

## Five new *Sorbus* (Rosaceae) taxa from the Avon Gorge, England

T. C. G. RICH\*

*Department of Biodiversity and Systematic Biology, National Museum of Wales,  
Cardiff, CF10 3NP*

S. A. HARRIS

*University of Oxford, Department of Plant Sciences, South Parks Road, Oxford, OX1 3RB*

and

S. J. HISCOCK

*School of Biological Sciences, University of Bristol, Woodland Road, Bristol, BS8 1UG*

### ABSTRACT

One new *Sorbus* species and four new hybrids are described from the Avon Gorge, Bristol. *Sorbus* × *avonensis* is a hybrid between *S. aria* and *S. porrigentiformis*. *Sorbus* × *houstoniae* is a hybrid between *S. aria* and *S. bristoliensis*. *Sorbus leighensis* is a distinct clone of *S. aria* × *S. porrigentiformis* and is locally frequent in the Avon Gorge; it is treated as a species. *Sorbus* × *robertsonii* is a hybrid between *S. aria* and *S. eminens*. *Sorbus* × *proctoris* is a hybrid between *S. aucuparia* and the cultivated *S. scalaris*.

**KEYWORDS:** Apomixis, hybrid, species, whitebeam, rowan.

### INTRODUCTION

The Avon Gorge in South-west England is a large Carboniferous Limestone gorge about 3 km long with wooded slopes and open rocks, cliffs and quarries on the western edge of the city of Bristol. It is designated as a Site of Special Scientific Interest (S.S.S.I.) and Special Area of Conservation (S.A.C.) for its outstanding flora and ravine woodlands (Ratcliffe 1977), and is the most diverse *Sorbus* site in Britain with endemic species such as *S. bristoliensis* Wilm. and *S. wilmottiana* E. F. Warb. (Rich & Houston 2004; Houston *et al.* 2008). During the course of a three-year project funded by the Leverhulme Foundation to elucidate the origin of the endemic *Sorbus* species in the Avon Gorge, five new *Sorbus* taxa have been discovered and their origins

ascertained by analysis of nuclear microsatellites (Robertson *et al.*, in preparation). In this paper the new taxa are described.

All the taxa have originated by hybridisation. It is likely that most *Sorbus* taxa derived from independent crossings of an apomictic polyploid with a variable sexual diploid would result in genetically different, apomictic, polyploids. Such apomictic hybrids could be considered species in their own right as they are reproductively isolated and genetically distinct, but we have adopted the following approach in deciding whether to treat them as hybrids or species. Following normal practice in other groups, the taxa are treated as hybrids if there are one or a few individuals of the same parentage which have probably originated from different hybridisation events (i.e. are polyphyletic), irrespective of whether they are apomictic or not, or polyploid or not. Where only a few such spontaneous hybrids occur in a number of different locations which cannot be differentiated morphologically, it is better to treat them as hybrids rather than describe a myriad of different species which are impractical to tell apart without DNA markers. Additionally, as the biological success of many of these hybrids appears to be low since they do not increase with time (although we do not know when they originated), these may be only short-lived, 'temporary' taxa. However, where there are significant numbers of individuals of a morphologically distinct, monophyletic, apomictic clone (i.e. they are biologically successful), they are treated as species, even if

\*e-mail: tim.rich@museumwales.ac.uk

of the same parentage as previously described taxa. For example, the locally frequent and distinct *S. leighensis* and the two slightly different examples of the hybrid *S. × avonensis* described below are all derived from *S. aria* (L.) Crantz  $\times$  *S. porrigentiformis* E. F. Warb., but are morphologically different from each other and from the readily recognised existing species *S. wilmottiana* E. F. Warb. and *S. whiteana* T. Rich & L. Houston which also have the same parentage (Robertson *et al.*, in preparation). If some of the hybrids should subsequently prove to be successful apomictic clones which become more frequent in the future, their rank could be raised to species.

#### METHODS

Broad leaves from the short, vegetative shoots in sunlit situations, excluding the oldest and youngest leaf (Aas *et al.* 1994), were measured on herbarium material in NMW. Fruits were measured on fresh material, and the colours matched against the Royal Horticultural Society colour charts (Royal Horticultural Society 1966).

Potential pollen viability was investigated using Alexander's Stain (Alexander 1969) on the flowering collections available. Anthers were removed from herbarium specimens with tweezers under a low-power binocular microscope, and placed on a slide with a drop of Alexander's Stain, warmed briefly on the hotplate, then broken up with the tweezers. The preparation was then covered with a cover-slip and replaced on the hotplate to improve the uptake of the stain. The slides were then examined under a high-power compound microscope for areas of dense pollen grains. Potentially viable grains were counted as those which were large and rounded-triangular with cell walls which stained green and with cytoplasm inside which stained uniformly bright red. Small deformed grains or those staining green only with very little or no red staining inside (i.e. no cytoplasm) were considered infertile. The numbers of pollen grains counted are cited for individual trees; averages and ranges of other species cited are taken from Rich (2009).

Soil pH was measured with a calibrated pHep2 Hanna pocket-sized pH meter in a 50:50 mixture with distilled water on soil samples collected from around the roots.

For nuclear microsatellite methods and results, see Robertson *et al.* (in preparation).

#### DESCRIPTIONS

*Sorbus aria* (L.) Crantz  $\times$  *S. porrigentiformis* E. F. Warb. = *S. × avonensis* T. Rich, **hybr. nov.**

**HOLOTYPUS:** St Vincent's Rocks South, Avon Gorge, v.c. 34 West Gloucestershire, England, ST/565.730, flowers 21 May 2007, L. Houston, and fruits and photographs 19 September 2007, T. C. G. Rich & L. Houston (NMW, accession number V. 2007.1.132).

**ISOTYPI:** BM, CGE.

Vernacular name: Avon Gorge Whitebeam.

Frutex vel arbor parva ad 7 m ut minimum. Gemmae ovoidoconicae, virides, ad apicem pilis exalbidis pilosae. Folia lata brachyblastorum 5.5–10.0  $\times$  4.0–7.5 cm, 1.2–1.4plo longiora quam latiora, obovata vel late elliptica, ad longitudinis suae 51–62 partes centesimas latissima, apice obtuso, basi late cuneata, in centro laminae 0–15 partibus centesimis ad costam leniter lobata, marginibus leniter biserratis dentes prorsum projectos ferentibus, sed 1–2 cm infimis prope petiolum fere integris; pagina superior atroviridis glabra; pagina inferior viridialba tomentosa, venis 15–20 ad angulum 25–32° a costa tentis. Petioli 8–20 mm. Inflorescentia ad 8 cm lata, aggregata, ramulis tomentosis instructa. Flores circa 16–18 mm lati, fragrantis. Sepala anguste triangularia, ad apicem viridula sed ad basin tomentosa, in marginibus sine glandibus. Petala circa 6  $\times$  5 mm, late elliptica, cupulata, alba. Antherae roseae. Styli 2, usque ad basin discreti, virides, basi pilosa. Fructus maximi 10–11  $\times$  10–12 mm, 0.85–1.0plo longiores quam latiores, plerumque aspectu magis minusve globoso, in medio latissimi, in maturitate rubri, lenticellis paucis parvis vel magnis praediti. Semina perfecte formata.

