Rep. Trans. Devon. Ass. Advmt Sci., **140**, *185–198*

(Figures 1–10)

A survey of *Sorbus* species at Watersmeet, North Devon, September 2007

Dr T. C. G. Rich

and

D. C. G. Cann

A survey of endemic Sorbus species, Whitebeams, was carried out in the woodlands of Watersmeet, North Devon. 478 Whitebeams were recorded, of which there were 28 S. vexans, 3 S. porrigentiformis, 270 S. subcuneata, 108 'No Parking Whitebeams' (an undescribed species), and 69 undetermined trees. The woodlands have exceptionally good populations of Whitebeams, supporting 98 per cent of the world population of the 'No Parking Whitebeam', about 82 per cent of the world population of S. subcuneata, and about 30 per cent of the world population of S. vexans.

Introduction

The superb woodlands at Watersmeet, North Devon are one of the largest areas of semi-natural woodland in Southwest England. They lie within the steep-sided East Lynn River valley and its tributary the Hoar Oak Water, with farmland or heathland and open grassland above. Some areas are ancient woodland with a long history of woodland cover, and others are secondary woodland colonising the adjacent ungrazed heathland and grasslands. They are owned by the National Trust, and are designated as a Site of Special Scientific Interest.

The Watersmeet woodlands are well known for their rare, endemic *Sorbus* species, Whitebeams. They are best known for both *S. subcuneata* Wilm., Slender Whitebeam, and for the strongly lobed form of *S. devoniensis* E. F. Warb., Devon Whitebeam, which became known as *Sorbus* 'No Parking' after a notice nailed to

a tree in the 1930s (this will be described as a new species by M. C. F. Proctor). Isoenzyme studies (Proctor *et al.*, 1989) showed that this 'No Parking Whitebeam' is distinct from *S. devoniensis* sensu stricto, and has an extremely restricted distribution to Watersmeet and the adjacent Sillery Sands. *Sorbus devoniensis* is quite widespread in Southwest England and Southeast Ireland, but does not occur at Watersmeet. *Sorbus subcuneata* also has a very restricted distribution along the North Devon-North Somerset coast from near Combe Martin to Minehead. Watersmeet also holds a small population of *S. porrigentiformis* E. F. Warb., Grey-leaved Whitebeam, a more widespread endemic of Southwest England and South Wales, and the type locality of *S. vexans* E. F. Warb., Bloody Whitebeam, another very rare tree with a distribution similar to that of *S. subcuneata*. Distribution maps for all species are given in Preston *et al.* (2002).

Despite their rarity, there is little recent information available on the numbers and status of the Whitebeams at Watersmeet. Some population data for all four species are available from the surveys carried out in 1984–1985 by M. E. Proctor, who reported at least 32 *S. vexans*, one *S. porrigentiformis*, 18 *S. subcuneata*, 13 'No Parking Whitebeams' and 106 undetermined trees of these latter two species (total 170 trees).

A joint meeting between the Botanical Society of the British Isles and the Devonshire Association was held on 29 and 30 September 2007 to collect data on the four endemics. The aims were first, to map the distribution of each species, and second, to collect performance data (height, girth and fruiting) to indicate the age structure of the populations to see if they are healthy or degenerative. The best way to assess tree age is to core trunks and count the tree rings, but coring may result in some damage to the trees (Houston *et al.*, 2008), so height and girth were used as non-invasive proxies. Tree height and girth can both indicate age of trees, and are usually highly correlated. Height is the poorer measure; it may be adapted locally to the surrounding woodland canopy height, and it is difficult to measure accurately quickly (it is usually estimated by eye). Girth is a better indicator of age; it can be measured accurately but the ring widths may vary depending on environmental conditions such as soils and light and it is not a perfect estimator of age either. The presence of fruit can show that the populations have potential to regenerate.

In this paper, the survey result are summarised; full details have been deposited with the Botanical Society of the British Isles, Devonshire Association, National Trust, Natural England, Threatened Plants Database and National Museum of Wales.

Methods

Most of the survey was carried out on 29 and 30 September 2007, with three subsequent visits in the following weeks to complete mapping of distributions in certain areas when often only the tree locations were noted.

