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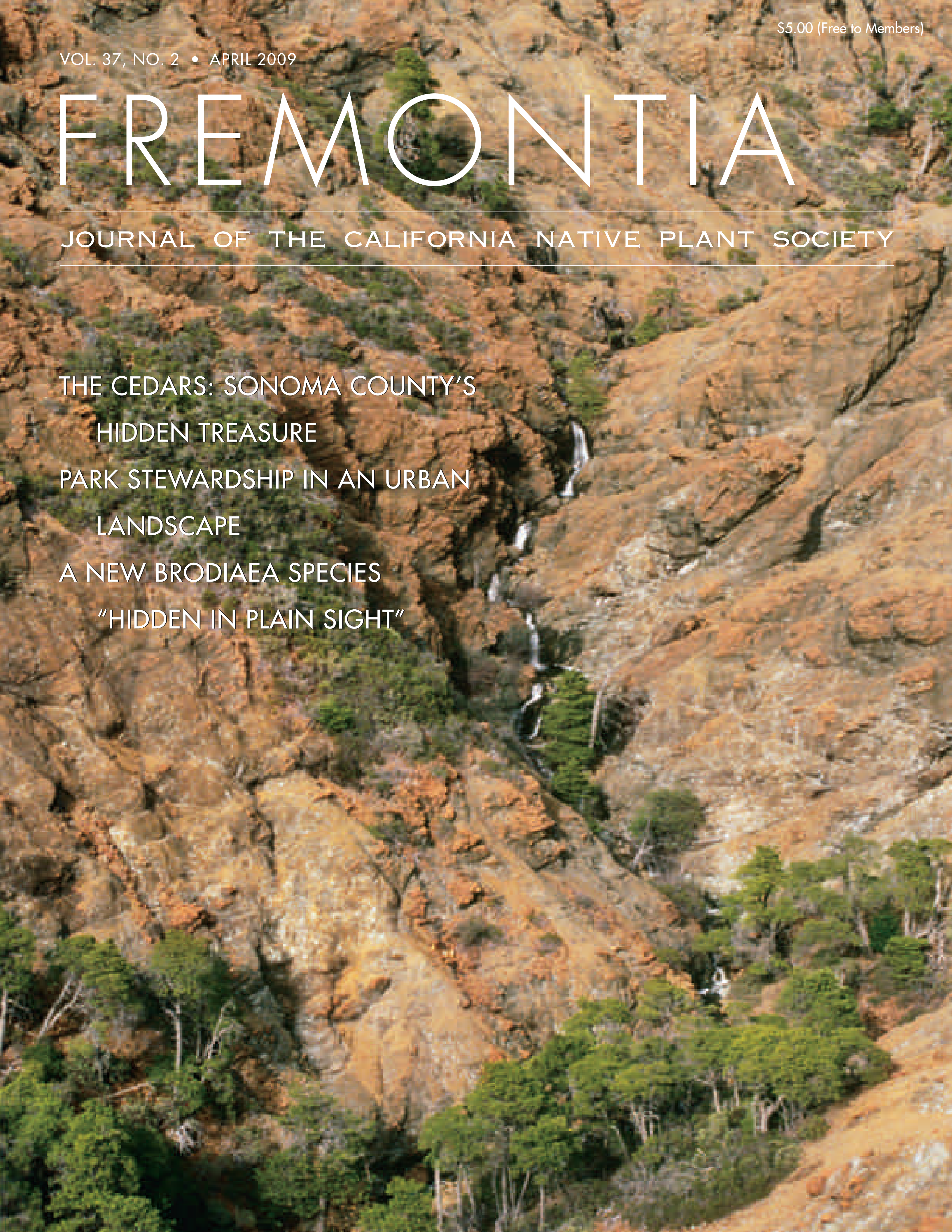

THE CEDARS: SONOMA COUNTY'S HIDDEN TREASURE

PARK STEWARDSHIP IN AN URBAN LANDSCAPE

A NEW BRODIAEA SPECIES "HIDDEN IN PLAIN SIGHT"

FREMONTIA

VOL. 37, NO. 2, APRIL 2009

CALIFORNIA NATIVE PLANT SOCIETY

Dedicated to the Preservation of the California Native Flora

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THE COVER: Falls Gorge. This steep multiple cascade series is in the upper Main Canyon on the BLM parcel. The presence of water is restricted to winter and spring months. Photograph by R. Raiche.

Looking west-northwest into the Main Canyon, a rare morning fog is retreating into the Gualala River side of the divide. Cypress trees are exceptionally effective at condensing fog into rain. All photographs by the author.

THE CEDARS: SONOMA COUNTY'S HIDDEN TREASURE

by Roger Raiche

A love of the California landscape and its plants is a common thread uniting nearly every CNPS member, and millions more. Yet each of us has one place that touches us far more vividly than all the others, a place we might return to again and again to take in the special connection we have established, much like renewing a friendship. The Cedars is the place that captured me.

This roughly 7,500-acre block of serpentine—used loosely here to refer to rocks and soil of ultramafic origin, i.e., high magnesium and iron (Coleman and Jove, 1992)—located in the northwestern section of Sonoma County is as unexpected as it is unique. Even life-long residents of the county find it hard to believe it exists. Indeed it is hard to see from any public road unless you know precisely when and where to look. Though remote and obscure, The Cedars is an area of great botanic, geologic, and scenic magnificence.

Part of the Outer North Coast Ranges, it is nine miles by air to Timber Cove on the coast. Its rounded ridges are 1,700 to 2,200 feet in elevation, thus only as high as, or even lower than, many of the surrounding ridges in that vicinity. But within this area is a complex

Mineral Falls, a 20-foot waterfall, is coated with multiple layers of calcium carbonate released from ultrabasic (pH greater than 11) springs near the top. Older gray deposits visible to the left have been dated to be 5,000 years old.

system of deeply cut canyons whose creek beds are about 1,000 feet lower than the ridgetops. These canyons feed two different river systems, the Russian River via two distinct branches of Austin Creek, and the Gualala River via the Wheatfield Fork. The two branches of Austin Creek, Big (or West) Austin Creek and East Austin Creek, have their headwaters in The Cedars but travel for over 12 miles apart before joining again two miles up from the Russian River. Cazadero, a small community, is the only nearby town. (When viewed on Google Earth, or other topographic programs, the approximate center is at 038°37'37.53"N, 123°07'21.51"W.)

It is still unclear when the name, The Cedars, was applied to this distinctive landscape. It was probably in the 1920s or 1930s when the area was mapped by the USGS. Earlier county maps labeled the area Red Slide. Today Red Slide is the specific name for the largest talus barren on the east side of The Cedars and a secondary drainage behind this barren. The Cedars' name is a botanical misnomer, as the "cedars" referred to are actually Sargent cypress (*Cupressus sargentii*). [California's cypresses are currently the subjects of differing taxonomic innovations that may result in a change in the genus name. Ed.] In popular usage, "cedar" is applied to many needle-leafed plants (including *Calocedrus*, *Juniperus*, *Thuja*, and *Tamarix*).

FIRST CONTACT

The Cedars has been an obsession since I first walked into what we now call the Main Canyon on a late July morning in 1981. In 1980, on a backroad trip to Salt Point with friends, I had spotted it from the upper section of King Ridge Road. I commented on its rockiness, its reddish coloration, and the flat-topped trees that I correctly assumed were cypress. These clues indicated serpentine, a substrate I already found fascinating. In July, as I hiked in, I had hopes of finding something interesting and unusual. Yet I was unprepared to experience a canyon so unique, beautiful, pristine, vast, and fascinating in its flora as I experienced that day. I can almost remember each footstep, each gasp of amazement as the landscape unfolded before me. There were banks dripping with huge colonies of California lady slipper orchid (*Cypripedium californicum*), bizarre mineralized formations, stunning barrens, and fascinating and rarely seen plants. I had been given permission to explore the canyon by a neighboring ranch owner, Bette Campbell, who had described it as a "moonscape." Indeed it was that, but it was much more.

Truly massive barrens and talus slopes, hued silver, tan, and red, shimmering in the summer heat were juxtaposed with ancient Sargent cypress woodlands, dark and thick with a rich understory of shrubs and herbs. This visual interplay was confounding but aesthetically exhilarating. After several hours exploring the canyon bottoms I climbed one of the knife-back ridges and saw canyon after canyon branching off into the distance. I realized this place was going to take some time to get to know, and this day's 11-hour exploration was merely a tease. I returned again and again during the next 15 years when I could get permission, not always a certain thing. I needed to explore each branch of each canyon over different months and over multiple seasons to be sure I was seeing and documenting everything. The Cedars did not disappoint me. There were undescribed species, odd disjunctions, and a number of species never collected in the county before.

Mineral Spring, also know as the Wedding Cake, is a calcium carbonate structure that routinely gets destroyed each winter yet rebuilds in almost exactly the same form each summer.

