ARCHAEO + MALACOLOGY GROUP NEWSLETTER

ISSUE 24, APRIL 2014

SHELL BIOMETRICS IN ARCHAEOLOGICAL AND PRESENT DAY LIMPET SAMPLES FROM AROUND ORKNEY.

T. L. BRANSOMBE, M.C. BELL, I. MAINLAND, A. WANT[1]

ACKNOWLEDGEMENTS

I would like to thank Dr. Angela Drummond for encouraging all her pupils to apply for this scheme, the Nuffield Foundation as well as ICIT of Heriot-Watt University for giving me the wonderful opportunity to take park in this project. Also, I would like to thank my supervisors Andrew Want, Mike Bell and Ingrid Mainland and also the Nuffield Coordinator, Frances Chapman, for their much appreciated help and guidance and support throughout the project.

INTRODUCTION

The coastal locations of virtually all of the archaeological sites on Orkney mean that shell is commonly found throughout them, especially in midden and floor contexts. In many of Orkney's archaeological sites the sandy soil gives a high pH (the soil is alkaline) which also lends to good preservation of these shells so that many of them are complete and measurable samples. Limpet shells are commonly accepted to change in shape according to environmental factors (both at different sites and shore levels) such as wave action, in order to reduce the drag

[1] tansybranscombe@yahoo.co.uk, m.c.bell@hw.ac.uk, Ingrid.mainland@uhi.ac.uk, a.want@hw.ac.uk

the waves produce in travelling over them. Due to these variations, limpet shells can be useful when looking at archaeological sites as they can be used in relating the archaeological samples to modern sites and therefore showing which beaches (and in some cases even the shore level on the beach) they were being collected from by the people inhabiting the sites at the time. They can also be used to find possible patterns of size selection by ancient gatherers as well as detecting differences between samples from different archaeological eras.

In this investigation, primary evidence was collected to attempt to look further into these possibilities and gauge whether these techniques would be applicable to the archaeological limpet samples on Orkney. In the following report, the findings will be presented under two broad topics; the relation of archaeological samples to present day populations and evidence of size selection by gatherers. The archaeological eras involved in this project are the late Iron Age, represented by samples from contexts at The Cairns and Mine Howe, and the Viking Age represented by contexts at Snusgar. For the research and implications of only modern collections taken at the same time, see Fairnie 2012.

HYPOTHESIS

It was expected that the modern limpet samples would show significant change in shell shape and size according to their locations on the shore and to the exposure at that location. It was thought that the drag created by higher exposure would result in lower, narrower shells in order for the limpets to become more streamlined and this was expected to be more prominent the lower down the shore where the limpets would be submerged (and exposed to wave action) for longer than those further up the shore. However, it was also considered that due to the increased time spent submerged by the lower shore limpets they would have more feeding opportunity and so their meat content could be larger making them attractive to gatherers. The variability according to exposure was expected to help place the archaeological limpet samples geographically by measuring which of the sites their morphometrics were closer to, perhaps even down as far as shore level. It seemed logical that ancient gatherers would have selected their limpets by size, avoiding the smaller limpets in order to have enough large limpets for use as food or bait. For this reason it was predicted that the size distribution of the archaeological samples would have a much smaller range than that of the archaeological limpets, because in the collection of the modern samples all limpets were taken regardless of their size.

METHOD

FIGURE 1: MAP SHOWING SAMPLING AND ARCHAEOLOGICAL SITES

The first part of the project consisted of the collection and measurement of the limpet samples. Six sites were chosen from which to collect limpet samples; three archaeological sites and three modern sites. The modern sites were chosen to be as close as possible to the archaeological sites as these were deemed the most likely places that the archaeological samples could have been collected from. The destinations eventually chosen were Skaill, Windwick and Sebay to correspond with the archaeological samples from the Viking site at Snusgar, the late Iron Age site at The Cairns and the Iron Age site at Mine Howe, respectively **(FIGURE 1).**

At the modern sites, three 4m^2 quadrats were marked out: one each in the upper, mid and lower shore areas. All the limpets were then removed from these areas using knives, and were put into separate bags. As many limpets as possible were measured on site to minimise fatality rates, but some did have to be taken back to the laboratory to be boiled and measured there. For each quadrat the degree of slope, geographical co-ordinates and the percent seaweed cover (estimated by eye) were also taken **(TABLE 1)**.

