Sorbus pseudomeinichii, a new endemic *Sorbus* (Rosaceae) microspecies from Arran, Scotland

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ABSTRACT

Sorbus pseudomeinichii Ashley Robertson sp. nov., a new endemic tree from the Isle of Arran, Scotland is described. Its leaf morphology is intermediate between *S. pseudofennica* and *S. aucuparia* and molecular studies support the hypothesis that it was formed by hybridisation between *S. pseudofennica* and *S. aucuparia*. All three hybridogenous taxa endemic to Arran, *S. arranensis*, *S. pseudofennica* and *S. pseudomeinichii*, can be considered endangered. To maximise their chances of long-term survival, all locations and components of this evolutionary complex should be conserved.

KEYWORDS: hybridisation, new species, *Sorbus arranensis*, *Sorbus pseudofennica*.

INTRODUCTION

Recent molecular studies (isozyme, nuclear DNA and chloroplast DNA) have confirmed that the Arran endemics, *Sorbus arranensis* Hedl. and *S. pseudofennica* E. F. Warb., are of hybrid origin, the former originating as *S. aucuparia* L. × *S. rupicola* (Syme) Hedl., and the latter subsequently as *S. arranensis* × *S. aucuparia* (Figure 1; Nelson-Jones *et al.* 2002; Robertson *et al*. 2004a). The discovery of an unusual *Sorbus* specimen, in the herbarium of the Royal Botanic Garden Edinburgh, collected by Dr D. McVean in 1949, prompted Lusby (1996) to suggest that further diversity was being produced within the complex in Arran by crosses between *S. pseudofennica* and *S. aucuparia* and, during a detailed study, a small number of trees were found that had a leaf morphology that matched this unusual specimen (Robertson *et al.* 2004b). Molecular marker analyses support the hypothesis that these trees originated as *S. aucuparia* × *S. pseudofennica* (Robertson *et al*. 2004b) and they are treated as a new species for consistency with other hybridogenous *Sorbus* taxa in Britain.

Sorbus pseudomeinichii Ashley Robertson **sp. nov.**

HOLOTYPUS: Glen Catacol, main burn, east bank, Arran (v.c. 100), Scotland, 1 June 2004, A. Robertson (**NMW**, accession number V.2004.017.21). ISOTYPUS: **BM**, **CGE**, **E**, **UPS**.

Arbor ad 4 m ut minimum. Gemmae lanceolatae, hirsutae. Stipulae leniter dentatae, caducae. Ramunculi juvenes petiolique, ut rhachides, modice tomentosi, pilis albis appressis simplicibus vestiti. Petioli 17–38 mm. Folia 75–130 × 45–105 mm, foliolorum lateralium 4–5 paribus folioque terminali majore, ambitu generali ovata, pinnarum paribus mediis longissimis. Foliola lateralia ad medium folii 25–55 × 9–23 mm, oblonga vel oblongolanceolata, rotundata sed ad basin asymmetrica, ad apicem obtusa vel acuta, marginibus propemodo a basi per unum longitudinis trientem serratis, dentibus prorsum flexis acuminatis, supra viridia glabrescentia, infra pallidiora et praecipue secus costam venasque sparsim pubescentia; pinnae infimae sessiles vel manifeste petiolatae, superiores saepe ad rhachin margini proximali adnatae. Foliolum terminale foliolis lateralibus plerumque simile sed multo grandius, 32–60 × 15–45 mm, ovatum, in parte media cum vel sine uno duobusve lobis profundis vel non profundis fissum (aliquando usque ad costam, in margine saltem distali, sectum), ad basin cuneatum, ad apicem plerumque obtusum. Pedunculi et inflorescentiae rami tomentosi. Inflorescentia

