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FORSELLESIA GREENE (*GLOSSOPETALON* GRAY), A THIRD GENUS IN THE CROSSOSOMATACEAE, ROSINEAE, ROSALES

Robert F. Thorne and Ron Scogin

Introduction

Until recently the Crossosomataceae were believed to be a small family consisting of only two or three species of the genus *Crossosoma* Nutt., restricted to the southwestern corner of the United States and adjacent northwestern Mexico. In 1975 Mason described the new genus *Apacheria* from the Chiracahua Mountains of southeastern Arizona and attributed this monospecific genus, quite correctly, to the Crossosomataceae. A third genus, *Forsellesia* Greene, originally described as *Glossopetalon* in 1853 by Asa Gray and attributed reluctantly by him to the Celastraceae, must now be transferred to the Crossosomataceae.

Except for a later attribution of *Glossopetalon* by Gray (1875) to the Staphyleaceae near *Euscaphis* Sieb. & Zucc., the genus has generally been retained, with reservations by Jepson (1936), other western North American botanists (as Brandegee, 1899), and Koehne (1894), as a rather exceptional genus in the Celastraceae. Like most other botanists acquainted with only one or two of the mostly unicarpellate, small-flowered, intricately-branched, shrubby species of *Forsellesia*, we had seen no special reason to doubt this almost universal placement of the genus in the Celastraceae, especially because the California species frequently occur in limestone areas of the Mojave Desert with the equally small-flowered and shrubby *Mortonia* Gray of the Celastraceae. However, in preparing this past year a lecture on the Celastraceae and relatives for an angiosperm phylogeny course, the senior author became intrigued by the noncelastraceous characteristics listed in a description of *Forsellesia* by Munz (1974), viz "Stamens equal or unequal, 4–10. Carpels 1–3, distinct, ovoid, sessile, attenuate to the stigma. Ovary superior, 1-loculed, 1–2-ovuled. Fr. a coriaceous follicle, striate, opening along the ventral suture." No other genus of the Celastraceae known to us had been described as having stamens diplostemonous, gynoecium apocarpous or monocarpellate, and fruit folliculate. Further study was indicated.

A quick examination of RSA-POM herbarium material and Ensign's revision (1942) established at once that the species of *Forsellesia* are quite out of place in both the Celastraceae and the Staphyleaceae. The study of one of our own collections of *F. nevadensis* (Gray) Greene revealed that the seeds have small, whitish arils very reminiscent of those in *Apacheria* and that the seeds are black, shiny, swollen, reniform, and presumably with

a campylotropous ovule like those of *Crossosoma.* A comparative examination of herbarium material of the three genera aroused our immediate suspicion that *Forsellesia* is a truly intermediate genus between *Crossosoma* and *Apacheria,* and that the Crossosomataceae are thereby a much larger, wider-ranging, hence, more important angiosperm family than we had previously suspected. A subsequent group study of the three genera of the Crossosomataceae at the Rancho Santa Ana Botanic Garden has resulted in this paper and the two immediately following by DeBuhr (1978), and Tatsuno and Scogin (1978) in this journal.

Nomenclature

The widespread use of both generic names *Glossopetalon* and *Forsellesia* for this one genus indicates a nomenclatural problem needing a resolution. The two names have been about equally applied by taxonomic authors, as *Glossopetalon* by St. John (1937), Tidestrom and Kittell (1941), Benson and Darrow (1945), Abrams (1951), Clokey (1951), Kearney and Peebles (1951), Peck (1961), Hitchcock et al. (1961), Shreve and Wiggins (1964), Hitchcock and Cronquist (1973), and Meyer (1976); and *Forsellesia* by Tidestrom (1925), Davis (1952), Harrington (1954), Munz and Keck (1963), Scholz (1964), Correll and Johnston (1970), Willis (1973), Munz (1974), and Beatley (1976).

