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Research article

The genus *Evotrochis* (Primulaceae) resurrected

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Abstract: The genus *Evotrochis* Raf. is reinstated (formerly *Primula* subg. *Sphondylia*), and its relation to *Dionysia* and the rest of the *Primula* group is discussed. Six new combinations are made.

Keywords: *Dionysia, Evotrochis, Primula, Sphondylia.*

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The circumscription of *Primula*

The taxonomy of *Primula* L. in the broadest sense has recently confronted several phylogenetic studies (Mast et al., 2001; Trift et al., 2002), showing that some parts of the genus, as traditionally circumscribed, are more closely related to other widely recognised genera than to the core of *Primula*. This violates the paradigm of natural classification – that organisms be grouped with their closest relatives – and renders *Primula* "paraphyletic", i.e. negatively defined by what it is *not*. There are two orthodox solutions to resolve this issue: we can include these genera in a broadly circumscribed *Primula,* or we can further chop up the latter. A third option is to adopt rank-free names, where the "genus" part of a species name does not indicate a more inclusive natural taxon of genus rank; in practice to freeze all names as they "are".

Different botanists have taken different courses in this conflict. Sojak (1980) revitalized the old genera *Auganthus* Link and *Aleuritia* Spach, whereas Mast and Reveal (2007) chose the opposite approach, sinking the shooting stars *Dodecatheon* L. in *Primula* as a section. Much less controversial was the move to let *Primula* engulf the genus *Cortusa* L. (as a subsection of sect. *Cortusoides* Balf.f.; Kovtonyuk, 2011). However, the genus *Dionysia* Fenzl has so far not been affected by nomenclatural changes. Although this taxon is very well supported as such, it would need to be included in *Primula* if a wide circumscription of the latter is maintained.

Why do we choose to recognize *Dionysia* and *Evotrochis* as genera?

The closest relative of *Dionysia* is a very distinct taxon, usually recognised as *Primula* subgenus *Sphondylia* (Duby) Rupr. (Wendelbo, 1961a; Trift et al., 2004). In other words, the latter is more closely related to *Dionysia* than to its "congeners" in *Primula*. In their forth-coming *Dionysia* monograph, Magnus Lidén & Iraj Mehregan (in prep.) have kept generic rank for the genus *Dionysia* in order not to forejudge a nomenclatural overhaul of the whole *Primula* group by introducing numerous new combinations that may eventually turn out synonyms. To bolster this approach, the least disruptive solution is chosen, recognising *Evotrochis* (i.e *Primula* subg. *Sphondylia*) as a genus.

In agreement with this position, Mehmet Fırat, based on many years field experience and herbarium studies, had long been of the opion that the Hakkari endemic *"Primula" davisii* is much more similar to *Dionysia* than to the rest of *Primula sensu lato*: their shared habit and habitat, foliose bracts, spherical capsule deeply dehiscing with five (to 9) valves, a general likeness in floral morphology (small deeply divided green calyces, long-tubed yellow

usually hairy or glandular corollas), as well as several phylogenetic studies; all suggest that *Dionysia* and *Evotrochis* belong together. Capsule dehiscence was previously considered a defining feature of *Dionysia*, but *Evotrochis* has very similar capsule dehiscence and capsules, only larger.

The close morphological and ecological similarity between *Evotrochis* and *Dionysia* was acknowledged long before molecular data where at hand. Duby (1844) and Smith and Fletcher (1948), more than one hundred years apart, both included the more lax-growing "primuloid" species of *Dionysia* in *Primula* subg. *Sphondylia*. If the two taxa were to be combined in one genus, the oldest name is *Evotrochis* Raf. This would be nomenclaturally unfortunate, as *Dionysia*, with cirka 60 species, is the much larger subclade. However, keeping both genera will be equally informative, because they are equally well supported, both morphologically and phylogenetically, as a combined genus would be. Note also that crosses within each genus usually work fine, whereas attempts at intergeneric hybrids have failed (Al Wadi and Richards 1992); an additional reason to keep them separate.