Shrub or small tree to at least 7 m. Buds ovoid-conical, green, pilose at tip with whitish hairs. Broad leaves of short shoots 5.5–10.0  $\times$  4.0–7.5 cm, 1.2–1.4 times as long as wide, obovate to broadly elliptic, widest at 51–62% along leaf length, with apex obtuse and base broadly cuneate, weakly lobed 0–15% of way to midrib at centre of leaf; margins weakly biserrate with teeth directed forwards, but with lowest 1–2 cm near the petiole nearly entire; upper surface dark green, glabrous; lower surface greenish-white tomentose, with 15–20 veins held at an angle of 25–32° to the midrib. Petioles 8–20 mm.

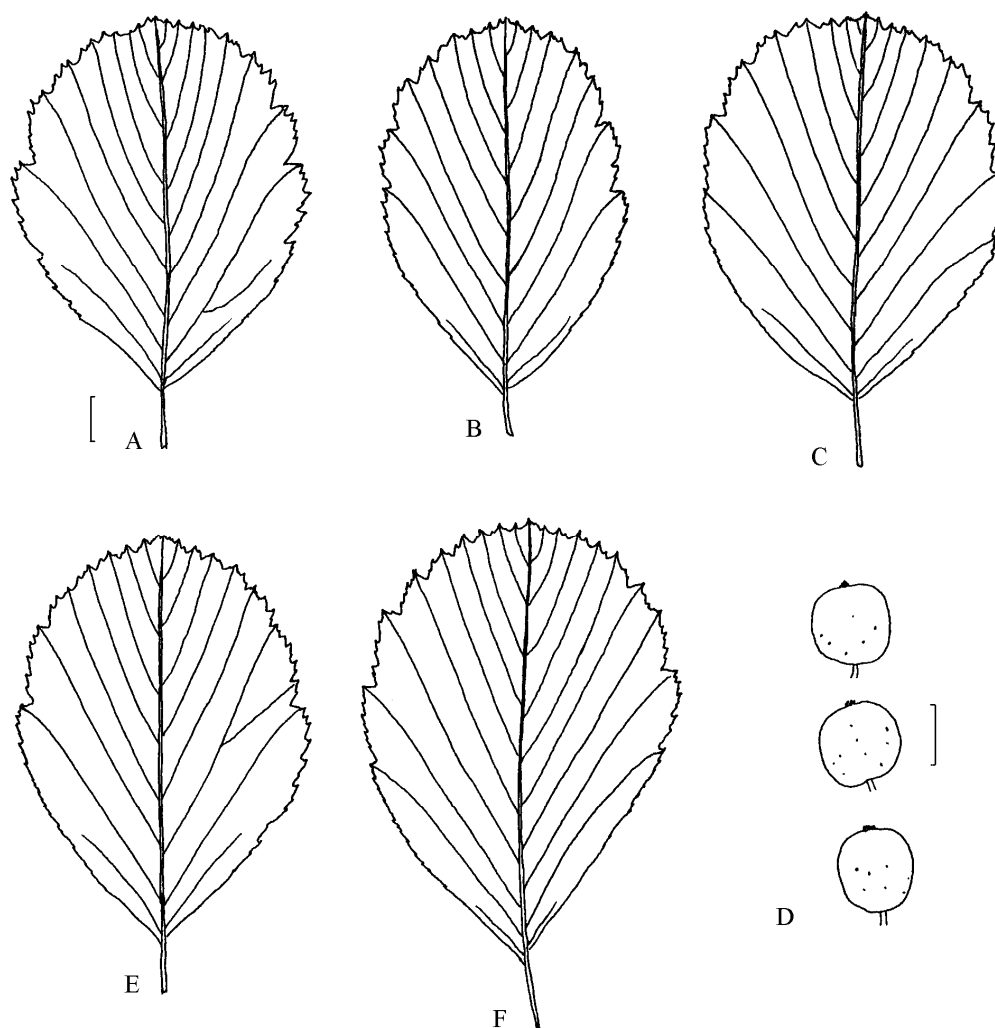


FIGURE 1. Leaves and fruits of *Sorbus* × *avonensis*. A–D, type. E–F, second tree. Scale bars 1 cm.

Inflorescence to 8 cm across, crowded; branchlets tomentose. Flowers *c.* 16–18 mm across, fragrant. Sepals narrowly triangular, greenish at tip but tomentose at base, without glands on margins. Petals *c.* 6 × 5 mm, broadly elliptic, cupped, white. Anthers pink. Styles 2, split to base, green, pilose at base. Largest fruits 10–11 × 10–12 mm, 0.85–1.0 times as long as wide but usually looking more or less globose, widest at the middle, red at maturity (RHS colour chart 44A, 45A), with a few small to large lenticels. Seeds fully formed.

*Sorbus* × *avonensis* is a member of the *Sorbus aria* group. The description is based on both the type tree and the second tree known from the opposite side of the gorge, which is identical genetically but differs slightly morphologically, though this may be due to environmental conditions.

Hybridisation seems to occur repeatedly between *S. aria* and *S. porrigentiformis* in the Avon Gorge. This has given rise to a series of morphological forms, some of which appear to have reproduced to form stable clones with a

significant number of plants (e.g. *S. eminens*, *S. whiteana*, *S. wilmottiana* and the new *S. leighensis* described below), and many of which have not; we intend this hybrid name to be applied to spontaneous *S. aria* × *S. porrigentiformis* plants which do not form significant populations. *Sorbus* × *avonensis* (Fig. 1) resembles *S. porrigentiformis* more than *S. aria*, with broadly obovate, weakly biserrate leaves and fruits globose to wider than long (length/width ratio 0.85–1.0), and has been recorded as *S. porrigentiformis* in the past in the Avon Gorge. *Sorbus porrigentiformis sensu stricto* has obovate, unlobed, obtuse, weakly biserrate leaves, and fruits usually wider than long (length/width ratio 0.8–1.0(–1.1)). *Sorbus aria* has white-tomentose undersides to the leaves, usually more veins and fruits usually longer than wide.

Nuclear microsatellite data suggest that, in the Avon Gorge at least, *S. porrigentiformis sensu stricto* is consistently tetraploid and that *S. × avonensis* is triploid (Robertson *et al.*, in preparation). Counts of  $2n = 51$  previously referred to *S. porrigentiformis* (e.g. by Warburg 1962, who interpreted *S. porrigentiformis* broadly, including both triploids and tetraploids) probably refer to hybrids. Pollen stainability in one *S. × avonensis* tree was 66% (167 pollen grains counted), lower than in *S. aria* (average 85%, range 23–100%) and slightly lower than in *S. porrigentiformis* (average 73%, range 61–84%). Fruits of *S. × avonensis* have apparently well-formed seeds, and some at least are viable.

