CROSSOSOMA

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Rancho Santa Ana Botanic Garden, Claremont CA 91711

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SOME WEEDS CALLED ESCAPED EXOTICS IN CALIFORNIA

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The question of what is a weed has many answers. Webster's New Collegiate Dictionary defines it as: Any plant growing in cultivated ground to the detriment of the crop or to the disfigurement of the place, an economically useless or unsightly plant. Other less formal definitions are: a plant out of place; a plant growing where it is not needed, wanted or appreciated; a plant that interferes with man's use of land wanted for a specific purpose. To these I would add: a plant that grows on land disturbed by man and disseminated through the actions of man, intentionally or more often unintentionally.

Weeds may be divided into two groups: 1. those introduced unintentionally through agricultural practices, sometimes by their seeds, as contaminants of crop plants, in feed for domestic animals or carried by the animals themselves; and 2. those introduced intentionally, mostly for use as ornamentals in the urban landscape or for other purposes as soil stabilization and erosion control or for food. Weeds introduced intentionally, mostly as ornamentals, sometimes are referred to as escaped exotics. Although this may not be the best term for these weedy plants, in California most ornamentals are exotics, that is, brought into the state from other regions and a few "escape" from their cultivated areas. Because most escaped exotics were orginally planted in gardens, parks and similar sites of cities and towns, their distribution is largely concentrated in urban areas. A few, however, have spread aggressively and have invaded native vegetation.

The California Native Plant Society (CNPS), dedicated to the preservation of the state's native plants, began to realize several

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years ago that in many parts of the state habitats of native plants were being invaded and the plants threatened by those non-native alien or exotic weeds here discussed as escaped exotics. In order to better understand the threat to and the impact of these escapes on the native flora, CNPS in 1977 established the Escaped Exotics Committee. At that time the committee was charged with the preparation of a list of the ten most invasive and damaging escaped exotics. In mid-1984 in order to deal with the question of how to control the most invasive escapes the committee was further directed to consider research and recommendations on control.

From observations and information received from CNPS members since becoming chairman of the Escaped Exotics Committee in 1979 I have proposed a list of fifteen invasive escapes that are widespread and damaging in different parts of the state. These are discussed in this paper. It would be helpful and much appreciated if members of the Southern California Botanists who are interested in this group of weedy plants and have observations and information on their distribution and control could pass along their comments to me.

From California's floristic literature I have compiled a list of about three hundred escaped exotics. These may be roughly divided into three groups according to where they occur and the problems they create. GROUP I. Benign weeds remain within their urban areas where they do not increase greatly in numbers and cause no problems or at most only unimportant ones. Examples: *Bellis perennis*, English daisy; *Lobularia maritima*, sweet alyssum; *Tropaeolum majus*, garden nasturtium; *Centranthus ruber*, Jupiter's beard. GROUP II. Minor weeds spread beyond the borders of urban areas but remain in disturbed situations in the vicinity of old home sites, abandoned fields and pastures, perhaps reaching the edge of native vegetation but not damaging to these areas by competing with native plants. Examples: *Nicotiana glauca*, tree tobacco; *Ricinus communis*, castor bean; *Zantedeschia aethiopica*, calla; *Robinia pseudoacacia*, black locust. GROUP III. Major weeds are the most troublesome, by aggressively spreading outside of disturbed urban and borders of urban areas, invading undisturbed native vegetation where they present serious or major problems as competitors of native plants. Once established in an area of native vegetation they are difficult or impossible to eradicate and control. Examples: *Cortaderia jubata*, Andean pampas grass, *Cytisus monspessulanus*, French broom; *Cytisus scoparius*, Scotch broom, *Ulex europaeus*, gorse. Not all escaped exotics, however, fall neatly into the three groups. A few fall into more than one group and others are borderline.

About two-thirds of the escaped exotics in California are rare in occurrence and known from only a single or a few localities in one

or perhaps two counties. Approximately a hundred are known from three or more counties and of these about twenty-five are found in two or more counties. Fifteen of the twenty-five occur in fifteen or more counties; these are the most widespread and make up Group III. Notes on these follow.

Ailanthus altissima, tree-of-heaven, a deciduous tree, was probably the only tree introduced into California during the days of the gold rush. According to W. L. Jepson Chinese miners brought seeds of it from their homeland to mining camps in the foothills of the Sierra Nevada. Since that time the tree has been planted for shade and ornament, is often seen as an escape and in some localities is very invasive.

Ammophila arenaria, European beach grass or marram, is a large, perennial, stout, clumping grass up to four feet tall, with far-creeping rhizomes. Its spike-like flowering stalks stand above the dense clump of leaves. Native to the coastal dunes of northern Europe, it was brought to California probably first to San Francisco, about a hundred years ago, to help stabilize the dunes of Golden Gate Park. Since that time it has spread extensively and is now established in dune areas of coastal California, where it crowds out native vegetation.

Carpobrotus edulis (Mesembryanthemum edule), Hottentot fig, is one of the perennial ice plants grown frequently as an ornamental ground cover and soil stabilizer. Within recent years it has been much used along freeways. A succulent vigorous grower, it has escaped from planted areas, particularly along the immediate coast in sand dunes, where it has become naturalized and is crowding out native dune vegetation. It produces few, if any, seeds, but spreads vegetatively. An early report of it as an escape was at Playa del Rey in 1918. The woody somewhat angular stems of the Hottentot fig have thick, fleshy, opposite, 3-sided leaves, 3 to 4 inches long and large showy, yellow to rose-pink flowers. It is sometimes confused with *Carpobrotus chilensis*, said to be native to the coastal dunes of California, which has slender leaves about 2 inches long and rose-pink flowers.