A total of 22 botanists were split into groups of 2–4, and each group was allocated an area marked on a 1:10,000 map to survey. An identification guide to *Sorbus* in Southwest England was given to each botanist, and the trees were demonstrated in the field. Identification was usually relatively easy if a good view of the canopy leaves could be obtained, and fallen leaves on the ground were often adequate for identification. Some samples were collected for verification by the authors. However, some small saplings only had a few atypical leaves on young shoots remaining and could not be identified, and some trees were recorded to genus if the botanists were not confident of the identification. *Sorbus aucuparia* L., Rowan, is widespread in the woods and was not mapped. A map showing where M. E. Proctor had found *S. subcuneata* and the 'No Parking Whitebeam' was also given to each group. The only plants noted by Proctor which we did not have time to look for were *S. vexans* at c. SS/7335.4870 and c. SS/7345.4890.

For each tree, the location was noted using hand-held GPS units, the height was estimated by eye, the girth measured at 1.3 m, the growth form noted as maiden or coppice, and fruit was noted if seen. It was often not easy to see the trees for the wood, and fallen leaves often provided useful clues as to the presence of a tree nearby. Individual trees were usually easy to define as discrete individuals, but sometimes it was not clear if a small sapling near a large trunk was a separate young tree or a sucker from the old one; in several cases some young trees were clear suckers attached to roots up to 1 m from the main trunk; this may have resulted in a few individuals being counted twice. One GPS reading was often used for several trees growing in close proximity. Heights between 4m and 12m tended to be estimated in multiples of 2m (i.e. multiples of people), so these estimates were

grouped into 2m size classes for presentation. It was not possible to measure some girths of trees on cliffs. Coppice included both natural coppice and coppicing from woodland management, and it was sometimes difficult to draw the line between recording a tree with a few small shoots coming from the base of a large trunk as a maiden or a coppice. Many oaks had single trunks selected from old coppice stools, and it is possible this might have occurred with the Whitebeams too, though they would probably not have been encouraged during woodland management. It sometimes proved difficult to see if fruit were present in the canopy on the largest trees.

The GPS units proved surprisingly accurate despite the dense woodland canopy and heavy cloud. The average difference between seven units at the start of the day was under 4m in either direction (maximum difference 15m east-west and 16m north-south), and the average reported accuracy was ±12.4m.

Results

A total of 478 Whitebeams were recorded, of which 28 were *S. vexans*, 3 *S. porrigentiformis*, 270 *S. subcuneata*, 108 'No Parking Whitebeams', and 69 undetermined trees of the latter two (often saplings which had lost most or all their leaves). The distributions of the species are mapped in Figs 1–4; the undetermined trees were concentrated in the central area (data not presented). There was a surprising amount of regeneration given the evidence of deer present. We have little doubt that there are more trees, as some groups under-recorded small saplings, some saplings in the understory had already lost their leaves, and it was difficult to cover the steep valleys sides and outcrops thoroughly.

Sorbus vexans preferred open, sunlit rocks (Fig. 1). *Sorbus porrigentiformis* seemed to be rare on the more calcareous outcrops of Lynton slates where it could reach the light (Fig. 2). 'No Parking Whitebeam' and *Sorbus subcuneata* were clustered in the central Watersmeet area in oak coppice (Figs 3 and 4). Very few trees occurred outside this area to the west, south and southeast where the woodlands change to taller *Ulmus-Fraxinus-Quercus* woodland or *Fagus* plantations. Some areas only had either *S. subcuneata* or 'No Parking Whitebeam', though sometimes they grew intermixed. As a general rule, Whitebeams prefer sunlit situations, but both of these species have probably inherited some shade tolerance from their

