

The Whitebeam problem, and a solution

Keith Rushforth

The Shippen, Ashill, Cullompton, Devon, EX15 3NL, U.K.

keith.rushforth@gmail.com

ABSTRACT

The position of *Sorbus sensu lato* within the **Malinae (Rosaceae)** and in the context of the historical treatment of five European Sorboid genera is reviewed, with an appraisal of published molecular studies. The treatment proposed here is to accept *Sorbus* L., *Cormus* Spach, *Aria* (Persoon) Host, *Chamaemespilus* Medikus, *Torminalis* Medikus, *Micromeles* Decaisne and *Pleiosorbus* Zhou & Wu and the five genera of hybrid origin proposed by Sennikov & Kurtto (*Hedlundia*, *Borkhausenia*, *Karpatisorbus*, *Majovskya* and *Normeyera*) and to describe *Griffitharia* Rushforth, *Alniaria* Rushforth, *Thomsonaria* Rushforth, *Dunnaria* Rushforth and *Wilsonaria* Rushforth as new genera for the Asiatic whitebeams. The genera in the Maloid group are reviewed and *Malus* Miller, *Eriolobus* (A.P. de Candolle) M. Roemer, *Chloromeles* (Decaisne) Decaisne, *Macromeles* Koidzumi, *Docynia* Decaisne and *Sinomalus* Koidzumi accepted and *Prameles* Rushforth described. Various new combinations are made. A key to the 45 genera recognised in the **Malinae** is presented. Published on-line www.phytologia.org *Phytologia* 100(4): 222-247 (Dec 21, 2018). ISSN 030319430.

KEY WORDS: Sorbus, Malinae, Rosaceae, taxonomy.

In a seminal paper looking at morphological characters Robertson, Phipps, Rohrer & Smith (1991) (hereafter Robertson *et al*) reinstated the treatment coherently expressed by Roemer (1847) that the European “Sorboids” comprise five separate genera. These genera are *Sorbus* L. [1753], *Torminalis* Medikus [1789], *Chamaemespilus* Medikus [1789], *Aria* (Persoon) Host [1831] and *Cormus* Spach [1834]. These were all sunk, along with *Aronia* Medikus [1789], *Eriolobus* (A. P. de Candolle) Roemer [1847] and *Micromeles* Decaisne [1874], by Wenzig (1883) into his concept of *Sorbus*. Rehder (1915, 266–279) espoused Wenzig’s concept of *Sorbus*, which by the early 1920s had superseded the wider use of *Pyrus* L. [1753] for the “Sorboid” genera. For much of the late 19th and early 20th centuries *Pyrus* was frequently used for both rowans (*Sorbus sensu stricto*) and whitebeams (*Sorbus sensu lato*), and for several other genera, including for some authors *Malus* Miller [1754], although Rehder kept *Malus* separate from *Sorbus* and *Pyrus*. However, Robertson *et al* pointed out the “uncomfortable fact” that the whitebeams in *Sorbus sensu lato* are closer to the apples (*Malus*) than to the rowans.

Two problems with Robertson *et al* – perhaps described as a shortcoming and as a flaw – were that a key to the genera was not provided and, more significant in the context of the Whitebeam problem, the many European microspecies derived from hybridisation between *Aria edulis* (Willd.) M. Roemer and *Chamaemespilus alpina* (Miller) Robertson & Phipps, *Sorbus aucuparia* L. and/or *Torminalis clusii* (M. Roemer) Robertson & Phipps—which due to their apomictic breeding system form a significant part of the native woody flora in parts of Europe and Asia east to Iran—were left in limbo without a usable generic name.

Since Robertson *et al*, molecular investigations have become available. In the Rosaceae there are four major papers covering the group, whether as Maloideae (traditional treatment as a subfamily of Rosaceae) or as Pyrinae, Pyreae or Malinae (as a subtribe in the Amygdalineae). These are Campbell *et al* (2007), Potter *et al* (2007), Li *et al* (2012)¹ and Lo & Donoghue (2012). These papers all suffer from a

¹ Hereinafter Campbell *et al*, Potter *et al*, and Li *et al*, similarly for Aldosoro *et al*, Qian *et al* and Guo *et al*.

very limited sampling of Sorboid genera and taxa. In Campbell *et al*, the Sorboids are: *Aria alnifolia* (Siebold & Zuccarini) Decaisne, *Chamaemespilus alpina*, *Cormus domestica* (L.) Spach, *Sorbus aucuparia* and *Torminalis clusii*. In other genera one to three species were sampled. Note the type species of *Aria* (*Aria edulis*) was not included in this analysis. Potter *et al* used a similar small set of taxa, not surprising when the five authors of Campbell *et al* are included in the eleven authors of Potter *et al*.

In Campbell *et al*, using cpDNA [fig 1] *Aria (alnifolia)*² is well removed from *Cormus* Spach and *Sorbus* L. with *Pyrus* L. sister to *Sorbus* with *Cormus* basal to these two genera, and with *Chamaemespilus* Medikus and *Torminalis* Medikus close together in an unresolved separate clade including *Malus*, *Docyniopsis* (C. K. Schneid.) Koidzumi³ and five other genera (out of the 28 Malinae genera included in the sampling). Fig 2, using data from the granule-bound starch synthase gene GBSSI-1A *Aria (alnifolia)* and *Chamaemespilus* are sister with *Torminalis* basal and with this clade sister to *Cormus* and *Sorbus* in a clade which is sister to *Pyracantha* M. Roemer [1847]. With GBSSI-1B, fig. 3, *Cormus* and *Sorbus* are in a clade which is sister to a poorly resolved clade which includes all the other 14 genera in the figure. In the poorly resolved clade, *Aria (alnifolia)* and *Chamaemespilus* are sister to each other but in an ill-defined group including *Malus* and *Docyniopsis* and two other genera. Note in this figure *Torminalis* is not present as presumably it does not have this gene. Using GBSSI-2A, fig. 4, all five Sorboid genera are in a poorly resolved clade, with *Aria (alnifolia)* close to *Chamaemespilus* at the top of the clade, *Cormus* in the middle and *Torminalis* sister to *Pyrus* with *Sorbus* near the bottom of the clade. In Fig 5, using GBSSI-2B, *Aria (alnifolia)* and *Chamaemespilus* are sister to a group including *Cormus*, *Docyniopsis*, *Eriolobus* and *Malus* but with *Sorbus* basal to 16 of the 22 genera in this cladogram (which again excludes *Torminalis*). Combining nrITS with GBSSI-2B in Fig. 6 has *Sorbus* basal to 22 other genera, with *Aria (alnifolia)* close to *Chamaemespilus* and sister to a clade containing *Cormus*, *Docyniopsis*, *Eriolobus*, *Malus* and *Chaenomeles* Lindley and *Torminalis* sister to a clade which includes *Pyrus* and *Cotoneaster* Medikus along with unresolved *Osteomeles* Lindley and *Photinia* Lindley (actually *Pourthiaea villosa* (DC) Decaisne). Fig. 7 which includes a dozen non-molecular characters gives a broadly similar arrangement to figure 6.

Figures 1 to 4 in Potter *et al* present a generally similar picture, with *Sorbus* basal to the group and *Aria (alnifolia)*, *Chamaemespilus*, *Cormus* and *Torminalis* more closely associated.

Lo & Donoghue sampled a much larger number of species and individuals. From Appendix A, which was not part of the published paper but accessible in the online version, in *Sorbus s.l.* their sample included 3 individuals of *Aria edulis*⁴ as well as 46 of the mainly hybrid⁵ apomictic tetraploid European and West Asian taxa (all as subgenus *Aria*), two of *Chamaemespilus alpina*, two of *Cormus domestica*, 22 assorted individuals of Sino-Himalayan origin as “*Micromeles*” [including *alnifolia*], 124 individuals of *Sorbus s.s.* – mainly Asiatic microspecies but including three samples each of *aucuparia*, *americana* Marshall and *commixta* Hedlund, and two individuals of *Torminalis clusii*. The species listed as belonging to the “*Micromeles*” group are *alnifolia*, *caloneura* (Stapf) Rehder, *epidendron* Handel-Mazzettii, *folgneri* (C. K. Schneider) Rehder, *hedlundii* C. K. Schneider, *hemsleyi* (C. K. Schneider) Rehder, *japonica* (Decaisne)

² I am putting the specific name of the specimen examined by Campbell *et al* after *Aria* as the analysis did not include the type species of *Aria* but a species which I consider is better placed in a separate genus

³ *Macromeles tschonokii* Koidzumi

⁴ As *Sorbus aria* Crantz

⁵ Using the segregate genera in Sennikov & Kurtto [2017] for the apomictic European and West Asian microspecies the species listed in Appendix A belong to tetraploid *Aria* and *Borkhausenia*, *Hedlundia* and *Karpatisorbus*, as below, but some of their West Asia taxa were not allocated to genera by Sennikov & Kurtto as their treatment is only for the European taxa

Rehder, *lanata* (D. Don) Schauer, ‘*melanocarpa*’⁶, *pallescens* Rehder, *thibetica*⁷, *tsinglingensis* C. L. Tang, *verticillata* Merrill, *vestita* (Wallich ex G. Don) Loddiges and *yuana* Spongberg.

Lo & Donaghue’s combined chloroplast tree (left hand side of fig. 1) resolved three major clades, viz. **A** *Amelanchier*—*Crataegus*⁸, **B** *Aria*—*Malus* and **C** *Cotoneaster*—*Pyrus*—*Sorbus*, with *Pyracantha* unresolved with **A** and **B-C**. In this presentation *Cormus* sits as a sister to *Sorbus* and “*Micromeles*”. *Torminalis* and *Chamaemespilus* are not shown.

The right hand side of the figure shows the result from the nuclear ribosomal ITS DNA sequencing. Including *Pyracantha* all the genera shown are initially unresolved. However, apart from this the *Amelanchier*—*Crataegus* clade is identical to that from the chloroplast DNA sequencing. The main differences are that *Malus*—*Aria*—*Cotoneaster* form a clade with “*Micromeles*” sitting between *Malus* and *Aria*, with *Pyrus*, *Pourthiaea*—*Aronia*, *Cormus* and *Sorbus* as unresolved. Again, *Chamaemespilus* and *Torminalis* are not shown.

The position of “*Micromeles*” occurring as sister to *Sorbus* in the chloroplast DNA sequencing and as sister to *Aria* and close to *Malus* in the nuclear ribosomal ITS DNA sequencing is used to suggest a hybrid origin for this group. However, the disparate cluster of distantly related taxa from eastern Asia, and possibly including North American *Aronia melanocarpa* (Michx.) Britton, may also provide an explanation for this.

Figure 2 suggests a chronology based on combined chloroplast and ITS data. This diagram excludes the “*Micromeles*” taxa. It lists *Torminalis clusii* as basal to a group of *Aria* species which includes *Chamaemespilus alpina*. However, it is disappointing that all the *Aria* taxa listed are part of the hybrid or apomictic Sorboids and include tetraploid *Aria* and apomictic hybrids which include *Aria edulis*, *Sorbus aucuparia* and/or *Torminalis clusii* in their genetics (but not *Chamaemespilus*) but that data from the three collections of *Aria edulis* is not included. In the clade including *Sorbus*, *Pyrus* and *Cotoneaster*, *Cormus* is basal to *Sorbus* and together they are sister to *Pyrus*.

Figure 4 adds nine non-molecular characters to the combined chloroplast and nuclear ITS combined data. This has *Torminalis* as basal to a sister group of *Aria* and *Chamaemespilus* and well removed from the clade which has *Pyrus* basal to a sister pair of *Cormus* and *Sorbus*.

It is pertinent to note, as a word of caution, how in figure 2 one of the two specimens analysed as *tschonoskii* comes out, as *Docyniopsis tschonoskii* with the two species of *Docynia* but another one (as *Malus tschonoskii*) is centred in the *Malus* cluster. As *tschonoskii* is one species, whether placed in *Malus* as Maximowicz⁹ named it or in *Macromeles* and *Docyniopsis* where Koidzumi put it, it is likely that one – I suspect the *Malus tschonoskii* sample – has been mis-identified.

⁶ This is recorded as from Ness Botanic Garden and presumed to be *megalocarpa* unless it was *Aronia melanocarpa* from elsewhere

⁷ Two collections are listed as *thibetica*. One is Clark & Sinclair 1546 from Edinburgh; this collection is from Bhutan and is *karchungii*. The second is cited as from Sichuan Expedition [SICH] 1464 but with the locality as ‘China; Dali; Huadianba’. However, SICH 1464 is not *thibetica* but appears to be *ambrozyana* from China, Sichuan, Xichang xian on the northern flank of Luoji shan. The whitebeam from Huadianba at the northern end of the Cang shan is *guanii*, from CLD 1501, thus neither is *S. thibetica* (Cardot) Handel-Mazzetti.

