rate calculated for the samples from other periods. It does, however, match the rate calculated for the sample of oysters from context 131 at Cross Street in Wokingham which belongs to the same general period.

The similarity in size and growth rates to oysters from other North Wessex sites, the similarity in infestation patterns (to be discussed in Chapter 10), and the presence of buckie, red or almond whelks (Neptunea antiqua) which are only found in the north-east, particularly off the Norfolk coast, at the present time, may be indications that the oysters at Reading Abbey Wharf came from the

East Anglian coast from which area they could have been rapidly shipped up the rivers Thames and Kennet to the Abbey.

Cross Street, Wokingham

This post-medieval sample from Cross Street contains smaller oyster shells than the smallest examples obtained from the Six Dials site of Hamwic (Saxon Southampton) where the lowest mean in SOU 169 pit 8474 context 9820 was 55 $\pm$ 13.8mm.

The growth curve for the Cross Street shells (BAC (4) 74 I context 131) was compared with the growth rate curves of samples from Saxon Hamwic (the Six Dials site in Southampton) and the growth rate of the Cross Street shells was seen to be much lower than the lowest rate found for shells from SOU 169 pit 8474 context 9820 (see Figure 9.35 for these two curves).

The oysters from this site are therefore small for the age represented, and the absolute growth rate is also much lower than that recorded from the Saxon Hamwic shells. The infestation evidence discussed in Chapter 10 also contributes to the suggestion that the oysters may have come from the north Kent or Essex coasts.

Moorgate and Coleman Street, London

Size comparisons of shells from this site were undertaken when the nearby Guildhall House shells were examined (see following section). However, growth rates from shells on this site were compared with others to check for similarities. Figure 9.36 shows the growth rate curves obtained for the two Moorgate contexts (MOG context 6565 & MOG context 51 g+ss) compared with those for the shells from the two Guildhall House contexts (GDH 85 context 409 & GDH context 309), Hamwic (SOU 99 context 896), and Cross Street,Wokingham (BAC 74 (4) I context 131). The figure illustrates the degree of distinction that can be demonstrated in oyster shell growth rates from different locations. The growth rates for shells from Moorgate and Guildhall

House are similar to each other and intermediate between the fast rate in one of the Hamwic sites and the low rate in shells from Cross Street, Wokingham. It is thought possible that the growth rate may be linked to place of origin on the basis that the environmental conditions in some locations would be more favourable for growth than others.

Guildhall House, London

Figures 9.37 and 9.38 show matrices with the results of the two sample t-tests on the RVMW measurements of the Guildhall and the Moorgate/Coleman Street samples. They illustrate that there was no significant difference in size between the two Guildhall House samples, nor between Moorgate context 51 samples and those from Guildhall House. There was a significant difference in size between Moorgate context 65 and the other samples. Moorgate context 65 shells were discovered to be different because of the odd distribution of ages of oyster within it, with many small young oysters. This can be clearly seen on the analysis of variance in Figure 9.39. The oyster shells from these two sites mostly share similar size characteristics.

Bury St Edmunds Abbey, Suffolk

The size characteristics of the large Saxon 5A group were compared extensively on an intersite level with samples from both archaeological sites and modern oyster beds in three regions. These were the east coast of Suffolk and Essex; London and north Wessex; and the south coast in the Poole and Southampton areas. The sites in the London and north Wessex region were grouped together because they constituted a band of entirely inland sites situated between the two other, coastal, regions which may have supplied them with oysters. The size comparisons by two sample t-tests and Kolmogorov-Smirnov tests involved a total of fifty-seven samples. Table 9.8 gives information on the sources of the information on oyster shells from the additional archaeological sites in the east-coast region.

The number in the sample, the mean of the left valve maximum diameter (LVMD) measurements and the standard deviation were calculated as a preliminary to undertaking simple statistical tests to compare samples. The results for the Bury St Edmunds Abbey samples and other east-coast samples are given in Table 9.9a. The same information for samples from London and north Wessex is given in Table 9.9b; and for south-coast samples in Table 9.9c. A glance at these tables reveals that the Bury St Edmunds Abbey shells are at the lower end of the size range with a mean of 67.8mm for group 5A, 63.6mm for the rest, and 60.9mm for the medieval group.

