



On the disintegration of Molluginaceae: a new genus and family (*Kewa*, Kewaceae) segregated from *Hypertelis*, and placement of *Macarthuria* in Macarthuriaceae

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Abstract

Molecular studies have shown that Molluginaceae in the traditional sense is polyphyletic. Several genera have already been separated into various families (e.g. Caryophyllaceae, Limeaceae, Lophiocarpaceae, Microteaceae), but recent studies have shown that *Macarthuria* and *Hypertelis* also make Molluginaceae polyphyletic if they remain to be included in this family. *Hypertelis* is biphyetic, with its type species found to belong to Molluginaceae *sensu stricto*, but the remainder of the genus is to be placed elsewhere. Therefore a new genus, *Kewa*, is proposed for the rest of *Hypertelis*, and two new family names are coined: Kewaceae and Macarthuriaceae, which are here morphologically characterized.

Key words: Australia, Madagascar, new family, new genus, Saint Helena, South Africa

Introduction

Molluginaceae were originally segregated from Aizoaceae based on anthocyanin presence and several morphological characters that are now known to be plesiomorphic in Caryophyllales (including the old Centrospermae). However, no clear synapomorphies are known for Molluginaceae (Endress & Bittrich 1993) and it is thus unsurprising that the family has been found to be polyphyletic in phylogenetic studies (Cuenoud *et al.* 2002, APG III 2009). Several genera previously placed in Molluginaceae have since been removed to other families, for instance *Corbichonia* Scopoli (1777: 264, now Lophiocarpaceae), *Limeum* Linnaeus (1759: 994, now Limeaceae), and *Corrigiola* Linnaeus (1753: 271) with *Telephium* Linnaeus (1753: 271, now Caryophyllaceae), but not all genera had been sequenced by the time of APG III (2009). Some unsampled genera have recently been included in studies on classification of Caryophyllales (Schäferhoff *et al.* 2009), the evolution of pigments (Brockington *et al.* 2011) and C₃/C₄ metabolism transitions (Christin *et al.* 2011). In these studies, *Microtea* Swartz (1788: 53) was placed in its own family Microteaceae, and *Hypertelis* Fenzl (1836: 352) and *Macarthuria* Hügel ex Endlicher (1837: 11) were found to belong elsewhere in Caryophyllales (see figure 1). We attempt to further resolve the issue of the remaining polyphyly in Molluginaceae by proposing two new family names.

In APG III (2009), *Macarthuria* was placed with *Limeum* in Limeaceae, based on its morphology, but no material of *Macarthuria* had at that time been included in any molecular study. Molecular evidence has shown that *Macarthuria* is sister to all core Caryophyllales (Brockington *et al.* 2011, Christin *et al.* 2011). Because it would be untenable to unite all these into a single family (which would result in Caryophyllaceae and Cactaceae being in the same family), a new family encompassing just this single genus, Macarthuriaceae, is described below.

Hypertelis, with nine species, has been found to be polyphyletic in a recent study (Christin *et al.* 2011). Its type species, *H. spergulacea* E.Mey. ex Fenzl (1839: 263), which was designated by Phillips (1951: 291), was found to be placed inside Molluginaceae *sensu stricto*, and was nested within *Mollugo* Linnaeus (1753: 89), from which it was previously segregated on the basis of its fleshy leaves with large stipules adnate to the leaf base and clasping the stem. The relationship was well-supported based on multiple plastid markers and single-copy nuclear genes, and the position was identical in both datasets (Christin *et al.* 2011). *Mollugo* itself is polyphyletic within Molluginaceae (Arakaki *et al.*,

2011, Christin *et al.* 2011), and even though *H. spergulacea* may have to be combined with *Mollugo*, other taxonomic changes will be needed within this family, and it is not within the framework of this study to revise the generic delimitations of Molluginaceae *sensu stricto*. What does interest us is that the remainder of *Hypertelis* was found in a clade including Aizoaceae, Phytolaccaceae and Nyctaginaceae, well-separated from Molluginaceae (Brockington *et al.* 2011, Christin *et al.* 2011), and within it possibly closest to Barbeuiaceae and Lophiocarpaceae. The remaining species are therefore treated as a separate genus, *Kewa* (described below), to be separated from *Hypertelis sensu stricto* and Molluginaceae as a whole on the basis of the flower characteristics: the flowers of *Kewa* have fewer stamens (3–15 versus 20–30 in *Hypertelis*) that are free. Additional differences are described in the key below. Further information on all these species can be found in the excellent review of the genus by Adamson (1958). He selected another species as the type of the genus, but the typification of Phillips (1951) takes priority, resulting in this nomenclatural change.

