THE USE OF VASCULAR PLANTS AS INDICATORS OF ANCIENT WOODLAND IN SOMERSET: THE DEVELOPMENT OF A COUNTY-SPECIFIC LIST

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SUMMARY

The conservation value of woodlands in the UK is widely considered to be a function of age and continuity. The Somerset Environmental Records Centre (SERC) has so far used the 100 vascular plant indicators of Hornby and Rose (1986) to determine if a site is ancient woodland. This present study tests the reliability of these indicators by comparing their distributions within a sample of ancient and secondary woodland sites. For one third of the species, the study found that their value as indicators was compromised by their apparent rarity. A further one third were discounted on the basis of unreliability. Only 36 of the 100 species were considered likely to be effective as indicators. Moreover, it is likely that none of the 100 species is incapable of colonising secondary woodland in Somerset. The probable reasons for this unreliability are discussed and alternative and complementary assessment procedures are suggested.

Keywords

Vascular plants, indicators, ancient woodland, Somerset, biodiversity

INTRODUCTION

The comparatively tiny fragments of ancient woodland which exist today in Somerset, and throughout the country, represent our only link with the expansive forests of prehistory. Many of the species contained within these woodlands evolved in a stable, contiguous environment, where specialisation conferred fitness and dispersal ability conferred little or none. But the same characteristics, which once brought these species so much success, now work to their detriment. Specialisation and poor dispersal ability point to a dependency on habitat continuity through both space and time. Whilst no ancient woodlands in Somerset have escaped intervention by man, these continuously wooded fragments do remain a haven for many threatened woodland specialists. As a consequence, identification of these areas is of paramount importance to nature conservation. Unfortunately, their scattered distribution and the ephemeral nature of much of their flora and fauna present major obstacles to the production of comprehensive species lists. The employment of biological indicators perhaps offers the only opportunity to identify these areas quickly and cost-effectively.

WOODLAND INDICATOR SPECIES

Biological indicators can be used to identify a range of environmental factors. A taxon is most valuable as an indicator if it can fulfil three broad characteristics: i) reliant upon or faithful to the factor under investigation, ii) easy to sample for and readily identifiable, iii) widely distributed.

These requirements mark out vascular plants as the prime candidates for indicators of ancient woodland. Amongst vascular plants there is a considerable number of widely distributed woodland specialists which are easy to locate at the right time of year and to identify to species level. It may be noted, however, that poor dispersal ability, one of the characteristics most likely to guarantee the faithfulness of a species to ancient woodland, is likely to compromise the extent of its distribution within the ancient woodland fragments. Conversely, a frequently occurring plant is likely to have a more effective mode of dispersal which would, in turn, compromise its faithfulness. The faithfulness of indicators is further compromised by variations in soils and climate from region to region. These factors can result in striking differences in the dispersal powers of a large number of plant species (Hornby and Rose 1986). As a consequence, a truly reliable list of indicators can only be achieved through a comparison of the flora of ancient and secondary woodlands in the same geographical area, with similar dimensions, soils and drainage characteristics. Although studies of this nature have been undertaken, most notably by Peterken (1974) in the limewoods of Lincolnshire, resource constraints have precluded widespread replication.

The Somerset Environmental Records Centre (SERC) has traditionally used the indicator list for south-west England (Hornby and Rose 1986) drawn up on behalf of the former Nature Conservancy Council (NCC). Hornby and Rose produced a provisional list of 100 species for each of the three regions of southern England following inspection of a large amount of woodland survey data. These lists were then refined and finalised after consultation with botanical experts with experience of woodland in southern England. The final lists, therefore, were more the product of consensus and compromise than objectivity. Application of the list for south-west England in Somerset has cast doubt on the degree of faithfulness to ancient woodland of many of the listed species.

After many years of intensive woodland recording by SERC, there is now an opportunity to develop a more reliable ancient woodland indicator list specific to Somerset which could be used for site evaluation. As an initial step in this process, this present study aims to test and to refine the list of indicators devised by Hornby and Rose (1986).