PREVIOUS BOTANICAL EXPLORATIONS

The Cedars have been visited by other botanists since at least the early 20th century, but due to its remoteness and access issues, most of the early collecting had been spotty and incomplete. The California lady slipper orchid specimen collected by A. L. Graff in 1928 from "the headwaters of Austin Creek" is certainly from The Cedars (Best et al., 1996). School teacher, orchardist, and botanical artist from nearby Guerneville, Freed W. Hoffman (Morrison, 1960), had a passion for serpentine areas and plants. He did the most extensive collecting in the 1940s and 1950s, collecting over 100 specimens from The Cedars (Jepson Online, 2008). He published two new taxa of jewelflowers (*Streptanthus*) from The Cedars—Morrison's jewelflower (*S. morrisonii*) and Dorr's Cabin jewelflower (*S. morrisonii* spp. *hirtiflorus*) (Hoffman, 1952). These were named in honor of his good friend and *Streptanthus* expert, John Morrison who lived in nearby Monte Rio. Hoffman referred to his explorations as "strep-trekking." Art Kruckeberg, the authority on California serpentines—he literally wrote the book (Kruckeberg, 1986)—visited in September 1966 to study the *Streptanthus* and later included several pictures from The Cedars in his book, which is dedicated to Freed Hoffman. Philip Wells, an authority on manzanitas (*Arctostaphylos*) visited in the 1970s and later published a new subspecies, The Cedars manzanita (*A. bakeri* ssp. *sublaevis*). Lawrence LaPre, a botanical consultant, also visited The Cedars in the 1980s to compare the jewelflowers at The Cedars with those to the east at The Geysers area on the Sonoma/Lake county line. The most common interest has been with jewelflowers and their perplexing taxonomy.

Peter Warner of Mendocino did a plant survey of the southwest corner of The Cedars in the vicinity of the Campbell Ranch (Warner, 1994). I have combined his observations and Hoffman's with mine to produce a plant list of just over 200 taxa, at all levels, of natives growing in or marginal to The Cedars and its contiguous serpentine extensions.

GEOLOGICAL EXPLORATION

The Cedars has been of considerable interest to miners and geologists. Back in the late 19th century both chromite ($FeCr2O4$) and magnesite ($MgCO3$) were discovered in the area and a number of mines exploited these deposits until after World War II. In the 1960s the area was investigated by both Ivan Barnes (USGS) and Dr. Robert Coleman (professor emeritus at Stanford University and authority on the geology of serpentines). Ivan Barnes's now famous paper on the proof of real time, low temperature, and near surface serpentinization utilized

A solitary Sargent cypress (*Cupressus sargentii*) marks the confluence of two forks of the upper section of Azalea Creek, a local name for one of the primary branches of Big Austin Creek within The Cedars.

samples from one of the calcium carbonate springs (now named in his honor) in The Cedars (Barnes et al., 1964). Serpentinization is the process where igneous ultramafic mantle rock (peridotite) is metamorphosed into secondary serpentine minerals. Calcium bicarbonate is a byproduct of this process. Rock from The Cedars was used to create PCC1, **P**eridotite **C**edars **C**azadero **1** (Fanagan, 1986), an analysis of all the minerals and their percentages in the peridotite at The Cedars. It serves as a standard to which all other peridotites are compared worldwide.

A current ongoing project by geobiology graduate researcher Orion Johnson at the University of Southern California (USC) is focused on determining the types of microbes and how they survive in the ultrabasic (pH greater than 11) waters emerging in certain spots. Low sodium, ultra-high pH springs are rare on Earth, yet provide an intriguing model of how primitive microbial life may evolve on planets.

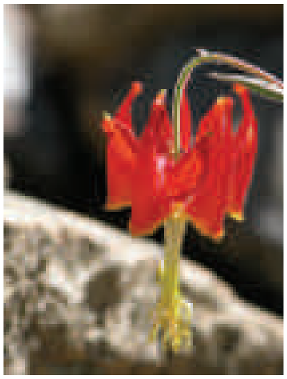
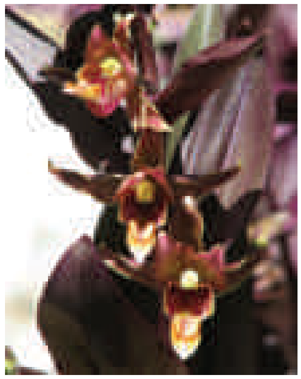
PLANTS

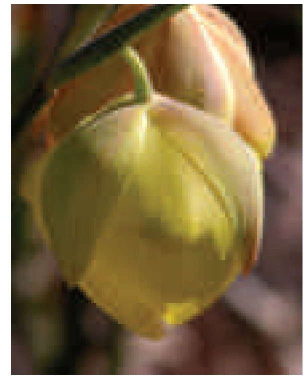
The Cedars is a classic example of a "floristic island," where many of the plants have no close relationship with those in the non-serpentine areas that surround it. The most interesting group is The Cedars' endemics, plants that only occur on The Cedars' contiguous serpentines. I currently consider eight entities to fall into this category, but one is not currently recognized botanically. This is a creambush (*Holodiscus*) that

ENDEMIC TAXA TO THE CEDARS

Common Name	CNPS Rarity*		Comments
Arctostaphylos bakeri ssp. *sublaevis*	The Cedars manzanita	1B.2	Hybridizes with *A. manzanita* on periphery of The Cedars. Type locality.
Calochortus raichei	The Cedars fairy lantern	1B.2	Strict endemic. Type locality.
Epipactis gigantea f. *rubrifolia*	Purple-leaf stream orchid	None	Strict endemic but variable leaf color. Type locality.
Erigeron serpentinus	Serpentine fleabane	1B.3	Strict endemic. Type locality.
Eriogonum cedrorum	The Cedars buckwheat	None	This recently described taxon is strictly endemic to The Cedars. Restricted to three limited areas. Type locality.
Holodiscus sp. nova	The Cedars creambush	None	This undescribed taxon is strictly endemic to The Cedars, found growing only on serpentine. Distinct from nearby *H. discolor*; characters "hold" in cultivation.
Streptanthus glandulosus ssp. *hoffmanii*	Hoffman's jewelflower	1B.3	A regional endemic, but The Cedars represents most known plants. Another subspecies of *S. glandulosus* occurs nearby with white flowers (ssp. *sonomensis*).
Strepthanthus morrisonii ssp. *hirtiflorus*	Dorr's Cabin jewelflower	1B.2	This subspecies is currently not recognized but is a good segregate. Very limited distribution. Still tracked for rarity. Strict serpentine endemic, the rarest of all the published *S. morrisonii* subtaxa. Type locality for both the species and this subspecies.

* (CNPS Online, 2008).




CLOCKWISE FROM TOP LEFT: **Closeup of serpentine columbine (*Aquilegia eximia*), a serpentine seepage endemic that flowers from June into September on four-foot-tall plants. • Purple-leaf stream orchid (*Epipactis gigantea* f. *rubrifolia*), an endemic. The burgundy foliage is already showing shades of green as is typical at flowering. • Closeup of a flower head of serpentine milkweed (*Asclepias solanoana*), a lovely prostrate-growing plant of serpentine barrens. • Closeup of endemic Cedars' fairy-lantern (*Calochortus raichei*), a late- and few-flowered bulb. Best flowering seasons depend on both early and late rains. • Unnamed Cedars' creambush (*Holodiscus* sp. nova). Both larger cane leaves and much smaller secondary branchlet leaves are shown. The combination of bright ruby-red juvenile growth, glabrous upper leaf surface, and leaf margins with teeth well below the middle is unique in California.**

has not been named, but which is the most visually distinct shrub throughout The Cedars.

The Cedars fairy-lantern (*Calochortus raichei*) is a perfect example of a strict endemic here. It occurs throughout all the interior canyons—though not everywhere—and even to the margin of serpentine rock, but never beyond. In many stretches it even avoids the margins, where it might be replaced by the widespread Diogenes' lantern (*C. amabilis*), though the two never seem to overlap. It is extremely late flowering for a low elevation species, typically blooming in early June to mid- or late July. Freed Hoffman first collected it in 1947 as the Mt. Diablo globe-lily (*Calochortus pulchellus*). At that time, the name *C. pulchellus* also included the now distinct *C. amabilis*.

I first saw the plant in flower in 1983, though I had puzzled over the large waxy-blue strap-like foliage the previous season. After several years of exhausting explorations to determine the range, collecting herbarium specimens, and comparing features of related species, I convinced *Calochortus* experts Stan Farwig and Vic Gerard that this was a completely new species. I was much honored when they named it for me in 1987, linking my name with the amazing Cedars.

The purple-leafed race of stream orchid (*Epipactis gigantea* f. *rubrifolia*) is another odd Cedars' endemic. At its most extreme, the plant emerges with almost black-purple foliage with a silvery iridescence that gradually fades to a dusky burgundy-green by flowering. The purple leaf character is variable. This is the only place in the entire extensive distribution of stream orchid where purple foliage has appeared. It probably deserves a taxonomic upgrade. 'Serpentine Night' is a very deep colored selection I made in 1982.

Serpentine fleabane (*Erigeron serpentinus*) is a low herb spreading underground to form lacy colonies with wiry stems less than eight inches tall with thread-like foliage, and sparse-looking daisies composed of 9 to 13 pale lilac ray flowers arranged imperfectly around a yellow center—thus looking odd or damaged. It prefers shady, damp, or richer soils, particularly in old cypress woodland. Small marble-sized galls on the upper stems are often mistaken as buds.

Solitary flower of serpentine fleabane (*Erigeron serpentinus*), an endemic to The Cedars. The ray petals are typically irregularly arranged.