The plastid DNA of the type tree is the widespread *Aria* type 'A' (Chester *et al.* 2006).

The only occurrences of *S. × avonensis* confirmed by nuclear microsatellites are two places on opposite sides of the Avon Gorge (Fig. 2; v.cc. 6, 34). One isolated tree occurs on open Carboniferous Limestone rocks and the other in taller woodland with *S. aria* and *S. bristoliensis* between the railway line and the towpath. Neither tree occurs with *S. porrigentiformis*. *Sorbus × avonensis* is likely to occur wherever the parents overlap in SW England and Wales. In particular we have seen triploid material from Burrington Combe (v.c. 6) and Blaise Castle (v.c. 34), and material of unknown ploidy from the Wye Valley (v.cc. 34, 36) which could be this hybrid, but DNA analysis may be the only certain method of verifying their identity.

The epithet '*avonensis*' relates to its occurrence in the Avon Gorge.

*Sorbus aria* (L.) Crantz × *S. bristoliensis* Wilm. = *S. × houstoniae* T. Rich, **hybr. nov.**

HOLOTYPE: rocks, Stokeleigh Camp, v.c. 6 North Somerset, England, ST/561.732, flowers 24 May 2005, T. C. G. Rich & L. Houston, and fruits 31 October 2004, T. C. G. Rich, A. Robertson & L. Houston (NMW, accession numbers V.2005.1.148 and V.2004.26.276).

Vernacular name: Houston's Whitebeam.

Arbor parva ad 5 m ut minimum. Gemmae ovoideoconicae, virides, ad apicem pilis exalbidis pilosae. Folia lata brachyblastorum 7.0–9.5 × 4.5–6.5 cm, 1.4–1.6plo longiora quam latiora, obovata vel obovatoelliptica, ad longitudinis suae 50–70 partes centesimas latissima, apice acuminato, basi late cuneata, in centro laminae 7–14 partibus centesimis ad costam valde lobata, marginibus leniter biserratis dentes prorsum projectos ferentibus, sed 1–2 cm infimis prope petiolum integris; pagina superior atroviridis glabra; pagina inferior viridialba tomentosa, venis 17–22 ad angulum 32–39° a costa tentis. Petioli 8–25 mm. Inflorescentia ad 8 cm lata, aggregata, ramulis tomentosis instructa. Flores 16–18 mm lati, fragrantis. Sepala anguste triangularia, ad apicem viridula sed ad basin tomentosa, in marginibus sine glandibus vel glandes 1–2 ferentes. Petala 5.5–7.5 × 5.5–6 mm, late elliptica vel fere orbicularia, cupulata, alba. Antherae roseae. Styli 2, per unum longitudinis trientem conjuncti, virides, glabri. Fructus maximi (11–)12–14(–14.5) × (11.5–)12–14.5(–15) mm, 0.9–1.1plo longiores quam latiores, plerumque aspectu magis minusve globoso, in medio latissimi, in maturitate croceorubri, lenticellarum parvarum mediocriumque numero modico praediti. Semina perfecte formata.

Small tree to at least 5 m. Buds ovoid-conical, green, pilose at tip with whitish hairs. Broad leaves of short shoots 7.0–9.5 × 4.5–6.5 cm, 1.4–1.6 times as long as wide, obovate to obovate-elliptic, widest at 50–70% along leaf length, with apex acuminate and base broadly cuneate, distinctly lobed 7–14% of way to midrib at centre of leaf; margins weakly biserrate with teeth directed forwards, but with lowest 1–2 cm near the petiole entire; upper surface dark green, glabrous; lower surface greenish-white tomentose, with 17–22 veins held at an angle of 32–39° to the midrib. Petioles 8–25 mm. Inflorescence to 8 cm across,

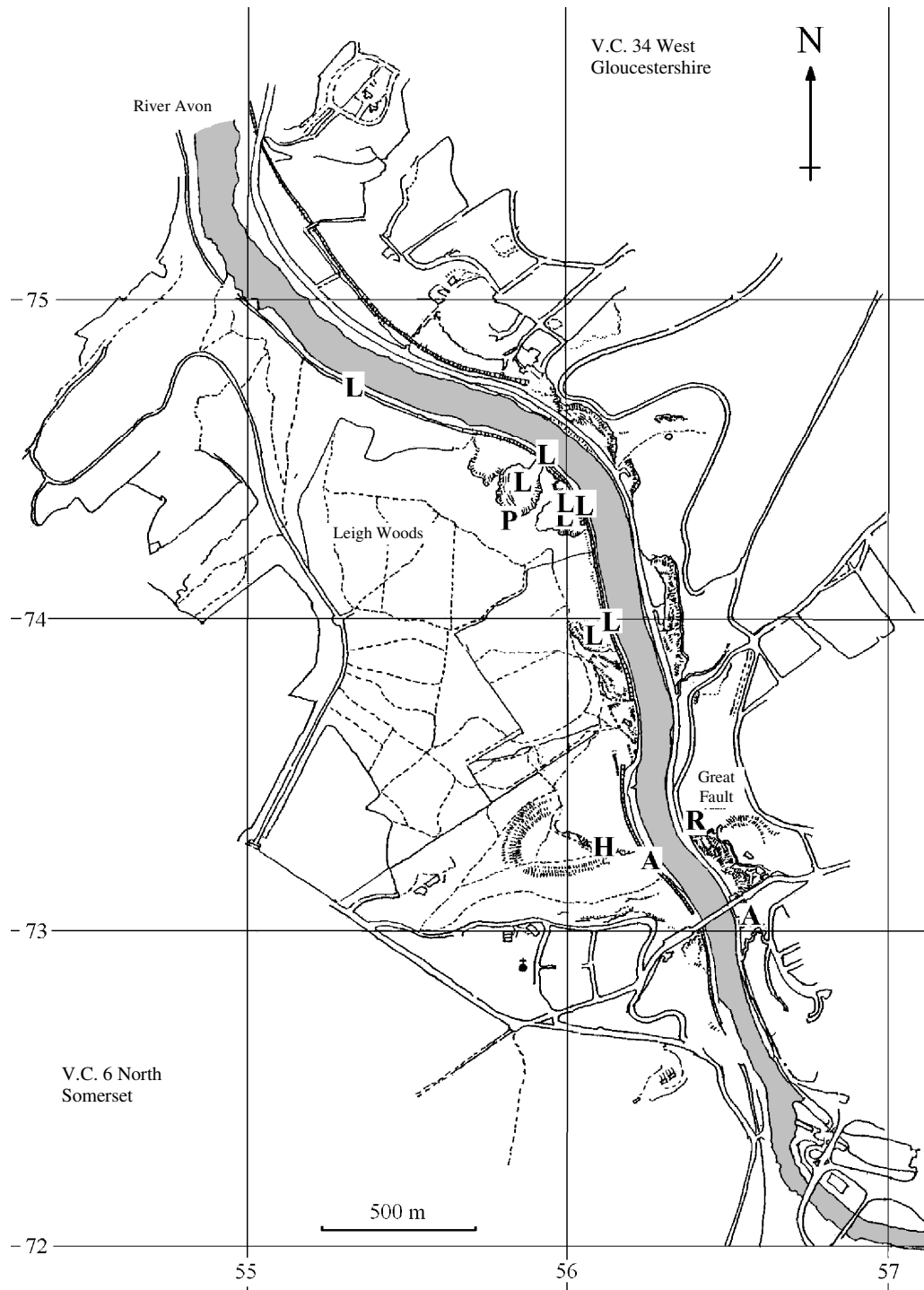


FIGURE 2. Distribution of new *Sorbus* taxa within the Avon Gorge, South-west England. A, *S. × avonensis*. H, *S. × houstoniae*. L, *S. leighensis*. P, *S. × proctoris*. R, *S. × robertsonii*. Base map courtesy L. Houston.