METHODS

Eighty two Somerset woodlands were selected for the study (41 'ancient' sites and 41 'secondary' sites). A woodland was identified as 'ancient' by reference to the following:

1 The NCC Somerset Inventory of Ancient Woodland (Lister and Pinches, 1986), which listed woodlands no less than 2ha in area. This document draws together evidence from a variety of sources, including:
   - The 1782 Day and Masters Somerset County Map.
   - The OS 1 inch First Edition maps – based on surveys dated 1800–1829.
   - The OS First Series 1:25 000, 1899–1950.
   - Historical and ground survey work undertaken by the STNC.
   - Ground survey work, recording vascular plants and lichens associated with old woodlands.
   - The Tithe maps of 1820s to 1840s.
   - A variety of further information, including archaeological studies and place-name evidence.

2 Identification by Anderson (1993) of woodlands, no less than 0.5ha in area, from the Tithe Maps of the 1820s–1840s.

Secondary sites were selected on the basis that they did not appear in 1 and 2 above, or were included in 2 as Tithe Map plantations. Additional evidence was drawn from: modern place names, such as 'Plantation', 'Planting' or 'Cover'; physical evidence of previous use, such as a disused railway line; and statements from surveyors and historians. This resulted in 41 secondary sites being selected for analysis. Some sites were excluded where they adjoined woodland which was possibly ancient and from which species may have spread on to even a small part of the secondary site.

Geology and soil science were not considered in selecting sites. However, in order to ensure a representative final list of vascular plants, taking account of county-wide variations, an even geographical spread of sites was sought, using data from a wide variety of woodland types. The vascular plant records for each selected site were drawn from survey data already held at SERC. The survey data for all the sites in this study were collected between February and June, when many woodland plants are in flower. Surveys carried out later in the year are likely to be incomplete, since many species disappear completely in late summer.

The relative distributions between ancient and secondary woodland were examined for each of the one hundred species listed by Hornby and Rose (1986). An index of faithfulness (F) to ancient woodland was obtained using the equation:

$$\frac{\text{Number of ancient sites in which species x occurs}}{\text{Total number of occurrences of species x}}$$

This produces an index ranging from 0 to 1. An index of 0.5 would indicate an observed absence of bias in the distribution of a species.

Chi-squared tests were carried out on each species to test the null hypothesis that their distributions were independent of woodland type (ancient or secondary). Where the number of observations amounts to ten or less the chi-squared test is unreliable. In such instances, the binomial distribution tables of Finney *et al*. (1963) were employed as an acceptable alternative (Wardlaw 1985).

DEFINITION OF TERMS

For the purposes of this study, the definitions of 'Ancient' is as cited in the NCC Somerset Inventory of Ancient woodland (Lister and Pinches 1986). The NCC Inventory uses the term 'Ancient' to refer to sites which have been continuously wooded since 1600, stating that the majority of these are believed to be Primary, i.e. in existence as woodland long before 1600. Those which are not Primary, but are indeed 'Ancient' (continuously wooded since 1600) are termed 'Ancient Secondary'. For the following study, no distinction has been made between 'Ancient Secondary' and 'Primary' woodland: all are referred to as 'Ancient'. It is often impossible to separate the 'Ancient Secondary' sites from the 'Primary' sites as these mature woods are likely to have many characteristics of true primary woodlands.

RESULTS

The principal constraint for this study proved to be the identification of woodlands of demonstrably recent origin. This prevented an analysis of data by soil type, which must be taken into consideration when inspecting the results. *Euphorbia amygdaloides* Wood Spurge,

Table 1: Those species which reject the null hypothesis that their distributions are independent of woodland type [2 x 2 contingency table: chi-squared test, except where the number of species records is ten or less (low data) which follow Finney *et al*. (1963)]. Also shown is the number of ancient woodlands and secondary woodlands in which each species was found to occur, together with their respective faithfulness indices (F). The final column indicates whether each species is included on the revised ancient woodland indicator list (see Table 3).

