CHAPTER 14: THE MOLLUSCAN ASSEMBLAGE

N Thew (1987)

14.1 INTRODUCTION

A number of studies of snail faunas from calcareous sands from the western coasts of Britain, including the coasts of the Hebrides and Ireland have now been completed by Evans and his co-workers Spencer and Vaughan (see Evans 1979 for bibliography). These, however, have been in the nature of column sampling through cliff sections to investigate environmental change through time, and few have included substantial archaeological layers, such as midden-site deposits, within the sample columns. The sampling of the sites of Baleshare and Hornish Point, and to a lesser extent Newtonferry and Balelone, was designed to investigate variation in archaeological material and environmental indicators through both space and time. For the molluscan analysis this represents a new departure and allows an investigation into the way that molluscan faunas vary with the form and intensity of natural processes of erosion or deposition and the colonisation of surfaces by vegetation as well as anthropic processes like cultivation or the deposition of refuse. The effects of 'intermediate' processes such as sheep and cattle grazing which affect vegetation and surface stability seem to be more difficult to detect in snail faunas. Molluscan analysis therefore, can perhaps progress from being merely a monitor of the environmental changes that have taken place through time, to the position where it is possible to throw some light on the mechanisms of site formation through the balance of natural and anthropogenic processes.

In general, the analysis suggests that mollusca are sensitive to vegetation and moisture, and to the lack of vegetation in areas where wind-blown sand is being deposited. Moreover, certain snail species seem to be sensitive to the deposition of fresh domestic organic waste, ie middening, while intensive ploughing also seems to influence molluscan faunas. Further work on modern snail faunas in analogous local environments needs to be undertaken in order to add more resolution and reliability to these preliminary indications. Already, it seems that careful investigation of the way in which molluscan faunas vary within complex archaeological deposits might allow an insight into the way that local environments and land use patterns vary across a site and how this variation changes through time. In turn these patterns constitute the site formation processes that result in the archaeological deposits.

The present study covers deposits ranging from later Bronze Age to later Iron Age as well as the post-Medieval period. Unfortunately, the results of the analysis thus far seem to indicate that more work needs to be done on unravelling the imprint of biological succession so that it is possible to compare later faunas with earlier ones.

14.2 INTERPRETATION OF THE RESULTS

Interpreting the results of the molluscan counts can only be tentative because of the low numbers recovered from the individual samples and the bias against certain species caused by flotation. The three species most likely to have been affected, *Vitrina*, *Oxyloma*, *Cepaea*, were usually present only in small numbers in previously published comparable studies.

Most of the samples revealed fluctuations in the relative numbers of a few 'significant' or 'dominant' species (*Pupilla muscorum*, *Cochlicopa* spp, and *Vallonia* spp), and the presence or absence of small numbers of several other species. These included species of wet habitats which, in most contexts, would have arrived in flood waters; the Helicelid snails (including *Cepaea*); *Helicella itala* and *Cochlicella acuta*, species newly arrived in the area and contemporary with the three earlier sites studied here; the Zonited group plus *Vitrina pellucida*, which being omnivores, can fluctuate independently; and two further species, *Lauria cylindraea* and *Vertigo pygmaea*. Fluctuations between small numbers of a restricted number of species are difficult to interpret and it would be possible to generalise and consider almost all contexts together as an 'open landscape, grassy, with greater or lesser stability, with varying dampness and varying amounts of anthropically deposited organic refuse'. It is believed that the fluctuations between context faunas are indicative of variations in the micro environment.

Evans, (1972; 1979) has noted the problem, that in periods of surface stability the fossil molluscan fauna will represent the immediate local environment, while during unstable periods the molluscs trapped in a sandy layer could represent a much wider catchment area. A variety of samples spatially separated across a site will reduce the problem.

Helicella itala and *Cochlicella acuta* appear to have arrived in the Outer Hebrides during Late Bronze times, thus were absent from the earliest levels at Baleshare and appeared only in small numbers during the Late Bronze Age phase of the site. Iron Age Baleshare and Hornish Point have, by contrast, significant numbers of *Helicella itala* and very few *Cochlicella acuta*. A post-Medieval context at Hornish Point and post-Medieval Newtonferry however, have faunas dominated by *Cochlicella acuta* and smaller numbers of *Helicella itala*. Comparing faunas between sites and between deposits of different ages is difficult. The pattern of arrival of these two species has made it possible to use the number of *Helicella itala* and *Cochlicella acuta* present within a sample as a tool for phasing and relative dating of sites. This has been attempted at Baleshare, and the four sites within this study are also compared.

The final problem in interpreting the molluscan faunal assemblages is that species can change their ecological range. Today, *Gyraulus laevis*, an aquatic snail, and *Vertigo angustior*, a terrestrial damp species found at Northton, Harris, Outer Hebrides, (Evans 1971) and Ardnave, Islay, Inner Hebrides, (Evans 1983), seem to be declining and forced into small local refuges which may not be representative of habitats which they occupied in the past. This does not apply to any of the species recovered in this study, although *Vallonia costata*, *Columella edentala*, *Pupilla moscorum*, *Zonitoides nitidus* and *Clausilia bidentata* would all appear to be declining within the Outer Hebrides. However, the converse can also be true and a species can extend its ecological range. In Orkney, *Lauria cylindracea*, a species that normally requires shady vegetated or rupestral (walls, rocks, etc) habitats has adapted to dry open fixed-dune pasture and sand-dune habitats. This change seems to have taken place in post-Roman or possibly post-Medieval times. The deposits with dominant *Lauria* at post-Medieval Newtonferry may indicate that *Lauria* similarly adapted within the Outer Hebrides.

Faunal association	**A**	**C/D**	**C**	**C**
Faunal groups	*I P*	*II P*	*III*	*IV*
	804 (Burnt)	633, 720, 805	531, 533. 803	520, 534,
IN SITU TERRESTRIAL FAUNAS				
Number	*<10*	*<10*	*40-50*	*10-20*
Dominant species				
Cochlicopa			*SIG*	*V.SIG*
Pupilla		*SIG*	*F.SIG*	*VF-F*
Vallonia		*SOME*	*V.SIG*	*SOME-F.SIG*
Indicator species				
Vertigo pygmaea	*SOME*		*SOME*	*VF-SOME*
Lauria cylinracea	*SIG*		*FEW*	*VF-SOME*
Omniverous species				
Oxychilus alliarus	*SOME*		*VF*	*VF-F*
Vitrina pellucida			*VF*	
Nesovitrea hammonis		*SOME*		*VF-SOME*
Helicelid species				
Helicella Itala				
Cochlicella acuta			*VF*	*VF*
Cepaea hortensis	*SOME*			
Flood arrivals				
Wet species				*VF* *Lym.trunculata*
Seaweed species				
Marine	*VF Rissoa* *Litt. saxatilis*		*VF Rissoa*	*VF-F Rissoa* VF-SOME *Litt. saxatilis*

Table 24. Balelone. Faunal groups and faunal associations as defined by species characteristics. Key: SIG = significant; F = few; VF = very few

Despite these problems, however, an attempt has been made to determine the nature of faunal assemblage variations and then interpret them. It would appear that fluctuations among the major species reflect, predominantly, natural environmental conditions. Variations in certain of the other species, however, seemed to be far more sensitive to patterns of human land-use. The 'faunal groupings' could therefore be clustered into 'faunal associations', two of which seem to reflect the presence of middening, while two other faunal associations indicated more or less stable natural grassland. At Hornish Point and Newtonferry, however, because of the great number of subdivisions required for certain stratigraphic blocks (eg Block 19) indicative of rapid changes in middening or natural deposition, a faunal matrix was constructed with fluctuations of main species along one axis, and fluctuations in the presence or absence of lesser indicator species along the other axis.

Interpretation of these faunal groupings and associations has allowed an assessment of the past local sub-Block environments to be made in terms of natural dampness, dryness, the degree of exposure and stability and middening. In some cases, however, the snail evidence indicating an absence of middening, would appear to conflict with the archaeological and soil evidence in sub-blocks with high organic contents and abundant bone, seed and seashell waste. Explanations to resolve these conflicts have been formulated in terms of the nature of organic material added to the soil (fresh or already decomposed) the rapidity of sediment accumulation (fresh waste buried before colonisation) and possible discrepancies with samples taken from the base or surface of contexts reflecting not the environment during accumulation of the contexts themselves, so much as the environment before or after a context was formed.

14.3 RESULTS

The counts for all molluscan species (terrestrial, aquatic and marine) from the floated samples, together with total numbers and the number of species for the terrestrial snails, can be found tabulated by Block within the appropriate sections of Chapters 4-8. Within these tables, samples are listed in stratigraphic order within blocks and in Block order, also for north, south and central portions of the complicated deposits of the midden sites investigated. Investigation of the molluscan assemblages within blocks has led to the stratigraphic blocks being further subdivided into sub-blocks (labelled A, B, C, etc) to allow a more detailed interpretation of the faunas.