Because of the earlier *Glossopetalum* Schreber in L. (Gen. Pl. ed. 8, 1: 205, 1789), a later synonym of the celastraceous *Goupia* Aublet (Hist. Plantes Guiane Franc., 295–8, pl. 116, 1775), Greene (1893) considered Gray's *Glossopetalon* to be a later homonym and supplied the new name *Forsellesia* for the genus. Ensign (1942) accepted Greene's interpretation and in her revision adopted *Forsellesia* as the valid generic name. St. John (1942) disagreed with both Greene and Ensign and returned to Gray's earlier name. He interpreted the International Code of Botanical Nomenclature as considering *Glossopetalum* and *Glossopetalon* as different names not apt to be confused and thus not to be treated as homonyms. Article 75 in the present Code (Stafleu, 1972) is not entirely clear in this matter. Genera listed as not apt to be confused include *Rubia* and *Rubus, Monochaete* and *Monochaetum, Peponia* and *Peponium, Iria* and *Iris, Desmostachys* and *Desmostachya,* and *Peltophorus* and *Peltophorum. Glossopetalum* with latinized ending and *Glossopetalon* with Greek ending would seem rather comparable. However, the same Article 75 lists as specific epithets treated as orthographic variants (hence, to be treated as homonyms) *polyanthemos* and *polyanthemus, macrostachys* and *macrostachyus, poikilantha* and *poikilanthes, macrocarpum* and *macrocarpon,* and *trachycaulum* and *trachycaulon.* This Article certainly seems to need revision and clarification. It does

seem more logical to us and to some of our correspondents (as Peter Raven and Dan Nicholson) to accept *Glossopetalum* and *Glossopetalon* as orthographic variants and, therefore, *Glossopetalon* as a later homonym. Those who favor Gray's name over Greene's would probably have to request conservation of the name to get general acceptance of their interpretation of Article 75. Inasmuch as all necessary combinations have been made and widely accepted under *Forsellesia*, it is very doubtful that *Glossopetalon* Gray would be conserved. We shall in the rest of the paper refer to the genus as *Forsellesia*.

Morphological Description of *Foresellesia*

Shrubs mostly small (though up to 3 m tall), deciduous, intricately branched, often spinescent, with angled, grooved, or ribbed, green to grayish slender branches with decurrent lines from the nodes; leaves small (5–20 mm long by 1–5 mm wide), alternate, scattered or crowded, simple, entire, lanceolate (rarely elliptic) to oblong or oblanceolate, glabrous, glaucous, or pubescent, with venation obscure (rarely venose), and usually with minute (mostly less than 1 mm or even 0.5 mm long), subulate, linear, or lance-deltoid stipules (some varieties and species exstipulate); flowers bisexual or polygamo-monoecious, actinomorphic, usually axillary on slender pedicels (1–5 mm long) or terminating short branchlets, sepals and petals each 5, less commonly 4, and rarely 6 or 3, petals white, narrow-oblanceolate (3–9 mm long by 0.4–2 mm wide), distinct, deciduous, longer than the usually ovate, hyaline-margined sepals (1.2–3 mm long by 1–2 mm wide); pedicels 1–5 mm long; stamens diplostemonous or isomerous, 10–4, equal or unequal in length and like the petals inserted under the edge of a fleshy, crenately 10–6-lobed disk, when unequal, the longer stamens usually opposite the sepals, anthers dehiscing longitudinally; pollen grains as yet largely unstudied but tricolporate and subspheroidal, grains of *F. spinescens* (Gray) Greene ca. 21 × 17 μm (Erdtman, 1952); carpels 3–1 though usually solitary [except in *F. pungens* (Brandg.) Heller], distinct, ovate (ca. 1 mm long), sessile on the disk, tapered to the somewhat lateral, oblongish to ovate-discoid stigma; ovules campylotropus, 2 or 1; fruit an asymmetrical, broadly-ovoid (3–5 mm by 2–3 mm), striated, coriaceous follicle opening along the ventral suture; seeds shiny, smooth, black or brown, swollen, reniform with copious endosperm and bearing a small, white, thin or fleshy, entire or lacerate aril. The anatomical features of stem and leaves are discussed in the following paper by DeBuhr (1978).

In certain features the least specialized species, hence the most critical for our purposes, is *F. pungens*. This small, diffusely-branched, nonspinescent, matted shrub, rarely more than 20 cm long, clings to vertical lime-

stone cliffs in the Sheep and Spring Mts. of southern Nevada and the nearby Clark Mts. of northeastern San Bernardino County, California. The leaves are narrowly elliptical, thick, pungent, crowded on the twigs, and exstipulate; flowers are terminal on short branchlets and borne on bracteose pedicels, with sepals 5, ovate, acuminate, often spinulose-tipped and denticulate, and petals 5, broadly oblanceolate; stamens 10, the 5 opposite the sepals one-third longer than those opposite the petals; carpels 3–1 but usually 2, ovoid, less than 1 mm long, 1 (to rarely 2) -ovuled, tapered to somewhat lateral, ovate-discoid stigma; ripe, open follicles 2 or 3, strongly striate, broadly-ovate, mostly 4.5 mm long × 3.5 mm wide (3–6 mm × 3–4 mm); seed usually 1, swollen, reniform, not seen mature.

