

## CROSSOSOMATACEAE: A FAMILY PRIMER

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Over a wide area of the American Southwest and extending to central Mexico occur four genera (*Crossosoma*, *Glossopetalon*, *Apacheria* and *Velascoa*) that make up the enigmatic family Crossosomataceae. All of the ten or so species are shrubs or subshrubs and occur primarily in scrub vegetation, often on limestone substrates. In the United States, members of the family range from the Channel Islands of California to Arizona, Nevada, Montana, northern Colorado, southern Oklahoma, and eastern Texas. In Mexico, the family is recorded from the states of Baja California (including Guadalupe Island), Sonora, Coahuila, Aguascalientes, and Queretaro. In California, four species of Crossosomataceae in two genera occur from near sea level to about 2450m elevation. Three genera and three species are recorded in Arizona (Mason 1992). In the wild, some of the species are of disjunct or very narrow distribution, suggesting that the present-day range of the family may be a relictual one. Their widely dispersed populations and subtle morphological traits have caused this peculiar group to remain obscure in botany and in cultivation alike.

As a family, the Crossosomataceae (from the Greek *krossoi*, fringe, and *soma*, or body, both pertaining to the aril of the seed) are characterized by their shrubby habit, with often intricately branched, spinescent branchlets; entire, alternate, simple (to tridentate) and mostly deciduous leaves; stipules minute or none; flowers solitary and axillary or terminal on short shoots, actinomorphic, bisexual or polygamo-monoecious, perigynous or hypogynous, usually with a nectary disk subtending the pistil(s); sepals (3-) 4-5 (-6), free; petals (3-) 4-5 (-6), ephemeral, free, more or less clawed, white to pinkish or purplish; stamens centripetal, (4-) 15-50, inserted on the disk or on the hypanthium, equal or subequal, anthers basifixed and dehiscent longitudinally; carpels 1-9, simple and free, with short styles and capitate, discoid or linear stigmas; fruit follicular, ventrally dehiscent, with 1 or few to many globular-reniform or obovate, brown or black arillate seeds. In proportion to the flowers and fruits, the seeds are rather large. A few specialized papers provide data for wood anatomy, biochemistry and morphology, respectively (De Buhr 1978, Tatsuno and Scogin 1978, Richardson 1970). Both Cronquist (1981) and Thorne (2001) have placed the family in the Order Rosales, whereas other authors have put it near such families as Dilleniaceae and Paeoniaceae in the Dilleniales. The floral perigyny of the family suggests affinity with Rosales, but the well-developed aril of the seed suggests the Dilleniales (Cronquist 1981). At a glance, one may observe a number of morphological characters, perhaps only reflecting convergence, shared with *Paeonia*, such as the general appearance of the numerous stamens, somewhat crumpled petals, follicular fruit with outwardly curved, 'lumpy' follicles, and proportionately large arillate seeds. Placed within either of these orders "the family must occupy an isolated position" (Cronquist 1981). Recent proposals regarding the phylogenetic placement of Crossosomataceae, based on gene sequencing work, place the family in its own order along with Stachyuraceae, Aphloiaceae, Strasburgeriaceae, Ixerbaceae and Staphyleaceae (Savolainen et al. 2000). The independent order Crossosomatales was first put forth by Takhtajan (see Takhtajan 1997), and appears to be closest to Geraniales. This current view moves the family a considerable distance from either the Dilleniales or the Rosales. The monophyly of the family and its close relationship to Stachyuraceae and Staphyleaceae in particular are well supported by the most recent rbcL gene sequence data (Sosa and Chase, in press). Periodic updates of Thorne's classification, incorporating recent molecular evidence, can be found on the web:

(<http://www.inform.umd.edu/PBIO/fam/thorneangiosp99.html>).



### KEY TO THE GENERA OF CROSSOSOMATACEAE

1. Stamens 15-50; carpels 1-9, 8-20mm long, stipitate ..... *Crossosoma*
- 1'. Stamens 4-10; carpels 1-4, 1-5mm long, sessile ..... 2
2. Hypanthium elongate, tubular; stamens 10, inserted on distal portion of hypanthium tube; nectary-disk absent ..... *Velasco*
- 2'. Hypanthium more or less cupular; stamens 4-10, inserted on rim of hypanthium; nectary-disk present ..... 3
3. Leaves opposite; flowers 4-merous; stigma decurrent on the style ..... *Apacheria*
- 3'. Leaves alternate; flowers (4-) 5 (-6)-merous; stigma terminal ..... *Glossopetalon*

**CROSSOSOMA** Described by Thomas Nuttall in 1847 and based on a collection by Gambel made on Santa Catalina Island, *Crossosoma californicum* became the first species in the genus. The only other known species, *C. bigelovii*, was published by Sereno Watson in 1876, based on specimens collected by Bigelow in Arizona. *Crossosoma* is distinguished from *Glossopetalon* by the more numerous stamens (15-50 vs. 4-10), and number of fruiting follicles (1-9 vs. 1-3), which are stipitate and 8-20mm long vs. sessile and 1-5mm long. Less diagnostically, the leaves of either species of *Crossosoma* are typically larger than those of members of the other genera.

