Studies in the floristic diversity of Durham walls, 1958–2008

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ABSTRACT

A study of the flora of the walls of Durham City over the period 2006–2008 indicated that the floristic diversity had increased by between 39% and 42% since a survey undertaken fifty years ago by Woodell & Rossiter (1959). In addition, the increased frequency of occurrence of twenty-four of the thirty-four key species from the first survey is apparent and there is group of seven species not recorded in the first survey that has become especially prevalent. The increases may be interpreted in terms of the amelioration of the atmospheric environment which has offset any potential reduction of diversity associated with gentrification of the city. An influx of native species has been mainly responsible for the rise in diversity, though the number of neophytes has increased by almost a third of the original total. The floristic diversity of the urban wall habitat is higher than that of rural settlements of the Durham Dales, emphasising the importance of the former as a refuge for many species which have been perceived as declining at the national scale. The walls of each rural settlement have a distinct floristic signature, but the main chasmophyte communities show close phytosociological affinities with the alliance Cymbalarion-Asplenion.

KEYWORDS: floristic diversity, walls, urban, rural, Durham City, Durham Dales.

INTRODUCTION

This paper takes its stimulus from an article by Woodell & Rossiter (1959) published in the *Proceedings of the Botanical Society of the British Isles* which reported the findings of a survey of the flora of the walls of Durham City in the period 1955–1958. Their study was based upon a survey of Cambridge walls by Risbeth (1948) and in turn, stimulated extensive research on the flora of the urban walls of Middlesex (Kent 1961), and more specific projects such as surveys of the churchyard walls in Middlesex (Kent 1964) and Norfolk (Silverwood 1965). Woodell continued his interest in urban habitats and became recognised as a leading authority in the genre (Woodell 1979). In the meantime, Segal (1969) published his classic volume on the ecology of European wall vegetation and this encouraged rural research projects such as those of Holland (1972) on the old walls of western Ireland, and Payne (1978) in south-eastern Essex. As interest in urban ecology increased, so did an appreciation of the importance of walls as modified cliff-like habitats with a special group of ecological characteristics. The popular text by Darlington (1981) entitled *Ecology of walls* brought the value of the habitat to public attention and the subject area was admirably developed by Gilbert (1989, 1996), through to the work of Larsen *et al*. (2000). Related studies of ruderality in a variety of urban habitats (Crowe 1979; Kent *et al*. 1999; Hill *et al*. 2002; Lundholm & Marlin 2006, *inter alia*) have all shown the value of walls in terms of microhabitat preference of certain species in the context of an environment which is subject to frequent disturbance. Other studies have placed a greater emphasis on the cryptogamic flora of walls, with examples ranging from a transect across County Durham by Wright (1984) to the recent *Flora of Dry Stone Walls* conservation project (Presland 2007, 2008a, b). As a result of various ecological investigations, the recognition of the ecological value of the built environment and walls has led to their inclusion in several Local Biodiversity Action Plans (*vide* those of Surrey County Council (2001) and Hull (2002), for example).

The history of the construction of the defences of the key military and ecclesiastical site of Durham, on its peninsula formed by the River Wear, is well known (Page 1928). Probable Anglo-Saxon walls surrounding the cathedral and castle were rebuilt by Bishop Flambard (1099–1128) and the defensive walls extended to encompass most of the peninsula in 1173–1174. In 1315 and again in 1337, the townsfolk petitioned the King for murage grants to construct walls to protect the market place, the focal trading point of the Bishop's Borough. The key aspect of these early details is that the wall habitat may be viewed as a relatively ancient artificial ecosystem and that, although many of the defences from the early historical periods do not survive, their

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continual alteration and augmentation have provided a constant sequence of mural habitats for populations of species to colonise. The greater proportion of the walls in the city, the heirs of this long history of urban evolution, are of eighteenth and nineteenth century origin and this fact is implicit in the statement by Woodell & Rossiter (1959) that 'factors contributing to the high number of species present are the great age of many of the buildings and walls in the city, and the present state of neglect of many of them.'

In the half century since this statement, there have been many aspects of urban development which would appear to have caused subtle ecological changes to the city environment and thus, the flora of Durham walls. The full effects of the Clean Air Act 1956 would not have been realised at the time of the 1955–1958 survey and atmospheric conditions have been further ameliorated by the Smoke Control Area provisions of the 1968 Act, reinforced by the Clean Air Act 1993. The Rivers (Prevention of Pollution) Act 1951 was in force and its repeal by the Control of Pollution Act 1974, no doubt contributed to increases in the floristic diversity of the riverside retaining walls. To a certain extent, these increases may have been negated by the construction of new flood defences of a structure less amenable to plant colonisation. Further, the perceived general gentrification of the city in association with the designation of the Cathedral and Castle environs as a World Heritage Site in 1986 (extended 2008) would seem to suggest a means for the potential rectification of the neglect described by Woodell & Rossiter. The basic hypothesis for this resurvey of the flora of Durham walls fifty years later, is that the combination of a variety of general environmental change and urban developmental processes have had a cumulative effect to reduce the floristic diversity of this particular habitat.

SURVEY AND METHODOLOGY

The methods of the investigation undertaken by Woodell & Rossiter were difficult to replicate based on the rather minimal information published in their 1959 paper. They 'listed the flora of 66 walls from Durham City and its environs' on 'a series of visits over the whole year'. The walls were mainly of the simple type, but the survey also included bridges, old buildings and stone buttresses. The composition and aspect of each wall and its function was recorded, but such data not included in the paper. Details are also lacking on the criteria by which the sample walls were chosen or what was the size of the sample. Some enlightenment was provided to the author by Dr Stan Woodell through personal communications in 1968, but unfortunately much of the raw data had been discarded at that time. Some original data was lodged with the Durham Colleges Natural History Society, founded by Woodell in 1953, to which the author had access as editor of the society journal in 1967–1968. These sources indicated that the survey was unstructured in terms of geography and that a wall was sampled initially when it had a complement of more than eight species in a fifteen metres length, and thereafter, whenever a new or different species not previously listed was noted. The walls chosen fell mainly within the urban core of the city around the castle and cathedral, radiating out to the Victorian terraces to the south of the city, perhaps within 'a radius of one mile from the castle'. Out-of-town sites at Shincliffe village, Old Durham and Finchale Priory, which fell within the purview of Durham City Council, were included in the survey on account of their age and heritage importance. The lists included only those species rooted in the fabric of the wall and the archive provided records of the occurrence of all the species recorded in four broad groups, i.e. the 14 species with 15 or more records (published in Woodell & Rossiter and identified in this paper as 'Category 1 species'); the 8 species recorded between 10 and 14 times ('Category 2 species'); the 21 between 5 and 9 times ('Category 3 species'); and the 129 species recorded less than 5 times ('Category 4 species').

