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FREMONTIA

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IN THIS ISSUE:

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Dedicated to the Preservation of the California Native Flora

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THE COVER: Coast live oak (*Quercus agrifolia*), one of the primary species affected by Sudden Oak Death (see article on page 3). Photograph by B. Hansen-Winter.

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DECONSTRUCTING SUDDEN OAK DEATH

by Steven Swain

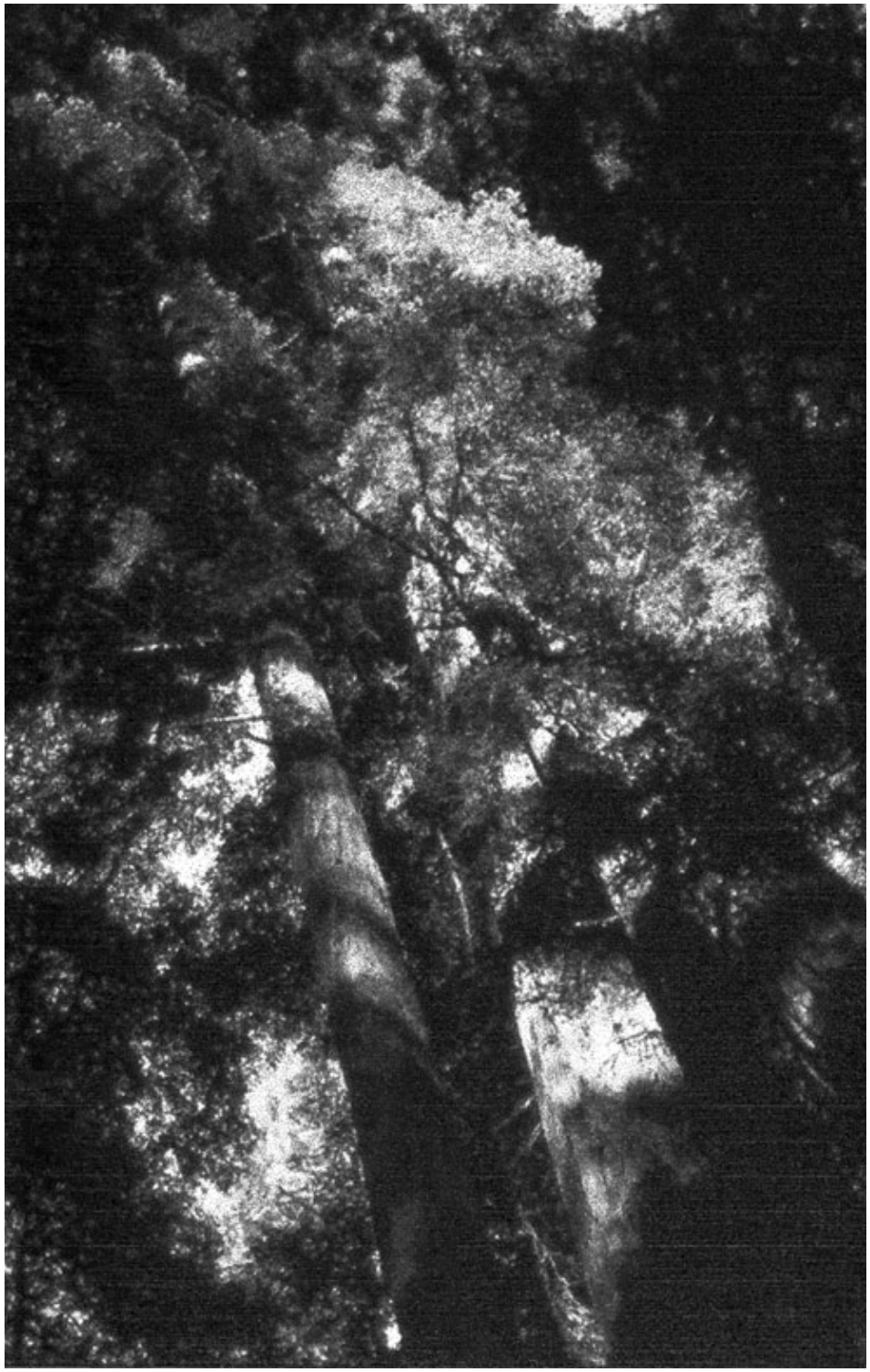
Sudden oak death is a disease that has killed tens of thousands of trees across the coastal regions of central California. That said, the name "sudden oak death" is somewhat a misnomer; the disease doesn't just attack oaks, and at this point has not always killed infected oaks. Generally, infected oaks do die, but it does not always happen suddenly. So then what is "sudden oak death"? The term generally has come to be used synonymously with infection of a plant or a community of plants by *Phytophthora ramorum*. This article is intended to briefly summarize the current state of knowledge of this pathogen, its distribution and effects, and what is being done to manage the disease and its impacts.

The disease was first discovered in Marin County, California in 1994 (Svihra 1999), and within a few years was reported from neighboring counties on California's central coast. The causal agent was still unknown at the time, so the disease was named after the most obvious symptoms—tan oaks (*Lithocarpus densiflorus*) and other oaks (*Quercus* spp.) dying in a somewhat sudden fashion.

THE PATHOGEN

The name "*Phytophthora*" literally means "plant destroyer." Most species within the genus are aggressive plant pathogens that infect and often kill their hosts; these microbes can also survive on infected plant parts and in the soil. The life cycle of *P. ramorum* is relatively typical of foliage-infecting *Phytophthora* species, perhaps with the exception that it is also capable of infecting trunk tissues.

Phytophthora species as a whole



Tan oak (*Lithocarpus densiflorus*) is hard-hit by SOD. It is pictured here from Muir Woods in Marin County with coast redwood (*Sequoia sempervirens*) which has also been discovered to be a host of the *Phytophthora* pathogen. Photograph by L. Vorobik.

are microbes that typically thrive under moist conditions. Worldwide, they represent root and leaf pathogens, but most temperate species on oaks are root pathogens. Like all other species in the genus, *P. ramorum* produces several different reproductive structures, including chlamydospores, zoospores, and sporangia. Each of these is somewhat specialized to a specific mode of dispersal. The chlamydospores produced by *P. ramorum* are survival structures; they act in a manner somewhat analogous to that of seeds, able to handle comparatively long periods of time in harsh environmental conditions. Zoospores of *P. ramorum* swim through water actively seeking hosts. These comparatively tiny spores are relatively short lived when exposed to dry air, but can survive up to 30 days in water (Davidson et al. 2002). Sporangia are larger structures that produce and release zoospores, or may infect plant tissues directly themselves.

The wide variety of spore types found in *Phytophthora* species allow these organisms several different methods of dispersal across the landscape: they can be transported by water, the movement of soil on tires, animal feet, or shoes, and possibly even wind. Once in place, certain spore types can subsist for long periods of time waiting for conditions to be optimal for infecting a new host. Morphological similarities between the sporangia produced by *P. ramorum* and those produced by the few known aerially dispersed *Phytophthora* species suggest that *P. ramorum* may be among those *Phytophthora* species that can be aerially dispersed. (Rizzo, pers. comm.). This hypothesis is supported by a distribution pattern across the landscape that suggests wind as a dispersal mechanism. While it is almost certain that the organism can be dispersed in wind-driven rain (Rizzo, pers. comm.), there is yet no evidence that aerial dispersal can occur in the absence of rain—only two of the sixty-odd *Phytophthora* species are known to do that.

Sporangia (larger oblong structures) as viewed under a microscope. Photograph courtesy of M. Garbelotto.

Phytophtora ramorum has a broad host range: at least fourteen different hosts species in several different

TABLE 1. KNOWN CALIFORNIA NATIVE HOST SPECIES FOR PHYTOPHTHORA RAMORUM AS OF 15 MAY, 2002

Latin Name	Common Name	Foliar Host	Trunk Canker	Branch Canker
Acer macrophyllum	Big-leaf maple	x		
Aesculus californica	California buckeye	x		
Arbutus menziesii	Madrone	x		x
Arctostaphyllos manzanita	Manzanita	x		x
Heteromeles arbutifolia	Toyon	x		x
Lithocarpus densiflorus	Tan oak	x	x	x
Lonicera hispidula	California honeysuckle	x		
Pseudotsuga menziesii	Douglas Fir	x		x
Quercus (subgenus *Lobatae)*	"Black" or "red" oaks			
agrifolia	Coast live oak		x	
kelloggii	California black oak		x	
parvula var. *shrevei*	Shreve's oak		x	
Rhamnus californica	California coffeeberry	x		
Rhododendron spp.[1]	Rhododendron varieties	x		
macrophyllum	California Rose-bay	x		
Sequoia sempervirens	Coast redwood			x
Umbellularia californica	Pepperwood	x		
Vaccinium ovatum	California huckleberry	x		x
Viburnum spp.[1]	Arrow-wood	x		x

[1]species in these genera are sold in the horticultural trade, and some represent a significant risk of contagion. They are often not native to California.
[2]These species have been added quite recently to the list, and researchers do not yet fully understand their role in *Phytophthora* pathology.

Pseudotsuga menziesii Douglas Fir

Sequoia sempervirens Coast redwood

families are susceptible to infection (Davidson et al. 2002; Rizzo et al. 2002a; Rizzo et al. 2002b). The symptoms can vary so much depending upon the infected host species that for all purposes *P. ramorum* causes two distinct diseases, one usually lethal and the other not.

Infection is frequently lethal to species that develop trunk cankers, which include tan oak (*Lithocarpus densiflorus*), coast live oak (*Quercus agrifolia*), black oak (*Quercus kelloggii*), and Shreve's oak (*Quercus parvula* var. *shrevii*). All of the *Quercus* species mentioned above are in the Subgenus *Lobatae*, and it appears that all of the members of this subgenus may be susceptible to infection by *P. ramorum* to one degree or another. (Other subgenera of *Quercus*, such as the white oaks [Subgenus *Quercus*], are not known to be susceptible [Rizzo et al, 2002a]). The infection of tan oak is noteworthy in that *P. ramorum* is able to cause trunk, branch, and leaf infections, often simultaneously. It is the first species in California known to be symptomatic of this disease (Svihra, 1999), and appears to be among the most susceptible species discovered. On tan oaks, the term "sudden oak death" is descriptive of the infection process, even though it isn't a true oak.

Most of the remaining (approximately twelve) host species (see table on page 4) are susceptible to nonlethal infection. They develop leaf infections, and commonly also develop cankers in their branches (hence the specific name *ramorum*, meaning "to branch"). The "foliar hosts" generally do not develop large cankers in their trunk tissues.

New hosts for *P. ramorum* are being discovered every year, and therefore the list of host species in Table 1 is expected to grow. The potential size of the completed host list may number into the hundreds of species; as an example, the host list for *P. cinnamomi* is in the vicinity of 2000 species.

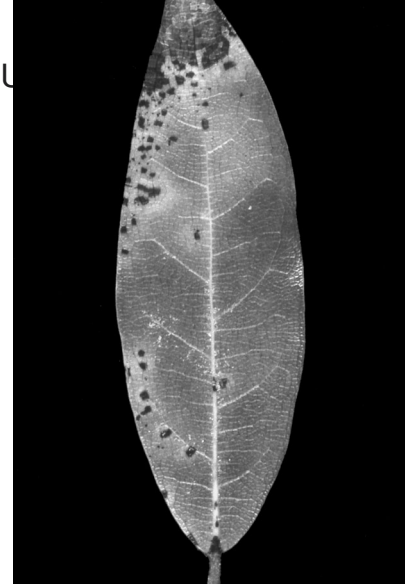
SYMPTOMS

Although the best known form of the disease involves the formation of trunk cankers leading to the disease commonly termed "sudden oak death," the more common form of the disease results in necrotic leaf spots on the foliar host. It appears that *P. ramorum* can be quite contagious, especially among certain foliar hosts such as *Rhododendron* species, tan oak, and California laurel (*Umbellularia californica*).