The genus *Evotrochis*

We cannot withhold from you the declaration by Rafinesque (1837) when he originally described the genus *Evotrochis*: "It is astonishing how the botanists could unite this fine distinct Genus with *Primula*". The genus is small, comprising from 5 to 8 species (depending on how closely related geographical vicariants are ranked). It is distributed in three geographically separate areas: The Himalayas (Nepal to east Afghanistan), the Red Sea area (Sinai, SW Arabian Peninsula, the Horn of Africa) and the Zagros mountains in west Iran and the Cilo-Cudi mountains in southeast corner of Turkey.

The genus *Evotrochis* and its sister group *Dionysia* share several characters, like chasmophytic (cliff-dwelling) habit, large foliaceous floral bracts and spherical capsules that split deeply into five valves (sometimes more through secondary splits). They are densely tufted with several flowering stems producing many-flowered inflorescences with yellow flowers in super-posed verticils. Glandular as well as eglandular multicellular hairs are found in both genera in various combinations. Together they would make a distinct taxon.

Evotrochis and *Dionysia* are nevertheless easy to tell apart. *Evotrochis* has conduplicate young leaves (Watt, 1904; Mast et al., 2001) (which should not be confused with the involute condition in e.g. *Primula* sects *Auricula* Duby and *Cuneifolia* Balf.f.). Emerging leaves of *Dionysia* are flat or with revolute margin. *Evotrochis* has 3- to 4-furrowed colporoidate pollen (*vs.* 5- to 8-furrowed stephanocolpate pollen in *Dionysia*), 18 chromosomes in the diploid set (*vs.* 2x=20 in the six *Dionysia* species counted) and powdery farina (*vs.* wooly). Finally, *Evotrochis* are rosulate herbs with condensed shoots and thick parenchymatous rhizomes, clad with petiole remnants, and emitting thick adventitious roots. *Dionysia* species, by contrast, are intricately branched dwarf shrubs with elongate woody shoots that due to secondary xylem growth slowly increase in width each year, and eventually shed epidermis and marcescent foliage, revealing a dense amorphous peculiar "bark" (Decrock, 1901).

In the genus *Dionysia*, there are species – indeed the best known – that are dense hemispherical cushions with sessile single flowers subtended by small bracts, and even violet corollas, but there is no doubt that these characters are derived within *Dionysia*, and that the ancestral forms of both genera were similar. *D. bornmuelleri* (Pax) Clay and *D. hissarica* Lipsky have indeed even been classified in *Evotrochis*, and conversely, species of *Evotrochis* are sometimes mistaken for *Dionysia*.

Character optimization on the *Primula* phylogeny in Mast et al. (2006), allows us to conclude that the ancestor of the *Dionysia* + *Evotrochis* clade was a rosulate chasmophyte with fairly large dentate leaves with revolute vernation, a stalked inflorescence with flowers in superposed verticils, foliaceous bracts, powdery farina, long-tubed yellow flowers (possibly with orange nectar guides), round deeply dehiscing capsules with several seeds.

The conduplicate (folded) leaf vernation is an evolutionary innovation or *synapomorphy* for *Evotrochis*. *Dionysia* has retained the ancestral condition with revolute vernation. The fruticose habit with elongate woody branches and the wooly farina are synapomorphies for *Dionysia*. For pollen and chromosome number the optimization is ambiguous, as both types appear in the sistergroups (*Primula* subgenera *Aleuritia* (Spach) Wendelbo and *Primula*).

It seems probable from morphology (*cf.* Wendelbo, 1961b) that the species in each of the three geographical areas are related. Mast et al. (2006) include five species of *Evotrochis* in their phylogeny, showing, as expected, that the closely similar *E. verticillata* and *simensis* form a clade. Together with the third Red Sea area species (*E.*

involucrata) they share the apomorphic conditions glabrous corolla and homostyly. This switch from heterostyly to homostyly does not seem to be coupled to self-fertility, as it is in several other cases like *Dionysia involucrata* Zaprjag. and the arctic *Primula* species.