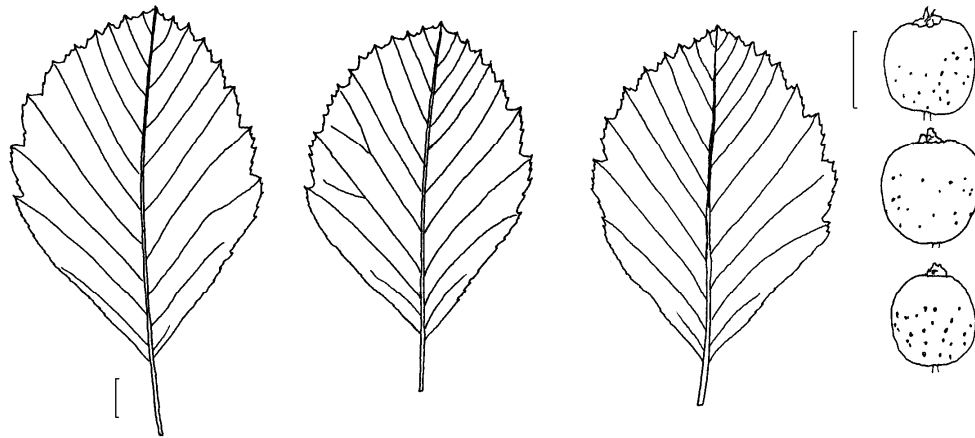


FIGURE 3. Leaves and fruits of *Sorbus* × *houstoniae*. Scale bars 1 cm.

crowded; branchlets tomentose. Flowers 16–18 mm across, fragrant. Sepals narrowly triangular, greenish at tip but tomentose at base, without or with 1–2 glands on margins. Petals 5.5–7.5 × 5.5–6 mm, broadly elliptic to nearly orbicular, cupped, white. Anthers pink. Styles 2, united for one-third of length, green, glabrous. Largest fruits (11–)12–14(–14.5) × (11.5–)12–14.5(–15) mm, 0.9–1.1 times as long as wide but usually looking more or less globose, widest at the middle, orangey-red at maturity (RHS colour chart 33A, 34A, 44A), with a moderate number of small and medium lenticels. Seeds fully formed.

*Sorbus* × *houstoniae* is a clear member of the *S. latifolia* group, intermediate between the *S. aria* group and *S. torminalis* (L.) Crantz.

*Sorbus* × *houstoniae* (Fig. 3) looks similar to *S. bristoliensis*, with which it is very easily confused. Both taxa have shallowly, acutely lobed, elliptic-obovate leaves that are greenish-white beneath, and orangey-red fruits. *Sorbus* × *houstoniae* differs from *S. bristoliensis* in having relatively broader leaves. *Sorbus* × *houstoniae* is not likely to be confused with *S. aria* which has red fruits and leaves white-tomentose beneath and usually without acute lobes.

Nuclear microsatellites and plastid DNA have shown that *S. × houstoniae* is a tetraploid derived from fertilisation of an unreduced triploid ovule of *S. bristoliensis* by normal haploid *S. aria* pollen (Robertson *et al.* in preparation). Microsatellite data do not support Challice & Kovanda's (1978) suggestion that an odd *S. bristoliensis* tree in the former Bristol University Botanic Garden at North Road, Leigh Woods is of this origin, though we are

not certain whether we sampled the same tree. The one hybrid tree had an average of 98% (50 pollen grains counted) stainable pollen, probably equivalent in fertility to *S. aria* (average 85%, range 23–100%) but much higher than *S. bristoliensis* (average 27%, range 11–38%). Fruits with fully-formed seeds occur, but it is not known if they are viable.

The sole tree confirmed by nuclear microsatellites occurs on a north-facing, vertical Carboniferous Limestone cliff below Stokeleigh Camp, Leigh Woods, North Somerset (v.c. 6), growing near both parents as well as other *Sorbus* species (Fig. 2). The tree is inaccessible without ropes. The main threat to its survival is growth of ivy.

Named after Ms Libby Houston, the “guardian angel” of the Avon Gorge, who not only first discovered it, but whose natural habitat also seems to be the same – clinging to impossible cliffs in remote parts of the gorge.

***Sorbus leighensis* T. Rich, sp. nov.**

HOLOTYPE: Quarry 4, Leigh Woods, v.c. 6 North Somerset, England, ST/561.739, flowers 15 May 2007, T. C. G. Rich & A. Robertson, and fruits and photographs 19 September 2007, T. C. G. Rich & L. Houston (NMW accession number V. 2007.1.180).

ISOTYPI: **BM, CGE**

Vernacular name: Leigh Woods Whitebeam.

Frutex vel arbor parva ad 10 m ut minimum. Gemmae ovoidoconicae, virides, ad apicem pilis albis pilosae. Folia lata brachyblastorum (6.5–)7.0–10.5 × (4.5–)5.0–7.0(–8.5) cm, 1.2–1.5(–1.6) plo longiora quam latiora, plerumque obovata, aliquando elliptica, ad longitudinis

suae (50–)55–65 partes centesimas latissima, apice truncato vel late obtuso, basi anguste rotundata vel cuneata, in centro laminae 6–13 partibus centesimis ad costam plerumque lobis non profundis obtusis secta, marginibus leniter biserratis dentes parvos exstantes ferentibus, sed parte infima prope petiolum circa 1 cm fere integra; pagina superior pallide viridis glabra; pagina inferior alba vel viridialba tomentosa, venis 15–19 ad angulum (22–)24–31(–35)° a costa tentis. Petioli 8–16 mm. Inflorescentia ad 9 cm lata, aggregata,

ramulis tomentosis instructa. Flores 18–20 mm lati, fragrantis. Sepala anguste triangularia vel deltoidea, ad apicem viridula sed ad basin tomentosa, in marginibus sine glandibus. Petala 7–8 × 5–6 mm, late elliptica, cupulata, alba. Antherae cremeae, leniter roseae. Styli 2(–3), usque ad basin discreti, virides, basi pilosa. Fructus maximi 10–12(–13) × 10–14(–14) mm, 0·8–1·1plo longiores quam latiores, plerumque aspectu globoso, in maturitate rubri, lenticellis paucis parvis vel mediocribus praediti. Semina perfecte formata.