For Balelone and Baleshare, sub-blocks have been clustered into faunal groups on the assumption that these groups are characteristic of different microenvironments (Tables 24 and 25). The faunal characteristics of these groups in terms

Faunal association		*Faunal groups*
A	***I***	**6A, 16A, 16C**
	I P	1, 16A (203, 204, 241, 240, 149, 150) 18 G, 25 **
B	***II***	**3 (13), 21B, 24D [3], 29 [2]**
	II H	5E, 11C, 11D
	II N	11C (259)
	III N	B8? (237) [1], 11 (113) [2]
	IV	5D [2]
	IV N	7A
	V	7C [4], 11A [1], 24A [1]
	V N	11A (158) [1], 14A [2]
	VI	4A, 24B.
	VI P	2A, 4B
	VII	7B, 21A (100)
C	***VIII N***	**2D, 15B (144)**
	IX	22 *** (280, 277), 23 (271, 272 **)
	IX P	17C, 20 ***, 22 ***, 23 *** [1] 27A ***, 27B (20, 22, 23, & 27A NO Helicella itala)
	X	5A * [1], 5B
	XI	5C [1], 15C [4]
	XI N	15B * (not 144).
	XI P	2B, 2E, 2F, 26 **
	XII	2C, 17B **
	XII N	16B *
	XII P	2C (59), 2D (57)
	XIII N	3B, 14B *
D	***XIV***	**6B, 11B [5], 24E [5]**
	XV	3A [1], 12, 15A, 15D Burnt, 19A
	XV N	19B Green
	XV P	?9
	XVI	7A [1],B 8, 10
	XVII N	24C

*Table 25. Baleshare. Faunal groups and faunal associations as defined by species characteristics. Key: [5] = number of small marine gastropods (from seaweed); * = wet land species from flooding (*** several; ** few; * very few)*

of abundance, and the relative importance of the various terrestrial species encountered are listed in handwritten tables which can be found in the site archive Table 26 lists the stratigraphical blocks at Baleshare in their chronological order with the sub-blocks assigned to their faunal groups.

Hornish Point and Newtonferry have stratigraphic blocks which vary considerably in their faunas, often from layer to layer. At Hornish Point the great number of sub-blocks made clustering into faunal groups prohibitively complicated. Consequently a faunal matrix was employed with sub-blocks being plotted according to their terrestrial species characteristics. At Newtonferry, individual contexts were plotted on a slightly different faunal matrix. The method of construction of these faunal matrices, available as handwritten tables in the site archive, allows for intersite comparison.

The divisions between the assemblage groups and associations reflect natural variation in the proportions of the dominant species, ie adaptable species, forming the bulk of the faunas from most contexts, and the representation of the indicator species, ie less numerically important but more sensitive indicators of environmental differences.

14.4 DISCUSSION AND INTERPRETATION OF THE MOLLUSCAN FAUNAS

14.4.1 General observations

Previous studies from coastal calcareous sands have yielded minimum counts of 50 individuals from 1.5 or 2.0 Kg samples, occasionally reaching maxima of 5,000 or more (Evans 1971; Evans & Spencer 1977; Evans & Vaughan 1983; Spencer 1975). By comparison 20 kilo floated samples give values between 5 or less and 500 or more. However, as noted above, discussion and interpretation of the data proceeds from the premise that the floated fauna is as representative of the original fauna as that recovered by sieving and picking. Further investigations in the Western Isles will, however, be able to test these preliminary results and interpretations by analysing samples taken specifically for molluscan fauna.

Factors affecting the numbers of molluscs present within a context include original population size, rates of deposition (slower deposition allows more molluscs to accumulate), greater stability (which encourages richer vegetation and molluscan faunas) and preservation. Preservation of the floated snails remains fairly constant throughout the samples analysed; some assemblages being of remarkably fresh appearance while others although stained or discoloured having lost little of their microsculpture. Unfortunately no note of staining, possibly due to humus-rich layers, was made. It is hoped to investigate this phenomenon in future studies. The medium of deposition would appear to have been fairly constant (largely through burial by windblown sand, or incorporation in a deepening turf horizon); mechanical weathering may therefore reflect attrition by human or animal activity. Variation in human and animal use of the sites may be already reflected in differences in the contemporaneous snail faunas in the present study and could provide an interesting area for analysis in future investigations. Thus the majority of numerical variations within molluscan assemblages are attributable to differences in the original populations and the rate of layer accumulation. Even allowing for the small proportion of snails recovered by flotation the original populations would appear to have been fairly low and with restricted species diversity in comparison with previously published sites. Sites like Northton and Buckquoy have numbers of 'non-wet species' rising to 23 and 20 respectively, while at other sites numbers of greater than 12 or 13 normally indicated a greater degree of stability and shade; values of 15 and over often coincide with species indicative of true shade, perhaps rich, long, very stable grassland or perhaps even open woodland in the case of Northton and Buckquoy. Non-wet species counts of 11 were encountered only from four contexts at Baleshare and two from Hornish Point, these two sites having single higher values of 12 and 14 respectively. At Newtonferry the highest value was 9 while at Balelone it was only 8. In all four cases, therefore, the molluscan counts indicate very open environments with almost no indication of true shade. interpretation depends upon discerning variations among faunas of restricted diversity which indicate environments with a greater or lesser degree of herbaceous cover and stability. Differences could be due to natural agencies like moisture or sand accumulation, both related to wind exposure, or to human agencies such as ploughing, fertilisation, deposition of rubbish or grazing.

	N Side	Centre	S Side
Late Bronze Age 1		**22 IX, IX P**	
		1335 +/- 60 bc	
Late Bronze Age 2	**20 IX P**		
	1020 +/- 65 bc		
	27A IX P		23 IX, IXP
	27B IX P		1080 +/- 50 bc
	960 +/- 50 bc		
Late Bronze Age 3	**17 A IV N**		
	B IX		
	C IX P		
	18 I P 790 +/- 60 bc		
	26 XI P		
	865 +/- 50 bc		
Iron Age 4	**25 I P**	**1 I P**	
	16A I, I P	2A VI P	
	16B XII N	2B XI P	
	16C I	2C XII	
	15A XV	2C (59) XII P	
	15B XI N	2D VIII N	
	15C XI	2D (57) XII P	
	15D XV 425 +/- 55 bc		
	19A XV		
	19B XV N 315 +/- 50 bc		
		12 XV	
Iron Age 5		**9 XV P**	**2E XI P**
		29 II	2F XI P
		10 XVI, XVI P	290 +/- 55 bc
		8 XVI 7A XVI	
		21A VII 95 +/- 50 bc	
		7B VII	24A V
		11A V 7C V	24B VI
		11B XIV	24C XVII N
		11C II H	24D II
		11D II H	24E XIV
		11(113) III N	125 +/- 50 bc
		8 (237) III N	
			5A X
		14A V N	5B X
			5C XI
		14B XIII N	5D IV
		21B 11	5E II H
			135 +/- 50 bc
Iron Age 6	**3B XIII N**	**3A XV**	
Iron Age 7			
		4A VI	6A I
		205 +/- 50 bp	
		4B VI P	6B XIV
			160 +/-
		MACHAIR SAND	

Table 26. Baleshare. Stratigraphic Blocks with faunal groups in chronological order (chronological order determined by stratigraphy, ^{14}C dates and relative dating using the proportions of Hellica italia *and* Cochlicella acuta *within the samples)*

Small numbers of 'wet' species have been found in contexts from all four sites, together with odd specimens of freshwater aquatic snails. Flooding from nearby freshwater marshes must be considered; Baleshare, Hornish Point and Newtonferry are located on low-lying flat coastal machair plains liable to episodic winter flooding due to rising water tables (Ritchie 1979). This would account for these 'wet' species often coinciding with faunas suggestive of open, fairly dry environments. Consequently the 'wet' species have been omitted from the main number of species values used to interpret the local environment. Their significance will be dealt with in a subsequent section.

Another factor affecting the composition of the terrestrial molluscan faunas seems to have been that of time, in relation to the process of biological succession. The species *Helicella itala* and *Cochlicella acuta* arrived in the Outer Hebrides during the Later Bronze Age and became established at some stage after the Iron Age becoming the dominant faunal component in calcareous coastal dune and machair habitats and largely replacing other previously numerous species like *Pupilla muscorum*, *Cochlicopa* spp, and *Vallonia* spp. (A later section discusses how the ratio of these two species within molluscan assemblages can be used for relative dating of archaeological deposits both within and between sites not greatly separated by distance or ecological setting).

In the tables listing the molluscan counts there are included small numbers of marine species labelled as 'seaweed imports'. Most of these small marine gastropods seem to have been brought in with collected seaweed during the summer months, although at Newtonferry some may have been blown in. Leaving seaweed on the surface areas of the midden-site, for sheep fodder or for soil stabilisation, may have had some influence on the microenvironment but this is not reflected in the molluscan faunas. Sub-blocks showing closely similar molluscan assemblages can have quite different numbers of these marine gastropods. The numbers of these seaweed species seem to be more closely related to larger stratigraphic units and different areas of the sites, as at Hornish Point.

