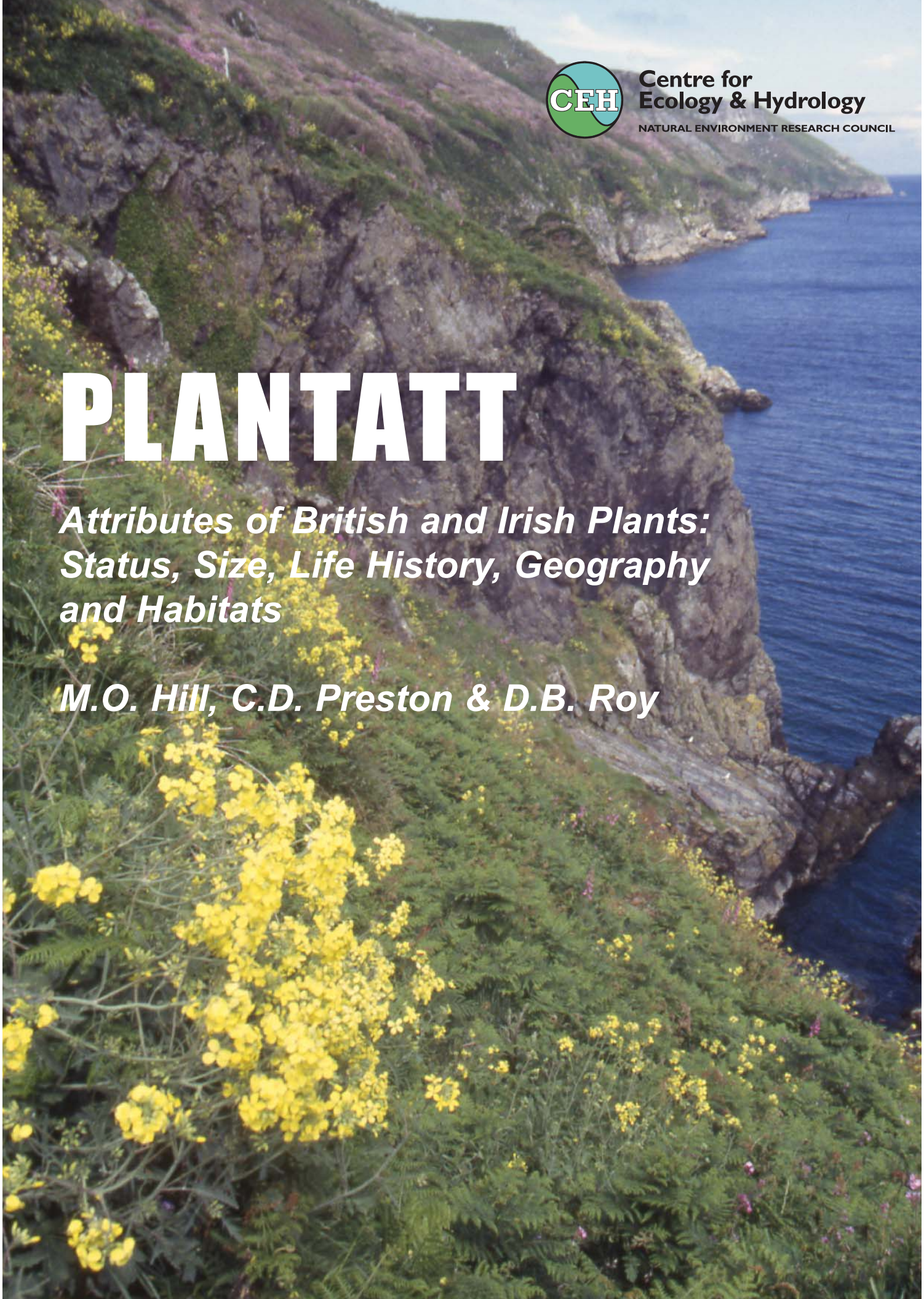

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PLANTATT

Attributes of British and Irish Plants: Status, Size, Life History, Geography and Habitats

M.O. Hill, C.D. Preston & D.B. Roy

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Attributes of British and Irish Plants: Status, Size, Life History, Geography and Habitats

for use in connection with the
New atlas of the British and Irish flora

M. O. Hill, C. D. Preston & D. B. Roy
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Cover photograph shows the endemic plant Coincya wrightii *on the cliffs of Lundy (courtesy of Roger Key, English Nature).*

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INTRODUCTION

In the course of our research on geographical distributions and climate change, we have frequently wanted to characterize the plants that constitute the wild flora of Britain and Ireland. Several sources of information were available, including the *Electronic Comparative Plant Ecology* (Hodgson *et al*., 1994), the Czech clonal plant database *Clopla1 (http://www.butbn.cas.cz/klimes/clopla1.htm)*, the BSBI database *(http://www.bsbi.org.uk/html/database.html),* the *Ecoflora* database (Fitter & Peat, 1994), and the indicator values of *Ellenberg* (Ellenberg *et al*., 1991). Inevitably, these sources were not sufficient for our purposes, and we have gradually assembled our own set of attribute data, linked to the database of the Biological Records Centre (BRC).