Site	Shore Level	Date	GPS	Slope	Seaweed Coverage
Skaill	Upper	03/07/2012	N59.05660 W3.33747	8°	F. Spiralis (all) 20%
	Mid	03/07/2012	N59.05660 W3.33760	9°	F. Vesivulosus (all) 50%
	Lower	03/07/2012	N59.056636 W3.33813	8°	25% (50% F. Serratus 50% F. Vesculosus)
Sebay	Upper	05/07/2012	N58.94026 W2.82960	13°	F. Spiralis (all) 45%
	Mid	05/07/2012	N58.94015 W2.82953	13°	80% (60% Ascophyllum 40% F. Spiralis)
	Lower	05/07/2012	N58.94032 W2.82932	13°	100% (all) Ascophyllum
Windwick	Upper	19/07/2012	N58.76578 W2.93668	N/A	40% (30% Ascophyllum 35% F. Serratus 35% F Veiculosus)
	Mid	19/07/2012	N58.76577 W2.93643	N/A	30% (10% Ascophyllum 50% F. Serratus 40% F Veiculosus)
	Lower	19/07/2012	N58.76583 W2.93613	N/A	20% (60% F. Serratus 40% F Vesiculosus)

Table 1: Site Descriptors

The measurements taken from each limpet consisted of maximum height, length and width, aa (apex to anterior), ap (apex to posterior) and x (the length from the apex to anterior along a horizontal axis rather than following the slope of the shell). Along with this, for each limpet a subjective 'starriness' rating was also taken on a scale of 1-5, with 1 being completely smooth and 5 being extremely starry.

The archaeological samples were taken from the Orkney Research Centre for Archaeology, based at Orkney College, under the guidance of the bone specialist Ingrid Mainland. For each archaeological context the samples were sieved using a 4mm gauze. The greater than 4mm fragments were used to count minimum number of individuals (MNI) and the number of identifiable specimens (NISP) which were both then weighed **(Table 2)**.

Site	Context	Measurable Limpets	MNI	Weight (g)	NISP	Weight (g)
Minehowe	56, 35	0	0	0	14	6.11
Minehowe	46, 33	0	1	1.39	11	1.85
Minehowe	500, 75	6	7	9.79	10	10.05
Minehowe	58	3	5	5.5	7	10.01
Minehowe	503, 83	9	13	16.82	128	44.87
Minehowe	503, 81	93	139	371.27	143	380.54
Snusgar	2232	46	51	217.37	88	253.72
Snusgar	2263	50	57	172.87	88	205.29
Snusgar	2264	30	39	113.78	43	115.82
Snusgar	2261	52	64	108.45	81	201.27
Snusgar	3362	32	38	140.84	48	150.5
The Cairns	703*	238	427	1053.59	2157	1515.8

*Only some of context sampled and measured

Table 2: Archaeological Context Records

These were then separated further into measurable and unmeasurable limpets which were also weighed, along with the fragments of less than 4mm and the greater than 4mm fragments from the samples that were not limpet (stone and other shell). For Mine Howe the entire limpet population was measured as there were relatively few, however in Snusgar nine different contexts from a range of areas and dates were chosen and only these were recorded. For the Cairns, only a sample of one context was recorded due to its large size. An extra measurement – level of erosion – also had to be added for the archaeological limpets as a measure of taphonomic processes that had affected the shell while buried. This was on a scale of 1-3 **(Figures 2-4)** with one being the best preserved and 3 being the least well preserved.

FIGURE 2: PHOTOGRAPH AND DESCRIPTOR OF PRISTINE/NEAR PRISTINE LIMPETS

The shell will either be smooth or clearly defined, unworn ridges. No stepping (lamellar degradation) on surface. Inside should be clearly marked and shiny with remnants of colour.

FIGURE 3: PHOTOGRAPH AND DESCRIPTOR OF LIMPETS SHOWING SURFACE EROSION

Obviously degraded (though still visible) ridges, but still no stepping or lamellar degradation. Markings inside the shell will probably not be clear, and the shell will have a bleached look all over.

FIGURE 4: PHOTOGRAPH AND DESCRIPTOR OF LIMPETS SHOWING HEAVY EROSION

Lamellar degradation present on surface shown through stepping. Uneven surface, obviously eroded. Interior again with no clear marking and entire shell bleached.

After all the limpets were measure, the resulting measurements were tabulated in Microsoft Excel. Power law graphs were made showing height by length, width by length, x by length and height by width. These helped to point out obviously incorrect data that had been mistyped or wrongly taken (often the limpets could be re-measured as those in the lab were all numbered). Following this, a series of further graphs and tables were formulated in order to analyse the measurements including size distribution histograms.