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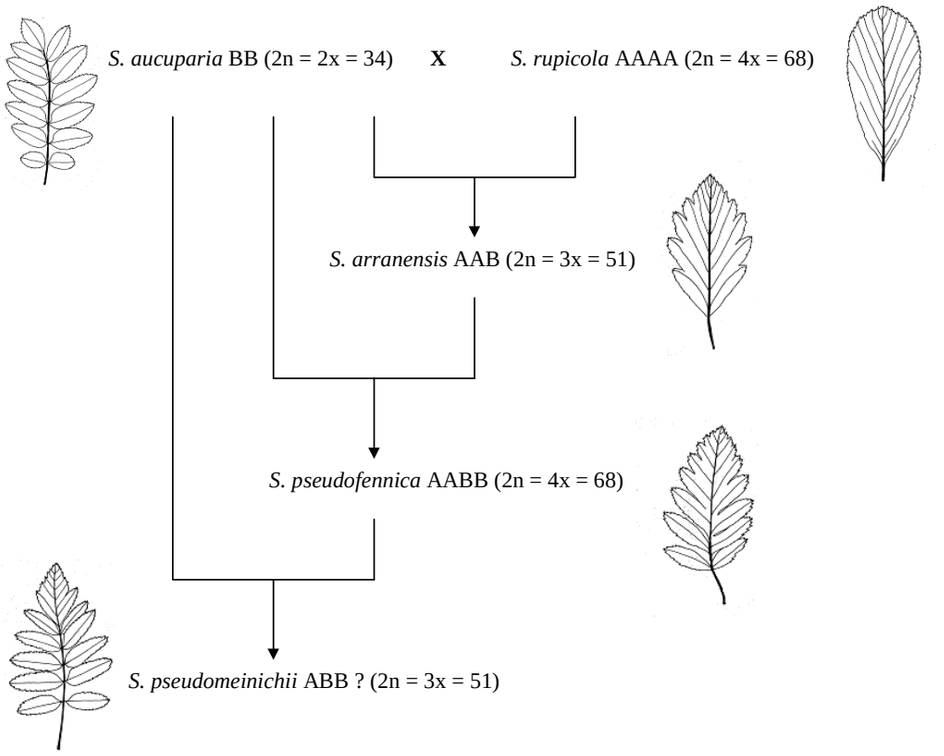

FIGURE 1. Relationships among Arran *Sorbus* taxa. The letters B and A indicate haploid genomes from *S. aucuparia* and *S. rupicola* respectively. Ploidy levels are given in brackets.

corymbosa. Sepala *c.* 1·5–2 mm, triangularia, ad basin sparsim hirsuta, apicem versus glabra, in marginibus glandulosodentata. Petala *c.* 4 mm, orbicularia breviter unguiculata alba cupulata, in facie superiore sparsim pubescentia. Stamina *c.* 20, cremea. Styli 3, usque ad basin discreti. Fructus inter *S. pseudofennicae* et *S. aucupariae* fructus intermedii.

Tree to at least 4 m tall. Buds lanceoloid, hairy. Stipules weakly toothed, deciduous. Young twigs, petioles and rachises moderately tomentose with white, appressed, simple hairs. Petioles 17–38 mm. Leaves 75–130 mm × 45–105 mm, with 4–5 pairs of lateral leaflets and a larger terminal leaflet, ovate in general outline with the middle pairs of pinnae the longest. Lateral leaflets at middle of leaf 25–55 mm × 9–23 mm, oblong or oblong-lanceolate, rounded but asymmetrical at the base, obtuse to acute at the apex, with margins serrate from near the base to about one third of the way along the leaf to the apex, with forward-pointing, acuminate teeth, green and glabrescent above, paler and sparsely pubescent below especially along the midrib and veins; lowest pinnae sessile or clearly stalked, the upper often adnate to the rachis on the proximal margin. Terminal leaflet generally similar to the lateral leaflets but much larger, 32–60 mm × 15–45 mm, ovate, with or without one or two, deep to shallow lobes at the middle (sometimes cut to the midrib at least on the distal margin), cuneate at the base, usually obtuse at the apex. Peduncles and inflorescence branches tomentose. Inflorescence corymbose. Sepals *c.* 1·5–2 mm, triangular, sparsely hairy at base and glabrous towards tip, glandular-toothed on margins. Petals *c.* 4 mm, orbicular with a short claw, white, cupped, sparsely pubescent on upper side. Stamens c. 20, cream. Styles 3, free to base. Fruits intermediate between those of *S. pseudofennica* and *S. aucuparia*.

Endemic to Arran, Scotland. Found beside the main burn in Glen Catacol (two plants), and in the tributary Allt nan Calman (one plant).