The establishment of the National Biodiversity Network (NBN) provided an additional stimulus to the assembling of attribute data, offering a suitable platform for online searches for species attributes. Some of the information published here is also available from the NBN gateway *(www.searchnbn.net)*. In 2002, the publication of the *New Atlas of the British and Irish Flora* (Preston, Pearman & Dines, 2002), together with results of a companion project to analyse change (Preston, Telfer *et al*., 2002), allowed us to complete the dataset that is presented here.

The dataset is partly old and partly new (Table 1). Biogeographic elements and Ellenberg values are taken with few modifications from earlier publications (Preston & Hill, 1997, 1999; Hill *et al*., 1999). Information that depends directly on the *New Atlas* is either new or (Change Index) is taken from the text of the *New Atlas*. Data on the Broad Habitats of plants are mostly drawn from an unpublished report (Preston *et al*., 2003). Information on plant height, perennation, life form and clonal growth was assembled from a variety of floras and monographs, with some personal observation; it is a new compilation. Further details of these attributes are provided in the following pages. The attribute categories are tabulated (Tables 2-13), with the numbe of taxa in each category listed in the column 'N='.

Table 1. Attributes, codes and names listed as columns in PLANTATT

Column name	Abbre-viation	Source or other comment
(a) Status and taxonomic		
Taxon name		Name in current flora (Stace, 1997)
Family	Fam	Stace (1997)
Native status	NS	*New Atlas* (Preston *et al*., 2002)
Conservation status	CS	Cheffings (2004)
Rarity status	RS	Calculated from *New Atlas* data
Change Index	Chg	*New Atlas* (Preston *et al*., 2002)
(b) Size and life form		
Height (terrestrial)	Hght	Several sources, listed below
Length (aquatic)	Len	Several sources, listed below
Perennation	P1, P2	Mainly Clapham, Tutin & Warburg (1962)
Life form	LF1, LF2	Clapham *et al*. (1962), heavily revised
Woodiness	W	Mainly Clapham *et al*. (1962)
Clonal spread	Clone1, Clone2	Sources are listed below; clone2 is mainly blank
(c) Geography & climate		
Major Biome (European distribution)	E1	Part of biogeographic element according to Preston & Hill (1997)
Eastern limit code	E2	Part of biogeographic element according to Preston & Hill (1997)
Continentality in Europe	C	Preston & Hill (1997) plus additions
Origin of alien taxa	Origin	*New Atlas* (Preston *et al*., 2002)
Number of 10-km squares in Britain (including Isle of Man)	GB	*New Atlas* (Preston *et al*., 2002)
Number of 10-km squares in Ireland	IR	*New Atlas* (Preston *et al*., 2002)
Number of 10-km squares in Channel Islands	CI	*New Atlas* (Preston *et al*., 2002)
January mean temperature	Tjan	Calculated from *New Atlas* plus climatic data
July mean temperature	Tjul	Calculated from *New Atlas* plus climatic data
Annual precipitation	Prec	Calculated from *New Atlas* plus climatic data
(d) Habitat		
Coastal	Co	Calculated from *New Atlas* plus Ellenberg salt value
Broad Habitats	Br Habitats	Preston *et al*. (2003), plus previously unreported data for aliens
Ellenberg indicator value	L, F, R, N, S	Hill *et al*. (1999)

SPECIES, FAMILIES, STATUS AND CHANGE

Species and families

The list of 1885 taxa includes all native British and Irish species, as well as natives of the Channel Islands not known from Britain or Ireland. There are no species restricted to the Isle of Man. All archaeophyte species are included, plus a number of well-established neophytes. A small number of subspecies, hybrids and aggregate species are also included. The number of taxa has been slightly increased from the 1791 that were listed for Ellenberg indicator values (Hill *et al*., 1999). Most of the additions are of neophytes, which, following the *New Atlas* (Preston *et al*., 2002), we now think to be sufficiently common or potentially interesting to be included.

The names of families have been abbreviated to four letters and follow Stace (1997).