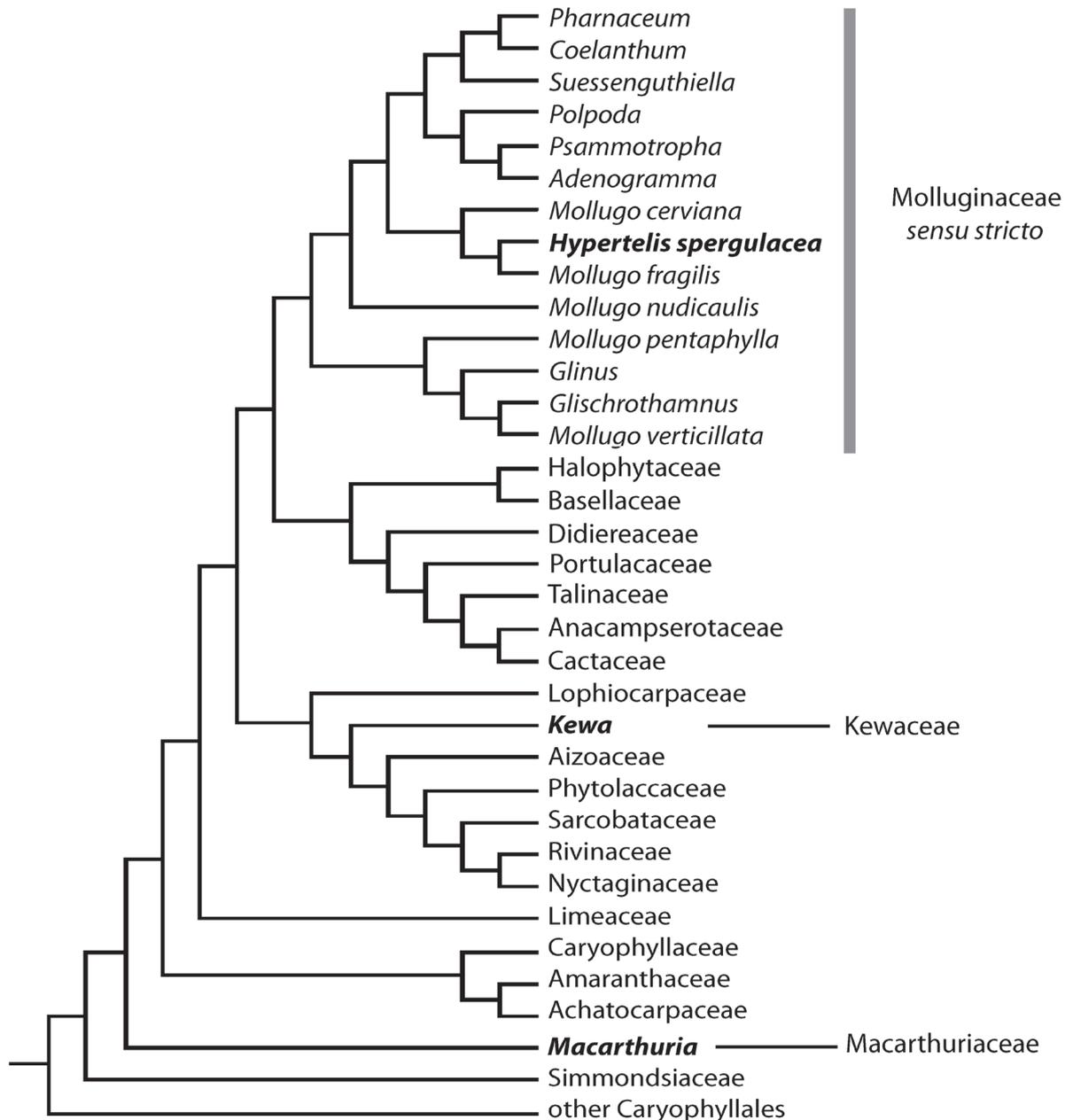


FIGURE 1. Phylogenetic position of Molluginaceae genera (including *Hypertelis*, *Kewa* and *Macarthuria*) among Caryophyllales. The topology was obtained through Bayesian inference of coding sequences from the plastid markers *rbcL*, *matK* and *trnK* (adapted from Christin *et al.* 2011).