⁸ Genera in the clades are: *Amelanchier* Medikus, *Crataegus* L., *Pyracantha* M. Roemer, *Pourthiaea* Decaisne

⁹ *Malus tschonoskii* Maximowicz, *Docyniopsis tschonoskii* (Maxim.) Koidzumi = *Macromeles tschonoskii* (Maxim.) Koidzumi

The omission of *Aria edulis* from their figure 2 cladogram raises the prospect that their data from this—the type species of *Aria*—was excluded from the other figures and thus questions the usefulness of the references to *Aria* in the other cladograms.

Li *et al* Table 1, listing the species, has three as *Aria* (*coronata* (Cardot) Ohashi & Iketani, *hemsleyi* (C. K. Schneid.) Ohashi & Iketani and *yuana* (Spongberg) Ohashi & Iketani) but not the type species, two specimens of *Chamaespilus alpina*, two of *Cormus domestica* and three samples of *Torminalis clusii*. Six samples are listed as *Micromeles*. These are three as *alnifolia*, and one each as *caloneura* Stapf, *thomsonii* and *tsinlingensis*, with the above caveat about the placing of *alnifolia*. The sample listed as *thomsonii* is of interest, as it is recorded from Jiangxi and likely to have been mis-identified. Twenty one samples are listed as *Sorbus*, including two of *aucuparia*.

Li *et al* produce two cladograms. In Fig. 1 on nrDNA ITS sequences *Sorbus*, *Torminalis*, *Cormus* and a cluster of taxa listed as variously *Aria* or *Micromeles* (but not including the type species of either genus) all come out in different clades. Fig. 2 gives a similar arrangement. In the *Sorbus* clade, the presence of the *Sorbus aronioides* Rehder sample suggests this was mis-identified.

Combining these four investigations, they provide support for separating the genera *Chamaespilus*, *Cormus* and *Torminalis* from *Sorbus*. However, it is not possible to draw any conclusions on the placement of *Aria*, as none of them present any data on *Aria edulis* even though three samples were included in the Lo & Donaghue (2012) sampling. The presented results show *Sorbus* and usually *Cormus* separate from *Chamaespilus* and *Torminalis*, with the former two genera closer to *Pyrus* and the latter pair closer to *Malus*. Thus even without results for *Aria edulis* the maintenance of *Sorbus sensu lata* is not coherent.

When presented with conflicting factual data there are two opposite ways in which to rationalise it. Rehder (1915, p276) gave his reasons for not accepting *Micromeles* as a genus with “Decaisne, who founded the genus *Micromeles*, distinguishes it from his *Aria* chiefly by the smaller flowers, the epigynous disk and the deciduous calyx. The difference in the size of the flowers is not very marked and has hardly any significance as a generic character. In typical *Aria* as represented by *Sorbus Aria* which Decaisne figures, the disk is certainly perigynous, but in such species as *S. cuspidata* Hedlund¹⁰ (*Aria lanata* Decaisne), *S. japonica* Hedlund and *S. alnifolia* K. Koch enumerated by Decaisne under *Aria*, the disk is distinctly epigynous as in the species referred by him to *Micromeles*. The deciduous calyx is not a distinguishing generic character with Decaisne, as he includes *S. japonica* and *S. alnifolia*, which both have a deciduous calyx, in *Aria*.”

Rehder took the view that as *Micromeles* and several other whitebeam species known at the time had epigynous disks this provides justification for uniting them with *Aria edulis* and its perigynous disk. However, Decaisne’s text (1874) describes his concept of *Aria* as having a perigynous disk, which Rehder agrees is shown in the illustration of *Aria edulis* [as *A. nivea* Host]. A likely conclusion is that Decaisne did not have good flowering material of the other taxa which he included in his *Aria* concept, which Rehder 40 years later was able to correct. Rehder also overlooked Decaisne’s reference to the small fruit in his characters separating *Micromeles* from *Aria*.

When faced with new information one option is to retrench, as Rehder did with his treatment of *Sorbus sensu lata*. However, the other option is to see how existing views need amending and thus what changes might be needed to accommodate the new data.

¹⁰ nomen illegitimate (or superfluous?) as *Pyrus vestita* Wallich ex G Don predates Spach’s *Crataegus cuspidata* which is based on the same Wallich specimens

Recently the retrenchment approach to the conflicting molecular data currently available has been taken as justification by Fay & Christenhusz (2018) for treating almost all the group as species of *Pyrus*. This has required the making of 843 new combinations and has obliterated the last two centuries of research. It also totally fails to provide any clarity on the relationship of the thousand or so species of *Pyrus* thereby created and in my opinion is a short sighted and retrograde step not supported by any available published data. Thus whilst at one level it has a degree of logic¹¹ it fails the primary purpose of taxonomy which is to assist our understanding of plants (or animals, fungi, etc.) and their relationships.

Fay & Christenhusz cite as justification for their approach the treatment of European hybridogenous taxa by Sennikov & Kurtto (2017) where rather than create hybrid genera to contain the numerous microspecies they treat them by creating normal genera of hybrid origin, reflecting the fact that as fertile apomictic species they behave as such rather than as one-off hybrids. Their units are *Hedlundia* Sennikov & Kurtto derived from hybrids between *Aria x Sorbus*, *Borkhausenia* Sennikov & Kurtto for the three-way hybrid derived from *Aria x Sorbus x Torminalis*, *Karpatisorbus* Sennikov & Kurtto for *Aria x Torminalis*, *Majovskya* Sennikov & Kurtto for *Aria x Chamaespilus* and *Normeyera* Sennikov & Kurtto for *Aria x Chamaespilus x Sorbus*, with *Aria* retained for the tetraploid apomictic forms believed to be derived from a doubling-up of the *Aria edulis* genome, or parts thereof. Sennikov & Kurtto's approach has been criticized for not following the standard treatment of creating hybrid genera (incorporating some letters from each of the postulated parental genus names). Personally I find their approach more credible than the hybrid genera approach as their genera are not one-off hybrids but dynamic naturally occurring microspecies.

However, regardless of whether Sennikov & Kurtto's genera are accepted with their names, they neatly and clearly define the groups of European apomictic taxa at the genus level. Thus they overcome the flaw in Robertson *et al*'s treatment and provide an approach for treating the European apomictic hybrid species. They do, however, leave a small number of West Asian apomictic taxa of similar hybrid parentage (some possibly with *Torminalis orientalis* (Schonbeck-Temesy) Robertson & Phipps as one component rather than *T. clusii*) needing new combinations into the hybrid genera.

With the status of the European and West Asian apomictic hybrid Sorboids settled by following Sennikov & Kurtto's approach [whether using their names or their concepts of the groups] the last remaining constraint to following Robertson *et al*'s revival of Roemer's five European Sorboid genera is the provision of appropriate genera for the non-European Sorboids. These are the various whitebeams found in Asia east of Iran and extending south into Sumatra. Whilst *Sorbus* is recorded in North America, the species all belong to *Sorbus sensu stricta* (McAllister 2005).

Aldosoro *et al* (2004) provided a monograph of part of *Sorbus s.l.*, treating *Sorbus* as having four subgenera, viz. *Sorbus*, *Cormus*, *Aria* (including *Chamaespilus*) and *Torminalis* (as *Torminaria* (DC) Reichenbach). They provide a key to the sections in their subgenus *Aria* based on morphological characters, including foliar characters and on style and seed placentation. My opinion is that this provides a firm basis for the treatment of the wider group. However, my opinion is that most of their sections justify treatment at the genus level. So whereas Aldosoro *et al* treat *Chamaespilus* as a section, the above review of published molecular data provides justification for its treatment as a genus, as followed by Roemer (1847) and Robertson *et al* (1992).

¹¹ Fay & Christenhusz accept *Pyracantha* as a separate lineage based on an ill-defined paper attributed to Zhang *et al* [2017] which does not feature in their bibliography and is at variance with Campbell *et al* (2007), Potter *et al* (2007) and Lo & Donaghue (2012) where *Pyracantha* is often central in the cladograms. Fertile hybrids between *Pyracantha* and *S. commixta* (*XSorbocantha*) have occurred in cultivation.

Guo *et al* (2016) provide a cladogram based on nrITS DNA from 40 samples of *Sorbus s.l.* with three *Cotoneaster* and one each of *Eriobotrya* Lindley and *Pyracantha* as out-groups. The data as presented does not give any origins for the samples apart from that of the subject species named in the paper as *Sorbus calcicola* W. B. Liao & W. Guo. Thus there has to be a caveat about their conclusions. However, the presented cladogram, figure 1, is interesting. *Pyracantha* and the clade for the three *Cotoneaster* taxa are not resolved from the clade containing all the other samples—thus contradicting a basic tenet in Fay & Christenhusz (2018) and removing part of their justification for a super *Pyrus*. The clade containing the 13 *Sorbus s.s.* samples branches off from the clade containing the *Eriobotrya* sample and those for the other whitebeams. Next to separate is a clade containing “*Sorbus aria*”, “*Sorbus graeca*” and “*S. aria* var. *salicifolia*”¹². If this clade includes correctly identified *Sorbus aria* it fills the omission in Campbell *et al* (2007) where the *Aria* sample is *alnifolia* and provides support for treating *Aria* as a separate genus. Within the larger whitebeam clade, the two samples of *alnifolia* are centrally located. The figure provides good, but not total, support for the treatment proposed below.

Key to the genera in the Malinae

As suggested above, a drawback in Robertson *et al* is that they were not able to provide a key to the genera in their concept of the group. They provided written descriptions of the genera they accepted but not in a manner which makes it easy to compare them. My attempt to rectify this shortcoming is presented below. It is based on literature references, especially Robertson *et al*, and the study of plants in the wild and in cultivation. The Key recognizes 45 genera, including several new genera which are formally described below.

1	A	Leaf trace on shoot showing 5 sets of vascular bundles in petiole, leaves pinnate	2
	B	Leaf trace showing 3 sets of vascular bundles in petiole, leaves simple or pinnate	3
2	A	Fruits more than 18mm, cells of flesh filled with tannins, bark deeply fissured	<i>Cormus</i>
	B	Fruits less than 15mm, cells without or no more than a trace of tannins, bark not as above	<i>Sorbus</i>
3	A	Ovules 3—many per carpel	4
	B	Ovules 1 or 2 per carpel	7
4	A	Styles free at base, erupting through a pit in the top of the hypanthium	<i>Cydonia</i>
	B	Styles fused at base or in lower 1/3 rd	5
5	A	Styles fused at base only, ovules 3—10 per locule, leaves evergreen or semi-evergreen, calyx persistent, fruit hairy	<i>Docynia</i>
	B	Styles fused in lower 1/3 rd , ovules >10 per locule, leaves deciduous, calyx deciduous, fruit glabrous	6
6	A	Stamens 25 or less	<i>Pseudocydonia</i>
	B	Stamens 40—55	<i>Chaenomeles</i>
7	A	Leaves fully pinnate with leaflets of similar size, 1 ovule per carpel	<i>Osteomeles</i>
	B	Leaves simple, or with 1—3 free leaflets at base, 2 ovules per carpel, rarely just 1	8

¹² This name is given as a synonym of the tetraploid *Aria rupicola* in Sennikov & Kurtto

