

### *Distribution and ecology*

Recorded in nine tetrads in East Kent (Philp 1982), the only area in which it has been reliably recorded in Britain. It has been recorded in 19 or 20 locations, of which 17 have been seen since 1980 and 9 since 1990. The populations are all small and scattered, and there are believed to be about 400-500 plants in Britain (Stone, in prep.).

It occurs on chalk downland and banks, usually on steep south-west to east-facing scarp slopes. The soils are mostly the deeper soils on the lower parts of the slopes rather than the shallow rendzinas on the crest; they are well-drained, high in calcium carbonate and low in nutrients and humus (Duffield 1979; Ingram & Ingram 1981).

At site A 45% of plants occurred in grassland up to 5 cm tall, 45% in grassland 5-15 cm tall and only 10% in grassland more than 15 cm tall, and it is not dependent on maintenance of a very short grassland (Duffield 1979). Observations by R.V. Russell indicate that it grows best in longer grass (>10cm tall) and the rosettes should not be exposed between May and July. The NVC type is mainly CG4 (R.V. Russell, pers. comm. 1996) which occurs in mosaics with CG2 and CG3.

Flowering was very poor during the 1976 drought, but was very good in 1977 and 1978. Flowering spikes get eaten off by rabbits, slugs and stock, and unprotected plants survive better in longer grass where there is less grazing than in short grass. Plants may be caged to protect them from sheep or rabbits, but cages tend to attract unwelcome attention from young cattle. Trampling by cattle and people has occasionally damaged plants (Duffield 1979).

### *Management*

Consistent grazing of sites by sheep and cattle has been shown to be important in maintaining and improving its grasslands but should be prevented throughout the flowering and fruiting period from late May to the end of August (Duffield 1979). Light young cattle grazing can be used if the site is over-grown, but heavy cattle trampling may be deleterious.

At site A there have been various regimes, none of which were designed specifically for the orchid. On one compartment at site A, prior to 1965 it was grazed by cattle from September to May and from 1965-1979 by sheep from September to May (5-12 ewes/ha). Elsewhere on another compartment it was grazed all year round by varying quantities of cattle and sheep (Duffield 1979).

Two sites managed by the White Cliffs Countryside Project in Kent have shown quite rapid increases in population following management to produce shorter, more open turf, and break down mats of leaf litter (P. Green, pers. comm. 1996). At one site (site B) the population has increased from 4 to over 50 plants. The small compartment is grazed from August to October by allowing cattle access from the main pasture and aiming to get a short turf c. 1-3 cm tall in April and 4-6 cm tall in June; there is some supplementary rabbit grazing too. The other site (site C) is currently being grazed in alternate years by cattle through the summer to bring the under-grazed site back into better condition. The turf is currently 3-6 cm in April and 8-12 cm in June, and although relatively few inflorescences survive to fruiting due to the grazing, the number of plants has been increasing.

At another Kent site (site D) the management is not ideal and the soils may also be sub-optimal. The plants are sporadic in appearance with up to eight plants in a good year, but sometimes none. The decline over the last 20 years is probably a consequence of under-grazing by cattle resulting in build up of rank grass and leaf litter. The site is now managed

for a number of plants and invertebrates with yearly rotational grazing of compartments cycling through no grazing, spring grazing, summer grazing then all year grazing with store cattle (0.4/ha) or sheep (3-5/ha), though results need to be assessed in the longer term (J. McAllister, pers. comm. 1996).

Duffield (1979) reported that it survived at the an East Sussex site and a Kent site E in ungrazed *Brachypodium pinnatum* grassland which was only checked by occasional fires. The rank tor-grass grassland at site D was given a controlled burn in February 1985 and followed up with summer grazing resulting in a sward 3-10 cm tall and  $\pm$  no bare ground, and then grazing was removed in 1986. Eight plants of *Ophrys fuciflora* reappeared the following year, but has declined again when the grazing was not maintained due to practicalities with the tenant (J. McAllister, pers. comm. 1996). A rapid burn at the end of the summer to remove thatch when the plants are underground is also unlikely to be damaging, but is not recommended management (P. Green, pers. comm. 1996).

Grassland at site A with one population was cut with a lawn mower to 5 cm in late summer in 1967 and in 1978, and was considered a useful alternative means of reducing dense grass when grazing was not practical (Duffield 1979). Mowing with a strimmer and removal of cuttings in September may be an effective way to bring small colonies under control and break up thatch (R.V. Russell, pers. comm. 1996).

Duffield (1979) reported that it had survived bulldozing and ploughing immediately prior to establishment at site A, probably as the sites were allowed to recolonise naturally. This is not recommended management!

#### *Recommendations*

A polycarpic, moderately long-lived winter-green perennial which reproduces mainly by seed and locally vegetatively; fruit set is very poor. It shows best in chalk grassland to 10-15 cm tall at flowering with up to c. 2% bare ground. Grazing by cattle (c. 2/ha) and/or sheep (5-10 ewes/ha) from September to March to obtain the above sward is recommended. Mowing in September may assist with control of rank swards.

### **3.9 *Ophrys sphegodes* - Early spider-orchid**

Red Data Book species (Wigginton, in prep.). Listed on Schedule 8 of the Wildlife and Countryside Act 1981.

#### *Life cycle*

A short-lived monocarpic to polycarpic, perennial, mycorrhizal herb, which mainly reproduces by seed. Up to 5% of the recruitment each year is vegetative resulting in clumps of shoots. 70% of plants flower in the first year in which they appear above ground, and most die afterwards. A small proportion of the plants live 6 or more years and some up to 10 years. Individual plants are able to enter periods of dormancy for 1-2(-3) years, and a mean of about 50% of the plants are dormant each year. The half-life is typically about 2 years (Hutchings 1987a, 1987b, 1990).

Leaves emerge from the tubers in autumn and are fully grown by the end of October and over-winter. Flowering takes place over a three week period in April and May and the leaves die back shortly afterwards leaving the fruiting spikes to mature. It persists through the summer as underground tubers.

On average 84% (range 65-97%) of the plants in a population which appear above ground flower each year. Most spikes have 2-4 flowers. Flowers are pollinated mainly by *Andrena* species, but only c. 10% of the flowers produce ripe seed. Self-pollination does occur but appears to be inefficient. The seeds take 3 months to mature. Seed dispersal is by wind. There is no information available on the length of the subterranean seedling phase, but it is presumably quite short.

Populations vary from a few plants to several thousand. The populations seem to have fairly random fluctuations from year to year at Castle Hill NNR (Hutchings 1990).

#### *Distribution and ecology*

It is a rare plant scattered across southern Britain and mainly concentrated in south-east England. Populations elsewhere are more transient and some of the decline is due to habitat loss. Being a southern European species it is likely to benefit from climate warming.

It occurs on ancient, species-rich chalk grassland and calcareous limestone grassland in southern Britain. It has also colonised quarries and war-time defence works on the chalk above Dover Harbour, and favours some disturbed sites (*Ophrys* is regarded as a 'weedy' genus in the Mediterranean, and this species is no exception). It occurs in NVC types CG1, CG2, CG3, CG4 and CG5 (Rodwell 1992; T. Rich, pers. obs.), but is most frequent in the shorter, sheep-grazed parts of CG2.