The recent research began with a feasibility study in September 2006 on the variety of fabric types and potential differences in floristic complement due to aspect and shade. This study indicated that all the walls were mortared, that the greater proportion was of local sandstone and that little significant difference between the floras of brick as opposed to sandstone fabric could be determined. Similarly, few variations due to either aspect or shade were apparent within the context of the selection of samples by the minimum species number criterion. The preliminary survey also concentrated on determining the general

potential for replication of the survey by Woodell & Rossiter, particularly the identification of potential sites for analysis, with attempts to identify specific sites mentioned in their paper and archive. Direct comparisons with a few sites were possible. For example, their 'brick kiln, in large meadow near river' is in fact the grain/root vegetable silo at Kepier Farm (site 66, NZ284434). Other sites could be identified as the only locality for a particular species in both surveys, such as *Campanula rotundifolia* on the wall opposite the Seven Stars Inn, Shincliffe (67, NZ293406), *Milium effusum* on Cathedral Banks, Pimlico (20, NZ271419) and *Stellaria holostea* in Margery Lane, Durham School (4, NZ268420). It soon became apparent that it would be possible to find a similar number of sites, with eight or more species in a minimum required length of fifteen metres, in a similar geographical spread, for analysis through 2007 and 2008. The 68 sites (*cf* 66 of Woodell & Rossiter) fell unevenly within ten monads with a concentration of 29 in NZ 2742, the World Heritage Site and old urban core of the city (see Appendix 3 for details). Each site was visited on three occasions in both 2007 and 2008 during the last fortnight of April, the last week of June/first week of July, and in the first fortnight of September. The total complement of chasmophytes actually rooted in the fabric of the wall was recorded.

Mention was also made in Woodell & Rossiter (1959) of the wall flora of towns and villages to the west of the city in Weardale and Teesdale, though with little specificity of locality. As a second part of the present survey, it was decided to attempt an overall comparison of urban/rural wall floras and feasibility studies were undertaken in the period from September 2007 to January 2008. Their aims were twofold. The first sought to examine the potential for the generation of a comparative data set from the towns and villages of Weardale (Frosterley & Wolsingham and Stanhope) and Teesdale (Barnard Castle and Middleton-in-Teesdale). Thirty sample sites were selected from four localities, two in each dale, from a total of thirteen monads in relatively close comparison with the similar number in the city (see Appendix 3 for details). The methods used and the frequency of visit during 2008 were the same as for the urban survey.

RESULTS

A. INDICATIONS OF URBAN FLORISTIC CHANGE, 1958–2008

After nomenclatural corrections since 1958, the total complement of species recorded in the two surveys in Durham City was 260, though this figure would certainly have been higher had identification of the microspecies of *Taraxacum officinale* and *Rubus fruticosus* been attempted. On the advice of Dr A.J. Richards, the former was recorded as *Taraxacum* Section *Ruderalia*, since most urban dandelions fall into this group and many may be identified to either *T. exacutum* or *T. ekmanii*. The mature specimens of *Rubus fruticosus* which were encountered usually keyed out to *R. dasyphyllus*, but most were too immature to be positively identified. A similar situation applied to many seedlings of *Cotoneaster* – *C. simonsii* and the *C.* × *wateri* complex – but *C. horizontalis* was usually distinct. No attempt was made to distinguish taxa and hybrids in *Rosa* Section *Caninae*, Subsection *Caninae*. The full list of species is presented in Appendix 1 in which three categories are recognised: those species recorded in both surveys; those recorded in 1959, but not seen as chasmophytes in 2006–2008; and those not recorded in 1959 but noted in 2006–2008. Of the 159 species of pteridophyte, gymnosperm and angiosperm recorded in the 1959 paper, 34 were not noted as chasmophytes in 2006–2008, but all, with the exception of *Deschampsia flexuosa, Galium saxatile* and *Genista rigida,* were recorded in a variety of other habitats, notably wall bases and in overhanging garden shrubbery. The 2006–2008 survey recorded 226 species, including 86 chasmophyte species that were not recorded in the original 1959 paper. The primary indication of change from comparison of the two data sets is thus that the overall diversity of the urban wall flora has not been reduced in the intervening fifty years, rather, that it has increased by between 39% and 42% using the total species difference between Woodell & Rossiter and the 226 species of the 2006–2008 survey, and the 260 total recorded species for the two surveys.

A second indication of the nature of change may be derived from a closer look at the patterns of distribution of the 226 species in the

2006–2008 survey. Basically, the following data indicate that the mural vegetation has become more prominent, better developed and that the likelihood of encountering a species-rich community is far greater in 2008 than in 1958.

a. the range of species number was from 12 to 46 with a mean number of 22·4 per sample; thirty-eight samples had 20 or more species;

b. 68 species occurred in seven (>10%) or more samples and 29 species in 17 (25%) or more samples;

c. 35 species occurred in 15 or more samples compared with 14 of Woodell & Rossiter (see Table 1);

d. 85 species occurred in five or more samples compared with 45 of Woodell & Rossiter;

e. 137 species occurred in four samples and less, 75 of these in only one sample; the relative numbers from Woodell & Rossiter were 129 and 74; the two surveys had only 72 and 39 species in common respectively in these two categories (see Appendix 2 for details).

Reference to Table 1 provides an insight into the changes in percentage frequency of individual species in the four categories recognised by Woodell & Rossiter. Of the fourteen species in Category 1 (Table 1a), only four (*Senecio jacobaea*, *Rubus fruticosus*, *Taraxacum* Section *Ruderalia* and *Epilobium montanum*) have increased in frequency. *Dactylis glomerata* and *Senecio vulgaris* are the two of the remaining ten species which show the greatest decline. Direct comparisons with species falling into Categories 2, 3 and 4 are not possible due to the lack of detail in the 1959 paper, but taking the maximum possible percentage frequency for each category (i.e. 21. 14 and 6) it is possible to see that none of the species achieving an overall frequency >20% in 2008 has declined. Category 2 is notable for the increase of *Hedera helix* and *Urtica dioica*, in Category 3 *Cymbalaria muralis, Galium aparine* and *Geum urbanum* stand out, whilst the three fern species *Phyllitis scolopendrium, Dryopteris filix-mas* and *Asplenium ruta-muraria* are of interest in Category 4.

The final group of seven species in Table 1e, those not recorded in the earlier survey, are of particular interest. Neophyte species such as *Epilobium ciliatum*, *Centranthus ruber*, *Cotoneaster horizontalis* and *Senecio squalidus* would fall into the common perception of invasive weed species, but perhaps not so the other three native species. In this context, an analysis of the status categories of the total complement of species, as defined by Preston, Pearman & Dines (2002) – native, archaeophyte and neophyte – provides some indication of the types of invading species since 1958. This must be viewed with a certain latitude for species such as *Clematis vitalba, Euphorbia amygdaloides* and *Meconopsis cambrica*, *inter alia*, considered native in a part of their range are clearly of horticultural origin on the city walls. With this reservation in mind, it is interesting to note that the main increase in diversity has been due to the addition of an increment of 54 native species in contrast with a mere ten neophytes.