On true oaks *P. ramorum* has only been found to cause trunk cankers, not foliar infections. Trunk tissue infection results in the death of patchy areas of the cambium, which frequently coalesce into large areas of dead tissue. To the passerby, the symptoms of this process appear as sticky, viscous, burgundy- or molasses-colored droplets on clear bark that are usually not associated with a wound. Canker symptoms on tan oaks are similar but are typically runnier and are preceded by a general browning of the entire canopy.

Among the foliar hosts, symptoms of infection are variable with plant species. The most common symptom is leaf spots, which are not always obvious to the casual observer. They are easily confused with many other maladies that the host plants may contract. *Phytophthora ramorum* produces few visible signs of its presence, as all of its structures are microscopic (Garbelotto et al., 2002). To view more images of typical symptoms on various hosts, please visit *www.suddenoakdeath.org*.

Bleeding from the bark of coast live oak Photograph courtesy of M. Garbelotto.



Spots caused by *Phytophthora ramorum* on a California laurel leaf. Photograph courtesy of M. Garbelotto.

Secondary infections or attacks by other organisms may accelerate the decline of infected oak and tan oak trees. Typical among these other organisms are oak bark beetles *(Pseudopityophthorus pubipennis)* and ambrosia beetles *(Monarthrum* spp.). These beetles leave pin-sized holes in the bark, surrounded by a fine sawdust-like material commonly termed "frass." Anecdotal evidence suggests that attacks by beetles are typically what causes oak trees to die "suddenly," rather than the comparatively slow-moving infections of *P. ramorum*.

Dead and dying trunk tissues are colonized by decay fungi. Common among this group of organisms is *Hypoxylon thoursianum*, which produces fruiting bodies that resemble small, rounded chunks of charcoal that grow on the bark of infected trees. The presence of *Hypoxylon*, beetles, or both, does not in any way indicate that the tree is infected with *P. ramorum*—these organisms are part of the general disease process that oaks and tan oaks have evolved with. The oaks colonized by these organisms may have been initially stressed for any of a multitude of reasons, as they have been for centuries.

DISTRIBUTION

In addition to the quarantine of infected materials, clear delineation of the disease is also critical to any proposed containment approach. As of May 9, 2002, the North American distribution of *P. ramorum* extended over more than 300 km of the central California coastline, and in one small isolated area of Curry County, Oregon, just north of California.

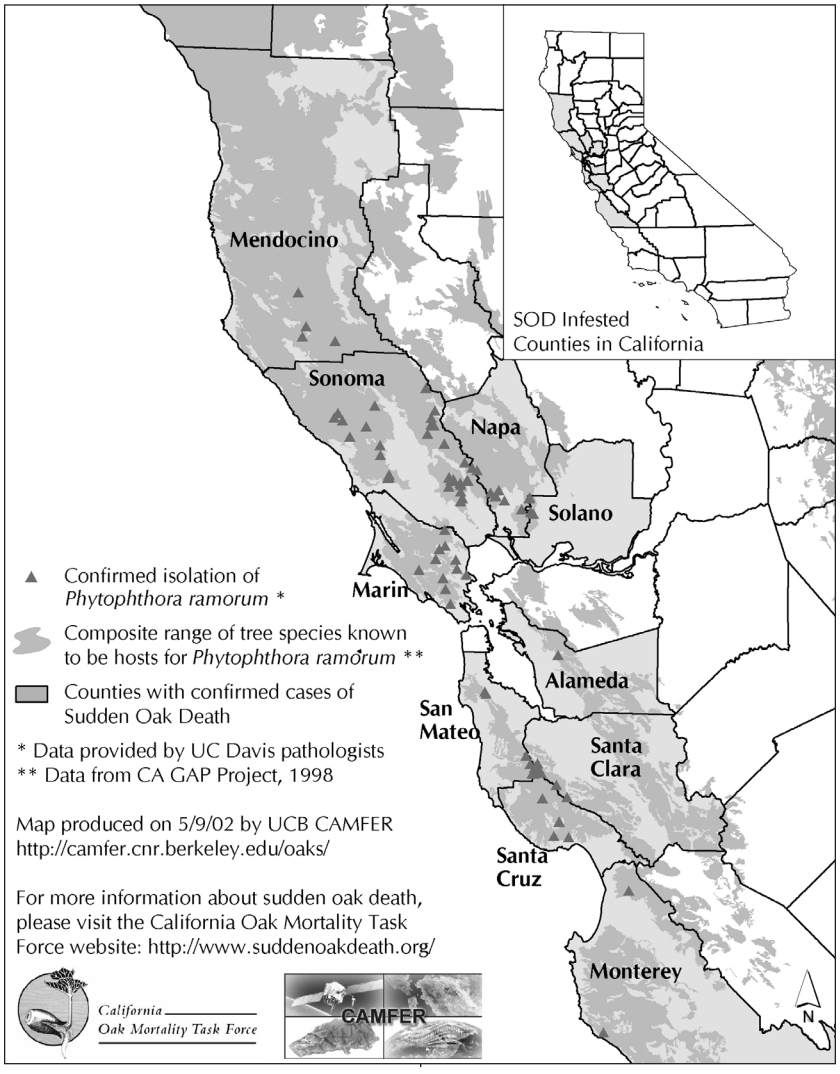
Phytophthora ramorum requires water to reproduce, and prefers temperatures in the vicinity of 20 Cº. Moist, comparatively cool climatic zones are frequently found in the coastal regions, and it is perhaps because of this that most of the confirmed distribution of *P. ramorum* occurs within 30 km of the coastline. In the San Francisco California area it has been found farther inland, but at the time of this writing has only been confirmed at locations with cool, California-influenced weather.

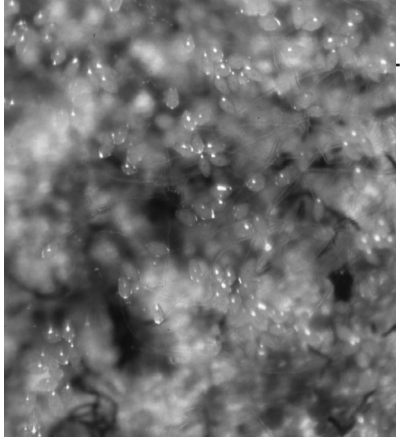
The current extent of the distribution of *P. ramorum* does not mean that the organism is necessarily limited to coastal climates. Dr. Matteo Garbelotto's heat treatment experiments clearly show that in certain host materials, such as California laurel leaves, *P. ramorum* is capable of surviving temperatures of 35 Cº for extended periods of time (Garbelotto, unpublished data). This suggests that although the pathogen may not be able to reproduce under the comparatively hot, dry summers of California's interior valley, it may be able to survive them. It is plausible that *P. ramorum* could be introduced to drier, warmer regions during the comparatively cool, moist weather frequently associated with springtime, and then reproduce whenever favorable conditions recur. Exactly how fast the disease would spread, how the symptoms would manifest themselves, and which hosts it would be capable of infecting under these conditions are all unknown at this time.

Hot, dry summers and cool moist spring weather typify many climates beyond California's central valley. If *P. ramorum* is not constrained to the west coast environment, this begs the question of how infectious it might be on host species found elsewhere on the continent, or indeed the world. Many of the oaks of eastern North America, for example red oak (*Quercus rubra*) and pin oak (*Quercus palustris*), are in the same subgenus *(Lobatae)* as susceptible western oaks. The two eastern oaks tested were at least as susceptible to *P. ramorum* as susceptible western oaks are (Rizzo et al., 2002). Although *P. ramorum* was first discovered in northern Europe, no European oaks are known to have become infected by the disease.

Until recently, monitoring the distribution of the disease has been based upon reports of suspected infestations coming in from the public. For the most part, the public seems to have keyed in on oak death as the defining characteristic that they are reporting, and this may be a direct result of the disease's common name. It may also be that many people simply aren't concerned about leaf spots on their laurel trees, or on other foliar hosts. Whatever

Confirmed distribution of sudden oak death as of May 9, 2002. Map courtesy of Karin Tuxen, CAMFER, UC Berkeley.





Microscopic view of leaf surface crowded with sporangia. Photograph courtesy of M. Garbelotto.

the reason, it now seems to take at least a few months for tan oak trees to show symptoms, and it may take years for coast live oak to show symptoms. The result is that we have been monitoring a phenomenon that is perhaps up to several years behind the arrival of the disease at a particular site, and therefore the actual extent of this disease may be significantly wider than what is represented in the distribution map. A number of researchers have suggested that perhaps a better way to find the current extent of the disease would be to begin monitoring California laurel leaf symptoms instead of dying oaks. California laurel trees seem to show symptoms quite a bit earlier than the canker-forming trees such as coast live oak and tan oak. The results of Sonoma County's disease monitoring efforts support this. We have found infected California laurel trees miles from any confirmed dead oak or tan oak tree in the Mark West Springs area of Sonoma County. Focusing on foliar symptoms in laurel trees has two advantages: the tree is relatively widespread and it is evergreen, which allows symptom identification and sampling throughout the year.

A better understanding of the epidemiology of the disease on its foliar hosts will facilitate disease monitoring and delineation. There is still much more that needs to be known about this subject.

RISK OF SPREAD

Phytophthora ramorum seems to be well suited to dispersal among its hosts by both anthropogenic (human-caused) and natural means. Spore production appears to be greatest on foliar hosts, in some cases approaching 70,000 spores per square centimeter of infected leaf tissue (Rizzo, pers. comm.). Spore production on woody materials is much lower when it occurs at all. This suggests that in terms of anthropogenic spread, the transportation of foliage is of greater comparative risk than the transportation of wood or wood products, although there may still be significant risk in the movement of infected woody material. Foliage is clearly a good platform for natural dispersal because of its position above ground and exposure to wind and rain.

For this reason, the development of phytosanitary disposal methods for host material from infected regions appears to be critical in containing the disease. Composting diseased host material appears to be a promising method of sanitizing it (see Table 3 on page 8). During the composting trials, after one week at 55 Cº,

TABLE 2. VIABLE PHYTOPHTHORA RAMORUM COLONIES (POSITIVE ISOLATIONS) BEFORE AND AFTER HEAT TREATMENT

Data here represent the results of one set of heat treatment trial results. This trial involved placing the infected samples in an oven for two weeks, testing them each week. Note that averages are calculated by considering each unit as a replicate. The heat exposure resulted in no viable *Phytophthora ramorum* colonies from any of the wood chips and or the saplings cankers, whether the material was exposed for one or two weeks. In the case of California laurel leaves, a one-week exposure only reduced *Phytophthora* viability, but did not completely eliminate it. A two-week exposure eliminated viable inoculum from the leaves as well.

Plant material	Total isolations attempted	Positive isolations before treatment (average %)	Positive isolations at one week (average %)	Positive isolations at two weeks (average %)
Coast live oak wood chips	80	92.5%	0%	0%
California laurel leaves	50	100%	17%	0%
Cankers	48	na	0%	0%

Based on unpublished data from Matteo Garbelotto, 2001.

