

## ***Thlaspi perfoliatum* L. (Cruciferae) in the British Isles: distribution**

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### ABSTRACT

The distribution of *Thlaspi perfoliatum* L. in the British Isles is analysed. The plant is restricted to the Cotswolds as a native on screes and open grassland. It readily colonizes suitable ground such as that created by quarrying from local sites. Seed appears to be randomly distributed in association with railways. It occurs elsewhere as a casual, but only persists when associated with oolite baserock. The origin of the native distribution is a phytogeographical puzzle.

### INTRODUCTION

*Thlaspi perfoliatum* L., Perfoliate Pennycress, has long been noted for its very restricted distribution in the British Isles (Boulger 1877). It is a small, spring-flowering annual particularly characteristic of open, oolitic limestone soils in the Cotswolds, where, although evidently once locally abundant (e.g. Riddelsdell *et al.* 1948), it is now becoming very scarce. The purpose of this paper is to analyse the distribution of the plant in the British Isles.

Four species of *Thlaspi* occur in the British Isles: *T. alliaceum*, *T. arvense*, *T. caerulescens* (*T. alpestre*) and *T. perfoliatum*. *T. perfoliatum* is easily distinguished from the other species by its 2-4(-6) ovate, perfoliate stem leaves and small (3.0-5.5(-7.5) mm), broadly obovate fruits which are narrowly winged above. Depauperate plants of *T. arvense* have occasionally been mistaken for *T. perfoliatum* but have fruits broadly winged all round.

Morphologically, British *T. perfoliatum* varies little except in size. Plants in the U.S.S.R. with conspicuously remotely dentate leaves have been distinguished as var. *denticulatum* N. Busch (Busch 1939), but in Britain there is continuous variation from entire to toothed leaves and hence the variety is not recognized. British *T. perfoliatum* is also morphologically indistinguishable from the bulk of European material examined at LTR and K and is therefore considered taxonomically identical.

Outside the British Isles, *T. perfoliatum* occurs as a native throughout Europe to northern France, Belgium and central Germany with a few scattered localities around the southern Baltic, and occurs eastwards to south-western Russia, Afghanistan and the Near East, and in N. Africa (Meusel *et al.* 1965).

### SOURCES OF RECORDS AND ASSESSMENT OF DATA

Records have been collated from national and county floras, journals, unpublished manuscripts, correspondence with B.S.B.I. vice-county Recorders and other botanists, the Biological Records Centre, Monks Wood and from the following herbaria: ABRN, BM, BRIST, BRISTM, CGE, CHM, DZS, E, GL, GLR, K, LANC, LIV, LSR, LTR, NMW, OXF, PLH, RNG and WARMS. Many sites

from which *T. perfoliatum* had been recorded in the past have been re-visited, and field data were collected in 1986 and 1987 from extant sites.

A number of records, mainly in Druce (1934), have been rejected. Records for v.cc. 30 and 53 are regarded as errors for *T. arvense* (Dony 1953; Gibbons 1975), and records for v.cc. 64 and 70 errors for *T. caerulea* (Lees 1888; Hodgson 1898). A specimen of *Lepidium perfoliatum* collected at Frodsham, Cheshire in 1929 (LIV) mis-named as *Thlaspi perfoliatum* may be the source of the v.c. 58 record (A. Gunn, pers. comm. 1986). The record for v.c. 38 is due to confusion of Kineton, Warwickshire with Kineton, Gloucestershire (Bagnall 1891). Worcestershire records from Bearborough (Butcher 1921) and Benborough (Harris 1928) probably refer to Scarborough, Cutsdean (J. Day, pers. comm. 1987) in v.c. 33, not v.c. 37. Another Worcestershire record from Evenlode (Amphlett & Rae 1909) is also in v.c. 33. Records for Bristol and Devon have also been rejected by White (1912) and Martin & Fraser (1939) respectively, and we have been unable to trace the origin of the "wall in Buckinghamshire" record in Lousley (1950). The Cleeve Hill, Cheltenham record (Ratcliffe 1975) is an error (T. C. E. Wells and D. A. Wells, pers. comm. 1987).