Species name	**Ancient**	**Secondary**	**F**	**Chi-square**	**Probability**	**New list?**
Lamiastrum galeobdolon	32	9	0.78	23.61	P<0.001	Y
Galium odoratum	23	4	0.85	17.89		Y
Anemone nemorosa	22	6	0.79	12.20		Y
Ribes rubrum sens.str.	10	0	1.00	low data		Y
Polypodium vulgare agg.	25	10	0.71	9.77	P<0.005	Y
Luzula pilosa	14	2	0.88	9.40		Y
Melica uniflora	14	2	0.88	9.40		Y
Ulmus glabra	17	4	0.81	9.22		Y
Potentilla sterilis	24	10	0.71	8.49		Y
Prunus avium	14	3	0.82	7.42	p<0.01	Y
Viola reichenbachiana	14	3	0.82	7.42		Y
Veronica montana	28	15	0.65	7.04		N
Viola riviniana	28	15	0.65	7.04		N
Hyacinthoides non-scripta	37	26	0.59	6.85		N
Paris quadrifolia	9	1	0.90	low data		Y
Milium effusum	13	3	0.81	6.29	p<0.05	Y
Conopodium majus	25	13	0.66	5.93		N
Allium ursinum	20	9	0.69	5.34		N
Quercus petraea	13	4	0.77	4.75		Y
Sanicula europaea	18	8	0.69	4.56		Y
Luzula sylvatica	8	1	0.89	low data		Y
Polystichum aculeatum	8	1	0.89	low data		Y
Polygonatum multiflorum	5	0	1.00	low data		Y
Adoxa moschatellina	26	16	0.62	3.95		N

for example, appears to be a reliable indicator on acid clays, but on chalk the species also occurs in many secondary woodlands (Hornby and Rose 1986). In the present study (see Table 2), *E. amygdaloides* was found to occur in three of the selected secondary woodlands, all of which were located in the east of the county on relatively calcareous soils. Such a result is inconclusive, but the treatment of species distribution as independent of edaphic factors is a limitation likely to compromise the faithfulness of a number of indicators.

A further consideration is the low number of occurrences of a number of species, which renders tentative any conclusions about their degree of faithfulness to ancient woodland. As with Peterken (1974) 'local observation' and 'knowledge of species behaviour' is necessary to aid the selection of species. The difficulty of identifying secondary sites also led to an imbalance in the mean areas of secondary and ancient woodlands (5.9ha and 12.5ha respectively). However, this study could find no evidence for a correlation between the areas of the selected woodlands and the number of ancient woodland indicators (product-moment correlation of log (area) against NCC indicators): secondary (r=0.245; d.f.=39) or ancient (r=0.176; d.f.=39). A comparison between the two data sets is therefore justified.

Table 1 presents the plant species on the south-west indicator list of Hornby and Rose (1986) which, in this present study, yielded a statistically significant bias in their distributions in favour of ancient woodland. The species vary widely in the degree of faithfulness they exhibit. *Hyacinthoides non-scripta* Bluebell and *Adoxa moschatellina* Moschatel exhibit only a small bias towards ancient sites. The chi-square test identifies this bias simply because of the large number of records. For the purposes of selection it is necessary to gauge the statistical test in the light of the faithfulness index (F) and vice versa. A degree of faithfulness of less than 0.7 must be seen as unsatisfactory, but an element of informed speculation is required to determine the true faithfulness of each species. Although such species as *Hyacinthoides non-scripta* reject the null hypothesis, the faithfulness is low and the large number of records reinforces a conclusion of unreliability. The species which can be discounted as unreliable indicators on this basis are: *Veronica Montana* Wood Speedwell*, Viola riviniana* Common Dog-violet*, Hyacinthoides non-scripta, Conopodium majus* Pignut and *Adoxa moschatellina*.

