Purshia DC. ex Poir.

bitterbrush and cliffrose

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Growth habit, occurrence, and use. The bitterbrush genus—*Purshia*—as presently circumscribed comprises 8 species of decumbent to arborescent shrubs of interior western North America. Three are common in the United States (table 1). The type species—antelope bitterbrush—has an essentially northern distribution, whereas cliffrose has an essentially southern distribution, and desert bitterbrush occurs in parts of the geographic area where the other 2 species have overlapping distributions. Cliffrose, along with the 5 Mexican species of the genus, has been traditionally referred to the genus *Cowania* D. Don. Cliffrose regularly forms hybrids with antelope bitterbrush, and desert bitterbrush could be interpreted as a stabilized hybrid between these species (Stutz and Thomas 1964). In fact, molecular genetics work by Jabbes (2000) indicates that *Purshia* was derived from *Cowania.* We follow Welsh and others (1987) in treating the group as congeneric under the name *Purshia.*

Members of the genus are erect, spreading or decumbent, freely branched shrubs up to 6 m in height. They have small, alternate, simple, apically lobed leaves that may be evergreen (cliffrose) to winter deciduous (antelope bitterbrush). Layering forms of bitterbrush (principally antelope bitterbrush) may resprout after fire, but erect forms are usually not fire tolerant. Because of their interesting habits, attractive foliage, and showy flowers, bitterbrush species have potential as ornamentals in low-maintenance landscapes.

Bitterbrush species are hardy and drought tolerant. Antelope bitterbrush occurs mainly on well-drained soils over a wide elevational range and is often a principal component of mixed shrub, pinyon–juniper, ponderosa pine, and sometimes lodgepole pine communities, where it is notable as a nurse plant for conifer seedlings (Geier-Hayes 1987; McArthur and others 1983; Nord 1965; Tew 1983). It is valued as a high-protein browse for domestic and wild ungulates, being especially important on winter ranges (Bishop and others 2001; Scholten 1983). It also supplies high-quality forage during spring and summer months (Austin and Urness 1983; Ngugi and others 1992). Cliffrose grows primarily on rocky sites in blackbrush–joshua tree woodland, sagebrush–grassland, piñyon–juniper woodland, mountain brush, and ponderosa pine communities, sometimes forming extensive stands on south-facing ridge slopes (McArthur and others 1983). It is also an important browse species, especially for mule deer (*Odocoileus hemionus*) (Plummer and others 1968). Desert bitterbrush is a component of blackbrush, chaparral, and piñyon–juniper communities.

The bitterbrush species form actinorhizal root nodules that fix nitrogen when soil water is adequate (Bond 1976; Kyle and Righetti 1996; Nelson 1983; Righetti and others 1983). They readily function as pioneer species that colonize harsh, steep disturbances and have been used extensively in revegetation and disturbed-land reclamation. An ethanol extract of antelope bitterbrush aerial stems was found to inhibit reverse transcriptase of HIV-1 and to contain the cyanoglucosides pushianin and menisdaurin (Nakanishi and others 1994). Unfortunately, the cyanoglucosides lacked the inhibitory activity of the original extract. Cliffrose has also been examined for beneficial secondary products (Hideyuki and others 1995; Ito and others 1999). Specific populations of antelope bitterbrush with distinctive attributes are recognized and are commercially harvested and sold, although to date only two ('Lassen' and 'Maybell') have been formally named (Davis and others 2002; Shaw and Monsen 1995).

Flowering and fruiting. Most of the medium to large, perfect, cream to sulfur yellow flowers of this genus appear during the first flush of flowering in April, May, or June, depending on elevation. In areas where they co-occur, antelope bitterbrush usually flowers 2 to 3 weeks before cliffrose. The flowers are borne on lateral spurs of the previous year's wood (Shaw and Monsen 1983). In cliffrose, summer rains may induce later flowering on current-year leaders, but these flowers rarely set good seeds (Alexander and others 1974). The flowers have a sweet fragrance and are primarily insect-pollinated. Each has 5 sepals, 5 separate petals, numerous stamens, and 1 to 10 pistils borne within a hypanthium. Flowers of antelope and desert bitterbrushes usually contain a single pistil with a relatively short, nonplumose style, whereas those of cliffrose contain multiple pistils. The pistils develop into single-seeded achenes with papery pericarps. In cliffrose the achenes are tipped with persistent 22- to 50-mm-long (1- to 2-in-long) plumose styles that give the plants a feathery appearance in fruit.