Chrysanthemum coronarium, garland chrysanthemum or crown daisy, is an annual with showy, bright yellow, daisy-like flower heads. It was first noted in 1919 in San Diego along railroad tracks and elsewhere. During recent years, especially the last ten, it has spread locally in San Diego County and today it is common in coastal areas. Since its initial introduction into San Diego County it has spread northward as far as Del Norte County.

Cortederia jubata, Andean pampas grass, is a large conspicuous grass with a dense clump of long basal leaves from the center of

which arise showy plumose flowering stems. A very aggressive weed, it has spread throughout the state from Humboldt County south to San Diego. It closely resembles *Cortederia selloana*, pampas grass, native of Argentina and southern Brazil, which has been cultivated as an ornamental in California since the 1870s. *C. jubata*, also from South America, is native of the Andes of Bolivia, Peru and Ecuador at elevations of 8,000 to 10,000 feet, and was probably also first introduced into California as an ornamental but at a much later date than *C. selloana*. These two large clumping grasses may be distinguished by their growth habits when in flowers. The ornamental *C. selloana* has flowering stalks that are about the same height as the clump of leaves and the flowering plumes stand very shortly above the leaves. In the weedy *C. jubata* the flowering stalks are about twice as tall as the clump of leaves; therefore, the plumes stand a considerable distance above the leaves. Plants of *Cortederia jubata* are apomictic; that is, fertilization is not necessary for seed production. A single plant with its countless flowers may produce large numbers of small, easily dispersed seeds. In some areas new plants are produced so abundantly that masses of clumps are formed. Once established such clumps are almost impossible to eradicate.

Cynodon dactylon, Bermuda grass, is a perennial that is disseminated by seeds as well as by rootstocks. Its introduction into California may date from 1858 when it was being sold by a San Francisco nurseryman. Today it is widely distributed throughout the warmer parts of California, and, although a grass with many uses, it has become one of the state's most troublesome weeds.

Cytisus monspessulanus, Mediterranean broom or French broom; *Cytisus scoparius*, Scotch broom; *Spartium junceum*, Spanish broom; and *Ulex europaeus*, gorse, whin or furse are closely related shrubs of the Legume Family, which were introduced into California as ornamentals during the 1850s to 1870s. Of the four, the two brooms and gorse are very troublesome and aggressive in northern and central California, Spanish broom is less troublesome. However, little information is available at present regarding the distribution and associated problems of the four in southern California. Because the French and Scotch brooms and gorse are so troublesome in the northern part of the state and Spanish broom is occasionally seen in southern California, the four should be watched in southern California and not allowed to spread.

Eucalyptus camaldulensis, river red gum, and *E. globulus*, blue gum, have been widely planted in California since the 1860s and 1870s. In some areas they have become naturalized, and particularly the blue gum in northern and central California has invaded areas of native vegetation. More information is needed regarding the

extent of their spread and their attendant problems in southern California.

Oxalis pes-caprae, Bermuda buttercup, is a showy, stemless perennial with bright yellow flowers and attractive foliage. It produces no seeds but spreads vegetatively by large numbers of small bulbs that are easily moved about making the plant difficult or impossible to eradicate and control. It occurs mostly in cultivated fields and other similar disturbed sites. So far as known it has not spread into native plant habitats. The common name is misleading, because the plant is not a buttercup and comes from South Africa, not Bermuda.

Senecio mikanoides, German ivy, a semi-woody climber with leaves similar in shape to those of English ivy, has been in California since the end of the last century. It occurs from northern to southern California and in some localities has moved into areas of native vegetation, particularly in coastal canyons and gullies, where it vigorously climbs over trees and shrubs eventually almost or entirely smothering them. Apparently it produces no seeds but spreads by vegetative means. It is a native of South Africa.

Tamarix ramosissima, tamarisk or salt cedar, is a shrub or small tree native to dry regions of southern Russia and parts of Asia. *T. ramosissima* appears to be the correct name for the tamarisk of the California deserts, which in the past has been called incorrectly *T. gallica* and *T. pentandra* and is sometimes mistaken for *T. chinensis,* also cultivated and sometimes an invader of native vegetation. However, *T. ramosissima* is more halophilous, less widely cultivated, more widely naturalized and more invasive than *T. chinensis.*

Tamarix ramosissima is the most widespread and damaging escape in the desert regions of southeastern California as well as in other southwestern desert areas. It grows densely in intermittent streams, often becoming very troublesome, sometimes forming extensive thickets that completely fill the stream channels. Plants have slender branchlets with minute scale-like leaves, superficially resembling those of some cedars, and numerous small pink to whitish flowers that are mostly seen in late spring and summer in showy panicles.

Vinca major, periwinkle or myrtle, is a perennial that has been cultivated as a ground cover. It apparently does not produce seeds but spreads vegetatively by underground stems. It has spread from plantings around old, often abandoned garden sites, mostly in areas with underground sources of moisture. Where conditions are particularly favorable it becomes naturalized and competes with native plants.

Editor's Note: As Elizabeth McClintock indicated in the California Native Plant Society Bulletin Volume 15(1), "This list is not intended as the 'last word' and [anyone] wishing to add others should feel free to do so." Elizabeth is considering doing a publication on the most damaging exotics and good color photos are desired. Also information on control measures for these exotics is sought. Write Elizabeth at 1335 Union Street, San Francisco, CA 94109.