14.4.2 Chronological implications from the molluscan data

In all published studies of coastal calcareous sand systems of great duration, except those from Orkney, the species *Helicella itala* and *Cochlicella acuta* arrive some time after the start of sand deposition and replace the previously numerically important species to dominate the molluscan faunas. Most of these studies comprise columns through accreting sand bodies, and it would appear that the process of arrival, establishment and domination by the *Helicella itala*/*Cochlicella acuta* pairing was relatively rapid. *Helicella itala* may have arrived slightly before *Cochlicella acuta* in many areas, alternatively *Cochlicella may* have arrived at the same time, but in such small numbers as not to be recovered through sampling. *Helicella itala* being more adaptable became more rapidly established. *Cochlicella*, with a distribution today almost entirely confined to calcareous west coast sand systems (except in western Ireland) is a specialist species highly adapted to such conditions and though established slightly after *Helicella itala*, swiftly became the dominant species in many areas (Orkney and Shetland lie outwith their northern limit). In north-west Scotland and Lewis today the most northerly areas with calcareous coastal sands have very few *Cochlicella*, *Helicella* being far more important (cf Cain *et al* 1969). *Cochlicella* today is the dominant species in the Uists, Barra and Harris (Welch 1979).

At Baleshare the earliest levels are devoid of *Helicella* or *Cochlicella*; they appeared in very small numbers as odd specimens during phases two and three. In phase four *Helicella* became regularly present in small numbers, only becoming established as an important faunal element from phase five onwards. *Cochlicella*, however, was only ever present in very small numbers.

By contrast, *Helicella itala* was present in some numbers from the earliest levels at Hornish Point, together with occasional specimens of *Cochlicella*. During the later phases *Cochlicella* became important, tending to replace *Helicella*. Block 20, the latest structure on the site, has one context typical of more modern faunas with *Cochlicella* completely dominant, having largely replaced the other previously common species like *Pupilla muscorum*, *Cochlicopa* spp and *Vallonia* spp.

All the contexts from Newtonferry demonstrate the same problem as the late context from Hornish Point, being similar to modern faunas with few *Cochlicopa*, *Vallonia* spp or *Pupilla*, these having been replaced by *Helicella* and especially *Cochlicella*. Significantly, the omnivorous group *Vitrina pellucida*, *Vitrea contracta* and *Oxychilus alliarius* seem to have been unaffected by changes in the representation of the dominant species, presumably because their life patterns were not in competition. Similarly *Vertigo pygmaea* and *Lauria cylindracea* seem not to have been competitively replaced by *Helicella-Cochlicella*: *Lauria cylindracea* appears in abundance in some of the lower levels of Newtonferry. This may be a similar phenomenon to that seen in Orkney where in the absence of *Helicella*/*Cochlicella*, *Lauria* seems to have broadened its ecological horizons some time in post-Roman or even post-Medieval times and adapted to more exposed and unstable open conditions among the fixed dune systems. Thus today in Orkney *Lauria* has competitively replaced *Pupilla* and *Vallonia excentrica* in many localities.

Another species which underwent a competitive decline seems to have been *Cepaea hortensis*. At Baleshare it was present throughout the sequence from the earliest to the latest deposits; only a single specimen was recovered from Hornish Point, and none from Newtonferry. Similarly, today *Cepaea hortensis*, like *Vallonia costata* and *Pupilla muscorum*, is rarely found in the Outer Hebrides, although it is more common in North East Scotland where *Cochlicella acuta* becomes scarce. In these areas *Cepaea* is in competition with *Helicella itala*, *Cepaea* being more common in richer, damper, more stable vegetation. (Cain *et al* 1969)

On the basis therefore of the molluscan faunas it would appear that of the four sites studied the earliest deposits are those of Phases 1 to 4 at Baleshare, followed by what would seem to be roughly contemporary levels from Phases 5 to 7 at Baleshare and all of the layers from Hornish Point except for Block 20; this Block, together with the sequence at Newtonferry could be interpreted as being rather later. The few contexts analysed from Balelone could be contemporary with the later phases from Baleshare and the deposits from Hornish Point.

The series of ^{14}C dates available, together with archaeological evidence, can be used to check the relative dating on the basis of the molluscan faunas. These suggest that *Helicella itala* became established earlier at Hornish Point than Baleshare.

The archaeological evidence from Block 20, Hornish Point, and the site of Newtonferry suggests that they are post-Medieval in date, considerably later than the rest of the deposits at Baleshare, Balelone and Hornish Point.

The only other comparative dating evidence for the arrival of *Helicella* and *Cochicella* in this area comes from the sites of Ardnave, Islay, and Northton, Harris. At Ardnave, Evans (1983) found a few specimens of *Cochlicella* and *Helicella* in earlier Bronze Age contexts dated to 3610 ± 85 uncal BP (GU-1371), by which time they appear to have become established. By contrast, at Northton (Evans 1971; 1972), there was no trace in earlier Bronze Age levels, dated to 3604 ± 70 uncal BP (BM-706) and 3481 ± 54 uncal BP (BM-707) (Burleigh *et al* 1973), or in the earlier of two Iron Age levels.

It is hoped that in future, the spread and ratios of these two species can be used as a relative dating tool, initially within single localities, and once their spread through the Scottish Isles has been dated, between sites, first ensuring that the rest of the faunal assemblages are broadly similar. This is the case for the sites of Baleshare, Balelone and Hornish Point. At Northton, however, another reason for their delay in becoming established may be that the background fauna indicates that the environment was considerably more shaded and moist than at Baleshare or Hornish Point.

The same two species may be useful, together with other Helicelid species like *Cernuella virgata*, in the relative dating of west coast calcareous sand locations further south. At Gwithian in Cornwall, *Helicella* and *Cochlicella* arrived some time after the Neolithic and were dominant by the Early Bronze Age (Spencer 1975).

14.4.3 Indications of flooding and their implications for midden-site formation

Possible explanations for the arrival of the 'wet' and aquatic species on the sites include flooding or the gathering of organic material from marshes for fertiliser, or other uses. The ecologies of the wet species and the freshwater species are listed in detail in appendices in the site archive. It seems likely that 'wet' species such as *Vertigo antivertigo* and *Zonitoides* as well as aquatic species arrived through episodes of flooding during the winter months: as during the summer months when water levels are low and the reeds in marshes, and weed in shallow water around the margins of the machair lakes could be cut, aquatic species like *Armiger crista* and *Gyaulus laevis* burrow into the mud to avoid drying out and *Lymnaea peregra* would have retreated with the dwindling water.

At Hornish Point 'wet' snails are found throughout the stratigraphy, although curiously with few from the earliest levels of the site (Blocks 1 and 26). By contrast, at Baleshare the earliest levels of Block 22 have a fairly high number of marsh snails but they are absent from the later levels. After layer [142] in Block 15 and [75] in Block 2 the only flood snails are a sequence of three in the fills [173, 172 & 17] of a gulley or drain [174] in Block 15, cut into earlier deposits; a single shell in Block 5 lower down on the southern slope of the site, and a lone specimen in layer [109], Block 14, at about the same height as layers [142] and [75] within the circular structure cut into the earlier midden-site deposits. Layers [142, 75 & 109] occur approximately halfway up the section through the midden exposed in the cliff face.

However, it is not impossible that these snails were introduced by human activity and here again we must note the tentative nature of the conclusions we have found on this first experiment in site-specific snail studies.

At Newtonferry the situation appears to lie in between that of Baleshare and Hornish Point, with a notable decrease in the number of 'wet' snails in the higher levels, but with odd specimens still being left, by presumed flood episodes.

At Baleshare the north and south of the site appear to have been subject to flooding though the confinement of *Vertigo antivertigo* to deposits in the northern half of the site may suggest that the vegetation of the marshes to the north may have been richer. At Hornish Point the 'wet' snails *Oxgloma pfeifferi* and *Zonitoides nitidus* indicate flooding from more permanent marshes to both north and south with the northern half of the site subject to greater flooding. The presence of two aquatic snails suggests that before coastal retreat a freshwater machair loch may have existed nearby to the north. The higher water table this implied helps to explain the greater flooding at Hornish Point.

The evidence for episodic flooding of these sites raises questions about site location and site formation processes. Some of these sites may have only been used seasonally and others permanently occupied, with provisions made to cope with seasonal flooding. Presumably, therefore, some system for protecting humans, animals and stored crops from flood damage would have been developed. The 'wet' snails in one of several gulley-like structures at Baleshare suggests that the function of at least some of them may have been drainage.