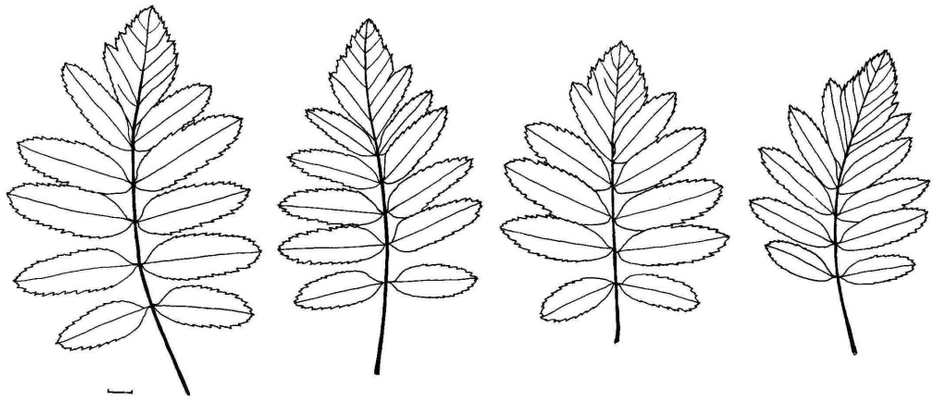

FIGURE 2. Leaves of *Sorbus pseudomeinichii*. Scale bar = 1 cm.

The altitudinal range is c. 150–200 m. One of the Glen Catacol plants, a sapling when first recorded, was not relocated in 2004 and appears to have died. The population of two trees qualifies it as 'Critically Endangered' under the IUCN (2001) Threat Criteria.

Sorbus pseudomeinichii (Figure 2) is an example of continuing evolution in *Sorbus*. It differs from *S. aucuparia* in having the terminal leaflet larger than the lateral leaflets (the terminal leaflet is about the same size as the lateral leaflets in *S. aucuparia*). It differs from *S. pseudofennica* in having largely pinnate leaves with 4–5 pairs of pinnae (typically 1–2 pairs of free pinnae in *S. pseudofennica*). *Sorbus arranensis* rarely has any free pinnae and is readily distinguished. The relationships between the taxa are summarised in Figure 1.

DISCUSSION

Isozyme, nuclear DNA and chloroplast DNA studies have shown that, like *S. arranensis* and *S. pseudofennica*, *S. pseudomeinichii* is a *Sorbus* hybrid that has ultimately been derived from the genomes of both *S. aucuparia* and *S. rupicola* (Robertson *et al.* 2004b). These studies also show that two of the trees, one of which is thought to have died, shared the same genetic marker profile, implying that they were members of the same apomictic clone. They are genetically distinct from the third tree. Neither of these two genetic marker profiles has been found before in *S. arranensis* or *S. pseudofennica*. The simplest explanation for the origin of these *S. pseudomeinichii* trees is that they are the product of sexual outcrossing between *S. pseudofennica* and *S. aucuparia*. This would give a triploid hybrid with a predominance of chromosomes from *S. aucuparia*. The genetic marker evidence is compatible with this hypothesis, as is an examination of pollen grain viability (Table 1), which suggests, in the context of other *Sorbus* species (Liljefors 1955), that *S. pseudomeinichii* is probably triploid (T. Rich, pers. comm. 2004).

The epithet *pseudomeinichii* has been chosen to draw attention to the similarity in origin to the Scandinavian *S. meinichii* (Lindeb.) Hedl., thought to be derived from *S. aucuparia* × *S. hybrida* L. (*S. fennica* Kalm ex Fries) (Liljefors 1953; Salvesen 1992; Bolstad & Salvesen 1999). Liljefors's (1953) experiments revealed that what was then considered *S. meinichii* existed in three forms: a tetraploid apomict (to which the name was originally applied), a triploid apomict and a triploid sexual hybrid. Liljefors (1953) proposed that the name *S. meinichii* should be retained for the tetraploid and a new name *Sorbus teodori* Liljef. given to the triploid forms. Bolstad and Salvesen (1999), using morphometric analysis and cytology, studied the relationships between the *S. meinichii* group, *S. hybrida* and *S. aucuparia.* They agreed with Liljefors (1953) that it was likely the *S. meinichii* forms had been derived from crosses between *S. aucuparia* and *S. hybrida*, but disputed the separation of *S. teodori* from *S. meinichii*. They showed that *S. meinichii* and *S. teodori* are, in reality, at the same ploidy level, which is triploid, not tetraploid as originally thought.