Because of the fragmentary, inconsistent, historical nature of many of the records used here, we have adopted a constant reductionist approach in assessment and acceptance of records, preferring caution to over-estimation. A record is considered here to be any unique combination of site (and habitat if stated), date and recorder. Records such as "Oaksey" and "near Oaksey" have been taken to be the same site unless other information indicates the contrary. Some records have been interpreted in the light of other records; for instance, specimens labelled "Tetbury" are assumed to refer to the classic Tetbury Road railway station site (cf. Boulger 1877) and not to the town itself. Literature records corresponding with herbarium specimens have been amalgamated to avoid duplication. Although there is a degree of subjectivity in interpretation, the resulting records are assumed to be representative. Details are lodged at the Biological Records Centre.

One other record is noted here but not included in any further analysis. *T. perfoliatum* was introduced to Cumnor Hill, Berkshire in about 1861 (Druce 1927), where, fortunately, it did not persist. As far as we are aware this is the only instance of deliberate introduction.

#### DISTRIBUTION AND HABITATS

We have accepted records for 35 10-km squares. There are no reliable records for Ireland. The records have been assessed on a consideration of ecology and habitat information (both past and present), site history and dates of records, recorders' comments and associated species. As many of the records have habitat information (Table 1; Figs 1A–C), the records for various habitats have been investigated further.

*Thlaspi perfoliatum* is usually considered a natural component of the vegetation on open screes, banks and pastures on oolitic limestone. Typically, the plant occurs in rubble virtually devoid of other vegetation or on shallow, bare rendzina soils with *Erophila verna* sensu lato and *Hieracium pilosella*, and is evidently dependent on the maintenance of open conditions for long-term survival.

TABLE 1. NUMBER OF RECORDS AND NUMBER OF 10-KM SQUARES FOR THE HABITATS IN WHICH *T. PERFOLIATUM* HAS BEEN RECORDED

Habitat	No. of records	No. of 10-km squares
Open pastures, screes, etc.,	44 (13.5%)	9
Quarries	51 (15.6%)	9
Railways	65 (20%)	17
Arable	4 (1.2%)	3
Walls	3 (0.9%)	3
Riverbanks	2 (0.6%)	2
Other	4 (1.2%)	4
Not recorded	155 (47.5%)	20