Block 22 at Baleshare has been interpreted as a deepened ploughsoil (*above*). Apart from the molluscan evidence suggesting that at least at some stages a reasonably stable grass-cover formed, the fairly large number of 'wet' snails in the sample from this deposit also indicate that the area was subject to quite severe winter flooding (at least in the lowest levels). The rest of the molluscan fauna, however, is indicative of reasonably dry conditions, so presumably by spring time the ground would have been dry enough for planting. The apparent severity of winter flooding in the very earliest levels, however, again raises the possibility that at least in its earliest stages Baleshare was a seasonal site. Moreover, the molluscan faunas indicate that between episodes of cultivation the ground was allowed to lie fallow. The great spatial extent of the earliest levels at Baleshare might be explicable therefore in terms of fairly large areas being subject to seasonal crop rotation. By continually building on the same location both the drainage would have been improved and the danger of flood damage lessened; this may, therefore, help to explain the existence of the numerous Iron Age and later midden-sites in low machair plain locations liable to episodic winter flooding.

Evidence of flooding from previously published sites is fairly rare. At Knap of Howar in Orkney, there are two horizons with *Lymnaea truncatula*. The first of these would appear to represent true marsh conditions, as the rest of the molluscan fauna changes to one which is indicative of this. The second, however, appears to represent flooding from a nearby marsh with a small number of *L. truncatula* coinciding with a much drier molluscan fauna. However, specimens of *Vertigo substriata* found unassociated with other 'wet' species from Knap of Howar, Buckhuoy and Skara Brae, seem rather to indicate damp and shady conditions as, unlike the other 'wet' species, *Vertigo substriata* is capable of living in normally damp locations and even surviving considerable periods of drying out. At Northton, Harris, the molluscan faunas contained small numbers of 'wet' species - including *Carychium minimum*, *Oxyloma pfeifferi*, *Vertigo substriata*, *Vertigo angustior*, *Zonitoides nitidus* and *Lymnaea truncatula* throughout most of the sequence in the sand cliff, except for the upper layers, including the horizons coinciding with Neolithic, Early Bronze Age and Iron Age occupation. These 'wet' species would seem to be incompatible with the rest of the faunas (as well as the occupation horizons), not only because of the dry, more open conditions indicated by prominent *Pupilla*, but also because *Oxyloma pleifferi* and *Lymnaea truncatula* would have avoided the more shaded areas, preferring open environments. The implication is therefore, that at Northton too the area around the site was subject to episodic winter flooding.

The advantages, in terms of the availability of good quality pasture and arable land, must evidently have outweighed the problems associated with inundation. But it is possible that the 'wet' snails preserved in the archaeological and natural deposits may only represent occasional flooding, once every ten or twenty years, the sites in fact being located in areas which avoided more regular inundation.

14.4.4 Understanding the environment from the molluscan data

Analysis of molluscan faunas from archaeological deposits differs from that from natural sediments in that interpretation of the environment becomes an interpretation of land use patterns around the archaeological sites. Thus ploughing, animal grazing and penning, and the disposal of different types of domestic rubbish create varying microenvironments in addition to the natural range of environments on which these human activities are superimposed.

Before it is possible to interpret the data in terms of environmental land-use variation, one must first discount other variable factors. Biological succession, and the superimposition of 'wet' species on the molluscan faunas through flooding have already been discussed. Climatic change is another potential factor. Some climatic deterioration seems to have occurred between *circa* 1000 bc, when the first deposits of Baleshare were accumulating, and 700 bc after which most of the deposits at the other four sites were laid down. These large-scale changes seem not to have affected the faunas. Similarly all the species found at Baleshare and Hornish Point were present from Neolithic or Early Bronze Age times in the Outer and Inner Hebrides, with the exception of *Helicella itala* and *Cochlicella acuta*, so the differential presence of species on sites cannot be explained in terms of species availability. Other natural factors which can affect local environments independently of human activity include the height of an area above the water table, and thus the proximity to marshy or damp areas; aspect, relative to prevailing wind direction (thus salt spray, moisture, etc from the sea) or isolation; and underlying and nearby rocks and soils which would affect drainage, natural vegetation or the availability of standing rocks for rupestral snail species.

At the four sites studied here natural factors affecting the molluscan faunas can be allowed for after an examination of the data. Variation which cannot be explained in these terms can therefore be attributed to human activities; altering vegetation patterns by clearance, planting, burning, or the grazing of animals or controlling 'natural' factors such as the draining of land to lower water tables. Moreover, humans can create entirely new microenvironments such as standing structures which can act as habitats for rupestral snails and form shaded areas.

Layers seem to represent the product of various different processes, important factors for these sites being: the accumulation of wind blown sand; deepening turf horizons incorporating organic material; the deposition of organic matter by grazing animals (although heavy sheep grazing will often prevent turf-lines from deepening); and finally the dumping of various types of domestic waste by the inhabitants of the archaeological site. Layer boundaries must therefore represent standstills in the processes of deposition.

As noted, most molluscan species live on or just below the surface, therefore molluscan faunas within layers must indicate, in the absence of a layer boundary, that deposition was gradual allowing the surface flora, fauna and layer accumulation to proceed without a noticeable break. Poor molluscan faunas within layers, therefore indicate rapid aggregation, and in natural conditions would be interpreted in terms of a rapid build up of wind-blown sand only ever covered with a restricted sparse herbaceous vegetation containing grass species adapted to unstable accumulating conditions. Thus, in a deepening turf horizon, a boundary before another similar layer, could mark a standstill perhaps caused by heavy grazing, or a series of severe frosts or droughts. A diffuse change to a sandier layer could merely mark the onset of more rapid sand aggregation. These changes, however, should be detectable by a continuous molluscan record, varying in abundance, and diversity. This is true also for surfaces grazed by animals.

The sedimentary mechanics of human dumping and ploughing are more complex. If dumping is in the nature of 'little and often' thin spreads can be incorporated into a single layer with a continuous molluscan record reflecting the nature of the surfaces of the spread material. If, however, dumping occurs in larger amounts then these will tend to form discrete layers with molluscan faunas and herbaceous floras only being able to colonise the surfaces of these deposits, there being no molluscan faunas inside the layers, thus helping to make boundaries more clear. These faunas and floras will reflect not only the nature of the dumped material below but also the amount of time that elapses before further dumping occurs or before natural aggregation begins. If dumped material is covered by naturally aggregated deposits the boundaries should be much more diffuse than those formed by repeated dumping.

One problem that remains in unravelling layer mechanics, is that of erosion and redeposition. Thus layer boundaries can mark episodes of erosion in an otherwise unbroken sequence of natural depositional events, while erosion can remove the faunas from the surface of colonised dump layers, leaving no indication of the dumped material except that which is naturally preserved. Eroded material can either be lost completely, or redeposited elsewhere on the site. Layers of naturally redeposited eroded material are more difficult to interpret than those *in situ* due to the mixing of faunas reflecting different environmental events. Redeposition can also result from human actions; material which has been accumulating in a rubbish dump can be removed and dumped. Such anthropically redeposited material could contain small numbers of derived snails which had previously colonised the rubbish tips.

Ploughing is a human activity that is difficult to detect in the molluscan faunas, it is akin to natural conditions of instability, and the molluscan faunas will reflect the vegetation cover and surface conditions that develop once ploughing has been completed. Thus, if the fallow period between ploughing episodes is great the molluscan faunas will tend to indicate a reasonably stable grass cover; with shorter intervals the fauna will indicate greater instability. Ploughing also destroys and mixes the faunas of all the fallow episodes thus producing an 'average' fauna. In ploughed deposits it is essential to know whether the surface or the body of the layer has been sampled. The surface fauna may simply indicate the greater stability associated with the final colonisation of an abandoned field.

Dominant and indicator species

At Baleshare, Balelone and Hornish Point the dominant species included *Pupilla muscorum*, *Cochlicopa* spp, and *Vallonia* spp which appear to have been in competition: rises in one species coinciding with decreases in other species (see Appendix 1 for the ecologies of the identified species).

The restricted number of species from the four study sites implies that extreme conditions with low diversity and poverty of habitats prevailed (cf Walden 1981, 370). This seems to have resulted both here and at other published sites, directly from human activities. Comparison with modern studies of faunas on grazed machair in Orkney (Evans & Vaughan 1983) demonstrate their similarity with those from Baleshare, Balelone and Hornish Point.

The impact of man around these three archaeological sites severely limited the numbers of ecological niches available. The rise and fall in the proportionate representation of the dominant species should give some indication of the past environment. *Pupilla muscorum* for example is favoured by dry, exposed, unstable conditions; although it can survive more shaded moister conditions in which it is often paired with *Vallonia excentrica*. It seems to be unable to compete with more specialised species and hence only becomes abundant in fairly marginal environments. Stability is the key to the success of the vallonia species, though it is able to tolerate some fluctuations in both moisture and shade: *Vallonia costata* is more of a pioneer species than *V. excentrica*, favoured by fairly dry, stable grassland but declining markedly in the face of competition with *V. excentrica*. It can tolerate a wider range of conditions, retreating to wetter, more exposed, unstable or rupestral locations, though it would presumably encounter competition from other species. Rises in constata in conjunction with rising pupilla can therefore be seen as indicating an increase in instability or available rupestral locations; rises in *V. excentrica* may indicate a damp stable grassland, and with cochlicopa a rise may indicate damper more unstable conditions. Significantly, *V. constata* is also a well known coloniser of gardens and rubbish-midden locations, and it is possible that sudden peaks in this species might intimate the dumping of domestic rubbish.