Slug and invertebrate damage is usually low, presumably due to chemical defences (Hutchings 1987a).

#### *Management*

As most of the reproduction is by seed from young plants, regular flowering of the population is critical and grazing must be carefully controlled. It is susceptible to grazing by vertebrates; in 1980 sheep removed most flowering spikes at Castle Hill with a devastating effect on the population (Hutchings 1987a). Some sites such as Dover and the Dorset coast are ungrazed and kept open by exposure and trampling. At Bullock Down SSSI the numbers of plants declined when grazing was removed and the grass became rank (D. C. Lang, pers. comm. 1996).

At Castle Hill NNR, plants occur in 2-5 cm tall, open CG2 grassland between clumps of longer CG5 grassland (the longer grass is important for invertebrates). It has a history of extensive cattle grazing (c. 0.5-1/ha, September-January) with some sheep. Between 1991 and 1996 the sheep component has been increased to light grazing all year round (c. 2 animals/ha), with increases to 4-6 animals/ha during the winter, and occasionally during flushes of grass growth. Cattle (0.5/ha) now graze between September and December. The grazing is adapted to the amount of grass present; for example in the very dry summer of 1995 there was so little grass that no cattle were put on in the autumn (rabbits are also present). Stock are kept off the orchid area during flowering and fruiting. The emphasis in recent years has been to move towards sheep grazing as these give a sward more suitable for the orchids, but *Brachypodium pinnatum* has spread so control with some winter cattle grazing is also needed (M. Emery, pers. comm. 1996).

Studies at Castle Hill show a marked decline in population when the site was lightly-grazed by cattle or sheep all year, with both rates of recruitment and mortality affected. When the site was grazed by sheep outside the flowering/fruiting period (i.e. April-August), recruitment was higher and mortality lower. Cattle were thought to damage the thin soil

causing erosion and compaction (but see Kent sites below), and intensive winter grazing damaged the rosettes (Hutchings 1990).

Queendown Warren SSSI was grazed for many years between September and December/January with 1-2 cows/ha resulting in a sward height of about 2-3 cm, and the population was fairly consistent at about 130 flowering plants per year. Two years after the introduction of spring and summer cattle grazing in 1994 at a lower density (c. 1 cow/ha), the population plummeted though it is not clear if this is related to management as no detailed census was carried out (D. Hutton, pers. comm. 1996).

At Lydden NR the management is for a number of plants and invertebrates aiming to get a mosaic of swards with 50-60% of the site at c. 2 cm tall and 1% bare ground (more bare ground would be beneficial for the invertebrates), and areas of longer grass to 20 cm in 5-10% of the site. Historically the site was grazed by cattle. The reserve now has yearly rotational grazing of compartments mostly with cattle (0.4 store animal/ha) or sheep (2-5 animals/ha) through a rotation of no grazing, spring grazing, summer grazing, and then all year grazing. Sometimes a mixture of stock is also used. The *Ophrys sphegodes* has spread following and increase in short grass and a reduction of the rank grassland (J. McAllister, pers. comm. 1996).

There is no information on responses to burning or mowing. Either can presumably be carried out safely in the summer after fruits have set.

#### *Recommendations*

A winter-green, short-lived perennial herb which reproduces mainly by seed. Short term fluctuations in grazing pattern can have marked effects on the population dynamics, and population should not be grazed in the flowering and fruiting seasons. Grazing should be by sheep from September to March (2 animals/ha) or by cattle (0.5-1 animals/ha), aiming to get a short CG2 sward to c. 2-5 cm with c. 1-5% bare ground. Some coastal sites may need no management.

### **3.10 *Orchis ustulata* - Burnt orchid**

Nationally Scarce species recorded in 66/294 10-km squares in Britain since 1970 (Stewart, Pearman & Preston 1994).

#### *Life cycle*

There are two distinct forms of this species which usually grow in discrete populations and which differ in flowering time and morphology; these are best treated as varieties at the moment (D. Lang, pers. comm. 1996). Var. *ustulata* mainly flowers in May and June, and var. *aestivalis* in July; the variety present will determine the timing of grazing.

A polycarpic, moderately long-lived perennial, mycorrhizal herb. It reproduces by seed and sometimes by formation of secondary rhizomes which results in small clusters of shoots. Germination experiments are under way but have so far proved unsuccessful (P. Corkhill, pers. comm. 1996). There is little information on development of the seedlings, but it is thought that plants may take 10 years to come to flower (Foley 1994). Summerhayes (1968) reported that the underground phase may last 10-15 years before leaves are produced and plants may flower from their 13-14th year, but this requires reinvestigation. Once established, the plants do seem to be long-lived.

Leaves appear during the autumn/winter, some from as early as September/October but others develop later, and they over-winter. Flowering occurs from early May to early July, or in July depending on the taxon present. Fruit set in many populations is often very low indeed, but can be improved by hand pollination. Ripe fruits are present about two months after flowering, and the tiny seeds are dispersed by wind after the pods split. Leaves can wither away at flowering/fruitletting but can persist if conditions are moist (G. Bellamy, R. Kell, pers. comms. 1996). Plants persist through the summer as underground tubers.

Most colonies are small with fewer than 25 flowering plants, but a few may have many thousands (eg 30,000 at Parsonage Down NNR). The numbers of plants flowering each year varies from year to year, with over half of the plants flowering in a good season, but many fewer in a poor year.

#### *Distribution and ecology*

It is scattered through much of England with the biggest concentrations in Wiltshire and East Sussex (Foley 1992, 1994), with one site in south Wales. The main reasons for loss are agricultural improvement (including ploughing), building and development, and possibly long-term over-grazing (Foley 1987).

The majority of sites are in grazed pastures, but some are on banks in hay meadows. It mainly occurs in short, herb-rich, moderately-grazed, old pastures on chalk and limestone, on a range of aspects but especially on south-facing sunny sites, on gentle to steeply sloping ground and earthworks. It also occurs in some hay meadows in Yorkshire and Wiltshire. The soils are always base-rich and well-drained. It has recolonised a couple of sites which were ploughed in the 1940s and 1950s and then abandoned, but this is very much an exception (Foley 1992).

It is commonly associated with *Sanguisorba minor*, *Anthyllis vulneraria*, *Lotus corniculatus*, *Primula veris*, *Rhinanthus minor*, *Polygala* spp., and *Gentianella* spp. It has been recorded in NVC types CG2, CG3 and MG5 (Rodwell 1992). It is not a strong competitor and will disappear from ungrazed sites, though it has survived long periods in quite tall meadow land (Foley 1994). Conversely, continued over-grazing has also resulted in loss of some sites, though it re-appeared probably from vegetative plants in one pasture when the grazing was relaxed after 20 years of heavy grazing.

Rabbits may nip off the inflorescences. Slugs may also damage plants.

