

Anciens peuplements littoraux et
relations Homme/Milieu sur les côtes
de l'Europe atlantique

Ancient Maritime Communities and
the Relationship between People and
Environment along the European
Atlantic Coasts

Sous la direction de / Edited by

Marie-Yvane Daire, Catherine Dupont,
Anna Baudry, Cyrille Billard, Jean-Marc Large,
Laurent Lespez, Eric Normand and Chris Scarre

Avec la collaboration de / With the collaboration of

Francis Bertin, Chloé Martin et Kate Sharpe

BAR International Series 2570
2013

Published by

Archaeopress
Publishers of British Archaeological Reports
Gordon House
276 Banbury Road
Oxford OX2 7ED
England
bar@archaeopress.com
www.archaeopress.com

BAR S2570

Anciens peuplements littoraux et relations Homme/Milieu sur les côtes de l'Europe Atlantique / Ancient Maritime Communities and the Relationship between People and Environment along the European Atlantic Coasts

© Archaeopress and the individual authors 2013

ISBN 978 1 4073 1191 3

pour citer ce volume / how to cite:

Daire M.Y., Dupont C., Baudry A., Billard C., Large J.M., Lespez L., Normand E., Scarre C. (dir.), 2013. Ancient Maritime Communities and the Relationship between People and Environment along the European Atlantic Coasts / Anciens peuplements littoraux et relations Homme/Milieu sur les côtes de l'Europe atlantique. Proceedings of the HOMER 2011 Conference, Vannes (France), 28/09-1/10/2011. British Archaeological Reports, International Series 2570, Oxford: Archaeopress.

Printed in England by Information Press, Oxford

All BAR titles are available from:

Hadrian Books Ltd
122 Banbury Road
Oxford
OX2 7BP
England
www.hadrianbooks.co.uk

The current BAR catalogue with details of all titles in print, prices and means of payment is available free from Hadrian Books or may be downloaded from www.archaeopress.com

FRUITS OF THE SEA: INVESTIGATING MARINE RESOURCE USE IN THE NORTH ATLANTIC ISLANDS.

Jennifer R JONES,

School of History, Archaeology and Religion, Cardiff University, Column Drive, Cardiff, CF10 3EU, United Kingdom,
email: jonesjr11@cardiff.ac.uk

Jacqui MULVILLE,

School of History, Archaeology and Religion, Cardiff University, Column Drive, Cardiff, CF10 3EU, United Kingdom,
email: mulvilleja@cardiff.ac.uk

Richard P. EVERSLED,

School of Chemistry, University of Bristol, Cantock's Close, Bristol, BS8 1TS, United Kingdom,
email: r.p.evershed@bristol.ac.uk

INTRODUCTION

The past and present island communities of the North Atlantic Islands have access to a rich and diverse resource base, including wild and domestic terrestrial animals, sea mammals, fish, shellfish, and birds. Understanding the changing role of marine resources through time in these islands can be a challenge for archaeologists. With the advancements of scientific techniques in archaeology a range of direct and indirect dietary indicators exist to investigate past diet. Pottery lipid residue analysis (Evershed *et al.*, 2008), human and faunal ^{13}C and $\delta^{15}\text{N}$ stable isotope analysis, and traditional zooarchaeological techniques can all be used to investigate past dietary behaviour on a range of different scales. Using a combination of these different techniques can enable a more complete understanding of the changing relationship between past North Atlantic Island communities and the sea.

THE NORTH ATLANTIC ISLANDS

The term "North Atlantic Islands" refers to the island groups off the coast of Scotland, (Figure 1), and can be broadly categorised into two groups; the Northern Isles which includes Orkney and Shetland, and the Western Isles, which refers to the islands of the Inner Hebrides and Outer Hebrides, including North and South Uist, Lewis and Harris.

Due to the rich and diverse archaeological heritage on the islands they have been subject to large scale research projects, generating a wealth of archaeological information. For instance, the SEARCH (Sheffield Environmental and Archaeological Research Campaign in the Hebrides) and derivative projects enabled survey and excavation of a wide range of archaeological sites in the Outer Hebrides including the sites at Mingulay, Barra and Pabbay (Branigan and Foster 2000), Bornais (Sharples 2005), Dun Vulcan (Parker Pearson and Sharples 1999), and Cille Donnain (Parker Pearson *et al.*, 2004). With such a vast quantity of archaeological information available in these islands, there is great potential to draw together the data from across the islands to investigate temporal and

geographical dietary trends.

CURRENT NORTH ATLANTIC SUBSISTENCE MODELS

Current models of subsistence in the North Atlantic Islands, based on stable isotope analysis have suggested that when the hunter-gatherer-fishers of the Mesolithic adopted farming in the Neolithic, marine foods no longer made a significant contribution to diet (Schulting and Richards 2002). The Neolithic decline in the importance of marine foods noted in the North Atlantic Islands is thought to continue until the arriving of the Viking settlers in the Norse period (Barrett *et al.*, 2001). This model is based on stable isotope analysis, representing an over-simplified understanding of dietary trends through time, without taking into account existing zooarchaeological evidence (Craig *et al.*, 2006; Milner *et al.*, 2004). Criticisms of the integrated approach are that zooarchaeological analysis of bones from the same sites as the human remains are necessary for valid interpretation (Hedges 2004), however as many of the skeletal remains come cemeteries and burials with no associated faunal remains this is not always realistic to achieve.

The rapid change in marine food consumption patterns during the Mesolithic Neolithic transition has been challenged in other parts of Europe, studies by Eriksson (2004) and Lidén *et al.*, (2004) demonstrate that marine resource use continued into the Neolithic in Sweden, suggesting that the transition was a more fluid event. The same can be seen in Denmark where studies have emphasised the highly complexity nature of the Mesolithic-Neolithic transition (Fischer *et al.*, 2007). More recently work by Craig *et al.*, (2011) of pottery residues and bioarchaeological evidence in the Western Baltic region has demonstrated post Neolithic marine resource use. These studies indicate that the issue of post Neolithic resource use is highly complex, and a wide degree of geographical variation has been observed, highlighting the need for a more integrated approach to understanding past marine subsistence.