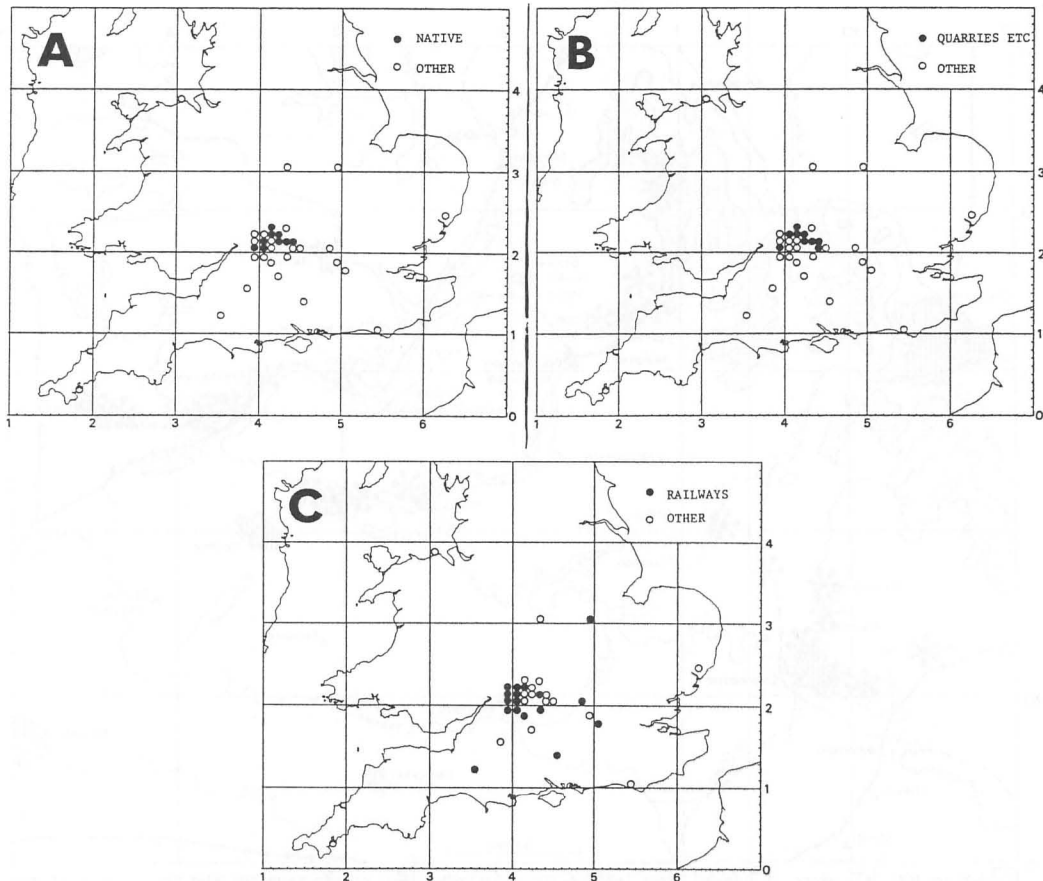


FIGURE 1. 10-km square records of *T. perfoliatum* (the Scottish record for Forres (Webster 1978) is not included on the maps). A: squares where it is thought to be native; B: squares in which it has been recorded in quarries, stone pits, etc.; C: squares where it has been recorded associated with railways.

It usually occurs in or near grassland containing other rare calcicoles characteristic of old grassland such as *Pulsatilla vulgaris*, *Thesium humifusum* and *Astragalus danicus*.

Fig. 1A is a map showing what we consider to be the native distribution. The plant may be native elsewhere in this area too. It is not considered native on quarry spoil heaps or railways as these are artificial habitats, even if seeds have spread by their own accord. Note that this is a stricter interpretation of the native range than that of Perring & Walters (1962).

When the records are plotted on a larger scale map (Fig. 2) they show that the native range can be divided into three regions: the area from which the plant was originally recorded in v.c. 23, and two areas in v.c. 33 – one to the north-west of Bourton-on-the-Water and the other to the south-west of Foss Cross extending to Cirencester and Sapperton. These are generally hilly areas with exposed, oolite rocks and shallow soils. Whether these three regions are the remains of a more continuous distribution in the Cotswolds or expansions from localized refugia (cf. Pigott & Walters 1954) is unknown.

Quarrying creates much habitat eminently suitable for the plant, and the records associated with quarries, stone pits, spoil, etc., are plotted in Fig. 1B. The map is similar to Fig. 1A, suggesting colonization from local native populations but little tendency to spread between such sites. *T. perfoliatum* has no specialized seed dispersal mechanisms.

Fig. 1C shows the distribution of records from railways, where *T. perfoliatum* is usually recorded