#### *Management*

According to Foley (1990) the favoured management at the largest pasture populations is light sheep grazing from early spring until March, and then with a further spell from July (- late August for var. *aestivalis*) to September. Some sites are successfully grazed by cattle, at least in combination with sheep, and for longer in the year. The orchids do benefit from an open sward (A. Knott, pers. comm. 1996), though the grazing should not be too heavy (Foley 1990). Some sites may benefit from the occasional light dressing of farmyard manure provided the low productivity of the grassland is maintained.

At Parsonage Down NNR the site is grazed all year by cattle (0.6 + calves/ha) and sheep (1+ twin lambs/ha) from April to February. The stocking rates are adjusted regularly in conjunction with layback grasslands to maintain the short CG2 grassland rather than specifically for the orchids. Pewsey Downs NNR has small populations of both varieties which flower best if a short sward with plenty of gaps is provided prior to the growing season

(A. Knott, pers. comm. 1996). The main NNR part has cattle (c. 1/ha) and sheep (0.7/ha + their lambs) all year to maintain the CG2 sward. A Nature Reserve Agreement compartment with var. *ustulata* is grazed by cattle (0.8-1.6/ha) all year except for April (to allow a *Bromopsis erecta* growth flush), with a winter clean-up graze by sheep to maintain the CG2/CG3 sward structure; var. *aestivalis* occurs in another area with similar stocking regimes. The Martin Down NNR population of 200-300 plants is grazed by sheep in April to catch the *Bromopsis erecta* growth flush and then again from October to December to clean up the grass (A. Knott, pers. comm. 1996).

At Wanlass Grasslands SSSI the management as part of a hay meadow is regarded as ideal (although plants are rarer in the main hay crop areas). The main population occurs on steep, uncut banks on calcareous glacial till in an MG5/CG2 grassland. The grassland has never been improved and is nutrient-poor and unproductive, and only receives a minimum dressing of organic manure once every three years or so. The banks are never cut when the field is cut for hay. Two or three weeks after cutting in late July or early August, the aftermath is lightly-grazed by cattle for 2-3 months, and then grazed by sheep supplemented with hay during the winter, before grazing is removed again around 1 May. The grassland on the uncut banks is about 5 cm tall by the end of the winter. A second small population reappeared after 20 years of heavy summer sheep grazing (5 ewes/ha) when the grazing was changed to c. 2 cattle/ha in May-June followed by sheep (1-2 ewes/ha) for the rest of the year (P. Evans, pers. comm. 1996).

Glebe Field NR was originally a unimproved, traditionally-managed sheep pasture set on a gentle south-facing slope with calcareous loam. A tiny population of six flowering plants has increased over the last 10 years to 120 plants, half of which may flower. This has been achieved by adopting a similar hay meadow regime to Wanlass, and has probably resulted from maturation of vegetative plants as fruit set is very low. The hay is cut anytime from mid July to September and then the aftermath grazed by sheep at a low stocking rate (1-2 ewes/ha) until December, and no manure is used (R. Kell, R. Wilson, pers. comms. 1996).

At Mount Caburn NNR the main colony is on a south-facing, sheltered slope with thin, dry soil and low productivity CG2c grassland c. 3-5 cm tall and with 1-2% bare ground. It is aimed to cattle graze (0.5/ha maximum) in spring to April, and again from July dependent upon grass growth, and winter graze with sheep (2-6 animals/ha), depending on grass growth (M. Emery, pers. comm. 1996).

At Lydden NR there is a tiny population of up to 20 plants which is not increasing. The management is for a range of plants and invertebrates aiming to get a mosaic of swards with 50-60% of the site at c. 2 cm tall and 1% bare ground (more bare ground would be beneficial for invertebrates), and areas of longer grass to 20 cm in 5-10% of the site. Historically the site was grazed by cattle but the reserve now has yearly rotational grazing of compartments with cattle (0.4 store animal/ha) or sheep (2-5 animals/ha) through a rotation of no grazing, spring grazing, summer grazing, and then all year grazing. Sometimes a mixture of stock is also used (J. McAllister, pers. comm. 1996).

Hornsleasow Roughs SSSI has a small population which does not flower every year in CG2 grassland c. 1-3 cm tall with little bare ground. It is grazed by sheep (up to c. 3/ha) for most of the year except for the *Pulsatilla* flowering period between March and May. The management is not ideal as it is grazed during the flowering period (M. Wilkinson, pers. comm. 1996).

Some small populations where rabbit grazing is a problem may require rabbit fencing. At Leyburn Glebe SSSI plants were protected by individual cages; this is very labour intensive to

look after and they had to be strimmed by hand when the meadow was mown (R. Kell, R. Wilson, pers. comms. 1996). Knocking Hoe NNR has a small population of 20 plants in closed turf c. 5-10 cm high which has been caged in recent years to protect it from the intensive rabbit grazing. Cages are removed and grass cut/weeded after fruits have been set, and are replaced when leaves are visible. Some damage by voles and slugs has been noted inside the cages. Natural fruit set is low and has been augmented by hand pollination (G. Bellamy, pers. comm. 1996).

#### *Recommendations*

A polycarpic perennial herb which reproduces mainly by seed, though seed production may be very low. Grazing should be light and preferably by sheep or sheep and cattle, from early spring until April, and then with a further spell from July (from late August for var. *aestivalis*) into the winter. Hay meadows can be managed by traditional patterns with no grazing between May and the end of July, followed by light cattle and/or sheep grazing through the winter.

### **3.11 *Polemonium caeruleum* - Jacob's-ladder**

Red Data Book species (Taylor, in prep.). Some sites have plants of garden origin which differ in having broader leaflets and in floral characters (Pigott 1958) and which are not of conservation interest.

#### *Life cycle*

A long-lived, polycarpic perennial which reproduces by seed (old rhizomes can sometimes split to give separate plants but other than this vegetative reproduction does not occur). Autumn-germinating seedlings can flower the next summer in cultivation but this usually takes longer in the wild. Individual plants certainly live for 10 years and probably longer (Pigott 1958).

The leaves appear in April and grow rapidly. Plants flowers from early June to July (exceptionally September). It is usually pollinated by bumblebees but is also self-fertile. Seed ripens in August but is often not shed until the autumn or even spring. Seeds are shaken out of the capsules, and there are no specialised dispersal mechanisms. The leaves and stems die down in autumn except for very young leaves and leaf initials which over-winter (Pigott 1958).

Seedlings are most plentiful in spring, with some present in the autumn, and they are frequent in years after wet summers. There is little information on the seedbank, but seeds are viable when stored at room temperature for a few years at least (Pigott 1958).

#### *Distribution and ecology*

As a native confined to a few areas of northern England, with garden escapes naturalised elsewhere on stream banks and waste ground. It is often very locally abundant.

