Orobanche reticulata Wallr.

Thistle Broomrape

Orobanche reticulata is a tall herb that is parasitic on *Cirsium* and *Carduus* species. It has a highly restricted distribution in the British Isles with the majority of populations close to the River Ure and River Wharfe in Yorkshire, where it grows in rough grassland and scrub overlying magnesian limestone. Most populations are small although its numbers can increase dramatically following disturbance or warm and wet autumns. Although it can tolerate eutrophic conditions, its rarity (usually <1,000 individuals in any one year) makes it highly susceptible to land use change, in particular gravel extraction, river and road development works.

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IDENTIFICATION

Orobanche reticulata is a tall herb that lacks chlorophyll and is completely parasitic on the roots of *Carduus* and *Cirsium* species. The stem has scale leaves (dense below) and the inflorescence, which often occupies most of the stem, is a cylindrical spike of creamy-white flowers that are suffused purple towards their apex. Two colour forms occur in Britain: in most populations the corolla base colour is white, however in a few sites they are creamy-yellow and less tinged purple distally (Jones, 1989). British populations belong to subsp. *pallidiflora* which some European botanists treat as a separate species, *O. pallidiflora*, as distinct from sub-alpine and alpine *O. reticulata* (Kreutz 1995; Piwowarczyk *et al.*, 2010).

Orobanche reticulata growing amongst *Cirsium arvense* at Quarry Moor, Ripon, 5 October 2015. ©Kevin Walker

SIMILAR SPECIES

Due to its limited host range in Britain, *O. reticulata* is unlikely to be confused with other broomrapes in the field, with the possible exception of tall *O. minor* which is occasionally found growing on thistles. However, *O. reticulata* is usually taller (to 70 cm) with more 'r-shaped' and open-mouthed cream-coloured corollas that are suffused with purple towards their apex due to presence of dark-tipped glandular hairs (Rumsey, 2008).

HABITATS

In Britain typical habitats for *O. reticulata* include the banks of rivers and adjacent floodplain grassland, scrub and woodland, but large populations also occur in dry grassland away from rivers including rough pastures, roadside verges and old quarries. Most of these habitats are disturbed, humid and eutrophic with a distinct nitrophilous element. Non-riparian populations appear more stable and may be its original native habitat (Foley, 1993) with colonies in marginal habitats, such as field borders and roadsides, representing the remnants of much larger grassland colonies that have been lost to ploughing.

Most British colonies are located on flat or gently sloping ground, and where it does occur on sloping ground nearly all have a westerly aspect (Hughes & Headley, 1996). It usually occurs on fertile, circum-neutral soils (pH 7-8) with a high sand content (Jones, 1989; Hughes & Headley, 1996). In Britain the most typical vegetation type is *Arrhenatherum elatius* grassland (NVC MG1a, MG1b, MG1e; Rodwell, 1992), often very tall, unmanaged stands with abundant *Arrhenatherum elatius*, *Cirsium arvense*, *Dactylis glomerata*, *Rubus fruticosus* and *Heracleum sphondylium*. In sites undergoing succession to scrub or woodland it is more often associated with *Rubus fruticosus-Holcus lanatus*

underscrub community (NVC W24) or more rarely *Crataegus monogyna-Hedera helix* (NVC W21) or *Prunus spinosa-Rubus fruticosus* (NVC W22) scrub.

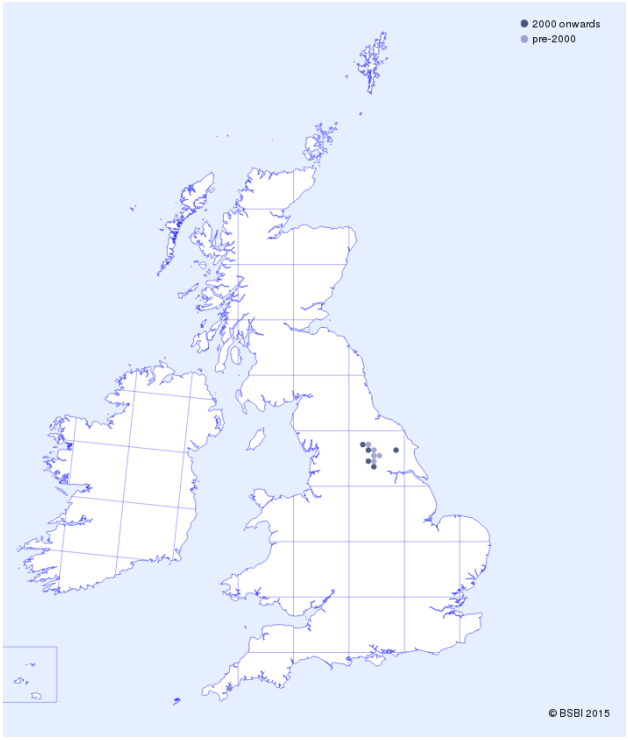
The habitats of lowland subsp. *pallidiflora* in Europe are very similar including xerothermic or semidry grasslands, ruderal habitats, waterlogged alkaline meadows, and humid forest and scrub usually on mesotrophic-alkaline sandy clays and loams (Piwowarczyk *et al.*, 2010).