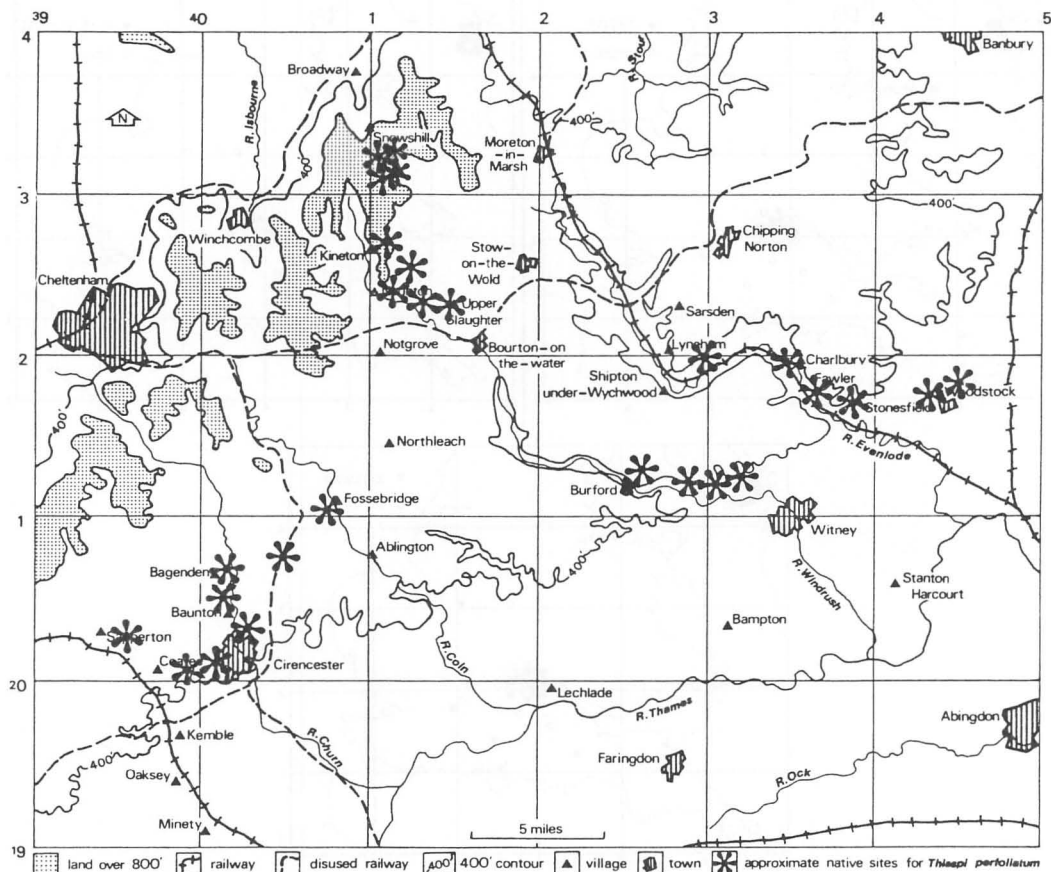


FIGURE 2. Approximate locations of sites where *T. perfoliatum* is thought to be native.

on chippings and cinders on the tracks, cuttings, embankments and old stations (e.g. Boulger 1877; Druce 1897; Messenger 1971; Holland *et al.* 1986). A comparison of the map with Fig. 1A indicates that the plant has been widely dispersed in association with the railways, probably as seeds transported in ballast and in the slipstream of passing trains. Twelve of the 17 10-km records are from outside the native range. When the number of 10-km square records per unit (1 km<sup>2</sup>) area is plotted as a function of distance from the centre of the native range, there is an inverse exponential relationship (Fig. 3). This is similar to seed and pollen rain observed in other plants (Harper 1977; Janzen 1970; Pigott & Huntley 1980) and suggests that seed dispersal in association with railways is largely a random process.

Three other habitats in which *T. perfoliatum* has been recorded but where it does not persist also deserve mention. Four records are from farms where it probably occurred as a weed in crops (e.g. Brenan 1946). The plant is a common weed in southern and eastern Europe (Busch (1936) describes it as a "noxious" weed in the U.S.S.R.) and hence seed could have been introduced with foreign grain, as presumably happened at Falmouth Docks (Davey 1909). However, the fact that the records are from within or at the edges of the known distribution and are absent from elsewhere in the country, and the war-time date of the Brenan (1946) record, suggest that the seed is more likely to have been of local origin. There are three records from walls, surprisingly few in view of the abundance of walls constructed with oolite rock in the Cotswolds, an apparently suitable habitat. Finally, there are two records from riverbanks, the populations presumably originating from seed