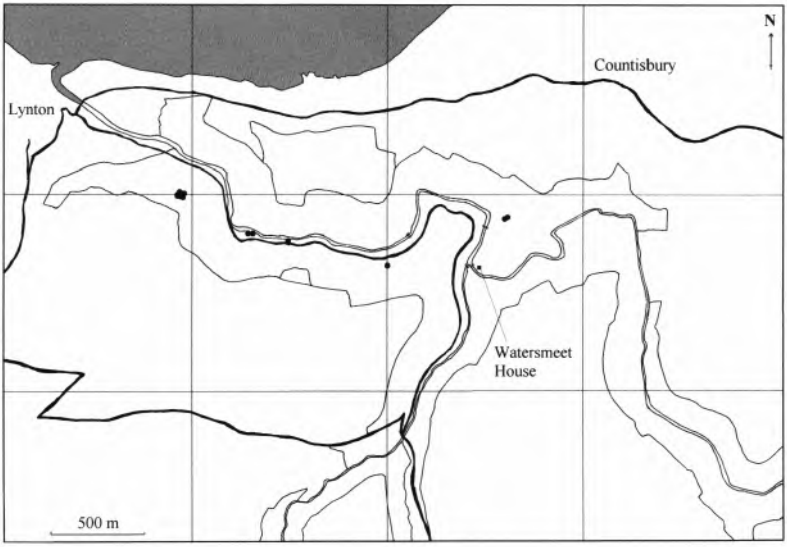

Figure 1. *Distribution of Sorbus vexans at Watersmeet.*

maternal parent *S. torminalis* (L.) Crantz, and it was surprising how many occurred as understory shrubs.

Most trees recorded by M. E. Proctor in 1984–1985 were refound; her maps were found to be highly reliable. Areas she marked as having many trees still had many trees. A few of her trees could not be refound (e.g. her *S. porrigentiformis* in Wester Wood), and are presumed to have gone, but could have been overlooked. The number of *S. vexans* above the road east of Fisherman's car park has decreased. The three-fold increase in the overall number of trees can be attributed to an increased intensity of survey, though it is possible some real population expansion has occurred too.

The number of maidens/coppiced trees of each species are summarised in Table 1. *Sorbus vexans* tend to occur as small plants on open rocks, and are naturally coppiced. Similarly, *S. porrigentiformis* will coppice on open rocks but can also form small trees. There were noticeably different proportions of 'No Parking Whitebeams' and *S. subcuneata* trees recorded as coppiced; it is possible that this might be due to biological differences between the species with *S. subcuneata* being more likely to have sucker shoots sprouting from the base.