CNPS ORANGE COUNTY CHAPTER SEEKING SLIDES OF RARE ORANGE COUNTY PLANTS

The Orange County Chapter of California Native Plant Society requests the help of SCB members in the assembly of a slide collection of Orange County's rare and endangered plant species. The collection will be used as a master reference file available for copy by educational institutions, parks interpretive programs and newspapers and other publications. Existing copyright and photographer credit will be given for those slides which are published or used for exhibits.

We need initially to know *who* has photographed *what*, and we'll get in touch with individual photographers for reproduction arrangements (at our cost) later. We are seeking closeup, aspect and habitat shots for each county species designated as endangered, rare or rare in California according to the CNPS 1980 or 1984 *Inventory*. Photos need not be taken in Orange County, though in-county pictures would be preferable.

If you have some good quality 35 mm slides that you would be willing to share with us, please contact the chapter rare plant coordinator, Karlin Marsh, P.O. Box 404, Silverado, CA 92676; phone (days) 649-2027. Thanks for your help!

SOUTHERN CALIFORNIA BOTANISTS PRESIDENT'S MESSAGE

Nineteen eighty four saw the continuation of a successful program by the Southern California Botanists. Through the continued efforts of one of our past presidents, Marvin Chesebro, we now have tax-exempt status. This will enable us to obtain our own bulk mailing permit in addition to allowing us other budgetary advantages, including not having to pay income taxes.

The spring plant sale was held at Fullerton Community College this year. The results were not as good as when it was held at Rancho Santa Ana Botanical Garden. We also held a fall sale at Ful-

lerton after concentrating more on publicity with again a less than desired result. Director Geoff Smith's efforts in obtaining the greatest selection of prime condition native plants yet seen at our plant sales made this doubly disappointing. We will be having only one plant sale in 1985, which will be held at Rancho Santa Ana Botanical Garden on April 13, so mark it on your calendar now. Once again, Geoff will have an excellent selection of native plants.

The potluck held at beautiful Descanso Gardens, while not well attended, provided the opportunity for the members who were there to become better acquainted as they sampled the varied culinary delights. We again had a superb speaker in Jim Dice from the Huntington Gardens, whose Mexico expeditions slides provided an exciting finale to a perfect evening.

Our symposium last year, entitled *Changing Climates and Endemism in Southwestern Deserts*, drew approximately 150 people. The five speakers presented excellent talks on a variety of subjects pertaining to our theme, with the introduction of several new techniques used to interpret climates and dispersal modes in the past. We plan to host this year's symposium again at UCI to take advantage of the excellent facilities as well as the support provided by the Cooperative Outdoor Program through Peter Bowler.

The field trip program has continued to provide opportunities for members to visit interesting localities with leaders knowledgeable of the local flora. Thanks to the several leaders and especially Walt Wright, who coordinated and led many of the trips, are in order. Our field trips in 1985 will be more closely coordinated with the new chapters of the California Native Plant Society here in Southern California. This will allow us to provide an even greater variety of field trips for our members.

Membership in the Southern California Botanists has remained at approximately 400 members the last two years. We hope to increase our membership this year, so please join with me in sharing with friends the periodic membership forms published in our journal,

Through the dedication of our managing editor of *Crossosoma*, Gene Jones, our publication has been getting to the members on schedule and the contents have improved. We still need articles, though, so any submitted will be greatly appreciated.

It has been a pleasure serving as president for the last two years, and I wish to thank all those who have helped and supported the SCB during my tenure. I hope you continue in your support of the new officers and directors so that we will continue to be an important organization in the protection of our increasingly fragile environment, not only here in Southern California, but the entire world.

Al Romspert

SOUTHWESTERN BOTANICAL SYSTEMATICS SYMPOSIUM

24-25 May, 1985

Trends in Systematic and Evolutionary Botany

The Rancho Santa Ana Botanic Garden will sponsor and host a symposium on Trends in Systematic and Evolutionary Botany on May 24th and 25th, 1985, at the Garden in Claremont, California. The purpose of this symposium is to examine current trends, and, if possible, suggest needs for and identify promising trends in systematic and evolutionary botany in the coming decade. Invited papers will be presented on pollination biology (H. Baker), chemical systematics (T. Swain), morphology (J. Skvarla), cladistics (M. Donoghue), physiological ecology (P. Rundel), aspects of modern floristics and traditional systematics (G. Prance), and research in botanical gardens (P.H. Raven).

This will be the first of an annual series of symposia planned at the Rancho Santa Ana Botanic Garden and is intended to provide a forum primarily for botanists in the southwestern United States and adjacent regions of Mexico.

On Friday evening (6:00-9:00 p.m.), an informal social occasion for all participants and speakers will be held in the home demonstration garden at the Botanic Garden. Invited papers will be presented on Saturday, May 25th, in the auditorium in the main building complex.

Library and herbarium facilities will be available during this meeting.

Low-cost housing will be available at nearby Pomona College. Further information will be sent to registrants.

Unfortunately, space is limited to 125.

REGISTRATION FORM

Yes, I plan to attend the symposium. Enclosed is my $30.00 registration fee ($20.00 for students).

NAME_____

PROFESSIONAL ADDRESS_____

_____

Spouses and other guests may attend the Friday social event and Saturday meals for $30.00 ($20.00 for students). A cash bar will be available on Saturday evening prior to dinner.

Please make checks payable to Rancho Santa Ana Botanic Garden.