The main fruit crop ripens from June through August, depending on species and elevation. Plants begin to bear seeds as early as 5 years of age. At least some fruits are produced in most years, and abundant seedcrops are produced on average every 2 to 3 years (Alexander and others 1974; Deitschman and others 1974). Cliffrose seeds (figure 1) are apparently dispersed principally by wind (Alexander and others 1974). Scatter-hoarding rodents such as chipmunks (*Tamias* spp.), disperse bitterbrush seeds (figure 2) and seedlings from rodent caches appear to account for nearly all (99%) natural recruitment as survivors from seedling clumps containing 2 to >100 individuals (Evans and others 1983; Vander Wall 1994).

Seed collection, cleaning, and storage. Bitterbrush plants produce more leader growth in favorable water years, and leader length is an indicator of the potential for seed production the following year (McCarty and Price 1942; Young and Young 1986). Fruits may be hand-stripped or beaten into hoppers or other containers when fully ripe; harvesters should take care to protect themselves from the fiberglass-like style hairs in the case of cliffrose. The window of opportunity is quite narrow, as ripe fruits are easily detached by wind and do not persist long on the plant, making close monitoring during ripening advisable. Plants in draws and other areas protected from wind may retain seed longer. Maturation dates for antelope bitterbrush have been predicted with reasonable accuracy using elevational and latitudinal predictors (Nord 1965). Well-timed harvests of antelope bitterbrush average 168 to 224 kg/ha (150 to 200 lb/acre) but may range up to 560 kg/ha (500 lb/acre) (Nord 1965). Fill percentages are usually high, although insects or drought stress during filling can damage the crop (Shaw and Monsen 1983). Krannitz (1997a) reported the variation in seed weight from 240 bitterbrush plants representing 10 sites in the southern Okanagan valley of Canada varied from 5 to 46 mg/seed with the population being skewed toward the small seeds. The representative weights given in table 2 are of cleaned seed (the smaller fraction is removed in cleaning). Krannitz also found that larger seeds had greater concentrations of nitrogen than smaller seeds and that shrubs that had been browsed most intensively the winter before seed-set had seeds with greater concentrations of magnesium (Krannitz 1997b).

A seed cleaner or barley de-bearder may be used to break the styles from cliffrose achenes and to remove the papery pericarps of bitterbrush species. The achenes (cliffrose) or seeds (bitterbrush species) may be separated from the inert material—which usually comprises from one-third (antelope bitterbrush) to two-thirds (cliffrose) of the total weight—using a fanning mill (Alexander and others 1974; Giunta and others 1978). In cliffrose, the achene is considered the seed unit, as the seed is held tightly within the pericarp and cannot be threshed out without damage. In bitterbrush species, the seeds are easily threshed free of their papery pericarps, and the seed unit is the seed itself. If properly dried (<10% moisture content), seeds of bitterbrush species can be warehouse-stored for 5 to 7 years (Belcher 1985) or even up to 15 years without losing viability (Stevens and others 1981).

Germination and seed testing. Bitterbrush and cliffrose seeds are mostly dormant but the inhibiting mechanism(s) is not understood (Booth 1999; Booth and Sowa 2001; Dreyer and Trousdale 1978; Meyer 1989; Meyer and Monsen 1989; Young and Evans 1976, 1981). Moist chilling is preferred for breaking dormancy (table 3). Although some collections are less dormant than others are—as indicated by germination percentages for untreated or partially treated seeds (table 3) (Booth 1999; Meyer and Monsen 1989)—there is no obvious relationship between collection site and chilling requirement (Meyer and Monsen 1989). Dormancy might be affected by high seed temperature (30 EC) while in the dry state (Meyer 1989) and is certainly affected by imbibition temperature (Booth 1999; Meyer 1989).