Native/alien status

Species of uncertain status are classified as 'native or alien'. Introduced species have been classified as *archaeophytes, neophytes* and *casuals* (Preston *et al*., 2002). Both archaeophytes and neophytes are introduced species which are present in the wild as naturalized populations, that is they are spreading vegetatively or reproducing effectively by seed. An archaeophyte is a plant that became naturalized before AD 1500. A neophyte is one that was first introduced after 1500, or was only present as a casual before 1500 and is naturalized now only because it was reintroduced subsequently. In contrast to archaeophytes and neophytes, a casual is a plant that is present only as populations which fail to persist in the wild for periods of more than approximately five years. Such a species is dependent on constant reintroduction (Macpherson *et al*., 1996).

Hybrids between two alien parents which were introduced to the wild as hybrids (e.g. *Crocosmia* x *crocosmiiflora, Euphorbia* x *pseudovirgata*) are classified as neophytes. Only hybrids between which have been formed spontaneously in the wild between two alien parents are classified as 'AX'.

Conservation status

The conservation status of plants is coded according to the system proposed by Hodgetts, Palmer & Wigginton (1996); see also Palmer *et al*. (1997). This status is an assessment of threat rather than rarity, although closely related to rarity in that only species known at the time of the assessment in less than 101 10-km squares have been allocated to one of the categories listed. The status listed is that given by Cheffings (2004). This replaces the statuses provided in the *Red Data Book* (Wigginton, 1999) and *Scarce plants in Britain* (Stewart, Pearman & Preston, 1994). Cheffings assigns a conservation status to native species and archaeophytes, with only a few exceptions. PLANTATT cannot be used to provide a complete list of threatened taxa as many subspecies listed by Cheffings are not treated separately by us.

Rarity status

Rarity status is based on counts of the number of 10-km squares in Britain and the Isle of Man in which the plant was recorded as a native in the period 1987-1999. Rare plants are those recorded in 1-15 10-km squares during this period; scarce plants are recorded in 16-100. The thresholds were those that were used in defining rare and scarce species for the *Red Data Book* and *Scarce plants*. Rarity status, however, is solely a measure of rarity rather than threat, and is based on data from the *New Atlas*. Cheffings assigns a conservation status to native species and archaeophytes, with only a few exceptions. PLANTATT cannot be used to provide a complete list of threatened taxa as many subspecies listed by Cheffings are not treated separately by us.

Alien species have by definition no native records, and therefore are not given a rarity status.

Table 2. Native status, Conservation status and Rarity status

Attribute and codes	N=	Explanation
(a) Native status		
AC	12	Alien casual; many are crop plants
AN	259	Neophyte, alien introduced after 1500
AR	151	Archaeophyte, alien introduced before 1500
AX	1	Spontaneous hybrid between two alien parents
N	1362	Native, not endemic
NA	46	Native or alien (native status doubtful)
NE	47	Native endemic
NH	7	Spontaneous hybrid between two native parents
(b) Conservation status		
CR	20	Critically endangered
DD	1	Data deficient
EN	34	Endangered
EW	4	Extinct in the wild
EX	10	Extinct
VU	119	Vulnerable
(c) Rarity status		
n	933	Present, not rare or scarce
r	234	Rare (1-15 10-km squares in Britain, 1987-1999)
s	254	Scarce (16-100 10-km squares in Britain, 1987-1999)
o	27	Absent from Britain and Isle of Man as a native, but native in Ireland or the Channel Islands
x	12	Apparently extinct (not recorded since 1986)
i	2	Insufficient data available to assess rarity
(blank)	423	Alien taxa
(d) Change Index		
(values)		Change between 1930-1960 and 1987-1999

Change Index

The Change Index (Telfer *et al*., 2002) measures the relative magnitude of change, comparing the period 1930-1960 with 1987-1999. It is explained in more detail in the Appendix. It ranges from -4.78 for the critically endangered *Galium tricornutum* to 4.70 for the much more frequently recorded *Prunus laurocerasus*. The Change Index has not been calculated for species not included in the first *Atlas of the British Flora* (Perring & Walters, 1962). Consequently, several aliens such as *Amsinckia micrantha* and *Crassula helmsii*, which have increased spectacularly in the intervening period, lack a value for the Change Index.

SIZE AND LIFE HISTORY ATTRIBUTES

Height and length

Heights, measured in centimetres, are given for terrestrial (or emergent) plants and lengths (cm) for submerged aquatic plants. A few amphibious or emergent plants such as *Persicaria amphibia* are scored for both height and length.

These values are intended as a general indication of the size of the plant. For procumbent plants, heights are an indication of the height of the less procumbent shoots. For scapose plants and ferns, heights are not stem lengths but leaf lengths. Likewise, lengths for isoetids (i.e. linear-leaved rosette-forming rooted aquatics) are in fact leaf lengths. For example *Lobelia dortmanna* has length 4 cm, which is certainly not the length of the scape.

Height and length values were drawn from a variety of sources, which are detailed in the Appendix.