Finally the two cochlicopa species seem to indicate, in the dune-machair system, a degree of instability, exposure and some dampness: *C. lubrica* favours damper, shadier, more sheltered habitats, while *C. lubricella* favours drier, more disturbed and exposed conditions.

At Newtonferry, and in a few late contexts at Hornish Point, however, the dominant species was *Cochlicella acuta*, with lesser amounts of *Helicella itala*. Today cochlicella is almost solely confined in its distribution to west coast calcareous sand system habitats: this specialist species successfully out-competed the previously dominant species, almost totally replacing *Pupilla muscorum* and causing a dramatic decline in the numbers of cochlicopa and vallonia. *Vallonia excentrica* in the most stable, regularly grazed grasslands and the cochlicopa species in damper habitats seem to have survived in some numbers. *Vallonia costata*, however today is virtually extinct from west coast sand systems.

In addition to the dominant species there are a number of numerically less important indicator species which provide finer detail of past environment. *Cochlicella acuta* and *Helicella itala*, for example, which when they first arrive at Baleshare, Balelone and Hornish Point are indicative of either dry, exposed, unstable conditions or reasonably dry, fairly short turf. These two Helicelid species although they are often found together would appear to be in competition to some degree. In the faunal matrix for Hornish Point, therefore, they are treated together as a Helicelid group. The third Helicelid species found during the study, *Cepaea hortensis*, would appear to be in competition with the other two. Today it seems to be favoured by locations with richer, denser, taller vegetation where Helicella is largely absent (Cain *et al* 1969). Where *Cochlicella* is present, however, it has all but eliminated *Cepaea*. This applies to all four sites studied here, with increasing quantities of *Helicella* and *Cochlicella* at Hornish Point relative to Baleshare leading to the virtual disappearance of *Cepaea*, which is totally absent from Newtonferry. The other indicator species seem to fluctuate independently of the dominant species groups (*Pupilla, Cochlicopa, Vallonia, Helicella* and *Cochlicopa*); they appear in similar numbers at Newtonferry, Baleshare, Hornish Point and Balelone. *Vertigo pygmaea* indicates stable, complete grassland, normally short-turfed and sheep-grazed; under these conditions it is often found with *Vallonia excentrica, Vallonia costata* and *Pupilla muscorum.* It seems to only reach slightly greater numbers in fairly moist stable turf. Similarly, if found in machair locations, the two species *Punctum pygmaeum* and *Euconulus fulvus* would seem to indicate fairly moist, stable, continuous grassland, possibly fairly rich in terms of abundance and diversity.

Lauria cylindricea is traditionally seen as a rupestral species living in woodland, among rocks, or less commonly in well established grassland in Orkney, however, it appears to have replaced *Pupilla muscorum* and *Vallonia excentrica* to a considerable extent. This change would appear to have taken place in post-Roman and even post-Medieval times; in other areas, it seems doubtful that *Lauria* could out compete *Cochlicella.* At Newtonferry the highest peaks of *Lauria* coincide with the highest frequencies of *Oxychilus* and other zonitids, seeming to indicate middening. At Baleshare, Balelone and Hornish Point, the smaller numbers of these may indicate the presence of nearby structures. At Iron Age Baleshare, for example, there seem to have been consistently more *Lauria* in the faunas from the northern than southern blocks; this phenomenon is perhaps associated with the large cairn which lies behind the northern half of the cliff section. From Hornish Point there is some evidence to suggest that peaks of *Lauria* do coincide with accumulation associated with structures, but other peaks in the southern half of the site are less easy to interpret.

The odd specimens of *Clausilia bidentata* and the single *Leiostyla anglica* are similarly difficult to interpret; both normally represent rupestral species but occasionally can be found in relatively damp grassland. Similarly, the single specimen of *Columella edentala* discovered implies a moderately damp environment, probably moist, stable grassland.

All of the above indicator species help to refine the picture of the 'natural' environment in terms of the type and degree of vegetation cover. It is only with the zonitid group, however, that one can move closer to understanding direct human action in the processes of midden formation through dumping of various types of domestic waste. While human agricultural activity seems to have restricted the diversity of molluscan faunas, by decreasing the richness of the vegetation cover, it would appear that within and around settlements new micro-environments can be created - rupestral locations associated with walled structures and tips of various types of rubbish. The zonitid species and *Vitrina pellucida* are omnivores and thus tend to fluctuate independently of other species groups. All four species are also rapid colonisers, well placed to take advantage of plant and animal refuse, moreover, they are all species requiring dampness and shelter, and dumps of organic waste could provide, in addition to a food source, both moisture and a safe haven.

Oxychilus alliances can become locally abundant given favourable conditions, but in coastal dune-machair systems are only ever found in relatively low numbers (less than 5%) in reasonably moist, stable, short-turf grassland grazed by sheep, avoiding turf grazed by cattle and unstable locations. In rich grassland, it is found with a variety of species including *Punctum pygmaeum, Vitrina pellucida, Vitrea crystallina* and *Nesovitrea hammonis*. At all four sites, *Oxychilus* regularly constituted around ten per cent of the context faunas, sometimes reaching as much as twenty per cent. By contrast *Vitrina pellucida*, and *Nesovibea hammonis* are only ever found in small numbers. *Vitrina pellucida,* in addition to moist stable grassland (when it is found in short-turf grazed by cattle), is also found in damp grassy hollows in the dune slacks of the coastal dune-machair system. When found without the other zonitid species, it may therefore, indicate cattle-grazed grassland or unstable conditions where some damp herbaceous vegetation is still available. *Nesovitea hammonis* is also found in moist stable grassland with *Oxychilus* and *Vibira*; intolerant of instability, it would appear to require more moisture than *Vitrina* and the other Zonitids.

Vitea contracta is also found only in small numbers. It can be found in moist stable shoreline turf, and appears to avoid unstable conditions or sandy grassland, preferring turf over a more compact substrate. At both Baleshare and Hornish Point odd specimens of *Vitrea* can be found in contexts with poor faunas and no other omnivorous species. Unlike *Oxychilus* and *Nesovitrea*, *Vitrea* can often be found crawling in open areas without vegetation as long as it has a reasonably sheltered place to retreat to such as stones or rocks. *Vitrea contracta* may have been able to colonise certain types of dumped material unsuited to *Oxychilus. Oxychilus* was the main coloniser of domestic rubbish, moving in from nearby moist, stable grassland where it would have been living with *Vitrina* and the other zonitids. *Oxychilus alliarius* is, with *Vallonia costata*, the only species normally found associated with domestic compost and midden heaps. More work needs to be done on modern analogues to understand the micro-ecological niches of these snail species in habitats associated with farms and small rural settlements.

Where *Oxychilus* does become relatively important in context faunal assemblages it is possible to say that this species is responding to the dumping of domestic organic refuse. However, in several sub-blocks, especially at Baleshare, peaks in the concentration of both preserved archaeological refuse (animal bone, carbonised seeds, sea shells and artefactual material) and soil organic are not reflected by rises in the number of *Oxychilus alliarius*. This raises the question of how different patterns of organic refuse disposal will be reflected in the molluscan faunas. The type, quantity, wetness, and mode of dumping will all affect the micro-environment. Organic, thinly spread over a surface, may not provide sufficient shelter or moisture to encourage colonisation by *Oxychilus*, and if this occurs regularly a thick uniform layer rich in organic and inorganic refuse may result; if this is rapidly followed by further dumping there may not be time for *Oxychilus* to colonise. Wet organic refuse will readily trap blown sand provoking rapid burial by natural aggregation, and again prevent *Oxychilus* from moving in. In these cases the rest of the molluscan faunas would also be very poor. Fertiliser which is rapidly ploughed in to an arable field need not be reflected by increased *Oxychilus*, although the molluscan faunas from fallow periods would still be present within the mixed up deposit.