RELATING ARCHAEOLOGICAL SAMPLES TO NEARBY PRESENT DAY POPULATIONS

To investigate this topic the power law graphs for Skaill, Windwick and Sebay **(FIGURE 5)** were compared to roughly gauge whether each modern site had a distinctly different growth rate. While a strong positive correlation could be seen in each graph, on the surface they looked broadly similar. To attempt to detect subtler differences in these, each graph was then assigned an equation in the form of y=axb, where 'b' expresses the proportionality between the two shown dimensions and 'a' expresses the allometry of growth. It was decided that differences in the 'a' and 'b' values for each site could show differences between how each limpet population grew, so these values were plotted against each other, with a graph for each relationship (e.g. height/length) showing the 'a'/'b' values for each site **(FIGURE 6).**

These graphs showed a negative correlation, with 'b' decreasing as 'a' increases. The modern points on the graph were grouped according to site to see whether they could be separated in order for archaeological points to be placed into a specific site. However, when grouped there were large areas of overlap which meant that the archaeological values could not be assigned to a specific modern site with any certainty. When placed on the graph alongside the modern values, the 'a'/'b' values for the archaeological samples were often quite apart from the main group. The values for The Cairns, in particular, seemed far off in all but the graph for the x/l relationship, whereas the values for Mine Howe usually stayed within the group of modern values. These large differences also added to the difficulty in associating the archaeological samples to nearby present day ones as even if the modern day values had grouped distinctly, most of the archaeological samples would have fallen far out of these groups.