Although *O. reticulata* is often found in areas prone to winter-flooding it does not appear to tolerate prolonged water-logging. It can grow in light shade amongst scrub or in recently felled areas but it does not persist under dense shade and has been lost from a few sites where a woodland canopy has developed (e.g. Langwith).

BIOGEOGRAPHY

Orobanche reticulata occurs throughout much of Europe extending eastwards through the Caucasus to the Himalaya and possibly in North Africa (Sell & Murrell, 2009). It is most frequent in the subalpine and alpine regions of central and southern Europe and much less common in northern Europe, where it reaches its northern limit, with isolated colonies in Britain, Scandinavia, the Baltic States, north Germany, and The Netherlands. The British plant is subsp. *pallidiflora* and this has a lowland distribution in Europe and is quite distinct from the more montane subsp. *reticulata*.

In Britain, *O. reticulata* is restricted to Yorkshire, where it appears to have been first discovered in the mid-nineteenth century, although it was not confirmed as a British species until 1909 (Druce, 1909; Foley, 1993; 1999). Since then it has been recorded from around 70 localities in 10 hectads, 52 of which were extant in 1992 (Foley, 1993). There have been no systematic surveys of its distribution since then but it still persists in many of its best-known localities (e.g. Cow Cliffe Pastures, Hook Moor, Quarry Moor, Ripon Parks). More than 85% of these populations are confined to the valleys of the River Ure and River Wharfe where these bisect the narrow belt of magnesian limestone between Ripon and Leeds with a few riverside colonies further downstream (e.g. Boroughbridge, Linton Locks). There is also a small cluster of non-riparian populations on the magnesian limestone near to Aberford (Hook Moor) and, uniquely in a British context, on the chalk at two sites near to Malton (Cow Cliffe Pastures and Wharram Quarry SSSIs). It was introduced to Wharram Quarry in the 1990s and is now flourishing with c.175 flowering spikes recorded in 2013 and 2014 (Emma Leighton, pers. comm.). All records away from this restricted area are now thought to be misidentifications (Foley, 1993).



Distribution of *Orobanche reticulata* in Great Britain and Ireland.

Its restriction to one small area has led to doubts about its native status (e.g. Pugsley, 1926) although its limited host range, morphological variability (Foley, 1992), as well as a comparable distribution pattern to other parts of northern Europe strongly support it being a genuinely native plant in Britain (Foley, 1993). Jones (1989) noted that its distribution falls entirely within the region with < 750 mm annual precipitation an average daily minimum February temperature of < 1.7˚C.

All British localities are lowland (10 to 125 m OD). In continental Europe subsp. *pallidiflora* occurs to 1205 m in the Western Bieszczady Mountians in Poland whereas subsp. *reticulata* ascends to 2500 m in the European Alps and 3660 m in the Himalayas (Piwowarczyk et al., 2010).

ECOLOGY

In Britain *O. reticulata* is a root parasite of thistles, almost always on *Cirsium arvense*, and more occasionally *C. eriophorum*, *C. palustre*, *C. vulgare*, *Carduus crispus* or *Carduus nutans*. There is also a single record of it parasitizing *C. heterophyllum* in a garden near to York where it must have been casual (Foley, 1993). It becomes increasingly polyphagous in continental Europe with hosts including members of the Cistaceae and Dipsicaceae. Interestingly it appears to avoid areas heavily infested by *C. arvense* preferring areas where the host is less abundant and more scattered, although it should be noted both the density and height of its hosts are significantly reduced by the presence of *O. reticulata* (Hughes & Headley , 1996).