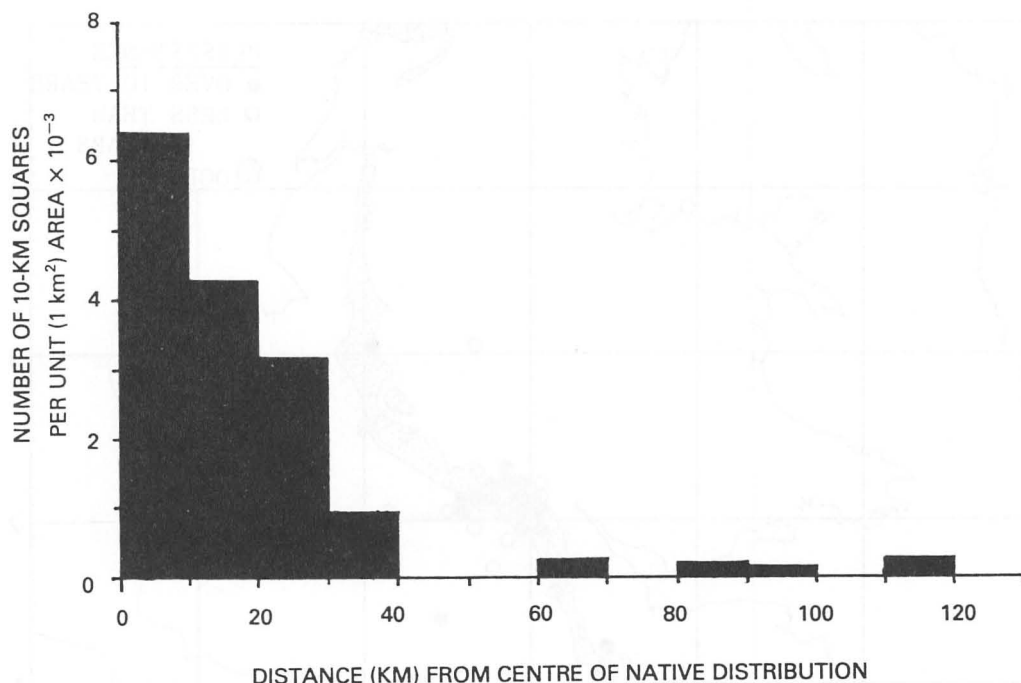


FIGURE 3. A graph showing, for records of *T. perfoliatum* associated with railways, the relationship between distance from the centre of distribution and the number of 10-km square records per unit (1 km²) area.

washed down the catchment, as is also reported for *T. caerulea* (cf. Gilbert in Milne-Redhead 1963).

Elsewhere, the plant occurs as a casual (e.g. Arnold 1907; Webster 1978) and there are a number of exasperating records without habitat information, e.g. Prestatyn (*W. Harrison*, 1923, **LIV**), Twycross (*Rev. A. Bloxam*, 1842, **K**) and Woodbridge (*W. R. Roberts*, in *Countryside N.S.* 3: 184, 1921).

A characteristic feature is the association of the plant with oolitic limestone. Fig. 4 shows 10-km squares in which the plant has been recorded for periods of 10 years or more. The correlation of persistence with the occurrence of oolite is very marked and is statistically significant ( $p < 0.01$ , using  $\chi^2$ ). Of the sites at which the plant persisted away from oolite baserock, one (v.c. 12) was probably introduced with oolite ballast and the other two are on limestone very similar to oolite. This strict association may result from very specific ecological requirements of the plants in the British Isles. On the continent, *T. perfoliatum* also occurs on other types of limestone and seems more catholic in its requirements.

#### DISCUSSION

Most features of the distribution can be explained by analysis of the habitat data. What can not be explained is the restriction of the plant as a native to the Cotswolds. This is as much a phytogeographical puzzle as is the distribution of *Pulsatilla vulgaris* (Wells & Barling 1971). The Cotswold localities are disjunct from the plant's range on the Continent, as are the localities around the Baltic. Pigott & Walters (1954) have interpreted the disjunct distributions of a number of species of open habitats in terms of widespread reductions of range during the post-glacial period, and it is possible that a similar explanation could be applied to *T. perfoliatum* too.