8	A	Seeds PYRENES with an extremely hard or bony seed coat	9
	B	Seeds not PYRENES, seed coat leathery	15
9	A	Thin fleshy layer which can be scrapped off separating the Pyrenes	10
	B	No fleshy layer separating the Pyrenes	12
10	A	Leaf venation craspedodromus, stamens 5—20	<i>Crataegus</i>
	B	Leaf venation camptodromus, stamens 20—40	11
11	A	Flowers single, many sclereids in flesh of fruits, leaves deciduous, stamens 20—40	<i>Mespilus</i>
	B	Flowers in large panicles, sclereids lacking in fruit flesh, leaves evergreen, stamens 20	<i>Hesperomeles</i>
12	A	Carpels/styles 1	13
	B	Carpels/styles 2—5	14
13	A	Stamens 20, leaves entire, not toothed, no adnation of hypanthium to carpel	<i>Dichomanthes</i>
	B	Stamens 10—15, leaves toothed, nearly full adnation	<i>Chamaemeles</i>
14	A	Plants with thorns, leaves toothed	<i>Pyracantha</i>
	B	Plants thorn less, leaves entire	<i>Cotoneaster</i>
15	A	Leaves evergreen, persisting for more than one year	16
	B	Leaves deciduous, falling at least before next year's leaves flush	20
16	A	Calyx soon deciduous, leaving a round depression at top of fruit	<i>Raphiolepis</i>
	B	Calyx persisting in ripe fruit	17
17	A	Styles fused at least at base	18
	B	Styles free	19
18	A	Inflorescence compound corymb, fruit less than 10mm	<i>Photinia</i>
	B	Inflorescence paniculate, fruit 7—50mm	<i>Eriobotrya</i>
19	A	Styles 2, stamens 10, fruit core leathery & broad	<i>Heteromeles</i>
	B	Styles 2—5, stamens 10—20, fruit pseudoberry without leathery core	<i>Malacomeles</i>
20	A	Stamens 25—55, if less than 30 stamens then fruit densely lenticellate & diameter or length more than 20mm	21
	B	Stamens 15—20(—30), fruit dimensions less than 20mm or if larger then fruit elenticellate	22
21	A	Flowers in large leafless corymbose panicles which are terminal on leafless shoots in autumn, stamens (25—)30—50, ovules superposed, carpels 3—5(—7) ovary fully adnate to hypanthium, fruit 2.5—5cm densely lenticellate, calyx deciduous or incurved	<i>Pleiosorbus</i>
	B	Flowers in leafy inflorescences in spring, in umbels or umbellate racemes, stamens 50—55, ovules co-lateral, carpels 4—5, fruit c. 2.5cm, not densely lenticellate, calyx prominent, lobes long, ovary only $\frac{3}{4}$ adnate to the hypanthium	<i>Macromeles</i>

- 22 A Leaf venation on flowering shoots craspedodromus with veins running to teeth or stopping a mm or so before the margin (hemi-craspedodromus) but not anastomosing 23
 B Leaf venation on flowering shoots camptodromus with veins looped or curved forwards, not parallel, not or rarely running straight to teeth 36
- 23 A Fruit noticeably longer than broad, rarely nearly round, carpels/styles 2(—3), ovules co-lateral *Alniaria*
 B Fruit round to oblate, not noticeably longer than broad or rarely longer than broad when the fruits/flowers are in umbels or umbel-like racemes, styles/carpels 2—5, ovules co-lateral or superposed 24
- 24 A Calyx deciduous, usually well before fruit matures leaving a circular depression 25
 B Calyx persistent in mature fruit 28
- 25 A Leaves silvery hairy on lamina beneath with rufous hairs on veins, flowers/fruits in corymbs *Dunnaria*
 B Leaves glabrous or sparsely hairy beneath, flowers/fruits in umbels, umbel-like racemes or convex or domed panicles 26
- 26 A Flowers/fruit in panicles or corymbose panicles, leaves serrate but not lobed 27
 B Flowers/fruits in umbels or short umbel-like racemes < 0.5cm, leaves lobed, especially on vegetative shoots *Sinomalus*
- 27 A Ovules superposed *Thomsonaria*
 B Ovules co-lateral *Micromeles*
- 28 A Flowers in umbels or umbel-like short racemes less 1cm, styles/carpels 5 29
 B Flowers in corymbs or corymbose panicles, styles/carpels 2—4 30
- 29 A Leaves with 3 lobes extending more than 1/3rd way to midrib, lobes acute, lateral lobes often divided, fruit ripens red to yellow, not waxy *Eriolobus*
 B Leaves shallowly lobed only on vigorous extension shoots, generally lobulated or toothed, fruit ripens green, rarely yellow, with a waxy exudation *Chloromeles*
- 30 A Leaves with 3—5 distinct lobes extending > 1/3rd way to midrib, carpels 2, fruit brown with many close or contiguous lenticels *Torminalis*
 B Leaves unlobed or lobulated with lobes less than 1/4 way to midrib 31
- 31 A Styles free 32
 B Styles fused at least at base 34
- 32 A Leaves simple or doubly toothed but not lobed with lobes extending no more than 1/5th way to midrib, leaf underside silvery hairy *Aria*¹³
 B Leaves with some free leaflets at base or lobes extending more than 1/5th way to midrib, leaf undersides grey tomentose 33

¹³ The tree widely cultivated in the UK as *Sorbus* 'John Mitchell' keys out here. It is known to have been raised at Westonbirt from seeds of *Griffitharia vestita* and it would appear that the other parent was a species of *Karpatiosorbus*, perhaps *devoniensis* or *latifolia*.

- 33 A Leaves with 1 or 2 (—3) free leaflets at base or pinnatilobed, fruit red to crimson
Hedlundia
B Leaves pinnatifid or sub-pinnate, fruit orange to red *Borkhausenia*
- 34 A Ovules co-lateral, styles 2—3, fruit yellowish-brown, orange-brown or reddish-brown with numerous large lenticels *Karpatiosorbus*
B Ovules superposed, styles 2—4(—5), fruit brown, green to yellow, often pink tinged, lenticels dense to well spaced 35
- 35 A Styles 3 or 4, leaves glabrous or sparsely hair when young, not tomentose, fruit brown, 12—20mm in diameter, covered in massed contiguous lenticels *Wilsonaria*
B Styles 2—4(—5), leaves white to silver tomentose beneath, fruits green to yellow, often pink tinged, 7—15(—30)mm lenticels well spaced or absent *Griffitharia*
- 36 A Calyx persistent in fruit 37
B Calyx deciduous in fruit, usually dropping off to leave a circular scar before ripe 47
- 37 A Pedicels & peduncles conspicuously warty or lenticellate, glabrous, pedicels long & slender, fruit without lenticels *Pourthiaea*
B Pedicels & peduncles with few scattered smooth lenticels, usually hairy, fruit with lenticels 38
- 38 A Flowers/fruits in umbels, umbel-like racemes or in long racemes 39
B Flowers/fruits in panicles or corymbose panicles 44
- 39 A Flowers/fruits in racemes > 2cm, styles/carpels usually 5 *Amelanchier*
B Flowers/fruits in umbels or umbel-like racemes < 2cm, styles/carpels 2—5 40
- 40 A Styles free 41
B Styles joined at least at base 42
- 41 A Styles passing through a pit at top of hypanthium, stamens 15—30, flesh of fruit with large stone cells, 2 ovules in each carpel not separated by a false partition *Pyrus*
B Styles not constrained by disk, stamens 20, flesh with few sclereids, ovules in carpels separated by a false partition *Peraphyllum*
- 42 A Ovules superposed, flowers/fruits in umbellate racemes, rachis 1—2cm *Prameles*
B Ovules co-lateral, flowers/fruits in umbels or fascicles, rachis less than 1cm 43
- 43 A Fruit fragrant, often waxy, dense layer of sclereid cells around the core & under the skin, flowers/fruits in umbel-like racemes, leaves often lobulated *Chloromeles*
B Fruit not fragrant, few sclereid cells, flowers/fruits in umbels, rachis less than 5mm, leaf margin serrate but not lobulated *Malus*
- 44 A Petals pink or red, upright or erect, styles 2(—3), fruit red, >1cm 45
B Petals white or pink, spreading, styles 5, fruit < 1cm *Aronia*
- 45 A Leaves glabrous, leaf margin finely serrate *Chamaemespilus*
B Leaves variously tomentose beneath, if glabrous then leaf margin doubly serrate or with small obtuse lobes 46

46	A	Leaves white tomentose beneath, margin minutely to doubly serrate	<i>Majovskya</i>
	B	Leaves glabrous to white or grey tomentose, margin doubly serrate or with very small obtuse lobes	<i>Normeyera</i>
47	A	Styles free, passing through a pit at the top of the hypanthium	<i>Pyrus</i>
	B	Styles joined at the base or in lower half	48
48	A	Flowers/fruit in panicles or corymbose panicles	49
	B	Flowers/fruits in umbels or umbel-like racemes with a rachis < 1cm	<i>Sinomalus</i>
49	A	Ovules superposed	<i>Thomsonaria</i>
	B	Ovules co-lateral	<i>Micromeles</i>

Proposed taxonomic treatment of *Sorbus sensu lato*.

Sorbus L. Sp. Pl. 2: 477. [1753]—Lectotype, designated by Rehder, 1949: *S. aucuparia* L. Two subgenera, 11 sections and circa 70—100 species, both diploid sexual and apomictic triploids and tetraploids. Distribution: Europe, North Africa (Morocco), Asia, North America. With *Cormus*, this genus is ‘unique’ in the leaf scar on the shoot showing five clusters of vascular tissue, whereas all the other genera in the Malinae have three.

Aria (Persoon) Host. Fl. Austriac. 2: 7 [1831]—Type *A. edulis* (Willdenov) M. Roemer Fam. Nat. Syn. Monogr. 3: 124. 1847. One (—few?) sexual diploid species and several tetraploid apomictic taxa, Europe, North Africa & West Asia.

Torminalis Medikus Philos. Bot. (Medikus) 1: 134. [1789] Type (only species listed by Medikus) *T. clusii* (M. Roemer) K. R. Robertson & J. B. Phipps. Syst. Bot. 16: 390. [1991] (= *Torminaria clusii* M. Roemer, Fam. Nat. Reg. Veg. Syn. 3: 130. [1847]—*Crataegus torminalis* L.). One species in Europe, North Africa & West Asia, second species, *T. orientalis* (Schonbeck-Temesy) K. R. Robertson & J. B. Phipps. Syst. Bot. 16: 390 [1991], in Iran.

Chamaemespilus Medikus Philos. Bot. (Medikus) 1: 138, 155. [1789] Type (only species listed by Medikus) *C. alpina* (Miller) K. R. Robertson & J. B. Phipps. Syst. Bot. 16: 390.—*Crataegus alpina* Miller, Gard. Dict., 8th ed., species number 3 under *Crataegus*. [1768]—*Mespilus chamaemespilus* L. Sp. Pl. 1: 479. [1753]. One species in Central Europe from Germany south to Spain, east to Greece and north to Bulgaria.

European and West Asian hybrid species involving *Aria edulis* (all) with variously *Sorbus aucuparia*, *Torminalis clusii* and rarely *Chamaemespilus alpina* are treated in Sennikov & Kurtto (2017) under the genera ***Hedlundia*** Sennikov & Kurtto (*Aria x Sorbus*), ***Borkhausenia*** Sennikov & Kurtto (*Aria x Sorbus x Torminalis*), ***Karpatiosorbus*** Sennikov & Kurtto (*Aria x Torminalis*), ***Majovskya*** Sennikov & Kurtto (*Aria x Chamaemespilus*) and ***Normeyera*** Sennikov & Kurtto (*Aria x Chamaemespilus x Sorbus*).

Cormus Spach Hist. Nat. Veg. (Spach) 2: 96. [1834] Type (only species listed by Spach) *C. domestica* (L.) Spach Hist. Nat. Veg. (Spach) 2: 97. [1834]—*Sorbus domestica* L. Sp. Pl. 477. 1753. One species in Europe, North Africa and West Asia to the Caucasus. There are no recorded hybrids of this genus.

Micromeles Decaisne Nouv. Arch. Mus. Paris 10: 168. [1874] Lectotype, designated by H. Ohashi & H. Iketani, J. Jap. Bot. 68: 357. [1993] *M. rhamnoides* Decaisne, loc. cit. 169. Robertson *et al* proposed *Sorbus alnifolia* as lectotype but this has to be rejected as Decaisne [1874] placed this species in *Aria* and

specifically excluded it from *Micromeles*. Aldosoro *et al* (p 170) proposed *M. griffithii* Decaisne having overlooked Ohashi & Iketani. This lectotype is superfluous.

The genus is characterised by the small, 4–7mm fruits without lenticels, two co-lateral ovules in the two carpels and generally craspedodromus venation, but camptodromus in *M. cuspidata*.

Decaisne established *Micromeles* with five species, viz. *verrucosa*, *castaneifolia*, *rhamnoides*, *khasiana* and *griffithii*¹⁴. *M. verrucosa* is based on the same collections (although probably not exactly the same specimens) as the earlier described *Pyrus cuspidata* Bertoloni. *M. castaneifolia* is based on Griffith 2077 which at Kew appears to fit *cuspidata*, although Aldosoro *et al* cite it as synonymous with *Pyrus granulosa* Bertoloni. Hooker f. (1878, Flora of British India 2: 379) has *castaneifolia* as a ‘doubtful species’. *M. khasiana* also is often treated as a synonym of *granulosa*, with which it shares a larger—circa 10–12mm) 4 celled fruit with a granular pulp. My view is that *M. granulosa* and *M. khasiana* do not fit in *Micromeles* but as part of the new genus *Thomsonaria* as proposed below. Thus on current information, of Decaisne’s five species, I would only include *M. rhamnoides*, *M. griffithii* and *P. cuspidata* in his genus. To this I provisionally add *Pyrus polycarpa* Hooker f., *Sorbus paucinerva* Merrill and *Sorbus salwinensis* T. T. Yu & L. T. Lu. Accordingly this requires the following new combinations:

Micromeles cuspidata (Bertol.) Rushforth. **Comb. nov.** —*Pyrus cuspidata* Bertol. Mem. Reale Accad. Sci. Ist. Bologna, ser. 2, 4: 311 [1864]. More commonly known from the later synonym based on *Micromeles verrucosa* Decaisne which has priority only in the genus *Sorbus*. It was described from the Khasia Hills, Meghalaya State, India. I am unclear as to how far east the true species is found as the name has been applied to various quite different entities, e.g. see *Thomsonaria subulata*, which has a much larger lenticellate and granular fruit with superposed ovules. I suspect that it is from such specimens that Aldosoro *et al* record *Pyrus cuspidata* [as *Sorbus verrucosa*] as having superposed ovules.