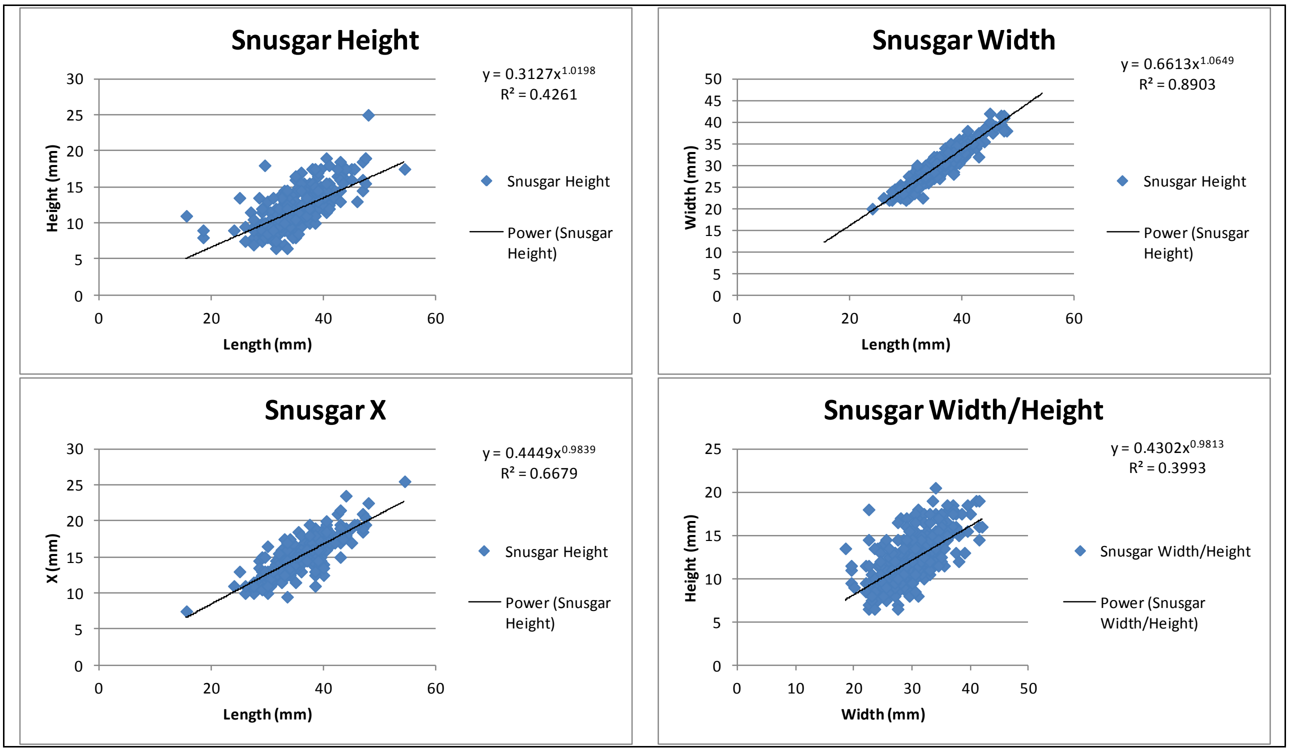

FIGURE 5: EXAMPLE POWER LAW GRAPHS

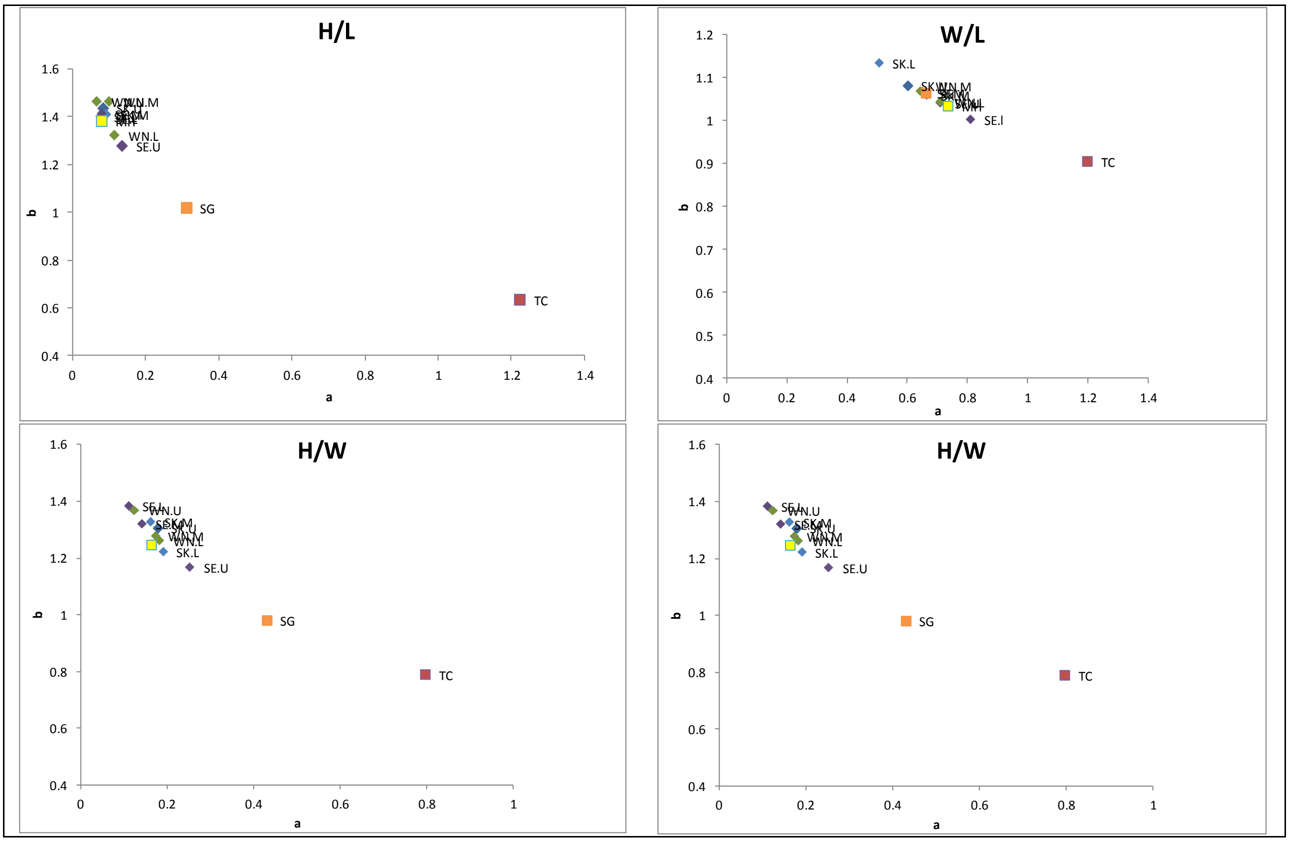

FIGURE 6: PLOTS OF 'A'/'B' VALUES

The last method used to try and relate the archaeological limpets to a particular population was to create graphs of predicted height given lengths of 15, 30 and 45mm at different sites (**FIGURE 7**).