Perennation

The categories are annual, biennial and perennial. Biennial is used as a shorthand to denote also monocarpic perennials. For example *Carlina vulgaris* and *Heracleum mantegazzianum* normally take several years to reach maturity but are categorized as biennials. The sources of data for perennation are mostly the same as those used for height and length. In a few cases (e.g. *Linum catharticum)*, we have relied on personal communication and scientific papers rather than floras.

A relatively small number of species fall into more than one of these categories. The secondary category is intended to be either less frequent or equally frequent. Thus *Poa annua* has primary perennation category P1=annual and secondary category P2 = perennial. Several floras suggest that *Cardamine flexuosa* and *Montia fontana* can be annual, biennial or perennial. These have been coded as P1 = **p**, P2 = **a** and P1 = **a**, P2 = **p** respectively.

Life form

The Raunkiaer system of life forms was set out by Clapham, Tutin & Warburg (1962), who listed life forms for most species. Their assignments provide an excellent starting point but contain numerous inconsistencies. Life forms have been fully revised for PLANTATT. Following German and Swiss authors (e.g. Lindacher, 1995), the category of helophytes or marsh plants has been omitted. The majority of these can grow in places that are not permanently flooded in winter. The position of the overwintering buds in such situations is taken as a guide to their life form. An additional life form of annual water plants has been added, so that the category therophytes are all terrestrial.

As with perennation, a secondary life form is given for some species. Details of how life forms were assigned and the relation of life form to plant height are given in the Appendix.

Woodiness

Woodiness is an attribute that applies to some chamaephytes, nanophanerophytes and phanerophytes. All other life forms are treated as herbaceous. Three categories are recognized, woody, semi-woody and herbaceous. Although we have been guided in part by Clapham, Tutin & Warburg (1962), we have not hesitated to express our own opinions where these differ.

Table 3. Size and life history attributes other than clonality; counts of primary attributes are in the column N1=, counts of secondary attributes are in N2=

Attribute or code	N1=	N2=	Explanation
(a) Height (cm)	*Hght*		Height (leaf length for scapose plants and ferns)
(b) Length (cm)	*Len*		Length (aquatic plants; leaf length for isoetids)
(c) Perennation	*P1*	*P2*	*Primary and secondary type of perennation*
a	455	14	Annual
b	96	14	Biennial, including monocarpic perennials
p	1334	42	Perennial
(d) Life form	*LF1*	*LF2*	*Primary and secondary life form (see Table A1)*
Ch	148	24	Chamaephyte
Gb	32		Bulbous geophyte
Gn	134	11	Non-bulbous geophyte (rhizome, corm or tuber)
hc	811	50	Hemicryptophyte
Hy	124	34	Perennial hydrophyte (perennial water plant)
Hz	25	1	Annual hydrophyte (aquatic therophyte)
Ph	108	15	Mega-, meso- and microphanerophyte
Pn	73	21	Nanophanerophyte
Th	430	14	Therophyte (annual land plant)
(e) Woodiness	*W*		
h	1651		Herbaceous
sw	27		Semi-woody
w	207		Woody

Clonality

Clonal growth is defined here as vegetative reproduction combined with lateral spread. Like perennation, clonality may have more than one value for a given species, reflecting the various ways in which clonal growth may occur. In some species there are varieties with clonal growth (*Arrhenatherum elatius* var. *bulbosum, Caltha palustris* var. *radicans*) while the normal form is not markedly clonal. In these two species, the variety with clonal growth is less frequent than the type variety, so that both plants are given Clone1 = **0** (not spreading clonally) as the primary state, whereas Clone2 = **DRg** and **Stol2** respectively. Two species with proliferous inflorescences really ought to have been assigned to three categories, namely *Juncus bulbosus* (**Node2**, **Irreg** and omitted **DRi**) and *Butomus umbellatus* (**Rhiz2**, **DRg** and omitted **DRi**). It did not seem worth having a third column just for these two, so the inflorescence character has been omitted.

Table 4. Categories of clonality; counts of primary attributes are in the column N1=, counts of secondary attributes are in N2=