Micromeles paucinerva (Merrill) Rushforth. **Comb. nov.** —*Sorbus paucinerva* Merrill. Brittonia 4: 75 [1941]. This species was found by Kingdon-Ward as part of the Vernay-Cutting expedition. It was only collected in flower but seems to have a relationship with *T. cuspidata*.

Micromeles salwinensis (T. T. Yu & L. T. Lu) Rushforth. **Comb. nov.**—*Sorbus salwinensis* T. T. Yu & L. T. Lu, Acta. Phytotax. Sin. 13(1): 102 [1975]. Kingdon-Ward 12955, 13054, 13499, 20890 and 21377, all collections from Burma, appear to belong to *M. salwinensis*, thus extending the range of *M. salwinensis*.

Micromeles polycarpa (Hooker f.) Rushforth. **Comb. nov.**—*Pyrus polycarpa* Hook. f., Fl. Brit. India 2: 378. [1878].

Pleiosorbus Zhou LiHua & Wu ZhengYi Act. Bot. Yunn. 24(4): 383–389 [2000]. Holotype *P. megacarpus* Zhou & Wu. This well marked genus is characterised by the superposed ovules in the large (2.5–5cm) extremely strongly lenticellate fruits. The flowers are in large terminal clusters on leafless shoots and open in the autumn, with the fruits ripening a year later. The flowers have upwards of (25–)32–50 stamens, with 3–5 (rarely to seven) styles and carpels with generally 2 ovules. In *Sorbus* in Flora of China vol 9, p 122 (Lu & Spongberg, 2003) it is reported that the ovules are (2–)3(–4) in each carpel but fruits I have opened have only had 2 ovules. The genus was established from collections made in the Medog region of South East Tibet collected in 1992. However, in May 1926 Kingdon-Ward found much the same plant in the Seinghku valley in the far north of Burma. Kingdon-Ward’s specimens were named as *Eriobotrya wardii* C. E. C. Fischer. Later in 1935/37 (see Kingdon-Ward [1941] page 266) he saw it again in the forest around Lagam, West Kameng district, Arunachal Pradesh, India. The genus has since been seen in Mechuka (West Siang district, Arunachal Pradesh), East Siang district and on the southern flank of Madoi Razi which is due north of PutaO, Kachin State, Burma. Examination shows that specimens

¹⁴ Decaisne spelt it as *griffithsii* but this is a typographical error universally corrected in literature.

from Burma differ from the material from Medog, Mechuka and Lagam in having a persistent calyx, cf. a deciduous calyx leaving a circular depression (see photograph 94 in Sun Hang & Zhou ZheKun [2000]). The fruit character of a persistent calyx is not recorded from the west side of the Indo-Burman range. Accordingly with our present knowledge of the genus, I propose to treat the genus as having two species, with *P. megacarpus* for the material from South East Tibet and North East India and *P. wardii* from Burma, requiring the following new combination:

Pleiosorbus wardii (C. E. C. Fischer) Rushforth. **Comb. nov.**—*Eriobotrya wardii* C. E. C. Fisher, Bull. Misc. Inform. Kew 1929(6): 205 [1929].

Griffitharia Rushforth. **Genus nov.** Type *Griffitharia guanii* (Rushforth) Rushforth.

This genus is distinguished by the craspedodromous venation to the leaves which are densely tomentose adaxially (only cobwebby in *G. wardii* and, nearly glabrous in early growth leaves in *G. needhamii*): the leaf margin is serrate or somewhat doubly serrate, but shallowly lobulated in *G. lanata*. The leaf hairs are generally white or silvery white on the lamina but in some species those on the veins are rufous. The fruit is 7—20(—30) mm, ovoid, oblate or rarely ellipsoidal. It is green, often with a pink or purplish tinge, and ripens to russet or yellow but not red. The flowers/fruits have 2—5 styles and carpels and 20 stamens. The styles are joined at the base and pressed together in the lower third. The two ovules in each carpel are superposed and the seeds radially inserted. The calyx is persistent with somewhat fleshy lobes. The hypanthium is nearly fully adnate to the ovary. The disk is epigynous. The fruits are moderately to heavily lenticellate except in *G. lanata* and *G. tibetica* where they are elenticellate. The carpels are inserted into the flesh off a central axis and the flesh rather granulose. The seeds are rounded to oboval, about half as thick as wide with rather acute angled margins, and thus resemble the seeds of apples (*Malus*) with persistent calyces.

Griffitharia is primarily Sino-Himalayan in distribution, from Eastern Afghanistan in the west along the Himalayan axis to West and Central China. The species are typical of the cool temperate zone, from 1850m to about 3300m and form small to medium trees, rarely growing to more than 20m. Generally the species are vicariads, although two species may be found in the same area but at different altitudes or perhaps aspects.

The following new combinations are required:

Griffitharia guanii (Rushforth) Rushforth. **Comb. nov.**—*Sorbus guanii* Rushforth, Int. Dendrol. Soc. Year Book 2009: 88 [2010]. The species is recorded from Huadianba at the northern end of the Cang shan, Yunnan.

Griffitharia vestita (Wall. ex G. Don) Rushforth. **Comb. nov.**—*Pyrus vestita* Wall. ex G. Don, Gen. hist. 2: 647 [1832]. This species occurs from Central/West Nepal to North West India.

Griffitharia sharmae (M. Watson, V. Manandhar & Rushforth) Rushforth. **Comb. nov.**—*Sorbus sharmae* M. Watson, V. Manandhar & Rushforth, Int. Dendrol. Soc. Year Book 2009: 79 [2010]. This species is found in Central to East Nepal.

Griffitharia hedlundii (C. K. Schneider) Rushforth. **Comb. nov.**—*Sorbus hedlundii* C. K. Schneider, Ill. Handb. Laubholz. 1: 685 [1906]. This species is recorded from Southern Sikkim. The plants in East Nepal with similar rufous hairs differ in the more strongly toothed leaves. Plants similar to *G. hedlundii* are recorded from Central South Bhutan (around Sengor) and perhaps east into Arunachal Pradesh.

Griffitharia karchungii (Rushforth) Rushforth. **Comb. nov.**—*Sorbus karchungii* Rushforth, Int. Dendrol. Soc. Year Book 2009: 81 [2010]. This is the species found in Bhutan. The type is from the higher altitude form. In central Bhutan at lower altitude the trees have large leaves but otherwise seem to fit here.

Griffitharia heseltinei (Rushforth) Rushforth. **Comb. nov.** —*Sorbus heseltinei* Rushforth, Int. Dendrol. Soc. Year Book 2009: 83 [2010]. This tree comes from the Tongkyuk and Gyala districts of SE Tibet to the north of the main Himalaya axis. The generally obovoid fruit has a distinctly yellow flesh, similar to the external colour.

Griffitharia heseltinei var. *glabrescens* (T. T. Yu & L. T. Lu) Rushforth. **Comb. nov.** —*Sorbus coronata* var. *glabrescens* T. T. Lu & L. T. Lu, Acta. Phytotax. Sin. 18: 494 [1980]. The recorded localities are Medog and Showa districts in SE Tibet and thus from the south and east of the record for the species; these are mainly on the south side of the main Himalaya axis. It differs from the species in the more glabrescent underside to the somewhat larger foliage. On present evidence it appears to be only a minor variant, hence the retention of the varietas status (rather than as subspecies).

Griffitharia wardii (Merrill) Rushforth. **Comb. nov.** —*Sorbus wardii* Merrill, Brittonia 4: 75 [1941]. This species is frequently cited in synonymy under *G. thibetica*. However, it differs from this species in the presence of lenticels in the fruit and smaller leaves. It is also easily separated by the character of the abaxial surface of the leaf. The covering of hairs is never dense and reveals the ‘bullulate’ under surface, with small raised lumps separated by dips—this character is always present in *G. wardii* but is occasionally found in *G. karchungii* and *G. schwerinii*. The species occurs from the Arunachal Pradesh border with Bhutan east to Northern Burma and the Dulong region of Yunnan, being a component of the upper temperate zone. Aldosoro *et al* propose the Kew specimen of KW 9623 as lectotype but Merrill was quite specific in Brittonia [1941] that unless specimens were noted as elsewhere, the holotypes were at the Arnold Arboretum (HUH), which is where the holotype of *Griffitharia wardii* resides.

Griffitharia burtonsmithiorum (Rushforth) Rushforth. **Comb. nov.** —*Sorbus burtonsmithiorum* [as *burtonsmithii*] Rushforth, Int. Dendrol. Soc. Year Book 2009: 85 [2010]. This is found in Northern Burma and the Dulong district of Yunnan at 1850—2700m, below the level at which *G. wardii* occurs.

Griffitharia thibetica (Cardot) Rushforth. **Comb. nov.** —*Pyrus* [as *Pirus*] *thibetica* Cardot, Notul. Syst. (Paris) 3: 349 [1918]. The name, as *Sorbus thibetica* (Cardot) Hand.-Mazz., is widely used to indicate any higher elevation species in this group from Yunnan to Bhutan and Nepal. Cardot’s description, based on the type Soulie 1237 from Thra-na near Tsekou in the Mekong valley, Yunnan, describes the fruit as “*haud lenticellati*”, i.e. without lenticels. This feature shows clearly in two George Forrest collections from the same place but is not otherwise shown by any other specimens from elsewhere in Yunnan, Burma, NE India or Bhutan which are all characterised by the many, and frequently large, lenticels on the fruit. The evidence indicates that this species is a local endemic in the valleys to the west of Tsekou which are known for local endemics, such as the only habitat for *Pseudotsuga forrestii* Craib.

Griffitharia atosanguinea (T. T. Yu & Tsai) Rushforth. **Comb. nov.** —*Sorbus atosanguinea* T. T. Yu & Tsai, Bull. Fan Mem. Inst. Biol. (Bot) 7: 119 [1936]. This is the common upland species in the genus from Western Yunnan. Apart from the strongly lenticellate fruit, the leaves are narrower than in *G. thibetica*, which may explain how Aldosoro *et al* confused it with *G. hemsleyi*.

Griffitharia hudsonii (Rushforth) Rushforth. **Comb. nov.** —*Sorbus hudsonii* Rushforth, Int. Dendrol. Soc. Year Book 2009: 89 [2010]. This tree is recorded from South West Yunnan from Lincang Daxue shan (Hunhua shan) and from the border of Yunnan with Burma as far north as 26° 30' N.

Griffitharia yongdeensis (Rushforth) Rushforth. **Comb. nov.** —*Sorbus yondeensis* Rushforth, Int. Dendrol. Soc. Year Book 2009: 90 [2010]. The original spelling as *yondeensis* is a typographical error for Yongde shan and I take this opportunity to correct it. Currently *G. yongdeensis* is only known from the Yongde DaXue shan, 24° 07' 17" N, 99° 39' 19" E, above Wu Mu Long township in South West Yunnan. *G.*

yongdeensis has *G. hudsonii* a short distance to the South East and to the North West, but the size, shape and texture of the foliage easily separates them.

Griffitharia pallescens (Rehder) Rushforth. **Comb. nov.** —*Sorbus pallescens* Rehder, *Plantae Wilsonianae* 2: 266 [1915]. This species is restricted to the area close to the West and South West of Kangding (Tachien-lu) in West Sichuan. It is characterised by the small—less than 5cm—ovate to ovate-oblong leaves on the flowering spur shoots and the small trusses of circa 15 flowers; leaves on extension shoots may be larger. The name, as *S. pallescens*, is commonly mis-used for the much more widely distributed species in South West Sichuan and across Yunnan, here treated as *G. ambrozyana*, which differs in the larger oblong to lanceolate leaves and larger trusses.