The plant appears to be restricted to oolitic soils in the British Isles by some unknown ecological

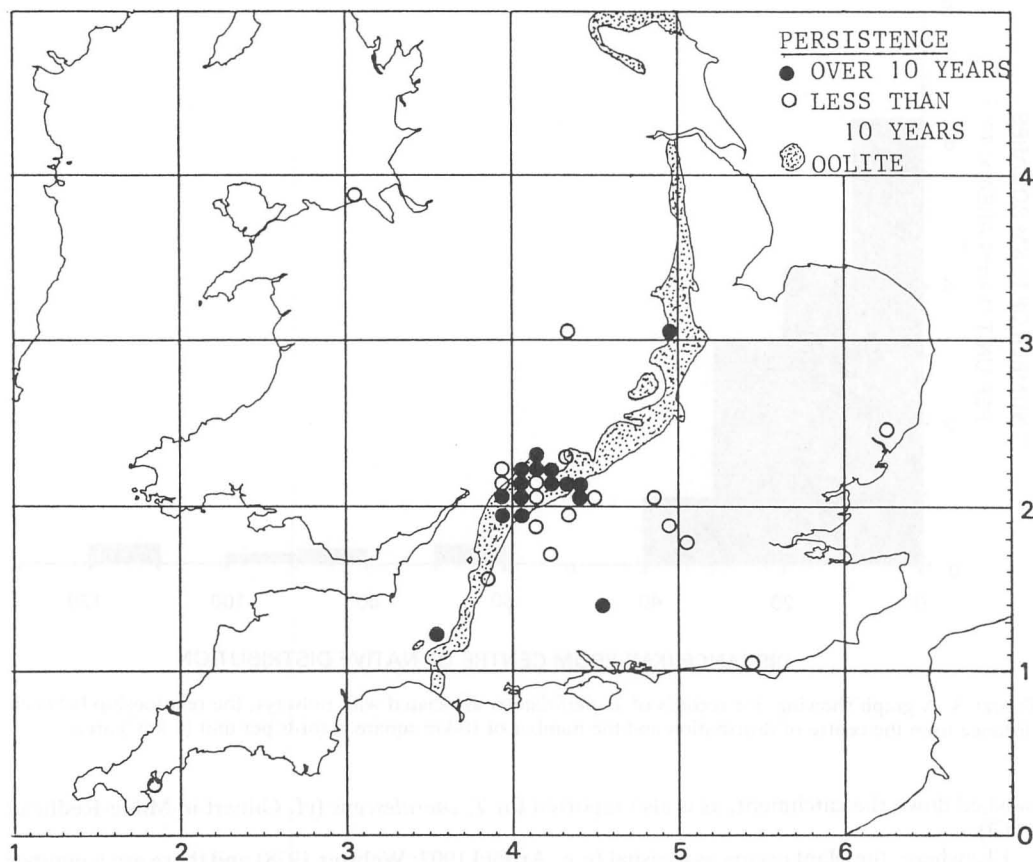


FIGURE 4. 10-km squares for which *T. perfoliatum* has been recorded for periods of 10 years or more in relation to the distribution of oolitic limestone baserock.

factor(s), but it is not currently restricted to the Cotswolds by climate, as introduced railway colonies in Somerset and Rutland have both persisted for over 20 years. It has not been recorded as a native on the other extensive areas of oolite in Purbeck and Dorset, Northamptonshire, Leicestershire and Lincolnshire, and East Yorkshire.

The occurrence of other calcicoles with restricted distribution growing in association with the *Thlaspi* suggests that the general areas in which the plant occurs have been open grassland for a long period of time. At a 10-km square level, the correlation between the occurrence of *T. perfoliatum* and the other rare grassland calcicoles is statistically highly significant ( $p < 0.001$ , using  $\chi^2$ ). Whether these other species have quaternary phytogeographic histories similar to that of *T. perfoliatum* remains to be seen, but it is interesting to note that the two other plants with their centres of distribution also on the Cotswold oolite, *Carex tomentosa* and *Stachys germanica*, occur there in quite different habitats. Further understanding will have to await detailed studies both of the autecology of *T. perfoliatum* and of the vegetation history of the Cotswolds.