Explanation is required when rich molluscan faunas indicative of stable conditions, but without any peak in *Oxychilus,* coincide with richly organic layers and abundant archaeological debris. Such contexts raise questions about the nature of both the organic and the archaeological material. Soil organic material could derive from a deepening moist turf horizon where grazing sheep contribute further organic matter. Similarly it would seem unlikely that manure of any type would be preferentially colonised by *Oxychilus*, as it would seem to have an advantage only with fresh animal and plant waste. Therefore, if rubbish were being allowed to collect in piles or as manure in byres, before being mucked out and spread on the midden, it would be in a partially decomposed or detrital state. This would also account for the occurrence of rich archaeological waste, as layers of rubbish piles were being periodically spread, rather than being regularly disposed of as smaller quantities of fresh waste deposited further from the settlement. Indeed many contexts poor in organic material do contain fairly rich artefactual assemblages indicating that organic waste had been disposed of separately or that it had accumulated and decomposed in rubbish piles before being spread. Conditions inside such refuse heaps would not have been conducive to exploitation of snails if decomposition in thick piles produced large amounts of heat or concentrates of organic acids. Perhaps small amounts of rubbish were regularly spread allowing total breakdown of soil organic and, thus insufficient material for *Oxychilus* to colonise. This idea is supported by a comparison of faunas from contexts at Baleshare, and Hornish Point. At Baleshare the naturally-eroded section seems to cut through deposits away from the centre of the site, while at Hornish Point the northern half of the section passes through a whole series of structures, presumably located near to the centre of the site. At Hornish Point the correlation between peaks in soil organic, archaeological material and *Oxychilus* alliances is good, whereas at Baleshare the correlation is good in the later blocks but falls down on some of the blocks from the middle Iron Age (Blocks 16, 15, 19 and 2A-D). The later blocks at Baleshare coincide with the central house structure while the middle Iron Age blocks have no contemporary domestic structures. It is therefore possible that peaks in *Oxychilus* reflect deposition of fresh domestic waste near the

BURNT SHELLS

Baleshare	**5A**	**21**	**1 Pupilla muscorum**
	11B	126	2 Pupilla muscorum
	24A	39	1 Oxychiles alliarius
	24E	37	2 Pupilla muscorum
Balelone	**1017**	**804**	**All shells in this context were burnt**
Hornish Point	**5E**	**64**	**1 Nesovitrea hammonis**

GREEN (Bronze or Copper) STAINED SHELLS

Baleshare	**15D**	**215**	}
	16A	149	} Many shells in these contexts
	19B	212	} were stained.
Hornish Point	**1F**	**70**	

Table 27. Burnt and green-stained snails

centre of the site (for example in parts of Block 19, Hornish Point, much of which represents tipping into earlier abandoned structures) while absence of peaks of *Oxychilus* coincident with peaks in soil organic and archaeological material could in some cases represent redeposited rubbish further away from the centre of the settlement, in areas which may have represented a type of in-field.

Finally it should be mentioned that the small number of burnt snails listed in Table 27 may indicate either deliberate or accidental burning of areas around the midden (stubble burning, burning of turf in preparation for ploughing?). The few green-stained snails may result from the decay of bronze or copper objects among rubbish deposits. The bright, blotchy fixed nature of the staining would suggest this rather than organic staining from cess.

14.4.5 Interpreting the faunal associations

Detailed interpretations of the sub-blocks and individual contexts from the four sites studied here, are given within the main text with the archaeological Block descriptions. In order to compare and contrast faunas both within and between the sites, sub-blocks were clustered into faunal groups for the sites of Baleshare and Balelone, and plotted on faunal matrices for Hornish Point and Newtonferry. The advantage of using faunal groups is to facilitate recognition of closely related sub-blocks. The faunal matrices do not cluster sub-blocks and contexts categorically, so they have the advantage of being more flexible and accurate, describing the faunas from these smaller stratigraphic units, rather than their aggregates. Both methods demonstrate, that the molluscan faunas cluster into 'faunal associations' defined by the same species characteristics. These faunal associations have been labelled A–D. Within these associations the dominant species (*Pupilla* sp, *Vallonia* spp, *Cochlicopa* spp at Baleshare, Balelone and Hornish, and *Lauria* sp, and *Cochlicopa* sp at Newtonferry) vary in space according to local ecological conditions such as vegetation, dryness, stability and possibly animal grazing patterns, and through time due to biological succession and the competitive replacement of some species (eg *Cochlicella acuta*/*Pupilla*). The faunal associations are naturally defined, however, not by fluctuations in the most numerous 'dominant species' so much as by variation in the 'indicator species'.

The main division is between faunal associations A and B which have relatively important numbers of *Oxychilus alliarius*, and C and D which do not. The implications of this have been discussed in the previous sub-section. *Vallonia costata*, as well as *Oxychilus* is a species which sometimes colonises midden deposits, cf contexts 158 (sub-Block 11A), 112 (19A), 6 (6A), 11 and 9 (5D) from Baleshare where peaks of *V. costata* coincide with important *Oxychilus; V costata* is also favoured by most grassland conditions (eg sub-Block 15B Baleshare, and sub-blocks in 26, I and also 19B, Hornish Point), so only where there are exceptional peaks of *V. costata* (Baleshare 143 (16B), Hornish 323 (20B) or rises in this species in an absence of moist grassland conditions (Baleshare 37 (24D)) can these phenomena be taken to indicate the deposition of some type of archaeological waste not colonised by *Oxychilus*.

The separation between faunal associations A and B on the basis of an absence of *Helicella itala* in association A may not be significant; the faunal matrix for Hornish Point shows how *Helicella itala* would appear to fluctuate relatively independently from *Oxychilus alliarius* within context and sub-Block molluscan faunas. Faunal associations C and D are divided by the absence of *Oxychilus* in D, compared with a small number in C. At Baleshare this division is also reflected by the other species of the Zonitid group (*Vitrea contracta* and *Nesovitrea hammonis*), together with *Vitrina pellucida, Punctum pygmaeum* and a single *Leiostyla anglica*. Where found together, such assemblages would appear to indicate fairly moist, stable, grassland conditions. If *Cepaea hortensis* was also present this stable turf may have been longer, while if absent the turf may have been short and sheep-grazed. Where small numbers of *Oxychilus* were present without other grassland species this may indicate that small amounts of middening were taking place.

At Hornish Point, *Punctum, Vitrina, Vitrea*, and *Nesovitrea* are found in contexts regardless of the presence or absence of *Oxychilus alliarius. Oxychilus* tends to avoid turf grazed by cattle, while *Vitrea* is found in contexts where there is neither *Oxychilus* or *Vertigo pygmaea* (at both Hornish Point and Baleshare) indicating a fairly bare, open, although not unstable ground surface.

Within all four faunal associations there is a wide spectrum of degrees of dampness, exposure and stability, the crucial difference depending upon variations in human activity influenced vegetation through arable, pastoral and habitational land use but it is the deposition of various types of settlement waste which give rise to the differences on which the faunal associations can be constructed. This is hardly surprising since the layers which make up the excavated deposits consist of a mix of naturally accumulated blown sand and organic from the vegetation cover, archaeological material which was dumped or collected as a result of site occupation, and organic material deriving similarly from dumping, gradual accumulation and dung.

14.5 CONCLUSIONS

14.5.1 Site formation processes

The extent to which the snail faunas reflect at least in part, the materials and processes which go into the formation of the recorded layers has been discussed above. Sand within the layers has arrived either as a result of wind movement, or of being moved or dumped by man. Soil organic material may have derived from the decay of *in situ* vegetation, dung, decomposed rubbish or seaweed placed to stabilise surfaces or as animal fodder. Redeposited humic material eroded from older dune or machair areas should also be considered in an attempt to explain layers rich in humic material but with snail faunas which do not reflect the presence of plentiful available organic foodstuffs. The archaeological material, likewise, may have been dumped as fresh domestic refuse, as partially decomposed manure or compost or redeposited from accumulated heaps which have then totally decomposed.

The processes involved in layer accumulation can be considered as natural, anthropogenic, and mixed. To understand these process further, and their differential involvement in the formation of the sites studied here, one must understand the four sites in terms of their location within the dune-machair system.

14.5.2 The dune-machair system and related geomorphological processes

The formation of the machair system has been outlined by Ritchie (above). The deep sand stratigraphies of the high machair plains preserve sequences of all the natural and anthropic environments that had existed on the accreting surfaces, including buried soils and archaeological deposits. However, the flat low machair plains are prone to erosion and redeposition; old soil horizons are almost never found beneath these low plains (Ritchie 1979). It is on these low plains along the western coast of the Outer Hebrides that many midden-mounds are found. Consideration of the processes which contribute to the formation of these sites on the low machair plains and in other locations, taken in conjunction with the snail evidence from the four sites studied, suggest meaningful histories for the formation of these particular sites.

Former site locations

Hornish Point and Baleshare both have numerous contexts with molluscan faunas indicative of more or less stable fixed-dune pasture which could only be found in the machair region of the dune-machair system. Very similar faunas have been described from modern fixed-dune pasture locations in the Inner Hebrides (Colonsay and Oronsay; Paul 1976), Orkney (Evans & Vaugan 1983) and the Outer Hebrides (from the extant turf of Northton, Harris; Evans 1971). The evidence from the snail faunas of dune-type conditions can, therefore, be interpreted as times of inland erosional sand-blows. Furthermore at both Hornish Point and Baleshare there are 'wet' snail species indicative of seasonal flooding from nearby lakes and marshes. Both these sites, therefore, were originally located on low machair deflation plains prone to wind-borne erosion and deposition; the former and modern presence of lakes and marshes suggesting that the sites were situated towards the landward margins of these plains (cf Ritchie 1979).