TABLE 1. POTENTIAL POLLEN VIABILITY ASSESSED USING ALEXANDER'S STAIN FOR ARRAN *SORBUS* TAXA HELD IN WELSH NATIONAL HERBARIUM (**NMW**). DATA COURTESY T. RICH, DECEMBER 2004

Taxon	Locality	Site code	**NMW** accession number	% viable pollen	No. of grains counted
S. arranensis	Diomhan Burn, east bank	A	V.2004.17.17	2%	85
	Diomhan tributary, north bank	B	V.2004.17.20	0%	100
	Catacol Burn, west bank	E	V.2004.17.12	4%	153
	Allt Easan Biorach, east bank	I	V.2004.17.13	5%	73
	Allt Easan Biorach, east bank	M	V.2004.17.14	1%	133
			Mean	3%	
S. pseudofennica	Diomhan Burn, west bank	A	V.2004.17.8	64%	60
	Diomhan Burn, west bank	A	V.2004.17.2	76%	105
	Diomhan Burn, west bank	A	V.2004.17.1	68%	89
	Diomhan Burn, east bank	A	V.2004.17.7	83%	96
	Catacol Burn, east bank	E	V.2004.17.3	64%	74
			Mean	71%	
S. pseudomeinichii	Catacol Burn, east bank (holotype)	C	V.2004. 17.21	0%	209

TABLE 2. LOCATIONS AND POPULATION SIZES OF ENDEMIC *SORBUS* TREES AT 14 SITES ON ARRAN

Locality	Grid Reference	Site Code	*S. arranensis* Population size	*S. pseudofennica* Population size	Most recent Survey
Diomhan Burn	NR925467	A	209	275	Robertson 1997
Diomhan tributary	NR930467	B	32	23	Robertson 1997
Allt nan Calman	NR918454	C	24	33	Robertson 1997
Abhainn Bheag	NR924489	D	0	40	Robertson 1997
Catacol Burn	NR917457	E	33	40	Robertson 1997
Catacol tributary	NR917457	E	8	25	Burlison 1986
Creag na h-lolaire	NR924475	F	1	0	Burlison 1986
Allt nan Champ	NR936430	G	30	0	Burlison 1986
Garbh Coire Dubh	NR951432	H	24	0	Burlison 1986
Allt Easan Biorach	NR953474	I	11	0	Robertson 1997
Allt Easan Biorach	NR952467	J	3	0	Robertson 1997
Allt Dubh	NR944470	L	27	0	Robertson 1997
Allt Easan Biorach	NR945496	M	4	0	Robertson 1997
North Glen Sannox	NR964457	N	1	0	King 1981
Total			407	436	

Previous surveys have identified 14 sites for *S. arranensis* and *S. pseudofennica* (Fig. 3), with total population sizes in 1997 of 407 and 436 plants respectively (Table 2). They are restricted to steep-sided, granite gorges on strongly acid soils (Table 3). Site K is no longer populated with either taxon due to a local extinction event, possibly a fire or landslide. Trees were last recorded at this site in 1956. Landslides or fire may also account for the lack of *S. rupicola* trees in the area. Competition from other *Sorbus* taxa or simply that *S. rupicola* has never been in the locality are possible alternative explanations. The nearest known stations for *S. rupicola* are: Gleann Dubh and Holy Island, both Arran and on the mainland, north of Arran, at Ardlamont Point.

High mortality rates and a lack of recruitment for *S. arranensis* and *S. pseudofennica* were used as justifications for the establishment of the Gleann Diomhan National Nature Reserve (McVean 1956; Bignal 1980; Boyd *et al.* 1988). A great deal of research has since