Attribute or code	N1=	N2=	Explanation
(f) Clonality	*Clone1*	*Clone2*	
0	1228		Little or no vegetative spread
0gr	25		Tussock-forming graminoid, may slowly spread
0tb	26		Tuberous or bulbous, slowing cloning by offsets
DRa	20	10	Detaching ramets above ground (often axillary)
DRg	4	16	Detaching ramets at or below ground
DRi		11	Detaching ramets on inflorescence
DRl		1	Detaching ramets on leaves *(Hammarbya)*
DRp		1	Detaching ramets on prothallus *(Trichomanes)*
Frag	7		Fragmenting as part of normal growth
Irreg	38	17	Irregularly fragmenting (mainly water plants)
Leaf		1	Plantlets formed on leaves *(Cardamine pratensis)*
Node1	19	20	Shortly creeping and rooting at nodes
Node2	76	9	Extensively creeping and rooting at nodes
Rhiz1	152	8	Rhizome shortly creeping
Rhiz2	209	15	Rhizome far-creeping
Root	37	3	Clones formed by suckering from roots
Stol1	14		Shortly creeping, stolons in illuminated medium
Stol2	26	5	Far-creeping by stolons in illuminated medium
Tip	5		Tip rooting (the stems often turn downwards)

The following comments may be helpful in distinguishing the clonal categories.

1. The category **0gr** is rather poorly defined. If a perennial graminoid (grass, sedge or rush) is repeatedly mown or heavily grazed, it may gradually form clones, even though this is not the normal condition.
2. The category **0tb** assumes that the ground is little disturbed. If there is regular disturbance, the offsets will be dispersed to new sites and the plant would then be indicated as **DRg** (detaching ramets at or below ground).
3. The small category **Frag** applies to duckweeds and *Azolla*.
4. The categories **Node** (creeping and rooting at nodes), **Rhiz** (rhizomatous or with subterranean stolons) and **Stol** (stoloniferous in the illuminated medium, either air or water) are divided into two, according to whether they spread a short distance in a season or are far-creeping. For rhizomatous plants, a rule of thumb is that a species whose new shoots arise at a distance less than a quarter of the height of the plant is shortly creeping,

while those that spread further are deemed to be far-creeping. Analogous distinctions are made for **Node** and **Stol**.

5. The distinction between **Node** and **Stol** is that in **Node** the horizontal or decumbent stem extends with indeterminate growth, rooting at the leafy nodes and not forming a new stem axis at each rooted position. In **Stol**, a new stem axis normally arises at the point of rooting, or the stolon is determinate, bending upwards and not progressing with indeterminate growth.

6. In the tip-rooting category, **Tip**, leafy stems that are not obviously stolons turn down at the apex and root there.

GEOGRAPHIC ATTRIBUTES

European and wider distributions, and continentality

The categorization of taxa to biogeographic elements and their designation as 'continental' or otherwise (Table 5) follow Preston & Hill (1997), with minor revisions and the addition of the hyperoceanic category from a subsequent paper (Preston & Hill, 1999). Elements are provided for native species and some archaeophytes; for archaeophytes the classification describes the archaeophytic range. In addition, some but not all alien species originating in Europe have also been assigned to biogeographic elements for PLANTATT and designated as continental. Geographic attributes are not provided for some hybrids.

Table 5. European and wider distribution, and continentality

Attribute and codes	N=	Explanation
(a) E1		*Biogeographic element, major biome*
1	82	Arctic-montane (main distribution in tundra or above tree-line in temperate mountains)
2	39	Boreo-arctic montane (in tundra and coniferous forest zones)
3	22	Wide-boreal (from temperate zone to tundra)
4	120	Boreal-montane (main distribution in coniferous forest zone)
5	244	Boreo-temperate (in conifer and broadleaf zones)
6	45	Wide-temperate (from Mediterranean region to coniferous forest zone)
7	621	Temperate (in broadleaf forest zone)
8	312	Southern-temperate (in Mediterranean region and broadleaf forest zones)
9	136	Mediterranean-atlantic (in Mediterranean region, and extending north in atlantic zone of temperate Europe)
0	15	Mediterranean (native range of some aliens)
(b) E2		*Biogeographic element, eastern limit category*
0	17	Hyperoceanic, with a western distribution in atlantic zone
1	207	Oceanic (in atlantic zone of Europe, not or scarcely reaching east to Sweden, Germany or S Spain)
2	148	Suboceanic (extending east to Sweden, C Europe or Italy)
3	577	European (extending to more continental parts of Europe but not to Siberia)
4	308	Eurosiberian (eastern limit between 60°E and 120°E)
5	114	Eurasian (extending across Asia to east of 120°E)
6	265	Circumpolar (in Europe, Asia and N America)
(c) C		*Continentality*
c	111	Species marked c are 'continental', i.e. they are rare in the atlantic zone of Europe but commoner further east

Native distribution of species alien in Britain and Ireland

The native distribution of aliens (Table 6) is taken from the *New Atlas*. This information is provided for neophytes and some archaeophytes. In Table 6, taxa present in two areas are included in both totals but taxa are excluded from the totals if they are only doubtfully native in the relevant area.