By contrast, the results for *Allium ursinum* Ramsons (F=0.69, P=<0.05) and *Sanicula europaea* Sanicle (F=0.69 P=<0.05) do not conclusively reject the conclusions of Hornby and Rose (1986). Low data may account for the low faithfulness indices. For *Sanicula europaea*, this possibility is supported by visual inspection of additional records held by SERC and by the autecological reports of Grime *et al*. (1988). *S. europaea* exhibits a strong association with woodland habitats and is tolerant of heavy shade. Although in eastern England the species appears to be an effective coloniser (Peterken 1974) elsewhere it only very rarely occurs in plantations. Seed production is generally less than 100 seeds per plant per year and plants do not flower until 8 to 16 years of age. There appears to be no persistent seed bank. Stands of *Allium ursinum*, by contrast, exhibit a large annual seed production and are less restricted to woodland habitats. Although seeds generally fall close to the parent plant observations suggest that flowing water may be an effective means of seed dispersal (James *et al.* 1995). Muddy tracks and minor roads are likely to be similarly effective. Consequently, the strong association of this species with both hedgerows and riparian corridors may render many records spurious as evidence for habitat continuity (although hedgerows and riparian corridors may be 'ancient' remnants too).

The results for the remaining NCC indicators of Hornby and Rose (1986) are presented in Table 2, except for those species which were unrecorded or occurred at only one ancient woodland site. Species absent or occurring only once are discounted from the revised list since the rarity of these species diminishes their value as indicators. Thirty-four species are eliminated on this basis, including *Populus tremula, Aconitum napellus agg.* Monk's-hood*, Campanula trachelium* Nettle-leaved Bellflower*, Dryopteris carthusiana* Narrow Buckler-fern*, Helleborus viridis* Green Hellebore*, Lathyrus sylvestris* Narrow-leaved Everlasting-pea and *Luzula forsteri* Southern Wood-rush. This study provides no additional evidence for a number of species on the NCC list because of low data (Table 2). However, there are problems of identification with *Malus sylvestris* Crab Apple and *Rosa arvensis* Field-rose. *M. sylvestris* can be confused with cultivated varieties *and R. arvensis* can hybridise in Somerset with *R. stylosa* Short-styled Field-rose and *R. canina* Dog-rose (Roe 1981). They are therefore discounted. Both *Solidago virgaurea* Goldenrod and *Lathyrus montanus* Bitter-vetch are discounted because of their lack of association with woodland habitats (Grime *et al*. 1988*). S. virgaurea* also has the ability to colonise abandoned quarry spoil and exposures (Grime *et al*. 1988) which may acquire secondary woodland cover.

All species in Table 2 with records of 26 or more are assumed to be unreliable as indicators. Species with low data (25 records or less) are rejected only if their distributions exhibit a statistically significant difference from an expected faithfulness (F) of 0.95 (chi-squared test; 2 x 2 contingency table). This equates to an observed faithfulness (F) of 0.69 or less, depending on the number of records. Such a procedure eliminates: *Carex remota* Remote Sedge (chi-square = 6.12, P<0.05); *Moehringia trinerva* Three-nerved Sandwort (chi-square = 4.23, P<0.05); *Stachys officinalis* Betony (chi-square = 11.0, P<0.001); *Tamus communis* Black

Table 2: The NCC indicators (Hornby and Rose 1986) which were found to occur in one or more of the ancient woodland sites and which accept the null hypothesis (chi-squared test) that the distribution of each species is independent of woodland type. The table presents the number of ancient woodlands and secondary woodlands in which each species occurs together with their respective faithfulness indices (F). The final column indicates whether each species is included on the revised ancient woodland indicator list (see Table 3).