Return this form to Botanical Systematics Symposium
Rancho Santa Ana Botanic Garden
1500 North College Avenue
Claremont, California 91711

☐ Check this box if you are interested in a cost-sharing, one-day field trip on Sunday, May 26th.

DO SOMETHING WILD!

The wildlife tax checkoff has come to California!

Legislation for the checkoff was introduced by Assemblyman Robert Campbell of Richmond, a member of the Assembly Committee on Water, Parks and Wildlife. It was signed by the governor in late October.

Unlike many of the other states, California's legislation will provide money only for endangered or rare species of fish, wildlife and plants.

The mechanics of it work this way: under terms of the act, California income tax payers can enter any amount as their contribution to endangered wildlife, and they can contribute by way of the tax form on line 36 of the short form or line 90 on the long form. Also, the donation can be made either from the amount to be refunded or by adding an amount to the tax payment.

Although the contribution will not be deductible on the state income tax form the following year, it is deductible on the federal income tax form.

Conservation organizations from all over California supported the legislation and at times provided the motivation to keep it on track at the Legislature.

"What impressed me," says Assemblyman Campbell, "was the diversity of conservation organizations involved in this legislation. We received help and supportive mail from fishing organizations, big national conservation organizations and relatively small but active single purpose organizations from a single location."

Action to promote the checkoff among the California population at large has already begun. Plans include radio and television public service announcements, special letters to tax preparers, even special newspaper ads where possible. Many of our fellow conservationists will be participating in the campaign by working with local broadcasters and press and through speaking engagements with local organizations.

What kind of success can we expect with the California Endangered Species Checkoff? The state of New York, operating a non-specific wildlife checkoff, collected $1,700,000 the first year in spite of some political difficulties and the inability to penetrate New York City's television market.

FIELD TRIPS

February 16, Saturday Fungus Foray, 10:00 a.m.

Greg and Walt Wright of the L.A. Mycological Society will lead this field trip to Arroyo Trabuco, Orange County, to look for edible and poisonous fungi. Meet at 9:30 a.m. in the *Day Use Parking Area* of O'Neil Park. Besides a fungal foray, this trip will include a national history tour of this area which is not yet open to the public. Please call D. Bramlet at (714) 549-0647 or (714) 855-0222, Walt Wright at (714) 529-4134 or Shirley Van Der Sluis at (714) 990-9092 for further details.

February 23, Saturday Laguna Hills, 10:30 a.m.

Karlin Marsh will lead this Orange County CNPS chapter field trip to the San Joaquin Hills above Laguna Beach. We will be looking for *Dudleya stolonifera, D. multicaulis* and many other interesting species. Take Hwy 1 to South Laguna and meet in the parking lot across from the Treasure Island trailer park.

February 24, Sunday Pushawalla Palms, 9:00 a.m.

John Stewart of the Living Desert Reserve will lead this Riverside CNPS chapter field trip to the Pushawalla Palm oasis. Take Interstate 10 to Palm Springs and take the Washington Street exit. Meet at the parking lot of the Motel 6. Call Andy Sanders (714) 787-3601.

March 9, Saturday Santa Margarita River, 9:30 a.m.

This is a joint trip with the Orange County CNPS chapter. This trip will examine the Stewart Mesa area for vernal pools. We will then explore the riparian habitat found at the junction of DeLuz Creek and the Santa Margarita River. Take Interstate 5 to Vandegriff Road and meet at the entrance to Camp Pendleton. Reservations by March 8 are a must, as clearances from the Marine Corps have yet to be received. Please call D. Bramlet (714) 855-0222 days or (714) 549-0647 evenings.

March 24, Sunday Rare Plants of the Salton Basin, 7:00 a.m.

John Stewart of the Living Desert Reserve will lead this Riverside CNPS field trip. The trip will search for *Ditaxis adenophora, D. californicum, Machaeranthera capoda, M. orcuttii* and *Pilostyles thurberi*. Take 110E past Palm Springs to the Ramona/Bob Hope Dr. exit on the Palm Desert Hwy 111. Go 2-3 miles to Portola Ave. and turn right on Portola. Go about 1-1/2 miles to the Living Desert Reserve. We will meet in the parking lot. Call Andy Sanders (714) 787-3601 for details.

March 30 - April 7 Easter week trip to Baja California

Walt Wright will lead a trip to southern Baja California over Easter week. Call Walt Wright at (714)529-4134 for details of the trip. Call as soon as possible!

March 30, Saturday Chino Hills State Park, 9:00 a.m.

An Orange County CNPS trip to see the grasslands and walnut woodlands. Call D. Bramlet (714) 855-0222 or (714) 549-0647 for details.

COMING 1985 EVENTS

April 13	*SCB Plant Sale*
April 20-21	*Mojave Desert with CNPS Riverside Chapter*
April 27	*Palms to Pines Trip, SCB*
May 4	*Chiquito Basin*
May 11	*Otay Mtn.*
May 18-19	*Antelope Valley*
May 25	*Mesa del Burro*
June 22	*San Bernardino Mtns.*

FIELD TRIP LEADERS NEEDED

As your new field trip chairman, I need your help in locating qualified leaders for field trips. If you would like to volunteer or know of someone I could contact, please call me at (714) 855-0222 or 549-0647.

Dave Bramlet

BACK ISSUES OF CROSSOSOMA

Back issues of CROSSOSOMA are available at six (6) dollars per volume plus one dollar for postage and handling. Inquiries should be addressed to: Editor--CROSSOSOMA, Department of Biological Science, California State University, Fullerton, CA 92634.

