CHAPTER 7:

CONCLUSIONS AND FUTURE WORK

'Working with bone measurements is, in the final analysis, a matter of experience. He who develops the expertise to a fine art will have success. But he who does not see the whole but loses himself in details risks drawing false conclusions' (Boessneck & von den Driesch 1978: 35)

7.1 CONCLUSIONS

It can be seen from this study that a great many factors affect bone size and shape in domestic mammals and that these factors are constantly interacting to form a final adult bone size and shape. The sizes and shapes of animal bones that we observe on archaeological sites show a complex picture of the interacting forces of genetics, environment and husbandry (or hunting) practices. In addition there is the ever present issue of taphonomy (see Section 5.3.3) which must be considered, having greatest affect here in bone fragmentation dramatically reducing sample sizes. A further taphonomic factor pertinent to this study is that of the collation of data from a wide variety of researchers and sources and forming these into a single database of measurements.

Overall it is clear that bone measurement data can elucidate issues of environmental change, animal husbandry and genetic issues (although these were not explored in detail in this study). With careful consideration of the bone measurement data and other lines of evidence some of the main influences can be picked out.

Environmental factors, particularly those affecting animal nutrition, seem to have a particularly strong influence. It is felt by the author that where, for example archaeological sheep from the Western or Northern Isles are compared to the modern Soay (e.g. Noddle 1974 & 1978), these similarities may be as much a result of the comparable environments in which they were raised as any genetic lineage they may share. As such, care must be taken when attributing animals with a particular shape of metacarpal, for instance, to a particular genotype.

What has also been apparent in this study is that different species may react differently to the environmental changes taking place at a particular locale. For example what may be good for sheep may be less good for goats; therefore a particular change in environment may not affect all species equally (see Section 6.5.1 above). This further complicates the picture created by biometrical studies and emphasises the need for distinction between these two closely related species, through morphology and biometry, before other biometrical considerations can be taken into account.

The application of the log-ratio method, although extremely useful for expanding sample sizes, should be employed with great care and an awareness of which bones are present and how they are distributed across the plot. It is possible that apparent differences between assemblages may be entirely the result of different elements being present, as was the case for bones from Iceland examined in the land degradation hypothesis (Section 6.5.1).

On its own biometry is a useful tool for indicating size and shape changes in domestic mammals which may indicate differences in sex, changes in environment, or the introduction of new stock to a site. However the author firmly believes that further strength lies in the potential of combining biometrical data with other forms of evidence, creating a powerful tool for the examination of changes in environment and economy. The following section will discuss proposed future work leading from this research.

7.2 Future Work

The sites in Greenland are particularly interesting, due to the short lived nature of the settlement and the marginal environment in which the Norse settlers lived. The data for many of the sites presented in this research is extremely scanty and this region probably above all of the others studied would benefit from an expansion in the size of the dataset. One of the main problems for the Greenland data is the age of the excavations from which they come and the lack of stratigraphic recording; however new sites are being identified and excavated and are producing animal bone assemblages (K. Smiarowsky pers. comm.) and thus in the near future the dataset will expand. This will allow for a more detailed investigation of the changes in domestic mammal bone size towards the end of the settlement. It would also be of interest to compare changes seen in sheep, cattle or goats with those seen (or not) in wild taxa such as caribou. Further investigation of why sheep and goats apparently react differently to the changes taking place in Greenland over the course of the settlement would also be extremely worthwhile. To gain a fuller understanding of why this may be, detailed examination of climate and vegetation changes would

need to be carried out. Such a study would truly benefit from integration with other techniques such as examination of stable isotope measurements, tooth micro-wear and possibly stress indicators such as enamel hypoplasias. All of these techniques have the potential for examining environmental or dietary changes (e.g. Niven *et al*. 2004; Leyden *et al*. 2006; Mainland 2006) and in combination should form a very powerful dataset which would have the potential to greatly advance theories on the abandonment of the Norse settlements in Greenland.

A similar approach could also be applied to a further examination of possible improvements in animal husbandry at Iron Age sites in the Northern and Western Isles of Scotland. In fact, Jacqui Mulville has already begun similar research in the Western Isles looking at animal health and diet (see Smith & Mulville 2004: 59). In the Northern Isles the application of stable isotope and tooth micro-wear studies to the samples that show apparent size increases over time during the later part of the Iron Age could clarify theories regarding the improved provision of fodder at this time. Additionally bones of the skull should be investigated for the changes in size proposed in Section 6.4.2.

A further line of future investigation is the different placing of the sheep and goats on the astragalus scatterplot for GUS (figures 6.81 & 6.82). To the author's knowledge no work has been done on the separation of sheep and goat based on metrical differences in the astragalus, although their morphological differences have been discussed by Boessneck (1969). If astragalus measurements could be used to

distinguish them this would be another tool added to the sheep-goat distinction toolbox and may potentially be easier to use than morphological criteria alone.

One line of research that has not been touched upon during this project and deserves investigation is the movement of livestock around the North Atlantic region. It is clear that as Scandinavian settlers moved into previously uninhabited landscapes, such as those of Iceland and the Faroe Islands that they would have had to take livestock with them. However this raises a number of questions, for instance where did these livestock come from? Were they brought all the way from the Scandinavian homelands, or picked up on the way in the Northern Isles of Scotland? For that matter did they bring livestock with them from Norway when they first settled in the Northern and Western Isles as some have suggested (e.g. Fenton 1997: 446)? Were livestock frequently reintroduced to some areas? Whether biometry alone can answer these questions is doubtful due to the wide variety of factors other than genetics that have been shown to affect bone shape. However it would be intriguing to see the results of a combined genetic and biometrical study to see how the two lines of evidence relate to each other. Not only could this inform us of the nature of stock movements around the North Atlantic region, during the Norse period and earlier, but it may also give some indication of the amount of size and shape variation that is due to genetic factors and how much is due to external factors such as climate or husbandry.

For biometrical studies to be a truly useful tool in the future interpretations of North Atlantic archaeology, several key factors need to be addressed. Firstly the acquisition

of more well stratified and dated sites, particularly in Greenland. Secondly, where possible sample sizes need to be improved, possibly through the use of methods such the calculation of log-ratio values, although these must be used with caution (see above). The distinction of sheep and goats appears to be another important issue that needs to be further addressed in these areas. Finally and most importantly, in order for biometry studies to really move forwards, integration with other lines of archaeological and scientific evidence such as those discussed above is essential.