It is essentially a refugium plant of upland screes and cliff ledges which are ungrazed or only lightly-grazed. The soils are usually mull or protorendzinas with more than 40% organic matter, pH more than 7 and high in calcium carbonate, and it also occurs on brown earths in Cheviots (Pigott 1958). Experience of cultivation of *Polemonium* species, and unpublished work on the Cheviots population, indicates that a high organic content of the soil improves the long term growth of the plants probably due to enhanced moisture retention capacity (D.

Allison, pers. comm. 1996). It occurs mainly on damp, steep slopes with a northerly aspect where the soils are kept moist by seepage but not water-logged (Pigott 1958). The damp microclimate is important as it is drought-sensitive and Fowler & Brown (1993) reported that it had begun declining in some sites in recent hot summers. It may not flower in dry conditions or deep shade (Pigott 1958).

It typical of light secondary ash woods or tall herb vegetation, and may best be regarded as a woodland edge/scrub margin plant. It is often associated with many plants which are regarded as nitrophiles (eg *Urtica dioica*, *Heracleum sphondylium*; see Rodwell 1992 for lists of associates in its typical NVC type MG2b). It also occurs in the NVC type MG1e in the White Peak (R. Jefferson, pers. comm. 1996). There is marked seasonality in the vegetation growth with rapid growth in spring and complete winter die-back, and many of the sites may have been formerly lightly-wooded (Pigott 1958).

Slugs eat the seedlings, and damage by bugs and a caterpillar has also been noted. Snails do not appear to affect it significantly (Taylor, in prep.). Rust fungi have also been noted infecting the plants (Pigott 1958). Most *Polemonium* species are susceptible to significant removal of foliage (D. Allison, pers. comm. 1996).

### *Management*

Like its MG2 tall herb community in general, *Polemonium* is sensitive to grazing by deer or sheep, and it has probably been eliminated from some sites and parts of others by grazing. Sheep eat the leaves and stems, but cattle seem to cause less damage. Where it is heavily-grazed, plants may consist of only single leaves; the plants persist at least in the short term but do not flower. The best colonies are where it is never grazed or only grazed occasionally. In the Alps it is sometimes abundant in heavily manured, cattle-grazed pastures (Pigott 1958).

The sites in Derbyshire vary in management from heavily sheep-grazed almost CG2 grasslands to unmanaged woodlands, and its ecological requirements seem to vary from site to site (B. Le Bas, I. Taylor, pers. comms. 1996). Some sites (eg Cheedale) have sub-populations in a variety of conditions including ledges, grassland, open scree and woodland.

A general management prescription for flower-rich tall grasslands (c.f. the *Polemonium* MG2 grasslands) has been drawn up for the White Peak (English Nature 1996). It is suggested that where populations are part of grazing units, the sites are fenced and grazed with young beef cattle (or less suitably, hill sheep) between early September and the end of December for one in every three years to open up the vegetation and litter layer, and control scrub. Stocking rates are not specified but farmers must not allow the land to be poached. Longer term management must be planned within the context of the local farming regimes, as for instance lowland sheep are unlikely to graze the tall herb communities. Occasional (eg once every three years) mowing or strimming with finely fragmented cuttings left in place may also be a substitute where grazing is impracticable. Regular or annual winter grazing may be tolerable but is unnecessary, and poaching may be damaging; is not recommended.

Where populations are very small and confined to ledges by grazing (eg Winnats Pass) it may be possible to expand the populations by fencing off the adjacent grassland and changing the grazing regime. Following reduction in the grazing regimes with temporary fences it has expanded into warmer and drier grasslands at Lathkil Dale which at first sight seemed unsuitable. However, annual temporary exclosures in Lathkil Dale with grazing from August/September until Christmas did not seem to work well, and flowering has been much better after two years of permanent exclosure. The colony appears to have been at its zenith



in the 1970s before the NNR was declared and before grazing was re-introduced to maintain the fine CG2 grasslands (B. Le Bas, pers. comm. 1996).

A few sites have plants in dense shade (e.g. parts of Cheedale and in Taddington Wood NT), and it may be possible to open up some sites which are densely wooded by thinning the canopy. Where scrub encroachment threatens plants young trees and saplings could be cleared, though this has not yet been tried.

#### *Recommendations*

A grassland / woodland edge perennial which reproduces by seed. It is sensitive to grazing, and sites should be ungrazed or grazed by cattle in the autumn at most once every three years. Occasional mowing or strimming with finely fragmented cuttings left in place may be a substitute for grazing if needed to control scrub or break up litter layers.

### **3.12 *Pulsatilla vulgaris* - Pasque flower**

Nationally Scarce species recorded in 19/67 10-km squares in Britain since 1970 (Stewart, Pearman & Preston 1994). Our subsp. *vulgaris* is endemic to west and central Europe.

#### *Life cycle*

A polycarpic perennial which appears to reproduce mainly vegetatively by growth of adventitious buds on the rhizome which form new rosettes near the parent plant. Plants grown from seed in pots will flower in 1.5-2.5 years but in the wild this is likely to be 4-5 years, and large plants may be 20 years old (Wells & Barling 1971; Wells 1994). Populations depend on survival of long-lived adults, and plants are believed to have a long half-life (Grubb 1990).

It is dormant without any above-ground parts during the late autumn and winter. Tightly furled leaves are visible in March, and unfurl at or after flowering. Leaves persist until early autumn or the first frosts.

Plants flower from March to June, usually peaking in late April but flower production and timing does vary from year to year. At least some plants in each population flower and seed each year, with some flowering successively, other remaining vegetative and some changing from year to year. Each plant usually produces 1-3(-12) flowers. They are usually pollinated by aculeate Hymenoptera and bees (Wells & Barling 1971). Kratochwil (1988) found in Germany that it had special adaptations to safeguard against self-pollination, but bagging experiments show that some self-pollination does occur at least in the Cotswolds (D. Barling, pers. comm. 1996). Kratochwil (1988) found a temperature of 12°C or above was important for pollination as it marked the onset of budding, opening and closing of the flower and dehiscence of the anthers, as well as stimulating activity of the pollinators. 37 species of Hymenoptera Apoidea pollinated the flowers but other visitors such as flies, beetles, Lepidoptera and Hymenoptera non-Apoidea did not contribute significantly to pollination. Fruit set exceeded 70% over a four year period, though only a few hours of favourable weather occurred in average years (Kratochwil 1988). Hand-pollination experiments show that seed set may be partly pollen-limited (Jonsson *et al* 1991). Drought in one summer may affect flowering the following year as primordia are initiated in late summer (D. Barling, pers. comm. 1996).

Some colonies produce a large amount of seed. Achenes ripen 4-5 weeks after the flowers open and fruits may be ripe from mid May to mid June. Flowers produce on average about

46 achenes, though not all may be fertile. In 1996, no viable seed was produced at Knocking Hoe and seed at Barton Hills was only 37% fertile, possibly due to the cold spring and lack of pollination (Bailey 1996). Dispersal by wind is likely to be inefficient. Recruitment from seed does occur in the field though it is a rare event (perhaps one in fifty quadrats might contain a seedling). The few observations show establishment occurs in the spring and autumn, and soil moisture is important for survival as seedlings get droughted so only survive in wet summers (Wells 1994; D. Barling, pers. comm. 1996). Seeds appear to be short-lived, and there is unlikely to be a seed bank.