Serpentine endemics (plants that only—or almost always—occur on serpentine, but may also exist on serpentine beyond The Cedars) form another category of plants here. Sargent cypress, Jepson musk brush (*Ceanothus jepsonii*), serpentine columbine (*Aquilegia eximia*), and bearded jewelflower (*Streptanthus barbiger*) are four good examples of this restriction. Some can also be said to be disjunct, i.e., disconnected from or beyond a plant's normal geographic range. Some are also extralimital, i.e., are at an extreme in their range. Most of these extralimital plants are at either their southern or western extremes. Some notable southern-limit entities are sticky manzanita (*Arctostaphylos viscida* ssp. *pulchella*), cotton grass (*Eriophorum criniger*), California lady slipper orchid, and showy phlox (*Phlox speciosa* ssp. *nitida*). Those significantly west of their primary range include Pringle's bird-beak (*Cordylanthus pringlei*), Brewer's willow (*Salix breweri*), green deermint (*Monardella viridis*), Venus maidenhair fern (*Adiantum capillis-veneris*), foxtail muhly (*Muhlenbergia andina*), hoary coffeeberry (*Rhamnus tomentella*), and Morrison's jewelflower. Serpentine milkweed (*Asclepias solanoana*) is at both its southern and western extremes. Only the clover *Trifolium buckwestiorum* is representative of a northern disjunction.

From a county perspective there are four plants not mentioned in *A Flora of Sonoma County* (Best et al., 1996) but which occur here.

Widespread species, which do occur in the general vicinity, often off of serpentine, also occur in The Cedars. Chamise (*Adenostoma fasciculatum*), mountain mahogany (*Cercocarpus betuloides*), wavy-leaf ceanothus (*Ceanothus foliosus*), and buckbrush (*C. cuneatus*) fit into this category.

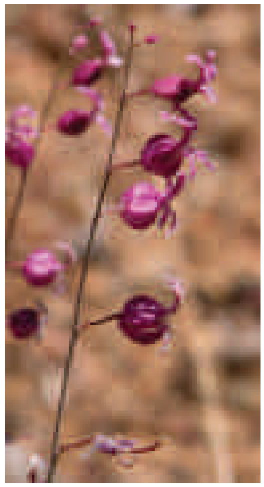
A profound dichotomy exists between the plants within The Cedars (the core species) and a different group that grows on the periphery. The contact zone—where the serpentine rock/soil meets other nonserpentine substrates, results in a mix of serpentine and nonserpentine species. Ancient landslides that slid off of the main block of serpentine have created a number of peripheral serpentine meadows and chaparrals which have plants that cannot be found inside the core area. Star brodiaea (*Brodiaea stellaris*), Sonoma jewelflower (*Streptanthus glandulosus* ssp. *sonomensis*), goldfields (*Lasthenia californica*), hog fennel (*Lomatium dasycarpum* ssp. *tomentosum*), and squirreltail (*Elymus elymoides*) are just a few examples.

Looking down Laton Gulch to the creekbed about 800' below. Laton Mine, one of the few topographic names, is near the bottom above the forest of Sargent cypress.

One plant that perfectly illustrates this inner/outer Cedars floral dichotomy is the Sonoma subspecies of bristly jewelflower, *S. glandulosus* ssp. *sonomensis* that has a white flower. Outside of the main Cedars the ssp. *sonomensis* is common in sparse serpentine grasslands, whereas the lilac-pink flowered ssp. *hoffmanii* occurs not far away on the rock and talus of the main block of The Cedars. More than a simple color difference, the two perform differently in the same season. For example, in 2007 the ssp. *hoffmanii* had a very bad flowering season, but the ssp. *sonomensis* had a spectacular flowering season. Here are two subspecies that are closely related, but which have accumulated a capacity to grow in different sites and respond to different environmental clues. This is evolution.

HABITATS

A good way to group the plants of The Cedars is to consider what habitat(s) they grow in. Natural habitats tend to blur one into another, so delineations are not absolute. However there are several primary habitats that repeat throughout this area.



Hoffman's jewelflower (*Streptanthus glandulosus* ssp. *hoffmanii*) is found on rocky areas throughout The Cedars, though populations vary enormously from year to year from nearly nonexistent to colorful displays of thousands.

Sargent cypress woodland is the most extensive habitat of The Cedars. It covers at least several thousand acres, and is often characterized by dense stands of small trees growing closely together. The cypress also occurs as tiny, dwarfed, bonsai-like specimens at the edge of barrens or as individuals peppered through chaparral. Primarily it forms a woodland with other trees, shrubs, and herbs. In richer sites, the cypress trees can be quite old and huge, and are often mixed with Douglas fir (*Pseudotsuga menziesii*), bay laurel (*Umbellularia californica*), and leather oak (*Quercus durata*). In the richest zones, canyon oak (*Q. chrysolepis*), tanoak (*Lithocarpus densiflora*) and madrone (*Arbutus menziesii*) may be present in limited numbers. These lush zones occur most commonly along the riparian corridors or on shady north-facing slopes or protected gullies. They are the most park-like of the habitats, and are especially inviting to humans. Typically, a surprisingly rich soil has developed due to hundreds of years of humus accumulation and a lack of catastrophic fires, though ground fires may have occurred. Understory shrubs are rare in the older woodlands, but The Cedars creambush is almost always present. This is the only habitat where poison-oak (*Toxicodendron diversilobum*) occurs, though infrequently and dwarfed. The understory herbaceous layer is perhaps the most interesting feature and is a complex mix of sedges, grasses, bulbs, annuals, biennials, and perennials growing tightly together, though often utilizing different seasons of growth. Over two dozen plants can be found together in many sites as part of this forb layer. Nearly omnipresent in all canyons are the following plants that are listed in sequence of bloom: toothwort (*Cardamine californica* var. *sinuata*), woodrush (*Luzula comosa*), Indian warrior (*Pedicularis densiflora*), star zigadene (*Zigadenus fremontii*), short-stem sedge (*Carex brevicaulis*), bedstraw (*Galium californicum*), long-tube iris (*Iris macrosiphon*), milkwort (*Polygala californica*), morning glory (*Calystegia* sp.; this plant has affinities to both *C. subacaulis* and *C. collina* ssp. *oxyphylla*), Torrey's melic grass (*Melica torreyana*), Indian pink (*Silene californica*), narrow-petal piperia (*Piperia leptopetala*), The Cedars fairy lantern, and green deermint.

Where the cypresses are more scattered, two manzanitas are common along with the leather oak. Sticky manzanita and The Cedars manzanita may be as abundant as the cypress. Given enough time, the manzanitas die out and the area transitions to cypress woodland.

Serpentine chaparral is also common, both with and without Sargent cypress. It is frequently dominated by the two manzanitas mentioned above with leather oak as a shrub. Jepson's musk brush and buckbrush are frequent constituents, as is toyon (*Heteromeles arbutifolia*). On mesic or north-facing chaparrals, red berry (*Rhamnus illicifolia*), bush monkey flower (*Mimulus aurantiacus*) and Cedars' creambush are prevalent. Several distinct chaparral variants occur. One has many compact forms of coast silktassel (*Garrya elliptica*); another an understory of serpentine reedgrass (*Calamagrostis ophitidis*); yet another only sticky manzanita. Understory elements are identical but fewer than in cypress woodlands

ADDITIONS TO THE FLORA OF SONOMA COUNTY FROM THE CEDARS

Not in *A Flora of Sonoma County*	Common Name	Habitat and Abundance
Adiantum capillus-veneris	Venus maidenhair fern	Carbonate seepages, rare.
Eriophorum criniger	Cotton grass	Seepages, common.
Moehringia latifolia	Wide-leaf moehringia	Mesic woodlands, uncommon.
Muhlenbergia andina	Foxtail muhly	Seepages, uncommon.

This cliffside grotto formed by calcium carbonate deposits provides an ideal site for many serpentine columbines (*Aquilegia eximia*).

A new species of wild buckwheat (*Eriogonum cedrorum*) is located in only a few sites within The Cedars, especially considering the vast amount of rock and talus available. Its botanical affinities are with ternate buckwheat (*E. ternatum*) of the Klamath Range and Snow Mountain buckwheat (*E. nervulosum*) of the Inner North Coast Range.

and vary considerably. Diversity decreases toward the ridgetops.

Vast serpentine barrens, talus, and acres of bare rock are another primary habitat within The Cedars. Visually quite impressive, they account for the moonscape description so frequently employed by visitors. A group of scientists working with NASA who visited The Cedars found some barrens to be quite reminiscent of pictures received from Mars!

The barrens are the most extreme habitat at The Cedars, yet they are not without plants. The biennial Morrison's jewelflower might be found alone in the most extreme sites, but bearded jewelflower can also occur by the thousands in late winter/spring. Serpentine phacelia (*Phacelia corymbosa*) is the most frequent perennial plant here. Two other perennials only occur on some sites. One is a new species of buckwheat (*Eriogonum*), and the other is serpentine milkweed, a startlingly gorgeous plant in flower. The Cedars creambush is the only large shrub that tolerates this habitat, where it is mostly restricted to deep talus slopes. Other annual, perennial, and bulb (or corm) constituents of this hostile habitat may occur by the tens of thousands, yet are visually overwhelmed by the amount of rock or talus except when these plants are in peak flower and they may create a mist of color.

Perennial water habitats can be subdivided in various ways, but floristically there are essentially two types, creekside and seepage. In some areas the creeks pass through old Sargent cypress woodlands that form an upper level riparian corridor. But, due to the enormous quan-

Red Slide, the tallest serpentine barren, is located on the southeast side of The Cedars. This barren is one of the few obvious land features visible from miles away.

tity of water that flows through the creeks in winter (Cazadero averages over 65 inches of rainfall per year, often in huge storms of five inches or more), there are only four shrubs that tolerate the fluctuating water levels and the powerful scouring action of the peak flows. They are Brewer's willow, Western azalea (*Rhododendron occidentale*), hoary coffeeberry, and Western spicebush (*Calycanthus occidentalis*) in decreasing order of frequency. In the East Austin Creek headwaters there is a long riparian stretch that also has common riparian trees such as white alder (*Alnus rhombifolia*), ash (*Fraxinus latifolia*), madrone, and canyon

Sargent's cypress (*Cupressus sargentii*) in the Azalea Creek drainage, part of the BLM lands.

oak that line the margins, but the first two do not occur at all within the serpentine canyon of Big Austin Creek.