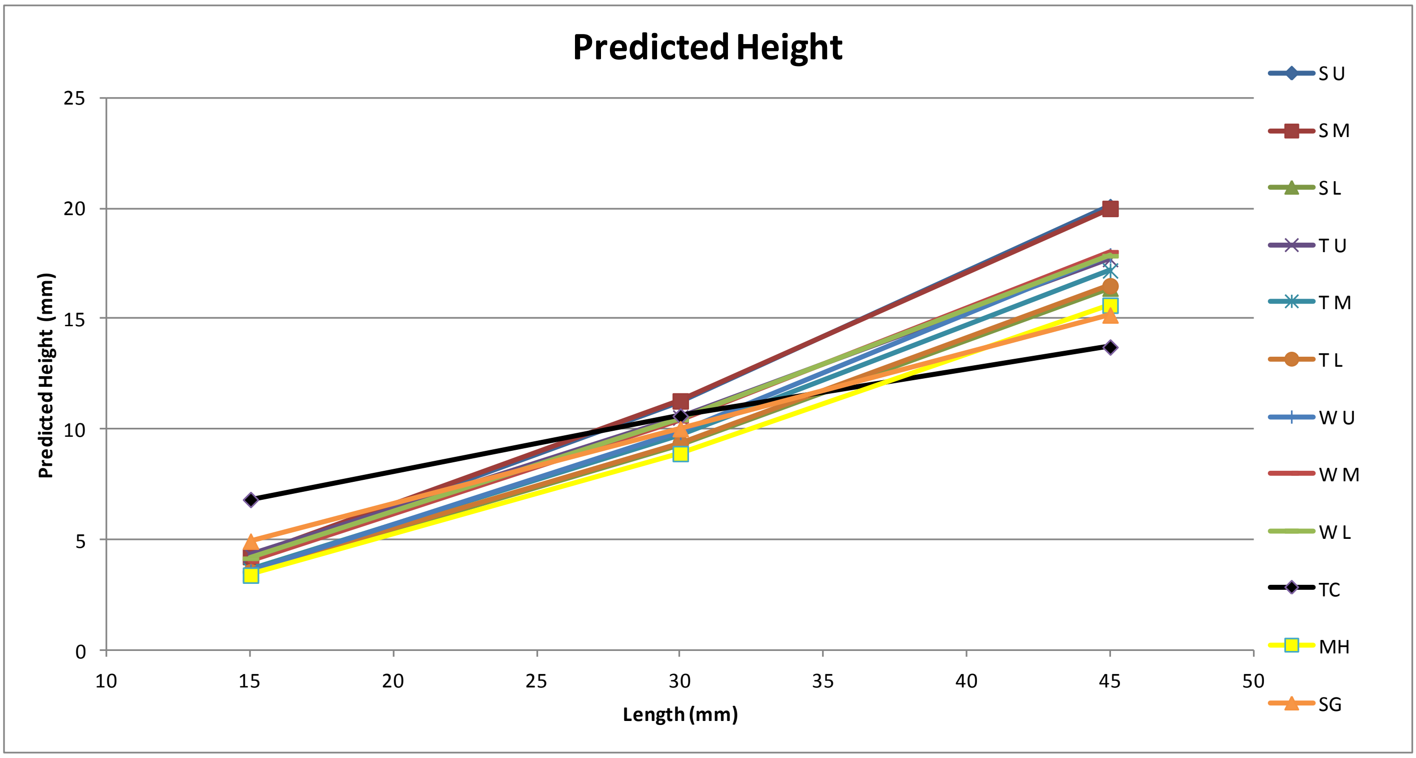

FIGURE 7: PREDICTED HEIGHT FOR DIFFERNT LENGTHS (T IS SEABAY)

These looked fairly similar for both the modern and archaeological samples so it was decided that further analysis would have to take place before differences could be seen. The squared difference between each modern and archaeological site was then calculated and tabulated (Table 3) to find the most similar modern area to each archaeological sample – the lower the number in the table, the more similar the two sites are.

	THE CAIRNS	MINEHOWE	SNUSGAR
SKAILL – U	47.94168	25.73874	26.08074
SKAILL – M	46.39295	25.5289	25.28163
SKAILL – L	19.86116	0.74532	4.106191
SEBAY – U	22.00218	7.872987	7.011719
SEBAY – M	22.98635	3.142647	5.879044
SEBAY – L	19.84325	1.017453	4.091767
WCK – U	28.34479	6.08772	9.213303
WCK – M	26.33765	8.44348	9.111016
WCK – L	24.12786	7.953808	7.954814

KEY: Best Match → Worst Match

Nearest Modern Site (In Bold)