Zooarchaeological analysis of North Atlantic Island assemblages dating from the Neolithic onwards demonstrate the presence of fish bones, shellfish, and sea mammal remains; however the lack of marine signature in the stable isotope evidence of human bones indicates

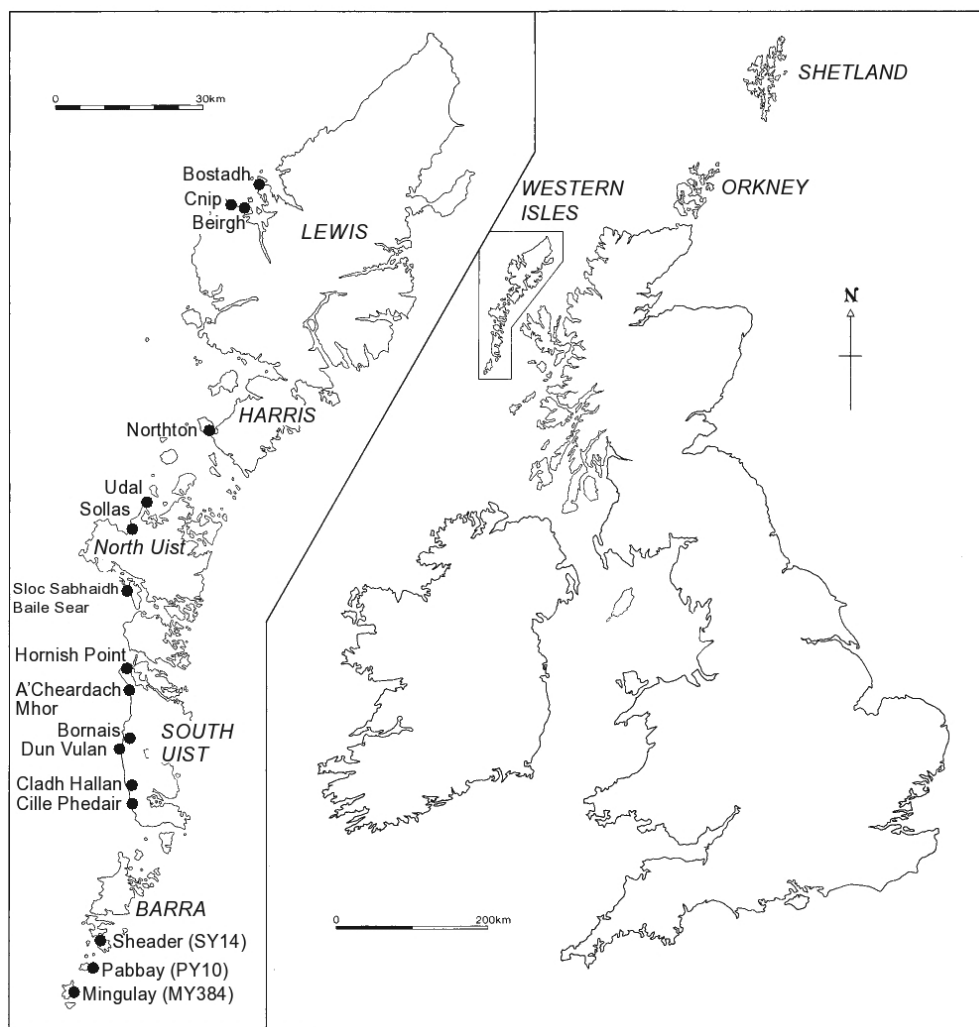


Figure 1. Location Map of the North Atlantic Island with a focus on the Outer Hebrides (image courtesy of Ian Dennis, Cardiff University).

that these foods were not being routinely eaten. Studies by Schulting *et al.*, (2004; Schulting and Richards 2009) have suggested that the limited marine resources recovered in Atlantic British assemblages may be a result of direct or indirect consumption of marine foods, or even non consumption based practises. The possible scenarios to explain this are that marine foods were eaten as a seasonal resource, a famine food, or may even have been used as animal fodder. Research from Holm of Papa Westray provides evidence for sheep seaweed consumption during the Neolithic (Balasse *et al.*, 2005, 2009) supporting the possibility that marine foods were utilised as animal fodder. Detailed analysis of human and faunal remains for $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ analysis in combination with traditional zooarchaeological methods enables a greater understanding of the discrepancies between these two datasets, and will identify possible marine based foddering strategies. Studies integrating zooarchaeological data, with human and faunal isotopic analysis exist, however they often small in scale, for instance considering individual sites, small study regions, or specific time periods, such as the research conducted by Borić *et al.*, (2004) studying Neolithic dietary change in the Danube region. In the North Atlantic specifically Schulting and Richards (2009) conducted a smaller scale study of Neolithic human, and animal stable isotope results,

in light of the zooarchaeological evidence. Regional studies of Northwest Europe using stable isotope evidence and more traditional zooarchaeological techniques (Tresset 2000, 2003), however these have been focussed on the Neolithic, and broader temporal comparisons would be to aid understanding of dietary trends. This paper will present a broader temporal and regional comparison of zooarchaeological and stable isotope data in the North Atlantic Islands to generate a greater understanding of the changing role of marine resource use in the lives of past island communities.

METHODOLOGY

Zooarchaeological analysis

A wealth of zooarchaeological data exists for the North Atlantic Island sites, with animal bone data from approximately 120 sites currently existing. Approaches towards North Atlantic island zooarchaeology to date are mainly site specific often with mammalian remains analysed independently from marine mammals, fish and shellfish (e.g. Bond 2007; Nicholson and Davis 2007; Ritchie 1983; Sharples 1984). Integrating data from many different sites poses challenges when drawing

comparisons in the dataset. Each of the sites in the study have been; preserved, excavated, sampled, sieved, analysed and published in a variety of different ways, making in depth comparisons difficult to achieve. In order to ensure consistency between the sites, only “Number of Identifiable Specimens” (NISPs) were used in the analysis, as they represent the most consistently recorded aspect of zooarchaeological data. Whilst using only NISPs does reduce the level of detail achieved, it ensures great ability to draw comparisons between sites with differing collection strategies. A recent review of zooarchaeological data across SW Asia and Europe using NISP values (Conolly *et al.*, 2010) demonstrates the ability to draw valid conclusions from this form of broad scale

analysis. Zooarchaeological analysis of the Western Isles provides comparisons with the detailed faunal stable isotope analysis. Figure 2 presents the list of sites from the Western Isles used in this paper, alongside the total identified NISPs for each site.

Correspondence analysis was selected to explore the data at these sites and to draw out initial patterns in the data. Correspondence Analysis (CA) is a form of multivariate analysis, and is frequently used as a measure of abundance in ecological datasets (Gauch 1982). Correspondence analysis is a descriptive technique, enabling comparisons between the assemblage compositions of each site to be drawn, as it groups together sites with similar characteristics (Shennan 1997, 318). CA calculates the importance of

Site list and NISPs of sites used in the Correspondence analysis			
Site Name	Period	Total Nisps*	Bibliographic reference
Northton	Neolithic	1437	Finlay (1984)
Udal North	Neolithic	939	Serjeantson (n.d.)
Udal North	Bronze Age	1208	Serjeantson (n.d.)
Udal North	Beaker	194	Serjeantson (n.d.)
Northton	Beaker	706	Finlay (1984)
Udal North	Early Iron Age	1963	Serjeantson (n.d.)
Mingulay MY 384	Iron Age	1015	Mulville (2000)
Sollas wheel house B	Iron Age	822	Finlay (1984)
Sollas wheelhouse A	Iron Age	1672	Finlay (1984)
Sollas	Iron Age	665	Finlay (1984)
Cnip	Iron Age	6300	McCormick (2006)
Hornish Point	Iron Age	1227	Halstead (2003)
A'Cheardach Mhor	Iron Age	631	Finlay (1984)
Northton	Middle Iron Age	257	Finlay (1984)
Northton	Late Iron Age	131	Finlay (1984)
Sheader (Search SY14)	Iron Age	590	Mulville (2000)
Bostadh	Late Iron Age	22735	Thoms (2004)
Dun Vulcan	Late Iron Age	8889	Mulville (1999)
A'Cheardach Mhor	Late Iron Age	201	Finlay (1984)
Dun Vulcan	Middle Iron Age	7465	Mulville (1999)
Berigh	Late Iron Age	2651	Thoms (2004)
Bostadh	Norse	4632	Thoms (2004)
*Nisps represent total of identifiable food species			

Figure 2. Site list and NISPs of sites used in the Correspondence analysis.

different variables within the dataset, and plots each zooarchaeological assemblage in accordance with how each assemblage “corresponds” to each other (Shennan 1997, 320). The CA was performed using Canoco 4.45, a program specialising in analysing environmental data.