TABLE 3. VIABLE PHYTOPHTHORA RAMORUM COLONIES (POSITIVE ISOLATIONS) BEFORE AND AFTER COMPOSTING

Data here represent the results of one set of composting trial results. This trial involved placing the infected samples in a compost pile for two weeks, testing them at the end of the trial. Note that averages are calculated by considering each unit as a replicate. The composting process resulted in no viable *Phytophthora ramorum* colonies from any treated material.

Plant material	Total isolations attempted	Total Positive isolations before treatment	Positive isolations before treatment (average %)	Positive isolations at two weeks (average %)
Coast live oak wood chips	32	31	97%	0%
California laurel leaves	25	15	60%	0%
Cankers	16	5	31%	0%

Based on unpublished data from Matteo Garbelotto, 2001.

P. ramorum could not be isolated from most substrates, and after two weeks *P. ramorum* could not be isolated from even the California laurel leaves (Garbelotto, unpublished data). Dr. Garbelotto is still conducting further tests aimed at determining how much time and temperature required to eliminate *P. ramorum* may vary with the season and substrate material. The final results will probably not be known for some time.

Firewood and other coarse plant materials also pose a risk of spread, but the exact extent of this risk is still unknown. In infected regions, firewood from host species should remain on site. Other firewood movement may be restricted or prohibited, depending upon several factors including the origin and destination of the material. Several other commodities are regulated in infected counties, including soil and nursery stock. Quarantine regulations are almost certainly going to change with time. To obtain the latest information on regulated articles and restrictions, call your local County Agricultural Commissioner.

IS P. RAMORUM AN INTRODUCED PATHOGEN?

Based on preliminary evidence, *Phytophthora ramorum* has what amounts to a largely clonal population structure (Garbelotto et al. 2002b). This organism seems well suited to asexual propagation, and apparently sexual reproduction of *P. ramorum* is not occurring within the state. This population structure has a number of significant implications.

Preliminary data on the limited genetic variability of California's *P. ramorum* population is not in agreement with the hypothesis that it is a native species. If *P. ramorum* is introduced, then the native plants in the central coast region are unlikely to have evolved any innate ability to defend themselves against it. The inability of host plants to defend themselves adequately against introduced diseases has caused such dramatic events such as Dutch elm disease (caused by the pathogen *Ophiostoma ulm)*, and chestnut blight (caused by the pathogen *Cryphonectria parasitica)*. This is not to say that the situation here is so dire, but rather to illustrate the potential for the most severely affected species, such as tan oak. Tan oak has indeed suffered substantial losses in the past seven years, with some stands suffering one hundred percent mortality.

The lack of genetic variability within the *P. ramorum* population of the western United States suggests that there is very little genetic recombination occurring within the population, and thus adaptation rates should be quite low. This is good news for plants that show only some resistance to the disease, such as our native oaks, as it implies that it will be much more difficult for *P. ramorum* to overcome the defenses of the oak population as a whole over time. Of course, this could all change overnight with the introduction of a new, sexually compatible strain of the disease. Preventing the introduction of any new strains is likely to prove difficult, as the origins of the pathogen are only hypothesized.

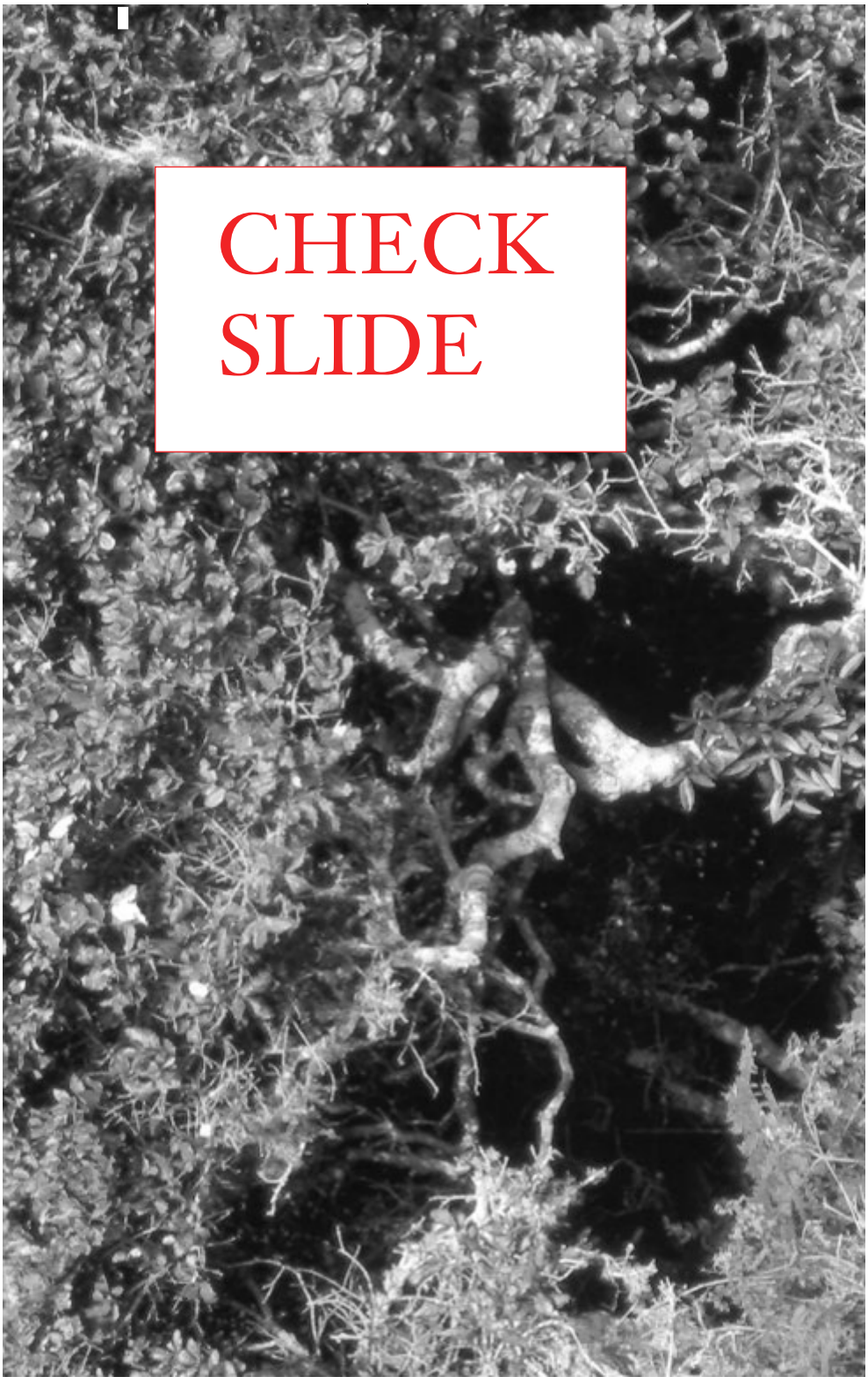
TREATMENT

Testing to develop treatment for individual oaks is still underway. A number of chemical control options appear to hold promise, but results are likely to still be several months, if not years, away. This is in part due to the very slow nature of oak mortality itself. In the absence of attack by bark beetles, trees can take years to die. The long time scale required for this process in turn requires equally long experimental times to obtain treatment results from the field.

Host mortality rates also appear to vary by species. For instance, mortality rates on tan oaks appear to be quite high, whereas they are somewhat lower for black and coast live oaks. They also seem to vary with climate, with higher rates in areas typified by comparatively cool and moist conditions.

If an effective treatment is found, it may be able to save individual trees of value, but it is unlikely that it will be able to be applied to the landscape as a whole. This is primarily because biological controls for forest dwelling *Phytophthora* species are unknown, and the wholesale spraying of entire regions with chemicals is likely to cause as many environmental problems as it cures.

The state of Oregon has taken a comparatively aggressive approach to the recent introduction of *P. ramorum*. They are attempting to eradicate the disease by cutting and burning all host plants within 50 to 100 feet of symptomatic foliage (Goheen, pers. comm.). This approach is possible is due to a combination of factors; one of these factors is the comparatively large distance between the area of infection in Oregon and the next closest confirmed site—a distance of over 250 kilometers. The lack of a nearby source of infection suggests that if the disease is eradicated the region is unlikely to be re-infected in the immediate future. This is conjecture, since the method of the original introduction is not known. The other factor making an eradication attempt possible is the limited size of the infection area. A total of



Foliage of living coast live oak (*Quercus agrifolia*) tree from Sonoma County. Photograph by J. Hickman.

Coast live oak (*Quercus agrifolia*) occurs in a variety of habitats throughout coastal California. It is shown here in a stand of chamise (*Adenostoma fasciculata*). Photograph by J. Hickman.

approximately 40 acres scattered over several sites in Curry County are known to be infected. This makes cutting and burning these areas in Oregon a realistic proposition. Results from this approach are forthcoming.

Eradication is not a realistic proposition in California. The current disease extent is still not fully known, but it is clear that the disease is relatively widespread on the central coast. Currently, the best approach in California seems to be to prevent the further spread of the disease.

Infected regions of California are currently under both state and federal quarantines designed to limit the movement of infectious material. As of the time of this writing, these regulations are currently being revised to make them consistent and compatible with one another. By the time this article is printed, they should have been reconciled. As new host species or new infection routes are discovered, these regulations will have to be amended.

FORESTS IN FLUX

California forests have been subject to many perturbations and disturbances throughout their history. Many present day woodlands may have been grassland at one time, and where there are now redwoods or pines, oaks may have once stood. Fire burned through many of these forests and woodlands every few years, and helped to shape the forests themselves. In the absence of fire, grasslands often succeeded to woodlands, and oak woodlands and forests often succeeded to other forest types. Disease seems to be part of these processes, although exactly how native diseases may have caused landscape-level changes in the forests is not fully understood. The effects of exotic pathogens are likely to be even less predictable.

Ultimately, *P. ramorum* is likely to result in changes to California's central coast forests. What these changes will be is difficult to estimate until we know more about the pathogen and its impacts. At this point, it seems these changes are unlikely to radically alter the landscape of the central coast over the long term, although they may be significant at a more local scale. Based on preliminary evidence, *P. ramorum* appears to have effects on the regeneration of some species, such as madrone *(Arbutus menziesii)*. Perhaps the greatest long-term threat posed by this disease is the potential elimination of tan oak as a significant component of west coast forests.

CONCLUSIONS

Although the common name "sudden oak death" does not really describe the ecology of the disease accurately, it does capture the essence of what we currently understand to be its major impact.

There is quite a bit that still remains to be discovered about this pathogen. It remains to be seen whether a quarantine or eradication efforts based on our current level of knowledge will be effective. At this point, the host species list is not complete, and the methods of dispersal are not completely understood. Until such basics are known, it will be difficult indeed to make any kind of accurate predictions about what effects the disease may have. Similarly, views on appropriate kinds of treatment, regulations to prevent spread of the disease, and enforcement of such regulations may change over time.

There are a number of resources available for further information on *Phytophthora ramorum*. For easy access to general background information, current host species lists, and images of symptoms, please visit *www.suddenoakdeath.org*. The local University of California Cooperative Extension office should be able to help you with further questions regarding sudden oak death, as should the local Agricultural Commissioner's office. The Agricultural Commissioner's office should also have information on the latest developments on quarantine regulations.

Drawing by M.H. Swift of tan oak (*Lithocarpus densiflorus*), from the 1910 Jepson *Silva of California*.