TABLE 3: TABLE SHOWING THE SQUARED DIFFERENCE BETWEEN PREDICTED HEIGHTS AND COLOUR-CODED TO SHOW CLOSEST MATCHES

It was found that although none of the most similar modern equivalents to the archaeological samples were within the expected site, they were often close and in all of the sites, the closest modern sample was found in the lower shore. Furthermore, when comparing one particular archaeological site to one particular present day site, with only one exception (MH/W), the closest modern sample is always in the lower shore. This pattern suggests either that the limpets on the lower shore were of greater abundance so show up more in the archaeological samples, or that the gatherers were preferentially selecting the limpets of the low shore. This could be due to the fact that limpets at the low shore may be of better quality meat because they spend more time submerged so have more opportunity for feeding.

While this research has not successfully connected each archaeological site to its nearest modern site as hypothesised, it has shown some patterns in the limpet samples. The biometrics of the three modern sites did not prove as different as expected, possibly due to the fact that the sites selected were not of different enough exposure levels. However, the final table created showing the squared differences between the predicted heights of the modern and archaeological sites did show a significant pattern of the closest place to each site being at the lower shore. This suggests that the gatherers were out collecting at low tide, and also could suggest that they were preferentially selecting better quality low shore limpets.

As previously mentioned, the modern measurements may have shown more difference had three sites of more varying exposure been chosen, but these sites may not have aligned with suitable archaeological sites anyway and so could have proved even less use in this investigation. In some places human error will have crept into the measurements, as although those taken in the laboratory were available to check, the limpets measured on site were immediately replaced so any unusual measurements (other than extremely obvious error e.g. missing out the decimal point) will go undetected. These incorrect measurements, though, should be few enough in number not to significantly skew results so it is felt that these should be fairly accurate.

EVIDENCE OF SIZE SELECTION BY GATHERERS

This subject was touched upon in the last topic, where it was concluded that it was quite possible that gatherers collected limpets at low tide in order to gain access to the larger limpets which perhaps had better quality meat due to the benefit of extra feeding time while submerged. To investigate the possibility of selection on a purely size related basis, length distribution histograms were compiled showing both the overall archaeological versus modern size distribution **(FIGURE 8)** and the size distribution of each particular site compared to its nearest modern site **(FIGURE 9).** For the purposes of these histograms, each length was rounded to the nearest whole number in order to better show the pattern occurring with less unnecessary noise. The frequency of each limpet lengths was also turned into a percentage so that each chart was comparable despite differences in original sample size.