B. A COMPARISON OF URBAN AND RURAL FLORAS AND THE NATURE OF RURAL SIGNATURES

	W & R	2006–2008	Both
Total	159	226	260
Native	106	160	173
Archaeophyte	17	20	23
Neophyte	36	46	64

Perhaps the most interesting feature of the Durham Dales data set from 120 samples of rural walls was the lower diversity when compared to that of Durham City, specifically, a total of 162 species as opposed to 226. The Durham Dales data set had 135 species in common with that of Durham City and also a total of 27 species not recorded on the urban walls. The difference may in part be explained by the absence of samples from riverside retaining walls in all rural localities except Barnard Castle. This locality did, however, have the lowest total of the four sub-sets, totals for which ranged between 95 and 107 species. Other differences may be seen in the summary data presented below, particularly in that the range and mean number of species per sample are considerably lower in the rural situation.

TABLE 1. SIGNIFICANT CHANGES IN PERCENTAGE FREQUENCY OF KEY SPECIES, 1958–2008
[1957/58 (a) and 2006–2008 (b)]

	a		b		+/-%
	n	%	n	%	
a. Changes in the Percentage Frequency of 1958 Category 1 species (>15 records/>23%)					
Taraxacum Section *Ruderalia*	42	64	54	79	+15
Chamerion angustifolium	35	53	34	50	-3
Sambucus nigra	27	41	22	32	-9
Dactylis glomerata	26	39	14	21	-18
Poa annua	26	39	16	24	-15
Epilobium montanum	25	38	31	46	+8
Acer pseudoplatanus	23	35	17	25	-10
Senecio vulgaris	18	27	6	9	-18
Lolium perenne	15	23	9	13	-10
Plantago lanceolata	15	23	15	22	-1
Poa pratensis agg.	15	23	12	18	-5
Rubus fruticosus	15	23	29	43	+20
Rumex obtusifolius	15	23	9	13	-10
Senecio jacobaea	15	23	35	51	+28
b. 1958 Category 2 species (10–14 records/15–21%) achieving >20% frequency in 2008 (5 species)					
Hedera helix	14	21	42	62	+41
Urtica dioica	14	21	36	53	+32
Agrostis stolonifera	14	21	22	32	+11
Festuca rubra	14	21	19	28	+7
Ranunculus repens	14	21	16	24	+3
c. 1958 Category 3 species (5–9 records/8–14%) achieving >20% frequency in 2008 (10 species)					
Cymbalaria muralis	9	14	34	50	+36
Galium aparine	9	14	30	44	+30
Geum urbanum	9	14	30	44	+30
Fraxinus excelsior	9	14	28	41	+27
Lapsana communis	9	14	27	40	+26
Sonchus oleraceus	9	14	25	37	+23
Arrhenatherum elatius	9	14	23	34	+20
Geranium robertianum	9	14	21	31	+17
Sonchus asper	9	14	19	28	+14
Sisymbrium officinale	9	14	14	21	+7
d. 1958 Category 4 species (1–4 records/max 6%) achieving >20% frequency in 2008 (5 species)					
Phyllitis scolopendrium	4	6	21	31	+25
Buddleia davidii	4	6	19	28	+22
Dryopteris filix-mas	4	6	18	26	+20
Tanacetum parthenium	4	6	18	26	+20
Asplenium ruta-muraria	4	6	15	22	+16
e. Percentage frequency of species not recorded in 1958, >20% in 2008 (7 species)					
Epilobium ciliatum	-	-	42	62	-
Holcus lanatus	-	-	28	41	-
Cotoneaster horizontalis	-	-	24	35	-
Centranthus ruber	-	-	19	28	-
Senecio squalidus	-	-	17	25	-
Hieracium vulgatum	-	-	16	24	-

	a	*b*	*c*	*d*	*e*	*f*	*g*
Durham City 2008	226	7	37	68	158	12–46	22·40
Durham Dales 2008	162	4	22	42	120	8–33	15·00
Barnard Castle	95	7	26	38	47	10–24	14·00
Middleton-in Teesdale	98	5	29	49	49	10–23	14·75
Stanhope	103	4	26	45	58	9–26	14·00
Fosterley & Wolsingham	107	4	26	61	46	8–33	16·26

[a. Total number of species; b. number of species in >50% samples; c. number of species in >20% samples; d. number of species in >10% samples; e. number of species in <10% samples; f. range of species numbers per sample; g. mean species number per sample.]

The differences in frequency of individual species recorded in >20% samples in either data set between the urban and rural situations are shown in Table 2 in which three groups are recognised: a. species more common on urban walls by >20% difference; b. species more common on urban walls by 10–19% difference; and c. species more common on rural walls. The greater proportion of species falling into categories a and b is the most interesting immediate feature of the table, whilst the percentage difference may be interpreted as a simple index of urbanity or rurality. This latter concept is rather tenuous when applied to the data set as a whole for the four data sub-sets provide an implication of specific floristic signatures for the dale villages. Reference to Table 3, in which the number of records for those species achieving an overall frequency >10% are presented for the four sub-sets, indicates local concentrations of certain indicator species combinations. The key species of the signatures are as follows:

Barnard Castle
Linaria purpurea, *Phyllitis scolopendrium*, *Centranthus ruber*
Middleton-in-Teesdale
Geranium lucidum, *Geranium robertianum*, *Dryopteris filix-mas*, *Poa pratensis*
Stanhope
Erinus alpinus, *Poa nemoralis*, *Arabis caucasica*, *Aubretia deltoidea*, *Mycelis muralis*, *Ceastium tomentosum*
Frosterley/Wolsingham
Cotoneaster horizontalis, *Alliaria petiolata*, *Tanacetum parthenium*, *Fraxinus excelsior*, *Arabis caucasica*, *Aubretia deltoidea*

DISCUSSION AND CONCLUSIONS

Four major discussion points emerge from the results presented above. First, the overall floristic diversity of the walls of Durham City has increased by between 39% and 42% in the period 1958–2008, suggesting that the prime factors of the amelioration of atmospheric conditions has enabled the colonization of the mural habitat with an increasing number of mainly native, as opposed neophyte species. The hypothesis that general urban gentrification has had a deleterious effect on biodiversity would thus seem to be unfounded. As a corollary to these findings, it is interesting to note that a comparison of urban and rural walls indicates that the flora of the former is more diverse than the latter, although the proviso must be made that the rural data set did not include samples from riverside retaining walls, whereas the urban sample did. Both these features provide a strong case for the integration of biodiversity into urban planning, a major field of largely theoretical research and development for the past twenty years which has begun to manifest itself in the twenty-first century mainly through the agency of Local Urban Biodiversity Action Plans.