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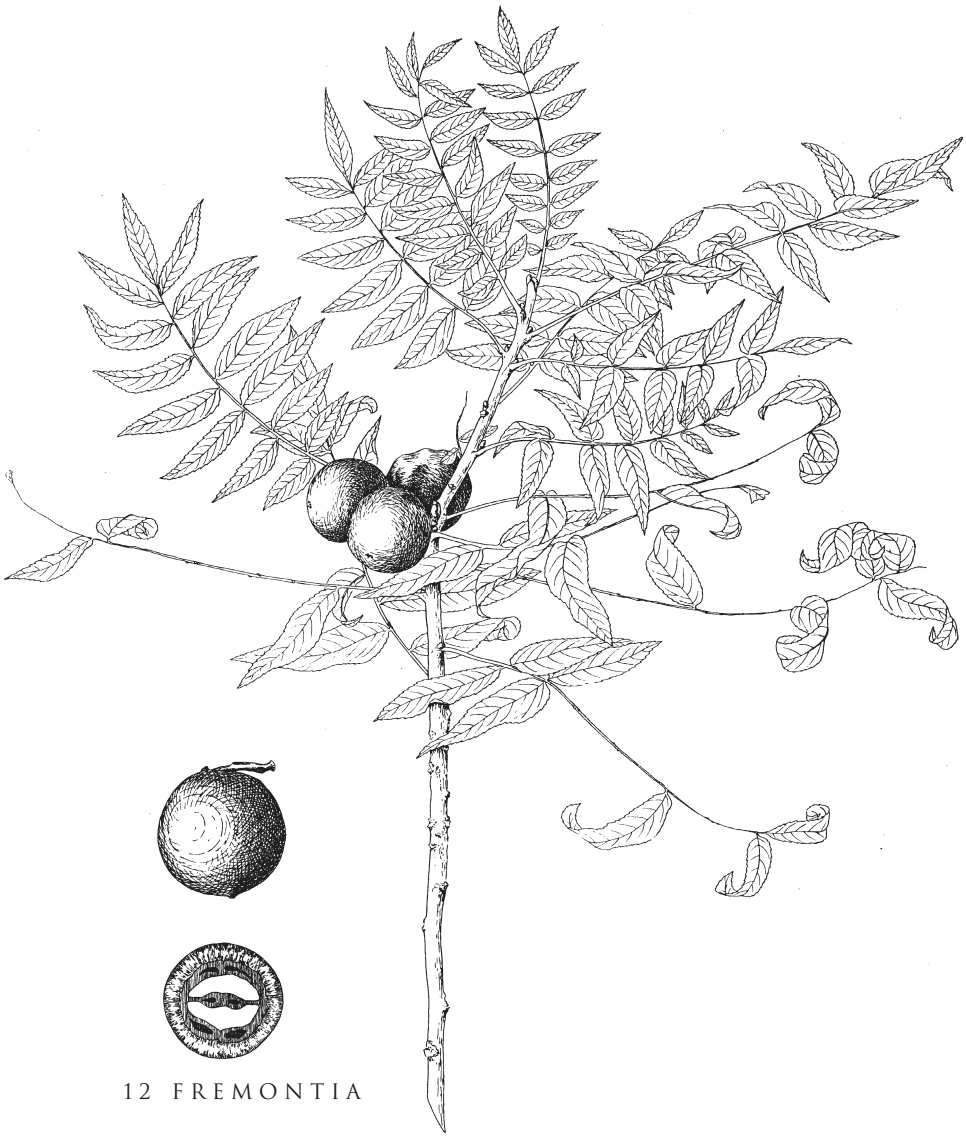
SOME PRELIMINARY OBSERVATIONS ON THE CALIFORNIA BLACK WALNUT (JUGLANS CALIFORNICA)

by E.N. Anderson

The California black walnut (*Juglans californica*) is a large shrub or small tree, smaller in every way (trunk, leaf, fruit) than northern California's Hinds walnut *(J. hindsii)*, and restricted to a narrow band within the southern California foothills. It occurs primarily on private land in or near urban areas, and is abundant within its small range. However, because only small and marginal scraps of its habitat are protected, it is of some concern to conservationists. So far, its fondness for steep slopes has protected it, and much of its population survives in the Los Angeles conurbation on islands of habitat too steep and unstable on which to build. However, current "level-the-mountains" construction has wiped it out from even these habitats in many areas, especially the Puente Hills, and its future is uncertain.

Walnut trees provide both food and habitat for wildlife. Rodents and other animals eat the kernel, and, in earlier times, Native American peoples utilized it. (The kernel is excellent eating, but too small and shellbound for modern exploitation,

Hinds walnut is treated as *Juglans californica* var. *hindsii* in *The Jepson Manual*, but in other publications is still recognized as the species *J. hindsii*. Illustration of the only taxon of Juglans treated by W.L. Jepson in his 1910 *Silva of California*, "*J. californica*." Habit drawing by M.H. Swift; detail drawings by A.J. Heindl and E. Roorback.



NOMENCLATURE

The two native black walnuts in California have been named in two different ways. According to *The Jepson Manual*, there is only one native *Juglans* species in California, *Juglans californica*, with two varieties, *J. c.* var. *californica* and *J. c.* var. *hindsii*. In contrast, the sixth edition of the *California Native Plant Society Inventory of Rare Plants* (among other authorities) treats these two taxa as distinct species: *Juglans californica* and *Juglans hindsii*. This article follows the latter treatment.

Various common names are used to refer to these two taxa. Here I use California black walnut (for *J. californica*) and Hinds walnut (for *J. hindsii*), but at least one other name pair is also in use: southern California black walnut and northern California black walnut.

except by ethnobotanists even more dedicated than I.) The tree also provides shade, erosion control, and other benefits. It has been used as a firewood source and an understock for commercial walnut production.

I have always had an interest in this tree, but my interest increased after I moved to Walnut Avenue in San Bernardino. I am not sure whether the street was named after the wild walnuts, but they abound here, with one huge stand beginning across the street from my house and extending up Bailey Canyon (on whose bank I live). I am uncomfortably aware that my house and my neighbors' houses exist at the expense of the downstream end of this stand. Walnut trees are still being replaced by houses in the area. A nearby stand of huge, ancient, multi-trunked walnuts was destroyed in February 2001 to make way for new houses. Most of the stands outside the San Bernardino National Forest are slated to follow. For this and other reasons, I have begun a more systematic inquiry into the life and times of the California black walnut.

Very little is known about the plant. Except for work by Jon Keeley (1990), C.A. Leskinin (1972), and students and associates at California State Polytechnic University (see Tenbrink et al., 1999), there is virtually no sustained work reported. A brief article by Quinn (1989) reviews conservation problems. Thus, almost any new information would seem to be valuable.

FORM

The California black walnut is now almost always seen as a large, multi-trunked shrub, ranging from 10 to 20 feet in height. However, it

The California black walnut (*Juglans californica*): Tree size in Devil Canyon, San Bernardino County, top. • California black walnuts do become trees; note pen for scale, bottom. Photographs by R. Frye.

can be a modestly imposing tree. The "record *Southern* California black walnut" (Byrne 2000, emphasis added), growing in Chico, is 116

feet high and 241 inches in circumference. This is a planted tree, far out of its natural range, and it may be a misidentification. Among naturally occurring trees, there are some single-trunked specimens in the Bailey Canyon–Devil Canyon area, more than 40 feet tall. Two growing near each other are worthy of note: one is 42 feet tall, with a spread of 40 feet, and a circumference (at 4 feet above ground) of 98 inches. The other is about the same height (but not easy to measure), with a spread of 51 feet. It branches a foot off the ground; the trunk below that is 102 inches around, and the biggest branch is 76 inches around at 4 feet. Keeley (1990) reports even larger trees in the old days, known now only from somewhat questionable descriptions.

RANGE

The California black walnut has a rather remarkable range. Its eastern limit is set very sharply by Waterman Canyon in the San Bernardino Mountains. It abounds in this canyon, but does not occur at all farther east. (Possible causes include drought and too frequent fire. The tree is vulnerable to fire when young, but quickly becomes resistant.) In the west, it extends almost to Point Conception in Santa Barbara County. Its northern limit is set, roughly, at the middle elevations of the Transverse Ranges. It is reported to extend just north of the Santa Ynez River in Santa Barbara County, and to about as far north in Ventura County (Griffin and Critchfield 1972). The southern limit is somewhat unclear. Griffin and Critchfield (1972) show an isolated stand in San Diego County in the moist mesa country just southeast of the point where Riverside, Orange, and San Diego Counties meet.

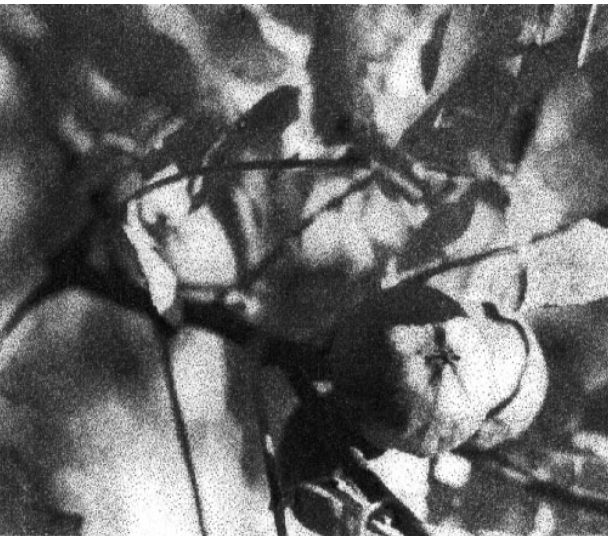
Why it should stop there, with so much excellent habitat to the south, is a mystery.

Within these limits, Griffin and Critchfield seriously underreport the range of the tree. For instance, they show what I assume is the Waterman Canyon stand as an isolated "x," when in fact it is merely the eastern end of a long and almost continuous belt of walnuts along the San Bernardino and San Gabriel front, reaching from the outwash fans of the canyons up to 3,500 feet. Similarly, they show scattered "x" marks in the Santa Ynez Mountains where the walnut is common as a north-slope tree.

In terms of altitude, the tree extends from near sea level in the Santa Monica Mountains to 3,500 feet in the San Bernardino canyons, but is rarely found above that elevation. Presumably, the much colder and snowier winters above 3,500 feet kill the seedlings.

Within these limits, the walnut abounds on the southernmost slopes of the Transverse Ranges, and throughout the Santa Ynez, Santa Monica, and northern Santa Ana mountains, and in the hills

Nuts and leaves of California black walnut. Photograph by R. Frye.



WALNUT IDENTIFICATION

Distinguishing the California black walnut from other nut trees can be a challenge. Eastern black walnut (*J. nigra*) and pecan (*Carya illinoiensis*) have been planted widely in southern California, often at homesteads now long abandoned. Sometimes the eastern black walnuts were planted among native walnuts; presumably the settlers thought the wild walnuts were a good indicator of places where eastern walnuts would also flourish. On Los Sauces Creek along State Highway 150 in southwestern Ventura County, there is an area where pecans have escaped from homestead plantings and enthusiastically colonized the riparian strip along the creek, within a California black walnut woodland. The pecans grow in permanently wet soil, the walnuts in drier sites, but they are in close proximity, with branches sometimes touching.

Eastern black walnut, Hinds walnut, and California black walnut were all used in pioneer days as understocks for Persian ("English") walnut (*J. regia*), and these under-stocks sometimes grow into trees when the grove is abandoned and the scionwood dies. One can tell such stands from natural stands by the regular spacing of the trees in orchard plantings and the presence of other planted species. Truly strange are some large walnuts one sometimes finds in natural groves: they have larger leaves and paler bark than the native, but they appear to be naturally occurring. They do not fruit. I suspect they are hybrids between the native and the eastern black walnut. There are at least three such trees in Bailey Canyon.

between. It is especially common, and often dominant, in the Puente Hills, the hills of urban Los Angeles, the Santa Monica Mountains, and the mountains of southern Ventura County. Here it often forms solid stands, with less dense savanna-like stands occurring on south and west faces. Pure, closed-canopy stands dominate many north-facing slopes.