Orobanche reticulata appears to behave as an annual or biennial in Britain and possibly only rarely as a perennial (Rumsey &. Jury, 1991). Seeds are dispersed in the autumn but probably need periods of cold (winter) and warm (summer) conditions to germinate (Jones, 1989). Therefore, seedlings probably develop in the autumn following dispersal, attaching themselves to a suitable host root. The underground tuber develops over the winter and spring and flowers in the

following summer (annual) or in the second summer (biennial) if it has not accumulated sufficient carbohydrate reserves (Hughes & Headley, 1996). The flowers are thought to be monocarpic although is not known for certain whether the tubers survive and continue to flower (i.e. the plant behaves as a polycarpic perennial).

O. reticulata flowers from June to August with the dead stems persisting and shedding seed for several months, thereby allowing surveys to be undertaken long after flowering has ceased. Secondary flowering in October and November has been reported from Poland but has not been observed in Britain (Piwowarczyk *et al.*, 2010). The flowers are bisexual and are likely to be pollinated by a wide range of insects including wasps, bees and flour beetles (Jones, 1989; Hughes & Headley, 1996). The flowers also display autogamy having a highly effective self-pollination mechanism towards the end of the flowering period (Jones, 1989).

Flower and seed production is high compared to other British broomrapes (c. 50 flowers per spike) with mature capsules producing between 2,000 and 4,000 tiny seeds. Therefore even small populations can produce large amounts of seed with the majority being dispersed very effectively by wind and/or water (Hughes & Headley, 1996). The seed can remain buoyant in water for 1.5 days (Jones, 1989) and its appearance in newly cleared sites, for example after clear-felling of trees at Ox Close Wood, suggests that seed can remain dormant for many years (Foley, 1999; Smith, 2103). As with other broomrapes seed germination requires a chemical exudate on the roots of the host although the exact nature of this stimulant in *O. reticulata* is unknown.

Although most populations in Britain are very small, often with less than 10 flowering plants, they can persist for many years. At a few sites numbers can occasionally approach 1,000 (e.g. c.900 at Quarry Moor, Ripon in 2015; Dan McAndrew, pers. comm.) although numbers usually vary dramatically from one year to the next. The reasons for this are unclear but appear to relate to its short-lived lifecycle and climatic variation with 'good' years usually following warm, wet autumns that are optimal for seed germination (Hughes & Headley, 1996). *O. reticulata* can also appear in large numbers a few years after disturbance events caused by animals, road building, rotovation, woodland clearance or erosion due to flooding. The reasons for this are unclear but could include increased seed penetration of the root zone of its hosts, increases in the abundance of its hosts, or the uncovering of dormant seed banks.

Flooding clearly plays an important role in some years either by dispersing seed or vegetative fragments or by creating new habitat for its hosts. Spring flooding appears to have few negative effects, probably because the tubers are already well established, whereas autumn flooding may be detrimental as it washes away whole plants and creates anaerobic soil conditions (Hughes & Headley, 1996). Predation by slugs and snails is also thought to have a detrimental effect on numbers, especially in the late winter and early spring when the tubers and new shoots grow near to the soil surface and are therefore vulnerable to attack (Jones, 1989; Hughes & Headley, 1996).

THREATS

The main threat to *O. reticulata* in the past was the loss of grassland to ploughing and quarrying and this has resulted in its restriction to marginal (ecotonal) habitats in some areas (e.g. field boundaries, roadside verges, embankments, islands in rivers, etc.). However, today the main threats appear to be deliberate destruction of its hosts, especially *C. arvense* (a noxious agricultural weed), gravel extraction, and engineering works affecting roads and rivers. Nevertheless it appears relatively resilient to disturbance and agricultural intensification and may have even increased in some areas, presumably because modern land practices favour *C. arvense*.

MANAGEMENT

Grazing is essential for maintaining the open conditions required by its host, ideally during the autumn and winter months to avoid damaging new plants as they emerge in the spring. Scrub removal and reinstatement of grazing may be needed on a few abandoned or disused sites, although it is unlikely that anything could be done to maintain riverside sites that are difficult to access. The disturbance caused by rotovation is also likely to benefit the species and has been used on a few sites to great effect.

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