Please state the volumes desired and include payment in your order. Checks should be made to Southern California Botanists.

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We thank all those who promptly remitted their 1985 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

SCB COMING EVENTS

February 16	Fungus Foray, Arroyo Trabuco, Orange County
February 23	Laguna Hills
February 24	Pushawalla Palms
March 9	Santa Margarita River
March 24	Rare Plants of the Salton Basin
March 30-April 7	Baja California
March 30	Chino Hills State Park
April 13	SCB Plant Sale, Rancho Santa Ana Botanic Garden
April 20-21	Mojave Desert
April 27	Palms to Pines Trip
May 4	Chiquito Basin
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A CENSUS OF BEE POLLINATORS IN LARGE AND SMALL POPULATIONS OF THE CAMPHOR WEED (*TRICHOSTEMA LANCEOLATUM*)

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Trichostema lanceolatum Benth., commonly known as camphor weed or vinegar weed, is one of the western North American species of *Trichostema*, a genus of plants in the mint family (Lamiaceae). *T. lanceolatum* grows on dry plains and low hills from cismontane California to Washington. Its common name arises from the pungent aroma of compounds secreted by the numerous glands covering its stem and leaves.

The flowers of *T. lanceolatum* have an S-shaped floral tube with the anthers and pistil protruding above the petals as described by Howe (in press). The petals serve as a landing site for bees and other pollinators. The weight of the pollinator on these petals and the thrust of sucking mouth parts into the nectar tube cause the anther and style mechanism to flex rapidly downward and strike the back of the insect. Such an arrangement warrants a deeper understanding of the types and numbers of pollinators which visit these fascinating flowers.

T. Spira (1978) found *T. lanceolatum* to have the highest nectar production of all the insect pollinated species of *Trichostema*. Thus pollinator frequencies for this plant would likewise be of interest from the standpoint of honey production.

The rate and type of nectar production, percentage of seed set, and other floral characteristics for the western North American species of *Trichostema* were estimated by T. Spira (1978, 1980, 1981). Although he analyzed the distribution of pollen on the bodies of bees collected in *Trichostema* fields, Spira did not determine the relative

numbers of pollinator bees present in these same populations. Evidently there has been no such study of pollinator frequencies in *Trichostema lanceolatum* fields as Spira's papers are the only ones that have dealt with pollination in these plants.

In the present study I have attempted to determine the differences in pollinator frequencies between seven small populations of *T. lanceolatum* and one large one. While such study has academic importance, the behavior of domestic and wild bees in fields of wild plants has been shown to have profound influence on pollination and seed set in fields of crop plants nearby (Anonymous, 1976).

One of the small populations in this study consisted of 16 plants growing in a cluster 5 m. in diameter in a vacant lot, 30 meters west of Apple Street, Newhall, California. There were no other populations of *T. lanceolatum* near this small one but other species blooming in that same study area included *Brassica geniculata* (Desf.) J. Ball., *Eremocarpus setigsrus* (Hook.) Benth., and *Stephanomeria virgata* Benth. Adjoining this field to the west was a small chaparral stand composed of *Adsnostoma fasciculatum* H. & A., *Eriogonum fasciculatum* Benth., *Quercus agrifolia* Nee, *Q. dumosa* Nutt., *Q. lobata* Nee and *Sambucus* sp.

Pollinator counts in this Apple Street population were taken over 10 minute intervals either by counting bees on all 16 plants at once or by watching only one very large plant. A tally was kept of each pollinator bee that visited the plant(s) and triggered the pollen mechanism of at least one flower during that time interval. Although quite simple, such observation and counting provided direct information concerning the numbers and kinds of bees triggering the flowers of *T. lanceolatum*. The 10 minute observational periods spanned seven days from 22 July to 22 August 1983, at various times ranging from 07:20 to 16:30. There were 19 such trials, a total of 190 minutes at Apple Street. The data are summarized in Table 1.

Table 1. Total numbers of various bees observed pollinating flowers in one large and several small populations of T. lanceolatum near Newhall, California.

Pollinator	Population Location	Population Size	Number of Pollinator Visits	Total Visits[1]	Percentage of Total
Apis mellifera L.	Apple St.	Small	3	74	4
" "	McBean Parkway	Small	1	35	3
" "	Pico Canyon Rd.	Large	189	512	37
Anthophora urbana cressson	Apple St.	Small	57	74	77
" " "	McBean Parkway	Small	7	35	20
" " "	Pico Canyon Rd.	Large	79	512	15
Bombus sonorus say	Apple St.	Small	14	74	19
" " "	McBean Parkway	Small	27	35	77
" " "	Pico Canyon Rd.	Large	244	512	48

[1]Total visits by all bee pollinators in that population.

On 22 August, 1983, between 15:00 and 17:00 an additional 90 minutes were spent making similar 10 minute pollinator counts in six other small populations of *T. lanceolatum* scattered along a grassy ridge about 300 meters north of Henry Mayo Newhall Memorial Hospital, McBean Parkway, Newhall, California. Data from these six additional small populations are also reported in Table 1.

The one large *T. lanceolatum* population of this study grew on the north side of Pica Canyon Rd., Newhall, California, in the stubble of oat plants that had been cut and harvested earlier. Here camphor weed plants were so numerous that pollinator counts could be made most effectively by walking into the field and recording all the pollinating bees visible within an estimated radius of seven meters while the observer was turning slowly through a complete circle in a time period of 60 seconds. After one such tally, 10 paces were taken further into this large population and the process repeated. A total of 63 such circular, one minute surveys was made on four different dates--13, 16, 21, and 22 August, 1983, between 09:00 to 10:00 or 14:00 to 16:00. These data likewise appear in Table 1.