Taxonomy

Macarthuraceae Christenh., *fam. nov.*

Type of the family:—*Macarthuria* Hügel ex Endlicher (1837: 11).

These are rigid or wiry, rush-like, perennial herbs or subshrubs with green stems. Leaves are alternate, with or without a petiole, lacking stipules. The blades are simple, linear or progressively reduced upwards to scales along the stem. Leaf blades have entire margins and obscure venation. Inflorescences are many-flowered, axillary or terminal compound cymes, or flowers solitary in the leaf axils. Flowers are actinomorphic and bisexual. The five or ten sepals are in two whorls and fused at the base. Petals are five and free, or absent. The eight stamens have filiform filaments that are fused to each other at the base. Anthers are basifixed and opening by lengthwise slits. The superior ovary is composed of three carpels that are fused into a single (or rarely three) locule(s). The three stylodes are fused into a single style at the base, each with an unlobed stigma. Fruits are loculicidal capsules with up to ten seeds.

The family differs from Molluginaceae and Microteaceae in having five petals (usually absent in Molluginaceae and Microteaceae), the basifixed anthers (dorsifixed in Molluginaceae and Microteaceae) and the three carpels forming a single locule (one to five carpels each forming a locule in Molluginaceae). They are shrubs that predominately photosynthesize with their rush-like stems; the leaves are often reduced and insignificant.

Kewaceae Christenh., *fam. nov.*

Type of the family:—*Kewa* Christenh., *gen. nov.*

These are annual or perennial herbs that can be slightly woody. Their leaves are alternate or in false whorls, usually more or less fasciculate at the stem tips, succulent, linear and terete. Stipules are present and fused to the base of the blade, sheathing the stem to different degrees. Inflorescences are terminal or apparently axillary, long-stalked (false) umbels. Flowers are bisexual and actinomorphic and have a whorl of five free sepals, of which three or four become petal-like (usually white or pink), but true petals are absent. The five to 15 (rarely fewer) stamens have shortly fused filaments and dorsifixed anthers opening by longitudinal slits. The superior ovary is composed of three to five fused carpels and is topped by short, fleshy stigmatic crests. The fruit is a membranaceous capsule that opens loculicidally. The family includes the single genus *Kewa*.

Kewa Christenh., *gen. nov.*

Type of the genus:—*Kewa salsoloides* (Burch.) Christenh. (= *Pharnaceum salsoloides* Burch.).

The genus differs from *Hypertelis sensu stricto* in having succulent, alternate, terete leaves, stipules that are adnate to the sheathing leaf bases, simple umbellate inflorescences on long stalks, the short stigmatic crests topping the ovary, and the absence of a nectary disk.

Etymology:—*Kewa* is named for Kew, a village in Richmond, Surrey, southwest London, where the internationally acclaimed Royal Botanic Gardens are situated. This botanical institute has conducted botanical research worldwide for over 250 years and has earned a global fame in taxonomy, conservation, horticulture and science. We chose to name it in honour of RBG Kew because members of the genus occur in areas (St. Helena, southern Africa, Madagascar) where Kew carried out research, and samples provided by Kew have been instrumental in resolving the relationships discussed here.