The oyster shells from the Saxon group 5A at Bury St Edmunds Abbey were compared with samples from other sites by two sample t-tests and Kolmogorov-Smirnov tests. The results are presented in Tables 9.10a, 9.10b and 9.10c. Table 9.10a shows that the Bury St Edmunds Abbey (BSEA) shells were not significantly different from another Saxon site in Suffolk, that of Burrow Hill (2, 3 and 4). There was also a similarity in size with a sample of Roman shells (16) from the North Shoebury site near Southend in Essex. Table 9.10b gives figures that reveal a similarity in size between oysters from BSEA and sites further afield. These include the early medieval site at Moorgate Street in London (20), samples from various periods at Reading Abbey Wharf in Berkshire (22 - 25), and Brown Street, Salisbury in Wiltshire (27). In comparisons with samples from south coast locations, no similarity in size could be demonstrated between BSEA and archaeological shells. However, a similarity was shown in three instances between modern Solent samples (46, 50 & 53) and BSEA. Information recently received regarding a Ministry of Agriculture Fisheries and Food oyster survey in 1989 (Walker, pers. comm.) indicates that these oyster beds are atypical of the region.

Further comparisons by t-tests were undertaken between the individual east-coast samples (Tables 9.11a, 9.11b and 9.11c). These tests confirmed the relationship between the BSEA (1), Burrow Hill (2, 3 & 4), and North Shoebury s.1063B (16) samples. There is also a similarity between shells from Roman Colchester (7), Roman North

Shoebury (13,14,15 &17) and modern shells from the Rivers Colne (10) and Roach (11).

Tables 9.12a, 9.12b and 9.12c give the t-test results for comparisons of the east-coast oyster samples with samples from London and north Wessex and the south coast respectively. Tables 9.12d and 9.12e show the results of comparisons between the east-coast samples and those from archaeological sites in Poole and Southampton respectively.

In addition to confirmation of the strong size relationships between the Bury St Edmunds Abbey shells and other samples previously mentioned, certain general patterns begin to emerge which have wider implications for the study of archaeological oyster shells from different chronological periods and this will be discussed later in this chapter.

The results of the size analyses have been summarised in Figure 9.40. This diagram presents the archaeological samples between all of which there is no significant difference in size. It shows that 33% of the east-coast samples were similar in size to BSEA group 5A; 60% of London and north Wessex samples were similar; but **none** of the south-coast samples were similar. Not shown are the three out of fourteen modern Solent samples that were similar to BSEA shells. These are, however, probably atypical of the region. The Ministry of Agriculture, Fisheries and Food survey of Solent oyster beds in 1989 shows them to be composed of younger oysters than the other Solent beds.

Discussion

The size tests with east-coast samples revealed that the Bury St Edmunds Abbey oyster shells were similar to shells from another Saxon site at Burrow Hill near Butley Creek in Suffolk, and to one sample of Roman shells from North Shoebury in Essex. Samples of medieval shells from Moorgate Street in London, and medieval and later period shells from Reading Abbey Wharf (Berkshire) and Brown Street in Salisbury (Wiltshire) resembled Group 5A shells. Every one of the

archaeological samples of oyster shell from south-coast sites was significantly different in size.

Thus on the evidence of size it is possible to say that the Bury oysters were collected on the east coast rather than the south coast. The very close similarity in size to the oysters from another Saxon site at Burrow Hill adjacent to the Butley River in Suffolk, and the relative proximity of this place to Bury St Edmunds, suggests that the Bury shells were probably collected in this vicinity.

OVERVIEW OF EVIDENCE FOR REGIONAL VARIATIONS IN SIZE OF OYSTER SHELLS

In this survey of size and size distribution in oyster shells, over 150 samples were examined, but small ones were eventually disregarded. This left a potential number of 7056 comparisons of size between individual samples. Of these, 2434 comparisons were actually made. Table 9.2 gives a breakdown of the sites and numbers of samples used in each kind of comparison. Table 9.13 gives the overall mean size of oysters from the four regions under consideration (standard deviations have not been included because the overall mean was calculated from the individual sample means). Figure 9.41 presents the percentage of results showing no significant difference in shell size in comparisons between samples from different regions.