In all eight populations of *T. lanceolatum* the following bees were present: *Anthophora urbana* Cresson, mason bees; *Apis mellifera* L., honeybees; and *Bombus sonorus* Say, bumblebees. Only one individual carpenter bee (*Xylocopa* sp.) was seen visiting flowers, whereas Spira (1980) reported *Xylocopa* individuals as being prominent pollinators during one of the two seasons he studied *T. lanceolatum* in central California.

Occasionally I observed moths such as the woodland skipper (*Ochlodes sylvanoides sylvanoides*, Boisduval) and the field skipper (*Atalopedes campestris*, Boisduval) pollinating camphor weed plants but no numerical record was kept of these moth visits.

The most frequent bee pollinator of *T. lanceolatum* in the Apple Street (small) population was *A. urbana* (77% of all visits), with *B. sonorus* second (19%), and *A. mellifera* last (4%)--see Table 1. In the six other small populations (near McBean Parkway) *B. sonorus* had the highest visitation rate (77%) followed by *A. urbana* (20%), and *A. mellifera* (3%). Thus either the mason bee or the bumblebee figured as the lead pollinator in these small populations and in each case honeybees avoided camphor weeds.

In the one large field of *T. lanceolatum* at Pico Canyon Road, however, the honeybee foragers showed widespread acceptance of camphor weed plants (37% of all visits), although here the bumblebees had the highest visitation rate (48%) and mason bees were lowest (15%). Thus in the seven populations where *T. lanceolatum* was low in numbers, honeybees avoided them in favor of other nearby plants but in one very large camphor weed population honeybees were a

significant pollination vector. Such behavior may be explained to some extent in terms of flower specialty habits of the bees and their foraging strategies.

Butler (1974, p. 190) wrote that "... as long as there is an abundance of rich syrup, or nectar, available at a given place honeybees that have found this source of food will confine their attention to it for many hours and even for days together." Minderhout (1931) also noted that honeybees in a large population of plants were constant not only to that one plant species but also to a certain small number of those plants in a foraging area that averaged only 10 m^2 within the much larger field. A pattern of constancy like Minderhout described may have prevailed at Pico Canyon Road where the honeybees were presented with a large number of *Trichostema lanceolatum* plants in close proximity and perhaps had specialized on camphor weed even though they were found to avoid the same plant at other locations.

The low level of *A. mellifera* participation in pollination of *T. lanceolatum* at all the seven small populations (Apple Street and McBean Parkway) cannot be attributed to reduced numbers of honeybees, since many of these bees were observed actively working flowers of other plant species at these same locations. At the Apple Street site, for example, honeybees showed a consistent preference for nearby *Brassica geniculata* and *Stephanomeria virgata* plants as opposed to the 16 individuals of *T. lanceolatum*. Perhaps the honeybees had already specialized on *B. geniculata* or *S. virgata* elsewhere as these species have a much wider overall spatial distribution than *T. lanceolatum* in the Newhall vicinity. The neglect of small camphor weed populations by honeybees may have thus depended on the small size and sparcity of these camphor weed populations.

Additionally, such avoidance of camphor weed by honeybees may have resulted from relatively low nectar yields. Although T. Spira showed that camphor weeds have the highest production of nectar among the western species of *Trichostema*, nectar production in *T. lanceolatum* may possibly be lower than that of *B. geniculata* or other preferred species.

The neglect of small camphor weed populations by honeybees may have further depended on color, odor, and/or floral morphology. Camphor weed secretes some highly aromatic compounds which may be mildly offensive to honeybees. Butler (1974) reported that the odor of solvents from his bee-marking procedures could disorient a treated bee for several minutes. Heinrich (1983) found that bumblebees distinguished between flowers that are difficult to handle and those that require no skill to manipulate. Perhaps honeybees specialize more readily on simpler flowers like mustard or *Stephanomeria* than on the more complex flowers of *Trichostema*. At any rate, it was obvious

that honeybees made more frequent visits to mustard flowers than to *Trichostema lanceolatum*. Linsley and MacSwain (1947) also found a distinct preference for mustard among honeybees such that the percentage of honeybees working alfalfa for pollen was increased when nearby mustard fields were cut.

Individual bumblebees (*Bombus sonorus*) moved between flowers of different species. Clements and Long (1923) found that only 49% of pollen loads carried by *Bombus* individuals were pure, 51% mixed, whereas Grant (1950, p. 380) reported that "... species of bumblebees are relatively inconstant..."

Henrich (1983) concluded that bumblebees routinely major on one species of flower while minoring on others. Thus the apparent "inconstancy" of bumblebees in this present study evidently stemmed from their majoring on one of the species present while minoring on two or three others. Heinrich (1983) further indicates that since bunblebees have neither scouts nor hive communication systems, the bees are best served by a pattern of sampling among their major and minor species. He reported that the bumblebees can change a minor to a major on one foraging trip and can thus more readily maximize foraging efficiency.

Concerning the mason bee, Spira (1980, p. 279) had noted that *A. urbana* was an important pollinating agent in *T. lanceolatum* populations during both years of his study in central California, although census data were not provided.