Table 6. Native distribution of species alien in Britain and Ireland

Code	N=	Explanation
Am	24	North America
Am4	22	Western North America
Am6	5	Eastern North America
As	10	Asia east of 60°E
As1	24	Asia between 60°E and 120°E
As2	9	Asia E of 120°E
Aus	3	Australia
Crop	15	Crop plant, does not have a native range
Eur	149	Europe
Gard	13	Garden origin, does not have a native range
NHem	6	N Hemisphere (Europe, Asia and North America)
NZ	4	New Zealand
SAf	5	Southern Africa
SAm	20	South America and/or Central America
Unk	10	Unknown

Counts of 10-km squares in the New Atlas

For each taxon, the number of 10-km squares in Britain, Ireland and the Channel Islands is enumerated (Table 7). For most natives, only the native distribution has been counted (blue dots in the *New Atlas*). For the small number of native species in which it proved impossible even to attempt to delimit the native range in the *New Atlas*, the count is for all squares. For alien taxa, all squares with records have been counted. Squares have been counted without regard to date, so that *Otanthus maritimus*, extinct in Britain, is recorded from 23 squares there.

Table 7. Counts of squares and climatic means

Attribute	Min	Max	Explanation
(a) Counts			*Counts of 10-km squares*
GB	0	2805	Great Britain and Isle of Man
IR	0	985	Ireland
CI	0	14	Channel Islands
(b) Climatic means			*Mean values for 10-km squares*
Tjan	-1.3	7.0	January mean temperature (°C)
Tjul	10.4	17.0	July mean temperature (°C)
Prec	553	3218	Annual precipitation (mm)

Climatic means

Climatic values for plants were calculated as the mean climate of the 10-km squares where they occur in Britain, Ireland and the Channel Islands, averaging over the squares enumerated for the counts. Climate data for 10-km squares were taken from baseline climate summaries of the UK Climate Impacts Programme (Hulme & Jenkins, 1998). These baseline summaries were constructed by interpolation of daily weather measurements from individual met stations, averaged over the 30-year period 1961-1990 (Barrow *et al.*, 1993).

HABITAT ATTRIBUTES

Coastal species

Species are deemed to be coastal if 80% of occupied squares are on the coast and if they depend on coastal habitat. Most coastal species have Ellenberg salt values (S values, defined below) greater than 0. Those with Ellenberg S = 0 were scrutinized carefully to ascertain whether their habitat was indeed coastal.

Broad Habitats

The preferences of species for Broad Habitats of the UK BAP are listed in the column labelled *Br Habitats*. Species' main habitat(s) are listed. No species is deemed to have a preference for more than four habitats. Minor habitats are ignored. For more information about Broad Habitats and species' preferences, refer to the Appendix.

Table 8. Coastal species and preferences for Broad Habitats

Attribute and codes	N=	Explanation
(a) Co		*Coastal species*
Co	145	At least 80% of occupied squares contain sea at high tide
(b) Br Habs		*Broad Habitats*
1	310	Broadleaved, mixed and yew woodland
2	32	Coniferous woodland
3	543	Boundary and linear features (eg hedges, roadsides, walls)
4	198	Arable and horticultural (includes orchards, excludes domestic gardens)
5	22	Improved grassland
6	163	Neutral grassland (includes coarse *Arrhenatherum* grassland)
7	218	Calcareous grassland (includes lowland and montane types)
8	89	Acid grassland (includes non-calcareous sandy grassland)
9	10	Bracken
10	83	Dwarf shrub heath (cover of dwarf shrubs at least 25%)
11	254	Fen, marsh and swamp (not wooded; includes flushes, rush-pastures, springs and mud communities)
12	41	Bog (on deep peat; includes bog pools as well as acid lowland valley mires on slightly shallower peat)
13	174	Standing water and canals
14	149	Rivers and streams
15	103	Montane habitats (acid grassland and heath with montane species)
16	292	Inland rock (heterogeneous - includes quarries, limestone pavement, cliffs, screes and skeletal soils over rock)
17	231	Built-up areas and gardens
18	74	Supralittoral rock (does not include maritime grassland)
19	135	Supralittoral sediment (strandlines, shingle, coastal dunes)
21	65	Littoral sediment (includes saltmarsh and saltmarsh pools)
23	1	Inshore sublittoral sediment (only *Zostera marina)*

Ellenberg's indicator values

Ellenberg defined seven major scales, of which five are presented here. The two that are omitted, T (temperature) and K (continentality), correspond quite closely to the major biome and eastern limit categories defined for European distributions by Preston & Hill (1997). Neither T nor K values are satisfactory in an oceanic climate such as that of Britain; those for K are particularly unreliable, especially as Ellenberg's definition was geographical rather than climatic.