Chemistry of *Forsellesia*

In order to assess the phytochemical similarity between species of *Forsellesia* and *Crossosoma*, a biochemical profile for *F. nevadensis* was compiled. Techniques used in analyzing *Forsellesia* materials are referenced in detail in a following paper by Tatsuno and Scogin (1978). Fresh materials of *F. nevadensis* were collected in the field and vouchers deposited at RSA (RSA #252,135).

Forsellesia nevadensis shares numerous phytochemical characteristics with the two species of *Crossosoma* including the common occurrence of gallic and ellagic acids in leaves and the common absence from leaf tissue of proanthocyanidins, cyanogenic glucosides, and saponins. Syringin cannot be chromatographically detected in wood extracts of *F. nevadensis* and, while present in *Crossosoma californicum* wood, syringin is also absent from the wood of *C. bigelovii*.

Cyanidin-3-glucoside has been provisionally identified from floral tissue of *F. nevadensis*. This identification remains provisional as it is based on spectral data on crude methanolic extracts and a single R_f value (15% HOAc-HCl) due to the extreme paucity of pigment in floral tissue and very limited experimental material. This anthocyanin also occurs in floral tissues of both *Crossosoma* species.

Forsellesia phytochemistry stands in contrast to *Crossosoma* constituents in that ellagitannins are absent from *Forsellesia* floral material (present in both *Crossosoma* species) and *Forsellesia* leaves contain two flavone glycosides (no flavonoids detectable in *Crossosoma* leaves). The flavonoids in in *F. nevadensis* leaves have been partially identified as acacetin 7-0-glycoside and acacetin 7-0-diglycoside. A complete characterization of these constituents will be published elsewhere.

In summary, the chemical constituents of *F. nevadensis* are basically similar to those of *Crossosoma* species with the exceptions of floral ellagitanins and leaf flavones.

Revised Description and Range of Crossosomataceae

A revised description of the Crossosomataceae to include the known species of all three genera, perhaps a dozen species in all, would minimally have to include the following morphological data: shrubs large (sometimes arborescent) to small (3 m tall to prostrate and a few cm high), deciduous, often spinescent and intricately branched; leaves alternate, scattered or fascicled, or opposite, simple, entire to tridentate, obtuse, apiculate, acute, or rarely pungent, glabrous or pubescent, glaucous or green, mostly obscurely veined, with stipules minute or absent; flowers solitary, axillary or terminal on short shoots, bisexual or polygamo-monoecious, actinomorphic with floral tube perigynous, turbinate or cup-shaped, lined with a fleshy to thin, glandular, crenately lobed disk; sepal lobes 5 or 4 (rarely 6 or 3), imbricate, persistent, mostly ovate, some denticulate; petals 5 or 4 (rarely 6 or 3), imbricate, white to rose or lavender, deciduous, round-ovate to commonly narrow-oblanceolate, usually much longer than the sepals, and often short-clawed and inserted at the edge of the glandular disk; stamens numerous (15–50), diplostemonous, or isostemonous (hence as few as 5 or 4), sometimes unequal in length, initiated centripetally (see Tatsuno, 1976), with anthers basifixed and dehiscing longitudinally; pollen grains subspheroidal, tricolporate with colpi rounded at the ends and pores rounded, the exine semitectate and per-reticulate with the reticulum heterobrochate, ranging in size from 14.8 × 15.2 μm to 18.7 × 20 μm or 17 × 21 μm; carpels 9 to 1, distinct, stipitate or sessile, tapered to capitate, discoid, or linear stigma, bearing numerous to 2 or 1 campylotropous, marginal ovules; fruits cyclindric to ovoid, coriaceous, asymmetrical follicles, often striate, opening by the ventral suture and bearing many to 2 or 1 globular-reniform or obovate, shiny black or dark brown, smooth or minutely papillate-tessellate, arillate seeds with slender, curved embryo in fleshy, often abundant endosperm; and arils fimbriate and large, fimbriolate, or entire and rather small, yellowish or whitish.

The species of the three genera, *Crossosoma*, *Forsellesia*, and *Apacheria*, range from just above sea-level to about 2,450 m, from islands to desert mountains, on rocky hillsides, canyon walls, or cliffs or in desert washes, usually in crevices in limestone, dolomite, granite, or volcanic rock, from Guadalupe Island, Baja California, and Aguascalientes and Coahuila States of mainland Mexico north through California, Arizona, New Mexico, and Texas to south-eastern Washington, Idaho, and Montana, reaching east nearly to Louisiana.