It can be seen from this table that in the Southampton, Poole, north Wessex and London regions there was a higher degree of similarity in size between samples from the same region than between each of those regions and the others. For example, using simple statistical tests in the Southampton region 25% of the samples showed no significant difference in size, compared with 11% of comparisons between Southampton and Poole samples, 2% between Southampton and north Wessex and London, and 16% between Southampton and the east-coast samples. In the Poole region 32% of samples were alike in contrast to 1%, 11% and 22% in comparisons between Poole and the other regions. Thirty-seven percent of samples in the north Wessex and London group

showed no significant difference compared with 1%, 2% and 20% in comparisons with the other regions.

The results from the east-coast region were more equivocal with 21% of samples within the region showing no significant difference in size, 22% in comparisons with Poole samples, 20% in comparisons with north Wessex and London samples, and 16% in comparisons with Southampton samples.

The evidence suggests that there is a greater probability of oyster samples that have originated in the same area having sizes and size distributions that exhibit no significant difference from each other.

SIZE VARIATIONS IN OYSTER SHELLS FROM COASTAL VERSUS INLAND SITES

The overall arithmetic mean size of shell was also calculated for oysters from inland and coastal archaeological sites. Inland sites included Owslebury, Hampshire; Corfe Castle, Isle of Purbeck; Greyhound Yard and Alington Avenue, Dorchester; Ludgershall Castle, Hampshire; Reading Abbey Wharf, Berkshire; Moorgate and Coleman Street, Guildhall House and Pudding Lane in London; and Bury St Edmunds Abbey in Suffolk. The average size of 4808 left valves was 77.1mm and the average of 8330 right valves was 65.6mm.

Coastal sites included Six Dials, Southampton; Newport Roman Villa, Isle of Wight; Thames Street, Paradise Street and Shipwright's Arms, in Poole, Dorset; Ower Farm, Isle of Purbeck; Burrow Hill, Leiston Abbey in Suffolk; and Colchester and North Shoebury in Essex. The average of 8725 left valves was 83.3mm and of 5137 right valves 67.9mm.

There is some evidence to suggest, therefore, that the average size of oysters from coastal sites is greater than those from inland sites. A more detailed analysis would be needed to verify this.

SIZE VARIATIONS IN OYSTER SHELLS FROM URBAN VERSUS RURAL SITES

The overall arithmetic mean was calculated for oyster shells from urban and from rural sites. Urban sites included Six Dials, Southampton; 11 The Hundred, Romsey, Hampshire; Thames Street, Poole, Dorset; Greyhound Yard, Dorchester; 39 Brown Street, Salisbury, Wiltshire; Reading Abbey Wharf, Berkshire; Cross Street, Wokingham, Berkshire; Moorgate and Coleman Street, Guildhall House and Pudding Lane in London; Bury St Edmunds Abbey, Suffolk; and Colchester, Essex. The mean size of 5451 left valves was 75.9mm and of 6186 right valves 66.5mm.

Rural sites included Owslebury, Hampshire; Newport Roman Villa, Isle of Wight; Paradise Street and Shipwright's Arms, Poole, Dorset; Ower Farm and Corfe Castle, Isle of Purbeck; Lodge Farm, Dorset; Alington Avenue, Dorchester; Halstock Roman Villa, Dorset; Ludgershall Castle, Hampshire; Burrow Hill and Leiston Abbey in Suffolk; and North Shoebury in Essex. The mean of 4736 left valves was 78.2mm and of 7284 right valves 66.3mm

On the basis of the above figures there may be a difference in size between shells from these two categories of site with oysters from rural sites tending to be slightly larger than those from urban ones. Not only would this need to be confirmed by further analysis but consideration would need to be given to the fact that the categories of inland and coastal overlap those of urban and rural sites.

SIZE VARIATIONS IN OYSTER SHELLS THROUGH TIME

Samples of oyster shells were allocated to one of five broad time spans: the Roman period (1st-4th century), the Saxon period (5th-10th century), the medieval period (11-16th century), the post-medieval period (17-19th century) and modern period (20th century). The number of shells involved was considerable, so instead of returning to the raw data and recalculating (which would have taken more time than was available), a simple arithmetic mean was derived from the sample means and the numbers of shells in each sample. This

did mean, however that standard deviations could not be calculated. As well as looking at the average size of oysters from each period, reference was made to the results of statistical tests between the samples which indicated whether compared samples were significantly different from each other or not.