Only sites that contained terrestrial mammals, marine mammals, fish and bird data were used in the analysis, to prevent false patterns emerging as a result of variations in sieving and sampling strategies. Marine shells were not included in this study as few sites recorded marine shell evidence, and therefore would have artificially skewed the patterns in the data. Ethnographic evidence of coastal dwelling communities indicates that shellfish are often processed away from settlement sites, to conserve the energy used to transport the heavy shells (Bird and Bliege Bird 1997), demonstrating that the absence of shells in archaeological assemblages does not mean that they were not consumed.

CA diagrams based on combined species NISP for terrestrial mammals, sea mammals, fish and birds were generated to identify any cohesion between sites of the same period. Sites with NISP totals of fewer than 100 bone fragments were not included in the analysis, as it is unknown how representative they are. In order to generate NISP values for each of the species groups, all edible terrestrial mammal fragments identifiable to species were totalled, including: cattle, sheep, pig, and red deer. Marine mammal fragments were totalled, combining each species of seal, whale fragments and general cetacean fragments. Seal was the most commonly encountered type of marine mammal in the assemblages. The bird NISPs represent the total identifiable fragments of each bird species, the bird species represented are mainly marine dwellers such as fulmar, gannet, shag and cormorant (Best pers. comm.). The total fish NISP represents the sum of the fish fragments identifiable to species.

Stable isotope analysis

Stable isotope evidence works on the basis that “you are what you eat”, the foods consumed by an individual leave a chemical signature in bone. Stable isotope analysis is therefore a direct indicator of dietary consumption. By comparing the ratios of $\delta^{13}\text{C}$: $\delta^{12}\text{C}$ and $\delta^{15}\text{N}$: $\delta^{14}\text{N}$ in bone collagen, it is possible to determine whether an individual was consuming marine foods. Carbon and nitrogen are used in the body as part of the growth and regeneration process, and remain in bone collagen for approximately 10-15 years, and therefore represent average diet over this time (Chisholm *et al.*, 1982 ; Schoeninger and De Niro 1984; Schulting and Richards 2002). The $\delta^{13}\text{C}$ value determines whether dietary protein consumed is from a terrestrial or a marine source, whereas the $\delta^{15}\text{N}$ value indicates the trophic level that an organism is feeding at. In Holocene Europe a typical terrestrial diet is represented by a $\delta^{13}\text{C}$ value of roughly 21‰, and $\delta^{15}\text{N}$ value of 6-9‰ in the bone collagen, whereas an entirely marine diet would generate a $\delta^{13}\text{C}$ value of -12‰, and a $\delta^{15}\text{N}$ value of 12-15‰ (Schulting and Richards 2002, 154). These values represent dietary extremes, and some variation in these values to be expected from individuals eating mixed terrestrial and marine diets (Hedges 2004; Milner *et al.*, 2004). Bulk collagen stable isotope analysis represents average diet and low levels of marine food consumption

would not necessarily be observed in the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of an individual.

Biochemical analysis of archaeological bone material involves destructive sampling, therefore to avoid causing damage to specimens that had already been analysed, it was necessary to collate all existing $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ data from published and unpublished sources. Prior to this investigation no coherent database of stable isotope generated in the North Atlantic islands existed. By collating all existing stable isotope data from human remains it from the North Atlantic Islands was possible to achieve a thorough chronology of dietary behaviour.

A wealth of human stable isotope data exists for the North Atlantic Islands for instance large scale projects at Westness (Barrett and Richards 2004) and Newark Bay (Richards *et al.*, 2006) have generated large bodies of data. Analysis of individual burials, such as at Cladh Hallan (Parker Pearson *et al.*, 2005), also provides a useful source of dietary information. Recent radiocarbon dating has also generated $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ results for instance at the sites of Dun Vulan, Bornais, and Kilpheder (Marshall pers. comm.), and Icegarth, Cnip, Sloc Sabhaidh and Lingro (Armit and Shapland pers. comm.), which have not previously been considered in palaeodietary studies. It is acknowledged that carbon and nitrogen results as a result of radiocarbon dating can produce greater variability in values (Schulting and Richards 2002, 163), however it was important to utilise these results to avoid additional damage to the fragile archaeological resource.

In order to be able to interpret the human $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values it was crucial to generate values of the most commonly eaten fauna in each time period and for each geographical location being studied, as $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values can fluctuate through time as a result of cultural and environmental processes (Bada *et al.*, 1990; Redfern *et al.*, 2010; Van Klinken *et al.*, 2000). Generating large numbers of faunal isotope samples from each period can enable typical $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ signatures to be characterised, to enhance interpretation of human values, and to understand more about the diet of animals in the past.

Faunal remains from the Western Isles were selected as a case study to aid with interpretation of human $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values. Background levels of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ can vary depending on a range of cultural and environmental factors, and which will be reflected in the local fauna. The main species analysed including cattle, sheep, pig, and red deer, representing commonly eaten wild and domestic species. Mature individuals were selected for analysis to prevent possibility of a weaning signature, which can create inflated nitrogen values (Richards *et al.*, 2006). The C: N ratio was noted for each specimen analysed to determine the level of post depositional diagenesis of collagen. All ratios were between 3.2-3.6, which is representative of *in vivo* collagen (De Niro 1985), ensuring that the results are accurate to use.

RESULTS

Zooarchaeological analysis

The correspondence analysis of zooarchaeological remains from 22 sites in the Western Isles is shown in Figure 3. The Neolithic phases of Northon (Finlay 1984) and Neolithic