The five remaining scales have values defined in the tables that follow. The values are based on those of Ellenberg *et al.* (1991). They are mostly reproduced from a previous publication (Hill *et al.,* 1999), with some additions because of the extra species included here. A few example species are given for each value, by way of explanation.

Light values (L)

The full range of Ellenberg values for light (Table 9) is not represented in the British flora. For canopy trees, light values refer to the tolerance of the sapling stage of the life cycle.

Table 9. Ellenberg values for light (L)

Code	N=	Explanation
1	0	Plant in deep shade (no examples for Britain or Ireland)
2	4	Between 1 and 3 *(Epipogium aphyllum, Neottia nidus-avis, Trichomanes speciosum)*
3	20	Shade plant, mostly less than 5% relative illumination, seldom more than 30% illumination when trees are in full leaf *(Galium odoratum, Listera cordata, Mercurialis perennis)*
4	70	Between 3 and 5 *(Circaea lutetiana, Lamiastrum galeobdolum, Poa nemoralis)*
5	120	Semi-shade plant, rarely in full light, but generally with more than 10% relative illumination when trees are in leaf *(Carex pendula, Hyacinthoides non-scripta, Primula vulgaris)*
6	213	Between 5 and 7 *(Anthriscus sylvestris, Digitalis purpurea, Teucrium scorodonia)*
7	680	Plant generally in well lit places, but also occurring in partial shade *(Arrhenatherum elatius, Carex flacca, Poa trivialis, Vicia cracca)*
8	576	Light-loving plant rarely found where relative illumination in summer is less than 40% *(Cardamine hirsuta, Orchis morio, Thymus polytrichus, Vaccinium oxycoccus)*
9	202	Plant in full light, found mostly in full sun *(Aster tripolium, Melilotus albus, Poa compressa, Primula farinosa)*

Moisture values (F)

Unlike the other Ellenberg values, moisture is on a scale of 1 to 12 (Table 10). We use the abbreviation F from the German Feuchtigkeit.

Table 10. Ellenberg values for moisture (F)

Code	N=	Explanation
1	3	Indicator of extreme dryness, restricted to soils that often dry out for some time *(Corynephorus canescens, Helianthemum apenninum, Koeleria vallesiana)*
2	28	Between 1 and 3 *(Clinopodium acinos, Saxifraga tridactylites, Sedum acre)*
3	168	Dry-site indicator, more often found on dry ground than in moist places *(Asplenium trichomanes, Centaurea scabiosa, Spergularia rubra)*
4	378	Between 3 and 5 *(Arctium minus, Helictotrichon pratense, Iris foetidissima, Thymus polytrichus)*
5	492	Moist-site indicator, mainly on fresh soils of average dampness *(Anthriscus sylvestris, Euphorbia amygdaloides, Hyacinthoides non-scripta, Solanum nigrum)*
6	226	Between 5 and 6 *(Agrostis stolonifera, Empetrum nigrum, Rumex crispus)*
7	141	Dampness indicator, mainly on constantly moist or damp, but not on wet soils *(Carex ovalis, Dactylorhiza maculata, Pulicaria dysenterica, Ranunculus repens)*
8	170	Between 7 and 9 *(Cardamine pratensis, Equisetum telmateia, Phalaris arundinacea, Schoenus nigricans)*
9	126	Wet-site indicator, often on water-saturated, badly aerated soils *(Drosera rotundifolia, Myosotis scorpioides, Vaccinium oxycoccus, Viola palustris)*
10	64	Indicator of shallow-water sites that may lack standing water for extensive periods *(Alisma plantago-aquatica, Carex limosa, Ranunculus lingua, Typha latifolia)*
11	34	Plant rooting under water, but at least for a time exposed above, or plant floating on the surface *(Lemna minor, Nuphar lutea, Sagittaria sagittifolia, Schoenoplectus lacustris)*
12	55	Submerged plant, permanently or almost constantly under water *(Isoetes lacustris, Potamogeton crispus, Ranunculus circinatus, Zostera marina)*

Reaction (R)

Reaction (Table 11) refers to environmental acidity, which would ordinarily be measured by pH. Except for water plants, R values reflect preferences for soil acidity.