The primary creeks also produce two distinct secondary habitats. One is alluvial gravel bars composed of gravel, rock, and boulders. For many decades these are very sterile and have a flora paralleling the barrens, but over time shrubs and cypresses will move in. The other unusual habitat is the large stretches of mortarbed, where the creek bottom is a solid pavement of cemented sand, gravel, cobbles, and rocks, which are far more resistant to erosion than the highly fractured bedrock. These are formed from the calcium carbonate-rich waters that ooze up through the alluvium during the drier summer months to harden as cement. Brewer's willow is the only plant capable of seeding into these pavements and surviving the winter scouring.

Seepages, the other perennial water habitat, are common on the creekbed margins but also can be perched high on cliff faces. Some are formed from the ambient waters that flow from fractures and have a normal pH range of 7 to 9. The more specialized seepages with calcium carbonate-saturated water have a pH from 9 to 12+; these have the most specialized plants. These sites represent yet another extreme anomaly. Surrounded by thousands of acres of calcium-deficient serpentine here is a habitat with an overabundance of calcium. Most commonly restricted to these seepages are Venus maidenhair fern, with only six sites noted so far, and California lady's slipper orchid. The lady's slipper orchid has about four dozen populations; several are quite old with over 100 flowering stems per colony. Their size and numbers have increased slowly over the last 27 years.

Other seepage-identified plants can occur in either type of seepage and include the four creekside shrubs mentioned above. These may be accompanied by the following common associates: serpentine columbine, Mendocino sedge (*Carex mendocinensis*), foxtail muhly, grass-of-Parnassus (*Parnassia californica*), purple-leafed stream orchid, and cotton grass. Closer to the mouth of the canyons are five-finger maidenhair (*Adiantum aleuticum*), white wool hedge-nettle (*Stachys albens*), blue-eyed grass (*Sisyrinchium bellum*), and leopard lily (*Lilium pardalinum*). As with water, the number of species decreases as one moves upstream.

CONSERVATION

The core serpentine area is currently owned by about two dozen landowners, and most are large holdings. Over 1,500 acres in the center is a land-locked Bureau of Land Management (BLM) parcel that cannot be accessed by the public. In 2006, BLM designated this as an Area of Critical Environmental Concern (ACEC), which is the strongest protection that BLM can offer its lands.

David McCrory and I bought a 520-acre parcel in 1999 after failing to interest conservation groups in acquiring the site. We removed a century of trash and constructed a simple trail to access various features and remote areas. I have been advocating for a Cedars' preserve since 1983, hosting dozens of field trips and lecturing on the values inherent in this special place. This was long before owning any of it, but ownership has facilitated this outreach.

In 2006, The Sonoma Land Trust (SLT) convened a series of planning meetings and field trips, bringing together a spectrum of agencies and botanical authorities to produce—with a grant from the Coastal Conservancy—a Conservation Plan for The Cedars (SLT, 2008) and surrounding areas. This document aims to guide future conservation efforts in this region. These conservation efforts would further the goals and objectives of over 11 federal, state, regional, and local plans (SLT, 2008). The core serpentine zone is envisioned primarily for conservation, education, and to promote scientific investigation. As a first step, a 40-acre parcel was acquired by the Sonoma Land Trust at the entrance to the primary canyon.

The Cedars is an other-worldly landscape that most visitors find astonishing and visually compelling. It is raw and wild, a Western landscape where rocks and plants are positioned in an exhilarating dynamic tension, much like the high arid mountains. The deep canyons, stark terrain, picturesque trees, welcoming pools, waterfalls, and remarkable calcium formations make the surrounding Sonoma County seem quite distant. It is a treasure for the county, the state, and the world.

Dr. Susan Harrison of the UC Davis Natural Reserve System, who has used The Cedars in various studies of serpentine plant diversity, concurs. "I cannot think of any other site I would consider more essential to conserve in its present pristine state for the sake of its outstanding contribution to California's flora."

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Mature trees, including coast live oak (*Quercus agrifolia*), western sycamore (*Platanus racemosa*), and California black walnut (*Juglans californica*), provide structure in the South Pasadena Nature Park. A retention basin, on the right side and foreground of the picture, collects urban runoff, allowing it to infiltrate the soil rather than flowing directly into the Arroyo Seco. All photographs by the author.

NATIVE BY DESIGN: COMMUNITY INVOLVEMENT IN THE CREATION AND STEWARDSHIP OF A NATURE PARK

by Barbara Eisenstein

On the morning of the second Saturday of the month I load up my car with garden tools and head to our city's newest park, the Arroyo Seco Woodland and Wildlife Park, more commonly known as the nature park. On good days there are as many as a dozen of us, on most days there are about four. Happy to be there, we put on gloves and start pulling weeds, picking up litter, and inspecting the area. We have been doing this for the past three years.

HISTORY

The history of the park begins in the late 1990s. Word got around that the city of South Pasadena was planning to sell for development a small piece of land next to the Arroyo Seco. A group of interested citizens mobilized to convince the city to convert the property into much needed parkland. Through their hard work and tenacity, the area was preserved, continuing a regional trend to maintain green space along the Arroyo Seco.

Volunteers put in countless hours attending meetings, making phone calls, and writing letters to prevent the sale of the property and to raise money to convert it into a park. A letter writing campaign directed at the office of then-Senator Adam Schiff resulted in an appropriation of $250,000 for the nature park. Concurrently, the city council, yielding to public sentiment, approved the concept of a nature park. The money was allocated to the Santa Monica Mountains Conservancy (SMMC) for park improvements. The Conservancy granted the funds to the Mountains and Recreation Conservation Authority (MRCA) to implement the project. In accepting the grant, the city agreed to assume the costs for ongoing maintenance and to preserve the area as passive open space in perpetuity.

MRCA worked with a volunteer citizen's task force to design the park, continuing the public involvement that has been a trademark of the park. Discussions with MRCA over a period of more than a year resulted in a landscape plan that reflected the community's desire to make this a place amenable to both people and animals.

MRCA graded the park, removed weeds, and added some new native plants. They created an entryway, signage, and a gathering area using attractive river rocks. They also built a water retention basin to prevent urban runoff from the street above from flowing into the Arroyo Seco flood control channel. A trail runs through the park, connecting it with parkland along the Arroyo to the north in Pasadena, and to the south in Los Angeles. In October of 2004 the efforts of many were rewarded with the official opening of the park. But this only marked the beginning of what can be described as a story of perseverance and optimism.

STEWARDSHIP

The three-and-a-half-acre property is adjacent to a concrete flood control channel of what was once a magnificent tributary to the Los Angeles River. Beyond the channel lies another corridor, the 110 Freeway, also known as the Arroyo Seco Parkway. The disturbed and weedy land was primarily used as an encampment for the homeless, though walkers, joggers, and equestrians traversed the land on the existing trails. Throughout much of Southern California, places like this are the only areas available for hiking, walking, bird watching, and generally interacting with nature.

Some see these forgotten areas as wasteland that can only be improved through commercial development. Others have a different vision. They see places within a vast urban area that can be shared by birds, coyotes, butterflies, lizards, and people. And in moments of extreme hopefulness and optimism, they see a time when the adjacent concrete flood control channel will be removed and our waterway can once again regain some of its earlier beauty and grandeur. When I go to the park, I am reminded how fragile this vision is. Without continued attention, the small park is in constant danger of reverting to its previous condition. Unless the public engages with the park, the homeless will return, graffiti will spread, and the weeds will take over.

FRIENDS OF THE NATURE PARK

For several years the city's Natural Resources Commission (NRC) sponsored cleanup and educational events in the nature park on Earth Day. As an NRC commissioner, I discussed with others the need for additional ongoing park stewardship. With help and support from members of the city council and the Natural Resources and Park Commissions, the public was invited to a special meeting to discuss ongoing park maintenance. A short article in the local newspaper informed the community of the meeting. It was attended by approximately 35 people including educators and students from the high school's environmental club, individuals who had been active in saving and improving the park, government representatives, and interested citizens. We agreed that I would oversee community stewardship activities.

In March of 2006, Friends of the Nature Park was created through the Department of Public Works (DPW) Adopt-A-Park program. As group leader it was my responsibility to notify the DPW of all upcoming cleanup events. Each year I signed an agreement form and sub-

The entry way is constructed of attractive river rock and welcomes visitors to the nature park.

mitted an annual schedule of cleanup sessions. Park stewards were asked to sign participation agreements that I delivered to the city.

Two years after the start of Friends of the Nature Park, I was considering discontinuing the program due to limited community participation. A city council member and devoted park steward suggested that we end our official Adopt-A-Park status so that we would not have to commit to dates a year in advance. We simply agreed to meet on the second Saturday of the month. July, August, November and December are excluded, the summer months being too hot and the winter months too busy. In an effort to further engage the community I also created a blog (www.nativeby design.blogspot.com) on which I announce upcoming workdays, and afterwards I report on what we found and did. For the past year I have continued to act as *de facto* group leader, though I no longer have any official city designation.