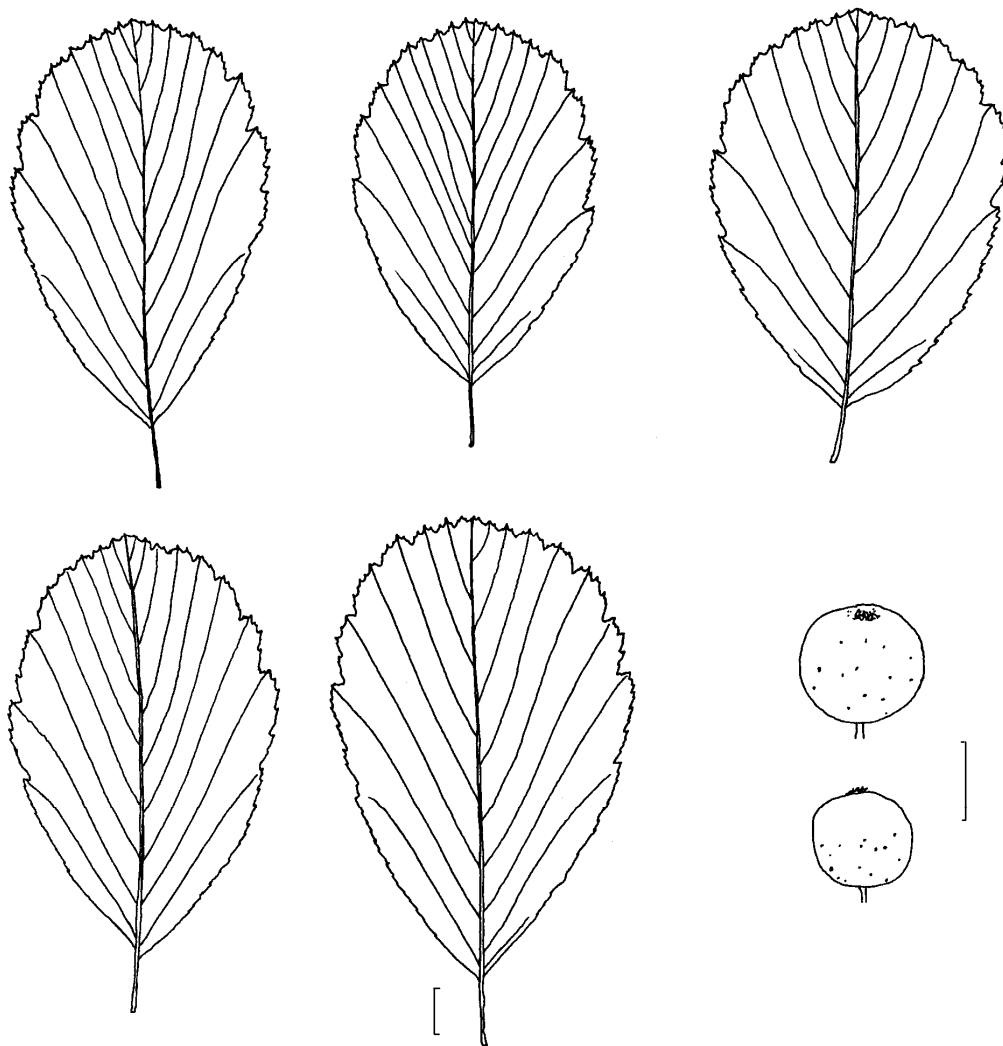


FIGURE 4. Leaves and fruits of *Sorbus leighensis*. Each leaf from a different tree. Scale bars 1 cm.

Shrub or small tree to at least 10 m. Buds ovoid-conical, green, pilose at tip with white hairs. Broad leaves of short shoots (6.5–)7.0–10.5 × (4.5–)5.0–7.0(–8.5) cm, 1.2–1.5(–1.6) times as long as wide, usually obovate, sometimes elliptic, widest at (50–)55–65% along leaf length, with apex truncate to broadly obtuse and base narrowly rounded to cuneate, usually with shallow, blunt lobes cut 6–13% of way to midrib at centre of leaf; margins weakly biserrate with small teeth directed outwards, but with lowest c. 1 cm near the petiole nearly entire; upper surface light green, glabrous; lower surface white to greenish-white tomentose, with 15–19 veins held at an angle of (22–)24–31(–35)° to the midrib. Petioles 8–16 mm. Inflorescence to 9 cm across, crowded; branchlets tomentose. Flowers 18–20 mm across, fragrant. Sepals narrowly triangular to deltoid, greenish at tip but tomentose at base, without glands on margins. Petals 7–8 × 5–6 mm, broadly elliptic, cupped, white. Anthers cream with a hint of pink. Styles 2(–3), split to base, green, pilose at base. Largest fruits 10–12(–13) × 10–14(–14) mm, 0.8–1.1 times as long as wide but usually looking globose, red at maturity (RHS colour chart 42A, 45A, 45B, 46A), with a few small to medium lenticels. Seeds fully formed.

*Sorbus leighensis* is a clear member of the *Sorbus aria* group. It can be readily distinguished from the other species in the *S. aria* group by the obovate, truncate leaves with small but distinct, shallow, blunt lobes (Fig. 4). Usually only one leaf in each short shoot is truncate at the apex, the others are obtuse.

This taxon has been known since at least the 1980s. It has been variously referred to as *S. 'Bristol porrigentiformis'* or '*Bristol pseudo-porrigentiformis*' by Proctor *et al.* (1989) and Proctor & Groenhof (1992). The tree sampled as '*S. wilmottiana* 23' by Lemche (1999) is also *S. leighensis*. Nuclear microsatellite markers show that *S. leighensis* is a triploid apomict derived from *S. aria* × *S. porrigentiformis* (Robertson *et al.* in preparation), and has the widespread *S. aria* plastid type 'A' (Chester *et al.* 2007). It has a distinct isozyme profile (Proctor & Groenhof 1992).

*Sorbus leighensis* is endemic to the Somerset side of the Avon Gorge (Fig. 2), where it is locally frequent. At least two plants occur in Quarry 2, at least 12 plants (possibly 20) are known in Quarry 3, at least 63 plants in Quarry 4 and at least three along the towpath. One easily found tree occurs on the sea wall

opposite the entrance to Quarry 2. Surprisingly, it has not been found on the Bristol side of the Avon Gorge (v.c. 34 West Gloucestershire). Some trees with virtually identical leaves occur in Burrington Combe, North Somerset (v.c. 6) but remain to be compared with plants from Avon Gorge using molecular markers.

The pollen stainability of four trees was variable: 6% (54 pollen grains counted), 13% (67 counted), 28% (72 counted) and 45% (88 counted; A. Patto, pers. comm. 2007), giving a mean of c. 23% which is fairly typical of triploids (Rich 2009). However it has fertile fruits and grows well from seed.