Griffitharia ambrozyana (C. K. Schneider) Rushforth. **Comb. nov.** —*Sorbus ambrozyana* C. K. Schneider, *Bot. gaz.* 63: 401 [1917]. **Syn. nov.** *Pyrus* [as *Pirus*] *coronata* Cardot. *Notul. Syst.* 3: 348 [1918]. This species is widespread across Yunnan and into South West Sichuan, such as the Muli district. The type specimen of Schneider 3913 at Harvard [HUH] has an extension shoot with lanceolate to narrow elliptic leaves contrasting with the oblong-ovate to oblong leaves in the fertile shoot. Cultivated plants often show this dimorphism between mature foliage and extension growths. Consequently I conclude that it is no longer appropriate to maintain the two as separate taxa.

Griffitharia needhamii (Rushforth) Rushforth. **Comb. nov.** —*Sorbus needhamii* Rushforth, *Bot. Mag.* 27 (4): 378 [2010]. Currently this species is only recorded from Leigong shan, Guizhou. The most distinctive aspect of this tree is the foliage; in the first flush, and thus what will be seen in a dried flowering or fruiting specimen, are almost glabrous leaves which are much closer in superficial appearance to the foliage of *Alniaria alnifolia*—only the later leaves show the hairy abaxial side typical of the genus but then the globose to obovate fruit with the persistent calyx crown will be present showing that the species belong here and not in *Alniaria*.

Griffitharia spongbergii (Rushforth) Rushforth. **Comb. nov.** —*Sorbus spongbergii* Rushforth, *Int. Dendrol. Soc. Year Book* 2009: 96 [2010]. This is recorded from southern Sichuan to the vicinity of Lijiang in Yunnan. It is best thought of as a southern vicariant of *G. pallescens*, differing in the larger inflorescence and larger and noticeably rufous hairy covering the veins on the underside of the leaves.

Griffitharia hemsleyi (C. K. Schneider) Rushforth. **Comb. nov.** —*Micromeles hemsleyi* C. K. Schneider, *Ill. Handb. Laubholz.* 1: 704 [1906]. This species is found in North West Hubei west across to North Chongqing and Northern Sichuan to the Tsinling shan in Shaanxi. The unique feature is the long pointed vegetative buds.

Griffitharia schwerinii (C. K. Schneider) Rushforth. **Comb. nov.** —*Micromeles schwerinii* C. K. Schneider, *Ill. Handb. Laubholz.* 1: 702 [1906]. **Syn.** *Sorbus henryi* Rehder, *Plantae Wilsonianae* 2: 276 [1915]. Schneider based this species on two specimens, Henry 8957 from the Emei shan (collected when Henry sent his most competent collector with Antwerp Pratt to West Sichuan) and Giraldi 986 from Tai Bai shan, Shaanxi. When Rehder transferred the species to *Sorbus* he could not make the obvious combination as Schneider had named a rowan—now generally treated as a synonym of *S. gracilis* (Sieb. & Zucc.) K. Koch—as *Sorbus schwerinii*. He provided a new name and effectively lectotypified the species on the Henry 8957 flowering specimen at Harvard (HUH). This lectotype is clearly consistent with the protologue, with only a few words in the description specific to the fruits. I have not seen the Giraldi 986 isotype but cultivated material from Tai Bai shan and southern Shaanxi does not match material in herbaria, on the Emei shan or in cultivation from the area around the Emei shan which is the area from which the Henry type was collected and to which I consider the species is restrict.

Griffitharia lanata (D. Don) Rushforth. **Comb. nov.**—*Pyrus lanata* D. Don, Prodr. Fl. Nepal. 237 [1825]. The species is recorded from West Nepal to Pakistan. It is odd for the genus in the lobulated leaves and in the generally larger fruits which are elenticellate.

In the cladogram in Guo *et al* *G. hemsleyi*, *G. thibetica*, *G. ambrozyana* (as *S. coronata*) and *G. pallescens* come out in one clade but with a subclade which includes *G. pallescens* as well as *Sorbus tsinlingensis* and *Sorbus calcicola*. I have not seen the type of *S. tsinlingensis* but the description in *Sorbus* in Flora of China vol 9: 124 (Lu & Spongberg, 2003) strongly supports treating it as part of the genus *Alniaria* until further information is available, especially as Guo *et al* do not indicate the source for their samples. Regarding *S. calcicola*, the photographs and line drawings suggest it is not a *Griffitharia* species. The combination of camptodromous venation, co-lateral ovules (as suggested by drawing C in fig. 2) and a persistent calyx are characters of *Pourthiaea* Decaisne [1874]. A key to the species of *Griffitharia* is provided in Rushforth [2010].

Alniaria Rushforth **Genus nov.** Type species *Alniaria alnifolia* (Sieb. & Zucc.) Rushforth.

This genus is characterised by the craspedodromous venation, the fruit which is basically longer than broad, rarely nearly as long as broad, the two carpels each with two co-lateral ovules and set in a well-developed core. The styles are joined at the base. The epigynous calyx is deciduous in most species but retained in *A. zahlbruckneri* and *A. hunanica* which have fleshy calyx lobes. The seeds are obovoid, rounded in transverse section with a rounded to mucronate tip, generally 6—7 mm by 3—4 mm and not flattened (if full) as found in *Griffitharia*, *Thomsonaria* and genera such as *Malus*. The fruit, with its co-lateral ovules and rounded seeds, shows a similarity to the (generally globose) fruits of *Sinomalus* but this has flowers/fruits in umbels.

The following new combinations are required:

Alniaria alnifolia (Sieb. & Zucc.) Rushforth. **Comb. nov.**—*Crataegus alnifolia* Sieb. & Zucc. Abh. Math.-Phys. Cl. Konigl. Bayer. Acad. Wiss. 4(2): 130 [1845]. This tree is found from Japan and Korea across Northern China to Gansu.

Alniaria japonica (Sieb.) Rushforth. **Comb. nov.**—*Sorbus japonica* Sieb. Verh. Batav. Genootsch. Kunst. Xii: 67 [1830]. This tree is recorded from Japan and Korea.

Alniaria zahlbruckneri (C. K. Schneid.) Rushforth. **Comb. nov.**—*Micromeles zahlbruckneri* C. K. Schneid. Bull. Herb. Boissier ser. II vi: 318 [1906]. It is recorded across central Northern China and possibly further south, and is unusual for the persistent calyx.

Alniaria folgneri (C. K. Schneid.) Rushforth. **Comb. nov.**—*Micromeles folgneri* C. K. Schneid. Bull. Herb. Boissier ser. II vi: 318 [1906]. This species is from central Northern China.

Alniaria nubium (Hand.-Mazz.) Rushforth. **Comb. nov.**—*Sorbus nubium* Hand.-Mazz. Anz. Akad. Wiss. Wien. Math.-Naturwiss Kl. 1921 lviii: 147 [1921]. This species has broader leaves than *A. folgneri* and is recorded from Hunan, Jiangxi and southern Anhui provinces, China.

Alniaria tsinlingensis (C. L. Tang) Rushforth. **Comb. nov.**—*Sorbus tsinlingensis* C. L. Tang. Fl. Tsinling. 1(2): 608 [1974]. This is recorded from Tai Bai shan, South Shaanxi and from SE Gansu. I have not seen material but the description of the fruit indicates that it belong here. Material of the tree at the Arnold Arboretum and recorded as grown from seeds sent from Beijing in 1988 does not belong with the species described in the Flora of China Rosaceae 9: 124 (Lu & Spongberg, 2003). It appears to belong with or be close to *Griffitharia hemsleyi*, which is also consistent with its position in the cladogram in Guo *et al*.

Alniaria chengii (C. J. Qi) Rushforth. **Comb. nov.**—*Sorbus chengii* C. J. Qi. J. Nanjing Technol. Coll. Forest Prod. 1981(3): 124 [1981]. I have not seen verified material of this species named from Hunan but a small grove on the Jiangxi side of Nan Feng Mian shan, the highest peak on the Hunan—Jiangxi border, appears to fit here.

Alniaria hunanica (C. J. Qi) Rushforth. **Comb. nov.**—*Sorbus hunanica* C. J. Qi. J. Nanjing Technol. Coll. Forest Prod. 1981(3): 125 [1981]. It is listed as a synonym of *A. zahlbruckneri* in Flora of China 9: 118 (Lu & Spongberg, 2003), but the fruits and foliage seem sufficiently distinct to warrant treating it as a separate species.

Alniaria yuana (Spongberg) Rushforth. **Comb. nov.**—*Sorbus yuana* Spongberg. J. Arnold Arbor. 67: 257 [1986]. This is a rare species from West Hubei and adjacent Chongqing provinces. The cladogram in Guo *et al* (2016) has *A. alnifolia*, *A. folgneri*, *A. yuana* and *A. zahlbruckneri* clustered together. However, it also has *Dunnaria dunnii* (Rehder) Rushforth beside *A. folgneri* with *A. japonica* and *A. tsinlingensis* elsewhere. Accordingly their sampling provides significant but not total support for the above treatment.

Thomsonaria Rushforth. **Genus nov.** Type species *Thomsonaria thomsonii* (King ex Hook. f.) Rushforth. This genus is characterised by the combination of the two superposed ovules in each of the 2—4 carpels, the medium-sized fruits (0.7—1.2cm, rarely larger) which have a deciduous calyx which leaves a large circular scar (often with a conical centre from the fused tops of the ovary or base of the joined styles). The typical fruit is green or greenish with spaced lenticels but in some species it is brownish with many lenticels. The flesh is somewhat granulose. The seeds are similar to *Griffitharia*. The flowers have 20 stamens, rarely 15. The leaves are either camptodromous – the typical state – or craspedodromous. They vary from glabrous to initially densely hairy – where the indumentum is often floccose – but are not persistently tomentose on the abaxial surface as characterises the typical state in *Griffitharia* and some species in *Alniaria*. The species are found from the Himalaya east across China and south into Southeast Asia and Sumatra. They occur in warm to cold temperate zones.

Thomsonaria thomsonii (King ex Hook. f.) Rushforth. **Comb. nov.**—*Pyrus thomsonii* King ex Hook. f., Fl. Brit. India 2(5): 379 [1878]. Aldosoro *et al* record that Gabrielian has proposed Hooker f. s.n. Sikkim: 8000 feet [K] as lectotype, which is a flowering specimen. However, Hooker ascribed the name to King MSS, i.e. to King's manuscript. The protologue for *Pyrus thomsonii* reads: "King MSS. ; glabrous, leaves very shortly petiole, elliptic-lanceolate or –oblanceolate acuminate, serrate above the middle glabrous, styles 2—4, fruit ¾ in. diam." which makes no mention (apart possibly in the style number!) to a flowering specimen. In the Kew herbarium King 3046, reference K000758226, collected 16/9/1876, is a fruiting specimen which is annotated *Pyrus thomsonii* King in G. King's handwriting. Furthermore, as Hooker points out (1878, p 379) "Young flowering specimens of this were distributed as *Photinia arguta*, Wall., var. ?, and are cited by Decaisne under his *Micromeles verrucosa* (*Pyrus cuspidata*, Bertol.) from which it differs in the glabrous narrow leaves with short petioles serrated only beyond the middle." Taking these two points together I consider there is a strong case for rejecting Gabrielian's choice of lectotype in favour of King 3046, which I propose as the lectotype. Plants with elliptic-lanceolate or elliptic-oblanceolate leaves appear to be restricted to the Sikkim area. In West Kameng, Arunachal Pradesh the leaves are shorter and more elliptic than lanceolate. The Flora of China account (Lu & Spongberg, 2003) has it as coming from Burma, Yunnan and Sichuan, a range extension which I do not believe is likely. The leaf drawing, from Forrest 13390 shown as *thomsonii* in Fig. 24A in Aldosoro *et al* suggests a different species than the Sikkim one.

Thomsonaria ferruginea (Hook. f.) Rushforth. **Comb. nov.**—*Pyrus ferruginea* Hook. f., Fl. Brit. India 2(5): 379 [1878]. This is recorded from Bhutan and possibly elsewhere along the Eastern Himalaya.

Thomsonaria aronioides (Rehder) Rushforth. **Comb. nov.** —*Sorbus aronioides* Rehder. *Plantae Wilsonianae* 2: 268 [1915]. This was named from West Sichuan but may also extend along the Yunnan—Burma border region.

Thomsonaria globosa (T. T. Yu & Tsai) Rushforth. **Comb. nov.** —*Sorbus globosa* T. T. Yu & Tsai. *Fan Mem. Inst. Biol. Bot.* 7: 121 [1936]. This was named from West Yunnan. The *Flora of China* account (Lu & Spongberg, 2003) includes adjacent Burma but also gives it as being found in Guizhou and Guangdong provinces. Some DNA investigation covering the full range might be interesting.