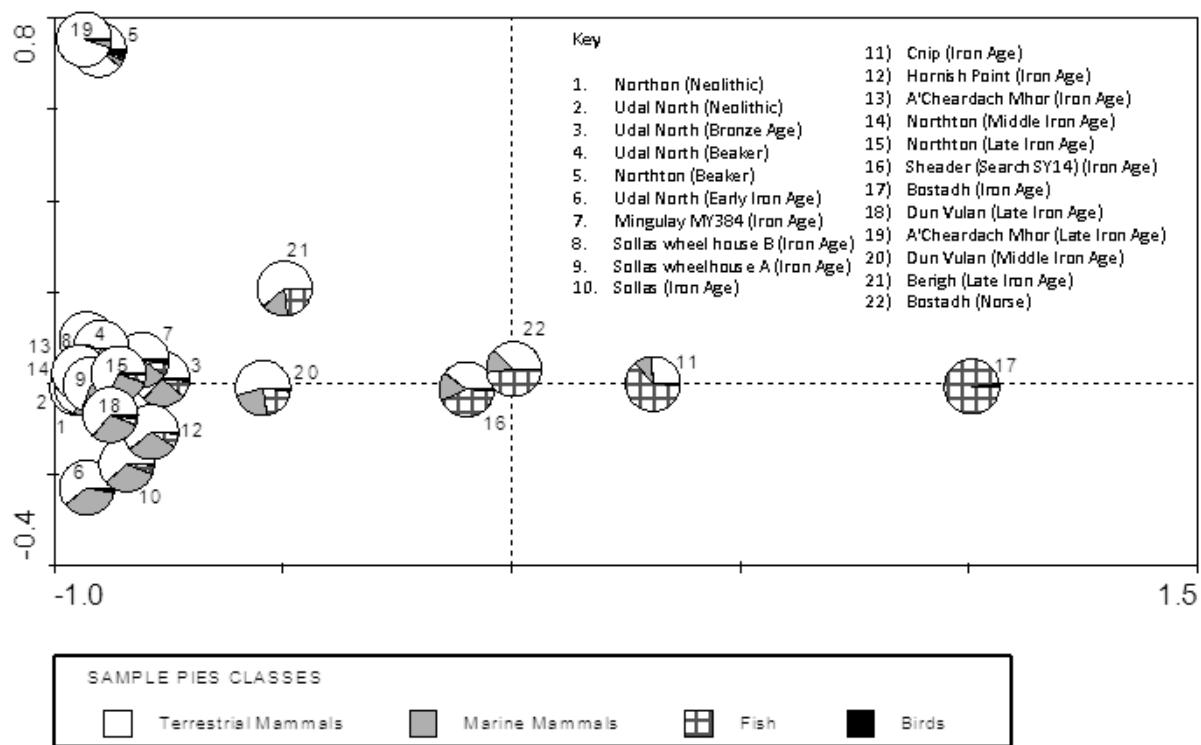


Figure 3. Correspondence analysis of species category NISPs in the Western Isles.

and Beaker period phases at Udal (Searjeantson no date) can be seen in the left hand side of the CA plot representing lower quantities of fish bones, combined with higher quantities of marine mammal bones being present. The Bronze Age phase at Udal North also plot in the same area of the graph demonstrating lower fish bone representation, with higher numbers of marine mammals, and low numbers of bird bones. Bird bones are not represented in great quantities at any of the sites used in this study.

There are several Iron Age sites identified as having relatively high levels of fish bone, for instance Late Iron Age Bostadh (Cerón-Carrasco 2005; Thoms 2004), Iron Age Sheadar (Mulville 2000) and Iron Age Cnip (McCormick 2006), indicating that fish were being utilised in abundance at these sites during the Iron Age. In contrast there are several sites that have lower levels of fish remains such as Iron Age Mingulay, Sollas, Middle Iron Age Northton, and the Late Iron Age Northon and Dun Vulan. Interestingly the Iron Age sites with fewer fish bones (Mingulay, Sollas, Northon and Dun Vulan) have larger numbers of sea mammal bone fragments, indicating a different pattern of exploitation. The variability in the Iron Age assemblages suggests that site individuality needs to be considered alongside the broader dietary patterns. As anticipated the Norse phases at Bostadh had high levels of fish bone present indicating that they were an important resource.

The Late Iron Age site of A'Cheardach Mhor and the Beaker phases of Northton (Finlay 1984) cluster in the top left of the graph, representing assemblages high terrestrial mammal NISP values, and, lower frequencies of marine mammal and fish bones. These sites were from older excavations and had smaller assemblage sizes in general, suggesting that they may have been affected by processes such as poor preservation, lack of sampling or lack of sieving.

Human Stable isotope values

The human stable isotope values from the Western and Northern Isles shown in Figure 4 demonstrate that marine resource subsistence strategies are much more complex than previously hypothesised (Barrett *et al.*, 2001; Schulting and Richards 2002). As demonstrated in previous studies the Mesolithic and Neolithic show distinct marine and terrestrial signatures respectively (Richards and Mellars 1998; Schulting and Richards 2002). The more recently analysed Neolithic skeletons from the tombs of Quanterness (Schulting *et al.*, 2010), and Holm of Papa Westray in Orkney do not have marine signatures. The Norse individuals from Westness (Barrett and Richards 2004) and Newark Bay (Richards *et al.*, 2006) demonstrate that some of the individuals at both sites were consuming marine foods. There is a cluster of Norse remains from Westness, Newark Bay, in addition to the individual analysed by the authors from Broch of Gurness that do not have a marine isotope signature, indicating variability in marine food consumption within the Norse period in Orkney.

When we begin to look at the isotope data from sites in between these periods, it is possible to see that $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ signatures consistent with consuming a dietary marine component can be observed in some of the Iron Age individuals from the Western Isles. For instance the burial at Iron Age Cnip (Armit pers. comm.), and five individuals from Middle Iron Age Dun Vulan (Pete Marshall pers. comm.) all display evidence of marine food consumption. Whilst it is acknowledged that results obtained from radiocarbon dating can be less precise than values achieved using collagen extraction for individual analysis of carbon and nitrogen, these Iron Age values stand out even from the other results achieved from

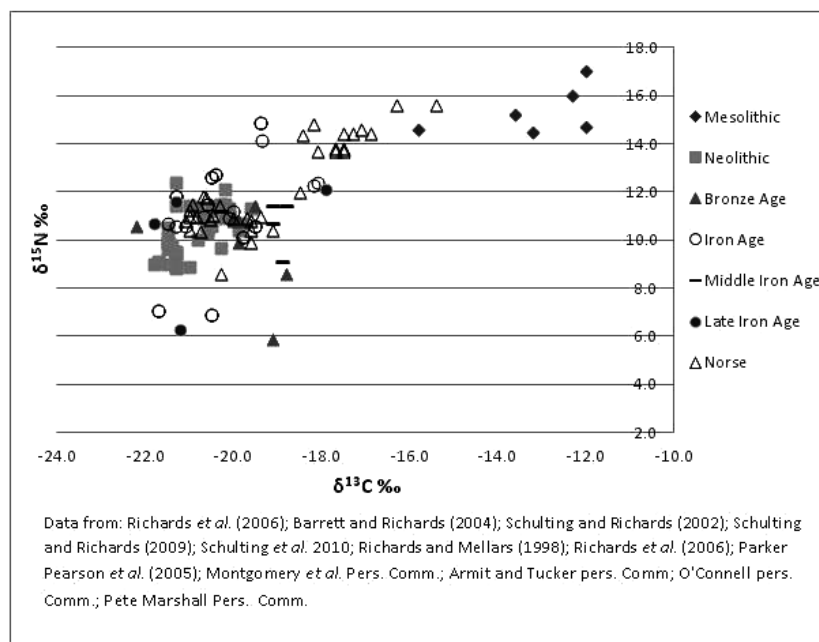


Figure 4. Human stable isotope values from the Northern and Western isles of Scotland.

radiocarbon analysis, indicating that they are a result of dietary behaviour rather than analytical variations.