Populations tend to be fairly stable, responding slowly to changes in management and sometimes climate. For instance, 1978 was an exceptional year for *Pulsatilla* in Cambridgeshire with plants flowering in abundance in known sites and reappearing on Newmarket Heath in places not seen in living memory (G. Crompton, pers. obs.).

Preliminary results from an analysis of DNA using the RAPD technique showed genetic differences between populations. The Rodborough Common, Gloucestershire population showed distinct differences from four populations in eastern England (Bailey 1996).

#### *Distribution and ecology*

Widely scattered in southern Britain on chalk and limestone (recent map in Wells 1994). It has declined due to agricultural 'improvements' such as ploughing, quarrying, building etc. (Wells 1968), and lack of grazing and scrub encroachment at several Bedfordshire sites (C. Bailey, pers. comm. 1996).

A species of short, dry, species-rich pastures, old quarry workings, and ancient earthworks which have escaped the plough. It usually occurs on shallow, calcareous soils of pH (5.2) 7.0-7.6, on steep south- to south-west-facing slopes where the microclimate is warm, the soils are shallow and dry, and competition from other species is restricted. It is commonly associated with *Carex caryophylla*, *Festuca ovina*, *Bromopsis erecta*, *Cirsium acaule*, *Helianthemum nummularium* and *Helictotrichon pratense* (Wells 1968; Wells & Barling 1971). The main NVC types are CG2, CG3 and CG5 (Rodwell 1992). Erosion of soil around the roots by rainstorms after drought has dried up the turf on steep slopes may result in plants being susceptible to drought the following year (D. Barling, pers. comm. 1996).

It is characteristically a plant of rabbit- and sheep-grazed calcareous grassland, and is well-adapted to grazing by herbivores. Leaves are eaten by sheep and rabbits. It is not affected by winter grazing as it is dormant (Wells & Barling 1971). Under heavy grazing it appears to produce phenotypically small and compact individuals (C. Bailey, pers. comm. 1996). A number of invertebrates have been observed feeding on the plants, and mice are reported to nibble flowers (Wells & Barling 1971).

It benefits from trampling which stimulates development of adventitious buds (Wells & Barling 1971).

#### *Management*

It occurs in both grazed and ungrazed swards; in the latter the main threats are lack of management and scrub encroachment. Plants can persist for many years in tall ungrazed turf and on the edge of hawthorn scrub (e.g. at Barton Hills 22 and at least 10 years respectively; Wells & Barling 1971). Flower production is markedly reduced once the average height of the vegetation reaches 10-15 cm (only 7% of plants flowered after five years without grazing at

Barton Hills NNR; Wells 1968). A build-up of litter may also be detrimental (Wells & Barling 1971; Wells 1994; Bailey 1996).

The preferred management is grazing, though short-term fluctuations in grazing intensity or short-term neglect are not necessarily critical as there is great flexibility (Wells 1968, 1994). Wells (1968) reported that at Barton Hills it has survived 100 years of sheep grazing (density unknown), 13 years of very heavy sheep grazing (5-8 sheep/ha for 9 months of year resulting in turf c. 2.5 cm long), 22 years of competition from *Bromopsis erecta* and *Crataegus monogyna* when the site was ungrazed, and burning at Easter when it was producing leaves and flowers. These management practices resulted in changes in its flowering behaviour but did not cause extinction. Barton Hills is currently grazed by rabbits all year and lightly-grazed by sheep (0.4 animals/ha) between April and December. The sward is c. 3-5 cm tall and with 30% bare ground - the sheep tend to concentrate on other more productive parts of the reserve when the *Pulsatilla* is flowering (G. Bellamy, pers. comm. 1996).

Barnsley Warren SSSI has one of the largest populations in Britain and has had the same management which is thought to be ideal since c. 1980. Sheep are used in high stocking densities to graze the *Pulsatilla* turf to a short, open turf (less than 3 cm, to 20% bare ground) intermittently for a February-March session, and then again from mid June onwards once fruit has been set (D. Barling, M. Wilkinson, pers. comms. 1996). Management at Bourton Downs SSSI is similar but with variable winter grazing (M. Wilkinson, pers. comm. 1996).

At Barnack Hills and Holes NNR it occurs in the south-facing sides of the hollows in short CG2 turf which are drought-stressed in summer. The grassland is grazed by sheep from September to December until the sward is less than 1 cm tall with up to c. 30% bare ground (C. Gardiner, pers. comm. 1996). At Knocking Hoe NNR the turf is heavily-grazed by rabbits alone without additional stock grazing and it has been eliminated from areas over-grazed by rabbits for several years (G. Bellamy, pers. comm. 1996).

Hornsleasow Roughs SSSI has a good population in CG2 grassland c. 1-3 cm tall with little bare ground. It is grazed by sheep (up to c. 3/ha) for most of the year except for the flowering period between March and May, though fruiting heads may get grazed off. The management agreement requires the site not to be over-grazed, and the regime maintains rather than optimises the population (M. Wilkinson, pers. comm. 1996).

The population at Rodborough Common SSSI has declined markedly as commoners' grazing rights are ceasing to be exercised. The site is still grazed by a few cattle (1.2/ha) mainly from May to August (sometimes October) but the unproductive slopes with rank CG5 grassland 15-20 cm tall are very under-grazed and the *Pulsatilla* is sparse. Cutting of the *Pulsatilla* slope colony has recently been introduced by the National Trust (M. Wilkinson, pers. comm. 1996).

It has survived, without apparent ill-effects, a range of cutting regimes carried out experimentally at Barton Hills between 1963 and 1969. These included cutting once a year in spring, summer or autumn, to cutting three times a year (Wells & Barling 1971). Fortnightly mowing on Newmarket Heath has allowed plants to persist for many years but they very rarely flower. Some *Brachypodium pinnatum*-dominated sites are traditionally burnt ('swaled') each year in February or March, and it survives this treatment and flowers normally (Wells & Barling 1971).

#### *Recommendations*

A polycarpic, long-lived perennial herb which mainly reproduces vegetatively, and also rarely from seed. Management should aim to produce turf to c. 5(-10) cm tall with up to 30%

bare ground, and there is much flexibility in how this is achieved. An ideal grazing regime is by sheep (up to 5/ha) from August to April. Plants also survive in burnt or mown swards.

### 3.13 *Teucrium botrys* - Cut-leaved germander

A Red Data Book species (Winship, in prep.). Listed on Schedule 8 Wildlife and Countryside Act 1981.

#### *Life cycle*

A predominantly monocarpic, annual or biennial herb (Mrs J. E. Smith, pers. comm. 1996). In cultivation, and possibly sometimes in the wild, some plants may also be a polycarpic, short-lived (to at least four years) perennial which dies back to a bud at ground level in the autumn (Winship 1994). The life cycle is somewhat plastic depending on time of germination and yearly weather conditions.