A second discussion topic concerns the importance of urban walls as a refuge habitat for certain groups of species which have been suggested to be in decline on a national scale. Indices for change in the national distribution of individual species have been generated in recent times by Preston, Pearman & Dines (2002) and by Braithwaite, Ellis & Preston (2006), the latter providing strong evidence that many species of their category BH17 (Built-up areas and gardens) have increased their frequency in recent times. The authors point out (p. 228) that ‘plants with low fertility requirements and those of climates characterised by low rainfall and warm summers have done especially well.’ The species in this category are those from a variety of urban habitats, not specifically those growing on walls, and conversely, many of those found on the walls of Durham City are more typical of other broad habitat types as defined by

TABLE 2. A COMPARISON OF SPECIES FREQUENCIES IN THE URBAN (DC) AND RURAL (DD) DATA SETS
(species with >20% frequency in one or both data sets)

	DC	*DD*	*Diff*
a. Species more common in urban walls (>20% difference)			
Lapsana communis	40	9	31
Geum urbanum	44	15	29
Holcus lanatus	41	13	28
Chamerion angustifolium	50	23	27
Arrhenatherum elatius	34	7	27
Fraxinus excelsior	42	15	27
Galium aparine	44	18	26
Epilobium montanum	46	23	23
Rubus fruticosus	43	21	22
Acer pseudoplatanus	25	3	22
Senecio squalidus	25	4	21
Epilobium ciliatum	62	42	20
Buddleia davidii	28	8	20
b. Species more common in urban walls (10–19% difference)			
Cotoneaster horizontalis	37	18	19
Agrostis stolonifera	32	13	19
Phyllitis scolopendrium	31	12	19
Sonchus asper	28	10	18
Sisymbrium officinale	20	3	17
Ranunculus repens	24	7	17
Senecio jacobaea	51	35	16
Plantago lanceolata	22	6	16
Hieracium vulgatum	24	9	15
Taraxacum Section *Ruderalia*	79	67	12
Sambucus nigra	32	20	12
Centranthus ruber	28	16	12
Hedera helix	62	51	11
Dryopteris filix-mas	26	15	11
Sonchus oleraceus	37	28	9
Urtica dioica	53	45	8
Geranium robertianum	31	23	8
Tanacetum parthenium	26	22	4
c. Species more common on rural walls			
Asplenium ruta-muraria	22	62	40
Sedum acre	4	28	24
Cardamine hirsuta	22	45	23
Asplenium trichomanes	16	36	20
Poa annua	24	36	12
Cymbalaria muralis	50	60	10
Dactylis glomerata	20	29	9
Poa compressa	12	20	8
Poa pratensis	18	21	3
Festuca rubra	28	30	2

TABLE 3. CHARACTERISTICS OF RURAL DATA SETS: FLORISTIC SIGNATURES FOR INDIVIDUAL SETTLEMENTS

[numbers of records for species achieving >10% total frequency for T (Total), BC (Barnard Castle), MT (Middleton-in-Teesdale), S (Stanhope), FW (Frosterley and Wolsingham)]

	T	BC	MT	S	FW
Taraxacum Section Ruderalia	80	17	18	20	25
Asplenium ruta-muraria	74	22	12	22	18
Cymbalaria muralis	72	23	18	18	13
Hedera helix	61	20	8	11	22
Cardamine hirsuta	54	15	16	8	15
Urtica dioica	54	11	10	13	20
Epilobium ciliatum	50	16	15	7	12
Poa annua	44	7	17	9	11
Asplenium trichomanes	43	11	13	13	6
Senecio jacobaea	42	16	9	4	13
Senecio vulgaris	40	13	13	8	6
Festuca rubra	36	7	10	10	9
Dactylis glomerata	35	8	8	9	10
Sedum acre	34	3	14	9	8
Sonchus oleraceus	34	10	6	10	8
Epilobium montanum	28	5	13	4	6
Geranium robertianum	28	3	**14**	7	4
Chamerion angustifolium	28	3	8	8	9
Tanacetum parthenium	26	8	3	5	**10**
Poa pratensis	25	5	**10**	5	5
Rubus fruticosus	25	9	6	6	4
Poa compressa	24	4	3	9	8
Sambucus nigra	24	7	2	6	9
Alliaria petiolata	23	6	5	2	**10**
Erinus alpinus	23	3	0	**16**	4
Linaria purpurea	23	**10**	3	5	5
Cotoneaster horizontalis	22	1	4	6	**11**
Galium aparine	21	6	4	3	8
Poa nemoralis	21	1	5	**14**	1
Centranthus ruber	19	**8**	2	4	5
Geranium lucidum	19	1	**14**	2	2
Dryopteris filix-mas	18	4	**10**	4	0
Fraxinus excelsior	18	2	4	1	**11**
Geum urbanum	18	5	7	1	5
Agrostis stolonifera	16	4	4	5	3
Arabis caucasica	16	0	1	**7**	**8**
Digitalis purpurea	16	6	6	3	3
Aubretia deltoidea	15	0	3	**7**	**5**
Holcus lanatus	15	3	6	1	5
Ulmus glabra	15	6	4	3	2
Polypodium vulgare	14	2	**9**	2	1
Phyllitis scolopendrium	14	**9**	2	2	1
Arabidopsis thaliana	13	0	**8**	2	3
Cerastium tomentosum	12	1	4	**6**	1
Mycelis muralis	12	2	0	**7**	3

TABLE 4. TYPES OF NATIONAL CHANGE INDICES AND URBAN CHANGE FREQUENCIES FOR SELECT SPECIES

[CI – Change Index from Preston, Pearman & Dines (2002); CF – Change Factor from Braithwaite, Ellis & Pearman (2006); %C – Durham City data 1958–2008]

	CI	CF	%C
a. All 3 measures positive			
Buddleia davidii	+3·73	+70	+22
Agrostis stolonifera	+3·66	+77	+11
Festuca rubra	+2·96	+22	+7
Sonchus asper	+0·78	+28	+14
Phyllitis scolopendrium	+0·45	+33	+25
Tanacetum parthenium	+0·23	+47	+20
Asplenium ruta-muraria	+0·15	+5	+16
Senecio jacobaea	+0·11	+4	+28
b. One national change index negative, urban positive			
Ranunculus repens	+0·55	-51	+3
Arrhenatherum elatius	+0·37	-2	+20
Urtica dioica	+0·28	-27	+32
Dryopteris filix-mas	+0·03	-13	+20
Cymbalaria muralis	-0·10	+10	+36
Sisymbrium officinale	-0·21	+6	+7
Geranium robertianum	-0·41	+13	+17
Sonchus oleraceus	-0·42	+18	+23
Lapsana communis	-0·47	+2	+26
Geum urbanum	-0·53	+11	+30
c. Both national change indices negative, urban positive			
Galium aparine	-0·09	-16	+30
Rubus fruticosus	-0·29	-19	+20
Epilobium montanum	-0·39	-10	+8
Hedera helix	-0·65	-26	+41
Fraxinus excelsior	-0·73	-12	+27
d. One national change index positive, urban negative			
Plantago lanceolata	+1·35	-75	-1
Poa annua	+0·83	-68	-15
Rumex obtusifolius	+0·66	-8	-10
Poa pratensis	+0·60	-28	-5
Acer pseudoplatanus	-0·40	+2	-10
e. All three measures negative			
Chamerion angustifolium	-0·01	-17	-3
Dactylis glomerata	-0·06	-19	-18
Lolium perenne	-0·29	-11	-10
Sambucus nigra	-0·75	-4	-9
Senecio vulgaris	-1·08	-9	-18

Braithwaite, Ellis & Pearman. In spite of these differences in the two categories, some comparisons are possible. Using the change index (CI) of Preston, Pearman & Dines (2002) and the Change Factor (CF) from Braithwaite, Ellis & Pearman (2006), Table 4 categorises the Durham City wall species into five groups: those with positive or negative values (a and e) for all three indices; those with conflicting national indices, positive for urban wall habitats (b); those with negative national values, positive for urban wall habitats (c); and those with conflicting national indices and negative values for urban walls (d). Many interpretations of these data are possible, but the over-riding impression that emerges is the importance of urban wall habitats as refuges for species which have been otherwise viewed as being in decline.