Faunal Stable isotope analysis

Figure 5 demonstrates that the vast majority of the herbivores consumed a typical terrestrial diet, with $\delta^{13}\text{C}$ values of between -20.4 and -22 ‰, and a $\delta^{15}\text{N}$ value of between 3.4‰ and 7.5‰. One Late Iron Age red deer from Bornais displayed a less negative $\delta^{13}\text{C}$ value which has been previously suggested as evidence of seaweed consumption (Mulville et al., 2009). None of the other 33 red deer from the Iron Age displayed evidence of seaweed consumption, indicating that it was not a commonplace activity. The range of $\delta^{13}\text{C}$ values between -19.1‰ and -21.8‰ observed in the human specimens is consistent

with the range of the herbivorous. The $\delta^{15}\text{N}$ values of the human range between 6.3‰ and 11.5‰, making them enriched in $\delta^{15}\text{N}$ in relation to the herbivorous species, which typically range between 3.4‰ and 7.5‰. This is a result of the humans consuming a high protein diet including meat and milk products.

Detailed isotopic analysis of Iron Age faunal remains from the Western Isles, shown in Figure 6, demonstrates that some of the Iron Age pigs have a marine signature, demonstrated by less negative $\delta^{13}\text{C}$ values and elevated $\delta^{15}\text{N}$ values than the other omnivorous pig specimens sampled in this period. The Iron Age pigs with marine signatures were all from the Middle Iron Age site of Dun Vulan, which is also the site where human specimens were observed to have a marine component to their diet. Marine signatures were observed in three out of the eight pigs

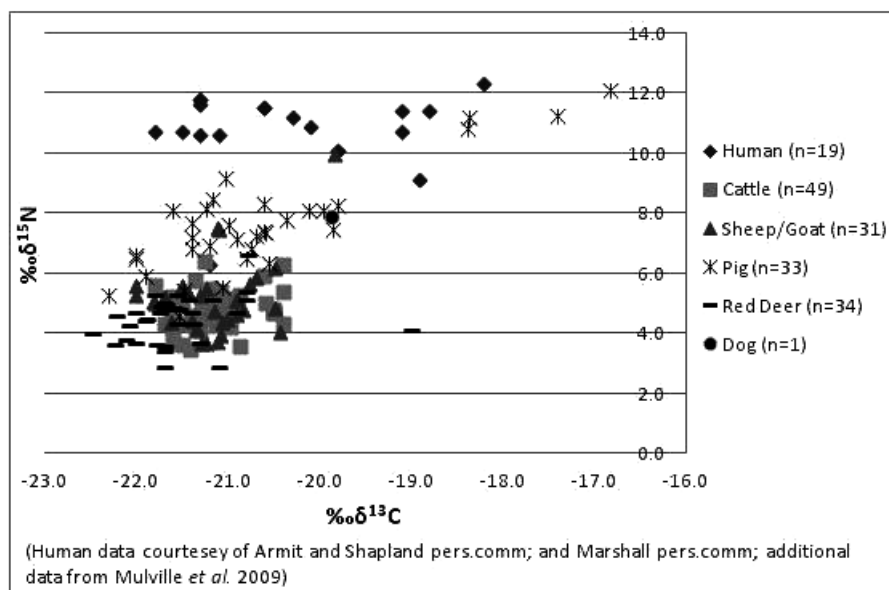


Figure 5. Stable Isotope values of Iron Age humans and terrestrial mammals in the Western Isles.

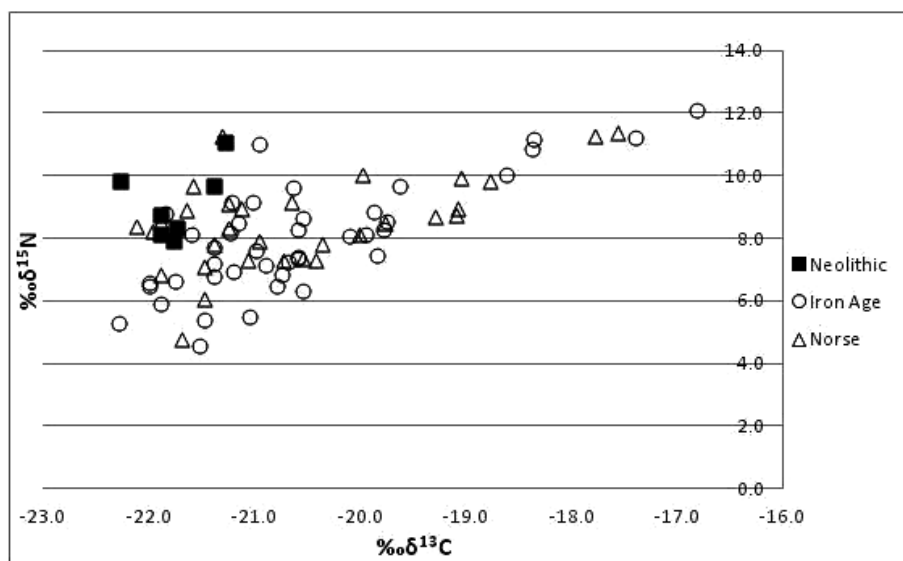


Figure 6. Stable isotope values through time of Pigs in the North Atlantic Islands.

analysed at that site, indicating that marine foddering was not an uncommon occurrence.

By comparing the Iron Age pigs with the pig specimens from additional time periods it was possible to establish that the marine signature in some of the Iron Age pigs was not a result of temporal variations in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$, as there are not distinctive temporal differences between each time period. Some of the Norse pig specimens also displayed evidence of having a marine component in their diet as displayed by the less negative $\delta^{13}\text{C}$ values, and enriched $\delta^{15}\text{N}$ values. In general the pig values have a wider spread of values ($\delta^{13}\text{C}$ between -16.8‰ and -22‰; $\delta^{15}\text{N}$ between 5.3 and 12.1‰). This wide variation in values can be explained by their omnivorous diet, with some specimens consuming large numbers of protein and marine foods causing variations in the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ observed in the bone collagen.

DISCUSSION

The zooarchaeological evidence when used in combination with the human and faunal stable isotope analysis demonstrates that whilst there is a decline in the level of marine foods being consumed in the Neolithic however, they do continue to be utilised to varying extents in each subsequent period. The decline in fish bones indicates that fish as a resource are less important in the Neolithic, Beaker Period, and Bronze Age, however many of the sites demonstrated relatively high proportions of marine mammals indicating a potential change in resource procurement strategies. It is possible that with the adoption of farming in the Neolithic communities placed less focus on actively fishing, and perhaps instead opting to scavenge for seals and cetacean on the beaches to supplement the staple diet of terrestrial diet. This intermitted procurement of marine mammals is supported by the absence of marine signature in the human stable isotope values, as low levels of marine foods can be consumed without the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values being affected (Milner *et al.*, 2004; Richards and Schulting 2006).

Understanding the relationship between these communities and marine mammals is difficult to assess, if the meat of these creatures was being consumed their bones would not necessarily be brought onto an archaeological site, as large quantities of meat can be butchered without the cumbersome bones being removed (Mulville 2005). The majority of marine mammal bones recorded at these sites were young seals, which would have proved to be simpler to hunt, indicating hunting was targeted towards easy to catch marine prey. Whale bones are identified as being a valuable architectural and artefactual resource in the North Atlantic (Mulville 2005; Savelle 1997), having implications for marine resources as a non-dietary commodity.