Reports on the degree of specialization or flower constancy of several species of mason bees are varied. Linsley and MacSwain (1942) found a rigid specialization of *A. linsleyi* in collecting pollen from *Salvia carducea* Benth. in the Mohave Desert where the bees by-passed other plants to obtain sage pollen even though this necessitated flying more than a mile from their nest. Bennett (1874) found that in a mixed field of *Lamium album* and *L. purpureum*, *Anthophora retusa* bees visited only the *L. album*. By way of concontrast, however, Grant (1950) reprinted data from studies in Colorado to show that only 20% of the pollen loads carried by *Anthophora* bees were pure loads.

In this present study, mason bees were the major species pollinating camphor weeds at the Apple Street site and they played a significant role at all of the other locations as well. I found *A. urbana* to have a high degree of specialization in that individual mason bees were not observed to visit several species in succession.

In this locality, camphor weed plants grow and flower from late May through August or September. Since this is well after the harvest of grains such as oats, it might prove feasible to sow *T. lanceolatum* seed along with the oats. After oat harvest, the camphor weeds would grow and provide valuable nectar forage for honeybees, as

occurred here in the Pica Canyon Road oat field. There may be other species of native California plants which could be raised in conjunction with grain production for their nectar yield. Camphor weed seems especially suited since its entire growing season follows grain harvest and it does not persist as a pernicious weed like mustard.

In conclusion, I found the solitary mason bee, *Anthophora urbana*, and the social bumblebee, *Bombus sonorus*, to be of major importance in the pollination of *T. lanceolatum* plants in both large and small plant populations. Honeybees, however, played an active part in camphor weed pollination only in the one large population studied. While some aspects of this behavior are understandable, more information is necessary to account for honeybees avoiding the camphor weeds in the small populations while visiting them in large populations.

ACKNOWLEDGEMENTS

I thank Roy Snelling of the Los Angeles County Museum of Natural History for identifying each of the bees mentioned in this paper and Julian Donahue of that same institution for identifying the two moths.

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WHALE-WATCHING EXPEDITION TO SAN IGNACIO LAGOON, BAJA CALIFORNIA SUR, MEXICO

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Claremont, California 91711

January 30, 1985, Dr. Kenneth Stager, Emeritus Curator of Ornithology and Mammology at the Los Angeles Museum of Natural History, and I, Curator of the Herbarium at the Rancho Santa Ana Botanic Garden, left Fisherman's Landing at San Diego on the large fishing cruiser, Qualifier 105, as the two naturalists on an eight-day, whale-watching cruise along the Pacific Coast of Baja California to the Laguna San Ignacio in Baja California Sur, Mexico, south of the Laguna Ojo de Liebre (Scammon's Lagoon). The crew of six hoped to show the 30 Coloradoans on tour with Ports o' Call, based in Denver, numerous gray whales, elephant seals, California sea-lions, dolphins, and other sea mammals, many aquatic birds and numerous flowering plants at the Laguna and also en route on the Islas San Benito del Oeste, Cedros, and San Martin.

After a day and night of cruising, we arrived on the morning of January 31 west of Isla Cedros at Isla San Benito del Oeste, a dry, rocky island about one square mile in area (2.5 for all three San Benito islands) and rising in the center to a height of about 600 feet. Aside from the island plants, the main attractions of the West Island are the harems of elephant seals, carefully guarded by the huge, battle-scarred beachmasters ready to challenge all male comers, the small Cassin's awklets then nesting in their burrows, the friendly feral burros, and perhaps ten pairs of ospreys nesting along the shores. The three skiffs from the Qualifier were quickly launched and used to transport the 32 tourists and naturalists to the presently all-but-deserted fishing village at the east end of the island. The flora of the three San Benito islands is sparse, some 40 natives, including 15 ephermerals, and 5 introduced weeds, presenting an open cover of maritime desert scrub, well supplied with cacti and agaves.

We managed to photograph, collect, or otherwise observe four weeds and 28 native plants on San Benito del Oeste. Especially exciting for me were the four endemics or near-endemics, *Dudleya linearis* (Greene) Britt. & Rose, *Hemizonia streetsii* A. Gray, *Mammillaria neopalmeri* Craig, and *Lavatera venosa* S. Wats. The reported *Cryptantha patula* Greene was not found, but in the effort to collect it, I amassed eight sheets of the similar and abundant *Cryptantha maritima* (Greene) Greene. We found only one colony of the *Dudleya* and most of the *Hemizonia* was not yet flowering. Aside from the showy *Lavatera* most of the color on the island was supplied by the yellow ray-flowers of *Encelia californica* Nutt., blue-violet flowers of *Dichelostemma pulchellum* (Salisb.) Heller, blue-dicks, orange petals of *Eschscholzia ramosa* Greene, the abundant island California-poppy, the white-bracted cyathea of *Euphorbia misera* Benth., and the white ray-flowers of *Perityle emoryi* Torr., a tiny daisy. Abundant also were *Agave sebastiana* Greene, not yet in bloom, *Frankenia palmeri* S. Wats., with tiny, white star-flowers, the obnoxious *Opuntia prolifera* Engelm., which was unduly familiar with the lady tourists and one careless botanist, the thorny *Lycium californicum* Nutt. ex A. Gray, the yellowish flowered *Atriplex barclayana* (Benth.) D. Dietr. ssp. *dilatata* (Greene) Hall & Clem., and the delightful and abundant colonies of nipplewort, *Mammillaria*, just opening up small white blossoms. Below tide line the surf-grass, probably *Phyllospadix torreyi* S. Wats. (not flowering) was most prolific.