Thomsonaria ligustrifolia (A. Chevalier) Rushforth. **Comb. nov.** —*Pyrus ligustrifolia* A. Chevalier. *Rev. Int. Bot. Appl. Agric. Trop.* 22: 375 [1942]. Named from Fansipan in North Vietnam, this small tree may also occur in Southern Yunnan.

Thomsonaria verticillata (Merrill) Rushforth. **Comb. nov.** —*Sorbus verticillata* Merrill. *Brittonia* 4: 77 [1941]. First named from the Adong valley in Kachin State, Burma, it has since been found in far eastern Arunachal Pradesh State, India.

Thomsonaria caloneura (Stapf) Rushforth. **Comb. nov.** —*Micromeles caloneura* Stapf. *Bull. Misc. Inform. Kew* 1910: 192 [1910]. This is a tree found over a wide area of Central China, mainly as subsp. *kwangtungensis* (T. T. Yu) Rushforth **Comb. & stat. nov.** —*Sorbus caloneura* var. *kwangtungensis* T. T. Yu, *Acta Phytotax. Sin.* 8: 223 [1963], which has slightly fewer veins and less coarsely toothed leaf margins.

Thomsonaria meliosmifolia (Rehder) Rushforth. **Comb. nov.** —*Sorbus meliosmifolia* Rehder. *Plantae Wilsonianae* 2: 270 [1915]. This was first named from West Sichuan but is now recorded from adjacent areas of Yunnan and Guizhou.

Thomsonaria elenorae (Aldosoro, Aedo & C. Navarro) Rushforth. **Comb. nov.** —*Sorbus elenorae* Aldosoro, Aedo & C. Navarro. *Syst. Bot. Mono.* 69: 51 [2004]. This species is a constituent of the warm temperate mountain flora from Guangdong, Guangxi, Guizhou, Hunan and Jiangxi. Aldosoro *et al* cite a specimen from Henan, which is unlikely to be a correct identification from so much further north; however, as the cited collection is numbered “Guangdong team 5280” I suspect a typographical error. This species has been mis-identified in the *Flora of China* 9: 117 (Lu & Spongberg, 2003) as part of the variation of *Sorbus megalocarpa* Rehder (here treated as *Wilsonaria megalocarpa*, see below) and the range given for *W. megalocarpa* as including Guizhou, Guangxi, Hunan and Jiangxi probably refers to *T. elenorae*.

Thomsonaria decaisneana (C. K. Schneid.) Rushforth. **Comb. nov.** —*Micromeles decaisneana* C. K. Schneid. *Bull. Herb. Boissier, ser. 2, (vi):* 269 [1906]. Synonym *Micromeles keissleri* C. K. Schneider, *Sorbus keissleri* (C. K. Schneid.) Rehder. This tree is recorded in Central China from West Hubei, Sichuan, Hunan, Guizhou, Jiangxi and Guangxi. It is more commonly known under the *keissleri* synonym as in *Sorbus* there is an earlier combination *Sorbus decaisneana* (which is a synonym of *Aria edulis*). However, in any other genus the *decaisneana* name has priority.

The following six species (*T. granulosa*, *T. corymbifera*, *T. khasiana*, *T. malayensis*, *T. crenulata* and *T. fragrans*) have traditionally been treated as one wide ranging taxon from the Khasia Hills of Meghalaya to Sumatra and north to North Vietnam and southern China. From 1915 this was under the name *Sorbus granulosa* (Bertol.) Rehder but since 1973 when Miquel’s *Vaccinium corymbiferum* was identified as belonging in this group then either as *Micromeles* or *Sorbus corymbifera*. As yet I have not critically examined material from across the range but less detailed examination suggests that several, if not all of them, are not the same taxon and accordingly that it is appropriate to make all six new combinations. In

particular, I note that Meijer 3460 from Mt. Merapi in Central Sumatra [K] has only 15 stamens whereas the flowering specimens from other localities appear to have 20 stamens. Clearly more investigation is required, including consideration of Spongberg's comment (Flora of China 9: 122, (Lu & Spongberg, 2003)) where he expresses the opinion that the variation between *T. corymbifera sensu lato* and *T. meliosmifolia* is continuous.

Thomsonaria granulosa (Bertol.) Rushforth. **Comb. nov.** — *Pyrus granulosa* Bertol. Mem. Reale Accad. Sci. Ist. Bologna, ser. 2, 4: 312 [1864]. This species is named from the Khasia Hills, Meghalaya, India.

Thomsonaria corymbifera (Miq.) Rushforth. **Comb. nov.** — *Vaccinium corymbiferum* Miquel. Fl. Ned. Ind. Eerste bijv.: 558 [1861]. This species is named from Sumatra, Indonesia.

Thomsonaria khasiana (Decaisne) Rushforth. **Comb. nov.** — *Micromeles khasiana* Decaisne. Nouv. Arch. Mus. Paris 10: 168. [1874]. This species is named from the Khasia Hills.

Thomsonaria malayensis (Ridley) Rushforth. **Comb. nov.** — *Micromeles malayensis* Ridley. J. Bot. 62: 296 [1924]. This species is named from Peninsular Malaya.

Thomsonaria crenulata (E. T. Geddes) Rushforth. **Comb. nov.** — *Pyrus crenulata* E. T. Geddes. Bull. Misc. Inform. Kew 1929: 108 [1929]. This species is named from Thailand.

Thomsonaria fragrans (E. T. Geddes) Rushforth. **Comb. nov.** — *Pyrus fragrans* E. T. Geddes. Bull. Misc. Inform. Kew 1930 (4): 161 [1930]. This species is named from Thailand.

Thomsonaria subulata (J. E. Vidal) Rushforth. **Comb. nov.** — *Sorbus verrucosa* Decaisne var. *subulata* J. E. Vidal. Fl. Cambodge, Laos, Vietnam 6: 32 [1968]; *Sorbus subulata* (J. E. Vidal) Nguyen T. H. & Yakovlev. Bot. Zhurn. (Moscow & Leningrad) 66: 1188 [1981]. This species is named from Fansipan in Lao Cai province, VietNam.

Thomsonaria brevipetiolata (Nguyen T. H. & Yakovlev) Rushforth. **Comb. nov.** — *Sorbus brevipetiolata* Nguyen T. H. & Yakovlev Bot. Zhurn. (Moscow & Leningrad) 66: 1189 [1981]. This species is recorded from North Vietnam. It clearly does not have any close relationship with *Micromeles rhamnoides*, despite Aldosoro *et al* treating it as a synonym of this species.

Thomsonaria astateria (Cardot) Rushforth. **Comb. nov.** — *Pyrus* [as *Pirus*] *asterteria* Cardot. Lecomte, Not. Syst. 3: 348. This species is known from central Yunnan. Cardot based it on five specimens collected by Ducloux (one with Bodinier) and one by Delavay which are housed in the Paris herbarium. When Aldosoro *et al* were seeking these prior to 2004 they failed to locate them and proposed a neotype from the 1984 SABE expedition to the Cang shan in West Yunnan. However, when the Curator of the Edinburgh Herbarium asked to the specimens on loan in 2009 they were promptly sent to Edinburgh—perhaps as they were sought under Cardot's name? Four of the Ducloux specimens (Ducloux & Bodinier 0114, Ducloux 3318, 4115 and 4751) have very similar densely rufous hairy new leaves and flowers and are dated February to March. The Delavay specimen has larger better developed leaves and is in flower, although with the date as May 1890. The fifth Ducloux specimen, Ducloux 3485, is dated 28th May 1905 and is in immature fruit.

I propose Ducloux 4115, Paris reference number P00689928, as LECTOTYPE. This is one of the young flowering specimens, but crucially it has a note in Ducloux's writing linking it with Ducloux 3485. Whilst this is not proof that the two specimens were from the same tree, it indicates Ducloux's opinion that they were the same entity. Ducloux 4115 was collected from near to Kunming and all the material enumerated by Cardot is from Kunming west to the Cang shan.

Thomsonaria epidendron (Hand.-Mazz.) Rushforth. **Comb. nov.** —*Sorbus epidendron* Hand.-Mazz. Symb. Sin. 7: 466 [1933]. This tree, or large epiphytic shrub, was named from the Yunnan-Burma border. *Thomsonaria detergibilis* (Merrill) Rushforth. **Comb. nov.** —*Sorbus detergibilis* Merrill. Brittonia 4: 76 [1941]. Merrill based this species on material collected by Kingdon-Ward in the Adong valley, northern Kachin State, Burma.

T. asterteria, *T. epidendron* and *T. detergibilis* clearly show affinity to each other but come from different habitats and on the present evidence I am content to treat them as separate species.

Thomsonaria kohimensis (Watt ex Brandis) Rushforth. **Comb. nov.** —*Pyrus kohimensis* Watt ex Brandis. Indian trees 292 [1906]. This is named from Kohima in Nagaland, India. Aldosoro *et al* extend the range further to the East, to Cambodia, and to the West, to the Siang valley in Arunachal Pradesh and Medog district in SE Tibet, citing the following four species as synonyms. The type, Watt 7341, has 15 stamens and a fruit suggesting an affinity more with the *T. granulosa* cluster of taxa. Accordingly I do not find treating these as synonyms convincing, and, noting Stephen Spongberg's comment (Flora of China Rosaceae 9: 123 (Lu & Spongberg, 2003)) that *T. paniculata* is better associated with *T. globosa* and the treatment of *T. ochracea* and *T. subochracea* as species in the Flora of China account, I propose the following new combinations:

Thomsonaria paniculata (T. T. Yu & Tsai) Rushforth. **Comb. nov.** —*Sorbus paniculata* T. T. Yu & Tsai. Bull. Fan Mem. Inst. Biol. Bot. 7: 122 [1936]. This species is recorded from North West Yunnan.

Thomsonaria candidissima (A. Chevalier) Rushforth. **Comb. nov.** —*Pyrus candidissima* A. Chevalier. Rev. Bot. Appl. Agric. Trop. 23: 374 [1942]. This tree is described from Cambodia.

Thomsonaria ochracea (Hand.-Mazz.) Rushforth. **Comb. nov.** —*Eriobotrya ochracea* Hand.-Mazz. Symb. Sin. 7: 476 [1933]. This was named from the Yunnan-Burma border, from relatively low altitude. The iso-type of Forrest 21076 at the British Museum Natural History (BM) is in new foliage and flower and shows a relationship with *T. astaterea* rather than with *T. kohimensis*.

Thomsonaria subochracea (T. T. Yu & L. T. Lu) Rushforth. **Comb. nov.** —*Sorbus subochracea* T. T. Yu & L. T. Lu. Acta Phytotax. Sin. 18(4): 494 [1980]. This was named from specimens from Medog, South East Tibet.

In the cladogram in Guo *et al* the five samples here listed in *Thomsonaria* come out in one larger clade, albeit along with the two samples listed as “*rhamnoides*” – which I suspect have nothing to do with the Himalayan species of that name but probably also belong in *Thomsonaria*.

Dunnaria Rushforth. **Genus nov.** Type species *Dunnaria dunnii* (Rehder) Rushforth

This genus is characterised by the paired superposed ovules set in two carpels, the styles joined at the base, the oblate or sub-globose fruit which is generally wider than long, rarely globose, and small at 5–8mm in diameter. The fruit has few lenticels, or sometimes none, and ripens to red. The calyx is deciduous, leaving a nearly closed pit at the top of the fruit. The leaves are tomentose beneath, sometimes rufous hairy on the main veins below, with craspedodromous venation. The deciduous calyx, paired carpels and fruit ripening to red suggests an affinity with *Alniaria*. However, the flowers have smaller rather incurved petals and the oblate fruit, the superposed ovules which developed into a seed c. 4mm x 2.5mm x 1mm with an angled margin (and thus not the effectively nearly rounded seed in trans-section) and the craspedodromous venation show it does not belong in *Alniaria*. I note, however, that in the cladogram in Guo *et al* the sample listed as “*dunii*” came in the same clade with some *Alniaria* taxa included in their study. From *Griffitharia* the

small fruits ripening to red and the deciduous calyx, showing a greater degree of enclosure of the ovary, differentiate it.

I conclude, therefore, that it is better placed in its own genus.

Dunniaria dunnii (Rehder) Rushforth. **Comb. nov.**—*Sorbus dunnii* Rehder. *Plantae Wilsonianae* 2: 273 [1915]. Syn. *Pyrus koehnei* Leveille [1912], non C. K. Schneider [1906]. This tree is recorded from South East Anhui, West Zhejiang, North West Fujian, North East Guangxi, South East Guizhou and North East Yunnan.