SATURDAY MORNING CLEANUPS

Each month the public is informed of cleanup events through newspaper and email announcements. An email list of approximately 100 addresses has grown from the attendees of the initial organizational meeting to include anyone who expresses interest. A small cadre meets monthly in the park. The number is sometimes as high as 40, when scouts, classes, and environmental clubs participate. There have also been times when I have found myself working alone. The group, though, is usually small, numbering less than ten.

Volunteers come equipped with garden gloves, garbage bags, shovels, and rakes. As group leader, I bring extra equipment, supplies, and bottled water. We remove litter and

TOP TO BOTTOM: **Jimson weed (*Datura wrightii*) is one of the few nonweedy perennials to naturalize in the park. Its showy flowers provide welcome color in open, sandy areas. • California buckwheat (*Eriogonum fasciculatum*) planted during park renovation has thrived and is reseeding itself. The white flowers that are followed by rich rusty maroon seedheads soften the urban scene across the Arroyo Seco. • Coyote brush (*Baccharis pilularis*), deer grass (*Muhlenbergia rigens*), western sycamore (*Platanus racemosa*), and a volunteer black willow (*Salix gooddingii*) provide habitat, shade, and refreshing green vegetation in this previously hot and dry area.**

weeds, and take note of larger problems for the city to address. We walk the trails looking for interesting wildlife. Although litter degrades the park making it ugly and unpleasant, it is the return of the invasive weeds that is of greatest concern. We have approached this problem with help from the city. Following the initial weed removal, the city continues to control weeds using chemical and physical methods. Our monthly visits allow us to notice and easily pull unwanted seedlings before they can flower and reseed. Currently we are targeting castor bean (*Ricinus communis*) and milk thistle (*Silybum marianum*). We will need to be vigilant for many years since there is an abundance of weed seeds in the soil.

But not all is bad. Walking through the park, we marvel at the local native trees. Huge old western sycamores (*Platanus racemosa*) and coast live oaks (*Quercus agrifolia*) shade much of the park. Inconspicuous flowers of the California black walnut (*Juglans californica*) develop into large, ornamental walnuts. Holly-leaved cherry (*Prunus ilicifolia*), mulefat (*Baccharis salicifolia*), manroot (*Marah macrocarpus*), virgin's bower (*Clematis ligusticifolia*), golden currant (*Ribes aureum* var. *gracillimum*), datura (*Datura wrightii*), and miner's lettuce (*Claytonia perfoliata*) all bloom and go to seed. If we can keep the invasive weeds at bay, these plants will have a chance to reestablish themselves, creating a friendly habitat for local animals. The flood control channel is a far cry from a natural waterway, but it does provide essential water, making this a good birding spot.

FUTURE PLANS

The park slopes down from a busy street to the flood control channel. The slope is well vegetated with native plants, many mentioned above. The central part of the park is fairly flat and was intended to be grassland with low-growing native perennials and grasses. Unfortunately weeds got the better of this area and within a year it was nothing but a field of weeds. The city deposited urban green waste in the area to smother the weeds. Through city and community efforts, that central area is no longer choked with weeds, but it now presents an unappealing barren look.

Scouts and parents clean up glass and litter in Sycamore Circle. Local youths involved in scout programs, environmental clubs, and other school related projects learn about the urban environment while serving their community.

In the next few years, we hope to beautify the area and provide cover for birds and other animals by introducing low-growing coastal sage scrub plants. These will include black sage (*Salvia mellifera*), California buckwheat (*Eriogonum fasciculatum*), bush sunflower (*Encelia californica*), arroyo lupine (*Lupinus succulentus*), and deerweed (*Lotus scoparius*), among others. This fall, with a small grant from the city, we will purchase and transplant about a hundred new plants. A volunteer is working on a planting plan, and with help from local scouts, we are preparing the site. Signage will educate visitors on what is being done, and will identify the new plants. In this way we will slowly move across the central mound, hopefully able to meet the challenges presented by gophers and weeds.

IN IT FOR THE LONG HAUL

The nature park is a reflection of many of our urban problems and challenges. It is a target for graffiti, broken glass, and litter. Weeds are always ready to reestablish themselves, crowding out the local native plants. Through much of the year, urban runoff—polluted with fertilizers, pesticides, and other toxins—flows through the concrete-lined waterway. This is the reality of our environment, yet each month a small group of citizens refuses to accept it. As we work, we see another possibility, one in which nature can be seen and enjoyed. Each month when we visit the park, we are on the lookout for interesting plants and wildlife, and we are rarely disappointed. The seeds of improvement are here; they just need to be nurtured.

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Aerial view of the Santa Rosa Plateau showing three vernal pools on the Mesa de Colorado. Populations of the rare Santa Rosa Basalt Brodiaea (*Brodiaea santarosae*) are found almost entirely on outcrops of Santa Rosa Basalt that date back ten million years. All photographs by W.P. Armstrong.

THE SANTA ROSA BASALT BRODIAEA: A NEW SPECIES "HIDDEN IN PLAIN SIGHT"

by Wayne P. Armstrong, Tom Chester, and Kay Madore

THE FASCINATING HISTORY OF THE SANTA ROSA BASALT BRODIAEA

Before roughly ten million years ago, the landscape of Southern California was as flat as eastern Kansas is today, a land of low rolling hills. There were no mountains, no frequent earthquakes, no San Andreas Fault, and fewer habitats for plant species, resulting in much less diversity. Furthermore, due to the absence of great mountain chains like the Sierra Nevada and Peninsular Ranges, Southern California received summer rainfall.

Then, about ten million years ago, an oceanic spreading center was subducted under the North American continental crust here. This began the process of mountain building in Southern California, including formation of the San Andreas Fault, migration of the Baja California peninsula away from mainland Mexico, the loss of our summer rainfall, and the diversification of species for which California is famous.

In a dying gasp, one of the segments of the oceanic spreading center repeatedly covered what is now southern Orange County, northwestern San Diego County, and southwestern Riverside County with lava (Kennedy, 1977). This flood basalt, called the Santa Rosa Basalt, completely covered the nearly flat landscape, killing all the plants formerly present, and providing a fresh surface that eventually became ready for colonization by pioneer plants.

However, basalt soils, like those derived from serpentine and gabbro, are not well tolerated by most plant species. These soils are deficient in some nutrients required for plant growth such as calcium and potassium, and they contain large amounts of minerals such as magnesium and iron that are toxic to many plant species. This is a strong stimulus for the evolution of new species that can thrive on such soils. Some plant genera, such as *Brodiaea*, have genes that make them more adept than others in being able to evolve species that can tolerate difficult soils. Two species in northern California, *B. pallida* and *B. stellaris*, have adapted to serpentine soils.

The authors recently discovered a new *Brodiaea* species that similarly adapted to the Southern California basalt. We named it *Brodiaea santarosae*, the Santa Rosa Basalt Brodiaea (Chester, Armstrong, and Madore, 2007a). Amazingly, this species had been seen by numerous botanists in the last half-century, yet it had gone unrecognized because it is superficially similar to two other *Brodiaea* species, *B. filifolia* and *B. orcuttii*. Even more surprising is that the confinement of this species to basalt soils only became apparent after we determined that it was taxonomically distinct from all other *Brodiaea* species and were writing our paper.

In addition to the probable origin of *Brodiaea santarosae* discussed above, this species has a number of other fascinating stories connected to it. We discuss two of them below. First, how this species was "hidden in plain sight" until its masquerade was uncovered. Second, how it was finally determined that this species was a basalt endemic, and how that led to the discovery of an ancient valley that was filled with basalt and has been recently uncovered by erosion.

A SPECIES "HIDDEN IN PLAIN SIGHT"

Brodiaea santarosae was first collected at the Santa Rosa Plateau in 1960, with the specimen determined as *B. orcuttii* by none other than Theodore F. Niehaus, who would 11 years later write what still remains as the definitive monograph on the genus *Brodiaea*. In 1985, another specimen of *B. santarosae* was determined as *B. filifolia*. In 1992, another specimen of *B. santarosae* was determined as a possible hybrid between *B. filifolia* and *B. orcuttii*. In all, we found a total of nine collections of *B. santarosae*, from six different botanists, determined as one of these three possibilities.

The confusion here stems from a remarkable variation in the staminodes of *B. santarosae.* Staminodes are flower parts that appear somewhat similar to stamens, hence the name, but do not contain pollen. They are often crucial in distinguishing species, such as some orchids and penstemons, in many plant families. *Brodiaea* staminodes range from thread-like to petal-like. From 10-50% of the flowers of *B. santarosae* have no staminodes at all, as do all flowers of *B. orcuttii*. The other 50-90% of the flowers of *B. santarosae* have thread-like or tapered staminodes, a property also shared by *B. filifolia*. It was not surprising that botanists mistook *B. santarosae* as one of these two other species; both the authors had also done so in the past when we had seen individual specimens.

Steve Boyd, Timothy Ross, Orlando Mistretta, and Dave Bramlet were the first to realize that this population of plants was distinct from previously known species. In their 1995 *Flora of the San Mateo Canyon Wilderness Area*, they reported that most of the plants found there appeared to be specimens intermediate between *B. filifolia* and *B. orcuttii*, and reported them as hybrids, or a hybrid swarm, between those two species.

In late May 2006 at Clay Hill, a small hill just to the west of the Mesa de Burro in the Santa Rosa Plateau, Kay Madore found a *Brodiaea* population that looked different to her. When Kay showed this population to Wayne and Tom, our jaws dropped wide open. We had never seen a *Brodiaea* population like this in the four years we had been studying *Brodiaea* species in Southern California. We were like kids in a candy store, going from one flower to the next in a delighted trance. We were shocked by the variability in the staminodes, and kept calling to each other, "Look at the staminodes of this flower!"