Table 11. Ellenberg values for reaction (R)

Code	N=	Explanation
1	10	Indicator of extreme acidity, never found on weakly acid or basic soils (*Andromeda polifolia, Lycopodium clavatum, Rubus chamaemorus, Ulex minor)*
2	50	Between 1 and 3 *(Agrostis curtisii, Calluna vulgaris, Drosera rotundifolia, Polygala serpyllifolia)*
3	61	Acidity indicator, mainly on acid soils, but exceptionally also on nearly neutral ones *(Agrostis vinealis, Dactylorhiza maculata, Galium saxatile, Pteridium aquilinum)*
4	127	Between 3 and 5 *(Agrostis capillaris, Carex panicea, Juncus effusus, Teucrium scorodonia)*
5	227	Indicator of moderately acid soils, only occasionally found on very acid or on neutral to basic soils *(Cardamine pratensis, Cirsium palustre, Rubus idaeus, Ulex europaeus)*
6	412	Between 5 and 7 *(Ammophila arenaria, Carex sylvatica, Lolium perenne, Ranunculus* ficaria)
7	698	Indicator of weakly acid to weakly basic conditions; never found on very acid soils *(Agrimonia eupatoria, Atriplex prostrata, Nuphar lutea, Phleum pratense)*
8	279	Between 7 and 9 *(Artemisia vulgaris, Carduus nutans, Iris foetidissima, Viola hirsuta)*
9	21	Indicator of basic reaction, always found on calcareous or other high-pH soils *(Bunium bulbocastanum, Clinopodium calamintha, Dryopteris submontana, Primula farinosa)*

Nitrogen (N)

Nitrogen values (Table 12) are in fact a general indication of preference for soil fertility. They are closely correlated with the stress values of Grime (1979, 2001), low N values corresponding to plants with high stress tolerance (Grime *et al*., 1997) and vice-versa.

Table 12. Ellenberg values for nitrogen (N)

Code	N=	Explanation
1	84	Indicator of extremely infertile sites *(Agrostis curtisii, Clinopodium acinos, Drosera rotundifolia, Rubus chamaemorus)*
2	323	Between 1 and 3 *(Aira praecox, Carex panicea, Linum catharticum, Scabiosa columbaria)*
3	286	Indicator of more or less infertile sites *(Centaurea scabiosa, Galium saxatile, Pimpinella saxifraga, Teucrium scorodonia)*
4	245	Between 3 and 5 *(Agrostis capillaris, Cirsium palustre, Plantago lanceolata, Primula vulgaris)*
5	342	Indicator of sites of intermediate fertility *(Angelica sylvestris, Digitalis purpurea, Iris foetidissima, Trifolium pratense)*
6	319	Between 5 and 7 *(Cirsium arvense, Glyceria fluitans, Poa trivialis, Rumex crispus)*
7	223	Plant often found in richly fertile places *(Atriplex prostrata, Epilobium hirsutum, Stellaria media, Typha latifolia)*
8	55	Between 7 and 9 *(Beta vulgaris, Galium aparine, Lamium album, Urtica dioica)*
9	8	Indicator of extremely rich situations, such as cattle resting places or near polluted rivers *(Arctium lappa, Artemisia absinthium, Hyoscyamus niger, Rumex obtusifolius)*

Salt tolerance (S)

Values for salt tolerance (Table 13) start at zero, corresponding to no tolerance of salt.

Table 13. Ellenberg values for salt tolerance (S)

Code	N=	Explanation
0	1605	Absent from saline sites; if in coastal situations, only accidental and non-persistent if subjected to saline spray or water (85% of the flora)
1	116	Slightly salt-tolerant species, rare to occasional on saline soils but capable of persisting in the present of salt (includes dune and dune-slack species where the ground water is fresh but where some inputs of salt spray are likely) *(Calystegia sepium, Chenopodium album, Oenanthe crocata, Sedum anglicum)*
2	28	Species occurring in both saline and non-saline situations, for which saline habitats are not strongly predominant *(Atriplex prostrata, Elytrigia repens, Phragmites australis, Rumex crispus)*
3	68	Species most common in coastal sites but regularly present in freshwater or on non-saline soils inland (includes strictly coastal species occurring in sites such as cliff crevices and sand dunes that are not obviously salt-affected) *(Cakile maritima, Cochlearia officinalis, Juncus gerardii, Spergularia rupicola)*
4	28	Species of salt meadows and upper saltmarsh, subject to at most only very occasional tidal inundation (includes species of brackish conditions, i.e. of consistent but low salinity) *(Atriplex littoralis, Elytrigia atherica, Glaux maritima, Triglochin maritimum)*
5	19	Species of the upper edge of saltmarsh, where not inundated by all tides (includes obligate halophytes of cliffs receiving regular salt spray) *(Aster tripolium, Crithmum maritimum, Puccinellia maritima, Suaeda vera)*
6	6	Species of mid-level saltmarsh *(Atriplex portulacoides, Cochlearia anglica, Limonium vulgare)*
7	3	Species of lower saltmarsh *(Spartina anglica, Suaeda maritima)*
8	4	Species more or less permanently inundated in sea water *(Zostera* spp.)
9	8	Species of extremely saline conditions, in sites where sea water evaporates, precipitating salt *(Salicornia europaea* agg.; these could equally well be treated as species of the lower marsh)