Finally, two points arise out of our experience in compiling the data base for *T. perfoliatum*. First, our analysis of distribution by habitat shows the potential of this type of data; habitat information ought to be collected systematically with other site details. Second, it is very worthwhile checking original sources of references; it is surprising how often records have been copied incorrectly (e.g. first records for v.cc. 7, 33 and 34), or missed (e.g. records for v.cc. 51 and 55 in LIV and K respectively).

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## REFERENCES

- AMPHLETT, J. & RAE, C. (1909). *The botany of Worcestershire*. Birmingham.
- ARNOLD, F. H. (1907). *Flora of Sussex*, 2nd ed. London.
- BAGNALL, J. E. (1891). *The flora of Warwickshire*. London.
- BOULGER, G. S. (1877). Remarks on the distribution of the Perfoliate Penny-Cress (*Thlaspi perfoliatum* Linn.) in Britain. *J. Linn. Soc.* **16**: 185–188.
- BRENNAN, J. P. M. (1946). Notes on the flora of Oxfordshire and Berkshire. *Rep. botl Soc. Exch. Club Br. Isl.* **12**: 784.
- BUSCH, N. A. (1939). *Thlaspi* L., in KOMAROV, V. L., ed. *Flora U.R.S.S.* **8**. Leningrad.
- BUTCHER, R. (1921). *Thlaspi perfoliatum* L. *Rep. botl Soc. Exch. Club Br. Isl.* **6**: 375.
- DAVEY, F. H. (1909). *Flora of Cornwall*. Penryn.
- DONY, J. G. (1953). *The flora of Bedfordshire*. Luton.
- DRUCE, G. C. (1897). *The flora of Berkshire*. Oxford.
- DRUCE, G. C. (1927). *The flora of Oxfordshire*, 2nd ed., Oxford.
- DRUCE, G. C. (1934). *The comital Flora of the British Isles*. Oxford.
- GIBBONS, E. J. (1975). *The flora of Lincolnshire*. Lincoln.
- HARPER, J. L. (1977). *Population biology of plants*. London.
- HARRIS, J. (1928). *Thlaspi perfoliatum* L. *Rep. botl Soc. Exch. Club Br. Isl.* **8**: 388.
- HODGSON, W. (1898). *Flora of Cumberland*. Carlisle.
- HOLLAND, S. C. *et al.*, eds. (1986). *Supplement to the Flora of Gloucestershire*. Bristol.
- JANZEN, D. H. (1970). Herbivores and the number of tree species in tropical forests. *Amer. Nat.* **104**: 501–528.
- LEES, F. A. (1888). *The flora of West Yorkshire*. London.
- LOUSLEY, J. E. (1950). *Wild flowers of chalk and limestone*. London.
- MARTIN, W. K. & FRASER, G. T. (1939). *Flora of Devon*. Arbroath.
- MESSINGER, K. G. (1971). *The flora of Rutland*. Leicester.
- MEUSEL, H., JÄGER, E. & WEINERT, E. (1965). *Vergleichende Chorologie der Zentraleuropäischen Flora*. Leipzig.
- MILNE-REDHEAD, E. (1963). *Conservation of the British flora*. London.
- PERRING, F. H. & WALTERS, S. M. (1962). *Atlas of the British flora*. London.
- PIGOTT, C. D. & HUNTLEY, J. P. (1980). Factors controlling the distribution of *Tilia cordata* at the northern limits of its geographical range. II. History in north-west England. *New Phytol.* **84**: 145–164.
- PIGOTT, C. D. & WALTERS, S. M. (1954). On the interpretation of the discontinuous distributions shown by certain British species of open habitats. *J. Ecol.* **42**: 95–116.
- RATCLIFFE, D. A. (1975). *A nature conservation review*, 2. Cambridge.
- RIDDLESDALE, H. J. *et al.* (1948). *Flora of Gloucestershire*. Cheltenham.
- WEBSTER, M. M. (1978). *Flora of Moray, Nairn and East Inverness*. Aberdeen.
- WELLS, T. C. E. & BARLING, D. M. (1971). *Pulsatilla vulgaris* Miller, in Biological Flora of the British Isles. *J. Ecol.* **59**: 275–292.
- WHITE, J. W. (1912). *The flora of Bristol*. Bristol.

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