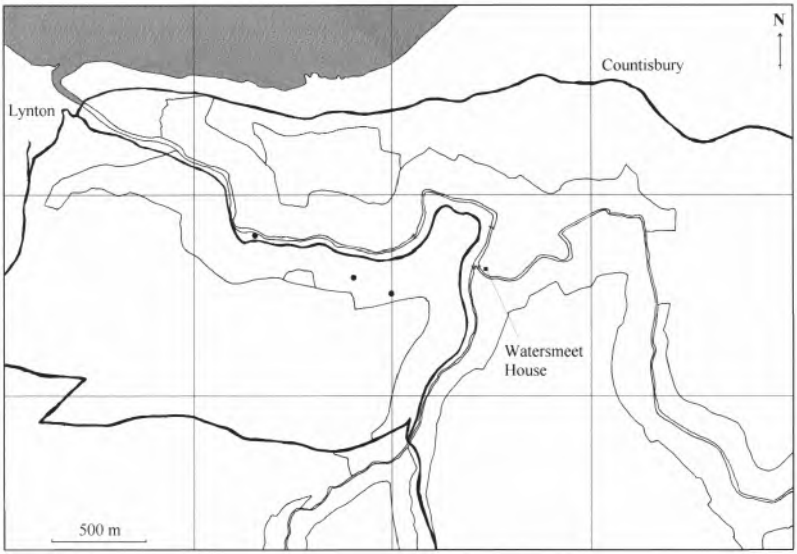

Figure 2. *Distribution of Sorbus porrigentiformis at Watersmeet.*

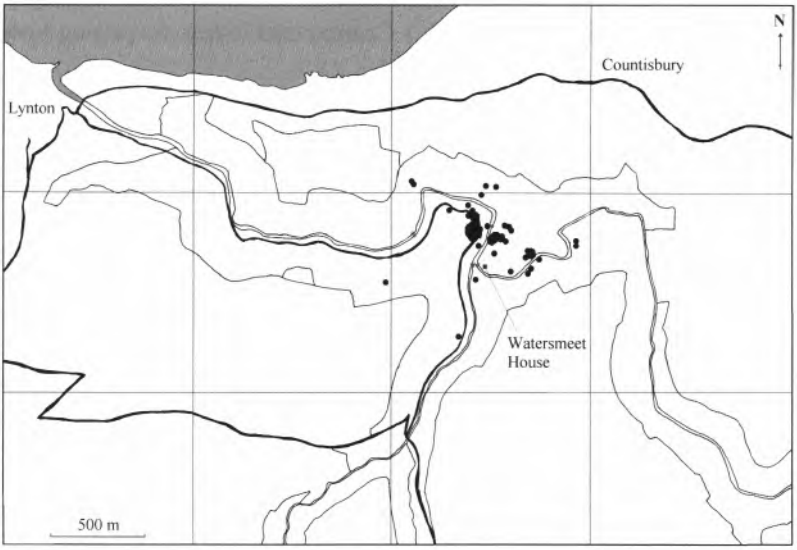

Figure 3. *Distribution of the 'No Parking Whitebeam' at Watersmeet.*

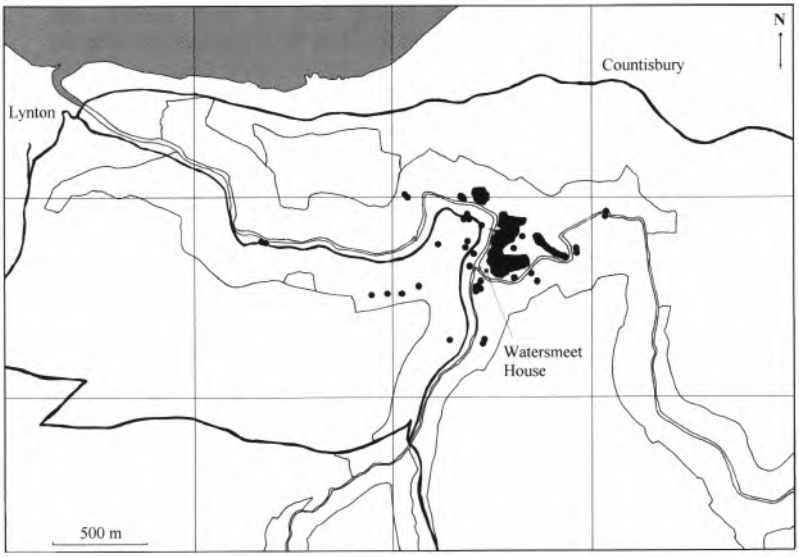

Figure 4. *Distribution of Sorbus subcuneata at Watersmeet.*

Table 1: *Number of maidens/coppiced trees of each species, with percentages (percentages exclude trees for which the growth form was not noted)*

Species	Maidens	Coppice	Not noted
Sorbus vexans	5 (20%)	20 (80%)	3
Sorbus porrigentiformis	1 (50%)	1 (50%)	1
'No Parking Whitebeam'	68 (68%)	33 (33%)	7
Sorbus subcuneata	90 (40%)	137 (60%)	43
Undetermined species	49 (71%)	20 (29%)	0

The numbers of fruiting and not-fruiting trees of each species are summarised in Table 2. No fruits were noted on *S. porrigentiformis*. The proportions of trees of *S. vexans*, *S. subcuneata* and the 'No Parking Whitebeam' fruiting were almost the same. An *ad hoc* observation was that there was much more fruit per tree on

Table 2: *Number of fruiting/not fruiting trees of each species, with percentages (percentages exclude trees for which the presence of fruit was not noted)*

Species	Fruiting	Not fruiting	Not noted
Sorbus vexans	14 (54%)	12 (46%)	2
Sorbus porrigentiformis	0	2 (100%)	1
'No Parking Whitebeam'	51 (49%)	53 (51%)	4
Sorbus subcuneata	112 (47%)	127 (53%)	31
Undetermined species	1 (2%)	54 (98%)	0

S. subcuneata than on the 'No Parking Whitebeam'. The large overall proportion of trees producing fruits is a sign of a healthy population.

The height and girth distributions for *S. vexans*, *S. subcuneata* and the 'No Parking Whitebeam' are shown in Figs 5–10 (there are too few data for *S. porrigentiformis* to draw any conclusions).

There are relatively few trees of *S. vexans*, but a range of size and age classes is present (Figs 5 and 6). It is difficult to ascertain their true age as many of the shrubs naturally coppice.