*Sorbus leighensis* occurs on open Carboniferous Limestone rocks and scree, and in open scrub with *S. aria*, *S. porrigentiformis* and *S. wilmottiana*. Soil from under the type tree had pH 7.8.

*Sorbus leighensis* has an I.U.C.N. (2001) conservation status of 'Endangered' due to the small population size (at least 80 plants, but not fully surveyed) and its restricted occurrence on one site. However, the whole population occurs within the Avon Gorge S.S.S.I. and S.A.C., and most trees occur on land owned by the National Trust. The main threats are scrub development, or clearance along the towpath.

The epithet '*leighensis*' is derived from its occurrence in Leigh Woods.

*Sorbus aria* (L.) Crantz × *S. eminens* E. F. Warb. = *S. × robertsonii* T. Rich, **hybr. nov.**

HOLOTYPE: Great Fault, Avon Gorge, Bristol, v.c. 34 West Gloucestershire, England. ST/564.733, flowers 15 May 2007, T. C. G. Rich, and fruits and photographs 19 September 2007, T. C. G. Rich & L. Houston (NMW, accession number V.2007.1.175).

ISOTYPI: **BM, CGE, OXF.**

Vernacular name: Robertson's Whitebeam.

Arbor ad 12 m ut minimum, truncis multis praedita. Gemmae ovoidoconicae, virides, ad apicem pilis exalbidis pilosae. Folia lata brachyblastorum 10.0–14.0(–14.5) × 7.5–10.0(–10.5) cm, (1.1–)1.2–1.6(–1.7) plo longiora quam latiora, obovata vel late elliptica, ad longitudinis suae 50–63(–69) partes centesimas latissima, apice obtuso, basi rotundata, marginibus non lobatis biserratis dentes parvos exstantes ferentibus, sed parte infima prope petiolum circa 1–3 cm fere integra; pagina superior viridis glabra; pagina inferior alba vel viridialba tomentosa, venis 20–26(–27) ad angulum 25–40° a costa tentis. Petioli 12–26 mm. Inflorescentia ad 7 cm lata,



aggregata, ramulis tomentosis instructa. Flores 14–17 mm lati, fragrantes. Sepala anguste triangularia, ad apicem acuminata viridula sed ad basin tomentosa, in marginibus sine glandibus. Petala 7–8 × 6 mm, late ovata vel late elliptica, cupulata, alba. Antherae cremaeae. Styli 2, usque ad basin discreti, virides, glabri. Fructus maximi (12–)13–16(–17) × 10–15 mm, (0.95–)1.0–1.2plo longiores quam latiores, plerumque aspectu longiore quam latiore, in medio latissimi vel obconici, in maturitate rubri, lenticellarum parvarum vel mediocrium numero modico praediti. Semina perfecte formata.

Tree to at least 12 m, with many trunks. Buds ovoid-conical, green, pilose at tip with whitish hairs. Broad leaves of short shoots 10.0–14.0(–14.5) × 7.5–10.0(–10.5) cm, (1.1–)1.2–1.6(–1.7) times as long as wide, obovate to broadly elliptic, widest at 50–63(–69)% along leaf length, with apex obtuse and base rounded; margins unlobed, biserrate with small teeth directed outwards, but with lowest *c.* 1–3 cm near the petiole nearly entire; upper surface green, glabrous; lower surface white to greenish-white tomentose, with 20–26(–27) veins held at an angle of 25–40° to the midrib. Petioles 12–26 mm. Inflorescence to 7 cm

across, crowded; branchlets tomentose. Flowers 14–17 mm across, fragrant. Sepals narrowly triangular, acuminate and greenish at tip but tomentose at base, without glands on margins. Petals 7–8 × 6 mm, broadly ovate to broadly elliptic, cupped, white. Anthers cream. Styles 2, split to base, green, glabrous. Largest fruits (12–)13–16(–17) × 10–15 mm, (0.95–)1.0–1.2 times as long as wide but usually looking longer than wide, widest at the middle or obconical, red at maturity (RHS colour chart 44A, 45B, 46A), with a moderate number of small to medium lenticels. Seeds fully formed.

*Sorbus* × *robertsonii* is a member of the *Sorbus aria* group.

The above description applies to the one tree in the Avon Gorge, Bristol whose identity has been confirmed from nuclear microsatellites (Robertson *et al.* in preparation). Apart from the obconical fruits, *S.* × *robertsonii* (Fig. 5) is approximately morphologically intermediate between its parents. *Sorbus aria* has ovate to elliptic, often shallowly lobed leaves which are acute to obtuse at the apex and have weakly biserrate to strongly biserrate margins, with fruits usually longer than wide or globose (length/width ratio 0.9–1.2). *Sorbus eminens* in its strict sense (i.e. excluding the trees with

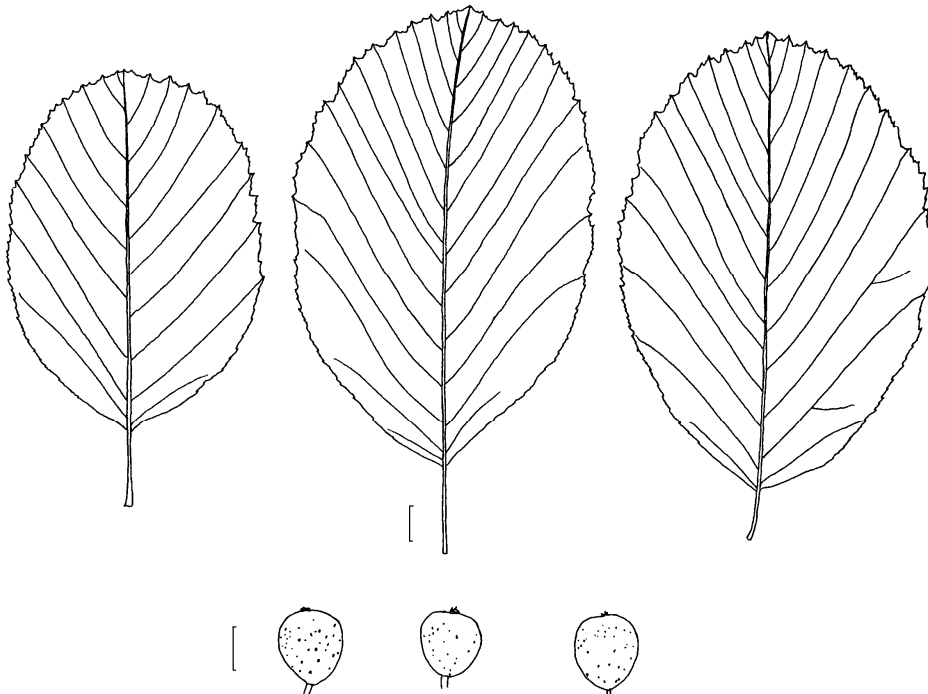


FIGURE 5. Leaves and fruits of *Sorbus* × *robertsonii*. Scale bars 1 cm.

cuneate leaf bases from the Symonds Yat area, West Gloucestershire/ Herefordshire, cf. Proctor & Groenhof 1992) has larger, usually more or less orbicular, unlobed, obtuse leaves with fine, uniserrate teething, and has fruits wider than long (length/width ratio 0.7–0.9). *Sorbus* × *robertsonii* has broadly elliptic to obovate leaves with weak biserrate teething and fruits longer than wide to globose or obconical (length/width ratio 1.0–1.2).