We quickly realized that these had to be members of the same population reported by Boyd et al. from San Mateo Canyon, and could hardly wait to begin studying samples at home. By coincidence, Tom had

Santa Rosa Basalt Brodiaea (*Brodiaea santarosae*) on Miller Mountain.

gathered samples of *B. filifolia* elsewhere at the Santa Rosa Plateau earlier that day, in order to begin trying to understand why those seemingly-pure plants of *B. filifolia* were so different from the descriptions of *B. filifolia* and hybrids from San Mateo Canyon. To study *Brodiaea* species in detail, fresh flowers are required since the staminodes and other important small flower parts are often lost to study when the flowers are pressed. Those parts are usually obscured by the petals and often destroyed by attempts to remove the petals in fragile, dried specimens.

The first step of the analysis was to split open the flowers and tediously measure 14 characteristics, most to the nearest 0.1 mm using a microscope, from each of 26 flowers, a total of 364 eye-straining measurements. We also gathered the range for each of those characteristics reported by Niehaus (1971) in his monograph for *B. filifolia* and *B. orcuttii*. We then took the measured characteristics two at a time and plotted them against each other, along with the Niehaus range for each.

The plots stunned us, since they contradicted our expectation from the field and from the San Mateo Canyon report that these were hybrids between *B. filifolia* and *B. orcuttii*. Kay's plants seemed to be a new species very different from *B. filifolia*, *B. orcuttii*, or a hybrid between those species. (See sidebar, "How is a Plant Species Defined?") In particular, despite our seeing plants in the field that we thought were *B. orcuttii*, no member of this population came close to *B. orcuttii* for many of the measurements.

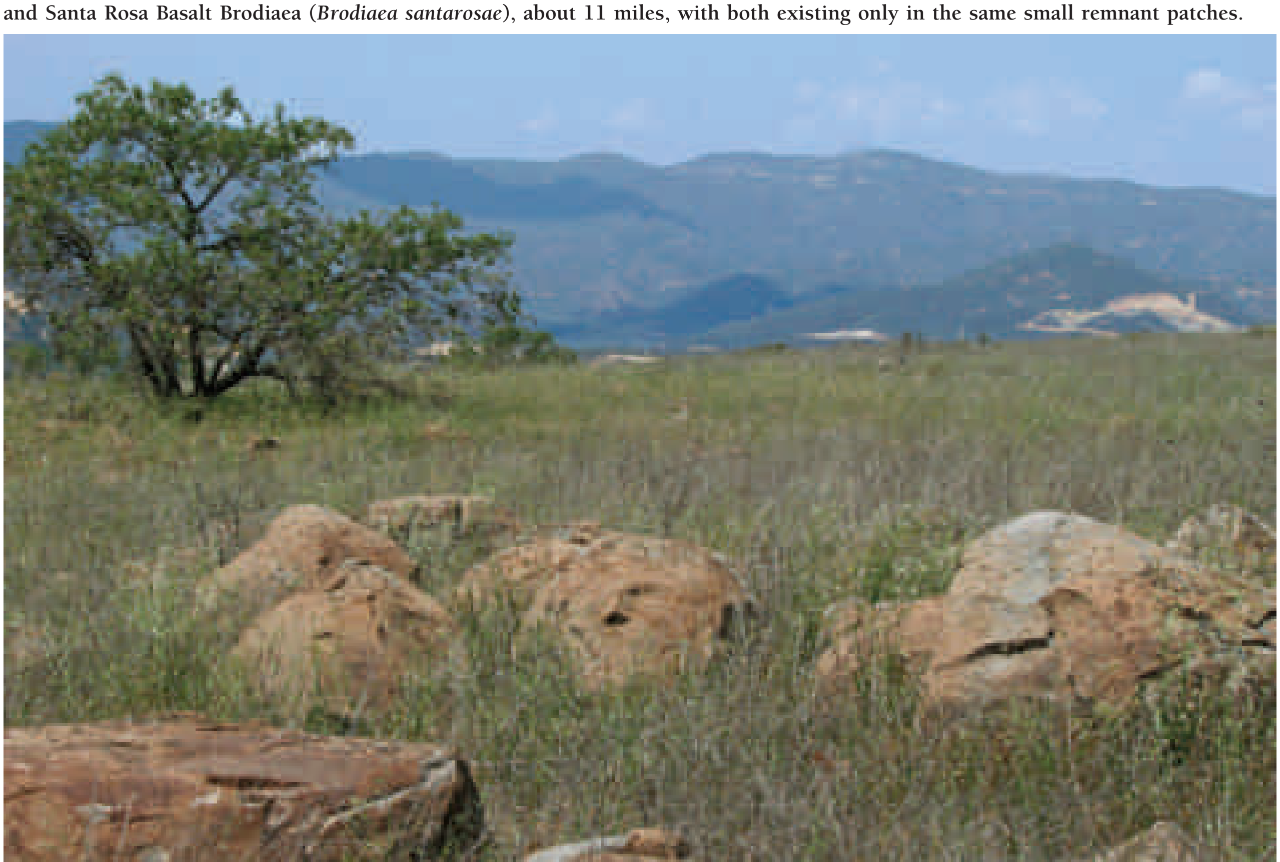
By comparison, the specimens of *B. filifolia* gathered elsewhere on that same day were nearly perfect fits to the Niehaus range for that species, without any resemblance to *B. santarosae* except for the shape of the staminodes.

Thus *B. santarosae* was finally unmasked. We, like previous botanists, had been misled by the variation in the staminodes and had failed to see characteristics that in hindsight stood out like a sore thumb. For example, the style of *B. santarosae* is much longer than any other Southern California species of *Brodiaea*; on average, it is twice the length of the style in *B. filifolia* and 40% longer than the style in *B. orcuttii*.

However, a lot more work was necessary before we could be confident that *B. santarosae* was a new species. We needed to gather and analyze much more data on many different populations to make sure we weren't being misled by any number of different possibilities. For example, it was possible that *B. santarosae* and *B. filifolia* separated out well only here at Clay Hill, and they were indeed intermixed elsewhere as part of a hybrid swarm. Also, the true range of characteristics for both *B. filifolia* and *B. orcuttii* could be larger than reported by Niehaus.

With the help of Steve Boyd in telling us where he had found populations of plants similar to ones at San Mateo Canyon, as well as Avenaloca Mesa locations from Zach Principe, we quickly collected and measured specimens from all other known populations of *B. santarosae*. We also used the Consortium of California Herbaria online database to find locations of both *B. filifolia* and *B. orcuttii*, and we measured

Foreground: Flat grassland with Santa Rosa Basalt boulders on Avenaloca Mesa. Background: Elsinore Peak (with antennae). Ten million years ago, the entire area shown in the picture was nearly flat and covered by basalt. Today, erosion has left basalt remnants in this picture only in the foreground and on Elsinore Peak. This picture shows nearly the full north-south current extent of both the Santa Rosa Basalt and Santa Rosa Basalt Brodiaea (*Brodiaea santarosae*), about 11 miles, with both existing only in the same small remnant patches.

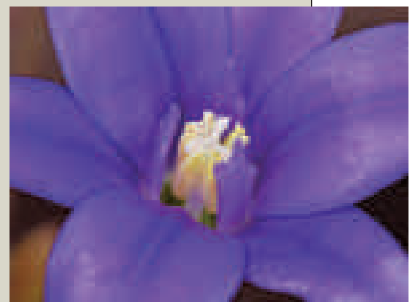


specimens from many known locations of both species. We also had the good fortune to find two specimens that turned out to be true F1 hybrids of *B. filifolia* and *B. orcuttii* at the vernal pools in San Marcos, the only location where those two species coexist (Armstrong, 2007). We also measured samples of *B. terrestris* ssp. *kernensis*, since it is the only other *Brodiaea* that occurs in the range of these three species. This work created a database of fresh specimens of all *Brodiaea* taxa found in this area that could be objectively analyzed to determine how separate these species were, as well as any possible relationships between those species.

We visited the three major Southern California herbaria, located at the San Diego Natural History Museum, Rancho Santa Ana Botanic Garden, and the University of California at Riverside, and measured as many characteristics as were possible on their specimens determined as *B. filifolia, B. orcuttii*, and *B. filifolia* X *B. orcuttii*.

The final dataset from our fieldwork consisted of 16 characteristics measured on each of 132 flowers (a total of 2,112 measurements!), along with additional measurements on the entire flowering stems for these samples, and measurements from herbarium specimens. These flowers came from 14 different locations spanning a distance of 50 miles north-south and 33 miles east-west.

HOW IS A PLANT SPECIES DEFINED?



A sterile hybrid *Brodiaea* found growing on the Santa Rosa Plateau. The parents are presumably *B. santarosae* and *B. terrestris* ssp. *kernensis* which have different chromosome numbers.

In botany, a *species* is a population of plants whose members have at least one, and usually many, recognizably distinct characteristics, along with a geographic range that is generally unique. Such a population consists of members that interbreed freely with each other, but not with other species, under natural conditions, and hence forms a closed gene pool. Species generally result when a population acquires some trait that prevents them from sharing genes with other closely related populations. Such changes are often due to geographic isolation, an ancient hybridization event, or a sudden mutation that results in different flowering times or acquiring different pollinators.