Species name	**Ancient**	**Secondary**	**F**	**New list?**
Acer campestre	27	19	0.59	N
Blechnum spicant	18	13	0.58	N
Bromus ramosus	5	3	0.63	Y
Carex pendula	20	13	0.61	N
Carex remota	13	9	0.59	N
Carex sylvatica	17	10	0.63	N
Chrysoplenium oppositifolium	17	13	0.57	N
Colchicum autumnale	4	1	0.80	Y
Daphnel laureola	6	3	0.67	Y
Epipactis helleborine	2	1	0.67	Y
Euphorbia amygdaloides	10	3	0.77	Y
Geum rivale	3	1	0.75	Y
Holcus mollis	18	9	0.67	N
Hypericum androsaemum	5	1	0.83	Y
Hypericum pulchrum	6	8	0.43	N
Ilex aquifolia	35	33	0.51	N
Iris foetidissima	8	8	0.50	N
Lathraea squamaria	2	0	1.00	Y
Lathyrus montana	4	3	0.57	N
Lysimachia nemorum	13	5	0.72	Y
Malus sylvestris sens.la.	7	2	0.78	N
Melempyrum pratense	4	2	0.67	Y
Moehringia trinerva	6	6	0.50	N
Narcissus pseudonarcissus	4	2	0.67	Y
Neottia nidus-avis	4	1	0.80	Y
Orchis mascula	19	11	0.63	N
Oxalis acetosella	25	16	0.61	N
Phyllitis scolopendrium	24	19	0.56	N
Plantanthera chlorantha	7	4	0.64	Y
Poa nemoralis	9	7	0.56	N
Polystichum setiferum	23	17	0.58	N
Primula vulgaris	32	23	0.58	N
Ranunculus auricomus	9	3	0.75	Y
Rosa arvensis	8	6	0.57	N
Solidago virgaurea	2	1	0.67	N
Sorbus torminalis	3	0	1.00	Y
Stachys officinalis	9	12	0.43	N
Tamus communis	11	8	0.58	N
Tilia cordata	2	1	0.67	Y
Viburnum opulus	10	4	0.71	Y
Vicia sepium	13	13	0.50	N
Vicia sylvatica	2	1	0.67	Y

Bryony (chi-square = 5.35, P<0.05*); Iris foetidissima* Stinking Iris (chi-square = 6.02, P<0.05); *Poa nemoralis* Wood Meadow-grass (chi-square = 4.58, P<0.05) and *Hypericum pulchrum* Slender St John's-wort (chi-square = 6.62, P<0.05). However, this study can offer no evidence on the faithfulness of the majority of those species which show a low number of records. They must be assumed to be reliable indicators on the basis of the work by Hornby and Rose (1986) although there is clearly need for further research

Table 3 presents the revised list of ancient woodland indicators totalling 36 species. The species are arranged subjectively into three groups according to the degree of confidence in their faithfulness to ancient sites. The number of revised indicators found in each of the ancient woodland sites selected for this study ranges from 2 to 24. The number of revised indicators found in the secondary woodlands ranges from 0 to 8. It follows, given the overlap, that some woodlands will be misidentified if classification rests solely on the use of ancient woodland indicators. If 5 indicators are required to classify a woodland as ancient then, from the 82 woodlands selected for this study, 12 would be misidentified (6 ancient and 6 secondary).

An adjunct to the present study has compared the distributions of other woodland species in an attempt to identify new, potential indicators (Table 4). Few additional species were identified, but *Taxus baccata* Yew, *Cornus sanguinea* Dogwood, *Euonymus europaea* Spindle and *Viburnum lantana* Wayfaring-tree appear to be the most promising. Peterken (1974) found *E. europaea* to be a reliable indicator of ancient woodlands in Linco1nshire. Caution is required, however, since *T. baccata, C. sanguinea* and *V. lantana* are all regularly planted. For example, three of the selected ancient woodland sites in this study in which *T. baccata* occurs are sites associated with conifer plantations. Further research is clearly required.

DISCUSSION

The results of this study suggest that very few of the plant species listed by Hornby and Rose (1986) do not exhibit a bias in their distributions in favour of ancient woodland. However, amongst the more common species, this bias is often slender and there are probably no common species incapable of colonising Somerset's secondary woodlands. More reliable indicators may be found amongst the 34 species discarded on the basis of their rarity, but this is far from certain. The restricting autecology of many of the listed species is seldom reflected in their distributions. Even the most promising indicators regularly occur in secondary woodland. Such an observation is evident despite the spatially disadvantaged nature of the secondary woodlands selected for this study. The secondary woodlands were on average substantially smaller than their ancient counterparts and efforts were made to avoid the selection of secondary sites which lie adjacent to ancient woodland remnants. It is reasonable to assume, therefore, that the use of vascular plants as the sole criterion for determining the status of Somerset's woodlands will lead to the misidentification of a substantial proportion of secondary woodlands.