Nomenclature

All cited specimens have been seen (at least photos) unless explicitly indicated.

Evotrochis Raf.

Fl. Tellur. 2: 76 (1837) – *Primula* sect. *Sphondylia* Duby in Prodr. [A. P. de Candolle]. 8: 33. 1844. – *P.* subg. *Sphondylia* (Duby) Rupr., Bull. Acad. Imp. Sci. Saint-Pétersbourg. 6: 218. 1863. – *P.* sect. *Floribundae* Pax, Bot. Jahrb. Syst. 10:171. 1889, *nom. illeg.* – *P.* sect. *Verticillata* Balf.f, J. Roy. Hort. Soc. 39:170. 1913, *nom. illeg.* – Type: lecto: *P. verticillata* Forsk., selected by Ruprecht (1863) for subg. *Sphondylia*; here selected for *Evotrochis*.

Etymologies: *Evo-trochis*: "well wheeled", from Greek εὖτροχος, referring to the large verticillate bracts. *Sphondylia*: Latin sp[h]ondylus (mussel, oyster, vertebra, from Greek σφόνδῠλος, vertebra), probably referring to the large bracts.

1. ***Evotrochis davisii*** (W.W.Sm.) Fırat, *comb. nov.* (Figure 1)

Primula davisii W.W.Sm., Notes Roy. Bot. Gard. Edinburgh 22: 45. 1955. – Type: Turkey, Hakkari: Cilo Dag, Di Derezi above Dezi, 5700–5900 ft. 6 Aug 1954. *P. H. Davis & Polunin D23876* (holo E, iso BM, G, K, LE).

Not farinous; densely short-glandular hairy all over. Heterostylous.

Hakkari and Şırnak province, SE Turkey, moist shaded cracks in limestone rocks, 1000–2100 m. Flowering time April-June. Kurdish name "Gulzêrîn" (Fırat, 2013).

2. ***Evotrochis gaubaeana*** (Bornm.) Fırat & Lidén, *comb. nov.* (Figure 2)

Primula gaubaeana Bornm., Neue Art Sekt. Floribundae Fl. Pers. (Mitt. Thuring. Bot. Ver., n. f., xlvii. 132: 1941) 1, T. 10. 1940. – Type: Lorestan, Pol-e-Kalchor [Kelahor bridge, ca 33°23'N, 47°59'E], 1100 m. *Gauba* (holo B? not seen).

Farinous in the inflorescence only; Flowers rather small, with at least two types of morphs within populations: with "normal" longistylous (pin) flowers with anthers halfway up the tube, and thrum flowers with anthers at the mouth of the flower, but style elongating and eventually reaching and slightly surpassing the anthers (like in *Dionysia teucrioides*).

West-central Zagros Mountains, Iran: Lorestan, Bakhtiari and Khuzestan provinces. Growing on humid lime cliffs, often in the spray of waterfalls, 600 to 2000 m.

3. ***Evotrochis verticillata*** (Forssk.) Fırat & Lidén, *comb. nov.* (Figure 3)

Primula verticillata Forssk., Fl. Aegypt.-Arab. 42. 1775. – *Evotrochis odorata* Raf., Fl. Tellur. 2: 76. 1837, *nom. illeg.* – Type: Jemen "in monte Kurma [Qosmah] ad rivulos aquarum". Mar 1763. P. *Forsskål* s.n. (lecto C10002834 [herb. Forsskålii 354], here selected; iso BM, C, LINN, S).

Farinous, otherwise glabrous; with large homostylous fragrant flowers with abundant nectar.

Mountains of SW Arabian Peninsula, possibly also Somalia. Growing on limestone cliffs, N-facing and/or close to streams, 1500–3000 m.