We have identified 11 characteristics of *B. santarosae* that distinguish it from the two other species with which it has been confused, *B. filifolia* and *B. orcuttii*. *B. santarosae* has a very distinctive range that corresponds to the current locations of the Santa Rosa Basalt. *B. santarosae* is completely geographically isolated from populations of *B. orcuttii*, and only a few populations of *B. filifolia* come within the range of *B. santarosae*. *B. santarosae* is isolated from *B. terrestris* ssp. *kernensis* by a failure to form fertile hybrids; we found only one hybrid between those two species, and it produced no pollen.

BELOW LEFT: **Upper: The six *Brodiaea* species of Southern California at roughly their correct relative sizes. Clockwise from upper left: *B. orcuttii*, *B. filifolia*, *B. santarosae*, *B. elegans* ssp. *elegans*, *B. kinkiensis*, and *B. terrestris* ssp. *kernensis*. Lower (in circles): Magnified view of the staminodes for these six species. Staminodes are modified sterile stamens that appear just inward from the petals, and are useful in separating many *Brodiaea* species.** • BELOW RIGHT: **Santa Rosa Basalt Brodiaea (*Brodiaea santarosae*). Note the long stamens and long, thread-like staminodes.**

ANALYSIS OF THE DATASET GAVE UNEQUIVOCAL RESULTS

1. Four separate species existed, each virtually equally distant from the other species in our analysis plots. In particular, *B. santarosae* was no closer to *B. filifolia* or *B. orcuttii* than it was to *B. terrestris* ssp. *kernensis*.

2. The San Marcos hybrids of *B. filifolia* X *B. orcuttii* were almost exactly intermediate to the

two parent species, precisely as expected of F1 hybrids in wild plants, and were just as distant from *B. santarosae* as were its parent species.

3. All populations of each of the four species were consistent with each other, with no evidence of geographic variation.

Details of the characteristics of these four species, and the analysis, are given in our *Madroño* paper and online (Chester et al., 2007a, b). Here are two brief examples of the uniqueness of *B. santarosae*:

1. The average value for the length of each of seven flower parts (flower tube, flower lobes, filament, anther, style, ovary, and staminode) varies significantly between the species. Each species has a characteristic signature in how many of its parts are significantly smaller or larger than those of at least one other species (see Table 1). In particular, *B. santarosae* has six parts that are significantly larger than at least one of the other species; i.e., all but its staminodes are larger than at least one other species. This demonstrates clearly how distant it is from the two species with which it was previously confused.

TABLE 1. COMPARISON OF LENGTHS FOR SEVEN FLOWER PARTS

	B. filifolia	*B. orcuttii*	*B. terrestris* ssp. *kernensis*	*B. santarosae*
# parts smaller	6	6	3	0
# parts larger	0	1	4	6
# parts not smaller or larger	1	0	0	1

2. The leaves, flowering stem, and the stalks connecting the individual flowers to that stem are significantly longer for *B. santarosae* than for any of the other three species. The common name of *B. filifolia* is thread-leaved brodiaea for its small very narrow leaves of typical length 30 cm (12 inches) with widths of one to two mm. The leaves of *B. santarosae* are so large that they can easily be mistaken for those of Mariposa lilies (*Calochortus*), with lengths of 60 cm (24 inches) and widths of up to six mm.

The flowering stem for *B. santarosae* can be up to four times longer than the stems of *B. filifolia* and *B. orcuttii*, and is also longer than stems of the *B. filifolia* X *B. orcuttii* hybrid. The upper right photograph on page 26 shows plants of *B. santarosae* and *B. terrestris* ssp. *kernensis* grown in identical conditions in pots containing soil derived from San Marcos Gabbro, which is chemically similar to basalt. The longest observed flowering stem of *B. santarosae* was 76 cm (30 inches). During a one week period in June 2007, the stem grew 18 cm. This is roughly one inch per day or one millimeter per hour!

If *B. santarosae* did not have such variable staminodes, it would have been recognized as a separate species long ago.

Tom Chester is standing on Clay Hill in the foreground, the type locality for *Brodiaea santarosae*, with the Mesa de Burro in the background. Basalt caps the mesa, Clay Hill, and also extends in a narrow finger from the left edge of the mesa down to the bottom of the road in the distance. Santa Rosa Basalt Brodiaea grows only in these basalt areas, and not in the seemingly identical surrounding areas.

B. SANTAROSAE LEADS TO GEOLOGIC DISCOVERIES

Plant species often grow differently on soils derived from different rock types. Sometimes the difference is so marked that aerial photographs can indicate geologic boundaries due to a change in vegetation. Some species are even confined to specific soils, especially the basalt-serpentine-gabbro soils that, as mentioned above, present challenges to plant colonization. For more information on this interesting subject, see Kruckeberg, 2006.

We are botanists, not geologists, and get most of our geologic knowledge from detailed geologic maps. We were very aware of the Santa

Rosa Basalt, which is clearly marked on geologic maps and could hardly be missed in the field since it forms the flat-topped mesas that define the Santa Rosa Plateau. We knew the rest of the Santa Rosa Plateau Ecological Reserve contained mostly two other rock formations: granodiorite plutonic rocks producing obvious exposed whitish boulders, and metasedimentary rocks that were easily weathered and hence produced few obvious exposures.

The first specimens we saw of *B. santarosae* were at Clay Hill, 0.3 miles west of, and 100 feet below, the nearest mapped basalt on the Mesa de Burro. That location is mapped as metasedimentary rock, and since there was no flat-topped basalt layer there and no obvious whitish boulders nearby, that seemed reasonable to us. Hence at the very beginning of our analysis, we had no inkling that this species was confined to basalt.

All subsequent specimens but one were found on Santa Rosa Basalt. The exception was at Elsinore Peak, which contains no flat-topped area, was not mentioned as being a location of Santa Rosa Basalt (Kennedy, 1977), nor was it mapped as basalt in Kennedy's map. Thus at the end of our field and herbarium work, we had found *B. santarosae* at six locations, four of which were on basalt, and two of which we thought were not.

One necessary detail for our paper was to give the rock type found at Elsinore Peak. By luck, instead of consulting Kennedy, 1977, we consulted the *Geological Map of California: Santa Ana Sheet*, 1966. We were shocked; it was mapped as basalt with the same geologic age as the Santa Rosa Basalt!

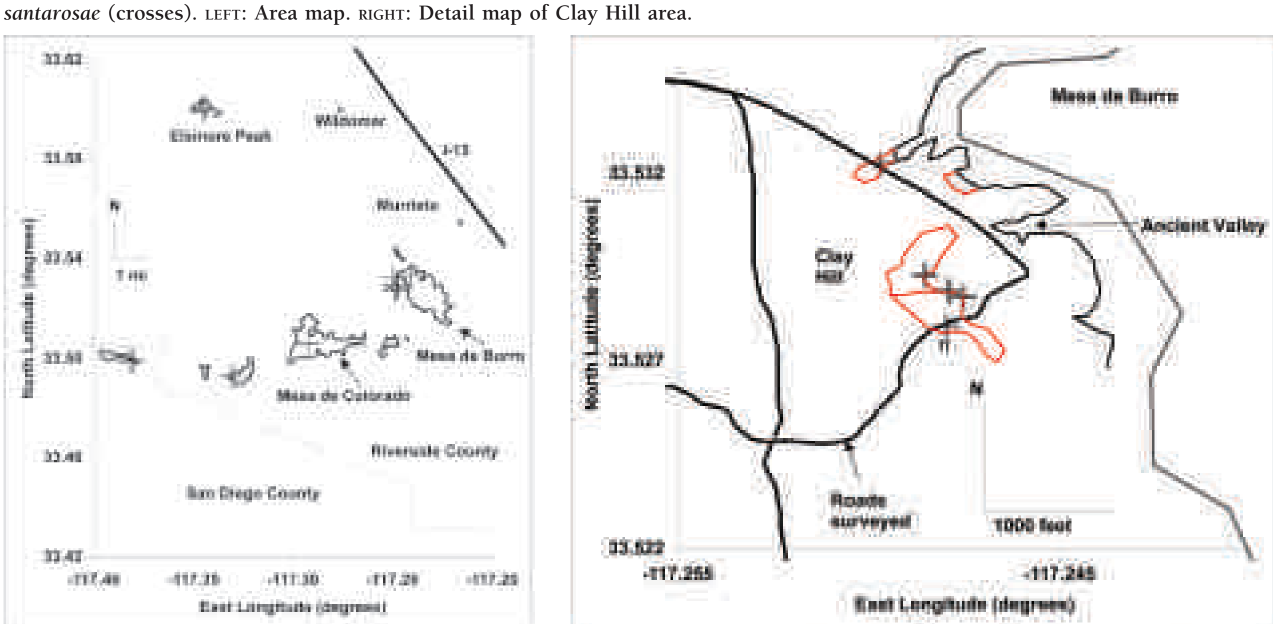
Suddenly it became clear to us that the soil at Clay Hill either might still be influenced by basalt—since the Santa Rosa Basalt had only recently geologically been stripped from that surface—or *B. santarosae* had simply persisted there for a short geologic time after the basalt vanished. This meant that *B. santarosae* was actually a basalt endemic, or nearly so.

We revised the draft of the paper to make the important claim that *B. santarosae occurs only on or very close to the Santa Rosa Basalt*, and thought we had properly addressed that issue.