The height frequency distribution of the 'No Parking Whitebeam' (Fig. 7) is skewed towards canopy trees 8–10 m tall, but overall there is a broad range of height classes present. The smallest size class is under-represented, which is at least partly an artefact of the survey (it is likely that many of the small, undetermined shrubs above the car park without leaves are this species). Larger trees have more fruit; the absence of fruit in some of the largest trees may be due to difficulties seeing fruits in the canopy. The girth frequency distribution of the 'No Parking Whitebeam' (Fig. 8) shows a similar pattern to the heights; the peak of girths at 41–50 cm also relate to trees in the canopy. The largest tree of all was the original 'No Parking' tree by the staff car park. The height and girth data taken together suggest at least sporadic regeneration and recruitment of young trees.

The height and girth frequency distributions of the *S. subcuneata* (Figs 9 and 10) follow a classic exponential decay indicating regular and repeated recruitment of young trees. There are relatively fewer trees 2–4 m high than might be expected, and again the smallest girth size classes are under-represented probably due to the survey methods.

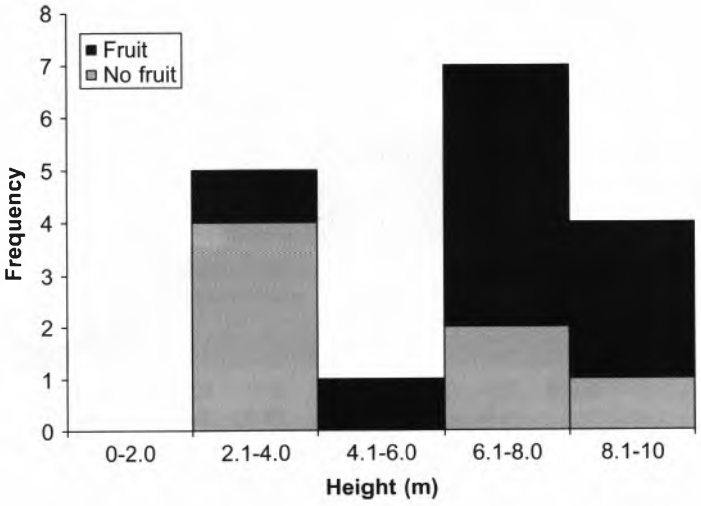

Figure 5. *Height distribution of Sorbus vexans, with or without fruit.*

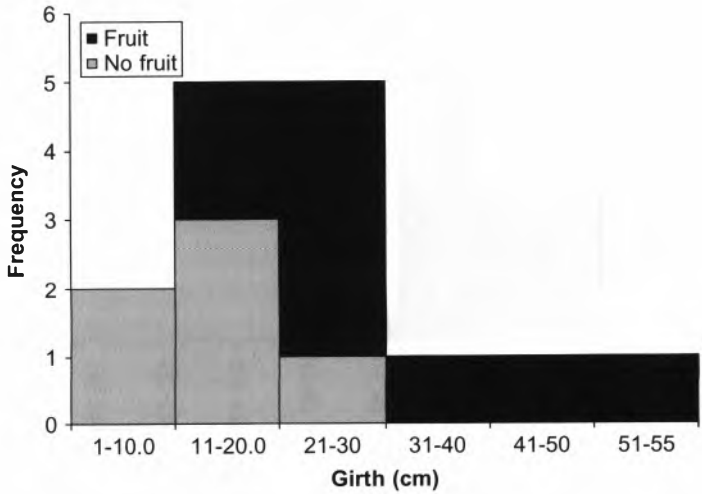

Figure 6. *Girth distribution of Sorbus vexans, with or without fruit.*

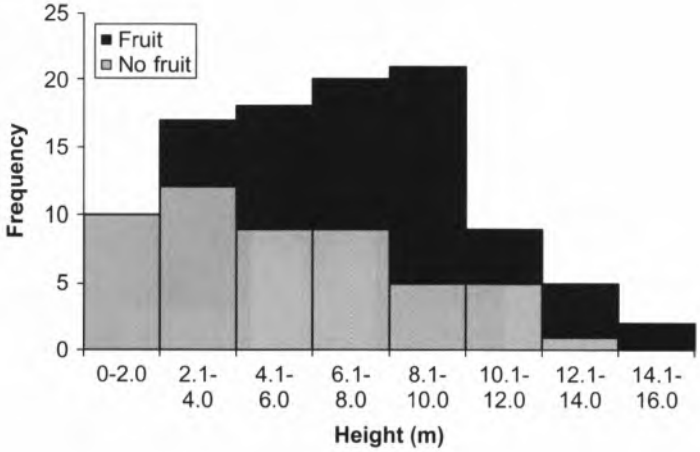

Figure 7. *Height distribution of 'No Parking Whitebeam' with or without fruit.*

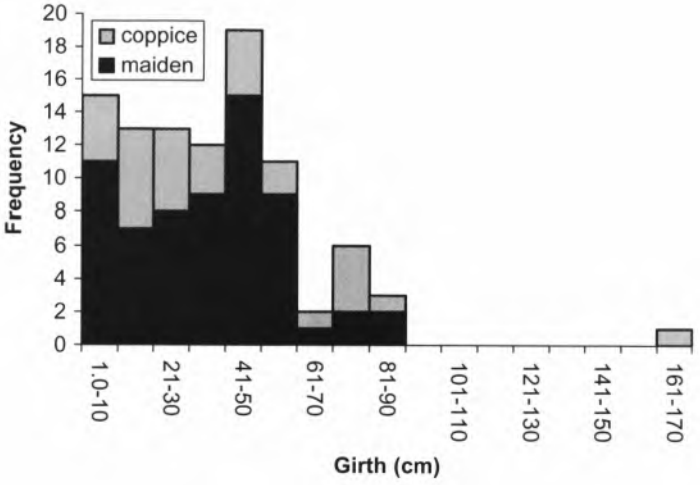

Figure 8. *Girth distribution of 'No Parking Whitebeam' for maidens and coppice.*

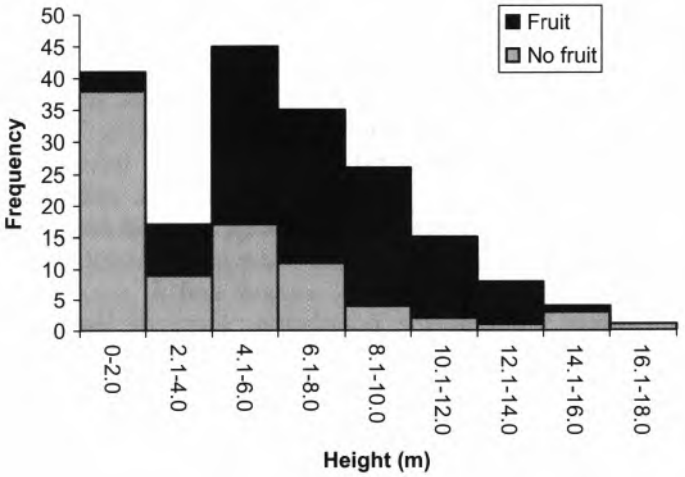

Figure 9. *Height distribution of Sorbus subcuneata with or without fruit.*

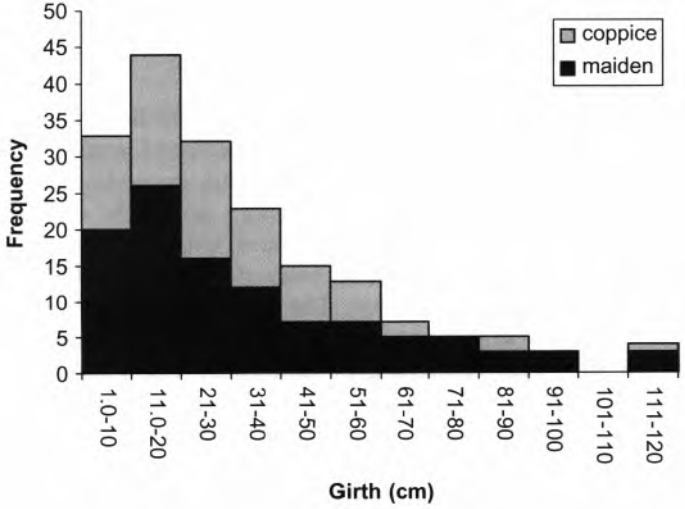

Figure 10. *Girth distribution of Sorbus subcuneata as maiden or coppice.*

Discussion

The survey has shown that the Watersmeet woodlands have exceptionally good populations of whitebeams. The Watersmeet woodlands are of key importance for three species, supporting 98 per cent of the world population of the 'No Parking Whitebeam', about 82 per cent of the world population of *S. subcuneata*, and about 30 per cent of the world population of *S. vexans*. *Sorbus porrigentiformis* is widespread in Southwest England and Wales and its total population is probably in the order of 500–1000 trees.