The marine signals found in the human and pig bone collagen from the Iron Age, combined with the higher frequencies of fish bones, of the Iron Age sites such as Cnip and Bostadh indicate that for some Iron Age populations fish was consumed on a semi regular basis. The few examples of pigs with marine signals could be explained by several different scenarios: for instance they may have been fed fish directly, or they may have consumed fish products as a waste product from human consumption and processing. Few fish bones and shellfish remains were identified at Dun Vulcan, which supports the possibility that the pigs might have been fed on marine products, which would destroy the bone evidence. Foddering of pigs on shellfish remains has been observed in coastal Brittany (Cocaign 1999) adding credence to this as a possibility.

The Iron Age pig specimens with marine signatures and five of the human specimens with marine signatures were from the Middle Iron Age broch site of Dun Vulcan, situated on a promontory leading out into the sea (Parker Pearson and Sharples 1999, Parker Pearson *et al.*, 2004). The proximity of this broch to the sea would mean that marine foods would have been readily available to the human and animal communities residing there. Brochs have been identified as possible high status locations in the landscape (Parker Pearson *et al.*, 1996) and the marine consumption during this period may be indicative of this elevated hierarchical role in the community. It is possible that the marine signature

of the humans is a product of consuming the pigs that had been eating a marine diet. This has wider implications for the interpretation of human stable isotope evidence. There is a great need for detailed sampling of the most commonly consumed fauna to characterise typical faunal $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values from each time period to determine their impact on the human values.

Whilst the correspondence analysis and isotopic analysis have provided an insight into broader trends in marine food consumption levels, the importance of site individuality is crucial in understanding more localised dietary trends. The increase of fish consumption in the Norse period demonstrates the need for site and region specific analysis in combination with the broader scale studies, for instance the Norse phases of Bornais in the Western Isles (Ingrem 2005) have high quantities of herring bone, whereas the Orcadian Norse sites have a high prevalence of cod bones (Barrett *et al.*, 2001; Barrett and Richards 2004), both of which are indicative of very different fishing strategies. The importance of different fish species in each of these periods indicates variations in the fishing strategies being utilised, implying that these communities had alternative approaches towards marine resource uses.

CONCLUSION

The results of the zooarchaeological analysis combined with the stable isotope analysis indicate that whilst there is a decline in marine food use in the Neolithic, they continue to be utilised at low level, and begin to increase in importance again during the Iron Age. The zooarchaeological analysis demonstrated that marine mammals in particular were still being utilised throughout time, suggesting a move from active fishing strategies to passive scavenging of marine mammals.

The marine signature identified in the pig specimens from the Western Isles has interesting implications for the interpretation of human $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ data. Consumption of pigs with a marine signature would impact on the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of the humans consuming these animals, and could easily be misinterpreted as evidence of marine consumption by the human population. Detailed analysis of the most commonly eaten food animals enables characterisation of typical $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of these animals, enabling more valid understanding of the human $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values. By accurately modelling past faunal diet we can begin to have a better understanding of past human dietary consumption, enhancing investigations into palaeodietary behaviour.

Broad scale dietary analysis can be useful in determining general patterns in the data, however considering site individuality is essential in understanding the role of marine resources in the lives of island communities.

ACKNOWLEDGEMENTS

The authors would like to thank Rona McGill and Jason Newton at the NERC (Natural Environment Research Council) Life Sciences Mass spectrometry facility in East Kilbride for their help with analysing the archaeological collagen samples, and to the Natural Environment

Research Council for sponsoring this research. Special thanks go to Alison Sheridan from the National Museum of Scotland for her kind help with sourcing samples, and to Tom Dawson providing bone samples from the site of Sloc Sabhaidh. The authors would like to thank Ian Armit, Fiona Shapland, Janet Montgomery and Tamsin O'Connell and Historic Scotland for permitting the stable isotope values to be used in this study. Thank you to Julia Best for providing information on bird bone NISP values for the Scottish Island sites, and to Niall Sharples for his help and expertise in Scottish Island archaeology.

BIBLIOGRAPHY

- Bada, J. L., Peterson, R. O., Schimmelmann, A. and Hedges, R. E. M. 1990. Moose teeth as monitors of environmental isotopic parameters. *Oecologia* 82 (1), 102-106.
- Balasse, M., Tresset, A., Dobney, K. and Ambrose, S. H. 2005. The use of isotope ratios to test for seaweed eating in sheep. *Journal of Zoology* 266 (3), 283-291.
- Balasse, M., Mainland, I. and Richards, M. P. 2009. Stable isotope evidence for seasonal consumption of marine seaweed by modern and archaeological sheep in the Orkney archipelago (Scotland). *Environmental Archaeology* 14, 1-14.
- Barrett, J. H., Beukens, R. P. and Nicholson, R. A. 2001. Diet and Ethnicity during the Viking colonization of northern Scotland: Evidence from fish bones and stable carbon isotopes. *Antiquity* 75 (287), 145-54.
- Barrett, J. H. and Richards, M. P. 2004. Identity, Gender, Religion and Economy: New Isotope and Radiocarbon Evidence for Marine Resource Intensification in Early Historic Orkney, Scotland, UK. *European Journal of Archaeology* 7 (3), 249-271.
- Bird, D. W. and Bliege Bird, R. L. 1997. Contemporary Shellfish Gathering Strategies among the Meriam of the Torres Strait Islands, Australia: Testing Predictions of a Central Place Foraging Model. *Journal of Archaeological Science* 24 (1), 39-63.
- Bond, J. M. 2007. The Mammal Bone. In J. Hunter, J. M. Bond and A. N. Smith, *Investigations in Sanday, Orkney Volume 1: Excavations at Pool, Sanday, a multi-period settlement from Neolithic to late Norse times*, 207-262. Kirkwall, The Orcadian in association with Historic Scotland.
- Borić, D., Grupe, G., Peter, J. and Mikić, Z. 2004. Is the Mesolithic-Neolithic subsistence dichotomy real? New stable isotope evidence from the Danube Gorges. *European Journal of Archaeology* 7 (3), 221-248.
- Branigan, K. and Foster, P. (eds.) 2000. *From Barra to Berneray. Archaeological Survey and excavation in the Southern Isles of the Outer Hebrides*. Sheffield, Sheffield University Press, Sheffield Environmental and Archaeological Research Campaign in the Hebrides 5.