It reproduces exclusively by seed. Seeds germinate mainly in spring and autumn, but seedlings may appear at other times of year depending on the weather. Plants which germinate in the spring can flower in the same year. Seedlings and young plants have green leaves through the winter. It flowers mainly from July to September (exceptionally to November), with seed taking about 4-6 weeks to mature. It is pollinated by bees and self-pollination may also occur (Clapham, Tutin & Moore 1987). There are no specialised seed dispersal mechanisms. There is likely to be a good seed bank.

Populations fluctuate markedly from year to year, probably related to the annual-biennial habit, climate and management. Some populations consist of only a very few plants, others may have several thousand.

#### *Distribution and ecology*

In 1996 known from seven sites scattered across southern England, and gone from nine other sites due to agricultural changes and development (Winship 1994).

It is recorded from arable field margins, fallow fields, open grasslands, disused quarries and chalk spoil heaps, and a chalk river cliff with open scrub. It is especially characteristic of open, disturbed sites and usually occurs on bareish soil. It is very tolerant of drought but not shade. The soils are usually bare, calcareous mineral soils low in nutrients (individual plants may benefit from nutrients from rabbit latrines) and it will also thrive on open, nutrient-rich soils. It is commonly associated with common plants of open disturbed chalky ground such as *Fragaria vesca*, *Hypericum perforatum* and *Inula conyza*, and sometimes rare species such as *Ajuga chamaepitys*, *Cerastium pumilum* and *Vulpia unilateralis* (these should also be taken into consideration when deciding on management). It is recorded in the NVC types CG2a and CG7a (Sanderson in Winship 1994)

It is tolerant of light to moderate grazing by rabbits, deer, sheep and cattle which seem to avoid eating it possibly due to the bitter taste and natural oils.

#### *Management*

The management of all sites has been reviewed in detail by Winship (1994), and detailed management plans for some sites have already been drawn up (eg Micheldever spoil heaps; Winship 1995). Where it is impractical to graze sites with stock, the open conditions need to

be maintained by physical disturbance. If scrub invasion is a problem, it can be controlled by hand-pulling or cutting and treating.

Grazing by stock to control scrub and create some open ground by poaching should be kept light. Rabbit burrows and disturbance provide much suitable habitat. As it is generally selectively avoided by stock, grazing can be carried out all year.

At Upper Halling SSSI it has responded well to a hand raking regime; woody species are removed and the moss carpet raked out every five years in late summer when plants are obvious and before seed is set so that damage can be avoided. This management practice is also being applied at Micheldever SSSI, with machine removal of heavy scrub (Winship 1995).

At Daneway Banks NR it has responded well to turf stripping and movement of soil; the site is now lightly cattle-grazed in the autumn and the plants are protected from grazing by dead bushes being placed over them (B. Darling, pers. comm. 1996). Historically this site was intensively grazed by rabbits (M. Wilkinson, pers. comm. 1996).

At Fames Rough SSSI the open ground required by plant is maintained by ploughing which has been very successful in exploiting the existing seedbank on the site. The current plan is to rotovate strips every five years (the first strip rotovated in 1992 will be re-rotovated in 1997) between December and February. A shallow (10 cm) plough has been found to give the best results, possibly because most of the *Teucrium* seedbank is likely to be in the top layer of soil. Also, deeper-situated seeds of robust weedy species are not exposed resulting in the vegetation staying short and open, and although there is some regrowth of invading scrub occurs it is manageable and can be controlled by mowing as the plough furrows slowly disappear over a period of 18-24 months. Deep (c. 30 cm) ploughing has been found to result in infestations of robust weedy species such as *Pastinaca* and *Echium*, severe scrub regrowth which is difficult to control and long-lasting plough furrows which hinder mowing. The site is also now sheep-grazed for up to 10 weeks each year to control scrub (*Teucrium* is not eaten). Sheep are intensively grazed on small compartments which are moved around the site until the desired scrub control has been achieved (G. Harkness, pers. comm. 1996).

At Box Hill there is no management as the site is kept open by natural slippage down the scarp; the population is very small and precarious but has persisted for many years.

#### *Recommendations*

A predominantly monocarpic, biennial of open disturbed ground which reproduces by seed. Management should aim to create open conditions in the autumn by rotovation, raking, turf cutting or light grazing as appropriate taking care to protect established seedlings. Scrub invasion should be limited by cutting scrub or by light grazing.

### **3.14 *Veronica spicata* subsp. *spicata* - Breckland spiked speedwell**

Red Data Book species, now only known from four 10-km squares (Rich, in prep.). Listed on Schedule 8 of the Wildlife and Countryside Act 1981.

For subsp. *hybrida*, western spiked speedwell, see Section 3.15 below. Some authorities (e.g. Pigott & Walters 1954) regard subsp. *hybrida* as an ecotype of subsp. *spicata* but the taxa are dealt with separately here as their management requirements are different due to the nature of the sites, and they do appear to differ in minor ecological characteristics. A biological flora for both subspecies is in preparation by Wilson *et al.*

### *Life cycle*

A polycarpic, perennial which can potentially live indefinitely by clonal growth. Abundant seed is produced but most growth is vegetative by rhizomes and stolons, and it is quick to exploit open, sandy ground (Birkinshaw 1990).

It is evergreen, and new growth starts from April with most shoot production from May to July. It flowers from (April-) July to October (-November), and is pollinated by various insects, especially bumblebees, and seed set is good (Birkinshaw 1990). It is self-compatible (Wilson *et al*, in prep.). Seed capsules split to release seeds in the autumn. There are no specialised seed dispersal mechanisms. Seeds show good germination in cultivation, and establishment in the wild is likely to be mainly in the autumn as seedlings are readily droughted. Establishment is more successful on bare earth than in fine swards, and more successful in fine, open swards compared to coarse, tussocky swards (Birkinshaw 1990).

### *Distribution and ecology*

Restricted to the Breckland in East Anglia in Britain, but widespread on the continent. It has been recorded recently in four out of twelve sites and has declined due to conversion of grazed grass-heaths to arable land, afforestation, under-grazing, bracken invasion and roads (Trist 1979; Birkinshaw 1990; Whitton 1990).

It occurs in short (less than 10 cm), dry grasslands of the Breckland. The soils are sandy, well-drained, drought-susceptible, nutrient-poor and often non-calcareous, and are often associated with peri-glacial stripes or patches (Coombe 1987; Birkinshaw 1990). It is generally intolerant of shade and competition, and grows poorly in tall, tussocky, closed swards (Birkinshaw 1990). The NVC types are U1, CG3 and CG7 (Birkinshaw 1990). Associated species include *Achillea millefolium*, *Agrostis capillaris*, *Bromopsis erecta*, *Festuca ovina*, *F. rubra*, *Filipendula vulgaris*, *Galium verum*, *Lotus corniculatus*, *Luzula campestris*, *Koeleria macrantha*, *Plantago lanceolata* and *Senecio jacobaea* (Trist 1979; Birkinshaw 1990). In lightly-grazed or mown pastures its micro-distribution is determined by tussocks of *Festuca ovina* and soil patterns (Watt 1964; Coombe 1987).