Furthermore, the low occurrence of vascular plant indicators in a woodland, cannot be interpreted as unequivocal proof of secondary status. Several factors can influence the actual number of indicators found in a wood (Edgington 1992), including geology, soils, topography, drainage, size and dimensions, management history and geographical location. Many woodland plant species do not thrive under a closed canopy and can only flourish following tree-falls. Coppicing and woodland ride creation mimics this process and woodlands managed in this way tend to present a more diverse and prominent flora at any given time. Jones (1997) found an association between the amount of 'edge' in Somerset's ancient woodland sites and the number of recorded ancient woodland indicators. It follows therefore that the application of vascular plant indicators is largely a test of spatial discontinuity influenced by temporal continuity. This may reflect the requirements of such groups as woodland butterflies, but not the requirements of many other woodland specialists (Hambler and Speight 1995).

The nature of any indicator imposes limits on the answers it can provide. Whilst woodland vascular plants do exhibit a dependency upon temporal continuity they are not likely to be

Table 3: The revised list of 36 ancient woodland indicators derived from the list by Hornby and Rose (1986), with the number of ancient and secondary woodlands in which each species was found to occur and their respective faithfulness indices (F). In descending order, the species are arranged subjectively into three groups according to the degree of confidence in their faithfulness to ancient sites. Species are arranged alphabetically within each group. Species marked with an asterisk (*) should be treated as reliable if the relevant record occurs well within the wood and the specimen does not appear to have been planted.

Species name	Common name	Ancient	Secondary	F
Anemone nemorosa	Wood Anemone	22	6	0.79
Galium odoratum	Woodruff	23	4	0.85
Lamiastrum galeobdolon	Yellow Archangel	32	9	0.78
Luzula pilosa	Hairy Wood-rush	14	2	0.88
Melica uniflora	Wood Melick	14	2	0.88
Ribes rubrum sens.str.	Red Currant	10	0	1.00
Ulmus glabra	Wych Elm	17	4	0.81
Luzula sylvatica	Great Wood-rush	8	1	0.89
Milium effusum	Wood Millet	13	3	0.81
Paris quadrifolia	Herb Paris	9	1	0.90
Polygpnum multiflorum	Solomon's-seal	5	0	1.00
Polypodium vulgare agg.	Common Polypody	25	10	0.71
Polystichum aculeatum	Hard Shield-fern	8	1	0.89
Potentilla sterilis	Barren Strawberry	24	10	0.71
Prunus avium	Wild Cherry	14	3	0.82
*Quercus petraea**	Sessile Oak*	13	4	0.77
Sanicula europaea	Sanicle	18	8	0.69
Viola reichenbachiana	Early Dog-violet	14	3	0.82
Bromus ramosus	Hairy Brome	5	3	0.63
Colchicum autumnale	Meadow Saffron	4	1	0.80
Daphne laureola	Spurge Laurel	6	3	0.67
Epipactis helleborine	Broad-leaved Helleborine	2	1	0.67
Euphorbia amygdaloides	Wood Spurge	10	3	0.77
Geum rivale	Water Avens	3	1	0.75
Hypericum androsaemum	Tutsan	5	1	0.83
Lathraea squamaria	Toothwort	2	0	1.00
Lysimachia nemorum	Yellow Pimpernel	13	5	0.72
Melampyrum pratense	Common Cow-wheat	4	2	0.67
*Narcissus pseudonarcissus**	Wild Daffodil*	4	2	0.67
Neottia nidus-avis	Bird's-nest Fungus	4	1	0.80
Plantanthera chlorantha	Greater Butterfly Orchid	7	4	0.64
Ranunculus auricomus	Goldilocks Buttercup	9	3	0.75
Sorbus torminalis	Wild Service Tree	3	0	1.00
*Tilia cordata**	Small-leaved Lime*	2	1	0.67
Viburnum opulus	Guelder Rose	10	4	0.71
Vicia sylvatica	Wood Vetch	2	1	0.67