Key to the species of *Hypertelis* and *Kewa*

1. Leaves in basal and distant whorls; the 20–30 stamens in bundles *Hypertelis spergulacea*
1. Leaves alternate or subopposite along the stem, often crowded but not whorled; the stamens 3–15, free 2
2. Perennial herbs; stems woody at least at the base 3
2. Annual herbs; stems herbaceous throughout, not woody at the base 8
3. Flowers more than 6 mm across; stipules minute, deciduous (St. Helena) *Kewa acida*
3. Flowers less than 4 mm across; stipules evident, persistent (Africa, Madagascar) 4
4. Peduncles, pedicels and perianth with projecting glandular warts *Kewa salsoloides*

4.	Peduncles, pedicels and perianth smooth, without warts	5
5.	Stamens 10–15, if 10 then in mainland Africa	<i>Kewa angrae-pequenae</i>
5.	Stamens 5 or 10, if 10 then in Madagascar	6
6.	Stamens 10; woody shrubs (Madagascar)	<i>Kewa suffruticosa</i>
6.	Stamens 5; herbs, woody at base only (mainland Africa)	7
7.	Umbels with 4–8 flowers; leaves subulate	<i>Kewa bowkeriana</i>
7.	Umbels with 2–3 flowers; leaves flattened	<i>Kewa caespitosa</i>
8.	Stamens 3; seeds smooth; peduncles shorter than the leaves	<i>Kewa arenicola</i>
8.	Stamens 5; seeds tuberculate; peduncles longer than the leaves	<i>Kewa trachysperma</i>

Checklist of the species of *Hypertelis* and *Kewa*

Hypertelis spergulacea E.Mey. ex Fenzl (1839: 263) (Molluginaceae).

Note:—This species is the sole member of *Hypertelis* and remains in Molluginaceae. It may belong to an expanded *Mollugo*, pending further study of that genus.

Distribution:—Namibia.

***Kewa acida* (Hook.) Christenh., comb. nov.** (Kewaceae).

Basionym: *Pharnaceum acidum* Hooker (1868: 26).

Homotypic synonym:—*Hypertelis acida* (Hook.f.) Müller (1908: 58).

Distribution:—St. Helena.

***Kewa angrae-pequenae* (Friedrich) Christenh., comb. nov.** (Kewaceae).

Basionym:—*Hypertelis angrae-pequenae* Friedrich (1955: 62).

Distribution:—Namibia, South Africa.

***Kewa arenicola* (Sond.) Christenh., comb. nov.** (Kewaceae).

Basionym:—*Hypertelis arenicola* Sond. in Harvey & Sonder (1860: 145).

Distribution:—South Africa.

***Kewa bowkeriana* (Sond.) Christenh., comb. nov.** (Kewaceae).

Basionym:—*Hypertelis bowkeriana* Sond. in Harvey & Sonder (1860: 145).

Distribution:—Ethiopia, Kenya, Tanzania, Mozambique, Zimbabwe, Botswana, Namibia, South Africa.

***Kewa caespitosa* (Friedrich) Christenh., comb. nov.** (Kewaceae).

Basionym:—*Hypertelis caespitosa* Friedrich (1955: 64).

Distribution:—Namibia, South Africa.

***Kewa salsoloides* (Burch.) Christenh., comb. nov.** (Kewaceae).

Basionym:—*Pharnaceum salsoloides* Burchell (1822: 286).

Homotypic synonym:—*Hypertelis salsoloides* (Burch.) Adamson (1958: 52).

Heterotypic synonyms:—*Pharnaceum verrucosum* Ecklon & Zeyher (1836: 286), *Hypertelis verrucosa* (Ecklon & Zeyher) Fenzl (1839: 262).

Distribution:—Mozambique, Angola, Namibia, South Africa.

***Kewa suffruticosa* (Baker) Christenh., comb. nov.** (Kewaceae).

Basionym:—*Pharnaceum suffruticosum* Baker (1884: 151).

Homotypic synonym:—*Hypertelis suffruticosa* (Baker) Adamson (1958: 55).

***Kewa trachysperma* (Adamson) Christenh., comb. nov.** (Kewaceae).

Basionym:—*Hypertelis trachysperma* Adamson in Adamson, Gerstner & Salter (1946: 35).

Distribution:—South Africa (Cape).

Name of uncertain position:—*Hypertelis longifolia* Gandoger (1912: 708) was collected from the Cape of South Africa. This taxon may well be the same as *Kewa trachysperma* (over which it would take nomenclatural priority), but the description is not sufficient to place it accurately among the two annual species of *Kewa*. The original description discusses petals and sepals, which cannot be distinguished in this genus (although there are petaloid sepals), so it may be a different genus altogether. We decided against making a combination for this name which has not been in use but for the type specimen (which we failed to locate).

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