The average size of oysters did vary from period to period. The details can be seen in Table 9.13 and Figure 9.42. An examination of 4075 left valves and 4740 right valves of twenty-five samples from eight sites belonging to the Roman period gave an average size of 80.4mm for left and 71.5mm for right valves. From the Saxon period 3550 left and 3563 right valves of twenty-three samples from six sites gave an average size of 74.5mm for left and 65.2mm for right valves. From the medieval period 1892 left and 2570 right valves of eighteen samples from eleven sites gave an average size of 75.2mm for left and 64.4mm for right valves. From the post-medieval period 654 left and 2422 right valves of twenty-one samples from eight sites gave an average of 69.6mm for left and 58.8mm for right valves. The 3346 modern oysters from eight samples and six sites were an average 78.3mm.

These figures confirm the notion often voiced by archaeologists that Roman oysters seem larger than medieval ones. Figure 9.42 illustrates the decrease in average size of oysters in samples from the Roman to the Saxon period, and again slightly between Saxon and medieval period. This reduction in overall size continues into the post-medieval period but rather unexpectedly the modern oysters show a recovery in average size almost to the original Roman level.

As well as looking at arithmetic mean size to give a rough indication of changes in size observable through time, consideration was also given to the results of two-sample t-tests and Kolmogorov-Smirnov tests carried out on some of the samples. Tables 9.14 - 9.18 give keys to the samples and their code numbers used in comparisons of Roman, Saxon. medieval, post-medieval and modern samples. Figures 9.44 - 9.58 are matrices of the results of size comparisons of

samples from different periods. A synthesis of these results is given in Figure 9.43 which shows the percentage of comparisons which showed non-significant difference in size within each period and between each of the periods. The higher the percentage of no significant difference comparisons, the greater the degree of uniformity between the samples.

54% of comparisons between Roman period sites showed no significant difference. The percentage decreased to 20% between Roman and Saxon samples, to 18% between Roman and medieval samples, to just 1% between Roman and post-medieval samples. However, the percentage rises again to 25% between Roman and modern samples. On the basis of these comparisons, it would seem that there is at least twice as much uniformity in sizes in samples from the same period as is found between that period and others. These comparisons using samples from the Roman period also echo the findings of the crudely generated arithmetic means that there was a steady decrease in size from Roman to post-medieval but with a recovery in the sizes of modern shells.

Comparisons using shells from the Saxon period display the same general tendencies as the Roman ones. There is twice as much similarity amongst samples within the Saxon period itself (32% not significantly different), compared with 16% in Saxon versus medieval samples, 18% in Saxon versus post-medieval samples, and only 3% of samples in comparisons with modern samples showing no significant difference.

The medieval samples did not adhere to the general pattern, the highest degree of uniformity (36%) being found between the medieval and post-medieval samples, and 25% and 23% found respectively in comparisons within the medieval period itself and with modern samples.

Post-medieval samples were the most uniform of all with 91% of comparisons within the period showing no significant difference

between samples compared with 15% no significant difference in comparisons with modern oysters.

Modern oysters displayed the greatest diversity in sizes of shell samples from the same period with only 14% showing no significant difference in size.

In summary, oysters belonging to samples from the same period tend to show a greater uniformity in size. In three out of the five periods (Roman, Saxon and post-medieval), samples were at least twice as likely to be similar in size within the period as in comparisons with other periods. There is a great deal of similarity in size between oyster samples from the medieval and post-medieval periods. Modern oyster samples display the greatest heterogeneity in size.

It should be noted that there is a greater similarity in size between samples belonging to the same period than in samples hailing from the same region.

DISCUSSION OF SPATIAL AND TEMPORAL VARIATIONS IN SIZE

The size of an oyster can be the result of a combination of factors. It is important to remember that the size of oysters in archaeological samples does not necessarily reflect the size of oysters in the population from which they were drawn. Inherent in a population of oysters may be characters responsible for a faster or slower growth rate. The developmental stage of the oyster will be reflected in the size of the shell.

Local environment and geographical position which incorporate such factors as latitude, seabed substrate, water depth and temperature, all of which in turn affect food supply and uptake of calcium carbonate, will also affect shell size.