The third aspect of the research concerns the general representativeness of the data at the regional and national scales, the primary indication of which must come from plant sociological considerations. The accepted classification of rock crevice and wall vegetation in western Europe is that published in Rodwell (2000) and Rodwell *et al*., (2000), and it is into the two alliances Centrantho-Parietarion Rivas-Martinez 1960 and Cymbalario-Asplenion Segal 1969 that most chasmophyte wall communities of Great Britain and Ireland may be classified. The city and county data for Durham indicate that stands of the former thermophilous communities are poorly represented and although indicator species such as *Centranthus ruber*, *Parietaria judaica*, *Antirrhinum majus* and *Erysimum cheiranthoides* are generally uncommon, it would seem to be of importance to flag these species as potential indicators of future climatic amelioration. Thus, the data primarily reflect the geographical realm of the Cymbalario-Asplenion. Whilst the combination of *Cymbalaria muralis* with either or both *Asplenium ruta-muraria* and *A. trichomanes* is a sound indication of such communities, combinations which are to be found quite commonly in both urban and rural data sets, it is important to realise that many wall samples do not fall into this typical wall community. Many stands combine species typical of weedy vegetation dominated by phospho-nitrophilous perennials (Galio-Urticetea, e.g. *Galium aparine* and *Urtica dioica*) with disturbance indicators such as *Chamerion angustifolium* (Epilobietea angustifolii) and, falling into the category of 'communities of open habitats', await closer definition. In terms of evidence for the boreal influence and the presence of stands referable to the alliance Cystopteridion fragilis Richard 1972, the presence of *Cystopteris fragilis* alone, or in combination with *Polypodium vulgare* and species of *Asplenium* is also a fringe feature, the type species being found in only ten of the Durham Dales samples, notably in the more humid atmosphere of Middleton-in-Teesdale.

The fourth point concerns the identification of potential climate change indicators as a basis for future monitoring. In addition to the group of Centrantho-Parietarion species and *Cystopteris fragilis* mentioned above, two other species are worthy of interest, namely *Ceterach officinarum* and *Erinus alpinus*. The former was not recorded in either data set, but was formerly known in one site, in Durham City (Graham 1988, Dr M. Smith pers. comm.). It was seen during the present survey in two rural localities in Weardale and one in lower Teesdale and appears to have spread since the publication of the County Flora in 1988. This member of the Submediterranean-Subatlantic element (Preston & Hill 1997) is presently known in only five tetrads, but may be following the trend noted by Rumsey (2002) of benefiting from the built environment in its spread in eastern England. According to *The Flora of North-east England* (2009), *Erinus alpinus* is only known in two tetrads post-2000. The present survey, however, added a further two tetrads to the east in Weardale and the first record for Teesdale at Barnard Castle. Being a plant of Subatlantic-Montane distribution, its liking for the cooler climates of northern England and Scotland was noted by Ellis (1993), whilst Horsfall (2002) records a change index of +1·52. It is a chasmophyte which is capable of colonizing the smallest of mortared cracks in walls wherein the small seeds germinate freely. It has a strong association with both *Asplenium ruta-muraria* and *Cymbalaria muralis* and the stands of wall vegetation in which it is dominant may be viewed as a humid, northern variant of the widespread OV42 community. The basic question to be posed in this context is whether changes in the distribution of representative species from these and other geographical elements, involving their spread into urban wall habitats, is a reliable reflection of a reaction to general climate change, or whether spread is encouraged by the peculiar microclimatic characteristics of the built environment?

ACKNOWLEDGMENTS

I am grateful to the Reverend Gordon and Mrs Paddy Graham for stimulating discussions in the early stages of the project and for advice on the incorporation of records for the genera *Rosa* and *Rubus*; to Dr John Richards for encouragement and advice on the genus *Taraxacum*; to Dr Margaret Bradshaw and the Upper Teesdale Botany Group for supplemental data from Barnard Castle; and to Dr Malcolm Smith for information on the changing fern flora of Durham in the past twenty-five years. The fieldwork for the urban section of the project was made possible by the requirement of Rosemary, Meredith and Joseph to attend the University of Durham Nursery on three days a week for the first two years of the project.

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(*Accepted May 2009*)

APPENDIX 1. FLORA OF DURHAM CITY WALLS, 1959–2008

[regular – recorded in both the 1959 and 2006–2008 surveys; *italic* – recorded in the 1959 survey but not noted as a chasmophyte in the 2006-2008 survey; ***bold/italic*** – not recorded in the 1959 survey but recorded as a chasmophyte in 2008; * nomenclature changes 1959–2008]