Studies of patch dynamics in species-rich *Veronica spicata* - *Avenula pratensis* grassland in southern Sweden between 1986 and 1989 showed little vegetative mobility of *V. spicata*, and no seedlings were observed (Rusch & van der Maarel 1992). Colonies in Cambridgeshire are also remarkably stable (Crompton in Birkinshaw 1990).

Plants are drought-tolerant though the leaves shrivel alarmingly, and in wet conditions it may be susceptible to fungal attack (Birkinshaw 1990). It is quite tolerant of grazing but may get uprooted by rabbits burrowing and scraping. Rabbits, hares and/or small rodents nip off the inflorescences but do not eat the leaves to any great extent (Watt 1971; Birkinshaw 1990).

### *Management*

The short, open grassland it requires can be maintained by mowing or grazing. Watt (1971) regarded it as a plant of the 'building phase' of the Breck heaths needing some open ground as maintained by rabbit grazing, and noted it would succumb to competition by grasses in the 'mature phase'. It is believed to have become extinct at two sites where cessation of grazing allowed rank swards to develop (Birkinshaw 1990).

Management at Weeting Heath NNR is largely by rabbit grazing, where there are two regimes (M. Wright, pers. comm. 1996). The turf heights are typically about 1 cm, very short

and with up to 30% bare ground. Five populations have rabbit-proof fences with gates which are closed in mid late April and grazing excluded until the beginning of November when they are opened and rabbits allowed to graze until the spring. This allows the plants to flower and set seed (hundreds of spikes in good years), and consequently it is spreading to new sites both within and outside the enclosures. Three populations are outside enclosures and are grazed by rabbits all year - the proportion of plants flowering depend on grazing by the rabbit populations which fluctuate with myxomatosis, etc. If the rabbit grazing is light some plants can flower and set seed. If the grazing is heavy no inflorescences survive and it spreads vegetatively. Recently the Norfolk Wildlife Trust have also introduced winter (September to March) sheep grazing but the grazing is not needed for management of the *Veronica*. The stocking rate is c. 2.5 ewes/ha, and they are moved around the reserve compartments. The sheep do not graze the turf as closely as the rabbits.

The race course gallops on Newmarket Heath are cut regularly to a height of about 10 cm; plants flourish over quite a large area but flowering is quite sparse (Coombe 1987). Burwell Heath is also mown (Birkinshaw 1990). At Wiltonhill Wood the population is hand-weeded to keep competing vegetation down (Birkinshaw 1990).

Seeds and plants were experimentally re-introduced to two sites (Birkinshaw 1990). The West Harling Heath transplant has failed, possibly due to dense grass growth. Plants put into an ungrazed enclosure at Cavenham Heath NNR survived until at least 1995 (may have been killed by the severe 1995 drought but not known if the site was optimal); the enclosure was cut with a brush cutter in the early years. No plants survived outside the enclosure, probably due to very heavy rabbit grazing (M. Wright, pers. comm. 1996).

#### *Recommendations*

A long-lived, ever-green, perennial which colonises open ground vegetatively but also reproduces by seed if the inflorescences are not grazed off. It requires short open turf, c. 1 cm tall and with up to 30% bare ground, and will be eliminated by closed, long turf. It is tolerant of heavy grazing by rabbits or sheep to high stocking rates. Sites can also be mown to maintain the short grass, but bare ground may also need to be created.

### **3.15 *Veronica spicata* subsp. *hybrida* - Western spiked speedwell**

Nationally Scarce species recorded in 16/18 10-km squares in Britain since 1970 (Stewart, Pearman & Preston 1994).

For subsp. *spicata*, Breckland spiked speedwell, see above.

#### *Life cycle*

A polycarpic, long-lived perennial, which reproduces by seed and spreads vegetatively. Vegetative reproduction is by clonal spread of stolons and rhizomes (2-4 cm per year), and it can potentially persist indefinitely due to its vegetative growth. Reproduction by seed does occur but appears to be at low frequency. Populations vary between sites from a few clumps to several thousand. Numbers of plants are fairly stable from year to year but vary in flowering performance, and it may be somewhat shy-flowering in some sites. Populations differ from one another in morphology (Pigott & Walters 1954), and Kay & John (1995) found fairly high levels of genetic variation between sites although it was clonal and partly monomorphic within populations.

It is evergreen. New shoot production may start in March in mild years, with peak shoot production between May and July. It flowers from (June-) July to October (-January), and is weakly self-compatible (6.6%; Pring 1958) but is probably mainly pollinated by bees. Pring (1958) found the anthers dehisce before the stigma matures, and self-pollination did not occur. In contrast Wilson *et al.* (in prep.) found that it was self-compatible and probably capable of self-pollination. Seed production is often prolific; calculations of seed-set in the Avon Gorge with each spike producing 100 flowers and 10 seeds per capsule indicate a seed rain of over 3 million seeds per year (Lovatt 1982). Kay (1994) reported isolated plants may set poor seed, presumably due to poor cross-pollination. Seeds ripen from September onwards and are shaken out of the capsules by wind (Lovatt 1982).

Whittington, Wilson & Humphries (1988) found seeds germinated at all temperatures investigated in the laboratory between 7.5 and 25°C but was better at warmer temperatures, and they required light. Seedling establishment in the wild is erratic and sparse, usually within 1.5 m of the parent plant (Kay 1994). Pring (1958) observed no seedlings in the wild, and suggested that the difficulty of establishment from seed might contribute to its rarity. In cultivation experiments she found that germination occurred best in warm, damp conditions, but seedlings were small and unable to emerge from 1 cm depth of soil. Mortality of seedlings was high and depended on water supply. Very few seedlings grown on acid soils survived for more than three months compared to neutral and calcareous soils. Lovatt (1982) did observe a few seedlings, mainly in the summer, and noted that as it had colonised quarries in the Avon Gorge efficiently it must have spread by seed. He suggested that to establish from seed its requirements were for surface germination in a bare area, in warm, damp weather; such conditions were only likely to be of limited occurrence.

Transplants to new sites were carried out by Pring (1958). Plants did not establish from seed, but rooted transplants have survived for many years but do not reproduce themselves from seed (Lovatt 1982).

#### *Distribution and ecology*

Scattered in western Britain (for a recent map see Kay 1994), where it is a typical refugium plant (Pigott & Walters 1954). It typically occurs on inaccessible cliff ledges and shelves, rocky slopes, rock crevices, stabilised screes, limestone pavements, open dry grasslands and exceptionally on walls and ledges on shale outcrops. The sites are often dry, open and sun-baked. The base rocks are usually limestone or dolerite, and the soils are dry stony limestone rankers, protorendzinas, loams, and humic soils on the tops of cliffs. Lovatt (1982) recorded it from soils with a mean depth of 7-14 cm in the Avon Gorge.