Young and Evans (1981) reported the required chilling period was shorter at 5 EC, than at 2 EC for all 3 species, and that adequately chilled seeds could germinate over a wide range of temperatures. A 28- to 30-day chill at 1 to 3 EC is highly recommended (AOSA 1993; Belcher1985; Booth 1999; Meyer 1989) followed by post-chill incubation at 15 EC (10/20 EC for cliffrose). Desert bitterbrush needs only 14 days of chilling (Belcher 1985). Germination of antelope bitterbrush seeds can be facilitated by a 24-hour soak in cold (2 EC) water prior to moist chilling, but soaking in warm water (>10 EC), or holding imbibed seeds at warm temperatures, decreases seedling vigor and increases pre-germination seed-weight loss (Booth 1999; Booth and Sowa 2001). Longer, colder chilling periods (28 days, 2 EC vs 14 days, 5 EC) increases seedling vigor (Booth 1999; Booth and Morgan 1993). Recommended germination-test periods are 28 days for antelope bitterbrush and cliffrose (AOSA 1993).

Soaking seeds in hydrogen peroxide (Everett and Meeuwig 1975) or a 1 to 3% solution of thiourea (Pearson 1957; Young and Evans 1981) will induce germination but these methods have not proven useful for field plantings. Booth (1999) found thiourea-treated seeds to have the lowest seedling vigor among 8 dormancy-breaking treatments and attributed the lower vigor to residual dormancy and to weight loss resulting from accelerated respiration (Booth 1999; Booth and Sowa 2001).

Tetrazolium (TZ) staining is acceptable for evaluating seed quality of bitterbrush (AOSA 1993; Weber and Weisner 1980). Meyer (2002) found no significant difference between TZ viability estimates and germination perentages after 8 weeks of chilling for either cliffrose or antelope bitterbrush. For TZ viability testing, seeds should be clipped at the cotyledon end (figure 3) and soaked in water for 6 to 24 hours. Then, the embryos can be popped-out of the cut end by gentle finger pressure and immersed in 1% TZ solution for 4 to 12 hours at room temperature before evaluation. Cliffrose must be soaked longer than bitterbrush before the embryos can be popped out.

Field seeding and nursery practice. Bitterbrush species are generally sown in fall or early winter in a mixture with other shrubs and forbs. They are used in upper sagebrush, pinyon-juniper woodlands, and mountain brush vegetation types to improve degraded wildlife habitat or re-vegetate bare roadcuts, gullies, south slopes, and other difficult sites (Alexander and others 1974). Because of the chilling requirement, spring-seeding should be avoided. Seeds may be drilled at a depth of 6 to 12 mm (¼ to ½ in) or deeper. Deeper seeding may provide some protection from rodent depredation, which can be a serious problem (Alexander and others 1974; Evans and others 1983; Vander Wall 1994). Seeding in late fall or early winter, when rodents are less active, may also alleviate this problem.

Broadcast-seeding is generally unsuccessful unless provision is made for covering the seeds. Aerial seeding is not recommended. The seedlings do not compete well with weedy annual grasses such as red brome (*Bromus rubens* L.) and cheatgrass (*B. tectorum* L.), or with heavy stands of perennial grasses. They are sensitive to frost and drought during establishment (Plummer and others 1968). Recommended (drill) seeding rates for cliffrose are 5 to 10% of the shrub mix at 8 to 10 kg/ha (7 to 9 lb/ac) (Alexander and others 1974; Plummer and others 1968) and 16 to 65 seeds/m (5 to 20 seeds/ft) for bitterbrush. The higher rates are advisable for both species when seeding in crust-forming soils. The most effective method of seeding large areas in conjunction with chaining is with a seed dribbler that drops seeds in front of the bulldozers pulling the chain.

Hand-planting into scalped sites with a tool such as a cased-hole punch planter can be very effective on a small scale (Booth 1995). The purpose of scalping is to control herbaceous competition within a half-meter (1½-ft) radius of the planting spots. Treating seeds with fungicide, planting seeds in groups, and planting with vermiculite to aid in moisture retention have all improved emergence and establishment of antelope bitterbrush (Booth 1980; Evans and others 1983; Ferguson and Basile 1967). Good emergence depends on adequate snowcover (Young and others 1993).