001 Acer plat	002 Acer pseu	003 Achi mill	***004 Aego poda***	005 Aeth cyna	006 Agro capi*
007 Agro stol	***008 Alch moll***	009 Alli peti	***010 Alli ursi***	011 Alnu glut	*012 Alop prat*
013 Alys saxa	***014 Ange sylv***	015 Anis ster*	016 Anth odor	017 Anth sylv	018 Anti maju
019 Aqui vulg	***020 Arab thal***	021 Arct minu	022 Arrh elat	023 Arte vulg	*024 Aste lanc*
025 Aste novi	***026 Athy fili***	*027 Atri patu*	***028 Aspl adia***	029 Aspl ruta	030 Aspl tric
031 Ball nigr	032 Bell pere	033 Betu pube	***034 Brac sylv***	035 Brom ramo*	036 Brom hord
037 Budd davi	*038 Cale offi*	***039 Caly sepi***	040 Caly silv	***041 Camp patu***	***042 Camp port***
043 Camp rapu	044 Camp rotu	045 Caps burs	***046 Card flex***	***047 Card hirs***	***048 Care pend***
049 Care remo	***050 Cata rigi***	051 Cent nigr	***052 Cent rube***	053 Cera font*	***054 Cera glom***
055 Cera tome	***057 Chae temu***	056 Cham angu*	***058 Chel maju***	***059 Clem vita***	060 Cirs arve
061 Cirs vulg	*062 Conv arve*	063 Cory avel	064 Coto frig	***065 Coto hori***	***066 Coto spec***
067 Coto sple	068 Crat mono	***069 Cruc laev***	070 Cymb mura	071 Cyno cris	072 Cyst scop*
073 Dact glom	***074 Dauc caro***	*075 Desc cesp*	*076 Desc flex*	*077 Dian cary*	078 Digi purp
079 Dips full	080 Dryo fili	***081 Elym cani***	082 Elyt repe*	***083 Epil cili***	084 Epil hirs
085 Epil mont	*086 Epil parv*	087 Equi arve	088 Erys chei*	***089 Euph amyg***	***090 Euph heli***
091 Euph pepl	***092 Fagu sylv***	093 Fall bald*	*094 Fall conv**	095 Fall japo*	096 Fest ovin
097 Fest prat	098 Fest rubr	*099 Ficu cari*	***100 Fili ulma***	***101 Foen vulg***	102 Frag vesc
*103 Frag xana**	104 Frax exce	105 Gali apar	***106 Gali palu***	*107 Gali saxa*	*108 Geni radi*
109 Gera luci	110 Gera robe	111 Geum urba	*112 Glec hede*	***113 Hebe xlew***	114 Hede heli
115 Hera mant	116 Hera spho	***117 Hesp matr***	118 Hier saba*	***119 Hier vulg***	***120 Holc lana***
121 Holc moll	122 Hord muri	***123 Hype andr***	***124 Hype caly***	125 Hype perf	126 Hypo radi
127 Iber semp	128 Ilex aqui	129 Impa glan	*130 Iris germ*	131 Labu anag	132 Lami albu
133 Lami purp	134 Laps comm.	*135 Lath odor*	136 Leon autu	137 Leon hisp	***138 Leyc form***
139 Ligu vulg	***140 Lina purp***	141 Loli mult	142 Loli pere	***143 Loni peri***	*144 Lupi noot*
145 Lyci barb	***146 Lyco euro***	***147 Lysi vulg***	***148 Maho aqui***	***149 Malv sylv***	*150 Matr disc*
151 Meco camb	***152 Medi lupu***	***153 Meli offi***	154 Ment aqua	155 Ment spic	*156 Merc pere*
157 Mili effu	***158 Myce mura***	***159 Myos sylv***	160 Myrr odor	***161 Oena croc***	***162 Oxal corn***
163 Papa rhoe	***164 Papa somn***	***165 Pari juda***	166 Pent semp	167 Peta hybr	168 Phal arun
169 Phyl scol	170 Pilo aura	171 Pilo offi*	*172 Pisu sati*	173 Plan lanc	174 Plan majo
175 Plan medi	176 Poa annu	177 Poa comp	***178 Poa nemo***	179 Poa prat	***180 Poa triv***
181 Poly avic	***182 Poly seti***	*183 Pote anse*	***184 Prun vulg***	***185 Prun aviu***	*186 Prun padu*
187 Prun spin	***188 Pseu lute***	189 Pter aqui	190 Quer petr	191 Ranu acri	192 Ranu repe
193 Rese lute	***194 Rhod pont***	195 Ribe rubr	196 Ribe uvac	197 Rosa cani*	198 Rubu frut
199 Rubu idae	200 Rume acet	*201 Rume acel*	***202 Rume cris***	203 Rume long	204 Rume obtu
205 Rume sang	206 Sagi apet	***207 Sagi proc***	208 Sali capr	209 Sali cine*	210 Sali vimi
211 Samb nigr	*212 Saxi xumb**	213 Sedu acre	214 Sedu albu	***215 Sedu refl***	216 Semp tect
217 Sene cine	218 Sene jaco	***219 Sene squa***	220 Sene visc	221 Sene vulg	222 Sile vulg
223 Sina arve	224 Sisy offi	***225 Sola dulc***	226 Soli cana*	227 Sonc aspe	228 Sonc oler
229 Sorb aucu	230 Sorb inter	231 Stac sylv	232 Stel holo	233 Stel medi	*234 Stel nemo*
235 Symp albu	*236 Symp offi*	237 Tana part*	***238 Tana vulg***	239 Tara rude	240 Taxu bacc
241Trag prat	***242 Trif dubi***	*243 Trif prat*	244 Trif repe	*245 Trip inod**	246 Tuss farf
247 Ulmu glabr	248 Urti dioi	*249 Urti uren*	250 Vale offi	251 Verb thap	***252 Verb virg***
253 Vero arve	254 Vero cham	***255 Vero serp***	***256 Vici crac***	***257 Vici hirs***	***258 Vici sati***
259 Vici sepi	*260 Vinc mino*				

APPENDIX 2. RECORDS OF SPECIES OCCURRING IN LESS THAN 20% (14) SAMPLES IN DURHAM CITY

(*Species only recorded in 2006–2008 denoted in **bold italic***)

No. Species

13 *Epilobium hirsutum (1)*

12 *Alliaria petiolata, Poa pratensis, Rosa canina, Ulmus glabra (4)*

11 *Artemisia vulgaris, Asplenium trichomanes, Plantago major (3)*

10 *Betula pubescens, Heracleum sphondylium, Stellaria media (3)*

9 *Cirsium vulgare, Lolium perenne, Rumex obtusifolius (3)*

8 *Anisantha sterilis, Digitalis purpurea, **Linaria purpurea**, **Meconopsis cambrica**, Poa compressa (5)*

7 *Alnus glutinosa, Anthriscus sylvestris, Capsella bursa-pastoris, **Cardamine flexuosa**, Cotoneaster spp, Elymus caninus, Festuca ovina, Myosotis sylvatica, Poa trivialis, **Sagina procumbens**, Taxus baccata, Trifolium repens (12)*

6 *Antirrhinum majus, Cirsium arvense, Hypocharis radicata, Impatiens glandulifera, **Prunus avium**, Senecio vulgaris, Stachys sylvatica. (7)*

5 *Achillea millefolium, **Arabidopsis thaliana**, Crataegus monogyna, Hieracium sabaudum, **Hypericum androsaemum**, **Ilex aquifolium**, Papaver rhoeas, Phalaris arundinacea, **Rumex sanguineus**, Veronica arvensis. (10)*

4 ***Aegopodium podagraria**, **Athyrium filix-femina**, **Brachypodium sylvaticum**, **Chaerophyllum temulentum**, **Euphorbia peplus**, **Fagus sylvatica**, Festuca pratensis, **Filipendula ulmaria**, Rumex longifolius. (9)*

3 *Ballota nigra, **Calystegia sepium**, Cerastium fontanum, Elytrigia repens, Equisetum arvense, Fragaria vesca, **Hebe × lewisii**, Lamium album, **Oenanthe crocata**, **Parietaria judaica**, **Poa nemoralis**, **Pseudofumaria lutea**, **Rhododendron ponticum**, Salix capraea, Sedum acre, **Solanum dulcamara**, **Trifolium dubium**, Verbascum thapsus, Veronica chamaedrys. (19)*