*Crossosoma californicum* – Long known from Santa Catalina, San Clemente and Guadalupe islands, in 1977, this species was found by Jim Henrickson on the Palos Verdes Peninsula in mainland Los Angeles County (Henrickson 16341, RSA!). This elevated peninsula is physiographically part of the Channel Islands group, and is surrounded by land that lies nearly at sea level today, and has been cut off by the sea in geologically recent times. Here, the species is known from only a very few plants where potential housing development is a perpetual threat to its existence. On Santa Catalina Island, the species is locally plentiful, while on San Clemente and Guadalupe islands it is scarce. Occurrences range from dry, westerly exposures to more mesic chaparral habitats.

A bushy shrub of robust habit, *C. californicum* grows to 2m tall, and often produces long, unbranched primary branches; abbreviated axillary shoots are also typical, and may comprise most new growth in years of low rainfall. Occasional specimens are arborescent, and grow to 5m tall (Munz 1959). In winter and spring, the plant is leafy in appearance, but by summer much or all of the foliage will have turned brown; these dead leaves persist until the following rainy season. The foliage is glaucescent, and this quality gives the plant a distinctive grayish or pale appearance. Individual leaves are subsessile, mucronate, mostly oblong-elliptic, about 3-7cm long and 8-15mm wide, with inconspicuous secondary venation. By its overall size and large mesophyllous leaves (to 9cm long), *C. californicum* is the largest species in the family.

In February to May, the solitary, suberect terminal flowers appear. In structure they resemble peonies, with broad, slightly rumpled and weakly clawed white petals 12-15mm long. The numerous stamens are about as long as the 2-7(-9) conspicuous carpels. Compared to the delicate appearance of the pedicels and other flower parts, the carpels are large at anthesis and are eventually heavy enough to make the ripe fruits nod downward. Each follicle is slightly lumpy, and outwardly curved toward the apex, growing to about 2cm long and ultimately opening partially along the adaxial (inner) suture to reveal shiny black seeds about 2.5mm in diameter. The seeds are equipped with a yellowish, fringed aril. The precise role of this aril in the distribution or germination of the seeds is unknown.



At Rancho Santa Ana Botanic Garden, *C. californicum* has proved to be a durable garden subject. Plants here grow both in full sun and in shady locations, but seem happiest under partially sunny conditions. In full bloom the plants are very attractive, with pure white flowers set amidst the soft, matte foliage. One distinctive clone in the Garden exhibits white flowers that become suffused medium pink with age. With a spring blooming season of about five weeks, and sporadic flowers sometimes appearing in other months, this species deserves to be more widely cultivated. The primary drawbacks to its gaining garden acceptance are the dead persistent leaves in late summer to fall, and susceptibility to freezing. Some supplemental watering in summer helps to keep the plants evergreen. Propagation is straightforward by fresh seeds in spring, or by cuttings using softwood material in late summer through fall.

*Crossosoma bigelovii* – Of much wider distribution than *C. californicum*, *C. bigelovii* occurs mainly in the Sonoran Desert, from Baja California through southern California to Arizona and Nevada. In California, populations grow below 1250m in canyons, and on dry, rocky slopes. This species is a shrub 1-2m tall, with slightly thorny branchlets, although more lush growth may be unarmed. Excepting those produced on long new shoots formed after good rains, the 5-15mm long leaves are typically fascicled [comma]; a feature separating it from *C. californicum*. The clawed petals are 9-12mm long and white to purplish in color. In fruit, the 1-3 follicles are 8-10mm long and uncurved to only slightly curved. The seeds are approximately 2mm in diameter, and are produced 2-5 per follicle. Also attractive when in flower, *C. bigelovii* is best suited to hot, dry climates. In consideration of its rock crevice habitat preferences, the root zone should receive some protection from midday and afternoon sun. Propagation as for *C. californicum*, although preferred longer shoots may be more difficult to obtain.