Wilsonaria Rushforth **Genus nov.** Type species *Wilsonaria megalocarpa* (Rehder) Rushforth. As Rehder notes (1915, p 267) “*Sorbus megalocarpa* ... does not seem to be closely related to any other *Sorbus*.” It has rather large fruits, 20—30mm long by 15—20mm in diameter, with persistent calyx lobes, many closely set lenticels, 3 or 4 carpels each with 2 superposed ovules, flowers in terminal corymbose panicles which open before the leaves and have 20 stamens, and large, largely glabrous leaves with craspedodromus venation.

The large corymbose flowers borne before the leaves suggest an affinity with *Pleiosorbus*. However, after careful consideration I have concluded that it does not fit there for the following reasons: Although the flowers are in large corymbs, these are subtended by leaves. It is just that the leaves develop more slowly than the flowers. In *Pleiosorbus* the corymbs open in the autumn and are leafless and remain so. Rarely a bud forms at the base of the inflorescence and opens around the time the fruits are ripe—which in *Pleiosorbus* is the next autumn—but nearly always the flowering shoot dies once the fruits are shed. The fruits take only a summer to ripen which compares with the full 12 months in *Pleiosorbus*. The 20 stamens in the flowers distinguish it from *Pleiosorbus* which has many stamens, at least 25 and usually 32—50 or so. In *Pleiosorbus* the leaves are camptodromus. The calyx is persistent with spreading lobes, cf. the incurved lobes of the calyx in *P. wardii* or the deciduous calyx of *P. megacarpus*.

From *Griffitharia* and *Thomsonaria* the fruit and foliage distinguish it. Accordingly I conclude that it is better treated in its own genus.

Wilsonaria megalocarpa (Rehder) Rushforth. **Comb. nov.**—*Sorbus megalocarpa* Rehder. *Plantae Wilsonianae* 2: 266 [1915]. This is found in West Sichuan south towards Kunming in Yunnan.

Wilsonaria arguta (T. T. Yu) Rushforth. **Comb. nov.**—*Sorbus arguta* T. T. Yu. *Acta Phytotax. Sin.* 8: 223 [1963]. This is recorded as a large shrub from South Sichuan and adjacent parts of Yunnan. I have not seen adequate material of *W. arguta* and thus am accepting it as a separate species from *W. megalocarpa* on the basis of the description and treatment in the *Flora of China* vol 9: 117 (Lu & Spongberg, 2003).

Wilsonaria guanxianensis (T. C. Ku) Rushforth. **Comb. nov.**—*Sorbus guanxianensis* T. C. Ku. *Bull. Bot. Res., Harbin* 10(3): 22 [1990]. This species seems to match Rehder’s *S. megalocarpa* var. *cuneata* but from observation of cultivated plants and from the description in the *Flora of China* vol 9: 117 (Lu & Spongberg, 2003) I think the evidence is sufficiently strong to justify treating it as additional species in *Wilsonaria*.

In Guo *et al* *Wilsonaria megalocarpa* comes out as a sister clade to *Thomsonaria*.

Unplaced Species

There are three species, two accepted in *Flora of China* vol. 9 (Lu & Spongberg, 2003), *S. rhombifolia* C. J. Qi & K. W. Liu and *S. yunnanensis* L. T. Lu and the more recently described *S. calcicola* W. B. Liao & W. Guo which I have not been able to place. They are all recorded from what I suspect is karst limestone and appear to have camptodromus venation and two carpels in the fruit which has a persistent calyx. I think

it is possible that they belong to another group, but as noted earlier the above characters are also ones shown by species in the genus *Pourthiaea*.

Taxonomic changes to *Malus sensu lato*.

Regarding *Malus*, unlike the situation with *Sorbus s.l.*, the published DNA surveys do not show *Malus s.l.* occurring in several disparate clades. When you look at Li *et al* which covers the widest sampling of the whole group, this has 32 Maloid samples which together with the *Chamaemeles* sample, cluster in a single clade (Figure 1). Thus in theory keeping them all in *Malus* could be a logical option. (Qian *et al* (2006) (modified from a Chinese paper by Liang *et al*, *non vide*) includes a similar number of *Malus s.l.* (Maloids) but with no outgroup. There is no record of the origins of their samples. Li *et al* list 32 but all their samples have gene bank references rather than origins, which could mean that most of the samples are common to the two studies.)

However, the Maloid with *Chamaemeles* clade (Fig. 1) in Li *et al* is similar in shape to the adjacent clade containing the genera *Chaenomeles*, *Cotoneaster*, *Cydonia*, *Pseudocydonia*, *Cormus*, *Pyrus* and *Pourthiaea*. So, although *Malus s.l.* is presented as a single clade, this clade appears as extensive as a clade containing seven nearly universally accepted genera and which genera are generally accepted as not being close, e.g. *Chaenomeles*, *Cydonia* and *Pseudocydonia* are close, all having multiple ovules in each carpel, and *Cormus* and *Pyrus* are also usually accepted as related, *Cotoneaster* and *Pourthiaea* are not considered close to each other or these other two groups. From this I conclude that the Maloid clade in Fig 1 of Li *et al* shows evidence in support of a narrower interpretation of genera within the Maloid group.

The clade in Li *et al* Fig. 1 has a sub-clade which includes *Chamaemeles*, *Chloromeles*, *Docynia*, *Malus doumeri*, *Docyniopsis* (= *Macromeles*), *Eriolobus* and *Malus florentina*. My interpretation is that this investigation is providing strong support for separating the following genera from *Malus* as discussed below:

Eriolobus (A. P. de Candolle) M. Roemer is well supported, with *E. trilobata* (Poiret) M. Roemer. Less clear is whether *E. florentina* (Zuccagni) Stapf belongs here or in a separate genus.

Chloromeles (Decaisne) Decaisne is also well supported for the American species (apart from *M. fusca* C. K. Schneider which belongs in *Sinomalus*, see below).

Macromeles Koidzumi. Morphology and DNA supports the treatment of *tschonoskii* as being in a separate genus, with superposed ovules and only part adnation of the ovary and hypanthium. In the recent past this has been in *Docyniopsis* (C. K. Schneider) Koidzumi [1934] but earlier Koidzumi had published *Macromeles* [1930] with *tschonoskii* as the type species. It would appear that he mistakenly thought Schneider's sectional name *Docyniopsis* had priority. He also included *Pyrus prattii* Hemsley and *Pyrus yunnanensis* Franchet in his genus. However these differ significantly from *Macromeles*, and show in a separate part of the cladogram to *tschonoskii* as discussed below.

Docynia Decaisne is also supported by Li *et al*.

Li *et al* place *Malus doumeri* (Bois.) A. Chevalier as unresolved from *Docynia* and basal to *Chloromeles*. This name (as *Pyrus doumeri* Boissier) is the oldest of perhaps four or five species from South East Asia, with *Pyrus doumeri* described from Langbian, South VietNam, *Malus formosana* Kawakami & Koidzumi from Taiwan, *Malus melliana* Hand.-Mazz. and *Malus leiocalyca* S. Z. Huang both from Southern China. *Pyrus laosensis* Cardot from Laos may also belong here. The one fruit of a species in this group which I have seen suggested at least a superficial similarity to *Chloromeles* but the stamen number is higher suggesting perhaps a closer relationship to *Macromeles*. Currently I am not in a position to resolve this

issue. These species are likely to key out in the above key to either *Macromeles* or *Chloromeles* but I suspect they represent a further distinct group. An affinity with *Docynia* has been suggested but the carpels have only two ovules.

The next clade to segregate in Li *et al* is one containing *M. prattii*, *M. yunnanensis*, *M. honanensis*, *M. ombrophila* and *M. kansuensis*. *M. prattii*, *M. ombrophila* and *M. yunnanensis* and relatives occur along the Himalayan chain as far as Bhutan as well as south along the Indo-Burman range. They clearly differ from *Macromeles* (*Docyniopsis*), where Koidzumi placed them, in the ovary being adnate to the hypanthium, the cupular cavity at the apex of the fruit and the flowers with 20 stamens. However, they differ from *Malus* in having superposed ovules (in which respect they agree with *Macromeles tschonoskii*), in the umbellate racemes and the larger number of leaf veins. My opinion is that this group is as distinct as *Eriolobus* and *Chloromeles* and best treated as a separate genus which I propose to name *Prameles* (from shortening Antwerp Pratt's name and adding the Greek name for apple - *meles*).

Prameles Rushforth. **Genus nov.** Type species *Prameles prattii* (Hemsley) Rushforth.

This genus is characterised by the fruits with five carpels, each containing two superposed ovules. The flowers and fruits are in umbellate racemes, with the pedicels (which very rarely are branched) arising along a 1—2cm length of rachis—most easily measured when in fruit from the resting bud at the base of the inflorescence. The calyx is persistent at the top of the fruit with the 5 lobes either somewhat pressed over the top of the fruit or more usually spreading as a rosette. The lobes are fleshy, white hairy on the margins (even in the otherwise glabrous *P. prattii*) and circa 2—4mm in length. The remnants of the fused styles/top of the ovary are set as a small cone in the apical pit. The seeds are somewhat flattened with at least one acute margin. The fruit has many small flat lenticels. It is globose to oval, 1.5—2cm in length and width, slightly indented at the base. The pedicels have a few lenticels. The leaves are elliptic to ovate, rounded to subcordate at the base with an acuminate to cordate apex. The veins are in 10 or so pairs which are impressed above and raised below. The venation is camptodromous with the veins anastomosing and rarely running to a tooth. The underside of the leaf varies from tomentose, with a light covering of woolly hairs over the primary, secondary and tertiary veins and lamina, to only a few hairs on the main veins. The underside of the lamina is bullulate, as in *Griffitharia wardii*.

Species of *Prameles* occur from Central China (Hubei) southwest along the Himalaya to Bhutan and SE Tibet and south along the Indo-Burman range. They occur in the warm temperate zone below species of *Griffitharia*, to which they show some similarity but never with the density of tomentum found in most *Griffitharia*.

Accordingly the following new combinations are required:

Prameles prattii (Hemsley) Rushforth. **Comb. nov.**—*Pyrus prattii* Hemsley, Bull. Misc. Inform. Kew 1895(97) 16: 1895.

Prameles yunnanensis (Franchet) Rushforth. **Comb. nov.**—*Pyrus yunnanensis* Franchet, Plantae Delavayanae 228 [1890].

Prameles ombrophila (Hand.-Mazz.) Rushforth. **Comb. nov.**—*Malus ombrophila* Handel-Mazzetti, Acad. Wiss. Wien, Math.-Naturwiss. Kl. Anz. 63: 8 [1926].

I do not consider that *M. honanensis* belongs in *Prameles*. In Li *et al* *M. honanensis* sits between *prattii* and *yunnanensis* on one side and *kansuensis* and *ombrophila*, whereas in Qian *et al* these are located centrally with species of section/subgenus *Sorbomalus* on both sides. My suspicion is that *M. honanensis* probably arose as a hybrid between *prattii* and *kansuensis*, as unlike all the species (including undescribed taxa) in *Prameles* it has only 3—4 carpels/styles.

Malus Miller. Typical *Malus* comprise species with a persistent calyx and paired co-lateral ovules in fruits with 5 carpels. These are listed as section *Malus* series *Malus* in Juniper & Mabberley (2006, p 184).

The remaining apples are those with a deciduous calyx.

In the main the fruits of many of these apple species with deciduous calyces, with their pairs of erect co-lateral seeds which are round in transverse section, is similar to the fruit of *Alniaria* and *Pourthiaea* (notwithstanding this having a persistent calyx). Robertson *et al* treated all the species they leave in *Malus* in one of their three subgenera of *Malus*, viz subgenera *Malus*, *Chloromeles* and *Sorbomalus*. The question, then, is whether subgenus *Sorbomalus* holds together.

Rehder (1940) divided his interpretation of *Malus* on the character of whether the leaves in bud are folded or rolled/convoluted. This results in some of the species with deciduous calyces being in section/subgenus *Malus* and others in section/subgenus *Sorbomalus*, creating some strange bedfellows. (This is effectively the treatment given in pages 184—186 in Juniper & Mabberley (2006) which has three further sections here treated as separate genera.) This includes series *Baccatae* (or section *Gymnomeles*) occurring in section *Malus* and series *Sieboldianae* and *Kansuenses* in section *Sorbomalus*. However, Qian *et al* point out that there five different forms of folding of the leaves can be detected, making the use of this feature as proposed by Rehder (1940) simplistic.

The cladograms in Qian *et al* and Li *et al* can be read to suggest treating this group as comprising more than one genus. However, I do not currently find support for treating the species with deciduous calyces in more than one group and thus my inclination at this stage is to treat them as one genus, for which the published name is *Sinomalus* Koidzumi, based on *Malus transitoria* var. *toringoides*. If the group were further divided, a new name would be needed for those keying out at couplet 48 in the above key.