Nuclear microsatellite data indicate that the hybrid is probably triploid, and thus intermediate between the diploid *S. aria* and the tetraploid *S. eminens*. Pollen stainability in the one hybrid tree was 74% (80 pollen grains counted), lower than in *S. aria* (average 85%, range 23–100%) but similar to that in *S. eminens* (average 80%, range 60–89%) (A. Patto pers. comm. 2007). Fruits have well-formed seeds which are presumably viable but this has not been tested yet.

The tree occurs at the top of a scree slope at the Great Fault, Avon Gorge, v.c. 34 West Gloucestershire (Fig. 2). It grows in open woodland in an area with both parents, and has soil pH 7.4. It is probable that hybrids also occur in several other mixed populations in the Bristol area, the Mendips and the Wye Valley in v.c.c. 6, 34, 35 and 36, where morphologically intermediate plants have been observed; however they await confirmation from DNA.

The hybrid is named after Ashley Robertson for his outstanding work in elucidating the origins of the Avon Gorge endemics (Robertson *et al.* in preparation), which, to quote White's (1912) *Flora of Bristol*, "pass ... the wit of many to disentangle".

*Sorbus aucuparia* L. × *S. scalaris* Koehne = *S. × proctoris* T. Rich, **hybr. nov.**

**HOLOTYPUS:** Top edge of Quarry 2, Leigh Woods, v.c. 6 North Somerset, England, ST/557.743, flowers 11 May 2007, T. C. G. Rich & A. Robertson, and fruits and photographs 19 September 2007, T. C. G. Rich & L. Houston (NMW, accession number V.2007.1.125).

**ISOTYPI:** **BM, CGE, E, LIV, OXF.**

Vernacular name: Proctor's Rowan.

Arbor ad 8 m ut minimum, erecta ramis verticalibus, sine surculis. Stipulae 5–8 × 11–15 mm, magnae, depressovatae, dentatae, persistentes. Gemmae ad 15 × 7 mm, lanceoloideae, obtusae, brunneolae, pilis

exalbidis in superficie marginibusque vestitae. Folia sterilia rosulata 15–18 × 6–8 cm, oblonga vel oblongoelliptica, pinnata, folioliorum lateralium paribus 9–10 folioloque terminali parvo sed simili praedita. Folia lateralia 35–45 × 10–15 mm, maxima in medio folii, ad basin apicemque versus paulo minora, oblonga, acuta, ad basin rotundata aliquantumque asymmetrica, per longitudinis suae tres partes quartas superiores dentibus prorsum projectis dentata, subsessilia, in pagina superiore atroviridia glabra, in pagina inferiore vivide cinereoviridia papillosa glabrescentia, costa sparsim tomentosa praedita. Petioli 2–3 cm, non alati, rubritincti. Inflorescentia ad 12 cm lata, tholiformis, densa, ramulis tomentosis instructa. Flores 8 mm in diametro. Sepala late triangularia, obtusa, dentes glanduliferos 0–3 in utroque margine ferentia. Petala 3–4.5 mm × 2.5–3.5 mm, late ovatorbicularia vel late elliptica, alba. Antherae roseae. Styli (2–)4. Fructus (7–)8–9 × (7–)8–9 mm, plerumque globosi vel nonnulli aliquantum latiores quam longiores vel longiores quam latiores, infra medium latissimi, in maturitate croceorubri, sine lenticellis vel lenticellas paucissimas parvas ferentes. Semina abortiva.

Tree to at least 8 m, erect with upright branches, not suckering. Stipules 5–8 × 11–15 mm, large, depressed-ovate, toothed, persistent. Buds to 15 × 7 mm, lanceoloid, obtuse, brownish with whitish hairs on surface and margins. Sterile rosette leaves 15–18 × 6–8 cm, oblong to oblong elliptic, pinnate with 9–10 pairs of lateral leaflets and a small but similar terminal leaflet. Lateral leaflets 35–45 × 10–15 mm, largest at the centre of the leaf and a little smaller at base and towards the apex, oblong, acute, rounded and slightly asymmetrical at the base, toothed for upper three-quarters of length with forward-directed teeth, subsessile, dark green and glabrous above, strongly greyish-green, papillose and glabrescent beneath with a sparsely tomentose midrib. Petioles 2–3 cm, not winged, red-flushed. Inflorescence to 12 cm across, domed, dense, with branchlets tomentose. Flowers 8 mm in diameter. Sepals broadly triangular, obtuse, with 0–3 glandular teeth on each edge. Petals 3–4.5 mm × 2.5–3.5 mm, broadly ovate-orbicular or broadly elliptic, white. Anthers pink. Styles (2–)4. Fruits (7–)8–9 × (7–)8–9 mm, mostly globose or some slightly wider than long or longer than wide, widest below the middle, orangey-red at maturity (RHS colour chart 33A), without or with a very few, small lenticels. Seeds abortive.

The identity of this hybrid was suggested by Hugh McAllister. *Sorbus* × *proctoris* is a member of *Sorbus* Subgenus *Sorbus*. It is intermediate between its parents with 19–21 free leaflets which tend to taper to the tip, large persistent stipules, pink anthers and fruits 7–9 mm (Fig. 6). *Sorbus aucuparia* has leaves with 13–17 free, oblong, more or less parallel-sided leaflets, small, deciduous stipules, yellow anthers and fruits (8–)9–11(–12) mm. *Sorbus scalaris* has leaves with 21–33 free, narrowly oblong, lanceolate to narrowly ovate leaflets somewhat tapering to the apex, large persistent stipules, pink anthers and fruits 6–7 mm.

Both parents are reported to have chromosome numbers of  $2n = 34$  (McAllister 2005) but preliminary molecular data suggest that the Leigh Woods hybrid is triploid. In 2007 the hybrid tree had 95% (60 pollen grains counted) pollen stainability (A. Patto, pers. comm. 2007) but, despite setting abundant fruit, was sterile with aborted seeds.

*Sorbus scalaris*, an ornamental tree from China closely related to *S. aucuparia*, is occasionally cultivated in Britain. It is self-incompatible, so isolated trees tend to produce hybrid progeny, and this hybrid has been

obtained in cultivation (McAllister 2005). So far one tree of this hybrid has been found in the wild in mixed deciduous woodland at the top edge of Quarry 2 in Leigh Woods (Fig. 2; v.c. 6) with *S. aucuparia*, *S. intermedia* (Ehrh.) Pers. and *S. aria* on soil pH 6.2. We do not know how it came to be at this location as we do not know of any *S. scalaris* trees in the area, though it is possible that one occurs in a garden opposite on the Bristol side of the gorge where other *Sorbus* species are planted (e.g. *S. decipiens* (Bechst.) Irmisch). It is most likely to have originated from seed dispersed across the gorge by a bird from a garden tree of either *S. scalaris* or *S. aucuparia*, but could have originated *in situ* from pollen of *S. scalaris* carried across the gorge by bees which fertilised local *S. aucuparia* in Leigh Woods.