**GLOSSOPETALON** A genus of about six species, ranging from California to eastern Texas, Montana and northern Mexico. This distribution encompasses the greater part of the range of the family. The plants generally occur on limestone formations between 2000 and 5500 feet elevation (Ensign, 1942). Some populations have been recorded as growing on basalt, as well (St. John, 1942). Members of *Glossopetalon* are intricately branched, often spinescent shrubs. In their floral morphology, the genus is distinguished from other Crossosomataceae by having fewer stamens (4-10 vs. 10-50), and sessile (vs. stipitate) fruiting carpels that are generally fewer (1-3 vs. 1-9) and smaller.

The generic name is the result of the reinstatement of *Glossopetalon* over *Forsellesia* by Holmgren (1988), following the use by various authors of either name throughout the literature (Thorne and Scogin 1978). The essence of the problem lies in the fact that *Glossopetalon* had been interpreted as a "homonym" of *Glossopetalum*, a genus, coincidentally enough (see below), of the Celastraceae. Furthermore, *Glossopetalum* was not legitimately published, and has been considered a synonym of *Goupia*. *Glossopetalon* and *Glossopetalum* have the same meaning, *petalum* being derived from the Latin for petal and *petalon* from the Greek; *glosso-* (from the Greek) indicates the 'tongue shape' of the petals. *Glossopetalon* was formerly included in Celastraceae or Staphyleaceae (Gray, 1853 and 1875, respectively). Thorne and Scogin (1978), upon examination of more complete material, and in comparison with the new genus *Apacheria*, realized that *Glossopetalon* was out of place in either of these families, and assigned the genus for the first time to Crossosomataceae. Munz (1974) had cited specific characteristics indicating that this genus fit rather uncomfortably in the other families, i.e., stamens sometimes unequal, ovary apocarpous with 1-3 distinct and sessile carpels, and the follicular fruit. Additionally, Thorne and Scogin (1978) cited the arillate seeds with campylotropous ovules as further characters that necessitated placing these plants in a family of their own.



In cultivation, well-grown, compact individuals of *Glossopetalon* species are attractive in full flower. They add interest to rock gardens and desert plantings, but since they have the general aspect of 'just another spiny desert shrub,' they are likely to remain in the background of horticulture. Even in the most likely botanical gardens, their appearance is only very occasional. Propagation is by fresh seed or softwood cuttings in late spring and summer.

*Glossopetalon pungens* – This species is perhaps the rarest member of the family. Known only from a few populations occurring on limestone in the Clark Mountains in California, and in the Sheep and Spring mountains in Nevada at 1700-2000m, *G. pungens* grows amidst other interesting 'desert island' confinees[period] In the Clark Mountains these include *Heuchera rubescens* var. *pachypoda* [var. *alpicola* in Jepson Manual], *Monardella linoides* ssp. *linoides*, *Phacelia perityloides* var. *jaegeri*, *Acer glabrum* var. *diffusum*, *Fraxinus anomala*, and others. The plant itself is intriguing as well with its mat-like habit and low, spreading branches sprouting from fissures on shaded, nearly vertical north-facing walls. In the vicinity one may also find *Glossopetalon spinescens* and at least one individual was seen here by the author and Bart O'Brien that was of 'intermediate' habit and leaf color, indicating that these two species may hybridize on occasion.

The overall height of *G. pungens* is typically only a few centimeters, more rarely to 20cm tall, and up to 100cm wide. Plants observed in 1998 in the Clark Mountains appeared to spread by shoots growing through thin humus deposits in cracks in the rocks. The outer branchlets of these plants were sometimes pendent, and usually held close to the nearly vertical substrate. The oblanceolate to elliptic leaves are 6-10mm long and rather stiff, with pungent tips, and bluish or grayish in color. Plane on the upper surface, the leaves bear several distinctively raised major veins on the lower surface. The flowers are similar to those of *G. spinescens*, with well-separated, delicate white petals.

*Glossopetalon spinescens* – A widespread and variable species, *G. spinescens* occurs throughout most of the range for the family. It is the only other species of *Glossopetalon* occurring in California. St. John (1942), under *G. stipuliferum*, notes that this species is "One of the most common shrubs of the Grand Canyon of the Snake [River]." Several varieties have been proposed, but the variability of the plants over a very broad geographical area makes the recognition of subspecific taxa difficult (Shevock in Hickman 1993).

*Glossopetalon spinescens* is a bushy, spinescent shrub growing to almost 2m tall, though individuals are commonly much smaller in stature. The 5-17mm long leaves are oblong to obovate, with acute tips and inconspicuous major veins on the lower surface. This leaf vein character and absence of spinose leaf tips, as well as the presence of minute, bristle-like stipules, serve to distinguish *G. spinescens* vegetatively from *G. pungens*. Further separating these two species are the axillary (vs. terminal) flowers, rounded (vs. spine-tipped) sepals and larger fruits (3-5.5mm long vs. less than 1mm long) of *G. spinescens*.