Balelone also has some evidence for former fixed-dune pasture, together with limited evidence for flooding. This site is situated some five metres higher than Baleshare and Hornish Point, and would appear to have been located on high machair plain. The former presence of marshes together with the modern machair rock or till is indicated (Ritchie 1979).

Newtonferry is different from the other sites in having molluscan faunas which are always typical of dune-type conditions. This site would appear to have been originally located among dunes near to the shore. The faunas suggest that the location was within the more stable part of the system rather than the active, mobile dune front. The presence of 'wet' and 'aquatic' snails within the assemblages suggest that there were freshwater lakes and marshes nearby. Today coastal recession has caused those freshwater bodies to become brackish.

The dune-machair systems now lost to the sea at Baleshare and Hornish Point may have exceeded a kilometre in width, though that at Balelone, with a steeper coastline, may have been less. At Newtonferry, rather less recession appears to have taken place, the site may have been a hundred metres or less from the beach.

14.6 THE MICROSCOPIC MARINE MOLLUSCA

C Pain & N Thew (1987)

14.6.1 Introduction

The distribution of the microscopic marine mollusca vertically and spatially through the layer contexts of the individual sites is given in each site Chapter. The numbers of shells within each context or even within phases of these sites are too small to deal with separately. Table 28 therefore, gives the aggregate numbers of microscopic marine mollusca for the four sites.

As with the land snails, the numbers of sieve-recovered marine gastropods are under represented possibly by as much as a factor of ten because recovery was by flotation only, without subsequent sorting of the residues.

Despite this problem however, the microscopic marine gastropods seem to present coherent groups when their ecologies are considered. The ecological requirements for all the microscopic and species present on the four sites studied is listed at the end of this text. It is evident that the microscopic species were too small to have been originally deliberately collected by hand.

Table 29 shows that all the microscopic species, including juvenile *Littorina littoralis* and *Littorina littorea*, with the exception of *Littorina neritoides* and possibly *Littorina saxatilis* live attached to stones or seaweed. With the exception of few specimens which may have reached the sites during the gathering of beach stones for the construction of buildings or other structures, the majority appears to have been transported to the site attached to seaweed.

Birds and even the wind can act as agents for transporting both microscopic and larger mollusca inland (Evans 1983). None of the microscopic specimens recovered, however, were broken or noticeably abraded with the exception

	Baleshare Bronze Age	Baleshare Iron Age	Hornish Pt Iron Age	Newtonferry Post-med	Balelone Iron Age
Sieve collected					
Onoba semicostata +	*0*	*0*	*0*	*2*	*0*
Cingula semistriata +	*0*	*1*	*0*	*0*	*0*
**Gibbula cineraria*	*0*	*1*	*24*	*0*	
Hydrobia ulvae+	*2*	*2*	*0*	*0*	
Zacuna pallidula+	*0*	*0*	*0*	*2*	
Lacuna vincta+	*0*	*1*	*4*	*15*	
**Littorina littoralis*	*0*	*0*	*14*	*11*	
**Littorina littorea*	*0*	*3*	*16*	*3*	
Littorina saxatilis	*0*	*0*	*2*		*5*
Littorina neritoides	*0*	*0*	*0*		*1*
Unidentified (broken)	0	0	1		0
Rissoa parva +	*3*	*20*	*321*	*98*	*5*
Retusa obtusa+	*0*	*0*	*0*	*1*	
Total	***(3)***	***(30)***	***(382)***	***(132)***	***(11)***
No of contexts	***96***	***79***	***171***	***36***	***10***
Average per context	***0.03***	***0.38***	***2.23***	***3.67***	***1.1***
Hand collected (this represents only those shells sent with the land shells)					
Buccinum undatum	*2*		*0*		
Gibbula cineraria	*7*		*6*		
Littorina littoralis	*39*		*53*		
Littorina littorea	*54*		*19*		
Nucealla lapillus	*4*		*0*		
Patella aspersa	*(2)*		*0*		
Patella vulagata	*1~*		*~*		
Bivalves					
Mytilus edulis	*1*				
Cerastoderma edule	*2*				
Pholadocea sp (?)	*1*				
Ensis arcuatus/Siliqua	*1~*				
Mya Arenaria	*1*				

*Table 28. Marine mollusca from Baleshare, Hornish Point, Newtonferry and Balelone. Key: ~ locally common: * includes apices broken from larger shells; + species most common, or only present in mature form in summer*

of a specimen of *Littorina saxatilis* and a single *Littorina neritoide* from Balelone. Moreover, in the cases of Baleshare and Hornish Point, and possibly Newtonferry, it seems likely that the sites were located at some distance from the sea at their time of occupation thus reducing the possibility of accidental introduction. The Balelone site with its steep rocky coast may have been different and coastal erosion between the time of occupation and the present may have been much less severe. The single specimens of weathered *Littorina neritoides* and *Littorina saxatilis*, inhabitants of the higher rocky shore, may have been blown on to the site. A few of the microscopic shells had changed colour. As this was almost certainly due to the chemical action of the soil the phenomenon is not regarded as being of any archaeological significance.

In its unprocessed form, seaweed can be used as food for human and animal, and also as fuel and fertiliser. As most of the microscopic species recovered on the sites are only abundant or present in their mature forms in summer, it seems highly likely that seaweed collection occurred at this time of year. As many of the mollusca were present in cultivation layers it would seem that seaweed was used extensively as a fertiliser. Its use for the other purposes cannot be excluded but these are very difficult to demonstrate archaeologically. Collection could have been by cutting or collection from the shore in the wake of storms.

In addition to its use as a fertiliser, seaweed served as a stabiliser to the sandy soils of the machair which are particularly susceptible to wind erosion when under cultivation. Bell (1981) records that when left on the surface seaweed takes four months to a year to decompose. If deposited in May or June, it would keep the soil moist throughout the summer months making it less susceptible to wind erosion.

The majority of the marine gastropods present on these sites indicate harvesting of seaweed or collection of driftweed from rocky shores. The harvesting zone would appear to be the lower to middle shore as all the microscopic species can be found there. The predominance of *Rissoa parva*, a species which lives as high as the middle shore, over seaweed species which are confined to the lower shore may suggest that much of the seaweed was cut from the middle shore. Moreover, *Rissoa parva* is commonest on fine weeds suggesting that this was being harvested in preference to the larger *Fucoid* or *Laminaria* species. Such a preference might be explained by an awareness that finer seaweeds decompose more quickly, providing more enrichment for present rather than future crops. Some of the larger weeds were, however, undoubtedly being deposited and the presence of the large *Fucoid* species

Onoba semicostate:	*Common in summer on all rocky and stony shores; under stones, among weeds and coralines; in silty crevices, and shelly gravel, always with a considerable quantity of silt. Near HWM – 100 mm sublittorally.*
Cingula semistriata:	*Not common in the N; present in summer under stones and at the base of weeds on rock; especially silty places and common locally in muddy rock pools. LW – 100 m sublittorally.*
Gibbula cineraria:	*Common on rocky shores under stones and on (top shell) seaweeds (Fucus, Laminari a, Bifurcata, + many small re d algal species), in pools, and on rough surfaces; requires some shelter and avoids exposed locations; tolerant of sandy, stony shores but avoids mud and very weedy localities. LW – 130 m.*
Hydrobia ulvae:	*Common in brackish and sheltere d intertidal locations with flat wet banks of firm mud or muddy sand, especially in estuaries; often found with Cerastoderma edul e; common also on weeds in muddy localities (ulvae, zostera and enteromorpha); tolerant of drying out by burrowing, but intolerant of direct wave action; salinities 2–42%, normally 10–30% and average 22%. HW – 20 m.*
Lacuna pallidula:	*Lives on holdfasts in the Laminari a zone, LW – 70 + m.*
Lacuna vincta:	*Common on seaweeds (especially Fucus sp, ceramium, zostera and polysiphonia, also Laminari a) – LW – c. 35 m.*
Littorina littoralis:	*Abundant on all rocky and stone shores; usually found on seaweed (Fucus, Ascophyllum); especially commo n where these plants border rock pools. Lower, MW – upper LW.*
Littorina litorea:	*?? Very common on rocky, stone, and sandy (and (edible winkl e) also muddy) beaches; lives on rocks and seaweeds. MW – LW.*
Littorina saxatilis:	*Abundant on all rocky coasts except the most exposed; usually in cracks, crevices and empty barnacle shells in asso - ciation with the seaweed Pelvetica canaliculata. HW – middle MW.*
Littorina neritoides:	*Locally abundant on all rocky coasts; found in rock cracks and crevices; HW and above, but migrates to lower areas of the shore inbreeding season March – April.*
Rissoa parva:	*Abundant in summer on rocky and stone shores among corallines and seaweeds (commo nest on base and fronds of smaller weeds with subdivided thallus – lamentaria, plumaria, callithamnion, Ceramium, Corallina; less commo n on weeds with undivided fronds – Fucus, Enteromorphe, Rhodymenia, Ulva, and also commo n on Laminaria hold especially fine weeds in rock pools; also under stones and in crevices. Middle MW – 2 m sublittorally.*
Retusa obtusa:	*Frequent in muddy estuaries and brackish water away from direct wave action; lives on flat wet banks of firm mud or muddy sand; tolerant of drying out through burrowing; commo n also on weeds in muddy localities. Lower HW – 15 m.*
Buccinum undatum:	*Found on both rocky and sandy shores; a (whelk) large species, it is mobile and not confined to particular surfaces; lower LW – deep water sublittorally.*
Nucella lapillus:	*On all rocky coasts except very exposed (do g whelk) ones; locally abundant wherever barnacles and mussels are found (feeds on other mollusca); usually found under stones and in rock crevices. HW – sublittorally.*
Patella aspersa:	*The dominant limpe t on lower parts of (limpe t) exposed rocky shores and higher where heavy wave action; avoids dryer and very sheltere d areas and brackish water; prefers areas washed by waves and pools; found on open rocks, in gullies and on the underside of overhangs; feeds on seaweed (Fucus sp algae, and Corallina sp algae). LW –sublittorally; and lower MW where strong wave action. Patella vulgata The dominant limpe t higher on all rocky shores from exposed to sheltere d when there is a firm clean surface for attachment; lives on rocks and stones, in crevices, under overhangs and in pools; tolerant of brackish water locations (salinity down to 3%) though normally lives in marine conditions (salinity > 25%).HW – LW, though less commo n on lower shore as replaced by P. aspersa, except in more sheltere d or brackish water locations.*
Bivalves	
Mytilus edulis:	*Very common on rocky and stone shores; (mussel) attached to rocks and usually in great local abundance; found in both sheltered and exposed locations. Lower HW – 15 m sublittorally.*
Cerastoderma edule:	*Common in clean sand, muddy sand, mud or (commo n cockle) muddy gravel, in sandy bays, estuaries and tidal rivers; burrows to a depth of no more than 5 cm; lives in water with salinity just below 20–35%. MW – 10 m sublittorally.*
Pholadacea: sp	*Burrowing species; into hard and softer (Piddoc k)rock, wood, peat, and firm sand.MW/LW – 10 m sublittorally.*
Ensis arcuatus/arcuatus:	*burrows into fine or coarse sand and also fine or coarse shell gravel. LW – 35 m; siliqua burrows into fine sand, gen - erally avoiding silty conditions. LW – 35m.*
Mya arenaria:	Very common in firm sand, mud, sandy mud and sandy gravel in seashore and estuaries. LW – 70 m.