2 *Aethusa cynapium, Agrostis capillaris, Arctium minus, **Asplenium adiantum-nigrum**, Calystegia silvatica, **Campanula patula**, **Campanula rapunculus**, **Carex pendula**, **Cotoneaster splendens**, Dipsacus fullonum, Fallopia japonica, **Hesperis matronalis**, Holcus mollis, Hypericum perforatum, Laburnum anagyroides, Lamium purpureum, Lolium multiflorum, **Malva sylvestris**, **Mycelis muralis**, **Oxalis corniculata**, **Papaver somniferum**, Pentaglottis sempervirens, **Polygonum aviculare**, Ranunculus acris, Reseda luteola, Ribes uva-crispa, Sagina apetala, Sedum album, Senecio viscosus, Sorbus aucuparia, Sorbus intermedia, **Tanacetum vulgare**, **Vicia cracca**, **Vicia hirsuta**. (34)*

1 ***Acer platanoides**, **Alchemilla mollis**, **Allium ursinum**, **Alyssum saxatile**, **Angelica sylvestris**, Anthoxanthum odoratum, Aquilegia vulgaris, Aster novi-belgi, Bellis perennis, Bromopsis ramosa, Bromus hordaceus, **Campanula portenschlagiana**, Campanula rotundifolia, **Carex remota**, **Catapodium rigidum**, Centaurea nigra, **Cerastium glomeratum**, Cerastium tomentosum, **Chelidonium majus**, **Clematis vitalba**, Corylus avellana, Cotoneaster frigida, **Cruciata laevipes**, Cynosurus cristatus, Cystisus scoparius, **Daucus carota**, Erysimum cheiranthoides, **Euphorbia amygdaloides**, **Euphorbia helioscopia**, Fallopia baldschuanica, **Foeniculum vulgare**, **Galium palustre**, Geranium lucidum, Hordeum murinum, **Hypericum calycinum, Iberis sempervirens**, Leontodon autumnalis, Leontodon hispidus, **Leycesteria formosa**, Ligustrum vulgare, **Lonicera periclymenum**, Lycium barbarum, **Lycopus europaeus**, **Lysimachia vulgaris**, **Mahonia aquifolium**, **Medicago lupulina**, **Melissa officinalis**, Mentha aquatica, Mentha spicata, Milium effusum, Myrrhis odorata, Petasites hybridus, Pilosella aurantiaca, Pilosella officinarum, **Polystichum setiferum**, **Prunella vulgaris**, **Prunus spinosa**, Quercus robur, **Ribes rubrum**, Rumex acetosa, **Rumex crispus**, Salix cinerea, Salix viminalis, **Sedum reflexum**, Sempervivum tectorum, **Senecio cinerea**, Silene vulgaris, Solidago canadensis, Stellaria holostea, **Symphoricarpos albus**, **Tragopogon pratensis**, Tussilago farfara, Valeriana officinalis, **Verbascum virgatum**, **Veronica serpyllifolia**, **Vicia sativa**. (75)*

APPENDIX 3. SUMMARY OF MONAD DISTRIBUTION OF SAMPLE SITES

1 km grid square reference (number of samples); full details are available on request

DURHAM CITY

NZ2642 (12); NZ2643 (2); NZ2741 (8); NZ2742 (29); NZ2743 (1); NZ2841 (1); NZ2842 (7); NZ2843 (2); NZ2940 (2); NZ2946 (1)

DURHAM DALES

Barnard Castle: NZ0416 (15); NZ0516 (15); ***Middleton-in-Teesdale***: NY9425 (23); NY9426 (2); NY9525 (5).

Stanhope: NY9940 (5); NZ9839 (3); NZ9939 (22); ***Frosterley & Wolsingham***: NZ0236 (12); NZ0336 (2); NZ0736 (2); NZ0737 (12); NZ0837 (2)

APPENDIX 4. FLORA OF DURHAM DALES WALLS, 2006–2008

(***bold/italic*** – flora of Durham Dales walls; *italic* – flora of Durham City walls 1958–2008)