*Glossopetalon* – other species – Under the genus *Forsellesia*, Ensign (1942) treated a total of eight species, including *G. pungens* and *G. spinescens*. Three of these eight species were published as new (*F. clokeyi*, *F. planitierum* and *F. texensis*- see below), and several forms and varieties were also described as novelties in this paper. With remarkable speed, St. John (1942) recombined all of Ensign's names under *Glossopetalon*. The remaining names treated as valid species by Ensign are *G. meionandra*, *G. nevadensis* and *G. stipulifera*, all three of which Holmgren (1988) treated as varieties under *G. spinescens*.

In her studies, Ensign found that characters such as vestiture, the nature of the stipules, and leaf size and shape were more reliable traits than stamen and petal count, which had previously been assigned critical importance. In spite of the various nomenclatural changes since its appearance



more than half a century ago, Ensign's revision remains the only modern treatment of *Glossopetalon*.

*Glossopetalon clokeyi* – A finely branched low shrub to 20cm tall, with leaves only 5-6mm long and 1-1.5mm wide. It grows at over 2500m elevation in Clark Co., Nevada. *Glossopetalon planitierum* grows in the Panhandle region of Oklahoma and Texas, and is a spinescent shrub with leaves 6-12mm long and 2.5-4mm wide. In central Texas grows *G. texensis*, with rather large leaves 1-2cm long and 3-5mm wide, and with the margins and veins thickened.

**APACHERIA** Described in 1975, this monospecific genus was first recorded from the botanically rich Chiricahua Mountains of southeastern Arizona (Mason, 1975). In these mountains, it appears to be restricted to the Chiricahua National Monument, where it grows on bare north- and south-facing rhyolitic outcrops at about 1900m elevation. This species had apparently not been collected prior to the early 1970s, even though these mountains have for many years attracted the interest of botanists. In 1981, *Apacheria* was collected in Socorro County, New Mexico in the San Mateo Mountains, also on rhyolite, and at a similar elevation (R. Fletcher and P. Knight 5837, RSA!).

This species has some characters in common with *Crossosoma bigelovii*, such as glabrous, highly branched stems, and a tendency to grow in rock crevices (Mason, 1975). The 'gestalt' of *A. chiricahuensis* suggests *Glossopetalon pungens* (R. Thorne, pers. comm.). *Apacheria* is perhaps most closely allied to *Glossopetalon*, though in the original description, no comparison was made with the latter genus. This oversight probably owes mainly to the fact that at that time *Glossopetalon* had not been assigned to Crossosomataceae. *Apacheria* is distinguished by having opposite leaves and 4-merous flowers; it is otherwise similar in most aspects to species of *Glossopetalon*. Occasionally, the flowers of *Glossopetalon* may be 4-merous, as well.

The solitary flowers of *Apacheria chiricahuensis* are borne at the ends of short shoots, with the stamens and petals inserted on the rim of the cup. Mason (1975) describes the aril of *Apacheria* as entire to fimbriolate vs. fimbriolate in *Crossosoma*; the seeds and pollen of both species are similar overall. This spinose shrub grows to about 50cm tall, and has leaves that are entire to weakly trilobed. Besides those published in Mason (1975), original illustrations (anonymous) of the plant can be found in *Crossosoma* 3(4):12 [November, 1977]. With its small flowers (petals 4-5mm long) and rather coarse appearance, *Apacheria* could be placed in the same horticultural category as *Glossopetalon*, i.e., of interest mainly to botanical gardens and collectors of arcane plants.

**VELASCOA** The most recently discovered taxon to be assigned to the family, *Velascoa recondita* is also the southernmost representative of the group (Calderon de Rzedowski and Rzedowski, 1997). The type locality lies in the extreme northeastern portion of the state of Queretaro in central Mexico, near the boundary with San Luis Potosí. *Velascoa* is the only genus that reaches central Mexico pine-oak forests and it is not found in northern xerophytic habitats like the rest of the Crossosomataceae. This taxon is at once distinct from others in the family by its funnellform hypanthium bearing nearly sessile anthers toward the apex of the hypanthium tube. The absence of a nectary disk around the pistils is a further unique character in the family. A peculiar vegetative feature is the presence of minute cylindrical projections on the newer stems; these are arranged in four longitudinal rows and are at first hyaline, becoming blackish with age. In common with some other members of the family, this species is restricted to only a small area in nature, where it grows in secluded rocky places at about 2500m elevation.



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