4. ***Evotrochis simensis*** (Hochst.) Fırat & Lidén, *comb. nov.*

Primula simensis Hochst., Gardn. & Field. Sert. Pl. t. 48. 1844. – *P. verticillata* ssp. *simensis* (Hochst.) W.W.Smith & Forrest, Notes Roy. Bot. Gard. Edinburgh 16: 28. 1943. – Type: "Ad rupium parietes humentes in monte simensi Silke" [13°22'N 38°17'E]. Feb 1840. *Schimper, Abyss. Exs. 662* (lecto K [Paola Bizzarri, Webbia 24 (1970)]); iso BR, FI, HAL, LG, M, MPU, P, REG, S, TUB).

Like previous, but usually smaller and mealier with less divided calyx and shorter corolla.

Mountains of Eritrea and Ethiopia, on vertical cliffs, often with seepage water nearby, 2000–4200 m. closely related to *E. verticillata*, and sometimes treated as a subspecies. We here follow the ranking of Pam Eveleigh (Primulaworld.com).

Figure 1. *Evotrochis davisii* (Turkey, Hakkari, Cilo mountain). **A**. general habitat; **B.** habitus; **C, D.** habit; **E.** habit with last year capsule deeply dehiscing with nine valves; **F.** whole plant (rhizome, basal leaves, bracts, calyx and corollas tube), **G.** general habit with dry corollas and immature capsules (photographed by M. Fırat).

Figure 2. *Evotrochis gaubaeana* (Iran, Khuzestan, waterfall close to Sheyvand). **A.** whole plant; **B, C**. longistylous flower; **D.** brevistylous flower with style elongating, and eventually reaching anthers (photographed by M. Lidén).

Figure 3. *Evotrochis verticillata* (cultivated in Göteborg Botanic Garden); **A.** whole plant; **B.** flower; **C, D.** rhizome, entire and cross-section (photographed by M. Lidén).

5. *Evotrochis involucrata* Raf.

Fl. Tellur. 2: 76. 1837. – *Primula verticillata sensu* Graham, Edinb. new Phil. Journ. 4: 393. 1828 and Hooker, Curtis's Bot. Mag. 55: t. 2842. 1828, non Forssk. (1775) – *P. involucrata* (Raf.) Link & Otto ex Sweet, Hort. Brit. [Sweet], ed. 3: 562. 1839. – *P. boveana* Duby in Prodr. [A. P. de Candolle]. 8: 35. 1844, *nom. illeg.* – *P. verticillata* ssp. *boveana* (Duby) W.W.Smith & Forrest, Notes Roy. Bot. Gard. Edinburgh 16: 43. 1928. – Type: Icon: Bot. Mag. t. 2842 (1828), cultivated specimen in Edinburgh Botanic Garden from seed communicated by Friedrich Otto, Berlin Botanischer Garten, in 1825 as "*Primula involucrata*"; original source Ehrenberg & Hemprich, Jun 1823, Sinai, Jebel Katarina.

Note: described by Rafinesque as "Egypt, fl. pale yellow hardly odorous. This is Pr. vertic. of some authors Grab. Hook. b. m. 2842, not of Forskal. 287." ("Grab. Hook. b. m. 2842" stand for: Graham; Hooker, Curtis's Bot. Mag. 2842).

Like previous, but calyx lobes dentate and corolla smaller, with irregularly crenate lobes, not scented. Sinai, Egypt, very rare: "four sites in the area of St Catherine's Mount. growing near springs or in caves." (Primulaworld.com), [ca 2000–2500 m?].

6. *Evotrochis floribunda* (Wall.) Fırat & Lidén, *comb. nov.*

Primula floribunda Wall., Tent. Fl. Napal. 2: 43. 1826. – Type: India, Deyra Doon, near Sansedarra, 2300–2500 ft. Apr 1825. *Wallich 604* (holo K; iso BM, E, HBG, M).