Sinomalus Koidzumi. Acta Phytotaxonomica et Geobotanica 1: 11 [1932]. Type species *Sinomalus toringoides* (Rehder) Koidzumi – lectotype selected here, as Koidzumi listed this as species 1. Koidzumi established *Sinomalus* with two species, *S. toringoides* and *S. tenuifolia*. *S. tenuifolia* was based on *Crataegus tenuifolia* Komarov [1901], non Britton [1900] and was replaced by *Crataegus komarovii* Sargent, in Plantae Wilsonianae 1: 183 [1912]. In 1934 Koidzumi transferred *transitoria* and *honanensis* to *Sinomalus*. Phipps has pointed out that *toringoides* at specific level is the same as the earlier described *Pyrus bhutanica*. Koidzumi described *Sinomalus* as having 3—5 styles and carpels. Whilst 5 styles/carpels are recorded, most species appear to have 3 or 4.

The following new combinations are required:

Sinomalus bhutanica (W. W. Smith) Rushforth. **Comb. nov.**—*Pyrus bhutanica* W. W. Smith. Rec. Bot. Surv. India 4: 265 [1911]. There is a proposal to conserve *toringoides* over *bhutanica*, which if accepted will make this combination redundant. The species is recorded from Gansu and Sichuan but the type specimen of *S. bhutanica* was collected from a cultivated tree in a monastery in Lhalung, Tibet.

Sinomalus komarovii (Sargent) Rushforth. **Comb. nov.**—*Crataegus komarovii* Sargent. Plantae Wilsonianae 1: 184 [1912]. This is recorded from South Jilin and nearby North Korea.

Sinomalus baccata (L.) Rushforth. **Comb. nov.**—*Pyrus baccata* L. Systema Naturae, ed. 12 2: 344 [1767]. This species is extremely widespread according to the literature and is probably an aggregate species.

Sinomalus mandshurica (Maximowicz) Rushforth. **Comb. nov.** *Pyrus baccata* var. *mandshurica* Maximowicz, Bull. Acad. Imp. Sci. Saint-Petersbourg, ser. 3 19(2): 170 [1874]. This is recorded from Northern and North East China and adjacent Russia.

Sinomalus halliana (Koehne) Rushforth. **Comb. nov.** *Malus halliana* Koehne, Gatt. Pomac. 27 [1890]. This is recorded from Japan, Korea and Eastern China.

Sinomalus hupehensis (Pampanini) Rushforth. **Comb. nov.** *Pyrus hupehensis* Pampanini, Nuevo Giorn. Bot. Ital., n.s. 17: 291 [1910]. This species is recorded from central China. However, it occurs either as a triploid or a tetraploid so probably apomictic and likely to contain a number of microspecies.

Sinomalus pallasiana (Juzepcuk) Rushforth. **Comb. nov.** *Malus pallasiana* Juzepcuk, Fl. URSS ix 370 [1939]. This is reported from Mongolia and adjacent parts of Siberia.

Sinomalus sachalinensis (Juzepcuk) Rushforth. **Comb. nov.** *Malus sachalinensis* Juzepcuk, Fl. URSS ix 372 [1939]. This is reported from Sakhalin.

Sinomalus spontanea (Makino) Rushforth. **Comb. nov.** *Malus spontanea* Makino, Bot. Mag. (Tokyo) 28: 295 [1914]. This is recorded from Japan.

Sinomalus sieboldii (Regel) Rushforth. **Comb. nov.** *Pyrus sieboldii* Regel, Index seminum (St. Petersburg) 51 [1858]. This is widespread across China, Korea and Japan.

Sinomalus muliensis (T. C. Ku) Rushforth. **Comb. nov.** *Malus muliensis* T. C. Ku, Acta Phytotax. Sin. 29: 83 [1991]. This is reported from around Muli in South West Sichuan.

Sinomalus daochengensis (C. L. Li) Rushforth. **Comb. nov.** *Malus daochengensis* C. L. Li, Acta Phytotax. Sin. 27: 301 [1989]. This is report from South West Sichuan and North West Yunnan.

Sinomalus jinxianensis (J. Q. Deng & J. Y. Hong) Rushforth. **Comb. nov.** *Malus jinxianensis* J. Q. Deng & J. Y. Hong, Acta Phytotax. Sin. 25: 326 [1987]. This is only known as a cultivated tree in South Liaoning.

Sinomalus kansuensis (Batalin) Rushforth. **Comb. nov.** *Pyrus kansuensis* Batalin, Trudy Imp. S.-Peterburgsk. Bot. Sada 13: 94 [1893]. This is recorded from Central West China.

Sinomalus fusca (Raf.) Rushforth. **Comb. nov.**—*Pyrus fusca* Raf. Med Fl. 2: 254 [1830]. This is the only species in the group not from East Asia. It is found in western North America from Alaska to California.

Sinomalus sikkimensis (Wenzig) Rushforth. **Comb. nov.** *Pyrus pashia* Bucc.-Ham. ex D. Don var. *sikkimensis* Wenzig, Linnaea 38: 49 [1874]. This species from Sikkim and Bhutan is unusual in the calyx which can be fleshy and persistent or caducous on different fruits in the same cluster. The leaves are much more hairy than in any other species in the genus. Whilst clearly a wild species, at least where I have seen it in Central Bhutan, I question whether it could be the result of introgression from a species of *Prameles* into the local form of *S. baccata*.

Sinomalus rockii (Rehder) Rushforth. **Comb. nov.** *Malus rockii* Rehder, J. Arnold Arbor. 14: 206 [1933]. The type specimen was collected in flower by Joseph Rock when travelling from Xiaguan (at the southern end of the Cang shan) west towards the Mekong (Lancang) river and the fruit is unknown. A collection, CLD 1463 from the northern end of the Cang shan, shows similarity to *S. sikkimensis*. However, the synonymy given in Lu & Spongberg (2003) includes the Bhutanese form of the *S. baccata* aggregate, which differ from *S. rockii* in several characters.

Final thoughts

Any opinion has to be tentatively final - final in that it is the best scheme that can be proposed on the author's interpretation of the available evidence on which it is based but tentative in that as and when new evidence becomes available it must be reviewed. Molecular investigation has shown that the “*mega-Sorbus*” concept proposed by Wenzig and reviewed by Rehder is untenable. Fay & Christenhusz rationalise this by proposing a “*mega-Pyrus*”—ignoring that all the other genera they subsume in their concept of *Pyrus* are well supported by currently available molecular data.

The treatment of *Sorbus s.l.* proposed here, and by extension in the key to the rest of the Malinae, is based on morphological characters but is also broadly supported by the published molecular investigations. However, there are considerable gaps in our knowledge—*Thomsonaria* has scarcely featured in molecular investigations and most species remain extremely poorly known. Clearly further investigation is required here, or with the placing of the taxa associated with, or lumped with, *Pyrus doumeri*, and I hope that a consequence of this paper will be to encourage directed research.

ACKNOWLEDGEMENTS

I would like to thank the Curators and staff of the RBG Edinburgh for assistance over nearly the last five decades and also the Curators of the herbaria at Kew and the British Museum Natural History for access to their collections, and to those at the New York, Harvard United Herbaria and Paris Herbarium for loaning material to Edinburgh for my study. I would like also to thank the Curator of the Kunming herbarium for sending me a photograph of the type specimen of *Pleiosorbus megacarpus*, and Guan Kai Yun, and to the Arnold Arboretum of Harvard University for photographs of their plant recorded as “*Sorbus tsinlingensis*”. Furthermore, I would also like to record my thanks to the attendees at two symposia I organised in 2014 and 2016 on the topics covered here, and who made invaluable comments on and improvements to my draft key, especially to Hugh McAllister, John Grimshaw, Tim Baxter, Tom Hudson, Maurice Foster, Eric Wahlsteen, Jonaton Leo, Dan Crowley and David West.

REFERENCES

- Aldosoro, J.J., C. Aedo, F. Muinoz Garmendia, F. Pando de la Hoz & C. Navarro. 2004. Revision of *Sorbus* Subgenera *Aria* and *Torminaria* (Rosaceae-Maloideae), Systematic Botany Monographs 69: 1 - 148.
- Campbell, C. S., R. C. Evans, D. R. Morgan, T. A. Dickinson & M. P. Arsenault. 2007. Phylogeny of subtribe Pyrinae (formerly the Maloideae, Rosaceae): Limited resolution of a complex evolutionary history. *Pl. Syst. Evol.* 266: 119 - 145.
- Decaisne, M. J. 1874. *Nouvelle Archives Du Museum D'Histoire Naturelle ser. 1* x pp 113 - 192.
- Fay, M. J. & M. J. M. Christenhusz. 2018. *Global Fl.* 4.
- Guo Wei, Qiang Fan, Huijuan Jing, Xiu Hu & Wenbo Liao. 2016. *Sorbus calcicola* (Rosaceae), a new species from Guangxi Province in China, *Phytotaxa* 261 (3): 260 - 266.
- Hooker, J. D. 1878. *Pyrus* in *Flora of British India* 2: 372 - 380.
- Juniper, B. E. & D. J. Mabberley. 2006. *The story of the Apple*, Timber Press, Portland.
- Koidzumi, G. 1930. *Florae Symbolae Orientali-Asiaticae – Contributions to the Knowledge of the Flora of Eastern Asia*, p53. Kyoto, Japan.
- Koidzumi, G. 1934. A synopsis of the genus *Malus*. *Acta Phytotaxonomica et Geobotanica*, III (4): 179—196.
- Kingdon-Ward, F. 1941. *Assam Adventure*, Jonathan Cape, London.
- Li Qing-yang, Wei Guo, Wen-bo Liao, James A. Macklin & Jian-Hua Li. 2012. Generic limits of Pyrinae: Insights from nuclear ribosomal DNA sequences *Botanical Studies* 53: 151 - 164.
- Lo, E. Y. Y. & M. J. Donoghue. 2012. Expanded phylogeny and dating analysis of the apples and their relatives (Pyreae, Rosaceae) *Molecular Phylogenetics and Evolution* 63: 230 - 243.

- Lu, Lingdi & S. A. Spongberg. 2003. *Sorbus* in Flora of China, editors Wu Zheng-yi & P. H. Raven, 9: 100 - 126.
- McAllister, H. 2005. The genus *Sorbus* – Mountain ash and other Rowans. Botanical Magazine Monograph, RBG Kew, London.
- Merrill, E. 1941. The Upper Burma Plants collected by Captain F. Kingdon Ward on the Vernay-Cutting Expedition, 1938—1939 *Brittonia* 4: 20—188.
- Potter, D., T. Eriksson, R. C. Evans, S. Oh, J. E. E. Smedmark, D. R. Morgan, M. Kerr, K. R. Robertson, M. Arsenault, T. A. Dickinson & C. S. Campbell. 2007. Phylogeny and Classification of Rosaceae, *Pl. Syst. Evol.* 266: 5 - 43.
- Qian, Guan-Ze, Lian-Fen Liu & Geng-Guo Tang. 2006. A new section in *Malus* (Rosaceae) from China, *Ann. Bot. Fennici* 43: 68 - 73.
- Rehder, A. 1915. *Plantae Wilsonianae*, vol. 2: 266 - 279.
- Rehder, A. 1940. *Manual of Cultivated Trees and Shrubs*, MacMillan, New York.
- Robertson, K. R., J. B. Phipps, J. R. Rohrer & P. G. Smith. 1991. A synopsis of genera in Maloideae Rosaceae. *Systematic Botany* 16(2): 376 - 394.
- Roemer, M. J. 1847. *Familiarum naturalium regni vegetabilis synopses monographicae*. III. Rosiflorae. Amygdalacearum et Pomacearum. Weimar: Landes-Industrie-Comptoir.
- Rushforth, K. 2010. A preliminary revision of the Sino-Himalayan Whitebeams (*Sorbus* section Thibeticae : Rosaceae), *Int. Dendrol. Soc. Year Book 2009*: 74 - 102
- Sennikov, A. N. & A. Kurtto. 2017. A phylogenetic checklist of *Sorbus* s.l. (Rosaceae) in Europe, *Memoranda Soc. Fauna Flora Fennica* 93: 1 - 78.
- Sun Hang & Zhou ZheKun. 2000. *Seed Plants of the Big Bend Gorge of Yalu Tsangpo in SE Tibet, E Himalayas*, Yunnan Science & Technology Press, Kunming.
- Wenzig, T. 1883. Die Pomaceen. Charaktere der Gattungen und Arten. *Jahrb. Konigl. Bot. Gart. Berline* 2: 287 - 307.