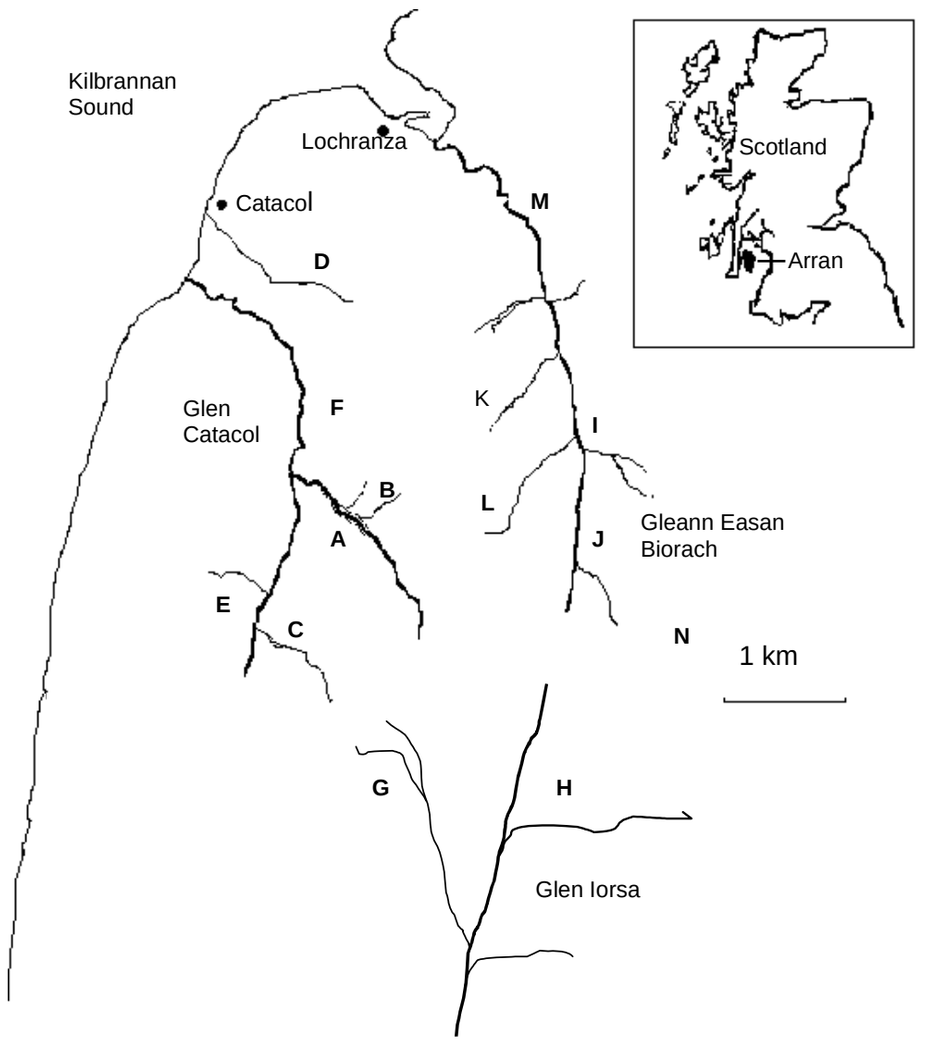

FIGURE 3. Locations of *Sorbus* species on Arran.

been carried out on their ecology and conservation, and although successive surveys have indicated an increase in the populations of both species there is no clear evidence to suggest that successful regeneration is occurring as differences between the survey methods make comparisons difficult (Robertson 2004). A true picture of the population trends will have to await further monitoring, perhaps using a standard protocol as developed for the *Sorbus* taxa at Craig y Cilau, Wales by Rich (2003).

Understanding the population dynamics of the Arran *Sorbus* taxa is central to any conservation plan, especially in the short-term. However, it is equally important to plan for the long-term. Long-term conservation plans should be centred on the processes and potential of the taxa to evolve. If evolution is thought not to be occurring then conservation policy should be aimed at preserving the unique products of hybridisation that are not to be repeated. If on the other hand evolution can be shown to be ongoing then conservation

TABLE 3. SOIL TYPES FOR ROOTING ZONES OF *SORBUS* SPECIES ON ARRAN. SAMPLES WERE AIR DRIED, AND LATER MIXED 50:50 WITH DISTILLED WATER AND PH MEASURED WITH A PHEP2 HANNA POCKET-SIZED PH METER AFTER EQUILIBRATION

Taxon	Locality	Site Code	Soil
S. arranensis	Diomhan Burn, east bank	A	Mixed black organic and grit, pH 3·5
	Diomhan tributary, north bank	B	Mixed black organic and grit, pH 3·5
	Allt Easan Biorach, east bank	I	Black organic peat, pH 3·7
	Allt Easan Biorach, east bank	J	Black organic peat, pH 3·8
	Allt Easan Biorach, east bank	M	Dark grey mixed grit and organic, pH 3·5
S. pseudofennica	Diomhan Burn, west bank	A	Black organic peat, pH 4·1
	Diomhan Burn, west bank	A	Dark, organic, pH 3·7
	Diomhan tributary, south bank	B	Dark grey mixed grit and organic, pH 3·6
	Allt nan Calman, north bank	C	Black organic peat, pH 3·7
	Catacol Burn, east bank	E	Black peat, pH 3·4
S. pseudomeinichii	Catacol Burn, east bank	E	Black organic peat, pH 4·0

policy should aim to ensure that management allows this evolutionary process to continue. The data presented here and in Robertson *et al*. (2004a, 2004b) have shown that the *Sorbus* complex on Arran is an actively evolving entity with new genotypes being generated throughout the range of the endemic taxa; there are now three *Sorbus* species that have evolved there. All three endemics can be considered endangered, and to maximise their evolutionary potential and long-term survival, the conservation management objective should be to ensure that all the components of the evolutionary complex, *S. arranensis*, *S. aucuparia*, *S. pseudofennica* and *S. pseudomeinichii* are retained in the northern glens of Arran.

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