ASSOCIATES

Attempts to restrict the walnut to one or another "plant community" serve only to show how inadequate the old plant community concept is for California's dynamic vegetation (see the sidebar below). Within their tiny range walnuts are everywhere—subject to their own idiosyncratic limits. In Bailey Canyon, for example, they occur in literally every habitat, from alluvial outwash to rock cliffs. Bailey Canyon is a most diverse place, and so one can find walnuts as a component of grassland, coastal sage scrub, several types of chaparral, riparian woodland, oak woodland, and mixed canyon woodland. Similarly, in Topanga Canyon in the Santa Monica Mountains, the walnut occurs in riparian woodland, chaparral, open cliffs, sage scrub, and grassland, from the bottom of the canyon to the top of the hills around it. The same could be said of many other canyons throughout the tree's range. Walnut grows on granite, carbonate, sandstone, shale, and alluvial terrain, with its usual riotous indifference to circumstances.

Tenbrink et al. (1999) note that the walnut's associates in pure-stand woodlands of the Los Angeles urban area are all non-native weeds, except for a rare milkweed. This is not always true elsewhere, however. Los Angeles presents a special case because of the intense disturbance caused by a century of extreme overgrazing followed by a century of urbanization. In other locations, the tree is often found in savannas that have been taken over by non-natives, but it also occurs with many native associates. In Bailey Canyon, for instance, more than 140 native plant species grow closely associated with walnuts. These range from various codominants in woodland, including oaks, California Sycamore (*Platanus racemosa*), *Ceanothus*, and *Adenostoma*, to understory species such as *Eriogonum fasciculatum*, *Rhus* spp., various annuals on dry sites, and plants such as *Solidago californica* in moist areas. There are also some small but solid forests of wild walnut, made up of trees up to 25 feet tall growing with the rather unusual associate velvet ash (*Fraxinus velutina*). Here and elsewhere in the San Bernardino range, the walnut often forms a natural fence around

WALNUT AS A COMPONENT OF VARIOUS PLANT COMMUNITIES

The California black walnut does not seem to restrict itself to a few distinct plant communities, but occurs across a wide range of habitats.

- **Forests and woodlands.** In parts of its range, California black walnut grows with various other tree species in forest and woodland communities. A unique forest formation grows on the northeast side of the Santa Susana Mountains and locally in the San Bernardino's westernmost canyons: a true forest of bigcone Douglas-fir (*Pseudotsuga macrocarpa*), oaks, and walnut. A magnificent oak–walnut forest, dominated by coast live oak (*Quercus agrifolia*), covers more than 5 square miles on the north face of Sulphur Mountain in Ventura County. Common associates include blue elderberry (*Sambucus mexicana*) and various riparian trees along waterways. Similar oak–walnut forests exist from the Santa Ynez Mountains to the Puente Hills, but in fragmented forms, with walnuts sometimes being confined to relatively dry sites or to sandy canyon areas. Mullahy (1992) has found walnut growing together with flowering ash (*Fraxinus dipetala*) or California laurel (*Umbellularia californica*) in woodland areas.
- **Sage scrub.** In scrub habitats dominated by *Salvia* species, California coast sagebrush (*Artemisia californica*), and other typical plants, walnut dominates moist sites. This is a common association on the lower Santa Susana and Santa Monica mountains, and occurs locally eastward to Waterman Canyon.
- **Chaparral.** In chaparral habitats, walnut often grows at the outer edges of the wet zones created by springs, especially seep springs. It also grows in dry washes.
- **Riparian woodland.** In riparian communities, walnut trees grow everywhere except in the permanently-wet corridor. They occur in dry washes, seasonally running washes, riparian outwash fans, and in the margins of gallery forests along permanent streams. California black walnut is often the dominant species in the latter two habitats. Its associates can range from dry wash species such as Whipple yucca (*Yucca whipplei)* to willows and other water-loving plants.

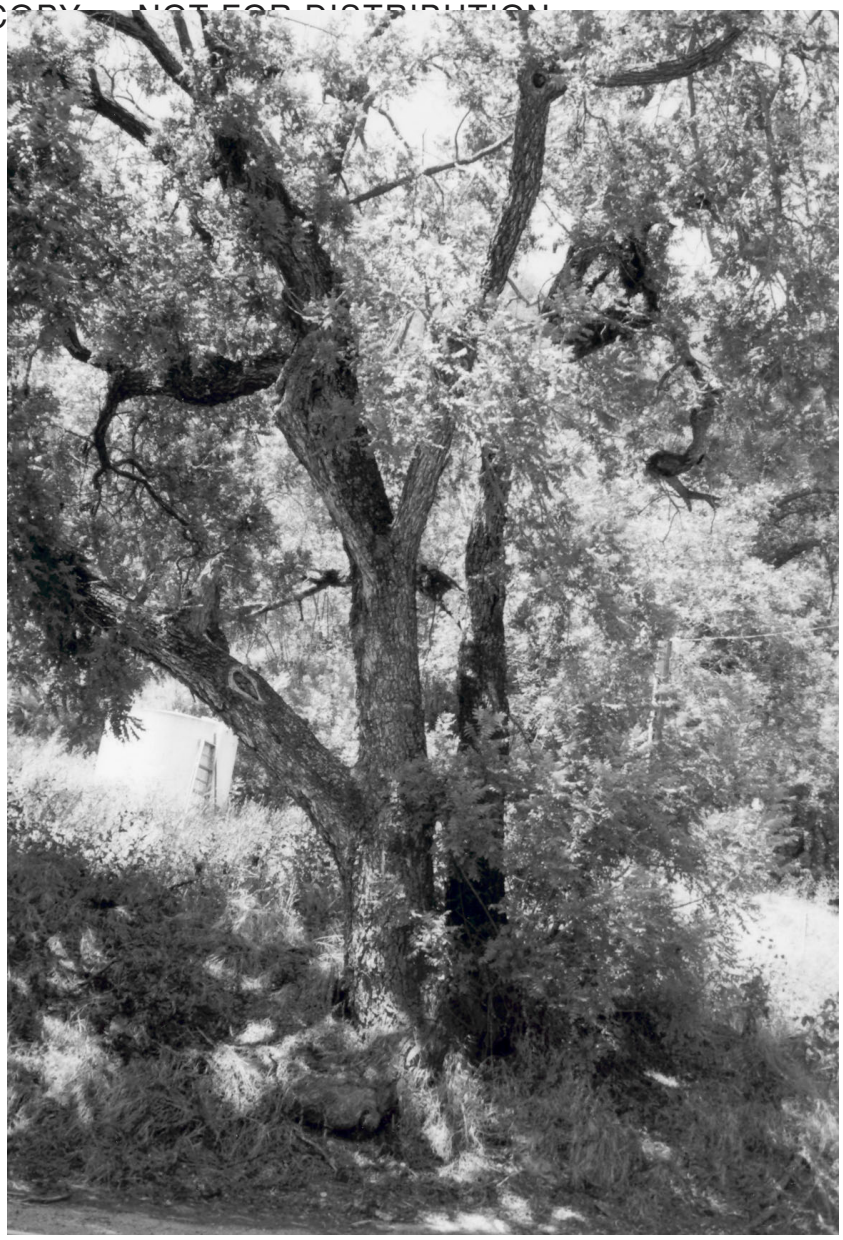
the huge mats of Arizona grape (*Vitis girdiana*) that cover seep springs.

Often the walnut grows with introduced grasses, probably because both take over highly unstable sites. But it more often grows with sage scrub or riparian species. It is rarer in chaparral, but not uncommon even there. In riparian areas it grows in drier soils near such plants as Pacific willow (*Salix lasiolepis*) and Arizona grape (*Vitis girdiana*).

HABITAT RESTRICTIONS

Overall, the range limits of the California black walnut are set by drought, cold, and probably fire. As noted, walnuts do not reach high altitudes. They do not occur on flat ground except for riparian outwash, and prefer (but are by no means confined to) north- and east-facing slopes. They do not occur in very dry sites, or even in moist areas that are frequently exposed to intense heat and drought. The limit in the San Bernardino range front (Waterman Canyon) is the limit of relatively cool, moist air and fairly heavy rainfall in the foothill zone. Eastward the slopes are hotter and drier, without much woodland of any kind. Walnuts do not occur in areas subject to intense and frequent fires since a healthy tree needs several years before it is large enough to withstand wildfire. The exact number of years depends on the season and intensity of the fires in a given area. Once a tree has developed a large root system it is considered fireproof since it can resprout from the stem/root base.

Walnuts are notably tough in the face of wind. On the alluvial fans of the San Bernardinos, foehn (Santa Ana) winds are frequent and intense, sometimes gusting well over 100 mph. No other tree seems to withstand this. Two-foot-thick olive and eucalyptus trees are broken off like matchsticks by foehn winds, and deep-rooted bushes are sometimes literally blown right out of the ground. The walnuts rarely show damage, though I have seen a few branches broken. Huge old walnut shrubs on the open alluvial flats, with multiple trunks each a foot thick seem impervious to the wind. No other tall plant grows in these environments, and planted trees are destroyed quickly.



California black walnut as small tree, Sulphur Mountain, Ventura County. Photograph by E.N. Anderson.

However, walnuts are found only in moist (not wet) to subarid (not arid) sites. They move down into riparian settings, but are outcompeted by willows and the like, probably because they are unable to deal with permanently wet conditions. I would suppose (and so do botanists I have asked about this) that fungus affects them. However, walnuts in my well-watered yard and in frequently watered but well-drained parks near my house are flourishing, even when surrounded by grass lawns that are kept constantly damp. Conversely, walnuts occur in dry sites only if there is some subsoil seepage and good water retention.

Walnuts prefer very loose soil.

Such soil allows rapid and deep water percolation, stays moist long into summer, allows seedlings to put down deep roots rapidly, and increases the chances that the seeds will get the deep burial they need when there is disturbance from flooding, landslides, rodent action, and the like. This means that walnuts are primarily found on unstable slopes with much dry creep; in soft, crumbling sedimentary rock (typified by the Puente Hills and the hills of Los Angeles, as at the Southwest Museum); and in sandy and gravelly riparian outwash. However, I have seen trees in almost every other imaginable place, from adobe clay to bare rock cliff.

REPRODUCTION

The most difficult time of almost any organism's life is the beginning. The vast majority of nuts borne by a California black walnut never germinate. They are eaten by squirrels and other animals, or they break down and decay.

My observations of wild and planted nuts suggest that they germinate only if they become buried rather deeply (more than an inch) and then are kept damp. They cannot take serious competition. In the modern world, rip gut Brome (*Bromus diandrus*) and other introduced pests rapidly invade every bare site and take all the water. On the other hand, walnuts do far better under such circumstances than other native trees, establishing themselves even in the thick cover of weedy grasses.

I have been monitoring six seedlings that became established in Bailey Canyon during the El Niño year of 1997–1998. Of these, four plants became established in small rockslides and two on roadbanks recently bermed up by the Forest Service along the edge of the Bailey Canyon forest road. All were in moist, but not wet, places. One is in the shade, the others in sun. The four most successful plants are in full sun on a south-facing slope, but they are near reliable seep springs. The six range in size from one feeble seedling in a very dry spot (ten inches tall as of June 2001) to one six feet high. The latter is growing very close to two of the others (both about three feet tall), in the same rockslide but in a moister spot.