It occurs in NVC types CG1, CG2, CG3, CG6, CG9, U1 and W21 (Rodwell 1992; D. Guest, pers. comm. 1996). The associated species vary between sites but include mixtures of calcicoles, therophytes and scrub species, and often include other rarities. In the Avon Gorge, Lovatt (1982) found the mean cover of vegetation was 59-93% with a mean height of 15-30 cm. He recorded it from four communities: typical *Bromopsis erecta* grassland (Mesobromium), *Bromopsis erecta* grassland with therophytes, open scrubby sites with woody and shade tolerant plants, and in sites with robust ruderals such as *Allium carinatum* and *Smyrniolum olusatrum* indicative of high soil nutrients (it has now been out-competed in these latter sites; L. Houston, pers. comm. 1996). Lovatt (1982) also noted some sites are more like calcareous heath than grassland.

It is moderately tolerant of shade and competition (Lovatt 1982), and plants can set seed in light shade. Pring (1958) found a 3-4-fold reduction in light intensity had little effect on growth in cultivation experiments, and found it was able to maintain itself in closed turf.



Partial shading by *Ligustrum* also appears to be beneficial on cliff ledges in the Avon Gorge, enabling plants to survive severe drought (L. Houston, pers. comm. 1996), and Lovatt (1982) suggested that the tall ecotype from the Avon Gorge may have evolved from a long co-existence with *Ligustrum* on ledges away from regular grazing. Like subsp. *spicata*, it cannot compete with dense tussocky grasses such as *Bromopsis erecta* or *Festuca ovina* (L. Houston, pers. comm. 1996). It is quite tolerant of drought, though flowering may be reduced (Pring 1958) and parts of patches may be killed off.

Stems and inflorescences are eaten by sheep, rabbits and small mammals. Cultivated plants were affected by aphids and mildew (Pring 1958).

### *Management*

Many cliff sites are unmanaged and the plant survives in open scrub and rocky grassland (e.g. Avon Gorge). Trimming of alien shrubs such as *Cotoneaster* may be needed in the Avon Gorge (Lovatt 1982), and the populations are now threatened by severe invasion of *Allium carinatum*, *Smyrniium olusatrum* and other alien plants (L. Houston, pers. comm. 1996).

It survived in a heavily sheep-grazed field for many years at Far Arnside SSSI, Cumbria, but the inflorescences were usually eaten off and it rarely flowered (M. Baecker, pers. comm. 1982). The successful management regime at this site now is to exclude stock from 1 June to 15 October, with grazing outside this period being "by sheep or sheep and cattle according to good agricultural practice"; rabbits also graze the site (I. Salter, pers. comm. 1996). At Humphrey Head SSSI it occurs on the ungrazed cliffs and on shorter grassland on the crest of the brow where it is lightly-grazed by sheep and rabbits (I. Salter, pers. comm. 1996).

In Wales, it thrives in areas of open vegetation, subject to little or no grazing, but will persist vegetatively in areas of closed sward subject to hard and continuous sheep grazing (e.g. parts of Great Orme's Head, Little Orme's Head and Gloddaeth). Many sites are grazed by rabbits which are noted to damage inflorescences. Scrub encroachment is one of the more immediate threats on several Welsh sites, and several colonies may have been lost to *Ulex* and other scrub invasion (D. Evans, D. Guest, A. Jones, D. Stevens, pers. comms. 1996).

Transplanted populations on the Gallery Roof in the Avon Gorge were mown with a strimmer twice a year in the mid 1980s; this appears to have been beneficial in maintaining the open conditions it prefers (Wilson *et al.*, in prep.).

Seedlings have become established on burnt ground (Evans & Davies 1978), and sporadic fires occur at two south Wales sites (D. Guest, pers. comm. 1996).

### *Recommendations*

A long-lived perennial which reproduces vegetatively and by seed. It typically occurs on cliffs and rocky slopes which require little or no management except control of scrub and non-native species. It will tolerate heavy grazing by sheep or mixed stock but does not flower; stock should therefore be excluded from June to September to optimise seed production.

## **3.16 Diagrammatic summary of life cycles**

The periods during which leaves, flowers and fruits are present for each of the species is summarised in Figure 1.

Figure 1. Summary of life cycles of selected rare lowland semi natural grassland plant species

SPECIES		MONTH											
		J	F	M	A	M	J	J	A	S	O	N	D
<i>Aceras anthropophorum</i>	Leaves	■	■	■	■	■	■					■	■
	Flowers					■	■	■					
	Fruits						■	■	■				
<i>Epipactis atrorubens</i>	Leaves				■	■	■	■	■	■	■	■	■
	Flowers						■	■	■				
	Fruits						■	■	■	■			
<i>Gentiana anglica</i>	Leaves		■	■	■	■	■	■	■	■	■	■	■
	Flowers			■	■	■	■	■					
	Fruits				■	■	■	■	■				
<i>Herminium monorchis</i>	Leaves					■	■	■	■	■	■		
	Flowers						■	■	■				
	Fruits						■	■	■	■			
<i>Himantoglossum hircinum</i>	Leaves	■	■	■	■	■	■	■	■	■	■	■	■
	Flowers					■	■	■	■				
	Fruits						■	■	■	■			
<i>Iberis amara</i>	Leaves	■	■	■	■	■	■	■	■	■	■	■	■
	Flowers					■	■	■	■	■	■	■	■
	Fruits						■	■	■	■	■	■	■
<i>Linum perenne</i>	Leaves			■	■	■	■	■	■	■	■	■	■
	Flowers					■	■	■	■	■			
	Fruits						■	■	■	■			
<i>Ophrys fuciflora</i>	Leaves	■	■	■	■	■	■	■	■	■	■	■	■
	Flowers						■	■	■				
	Fruits						■	■	■	■			
<i>Ophrys sphegodes</i>	Leaves	■	■	■	■	■	■	■	■	■	■	■	■
	Flowers				■	■	■	■	■				
	Fruits						■	■	■	■			
<i>Orchis ustulata</i>	Leaves	■	■	■	■	■	■	■	■	■	■	■	■
	Flowers					■	■	■	■				
	Fruits						■	■	■	■			
<i>Polemonium caeruleum</i>	Leaves				■	■	■	■	■	■	■	■	■
	Flowers						■	■	■				
	Fruits						■	■	■	■			
<i>Pulsatilla vulgaris</i>	Leaves			■	■	■	■	■	■	■	■	■	■
	Flowers			■	■	■	■	■					
	Fruits					■	■	■	■				
<i>Teucrium botrys</i>	Leaves	■	■	■	■	■	■	■	■	■	■	■	■
	Flowers						■	■	■	■			
	Fruits						■	■	■	■	■	■	■
<i>Veronica spicata</i> subsp. <i>spicata</i>	Leaves	■	■	■	■	■	■	■	■	■	■	■	■
	Flowers						■	■	■	■	■	■	■
	Fruits						■	■	■	■	■	■	■
<i>Veronica spicata</i> subsp. <i>hybrida</i>	Leaves	■	■	■	■	■	■	■	■	■	■	■	■
	Flowers						■	■	■	■	■	■	■
	Fruits						■	■	■	■	■	■	■