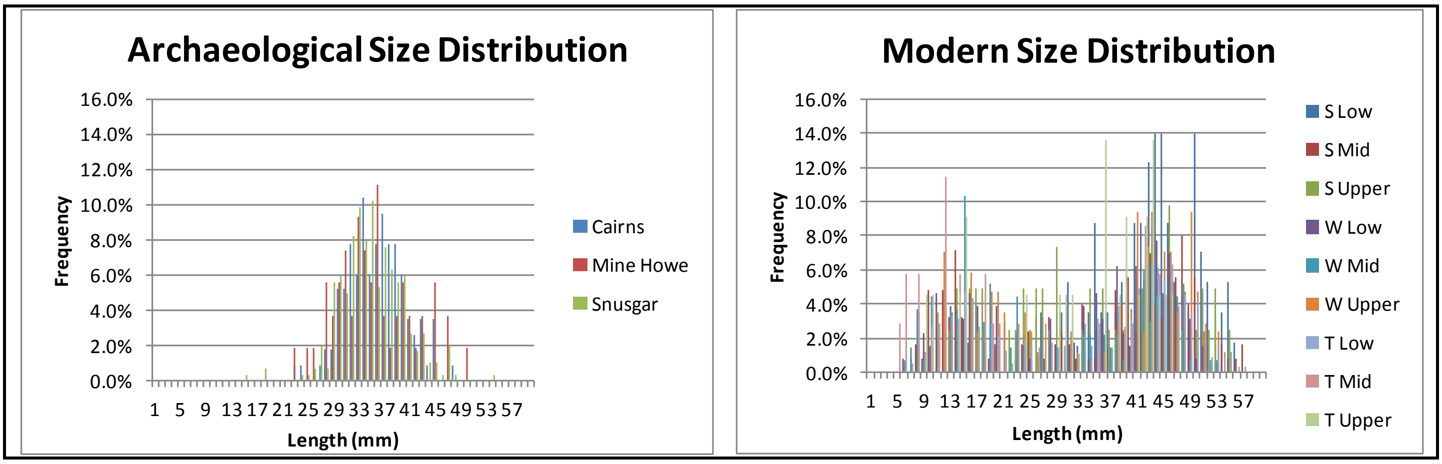

FIGURE 8: OVERALL ARCHAEOLOGICAL AND MODERN SIZE DISTRIBUTION

In the overall present day compared to archaeological length distribution, a clear pattern could be seen that was also present in the separate comparison of each site. The modern day distribution charts seem to have several spikes, most notably at around 14 and 45mm, which could indicate the seasonal growth of the limpets. The modern charts range from lengths as small as only 5mm to ones as large as 57mm. In contrast, the archaeological samples have a normal bell-shaped curve and only one peak at around 35mm. The range of the archaeological samples is also smaller, with limpets only as small as 15mm, and the largest being 54mm and the next largest being only 50mm. This unusual shape suggests several things.

The lack of small limpets seems to clearly show that gatherers in the late Iron Age and Viking age were specifically selecting their limpets for size, choosing only the larger limpets and leaving the limpets to grow until they are around 15mm in length. This is probably due to the fact that these limpets would likely have been used either as part of a meal or as bait. In either case, very small limpets would not be worth the time taken to collect them, as they would contain too little meat to make a decent meal or to entice fish. In order to do either of these things with such small limpets, a very large number would need to be collected which would take more time than collecting fewer, larger limpets. However, there are other possible explanations for this pattern in the size distribution. One such explanation is that perhaps these limpets were present in the archaeological contexts when they were originally laid down, but due to their fragility have been broken up and degraded more than the larger limpets so they do not remain in large enough fragments to be measured.