In 2001, following late and very heavy rains, a large number of walnuts germinated in Bailey Canyon. I have found more than 30. Virtually all were in shade. Most were in two areas: on a recently bermed-up road cut on a moist north slope, and under a grove of walnuts at the canyon mouth. In both cases they are competing actively with other plants; in the second case, they are coming up through heavy *Bromus diandrus* cover.

Meanwhile, I planted several wild walnuts in the fall of 1998, and several more in 1999 and 2000 on my steep bank along Bailey Canyon Creek. I watered them along with several young domestic fruit trees, deep soaking them every week in dry weather, and every three days in very dry weather. Several of the seeds sprouted. Some in drier parts of the slope briefly flourished and then died, apparently due to gopher predation. Others, however, are well-grown. One planted in 1998—now ten feet tall and four inches thick—is in a particularly

California black walnut bush within coastal sage scrub bush, Grimes Canyon, Ventura County. Photograph by E.N. Anderson.

Late spring foliage; Bailey Canyon, San Bernardino County. Photograph by E.N. Anderson.

moist spot with good soil and shelter from the persistent wind. Another, planted in 1999, is already eight feet tall. All have grown into single-trunk trees. By comparison, nearby canyon oak (*Quercus chrysolepis*) and brush cherry (*Prunus* sp.) seeds planted at the same time have produced very few seedlings, and are now only three to five inches high. Evidently the walnut is magnificently competitive when it gets any chance at all, but it requires special circumstances. It seems the trees naturally establish themselves largely in places cleared and "prepared" by floods and rockslides, with a significant minority establishing via rodent agency—either through deliberate storage or as a result of the nut falling into a rodent hole.

It is worth noting that all young walnuts begin life with a definite trunk and try to grow as a tree. One must assume that the usual large-shrub form of the plant is due to resprouting after fires or floods. Under these circumstances, a large (occasionally enormous) lignotuber is formed.

Walnut roots rapidly go deep into the soil and into rock cracks. Individuals weathering out of the wall in Bailey Canyon display thick, tough roots tens of feet long.

Hope for the future: Reforestation with California black walnut by California Dept. of Water and Power along channelized sector of Bailey Canyon. Photograph by R. Frye.

CONSERVATION

I think it is imperative to form an overall plan for preserving samples of different California black walnut populations and their habitats. The following are particularly important.

First priority. The solid stands on recent sedimentary rock in the Puente Hills and the hills of downtown Los Angeles (especially at and near the Southwest Museum). These are desperately endangered, as well as being the most central, characteristic, and pure stands of the walnut.

Second priority. The unique and magnificent forest of Sulphur Mountain. Small pockets of similar habitat exist on other nearby ranges, notably the Santa Susanas, but the Sulphur Mountain stand is the only large and unbroken forest of its type in the world.

Third priority. Various smaller pockets of unusual interest, especially those at the extreme ends of the plant's distribution, also deserve attention. These include populations in south-west Santa Barbara County, the southern Santa Anas, the San Bernardinos (mostly preserved in the San Bernardino National Forest and related conservation lands), and small groves in chaparral and sage scrub on the Santa Monica and Santa Susana mountains. One area of particular note is the outwash of Cable Canyon, along the 215 freeway between Verdemont and Devore in San Bernardino County. Here, about 200 acres—for sale, zoned for industry—is essentially untouched and virgin alluvial wash scrub, dominated by walnut and arborescent birchleaf mountain mahogany (*Cercocarpus betuloides*), with an understory of *Ceanothus* spp., Whipple yucca, and various sage scrub plants. This plot could easily be added to the nearby Glen Helen County Park, which does—mercifully—preserve a small patch of similar habitat. (Unfortunately, this patch is somewhat disturbed, and is vulnerable to destruction by expanding park facilities.)

Throughout its range, the walnut is endangered by the same factor that is rapidly wiping out all native vegetation in the region: invasion by weedy aliens that, under current conditions of fire and pollution, outcompete all natives.

HORTICULTURAL VALUE

I cannot understand why the walnut is not popular as an ornamental or used more widely for erosion control. It is the ideal native. It starts easily from readily available, easy-to-plant propagules. Anyone can gather walnuts from places where there is no longer any hope of natural germination and grow all the trees they want without cost. The walnut grows quickly and adapts to all but the most extreme local conditions. It provides shade during the hot summer months, but is leafless in the winter when the sun's warmth is most needed. It is a versatile plant, and can be trained as a shrub or tree. In addition, it provides wildlife with food and shelter. The walnuts also coped considerable better than the oaks with the unprecedented drought of 2002. One reason is that the walnuts can shed their leaves if conditions are harsh.

Last and not least, the walnut has one of the most beautiful forms and foliage of all native broadleaved trees. At a time when natives are increasing in popularity, the walnut should be planted more widely, as it is easier to grow and grows more quickly than most others. In fact, it should be made a plant of choice for restoration projects throughout the Los Angeles basin, if only to replace the thousands of acres of walnuts that have been lost to urbanization and alien plants.

One wishes that CalTrans and

An all too common story: The last wild walnut of Walnut Avenue (San Bernardino, 2001). Soon it too fell to the bulldozers in the background. Photograph by R. Frye.

other governmental agencies would plant only natives instead of introduced species. While many natives are difficult to grow or grow very slowly, and some are undesirable for other reasons, there are many—including not only both native species of walnut but also the California sycamore, the toyon (*Heteromeles arbutifolia*), the California laurel (*Umbellularia californica*), many evergreens, many *Ceanothus* forms, and others—that are competitive in every way with introduced species. These should be planted more, especially if the species is threatened or vulnerable as is the walnut.

It is good to be able to end on an upbeat note. At the end of my street (Walnut Avenue) is a large reservoir, part of the California Water Project. Construction of the reservoir involved channelizing Bailey Creek in cement, and in the process many walnuts were eliminated. In winter 1999–2000, the authorities saw fit to plant hundreds of young California black walnuts along the channel. They have received excellent care and are flourishing. Hopefully in the not-too-distant future they will be numbered among the many new groves of California black walnut that have been restored or replanted in California. I, for one, would love to be present on the day when *Juglans californica* is officially removed from our state's list of threatened species.

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Professor-Emeritus Major sampling alpine vegetation on Kilyaktalik Peaks, Alaska, with Bruce Dale on 18 July, 18, 1984, three years after his retirement from University of California, Davis. Jack was 67 at the time. Photograph by M. Major.

AN APPRECIATION OF JACK MAJOR, 1917–2001

by M.G. Barbour, P.A. Castelfranco, R.W. Pearcy, and M. Rejmanek

And on his grave some kindly person wrote,
Never did he jump on a bandwagon…
He preferred to walk.

—"Epitaph" by
Paul Castelfranco (1991)

Jack Major, Professor Emeritus of Plant Ecology at the University of California, Davis (UCD), died 13 February 2001 in Davis at the age of 83. Professor Major had a profound impact on the direction of plant ecology in the United States during the second half of the 20th century. Besides his immediate family—brother Ted, wife Mary, and sons Paul, John, and James—he left behind many students and colleagues who fondly remember his great academic gifts to them.

Jack's academic home for most of his career was the UCD Botany Department, where he taught from 1955 until retirement in 1981. His spiritual home, however, was in the mountains: the Uinta Mountains of Utah, the Sierra Nevada of California, the Grand Tetons of Wyoming, the Brooks Range and the Juneau Ice Fields of Alaska, and the Himalayas of Nepal. These were the environments that he most often shared with graduate students and those undergraduates fortunate

enough to take his plant ecology classes.

He truly was the ideal scientist described by Poincare (1958): one who "does not study Nature because it is useful to do so. He studies it because he takes pleasure in it . . . [and] because it is beautiful."

Jack was born on March 15, 1917 in Salt Lake City, Utah, and completed high school there in 1935. He went on to Utah State Agricultural College (now Utah State University) and received a BS in Range Management in 1942. For the next several years he served in the Army's 10th Mountain Division, the justifiably famous unit of 1,000 skiers and alpinists who trained hard in the mountain west before participating in the Italian campaign of World War II. (After the war, a number of men from that division went on to become conservationists, ecologists, and leaders in the promotion of recreational skiing.) Between 1946 and 1953, Jack attended graduate school at the University of California, Berkeley, obtaining a PhD in Soil Science under the direction of Professor Hans Jenny. During this time he also met and married Mary Cecil, thanks to an introduction from brother Ted, who had met Mary by chance on a rock climbing expedition in the Grand Tetons. She, too, had a love for the mountains.

Jack was hired as a member of a young weed science group in the Botany Department at UCD. His strong interest in the ecology of undisturbed mountain vegetation, however, conflicted with the weed group's focus on plants in agronomic, low-elevation settings. This habitat bias gradually distanced him from weed science, and a 1964 Fulbright Fellowship to Innsbruck, Austria, was to cement a lifetime's focus on vegetation science.

He had a driving curiosity that made him an extensive reader of, and correspondent with, scientists who specialized in a wide range of topics, including those who wrote in other languages. As a result, he was far ahead of his time. For example, inspired by his major professor's book, *The Factors of Soil Formation* (Jenny 1941), Major wrote a paper that proposed to use differential equations to describe vegetation–environment relationships for any given plant community (Major 1951). Not for another quarter of a century, however, did any ecologist actually begin to *use* differential equations in the description and modeling of plant communities.

One measure of Professor Major's vision and impact is the fact that several of his earliest papers are still cited today, in some cases more often now than originally. According to the ISI Web of Science, "A functional, factorial approach to plant ecology" (Major 1951) has been cited 91 times in the past 25 years. His superb synthesis of California's flora, geology, and ecology in "Endemism and speciation in the California flora" (Stebbins and Major 1965) has been cited 102 times in the same period, and a third paper, "Buried viable seeds in California bunchgrass sites and their bearing on the definition of flora" (Major and Pyott 1966), has been cited 138 times—at the rate of seven times per year for the most recent five years. His work on primary succession following glacial retreat (Crocker and Major 1955) is a classic, cited nearly 300 times in the last 25 years and still described in many textbooks nearly a half-century later (e.g., Barbour et al. 1999; Begon et al. 1996; Krebs 2001).

Jack was one of very few Americans to practice the phytosociological protocols widely used in Europe (and throughout the non-English-speaking world) for sampling and classifying vegetation. Consequently, relevé-style sampling and syntaxonomy were employed by most of his students in their theses and dissertations (e.g., Neilson 1961; Pemble 1970; Taylor 1976; Burke 1979; Benedict 1981). Jack's gentle leadership in pulling reluctant American ecologists across a then-narrow bridge of communication with the rest of the world was without doubt of seminal help to Robert Whittaker when, in the 1970s, his travels and publications widened that bridge. Only now—20 to 30 years after his students have finished their graduate degrees—are phytosociological papers becoming accepted and publishable in the US. A retrospective appreciation of the value of his work, (and that of his students) to conservation and park management was written by David Parsons on the occasion of Jack's retirement (Parsons 1982; Anonymous 1982).

Throughout his career, Dr. Major was as well known for his reviews of ecological books written in other languages as for his own

Recently tenured Associate Professor Major behind a typewriter in his office in the Botany Department in on the UC Davis campus, February, 18, 1963. Jack was 45 years old at the time. Photograph by R. Gankin.