- Cerón-Carrasco, R. N. 2005. *Of Fish and Men: A study of the Utilization of Marine Resources as Recovered from Selected Hebridean Archaeological Sites*. Oxford, Archaeopress, British Archaeological reports, British Series 400.
- Chisholm, B. S., Nelson, D. E., and Schwarcz, H. P. 1982. Stable Carbon isotope Ratios as a measure of marine versus terrestrial protein in Ancient Diets. *Science* 216 (4550), 1131-1132.
- Cocaïgn, J. Y. 1999. Aux origines du peuplement littoral. In G. Prigent (éd.) *Pêche à pied et usages de l'estran*, 15-18. Rennes, Apogée.
- Conolly, J., Colledge, S., Dobney, K., Vigne, J. D., Peters, J., Stopp, B., Manning, K. and Shennan, S. J. 2010. Meta-analysis of zooarchaeological data from SW Asia and SE Europe provides insight into the origins and spread of animal husbandry. *Journal of Archaeological Science* 38 (3), 538-545.
- Craig, O. E., Ross, R., Andersen, S. H., Milner, N. and Bailey, G. N. 2006. Focus: sulphur isotope variation in archaeological marine fauna from northern Europe. *Journal of Archaeological Science* 33 (11), 1642-1646.
- Craig, O., Steele, V. J., Fischer, A., Hartz, S., Andersen, S. H., Donohoe, P., Glykou, A., Saul, H., Jones, M., Koch, E. and Heron, C. 2011. Ancient lipids reveal continuity in culinary practices across the transition to agriculture in Northern Europe. *Proceedings of the National Academy of Science of the United States of America* 108 (44), 17910-17915.
- De Niro, M. J. 1985. Post-mortem preservation and alteration of in vivo bone collagen isotope ratios in relation to paleodietary reconstruction. *Nature* 317 (6040), 806-809.
- Eriksson, G. 2004. Part-time farmers or hard-core sealers? Västerbjers studied by means of stable isotope analysis. *Journal of Anthropological Archaeology* 23 (2), 135-162.
- Evershed, R. P., Copley, M. S., Dickson, L. and Hansel, F. A. 2008. Experimental evidence for the processing of marine animal products and other commodities containing polyunsaturated fatty acids in pottery vessels. *Archaeometry* 50 (1), 101-113.
- Finlay, J. 1984. *Faunal Evidence for Prehistoric Economy and Settlement in the Outer Hebrides to 400AD*. Unpublished PhD Thesis, University of Edinburgh.
- Fischer, A., Jesper Olsen, B., Richards, M., Heinemeier, J., Sveinbjörnsdóttire, A. E. and Bennike, P. 2007. Coast-land mobility and diet in the Danish Mesolithic and Neolithic: evidence from stable isotope values of humans and dogs. *Journal of Archaeological Science* 34 (12), 2125-2150.
- Gauch, H. G. 1982. *Multivariate analysis in community ecology*. Cambridge, Cambridge University Press.
- Hedges, R. E. M. 2004. Isotopes and Red Herrings: Comments on Milner *et al.*, and Lidén *et al.*, *Antiquity* 78 (299), 34-37.
- Ingram, C. 2005. The Fish. In N. Sharples (ed.), *A Norse Farmstead in the Outer Hebrides. Excavations at Mound 3 Bornais, South Uist*, 176. Oxford, Oxbow books, Cardiff Studies in Archaeology.
- Lidén, K., Eriksson, G., Nordqvist, B., Götherström, A. and Bendixen, E. 2004. "The wet and the wild followed by the dry and the tame"-or did they occur at the same time? Diet in Mesolithic-Neolithic southern Sweden. *Antiquity* 78 (299), 23-33.
- McCormick, F. 2006. Animal Bone. In I. Armit and R. Ceron-Carrasco (eds.), *Anatomy of an Iron Age Roundhouse: The Cnip Wheelhouse Excavations, Lewis*, 161-172. Edinburgh. Society of Antiquaries of Scotland.
- Milner, N., Craig, O. E., Bailey, G. N., Pedersen, K. and Anderson, S. H. 2004. Something Fishy in the Neolithic? A re-evaluation of stable isotope analysis of Mesolithic and Neolithic Coastal Populations. *Antiquity* 78 (299), 9-22.
- Mulville, J. 1999. The faunal remains. In M. Parker Pearson and N. Sharples (eds), *Between Land and Sea. Excavations at Dun Vulcan, South Uist*, 234. Sheffield, Sheffield Academic, Sheffield Environmental and Archaeological Research Campaign in the Hebrides 3.
- Mulville, J. 2000. The faunal remains. In K. Branigan and P. Foster (eds.) *From Barra to Berneray. Archaeological Survey and excavation in the Southern Isles of the Outer Hebrides*, 299. Sheffield, Sheffield University Press, Sheffield Environmental and Archaeological Research Campaign in the Hebrides 5.
- Mulville, J. 2005. A whale of a problem: the use of archaeological evidence to support modern whaling. In G. G. Monks (ed.), *The exploitation and cultural importance of sea mammals*. Proceedings of the 9th Conference of the International Council of Archaeozoology, Durham, August 2002, 154-166. Oxford, Oxbow books.
- Mulville, J., Madgwick, R., Stevens, R., O'Connell, T., Craig, O., Powell, A., Sharples, N. and Parker Pearson, M. 2009. Isotopic Analysis of Faunal Material from South Uist, Western Isles, Scotland. *Journal of North Atlantic* 2, 51-59.
- Nicholson, R. A. and Davis, G. 2007. Mammal Bones. In S. J. Dockrill, J. M. Bond, A. N. Smith, and R. A. Nicholson (eds.), *Investigations in Sanday Orkney Volume 2: Tofts Ness Sanday, An Island Landscape Through 3000 Years of Prehistory*, 169-195. Kirkwall - Orkney, The Orcadian in association with Oxbow Books.