significantly affected by any brief hiatus in suitable conditions. A clear-felled woodland is likely to lose most of its specialist invertebrates, but many plants will persist in the seed-bank for some time. *Euphorbia amygdaloides*, for instance, can persist in a seed-bank for 125 years (Rackham 1986). The notion that floristic diversity is commensurate with overall biodiversity is a largely untested assumption. A wholly objective and verifiable assessment procedure could only be attained with a deeper understanding of the synergistic and antagonistic relationships between woodland taxa and the spatial and temporal characteristics of their environment. The

Table 4. New, potential indicators identified by the study which reject the null hypothesis that their distributions are independent of woodland type (chi-squared test; 2x2 contingency table). The table also shows the number of ancient woodlands and secondary woodlands in which each species was found to occur together with their respective faithfulness indices (F).

Species name	**Ancient**	**Secondary**	**F**	**Chi-square**	**Probability**
Ajuga reptans	28	15	0.65	7.0411	P<0.01
Euonymus europaeus	18	7	0.72	5.7544	P<0.05
Fragaria vesca	19	8	0.70	5.5219	P<0.05
Ranunculus ficaria	33	22	0.60	5.5219	P<0.05
Cornus sanguinea	15	5	0.75	5.3565	P<0.05
Viburnum lantana	12	3	0.80	5.2219	P<0.05
Taxus baccata	8	1	0.89	low data	P<0.05

employment in Somerset of an additional group of indicators to work in concert with vascular plants could prove a valuable first step in this holistic approach. Saproxylic invertebrates, for instance, have attracted much recent interest as potential indicators, but collection and identification do present problems (Lott 1996). Archaeological evidence may be the most effective way of determining a site's age, whilst not necessarily reflecting high biodiversity, but such a procedure is also problematic, since it is subject to individual interpretation.

There is a marked contrast between the success of Peterken (1974) in identifying reliable vascular plant indicators in Lincolnshire and the very limited success of the present study for woodlands in Somerset. Alternative methodologies may be required to clarify the autecology of plant species within Somerset: perhaps by mapping the rates and the nature of colonisation into secondary woodlands of known age. However, the basis of the contrast between the two counties is likely to be more historical than autecological. The landscape of Lincolnshire largely derives from the Enclosure Acts of the 18th and 19th centuries, with fewer woodlands and younger, species-poor hedgerows (Rackham 1986). Ancient hedgerows are abundant in Somerset, by contrast, supporting many vascular plant indicators and these must provide an important source for the colonisation of secondary woodland habitats. The absence of any apparent relationship between the area of ancient woodland sites and the number of ancient woodland indicators provides indirect support for the importance of this interconnectedness. Doubtless, such a rich, ancient network of hedgerows and copses presents a suite of problems for a systematic approach towards nature conservation. But, for Somerset, these problems are but blessings in disguise.

CONCLUSIONS

Table 1 shows the unexpectedly restricted list of vascular plants that in Somerset occur almost entirely in ancient woodlands. This list is dominated by *Ribes rubrum* Red Currant, *Galium odoratum* Sweet Woodruff and *Lamiastrum galeobdolon* Yellow Archangel.

The analysis shows that many of the vascular plant indicators previously used in Somerset are not well connected with ancient woodlands.

Additional assessments, not based solely on the connection between floristics and ancientness, are required in order to be completely confident that any wood is secondary rather than ancient.

About the authors

Bill Butcher is the director of SERC (the Somerset Environmental Records Centre) and the other three authors were working there when this survey was carried out. Richard Thompson was the project officer who designed the work, while Paul Williams and Maria Warren carried out much of it. All are graduates with considerable experience of Somerset woods and the database on which this survey depended.

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