JACK MAJOR STUDENT GRANT FUND

At the request of Mrs. Mary Major, the Davis Botanical Society has started a student grant fund in memory of Jack. The Society will use the fund to award grants of up to $500 a year to UC Davis students for field research in botany (including plant development, ecology, systematics, or geography), to support student field work in California and elsewhere. The Society is trying to obtain enough contributions to endow the grant fund ($10,000), so that awards can be made in Jack's name in perpetuity. If you would like to donate, please send contributions to: Treasurer, the Davis Botanical Society, Plant Biology, One Shields Avenue, UC Davis, Davis, CA 95616 (make checks out to UC Regents).

research. In 1975 the Ecological Society of America gave him the first Distinguished Service Citation specifically for his prodigious reviewing activity, judged to be an outstanding service to Society members. According to then-President Richard Miller (1975), "Major's reviews have consistently pointed out gaps in our own knowledge of American ecosystems and have indicated directions for fruitful new research . . . [We] would be immeasurably poorer without his dedicated efforts."

Jack was a gentleman scholar: learned but soft-spoken and modest to the point of self-effacement. If presented, in conversation, with an opinion contrary to his own, he was sincerely quizzical and would quite innocently ask why one thought that way, rather than offering a defensive or challenging counter-statement. In this manner,

Jack and his wife Mary (nee Cecil) in one of their favorite places, the subalpine zone of the Grand Teton Mountains, August, 1992, when Jack was 75 years old. Photograph by T. Major.

Jack made those around him feel equally learned. Even when he disagreed with them, his own contrary opinions were delivered so delicately and non-confrontationally (usually ending with his traditional phrase, "Is this alright?) that the recipients might not realize their logic had been shredded until reflecting on it some days later.

His forte in teaching was working with small groups, because his low-key manner was not well suited to large lecture sections or busloads of fieldtrip students. His method of teaching was Socratic, inviting questions and asking questions back, usually including his stock phrase, "Is this alright?" because he didn't want to lose anyone. His classes and his research interests were reflected in theses, dissertations, and publications on a wide variety of topics: alpine plant communities (Major and Taylor 1977, 1988), biogeography (Taylor 1977), California vegetation (Barbour and Major 1977, 1988), gradient analysis (Waring and Major 1964), plant ecophysiology (Macdonald 1981; Barry 1971), plant–soil relations (Myatt 1968), systematics (e.g., Gankin 1957), and vegetation change (Vankat 1970; Vankat and Major 1978). He was mentor to more than a dozen graduate students of his own and to many more via correspondence or by way of serving as a member on their thesis or dissertation committees.

Other obituaries of Professor Major have appeared in *Madroño* 48:215-218, *Bulletin of the Ecological Society of America* 82:174-176, and the University of California's 2003 *In Memorium* volume.

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INDEX TO FREMONTIA: VOLUMES 28 AND 29 JANUARY 2000–OCTOBER 2001

Compiled by Vivian Parker

During the period covered by this index, several combined issues of *Fremontia* were published. The January 2000 issue [listed here as 28(1)], encompasses Vol. 27, No. 4 and Vol. 28, No. 1; the April–October 2000 issue includes Vol. 28, Nos. 2, 3, and 4; and the July–October 2001 issue comprises Vol. 29, Nos. 3 and 4.

A

Baccharis (*Baccharis douglasii*). Illustrations by Margaret Warriner Buck, from *The Wild Flowers of California* by Mary Elizabeth Parsons.

B

C

Columbine (*Aquilegia truncata*).

Sunshine (*Baeria gracilis*).

California trillium (*Trillium sessile* var. *californicum*).

D

E

F

G

Silk-tassle tree (*Garrya elliptica*).

Alfalfa (*Medicago sativa*).

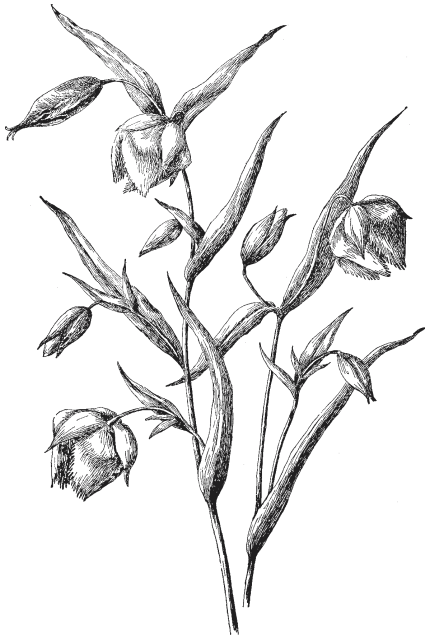
H

Tree mallow (*Lavatera assurgentiflora*).

Rattleweed (*Astragalus leucopsis*).

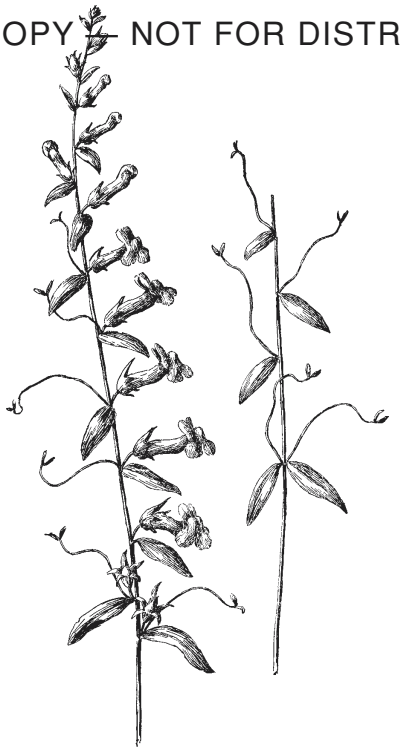
N

O



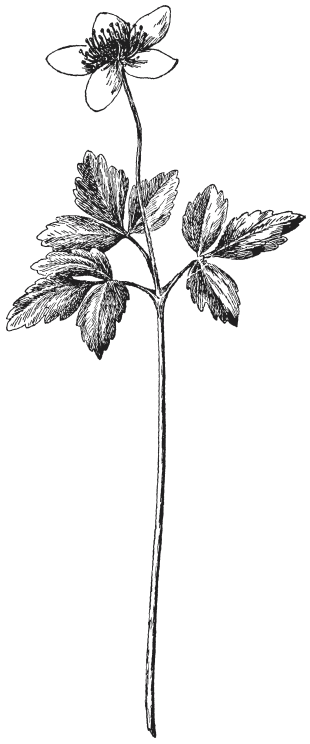
Satin-bell (*Calochortus albus*).

P



Violet snapdragon (*Antirrbinum vagans*).

Wood anemone (*Anemone cinquefolia*).



Vivian Parker, 6221 Shoo Fly Rd., Kelsey, CA 95667. vparker@innercite.com

NOTES AND COMMENTS

SUPERIOR COURT RULES ON UC MERCED CEQA LAWSUIT

The CEQA lawsuit, brought against the UC Regents by three San Joaquin Valley groups, was heard today [October 2, 2002] in Merced County Superior Court. The suit was denied and will be appealed immediately by the petitioners. A request for a stay, to halt any construction until the merits of the case are heard, will also be filed with the 5th District Appellate Court.

Petitioners are the San Joaquin Raptor/Wildlife Rescue Center, Protect Our Water and Central Valley Safe Environment Network. Spokespersons for the group expressed no surprise at the local judge's ruling. "We assumed that the case would ultimately be decided by the Appellate Court and that process is now underway."

Defendants in the case are the Regents of the University of California, Merced County, the Virginia Smith Trust, and the Merced Irrigation District.

There are other significant federal environmental review processs for the UC Merced project ongoing and undecided, including those addressing the site location and the impacts to federally protected species. While UC has indicated their intention to begin construction without a decision on these processes, to do so is clearly a roll of the dice with public money.

For further information contact:

Lydia Miller
San Joaquin Raptor Rescue Center
(209) 723-9283
raptorctr@bigvalley.net

Steve Burke
Protect Our Water
(209) 523-1391
sburke@ainet.com

and visit the website *www.vernalpools.org*.

LETTERS TO THE EDITOR

The Three-Hole Punch

Dear Editor,

I heartily agree with the favorable comments about the new *Fremontia*. Although not a botanist, I read every issue cover to cover. On the three-hole punch—what harm does it do? Even if helpful to only a few, it harms no one. Keep it!

Anne Funkhouser,
San Hedrin Chapter

Dear Editor,

As a lowly but longtime member of CNPS, I cast my vote for the three-hole punch in *Fremontia*. It is a treat to be able to keep my issues together in a manner that preserves and protects the copies.

Georgie Waugh,
Sacramento Chapter

Dear Editor,

I just finished reading the recent *Fremontia*, and wanted to register my "vote" on the three-hole punch issue—I have never once found the holes useful, so as far as I am concerned *Fremontia* may become "whole" again.

And, I wanted to add my commendations for the revised look and continued great content of *Fremontia*. Keep up the great work! Please!

Jim Morefield,
Bristlecone Chapter

Dear Editor,

Count me in favor.

After reading, my copies go right into a three-ring binder. It would strain my hole-puncher to go through such a thickness.

Nice issue!

Larry Blakely,
Bristlecone Chapter

Dear Editor,

In response to the gentleman from Arcata regarding the three-hole punch, i.e., "How many fingers does it take to count members . . . ?:

One Finger

A native New Yorker, I love and know
The flora of the state I now call home.
Through California I choose to roam,
From desert to mountain,
With friends or alone.

The Fremontia*s I've saved are such a treasure,*
Thumbing through old ones gives me great pleasure.
I've kept them all, since '83,
They're neatly in binders for all to see.

If the holes were't there
I'd have to make them.
So from each issue, I hope
You won't take them!

Lisa Steadman,
Yerba Buena Chapter

Old Issues of *Fremontia*

Dear Editor,

I've been a CNPS member for years and have back issues of *Fremontia* (1991 to present) that I'd like to donate to a library or other organization that could use them. Any suggestions on whom to contact?

Nancy Teater,
Santa Clara Valley Chapter

From the Editor: I have received several inquiries about what to do with back issues or sets of Fremontia. *CNPS wants to make sure that the valuable information contained in back issues of* Fremontia *is disseminated in as many directions as possible. If you have a near-complete set of* Fremontia *that you would like to pass on, please try and route them to your local chapter for giving away (or for a small donation) at events; this can help educate others about California's native plants and may also help in the recruitment of new members. Also, the State Office and Education Committee will route old issues to schools or other places that are building reference materials on the botanical heritage of our state.*

BOOKS RECEIVED

Brooms: Managing Invasive Alien Shrubs, Video tape produced by produced by Leif Joslyn of Ecovisions, Inc. An excellent 45 minutes with appealing footage, and informative and accurate script. This video is well-paced, and holds the interest throughout. Details on control are thorough and clear. It manages to make broom look spectacularly beautiful and menacing at the same time. Price $25. Further info: *www.thebrooms.org*

The Manzanitas of California: also of Mexico and the World, written and published by P.V. Wells. 2000. University of Kansas, Lawrence. 151 pp., 150 illustrations. The compendium of Phillip Wells's knowledge of manzanitas (*Arctostaphylos* spp.) is now available to all by writing the Department of Ecology & Evolutionary Biology, Haworth Hall, University of Kansas, Lawrence, KS 66045, or by calling (785) 864-4619. Price $50.

BOOK REVIEWS

Penstemons, by Robert Nold. 1999. Timber Press. 307 pages. 43 color photos, 12 watercolor botanical paintings, 18 black-and-white line drawings. $29.95.