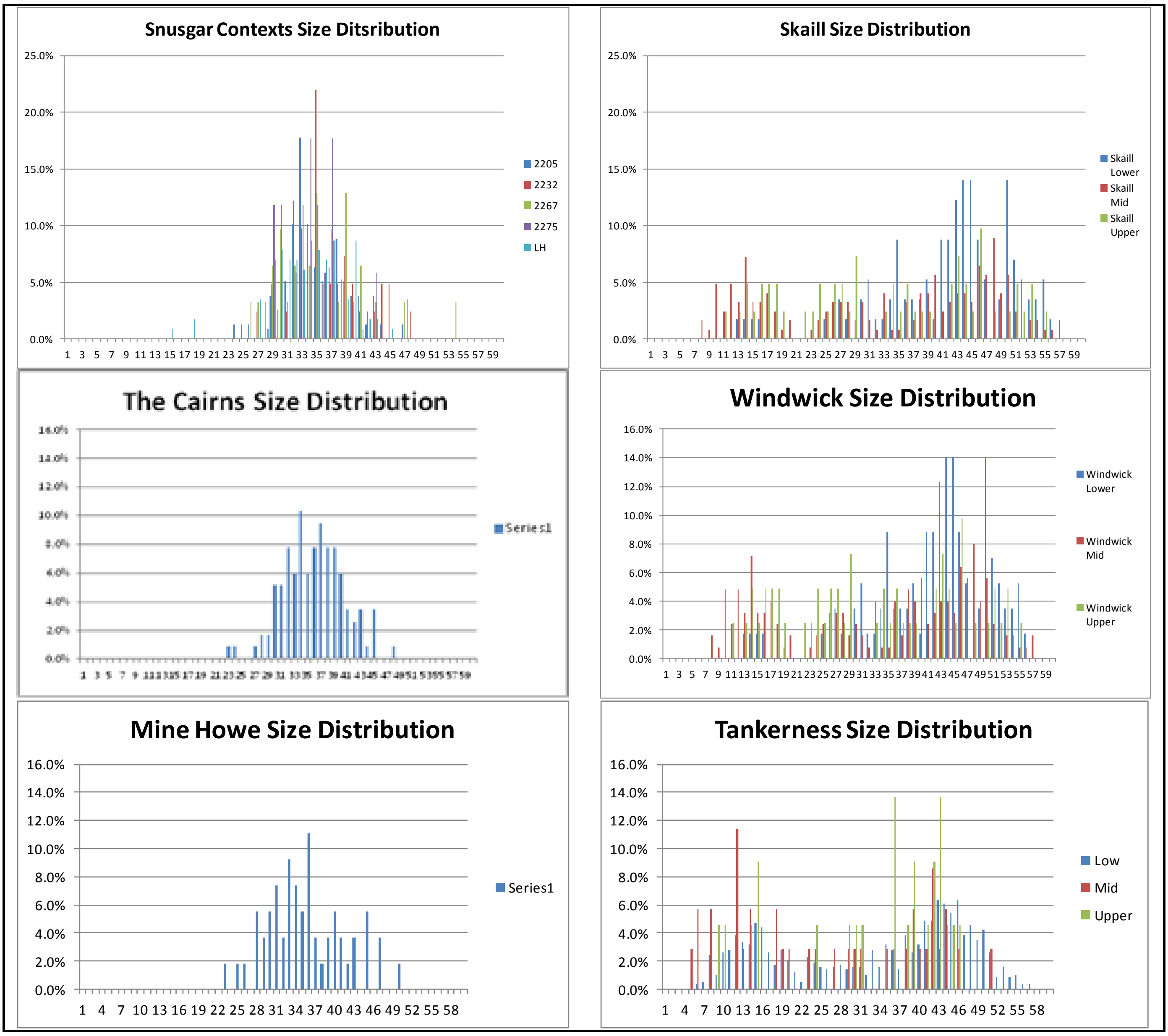

FIGURE 9: SIZE DISTRIBUTION CHARTS FOR EACH INDIVIDUAL SITE (AXES SAME AS IN FIGURE 5)

The lack of large limpets in the archaeological samples is also interesting. It is suggested that this shows the exploitation pressure placed on the limpet population by the Viking and Iron Age communities, a scenario in which these communities collect limpets so intensively that none are left to reach maturity. Again though, it is possible that these very large limpets were present originally but due to their size were more susceptible to breakages. Indeed, it can be suggested that the archaeological size distribution graph does not actually show the sizes at which most limpets were picked, but instead show the sizes at which most limpets have survived intact, with the peak at approx. 35mm in fact representing the size at which there is the highest chance of complete preservation. When comparing the samples from these two ages, another pattern emerges in that the Iron Age samples seem to show slightly more large limpets that the Viking sample at Snusgar. This suggests either that Vikings in general were placing even more exploitation pressure on limpet populations than the Iron Age people, or that this community in particular was doing so compared to others around Orkney. The latter seems quite probable, as the settlement at Snusgar (the Viking settlement) is the closest to the sea of the three sites so would probably have been more dependent on food from coastal sources such as limpets. Here it is not so reasonable to suggest the presence of fewer large limpets at Snusgar is due to worse preservation as the very sandy soil as Snusgar gave very high levels of preservation, more so than at the other two sites, with many limpets classed as pristine or near pristine (Figure 2).

From the results provided in this topic, several conclusions can be drawn. Firstly that due to the lack of smaller limpets at all three archaeological sites it is likely that limpet gatherers from these sites chose to ignore small limpets and chose only those worth using for food or bait. The entire lack of any limpet smaller than approx. 15mm suggests that size selection is more probable than the alternative explanation - that none of the small limpets survived due to taphonomic processes – because surely even if the smaller limpets had been more quickly degraded there would still be at least some measurable remains. The same does not apply to the lack of larger limpets as there are some large outliers in the archaeological samples (see Snusgar Size Distribution chart Figure 9) however there is a possibility that these outliers are down to human error. Also, despite their larger surface area, large limpet shells do not seem as if they should degrade faster than their medium-sized counterparts as they are also much thicker. So, it seems the explanation of exploitation pressure is equally, if not more plausible than that of quick degradation. Concerning the difference between the Iron Age sites The Cairns and Mine Howe having more large limpet shells than the Viking site Snusgar, more research would have to be done in order to reach a conclusion. This could involve the selection of further sites from these two eras in order to see whether the Vikings did indeed use more limpets (thus allowing less to reach maturity) or whether it was just that particular settlement at Snusgar, due to its close proximity to the sea, which had more of a dependence upon them.

REFERENCES

Baxter, J.M. (1983) Allometric Relationships of *Patella vulgata* L. Shell Characters at Three Adjacent Sites at Sandwick Bay in Orkney. *Journal of Natural History.* 17(5): 743-755

Bell, M. (2012) Analysis of Limpet Shell Shape

Cabral, J.P. and da Silva, C.F. (2003) Morphometric Analysis of Limpets from an Iron-Age Shell Midden found in Northwest Portugal. *Journal of Archaeological Science*; 30 (7): 817-829

Claassen, C. (1998) *Shells*, Cambridge University Press

Want, A. (per comm) Shell Morphological Analysis of *Patella ulyssiponensis* and *P. vulgata*