Efarinose, pubescent with many-celled hairs and sparse sessile glands. Mixed styly.

Himalaya from Nepal to Pakistan (E Afghanistan?], 500–2700 m. On lime cliffs, usually shady or moist, often close to streams.

7. ***Evotrochis edelbergii*** (O.Schwarz) Fırat & Lidén, *comb. nov.*

Primula edelbergii O.Schwarz, Feddes Repert. Spec. Nov. Regni Veg. 64: 85. 1961. – Type: cultivated from seed in Jena from *Edelberg 413 or 403* (JE?).

Primula floribunda ssp. *occidentalis* Wendelbo [in Köie & Rech.f., Symb. Afghan. 4] Biol. Skr. 10(3): 66. 1958. – Type: Afghanistan, Nuristan: below garden of Vama, 1450 m. 12 Apr 1948. *Edelberg 403* (holo C).

Like previous, but with subsessile glands only and leaf lamina abruptly set off. Heterostylous.

E Afghanistan (Nuristan). Lime cliffs, 600–2100 m.

Evidently closely related to *E. floribunda*, and the two are sometimes treated as subspecies of one species, for which the correct name is *E. floribunda*. We here follow the ranking of Pam Eveleigh (Primulaworld.com).

Appendix: The Kew primrose

We can not avoid mentioning this widely cultivated species in an overview of *Evotrochis*. We list below the entities involved, the way we believe they should be named under *Primula*, but without suggesting new combinations, as there is possibly a questionmark as to the author designation of the "Kew primrose".

Primula x ***kewensis*** W.Watson [as *Primula kewensis*]
Gard. Chron. ser. 3, 27:130, 195. 1900. – Type: cultivated in Kew Gardens. 19 Feb 1900 (K).
Sterile homoploid hybrid plant discovered in Kew gardens in 1899 from a spontaneous cross between cultivated *Evotrochis floribunda* (♀) and *E. verticillata*.

Primula kewensis "the Kew Primrose", not *Primula* x *kewensis* W.Watson
Self-compatible fully fertile tetraploid, spontaneously sporting from *Primula* x *kewensis* in 1905 through somatic doubling in a meristem. This, and later independently derived tetraploids of the same parentage, have been commercialised under the name *Primula kewensis* or (incorrectly; see note) *Primula* x *kewensis*, and further bred and spread. There are also named cultivars. We are uncertain what authorship to ascribe to this species, or if the epithet needs to be formally conserved.

Primula x ***jenensis*** O.Schwarz
Wiss. Zeitschr. Friedrich-Schiller-Univ. Jena, Mat. Naturwiss. (Beitr. Phytotax., 3) 21: 967. 1972.

Arose from hybridization between *Evotrochis edelbergii* and *E. verticillata* in cultivation in Jena (Germany). Note that the validity of this epithet for the nothospecies will depend on the status awarded to *E. edelbergii*; if it is treated as a subspecies of a broadly circumscribed *E. floribunda*, *Primula* x *jenensis* becomes a synonym of *Primula* x *kewensis*.

Note: If a hybrid is given a "latin" specific epithet, this is prefixed with "x". Nowadays, this practice is permissible (but not particularly encouraged) for recurring or vegetatively increasing hybrids in the wild, not for cultivars. It is unfortunate that the two primary hybrids above, that arose or were made in cultivation, were ever awarded scientific binomials, confusing later nomenclature. Importantly, "x" must not be used in names of sexually reproducing allopolyploids, like *Drosera anglica* Huds. or *Sporobolus anglicus* (C.E.Hubb.) P.M.Peterson & Saarela, regardless of whether they, like the Kew primrose, arose in cultivation. There are a few more instances of named sterile cultivated hybrids giving rise to sexually reproducing plants through somatic doubling, and where the notho-epithet is still used, but without the "x", e.g. *Aesculus carnea*.

Ethical Approval

The authors declare that no need to ethical approval.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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