Bitterbrush species are readily grown as bareroot or container stock, and outplanting may succeed where direct seeding has failed (Alexander and others 1974). Care must be taken to lift or transplant stock only when the plants are hardened or dormant, as survival of actively growing plants is generally low (Landis and Simonich 1984; Shaw 1984). Plants are easier to handle and have higher survival rates if allowed to reach sufficient size before field transplanting. One-year-old bareroot stock or container seedlings 16 to 20 weeks of age are usually large enough (Alexander and others 1974; Shaw 1984). On more level terrain, a conventional tree-planter may be used (Alexander and others 1974). Transplanting should be carried out at a time and such a way as to assure that the transplants will have adequate moisture for root development for 4 to 6 weeks after planting. This may be accomplished by planting in very early spring or by watering at the time of planting. Fall-planted seedlings may require supplemental watering. Controlling competition from weedy annual or perennial grasses before planting will enhance survival and first-season growth.

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Figure 1—*Purshia mexicana,* cliffrose: achenes, H 2.

[fig. 1 from *Cowania*, p.353, 1974 edition]

Figure 2—*Purshia glandulosa,* desert bitterbrush **(top)** and *P. tridentata,* antelope bitterbrush **(bottom)**: achenes and cleaned seeds, H 2.

[fig. 2 from *Purshia*, p.686, 1974 edition]

Figure 3—*Purshia mexicana,* cliffrose: longitudinal section (left), H 10 and *P. tridentata,* antelope bitterbrush: longitudinal section (right), H 6.

[combine fig. 2 from *Cowania,* p.354, and fig. 3 from *Purshia,* p.687, 1974 edition]

Table 1—*Purshia,* bitterbrush and cliffrose: common names and geographic distributions

Scientific name & synonym	Common name	Geographic distribution
P. glandulosa Curran *P. tridentata* var. *glandulosa* (Curran) M.E. Jones	desert bitterbrush	SW Utah, S Nevada, & S California
P. mexicana (D. Don) Henrickson *Cowania mexicana* D. Don	cliffrose	S Colorado W through Utah to S California & S to New Mexico, Arizona, Sonora, & Chihuahua
P. tridentata (Pursh) DC.	antelope bitterbrush	British Columbia to W Montana, S to New Mexico, California, & N Arizona

Sources: Little (1979), Sargent (1965), Vines (1960).

Table 2—*Purshia,* bitterbrush and cliffrose: seed yield data (seeds/weight) for mechanically cleaned seeds*

	Mean		Range	
Species	/kg	/lb	/kg	/lb
P. glandulosa	50,850	26,540	45,000–90,000	20,300–40,900
P. mexicana	129,000	58,600	108,000–210,000	49,000–95,000
P. tridentata	35,000	15,750	29,000–51,000	13,400–23,200

Sources: Alexander and others (1974), Belcher (1985), Deitschman and others (1974), Meyer (2002), Meyer and others (1988).

Table 3—*Purshia,* bitterbrush and cliffrose: germination data

Species	0	2 wk	4 wk	6 wk	8 wk	10 wk	12 wk	Samples
P. glandulosa	—	—	—	93	—	—	100	1*
	10	56	81	100	65	—	32	1†
P. mexicana	6	33	83	94	100	—	—	6
	6	64	91	100	32	—	19	1†
P. tridentata	2	43	88	98	100	—	—	13
	13	60	100	100	36	—	37	1†

Sources: Deitschman and others (1974), Meyer (2002), Meyer and Monsen (1989), Young and Evans (1981).

Note: Values are expressed as percentage of initially viable seeds after moist chilling at to 2 EC for 0 to 12 weeks followed by incubation at 15 EC or 10/20 EC for 4 weeks.

* These seeds were chilled at 3 to 5 EC and germination was scored during chilling.

† Decrease in germination percentage after 6 weeks was due to seed mortality during the test.