Fortunately, one of the *Madroño* reviewers of the scientific paper asked us if we had done any chemical soil analysis to understand why one population grew on non-basalt soil. As a result, we revisited Clay Hill and for the fourth time were dumbfounded by this species: there was unmapped basalt at Clay Hill! This meant that every vouchered population was found on basalt soils, and *B. santarosae* was a true basalt endemic. We revised our paper accordingly and it was published in October 2007.

Little did we know that *B. santarosae* had two more surprises for us. The surprises came when we returned to the type locality of Clay Hill in November 2007 to map the extent of the basalt in that area. Not surprisingly, our mapping revealed just how faithful *B. santarosae* is to the basalt. There are 1.72 miles of road surrounding Clay Hill that were completely surveyed both for *B. santarosae* and for basalt. In our 2006 plant survey, made without any suspicion that *B. santarosae* was confined to basalt, we found two locations of *B. santarosae*, at mile 0.26 and mile 0.73. In our 2007 basalt survey, we found basalt only at precisely the *B. santarosae* loca-

Remaining areas of Santa Rosa Basalt (black lines) and areas of Santiago Peak Volcanics (red lines), along with locations of *Brodiaea santarosae* (crosses). LEFT: **Area map.** RIGHT: **Detail map of Clay Hill area.**



ABOVE: ***Brodiaea santarosae*** **(left) compared with the San Marcos *B. filifolia* x *B. orcuttii* F1 hybrid. The hybrid flower is about 40% smaller, and its internal parts have distinctly different relative sizes. • RIGHT: Comparison of *Brodiaea santarosae* (left) with *B. terrestris* ssp. *kernensis*. Both plants were grown in San Marcos Gabbro soil. The *B. santarosae* plant was 76 cm tall, the tallest species of *Brodiaea* in Southern California.**

tions. Yet to the eye, there is no obvious difference at all between the habitat on and off the basalt.

The first surprise came when we looked at Mesa de Burro from Clay Hill and suddenly realized we were seeing an ancient valley from 10 million years ago that was still preserved in its west face. This ancient valley had not been noticed before because it is very broad and shallow, about 2,000 feet wide at its top

POSSIBLE FUTURE OF *B. SANTAROSAE*

CNPS is proposing to place *Brodiaea santarosae* on List 1B.3; rare, threatened, or endangered, but without current significant human threats to the population. However, the greatest threat to this species may be the natural loss of its habitat.

B. santarosae is primarily associated with the Santa Rosa Basalt. At least 97% of the basalt has been eroded in the 8-11 million years since it formed, with most of that erosion probably coming in the last three million years in which the Santa Ana Mountains were uplifted.

It will take much less than another 30,000 to 300,000 years (3% of the previous erosion interval, using two different estimates of the erosion interval) to erode the remaining basalt since the basalt has now been broken up into small areas and is now being eroded on all sides. Thus *B. santarosae* is doomed to go extinct in the wild in the near geologic future (about 100,000 years or so) unless it can adapt to non-basaltic soils, or unless viable populations are found to be present on basalt soil not derived from the Santa Rosa Basalt.

With the recent discovery that *B. santarosae* can at least persist for some time on the basalt of the Santiago Peak Volcanics, there is hope of finding such populations in the San Mateo Canyon area, where there are extensive exposures of that formation. We plan future surveys there in order to untangle the previous confusion with *B. filifolia*, and to examine the geologic formations on which *B. santarosae* grows.

and only 100 feet deep. Our basalt mapping revealed about 500 horizontal feet of the lowermost part of that valley was still covered with the first lava flows to fill that area, but which had not been noted before since the lava was heavily eroded. We also found traces of lava flows that covered a portion of the sides of that valley another 1,200 feet downstream. For more information, see Chester et al., 2007c.

The second surprise came when we were showing the rocks at Clay Hill to a geologist, Norrie Robbins. Due to her insistence on splitting open the rocks to see a fresh surface, we discovered that the basalt at Clay Hill itself was actually from the approximately 150 million year old Santiago Peak Volcanics! This simultaneously mortified us, that we had misidentified the rock formation, and delighted us, that this meant there was the possibility that *B. santarosae* could outlast the Santa Rosa Basalt. (See sidebar, "Possible Future of *B. santarosae*.")

Who would have thought that a plant could lead to finding previously unknown areas of basalt, as well as a previously unrecognized preserved ancient valley?

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Nature's Operating Instructions: The True Biotechnologies. Kenny Ausubel with J.P. Harpignies (editors). University of California Press, 2004. 256 Pages. $16.95 soft cover.

I found this book interesting for two reasons: one, because the subject of "bioneering" is a new concept to me . . . but I may be behind the curve on this one . . . and two, because the information is worth thinking about.

I think bioneering is a term that will creep into our consciousness as time goes along. It refers to the practice of purposely working with nature as a partner in a problem-solving process. This concept is not new but the intentional application, as one might apply the principles of engineering in solving a problem, is not normally in the forefront of our thoughts. The term, and the book, emerged as practitioners began gathering in organized annual conferences starting in 1990.

In their own words, bioneers are " . . . scientists and artists, gardeners and economists, activists and public servants, architects and ecologists, farmers and journalists, priests and shamans, policymakers and everyday people committed to preserving and supporting the future of life on earth." They do this by using living systems as coworkers, thus employing nature's technology to break down toxins and waste, to provide ecologically sound designs for industries, buildings, and lifestyles by learning and adopting nature's own operating instructions.

This is a book of personal stories broken down into five parts—Biomimicry: Working with Nature to Heal Nature; Listening to the Land: Ecology as the Art of Restoring Relationships; Graffiti in the Book of Life: Genetic Engineering and the Vandalism of Nature; The Industrial Evolution: Biology Meets Business; and Natural Magic: Spirit, Mystery, and Wonder.

A bioneer asks, "What would Nature do here?" The answers are often amazing and cleverly hidden until the quest is taken on in earnest. Would you have thought of making a close examination of lotus leaf surfaces to solve the problem of keeping buildings clean without the need to spend time, money, and energy on sandblasting? The question asked was, "How does Nature stay clean?"

Tell me, what human-engineered solution has solved the problem of desalinating water using the energy of the sun and membranes manufactured from the surrounding environment? Take a close look at Nature's solution in mangrove forests.

And what about underwater glues manufactured from the sun's energy and the surrounding sea as a source of raw materials?

What engineer would have come up with the idea of "eco-machines" powered by the notion that waste equals food? In Nature, "waste" simply doesn't exist. That is certainly the case when treating wastewater with a concept called "living technologies."

So, the story goes on.

This book is a collection of 26 firsthand essays of bioneering in action. The essays are short, easy to understand, and autobiographical in discussing problems at hand and how they were solved. See what can happen when you are a part *of* Nature instead of apart *from* Nature. The genius of Nature is worth investigating.

The back of the book contains useful references and further information on bioneering.

Norden H. (Dan) Cheatham
East Bay Chapter

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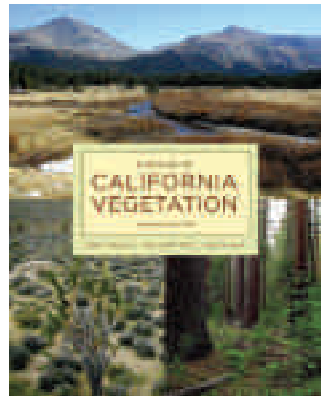

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Members and others are invited to submit material for publication in *Fremontia*. Instructions for contributors can be found on the CNPS website, *www.cnps.org*, or can be requested from *Fremontia* Editor Bob Hass at *bhass@cnps.org*.

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Kay Madore has her own business as a life and wellness coach. She is a longtime docent at the Santa Rosa Plateau Ecological Reserve and conducts vegetation surveys for The Nature Conservancy.

Roger Raiche is an extraordinary plantsman and field botanist, and is well known for his broad horticultural expertise. He was in charge of the California Collection at the UC Botanical Garden in Berkeley for 23 years, revamping the collection and displays, and adding thousands of new plants while exploring and documenting many remote areas of the state. In 2003 he left UC to pursue garden design fulltime at his business, Planet Horticulture (www.planethorticulture.com).

FROM THE EDITOR

Transitions are an inevitable part of life. For this issue of *Fremontia*, Bart O'Brien and I are sharing editorial responsibilities, although he completed the lion's share of its contents. Beginning with the following issue, I will be taking over as editor.

Bart assumed editorship of *Fremontia* back in the summer of 2006 when he coedited the July issue with Linda Vorobik, who was his predecessor. During his tenure, Bart maintained the journal's high standards of excellence. It continued to carry articles on a variety of botanical topics contributed by some of the best scientists in the state and the country. The journal also covered many of the most significant conservation issues in California, as well as features on a host of horticultural topics. Bart was careful to ensure that the writing—even on very complex topics—remained accessible to all readers. And with the skillful assistance of designer Beth Hansen-Winter, the journal continued to captivate all with its stunning photography.

As for Bart, he will continue on as director of special programs at Rancho Santa Ana Botanic Garden (RSABG). He is currently working on two book projects. One, with coauthors Carol Bornstein and David Fross, is on alternatives to lawns; the other is editing a manuscript on the propagation of California native plants at RSABG from 1950 to 1970. Among other activities, he is leading a project to create a CNPS-type inventory for the rare, endangered, and endemic vascular plants of northwestern Baja, California, Mexico.

Both Bart and Linda will be hard acts to follow, but I intend to do everything possible to ensure that the publication remains highly regarded. To that end, I will be working closely with the revitalized *Fremontia* Editorial Committee, and also welcome suggestions from CNPS members, which can be sent to bhass@cnps.org.

—Bob Hass