Table 29. The ecological requirements of the marine mollusc an species found at Baleshare, Hornish Point, Newtonferry and Baleshare

is evidenced by the presence of juvenile species of *Littorina littoralis* and *Littorina littorea*.

Two species, *Hydrobia alvae* and *Retusa obtusa*, live on muddy shores, either on or within the mud, or on weeds in muddy localities. These species could indicate either the gathering of finer, smaller weeds on muddy shores, or alternatively accidental collection during the collection of cockles (*Cerastoderma edule*), with which they are commonly found.

14.6.2 Balelone

Only a small number of seaweed shells, all species from exposed rocky coasts, were found in the ten contexts sampled for snails. The single specimen of *Littorina neritoides* was abraded and could have been blown onto the site. This seems possible as the high rocky shore of its environs suggest that little coastal erosion occurred since the Iron Age. One example of the *Littorina saxatilis* was also abraded. The remaining *Littorina saxatilis* specimens, however, were undamaged. This appears to imply seaweed collection from the higher shore while collection of the weed from the lower and middle shore is evidenced by the few *Rissoa* specimens present.

14.6.3 Baleshare

The microscopic shells from Baleshare demonstrate collection from both rocky and sandy shores. The single specimen of *Cingular semistriata* shows that at least some of the rocky shore was rather sheltered and contained silty crevices or muddy rock pools. The rocky shore seaweeds could have been gathered from the exposed west-northwest-facing rocky and stony beaches, while the sandy species would have been brought with seaweed from the sheltered muddy and sandy lagoonal areas east of Baleshare Island. The nearest muddy and sandy beaches are less than 1 km to the north and east, whilst it would seem that in the Bronze Age and Iron Age a similar distance of 0.5-1.0 km separated Baleshare from the western rocky coast. *Hydrobia Ulvae* indicates the collection of seaweed from muddy, possibly estuarine, areas.

The frequency of microscopic gastropods indicates that seaweed gathering was at a relatively low level during the Bronze Age, increasing in importance during the Iron Age. The frequencies of seaweed mollusca at Baleshare, however, were generally less than 20% of that noted in contemporary contexts at Hornish Point. The differing nature of the contexts on the two sites rather than contrasting economic activities may account for this discrepancy (*below*).

14.6.4 Hornish Point

The high number of seaweed gastropods at Hornish Point implies that harvesting and collection of seaweed was a common summer activity at the site. The faunal composition is generally similar to that at Baleshare except that there are no indications of seaweed being gathered from sandy or muddy shores, with only species from rocky or stony shores being represented. Furthermore, there are no species like *Cingula semistriata* to indicate that there were any sheltered areas on this rocky shore. Hornish Point is presently flanked by a stony, rocky shore to the west, north and north-east, although there is evidence that like Baleshare, it may have been an inland site during the Iron Age.

Seaweed seems to have been collected from the lower and middle shores, although the two specimens of *Littorina saxatilis* may imply collection also from the higher shore. The dominance of *Rissoa* and the absence of certain species such as *Onaba semicostate*, presently common on *Laminaria* and *Fucoid* in the Outer Hebrides (Smith 1979), implies that the majority of weed collected may have been smaller, finer-leaved algal species. *Lacuna vincta* is also fairly common on smaller weed species but confined to the lower shore. It may have arrived, however, with larger *Fucoid* species (bladder wracks), the collection of which is implied by juvenile specimens of *Littorina littoralis* and *Littorina littorea*. These larger weeds would appear, however, to have been collected in small quantities.

The lower frequency of seaweed mollusca at Iron Age Baleshare has already been noted. The contexts sampled at Hornish Point came from the centre of activity on the site and are associated with buildings and midden-field immediately adjacent to them. Those excavated at Baleshare were located in the midden-field towards the periphery of the site away from the centres of activity. It is possible, therefore, that economic activities involving seaweed were practised more intensively at the centre than the periphery of these Iron Age sites. Seaweed species often seem to coincide with layers that have land snail indications of field middening or simply dumping of organic domestic refuse (Block 19). This may suggest that seaweed was deliberately incorporated into dung heaps and, more importantly, that the more intensively tilled and fertilised land was confined to the immediate vicinity of the settlement as predicted in central place models. Blocks 9, 11 and 12, however, have no land snail indication of middening but have significant numbers of seaweed species. In this case, it may be suggested that seaweed was deposited locally as animal fodder or more likely, that seaweed was the sole method of soil fertilisation. No burnt seaweed shells were noted at either Baleshare or Hornish Point. This would seem to suggest that seaweed was not used as fuel which is not surprising as extensive supplies of peat was available locally.

The presence in Block 9 of many *Gibbula cineraria* apices, in addition to *Rissoa parva* and a few *Lacuna vincta*, would suggest that both fine algal weeds and larger bladder wrack (*Fucoid*) and other weeds were left on the midden-fields.

The presence of seaweed mollusca in some of the building deposits at Hornish Point (eg Block 19) suggests that seaweed was exploited as food as it was dumped with other organic domestic refuse to fill old disused buildings from which it is unlikely to have been re-distributed as fertiliser. The seaweed shells were almost entirely *Rissoa parva*, indicating that finer, smaller weeds were preferred for human consumption, although a few *Gibbula* shells may suggest that larger weeds were also eaten.

14.6.5 Newtonferry

This post-Medieval site produced the highest frequency of seaweed species per context of the four sites studied, reflecting the importance of seaweed as a fertiliser in the past, a phenomenon clearly evidenced by the documentary sources.

It appears that the excavated contexts are from near the centre of the site as the contexts were associated with buildings and midden-fields. The fauna are similar to those from Baleshare and Hornish Point in that they were largely derived from a rocky shore, from finer, smaller weeds, while some larger types were gathered from the lower and middle shores. The presence of *Lacuna pallidula* and *Onoba semicostate* suggests that *Laminaria* was also collected, possibly as driftweed. *Onaba semicostate* also indicates that some weed was collected from more sheltered rocky coasts. At present, such a coastal type is located immediately to the west and east of the site. The single specimen of *Retusa obtusa*, a mud-bank species, may show that weed was also being taken from the small, brackish Loch an Sticar 500 m south of the site or, possibly, from the sheltered bay where Newtonferry is situated. Alternatively, this specimen may have been introduced with collected cockles.

The distribution of seaweed species within the Newtonferry deposits indicates that whilst present in layers producing land-snail assemblages suggestive of middening, the highest concentrations were in layers devoid of such evidence, indicating that at Newtonferry seaweed was collected primarily as fertiliser and possible stabiliser for the midden-fields.