- Parker Pearson, M., Sharples, N. and Mulville, J. 1996. Brochs and Iron Age society: a reappraisal. *Antiquity* 70 (267), 57-67.
- Parker Pearson, M. and Sharples, N. 1999. *Between Land and Sea. Excavations at Dun Vulan, South Uist*. Sheffield, Sheffield Academic, Sheffield Environmental and Archaeological Research Campaign in the Hebrides 3.
- Parker Pearson, M., Sharples, N. and Symonds, J. 2004. *South Uist: archaeology and history of a Hebridean Island*. Stroud, Tempus.
- Parker Pearson, M., Chamberlain, A., Craig, O., Marshall, P., Mulville, J., Smith, H., Chenery, C., Collins, M., Cook, G., Craig, G., Evans, J., Hiller, J., Montgomery, J., Schwenninger, J. L., Taylor, G. and Wess, T. 2005. Evidence for mummification in Bronze Age Britain. *Antiquity* 79 (305), 529-546.
- Redfern, R. C., Hamlin, C. and Beavan Athfield, N. 2010. Temporal changes in diet: a stable isotope analysis of late Iron Age and Roman Dorset, Britain. *Journal of Archaeological Science* 37 (6), 1149-1160.
- Richards, M. P. and Mellars, P. A. 1998. Stable isotopes and the seasonality of the Oronsay Middens. *Antiquity* 72 (275), 178-184.
- Richards, M. P. and Schulting, R. J. 2006. Against the grain? A response to Milner *et al.*, (2004). *Antiquity* 80 (308), 444-458.
- Richards, M. P., Fuller, B. T. and Molleson, T. I. 2006. Stable isotope palaeodietary study of humans and fauna from the multi-period (Iron Age, Viking and Later Medieval) site of Newark Bay, Orkney. *Journal of Archaeological Science* 33 (1), 122-131.
- Ritchie, A. 1983. Excavation of a Neolithic Farmstead at Knap of Howar, Papa Westray Orkney. *Proceeding of the Society of Antiquaries of Scotland* 113, 40-121.
- Savelle, J. M. 1997. The Role of Architectural Utility in the Formation of Zooarchaeological Whale Bone Assemblages. *Journal of Archaeological Science* 24 (10), 869-885.
- Schoeninger, M. J. and De Niro M. J. 1984. Nitrogen and carbon isotopic composition of bone collagen from marine and terrestrial animals. *Geochimica Cosmochimica Acta* 48 (4), 625-639.
- Schulting, R. J. and Richards, M. P. 2002. The Wet, the wild and the Domesticated: The Mesolithic-Neolithic Transition on the West Coast of Scotland. *European Journal of Archaeology* 5 (2), 147-189.
- Schulting, R. J. and Richards, M. P. 2009. Radiocarbon dates and stable isotope values on human remains. In A. Ritchie (ed.), *On the Fringe of Neolithic Europe, excavation of a chambered cairn on the Holm of Papa Westray, Orkney*, 67-74. Edinburgh, Society of Antiquaries of Scotland.
- Schulting, R. J., Tresset, A. and Dupont, C. 2004. From harvesting the sea to stock rearing along the Atlantic façade of north-west Europe. *Environmental Archaeology* 9, 143-154.
- Schulting, R. J., Sheridan, A., Crozier, R. and Murphy, E. 2010. Revisiting Quanterness: new AMS dates and stable isotope data from an Orcadian chamber tomb. *Proceedings of the Society of Antiquaries of Scotland* 140, 1
- Serjeantson, D. no date. The mammal, bird and fish remains from Udal North: interim report, Excavations at the Udal, North Uist. Southampton, Unpublished internal report.
- Sharples, N. 1984. Excavations at Pierowall Quarry, Westray, Orkney. *Proceeding of the society of Antiquaries of Scotland* 114, 75-125.
- Sharples, N. 2005. *A Norse Farmstead in the Outer Hebrides. Excavations at Mound 3 Bornais, South Uist*. Oxford, Oxbow books, Cardiff Studies in Archaeology.
- Shennan, S. 1997. *Quantifying Archaeology*. Edinburgh, Edinburgh University Press.
- Thoms, J. 2004. *Aspects of economy and environment of north west Lewis in the first millennium AD: the non-marine faunal evidence from Bostadh and Beirgh considered within the framework of north Atlantic Scotland*. Unpublished PhD thesis, University of Edinburgh.
- Tresset, A. 2000. Early husbandry in Atlantic areas. Animal introductions, diffusions of techniques and native acculturation at the north-western fringe of Europe. In J. C. Henderson (ed.), *The Prehistory and Early History of Atlantic Europe*. Papers from a session held at the European Association of Archaeologists Fourth Annual Meeting, Göteborg, 1988, 17-32. Oxford, Archaeopress, British Archaeological Reports, International Series 861.
- Tresset, A. 2003. French connections II: of a cows and men. In I. Armit, E. Murohy, E. Neils and D. Simpson (eds.), *Neolithic Settlement in Ireland and Western Britain*, 18-30. Oxford, Oxbow books.
- Van Klinken, G. J., Richards, M. P. and Hedges, R. E. M. 2000. An overview of the causes for Stable Isotopic variations in past European Human Populations: Environmental, Ecophysiological and Cultural Effects. In S. H. Ambrose and M. A. Katzenberg (eds.), *Biogeochemical Approaches to Paleodietary Analysis*, 39-64. New York, Kluwer Academic - Plenum Publishers, Advances in Archaeological and Museum Science 5.-50.

FRUITS OF THE SEA: INVESTIGATING MARINE RESOURCE USE IN THE NORTH ATLANTIC ISLANDS.

Jennifer R JONES, Jacqui MULVILLE and Richard P. EVERSLED

KEY-WORDS:

North Atlantic Islands, Stable Isotopes, Zooarchaeology, Marine Resources.

ABSTRACT:

The ancient populations of the UK North Atlantic Islands have a long and complex relationship with marine resources. Past archaeological models of subsistence in the islands, based on human stable isotope data suggest that marine foods ceased to be utilised to any great extent in the Neolithic (Schulting and Richards 2002), a trend thought to continue until the Norse Period (Barrett and Richards 2004). Zooarchaeological assemblages containing fish and marine mammal remains however demonstrate that marine resources continue to be used throughout prehistory and into history, contradicting the stable isotope evidence. By considering human and animal stable isotope evidence in conjunction with large scale zooarchaeological analysis, it is possible to achieve a holistic understanding of trends in marine resource use through time. Results demonstrated that whilst marine food use does decline in the Neolithic they still continue to be utilised at low levels, and marine mammals occur regularly in Neolithic, Beaker, Bronze Age, and Iron Age assemblages. Human and pig stable isotope evidence from specimens from the Iron Age in the Western Isles demonstrate that marine foods were being consumed by both people and animals, which is corroborated by zooarchaeological analysis of sites revealing higher quantities of fish bones in some of the Iron Age sites. The marine signature observed in several pig specimens has implications for the interpretation of human remains, highlighting the need for detailed faunal dietary modelling to enable valid interpretation of human $\delta^{13}\text{C}$ values and $\delta^{15}\text{N}$ values.

FRUITS DE LA MER : ENQUÊTE SUR L'UTILISATION DES RESSOURCES MARINES DANS LES ÎLES DE L'ATLANTIQUE NORD.

Jennifer R JONES, Jacqui MULVILLE and Richard P. EVERSLED

MOTS-CLÉS :

Îles atlantiques du Nord, Isotopes stables, archéozoologie, ressources marines.

RÉSUMÉ :

Les anciennes communautés humaines des îles atlantiques du Nord ont une longue et complexe relation avec des ressources marines. Les modèles actuels de subsistance des îles, basés sur des isotopes stables, indiquent que l'exploitation des ressources marines a cessé d'être pratiquée à grande échelle au Néolithique (Schulting and Richards 2002), et ont été utilisés avec parcimonie jusqu'à la période « Norse » (Barrett and Richards 2004). Les ensembles archéozoologiques contenant des restes de poissons et de mammifères marins montrent cependant que les ressources marines ont continué à être utilisées pendant toute la Préhistoire, ce qui contredit les données isotopiques. En prenant en compte les isotopes stables animaux et humains, en lien avec une large approche archéozoologique, il est possible d'avoir une compréhension holistique des usages des ressources marines au fil du temps. Les résultats indiquent que tandis que la nourriture d'origine marine décline au cours du Néolithique, elle est cependant présente à un niveau moindre, les mammifères marins sont régulièrement présents dans les ensembles du Néolithique, du Campaniforme, de l'âge du Bronze et du Fer. Le témoignage des isotopes stables d'humains et de porc issus datés de l'âge du Fer et issus des îles de l'Ouest montrent que la nourriture d'origine marine était consommée par les deux espèces ce qui est corroboré par les analyses archéozoologiques de ces sites qui révèlent une quantité supérieure de restes de poissons sur certains de ces sites de l'âge du Fer. La signature marine observée sur plusieurs spécimens de porc a des conséquences pour l'interprétation des restes humains, soulignant le besoin de disposer de modèles détaillés sur la faune marine consommée pour valider l'interprétation des valeurs de $\delta^{13}\text{C}$ et $\delta^{15}\text{N}$ obtenues sur les humains.