The occurrence of this hybrid gives the potential for genes from a non-native species to enter the *Sorbus* gene-pool in the Avon Gorge. If this has not already happened and they are perceived to be a threat to the indigenous species, one option would be to remove the tree.

Named in honour of Michael C. F. Proctor for his excellent work on *Sorbus* (Proctor *et al.* 1989; Proctor & Groenhof 1992).

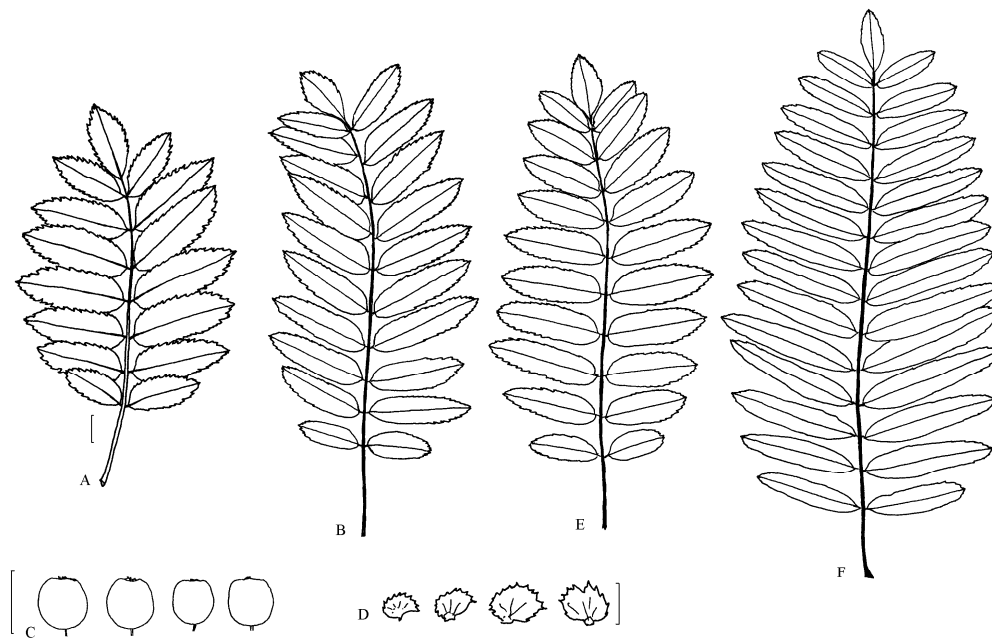


FIGURE 6. Leaves, stipules and fruits of *Sorbus* × *proctoris*, and leaves of its parents. A, *S. aucuparia*. B–E, *S. x proctoris*. F, *S. scalaris*. Scale bars 1 cm.

## ACKNOWLEDGMENTS

We would like to thank Wolfgang Bopp, Libby Houston, Hugh McAllister, Bill Morris, Alex Patto and Ashley Robertson for their help. We

are grateful to Philip Oswald for the Latin translations and many improvements to the manuscript. The work by Ashley Robertson on which these taxa are based was funded by the Leverhulme Foundation.

## REFERENCES

- AAS, G., MAIER, J., BALTISBERGER, M. & METZGER, S. (1994). Morphology, isozyme variation, cytology and reproduction of hybrids between *Sorbus aria* (L.) Crantz and *S. torminalis* (L.) Crantz. *Botanica Helvetica* **104**: 195–214.
- ALEXANDER, M. P. (1969). Differential staining of aborted and non-aborted pollen. *Stain Technology* **44**: 117–122.
- CHALLICE, J. & KOVANDA, M. (1978). Flavonoids as markers of taxonomic relationships in the genus *Sorbus* in Europe. *Preslia* **50**: 305–320.
- CHESTER, M., COWAN, R. S., FAY, M. F. & RICH, T. C. G. (2007). Parentage of endemic *Sorbus* L. (Rosaceae) species in the British Isles – evidence from plastid DNA. *Botanical Journal of the Linnean Society* **154**: 291–304.
- HOUSTON, L., ROBERTSON, A. & RICH, T. C. G. (2008). The distribution, population size and growth of the rare English endemic *Sorbus bristoliensis* A. J. Wilmott, Bristol Whitebeam (Rosaceae). *Watsonia* **27**: 37–49.
- I.U.C.N. (2001). *I.U.C.N. Red List Categories*. Version 3.1. The World Conservation Union, Gland.
- LEMICHE, E. B. (1999). *The origins and interactions of British Sorbus species*. PhD thesis, Darwin College, Cambridge.
- MCALLISTER, H. A. (2005). *The genus Sorbus*. The Royal Botanic Gardens, Kew.
- PROCTOR, M. C. F., PROCTOR, M. E. & GROENHOF, A. C. (1989). Evidence from peroxidase polymorphism on the taxonomy and reproduction of some *Sorbus* populations in south-west England. *New Phytologist* **112**: 569–575.
- PROCTOR, M. C. F. & GROENHOF, A. C. (1992). Peroxidase isoenzyme and morphological variation in *Sorbus* L. in South Wales and adjacent areas, with particular reference to *S. porrigentifformis* E. F. Warb. *Watsonia* **19**: 21–37.
- RATCLIFFE, D., ed. (1977). *A nature conservation review*. Cambridge University Press, Cambridge.
- RICH, T. C. G. (2009). Pollen stainability in British *Sorbus* L. *Plant Ecology and Diversity* (in press).
- RICH, T. C. G. & HOUSTON, L. (2004). The distribution and population sizes of the rare English endemic *Sorbus wilmottiana* E. F. Warburg, Wilmott's Whitebeam (Rosaceae). *Watsonia* **25**: 185–191.
- ROBERTSON, A., RICH, T. C. G., HOUSTON, L., ALLEN, S., ROBERTS, C., HARRIS, S. A. & HISCOCK, S. J. (in preparation). Hybridisation and polyploidy as drivers of continuing evolution and speciation in *Sorbus* (Rosaceae).
- ROYAL HORTICULTURAL SOCIETY (1966). *R. H. S. colour chart*. Royal Horticultural Society, London.
- WARBURG, E. F. (1962). *Sorbus* L., pp. 423–437 in CLAPHAM, A. R., TUTIN, T. G. & WARBURG, E. F. (1962). *Flora of the British Isles*. 2nd ed. Cambridge University Press, Cambridge.
- WHITE, J. W. (1912). *The flora of Bristol*. John Wright and Sons, Bristol.

(Accepted October 2008)