001 Acer plat	***002 Acer pseu***	***003 Achi mill***	*004 Aego poda*	*005 Aeth cyna*	***006 Agro capi****
007 Agro stol	***008 Alch moll***	***009 Alli peti***	*010 Alli ursi*	*011 Alnu glut*	*012 Alop prat*
013 Alys saxa	*014 Ange sylv*	***015 Anis ster****	***016 Anth odor***	***017 Anth sylv***	***018 Anti maju***
019 Aqui vulg	***020 Arab thal***	*021 Arct minu*	***022 Arrh elat***	*023 Arte vulg*	*024 Aste lanc*
025 Aste novi	***026 Athy fili***	*027 Atri patu*	***028 Aspl adia***	***029 Aspl ruta***	***030 Aspl tric***
031 Ball nigr	*032 Bell pere*	***033 Betu pube***	*034 Brac sylv*	***035 Brom ramo****	***036 Brom hord***
037 Budd davi	*038 Cale offi*	*039 Caly sepi*	***040 Caly silv***	*041 Camp patu*	***042 Camp port***
043 Camp rapu	*044 Camp rotu*	***045 Caps burs***	***046 Card flex***	***047 Card hirs***	*048 Care pend*
049 Care remo	***050 Cata rigi***	***051 Cent nigr***	***052 Cent rube***	***053 Cera font****	***054 Cera glom***
055 Cera tome	*057 Chae temu*	*056 Cham angu**	*058 Chel maju*	*059 Clem vita*	*060 Cirs arve*
061 Cirs vulg	*062 Conv arve*	*063 Cory avel*	*064 Coto frig*	***065 Coto hori***	***066 Coto spec***
067 Coto sple	***068 Crat mono***	*069 Cruc laev*	***070 Cymb mura***	*071 Cyno cris*	*072 Cyst scop**
073 Dact glom	*074 Dauc caro*	*075 Desc cesp*	*076 Desc flex*	*077 Dian cary*	***078 Digi purp***
079 Dips full	***080 Dryo fili***	***081 Elym cani***	***082 Elyt repe****	***083 Epil cili***	*084 Epil hirs*
085 Epil mont	*086 Epil parv*	***087 Equi arve***	***088 Erys chei****	***089 Euph amyg***	*090 Euph heli*
091 Euph pepl	***092 Fagu sylv***	*093 Fall bald**	*094 Fall conv**	*095 Fall japo**	*096 Fest ovin*
097 Fest prat	***098 Fest rubr***	*099 Ficu cari*	*100 Fili ulma*	*101 Foen vulg*	***102 Frag vesc***
*103 Frag xana**	***104 Frax exce***	***105 Gali apar***	*106 Gali palu*	*107 Gali saxa*	*108 Geni radi*
109 Gera luci	***110 Gera robe***	***111 Geum urba***	*112 Glec hede*	*113 Hebe xlew*	***114 Hede heli***
115 Hera mant	*116 Hera spho*	*117 Hesp matr*	*118 Hier saba**	***119 Hier vulg***	***120 Holc lana***
121 Holc moll	*122 Hord muri*	*123 Hype andr*	*124 Hype caly*	*125 Hype perf*	*126 Hypo radi*
127 Iber semp	***128 Ilex aqui***	*129 Impa glan*	*130 Iris germ*	***131 Labu anag***	***132 Lami albu***
133 Lami purp	***134 Laps comm***	*135 Lath odor*	*136 Leon autu*	*137 Leon hisp*	***138 Leyc form***
139 Ligu vulg	***140 Lina purp***	*141 Loli mult*	***142 Loli pere***	*143 Loni peri*	*144 Lupi noot*
145 Lyci barb	*146 Lyco euro*	*147 Lysi vulg*	*148 Maho aqui*	***149 Malv sylv***	*150 Matr disc*
151 Meco camb	***152 Medi lupu***	*153 Meli offi*	*154 Ment aqua*	*155 Ment spic*	*156 Merc pere*
157 Mili effu	***158 Myce mura***	***159 Myos sylv***	***160 Myrr odor***	*161 Oena croc*	*162 Oxal corn*
163 Papa rhoe	*164 Papa somn*	***165 Pari juda***	*166 Pent semp*	*167 Peta hybr*	*168 Phal arun*
169 Phyl scol	***170 Pilo aura***	***171 Pilo offi****	*172 Pisu sati*	***173 Plan lanc***	***174 Plan majo***
175 Plan medi	***176 Poa annu***	***177 Poa comp***	***178 Poa nemo***	***179 Poa prat***	*180 Poa triv*
181 Poly avic	*182 Poly seti*	*183 Pote anse*	***184 Prun vulg***	***185 Prun aviu***	*186 Prun padu*
187 Prun spin	***188 Pseu lute***	*189 Pter aqui*	*190 Quer petr*	*191 Ranu acri*	***192 Ranu repe***
193 Rese lute	*194 Rhod pont*	*195 Ribe rubr*	***196 Ribe uvac***	***197 Rosa cani****	***198 Rubu frut***
199 Rubu idae	***200 Rume acet***	*201 Rume acel*	*202 Rume cris*	*203 Rume long*	***204 Rume obtu***
205 Rume sang	***206 Sagi apet***	***207 Sagi proc***	***208 Sali capr***	*209 Sali cine**	*210 Sali vimi*
211 Samb nigr	*212 Saxi xumb**	***213 Sedu acre***	***214 Sedu albu***	*215 Sedu refl*	***216 Semp tect***
217 Sene cine	***218 Sene jaco***	***219 Sene squa***	***220 Sene visc***	***221 Sene vulg***	*222 Sile vulg*
223 Sina arve	***224 Sisy offi***	*225 Sola dulc*	*226 Soli cana**	***227 Sonc aspe***	***228 Sonc oler***
229 Sorb aucu	*230 Sorb inter*	***231 Stac sylv***	*232 Stel holo*	***233 Stel medi***	*234 Stel nemo*
235 Symp albu	*236 Symp offi*	***237 Tana part****	*238 Tana vulg*	***239 Tara rude***	***240 Taxu bacc***
241Trag prat	***242 Trif dubi***	***243 Trif prat***	***244 Trif repe***	*245 Trip inod**	*246 Tuss farf*
247 Ulmu glabr	***248 Urti dioi***	*249 Urti uren*	*250 Vale offi*	***251 Verb thap***	*252 Verb virg*
253 Vero arve	***254 Vero cham***	***255 Vero serp***	*256 Vici crac*	*257 Vici hirs*	*258 Vici sati*
259 Vici sepi	*260 Vinc mino*	***135 in common***			

Species recorded on Durham Dales walls and not in Durham City

001 Alli oler	002 Arab cauc	003 Arab hirs	004 Aren serp	005 Aubr delt	006 Camp pers
007 Coni macu	008 Crep capi	009 Cyst frag	010 Erig karv	011 Erin alpi	012 Erop vern
013 Euph esul	014 Leuc vulg	015 Orig vulg	016 Poly vulg	017 Pote ster	018 Ranu bulb
019 Ribe nigr	020Ribe sang	021 Sedu spur	022 Sher arve	023 Sile dioi	024 Symp orie
025 Syri vulg	026 Vero hede	027 Vinc majo			

APPENDIX 5. RECORDS OF SPECIES OCCURRING IN LESS THAN 10% (12) SAMPLES IN THE DURHAM DALES

No	Species
11	*Cotoneaster* sp., *Rosa canina, Sedum album*
10	*Cystopteris fragilis, Meconopsis cambrica, Pseudofumaria lutea, Ribes uva-crispa, Taxus baccata*
9	*Hieracium vulgatum, Veronica arvensis*
8	*Ranunculus repens*
7	*Myosotis sylvatica, Plantago lanceolata*
6	*Anthriscus sylvestris, Capsella bursa-pastoris, Leucanthemum vulgare, Sempervivum tectorum*
5	*Antirrhinum majus, Cerastium fontanum, Cirsium vulgare, Crataegus monogyna, Erophila verna, Euphorbia peplus, Parietaria judaica, Ribes sanguineum, Sagina procumbens*
4	*Achillea millefolium, Arenaria serpyllifolia, Erysimum cheiranthoides, Sagina apetala, Sedum spurium, Stellaria media, Symphoricarpos albus*
3	*Agrostis capillaris, Alchemilla mollis, Anisantha sterilis, Cardamine flexuosa, Elytrigia repens, Euphorbia esula, Lolium perenne, Medicago lupulina, Pilosella aurantiaca, Plantago major, Rubus idaeus, Rumexs obtusifolius, Senecio viscosus, Trifolium repens, Veronica hederifolia*
2	*Alyssum saxatile, Aquilegia vulgaris, Asplenium adiantum-nigrum, Betula pubescens, Bromus hordaceus, Calystegia sivatica, Campanula persicifolia, Campanula portenschlagiana, Conium maculatum, Crepis capillaris, Centaurea nigra, Fragaria vesca, Lamium album, Poa angustifolia, Prunella vulgaris, Ribes nigrum, Rumex acetosa, Salix capraea, Sorbus aucuparia, Symphytum orientale, Syringa vulgaris, Verbascum thapsus, Veronica chamaedrys, Veronica serpyllifolia, Vinca major*
1	*Allium oleraceum, Anthoxanthum odoratum, Arabis hirsuta, Asplenium adiantum-nigrum, Athyrium filix-femina, Bromopsis ramosa, Catapodium rigidum, Cerastium glomeratum, Chaerophyllum temulentum, Cirsium arvense, Dipsacus fullonum, Elytrigia canina, Equisetum arvense, Erigeron karvinskianus, Euphorbia amygdaloides, Fagus sylvatica, Ilex aquifolium, Laburnum anagyroides, Leycesteria formosa, Lonicera periclymenum, Malva sylvestris, Myrrhis odorata, Origanum vulgare, Papaver rhoeas, Pilosella officinarum, Potentilla sterilis, Prunus avium, Prunus laurocerasus, Prunus spinosa, Ranunculus bulbosus, Reseda luteola, Sherardia arvensis, Silene dioica, Stachys sylvatica, Stellaria graminea, Trifolium dubium, Trifolium pratense, Vicia sepium*