In the preface of this handsome book, Robert Nold states that he attempts "to describe all the species of penstemon known to me either personally or by name." Given the great size and difficulty of the genus, this statement, at first blush, smacks of hubris; alternatively it might serve as a caveat to excuse omission of taxa. Not so, on either count. In his species descriptions, as well as in the chapter on relationships within the genus, Nold includes essentially all *Penstemon* taxa recognized in current manuals or treated in recent literature (to 1999). And, in non-technical, evocative language, he gives a brief and accurate description of each.

Penstemon, an enormous endemic North American genus ("some 270 species, depending on which authority is consulted") has never been fully monographed. To date, there is no single treatment of the genus throughout its range that fully treats the identity and delimitation of its many geographic variants. A confused and overlapping literature has accumulated for this much-studied genus. Nold manages to avoid this potential mine-field of nomenclatural difficulty with refreshing humility—perhaps surprising, considering his obvious deep familiarity with penstemons in the wild, in the garden, and in the literature.

cut a word or two to eliminate all the hyphens

Chapter 7, "the A–Z heart of the book," comprises almost half the pages. A description of each species is given, along with distribution data, habitat preference, and flowering time. The author adds comments drawn from his own gardening and field experience, and evaluates garden worthiness. The chapter is highly readable, somehow escaping the dryness that such a listing often entails. The text subtly, but carefully, reveals the degree of his familiarity with a given taxon. Two examples, taken at random, will illustrate this. He notes that *Penstemon scapoides* "is a peculiar plant" (interpretation: he has seen it) and "would be a nice plant for the dry rock garden" (interpretation: he has not grown it). He writes that *Penstemon saltarius* is "described by Crosswhite as having small oblancelolate leaves" and is "yet another Mexican species not in cultivation" (interpretation: he has neither seen nor grown it).

Five of the chapters deal primarily with different aspects of gardening with penstemons. Plainly, these chapters are based on extensive personal experience: they are practical, helpful, and often humorous. California gardeners who wish to grow native plants will not want to miss his comments and fresh philosophy in Chapter 2 concerning so-called dry-land gardening. Six chapters are devoted to the taxonomy, morphology, and distribution of species in the wild. Included in Chapter 6 (which groups the taxa within appropriate subgenera and sections) is such synonymy as is necessary to allow cross-referencing with most manuals in current use. With the use of this synonymy and the extensive Bibliography, horticulturists finding unfamiliar names attached to old friends can, with further study, unscramble nomenclatural history and the rationale for name changes.

The appendices, designed to assist gardeners with sources, color schemes, gardening schedules, etc., are nice. For those who need the jargon of the specialist, the glossary is comprehensive. In a group that is difficult to photograph effectively, I find the photographic plates (with few exceptions) excellent, and correctly identified. The watercolor renderings are marvelous; they capture the grace and nuance of the illustrated species. Line drawings of critical flower and anther morphology are helpful, although some of the drawings are so similar to the excellent illustrations in the treatment of *Penstemon* in *The Intermountain Flora*, Volume IV, that acknowledgement of these probable prototypes might be appropriate.

There is little to fault in this book, which is concisely written and tightly edited. The contents of each entry in the Table of Contents, from the Foreword through the Index, seems to me, as I read the book, necessary to the subject, non-redundant, and thoroughly interesting. I would have found helpful a cross-reference for each species treated alphabetically in Chapter 7 (Species Descriptions) to the same species listed in Chapter 6 (Divisions of the Genus); this would allow quick reference to the names of closely related taxa and to systematic placement within the genus. I noted only one

misspelling of a scientific name: *Penstemon thompsoniae* var. *desperatus*. Nold provides in this appealing and entertaining book an extraordinary synopsis of the genus *Penstemon* for the dedicated gardener. I find a refreshing unselfconscious honesty in the author's understated writing that contributes great credibility. Penstemons seem to have the tendency (properly so!) to acquire passionate devotees, Nold certainly included. Nonetheless, he seldom succumbs to overstatement or wordy emotional passages. It is one of the strong points of the book that he does not involve himself in the taxonomic and systematic quagmires of this difficult group, but simply treats the taxa as they are broadly accepted in the principal current manuals and in recent literature. The book will serve to narrow, not widen, the gulf between taxonomists and gardeners.

Elizabeth Neese,
East Bay Chapter

Coast Redwood: A Natural and Cultural History, edited by John Evarts and Marjorie Popper. 2001. Cachuma Press, Los Olivos, CA. 228 pp., ill., $27.95 softcover, $37.95 hardcover.

This is the second book on redwoods to be published in the last three years, and the most impressive. The other, published in 1999, is *The Redwood Forest*, a scientific treatment of the redwood ecosystem edited by Reed Noss and reviewed in the January 2000 issue of *Fremontia* (vols. 27:4 and 28:1 combined). Although I provided information to the editors on several topics discussed in *Coast Redwood: A Natural and Cultural History*, I did not see any of the chapters until after publication, and feel that I can now give a fair and impartial review.

Coast Redwood: A Natural and Cultural History has the photos and contextual information that the Reed Noss book is lacking and provides additional information on history, sociopolitical issues, and redwood management. It has a less technical and more unified approach while still being based on the latest scientific findings. In fact, the two books complement each other, with the Noss book providing some of the scientific detail lacking in this book. The two books also differ in their geographic focus. The Noss book is concerned mostly with the northern part of the redwood region, while this book is focused on the southern end, especially the Santa Cruz Mountains. Unfortunately neither book does a good job of explaining the distribution of flora and fauna throughout the redwood region, and the changes in species composition that occur from north to south.

The seven well written chapters in *Coast Redwood: A Natural and Cultural History* cover such topics as origin, distribution, life history, forest ecology, associated wildlife, logging, history, conservation, and management. Chapters were authored or coauthored by Michael Barbour, Mark Borchert, Sandy Lydon, Valerie Whitworth, and the two editors. The editors did an excellent job of coordinating the efforts of the other authors and the chapters flow smoothly one into the next, the whole book reading like one comprehensive story. One weakness of the book is that the references from all chapters are grouped together at the end of the book, rather than being listed by chapter. This makes it difficult for the reader to find additional information sources for facts cited in the text. Several useful appendices follow the text, including information such as precipitation and temperature averages from different stations throughout the coast redwood region, timber harvest volumes from different counties over time, and an index to common and scientific plant names. One serious omission is an index to common and scientific animal names used in the text.

The most striking feature of the book is the hundreds of full color and historic black-and-white photos that illustrate the text. These supplement the text superbly and are of the highest quality. Lead photo editor John Evarts should be commended for a doing a truly excellent job.

The text is exemplary as well, with broad and up-to-date coverage of all of the book's major themes. The history section is informative, entertaining, and contemporary enough to include a capsule history of the fight to save the Headwaters Forest. A well-warranted inclusion is a two-page sidebar on Julia Butterfly Hill, whose tree-sit was arguably one of the most heroic acts ever undertaken in the redwood conservation movement. Her action reminds us that the "save-the-redwoods" fight continues to this very day.

Coast redwood (*Sequoia sempervirens*), from the W.L. Jepson *Silva of California*. Drawing by E. Roorbach.

There is good coverage of all aspects of redwood ecology but not in much detail. For example, the coverage of old-growth forest ecology omits any discussion of the important ecological processes that are impaired or lacking in second-growth forests. These processes, such as the nutrient transformations performed by organisms in tree canopies and in the soil, are what make forests self-sustaining in the long term. The book fails to recognize that it is the loss of these natural processes during logging that has prompted citizens, researchers, local governments, and conservation groups to request reform of California's forest practice rules. Unfortunately these efforts to create a science-based approach to logging have not been supported by foresters as a whole, the timber industry, or the California Board of Forestry.

I found a few minor errors in the book. On page 38 it says that there are no species of higher plants whose range exactly overlaps that of redwood. But I believe that the lily, fetid adder's tongue (*Scoliopus bigelovii*), has a matching distribution. This interestingly named and unique winter-flowering wildflower warrants its own sidebar in the book, but it is not mentioned. On page 68 it says there are only three species of true oaks found in the redwood forest, while CNPS members will be able to name at least four species, not counting tan oak. On page 78 it says that in the Santa Cruz Mountains only Scott and Waddell Creeks support Coho Salmon while in actuality Gazos Creek also supports them and was the location of a recent stream restoration effort after it was damaged by the San Mateo County Public Works Department. CNPS members will probably find the discussion of associated herbaceous flora to be much too brief and the invasive exotics section to be incomplete—lacking, for example, any mention of the "redwood forest-favoring" *Epipactis helleborine*, our only invasive exotic orchid. However, these are only minor drawbacks from an otherwise well-researched, thoughtfully written, and carefully edited book.

Naturalists and redwood-lovers of all types will find this book to be essential. Environmental professionals who work on redwood lands will want to read it to broaden their perspective on redwood issues and subjects outside their own area of expertise. The park visitor or redwood landowner who wants to learn more about the natural and cultural history of this charismatic species will likely find the answers in this book. I wholeheartedly recommend it to every park docent, naturalist, land manager, and conservationist throughout the redwood region. Add it to your library and place it on the shelf next to the Reed Noss book. Together they provide the most complete collection of redwood information that has ever been published.

Steve Singer, Santa Cruz Chapter

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EDITORIAL

The last issue of *Fremontia* (Vol. 29 #3 & 4) pointed up the perils to our rare California plants; this issue describes threats to some relatively common native trees. Steven Swain informs of us what is known about the Sudden Oak Death pathogen, its hosts, and the impacts the pathogen has had on tan oak (*Lithocarpus densiflorus*) and oaks (*Quercus* spp.). Gene Anderson describes what he knows of the walnut of southern California (*J. californica* according to the Jepson Manual, *J. californica* var. *californica* according to the CNPS 6th Inventory), and how its populations are dwindling due to habitat loss. A tribute to the late Jack Major is presented by colleague and co-author of *Terrestrial Vegetation of California*, Michael Barbour. Also included is the two-year index (2000 and 2001), compiled by Vivian Parker.

I was recently asked by a potential contributor if *Fremontia* was a peer-reviewed journal. It is peer-reviewed, in that each article submitted is reviewed by two or more members of the *Fremontia* Editorial Advisory Board (listed at the bottom of this page); alternatively, each article appearing in a theme issue, such as the rare plant double issue mentioned above, is reviewed and edited by the convening editor as well as other contributors for that issue. One goal for *Fremontia* is that content is well-edited and science-based, but the additional goal of this journal is to inform and educate a broad audience, and therefore the articles are not as heavily laden with facts as those for a scientific journal. I do encourage letters to the editor if you find errors or have additional information that would supplement the content found here.

Linda Ann Vorobik, Editor

CONTRIBUTORS

Gene (E.N.) Anderson is Professor of Anthropology at UC Riverside, where he has taught for 35 years. He specializes in cultural ecology and ethnobiology.

Michael Barbour has been a plant ecology faculty member of UC Davis for 35 years and currently is in the Environmental Horticulture Department.

Paul Castelfranco is an Emeritus Professor of Plant Biology at UC Davis and a published poet; he was also a colleague of Jack Major's in the weed science group.

Vivian Parker (Conservation Chair, Shasta Chapter CNPS) is Biologist and Resource Policy Analyst for the California Indian Basketweavers Association.

Robert Pearcy is a Professor in the Section of Evolution and Ecology at UC Davis, and teaches the plant ecology course that Jack Major initiated half a century ago.

Marcel Rejmanek is a Professor in the Section of Evolution and Ecology at UC Davis. His research and teaching focus on invasive plants, but he also enjoys tracing the human history of ecological ideas.

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