Evidence of oyster farming is difficult to demonstrate but it should be noted that cultivation techniques do not necessarily lead to an

increase in size compared with that achieved in wild or natural populations because, although separation and relaying of oysters should allow individual oysters the space to achieve their optimum potential in size and shape while the meat fattens in relatively better nutrient-enriched waters, abrasion by increased levels of water borne mineral particles typical of these waters, and possible exposure to the air on intertidal beds or extremes of weather in shallow waters may lead to an increase in shell thickness rather than diameter

The way the oysters have been harvested will influence the sizes in the sample. Collection by hand will have a different effect on sizes of oysters in the sample as compared with more advanced methods using boats since dredge net sizes, local regulations governing size of catch and sizes of oysters to be caught, plus size preferences at the marketing level, may have affected the size of shells in the sample.

The intensity with which the oysters are fished will have an effect on the size as well as on the numbers available in subsequent years. Over-exploitation is traditionally believed to lead to a decrease in the size of oysters recovered, but recently evidence has come to light that it can also lead to larger oysters being collected in the long run either where small oysters are fished out or where the smaller oysters are protected (Davies, pers. comm.), presumably prior to the virtual extinction of the beds when all the larger breeding stock has been removed.

Athough it is now known that large and small oysters survive in transit equally well, certain sizes may have been thought to remain fresher on long journeys, thus influencing the selection of oysters for marketing. Culinary preferences for larger, pied du cheval type of oysters more suitable for cooking or smaller oysters for raw consumption may have affected the sizes in the sample.

Add to the above factors the unknown depositional history of the oyster shells and variable techniques of excavation and post-

excavational treatment, and it can be seen that a simple explanation to account for spatial variation in oyster size is not possible.

It has been possible to demonstrate spatial variation in size and size distribution in oyster shell samples on both an intrasite and intersite basis. On the intersite level it has been possible to distinguish, to a greater or lesser degree, size variations attributable to general region, position relative to the sea (inland versus coastal sites), and degree of development of the site (urban versus rural).

When the oyster sizes were considered by region, it was discovered that oysters seem to achieve their greatest size in the Poole region, followed by those from the Southampton and Solent region, and the east-coast region. The smallest oysters of all tended to come from the north Wessex and London region. More detailed investigation of the existing and additional data would be desirable to confirm this trend and perhaps refine the regional categories to actual site of origin since, as outlined above, there may be many circumstances at work apart from geographical location affecting the size of oysters.

Similarly, when oysters from different categories of site were considered, there were indications of detectable differences between urban sites with smaller shells and rural sites with larger ones; and between inland samples of smaller average size than coastal ones. However, these categories are interrelated so that, for example, an inland site may also be urban or a coastal site urban. So verification of the size differences must also be accompanied by a consideration of the interrelated factors. The possible reasons contributing to spatially differentiated size categories will be considered in greater depth in the final chapter, 11.

It has also been possible to demonstrate, perhaps more convincingly, that the average size of oysters has varied throughout history. The largest shells have been recorded for deposits dating to the Roman period with a subsequent decline in size until the present time when

oysters overall seem to be increasing in size again, almost to the Roman scale.

Reduction in shellfish size through time has usually been attributed to overfishing. Over-exploitation obviously has a major effect on size of oyster caught. However, the apparent increase in size of modern oysters seems to indicate that other factors may play a part. The demands on modern populations of oysters from fishermen in the twentieth century must be at least as great as they were in the past. Additional environmental pressures on oyster beds imposed by increasing industrialisation, changing agricultural practices, land reclamation and recreational purposes with associated pollution problems and diseases could be thought to ensure further decline in size. It seems possible that some aspects of changing environmental conditions may have promoted growth rate. And it is tempting to speculate that a combination of increased nutrient levels in coastal and estuarine waters through increased soil run-off with associated enrichment, and a slight temperature rise might be responsible.

As with spatially determined variations in oyster shell size, the causes of temporal variations may not be straightforward and their elucidation requires much further work. In the next chapter, 10, intersite variations in infestation will be considered. When the patterns of infestation in oyster shells were examined on a broad scale, much evidence was uncovered to consolidate the ideas of regional and temporal variation proposed in this chapter.