Synoptic key to the three genera of Crossosomataceae

1. Shrubs, arborescent to subprostrate; leaves entire, elliptic to obovate, obtuse, apiculate, alternate, scattered or fascicled, exstipulate; flowers

terminal; sepals and petals 5, the latter white or rose; stamens numerous (15–50); carpels (9–)7–3(–1), stipitate with capitate stigmas; follicles nonstriate with many to several (more than 20–5–2) seeds with conspicuous, yellowish, deeply lacerate arils; $n = 12$; S. Nevada, Arizona, and California to Guadalupe Island, Baja California, and Sonora *Crossosoma*

– Shrubs, small, intricately branched, and often prostrate or matted; leaves entire or bi- or tri-lobed, oblong or lanceolate (rarely elliptic) to oblanceolate or spatulate, alternate or opposite, exstipulate or with minute stipules; flowers on short shoots or axillary; sepals and petals 5 or 4 (rarely 6 or 3), the latter white; stamens isomerous or diplostemonous (4–10); carpels 4–1, sessile and tapered to linear, oblongish, or ovate-discoid stigmas; follicles strongly striate with 2 or 1 seeds with inconspicuous, fibriolate or entire arils 2

2. Leaves alternate, entire, oblong, or lanceolate to oblanceolate or spatulate, acute (rarely elliptic and pungent), usually with minute stipules or exstipulate; flowers usually axillary, rarely on short shoots; sepals and petals (6–)5–4(–3); stamens 10–4; carpels (3–2)–1, with oblongish to ovate-discoid stigmas; ovules and seeds 2 or 1; Washington and Montana south to California, Aguascalientes, and Texas *Forsellesia*

– Leaves opposite, entire to trilobed, oblanceolate to spatulate, apiculate, with minute stipules; flowers terminal on short shoots; sepals and petals 4; stamens 8; carpels 4(–1) with linear stigmas; ovules 2; seeds 2 or 1; Chiricahua Mts. of SE Arizona *Apacheria*

Summary

Because of such unlikely celastraceous features as diplostemony, apocarpy, folliculate fruits, and campylotropous ovules, *Forsellesia* Greene has been transferred out of the Celastraceae, where it has resided uncomfortably for some 125 years, into the rosalean Crossosomataceae to join the related genera, *Crossosoma* and *Apacheria*. The later name *Forsellesia* of Greene (1893) is preferred over *Glossopetalon* of Gray (1853), considered a later homonym of *Glossopetalum* Schreber in L. (1789), according to Article 75 of the International Code of Botanical Nomenclature. A detailed morphological description of *Forsellesia* is synthesized and the chemical similarities of *Forsellesia* to *Crossosoma* discussed. A revised morphological description of the expanded Crossosomataceae and the enlarged distribution of the family in the western United States and Mexico are presented along with a synoptical key to the three genera.

Acknowledgments

This joint effort to transfer *Forsellesia* to the family where it belongs after 125 years of misplacement was made possible by the cooperation of

many of our associates at the Rancho Santa Ana Botanic Garden. The immediately following papers indicate the deep involvement of Larry DeBuhr and Alicia Tatsuno through their study of the anatomy and chemistry respectively of members of the Crossosomataceae. Furthermore, Larry DeBuhr presented for us (Thorne, DeBuhr, and Scogin, 1977) at the AIBS meetings in East Lansing in August 1977 our preliminary findings about *Forsellesia*. Barry Prigge, Chris Davidson, Dick Tilforth, and Walter Wisura were most helpful in the field in our efforts to obtain California material of *F. pungens* and *F. nevadensis*. Susan Meyer of the Garden, Susan Cochrane and Tom Ackerman of the Nevada Test Site Herbarium, and Wesley E. Niles, Curator of the Herbarium of the University of Nevada, Las Vegas, supplied us with valuable material of *F. pungens* and *F. nevadensis* from southern Nevada. Arthur Gibson and Charles Mason of the University of Arizona, Tucson, and Donald Pinkava and Elinor Lehto of Arizona State University, Tempe, generously supplied us with specimens of *Apacheria chiricahuensis* C. T. Mason. Art Gibson, in addition, guided the senior author and Dick Tilforth unerringly to flowering and fruiting plants of *Apacheria* in the Chiricahua Mts. of Arizona.

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