There are small numbers of *S. vexans* and *S. porrigentiformis* at Watersmeet, both having populations more or less equivalent to the 1984–1985 survey, though both species were found in new sites. Both species require unshaded growth conditions, and both seem restricted by the limited amount of habitat available. Both species would probably benefit from some careful, selective woodland management around them to maintain them in open conditions and promote regeneration.

There are many more 'No Parking Whitebeam' and *S. subcuneata* than previously known, which is probably attributable to the more detailed survey. Both species appear well-suited to the woodland habitat, though both flourish best in the areas of shorter, open woodland. Both species seem to be regenerating freely and there is little current cause for concern for their future.

Significant variation in the canopy and ground flora was noticed during the survey, ranging from short *Quercus-Luzula* woodland to tall *Ulmus-Fraxinus-Mercurialis* woodland, suggesting significant differences in geology and woodland history across the site. Most of the Watersmeet area is on the Lynton Slates, with the Lynmouth-East Lynn Valley fault separating them from the Hangman Grits to the north-east (Edmonds *et al.*, 1983). The Lynton Slates are mudstones, siltstones and grey sandstones, usually fine to medium-grained, with occasional thin beds of dark grey limestone. The Hangman Grits tend to be predominantly arenaceous and quartzose sandstones with alternating shales or slates. Overlying the solid geology in much of the East Lynn Valley is a layer of head (angular composed of weathered rocks and stony clay), and occasional screes. There is, however, considerable local variation in composition of all the substrates, resulting in a range of soil types. The *S. vexans* seemed to be consistently in relatively acidic places (as judged from the

associated flora), and the 'No Parking Whitebeam' and *S. subcuneata* predominantly on the more acidic areas, though a few examples of each also occurred in more neutral conditions.

The 'No Parking Whitebeam' and *S. subcuneata* were most frequent in the areas of short *Quercus* woodland, and were rare or absent from the tall *Ulmus-Fraxinus-Quercus* woodland. *Sorbus subcuneata* was also noted colonising areas of open bracken and scrub in Myrtleberry Cleave. Historically, the *Quercus* woodland used to be cut on an approximate 25 year rotation for charcoal, fencing, pit props and tanning, and this would have allowed the Whitebeams to flourish in the early years before the canopy closed; the concentration of Whitebeams in the oak coppice may be relict from those times. The taller areas of woodland may not have been cut so frequently, and the Whitebeams would have been shaded out. The skewed height and girth distribution of the 'No Parking Whitebeam' could reflect historical management.

Deer were seen on several occasions in the woods, and there was evidence of damage to bark on some Whitebeams. Overall, deer do not seem to be affecting the 'No Parking Whitebeam' and *S. subcuneata* seriously, as there are many young trees of both species. Two small exclosure plots had been established in the woods presumably to look at the impact of deer browsing on trees in general.

The survey could be repeated in another 20–25 years to assess trends in the populations. Except for a few of the more isolated trees, the GPS grid references are probably not sufficiently accurate to allow long term monitoring of individual trees.

Acknowledgements

We would like to thank Chris Bailes, Frances and Malcolm Billinge, John Bradbeer, Mary Breeds, Julia Carey, Geoffrey Field, Paul Gainey, Barry and Jane Goater, Peter Hilton, Bob Hodgson, Jeremy Ison, Mark Jannick, Andy McVeigh, Ted Pratt, David Price, Clare Rand, Martin Rand, Roger Smith and Lawrence Taylor for help with the survey, and Steve Mulberry and Julian Gurney of the National Trust, and Flemming Ulf-Hansen of Natural England, for their help and information.

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