After climbing to the deserted lighthouse on the north end of the island at about 300 feet, we consumed our box-lunches and circled the central hill to return to the village in the early afternoon. Transported back to our ship, we broke out the fishing rods and quickly filled a barrel with highly edible Pacific white fish, returning to the deep many more smaller fish not deemed keepers by the crew. Needless to relate, we ate high off the hog and fisheries on our trip, having fantastic meals of fish, sushi, bouillabaisse, chowder, lobster tails, clams, scallops, etc. Coffee, tea, cold drinks, cookies, and candy were always available for snacks, and a happy hour late each afternoon before supper kept the passengers in good spirits.

We crossed the bar at Laguna San Ignacio next morning, Feb. 1, to spend three days here studying the numerous whales, sea birds, mangrove thickets, salinas (salt-flats), clam and scallop beds among the eel-grass, *Zostera marina* L., shell beaches, and rolling dunes. The weather was often cool, windy, and sometimes rainy so that the whales, though abundant and busy with their calves or amorous activities, were not enthusiastic about lolling on the surface to be petted or scratched. That would come with warmer weather. I found

the botanizing excellent and the engineer generous in placing my presses in the warm engine room to avoid mildew. Besides being the best whaling lagoon in Baja California, San Ignacio is the northernmost station on the Pacific coast for the two mangroves, *Rhizophora mangle* L., the red mangrove, and *Laguncularia racemosa* (L.) Gaertn. f., the white mangrove of the Combretaceae. Here the mangroves, however, are hardly more than shrubs, forming extensive but low thickets, below and at the tide line along with marshes of the salt-water cord grass, *Spartina foliosa* Trin. Abundant behind these tidal plant communities in the low salinas were numerous halophytes of the genera *Allenrolfea, Anthrocnemum, Atriplex, Batis, Monanthochloe, Salicornia, Sesuvium, Sporobolus,* and *Suaeda.* Most exciting to me on the salt-flats, dunes, and coquina rock ridges were southern or local species not seen in northern Baja California, especially *Atriplex frankenioides* R. Moran, *Sesuvium portulacastrum* L., *Sporobolus virginicus* (L.) Kunth, *Encelia laciniata* Vasey & Rose, *E. palmeri* Vasey & Rose, *E. ventorum* Brandegee, *Astragalus magdalenae* Greene, *Cryptantha angelica* Jtn., *Chaenactis lacera* Greene, *Drymaria viscosa* S. Wats., *Porophyllum maritimum* Brandegee, and an unknown, succulent *Camissonia.* On the higher coquina ridges a few of the Vizcaino Desert species were observed, especially *Fouquieria diquetii* (Van Tiegh.) I. M. Jtn., with brilliant red, tubular flowers, *Jatropha cinerea* (C. G. Ortega) Muell.-Arg. in DC., *Capparis atamisquea* (Miers) O. Ktze., *Pachycereus pringlei* (S. Wats.) Britt & Rose, *Yucca valida* Brandegee, *Stenocereus gummosus* (Engelm.) Gibson, *Opuntia cholla* Weber, *Lophocereus schottii* (Engelm) Britt. & Rose, and *Sarcostemma arenarium* Decne.

Great quantities of sand-dollars, bivalves, and other shells were gathered by this and other beachcombers. Also the ornithologists among us were delighted to see many birds new to our life-lists: reddish egret, black brant, surf scoter, greater yellowlegs, dunlin, long-billed dowitcher, western sandpiper, Bonaparte gull, royal tern, mangrove warbler, savannah sparrow, along with great numbers of more familiar herons, egrets, white ibis, shore birds, gulls, raptors, owls, warblers, etc.

After crossing the Laguna bar, another bout of fabulous fishing over a secret fishing hold off Punta Abreojos quickly filled another fish barrel on the afternoon of our third day. Then we headed north to Isla Cedros, which we reached on the morning of Feb. 4. While spending some time in the skiffs observing the elephant seal and sea-lion harems under the firm control of the beachmasters and playing with the yearling sea-lions cavorting in the clear water around us, we had the good fortune to observe a vicious battle between two elephant-seal harem bulls. The aggressive challenger, a huge, scarred veteran, was soundly thrashed and driven into the water

bleeding profusely from a bad head wound. He thus lost his entire harem and was seen later hauled out on another beach somewhat to the north. Other, younger bulls, not yet ready to challenge the beach-masters, also lay among the sea-lions, apparently on good terms with these smaller mammals.

With the mammalian photography out of the way, we headed farther north to a small village near the north end of Cedros, where the skiffs landed the hikers. Most of the tourists preferred to skirt the coast north to the lighthouse, but nine hardy hikers joined me to climb up the old copper mine canyon (Canada de la Mina), with three of them persevering with me to the pine ridge above the mine. For our efforts, we four were thoroughly soaked by a rainstorm that came over the Pacific ridge to terminate our warm, sunny day of hiking and botanizing. Despite the difficult climb and miserable rain, we managed to haul back to the skiffs about 60 numbers of exciting plants, many of them endemic to Isla Cedros or at least originally named from island collections. Above the mine we collected the endemic pine, *Pinus radiata* D. Don ssp. *cedrosensis* (J. T. Howell) Nemo and the California juniper, *Juniperus californica* Carr., after which the island is named, along with such exciting endemics as *Dudleya pachyphytum* Moran & Benedict, not described until 1980, and a marvelous, thick-leaved, glaucous rosette plant, *Senecio cedrosensis* Greene, *Eriogonum molle* Greene and its hybrid with *E. fasciculatum* Benth., *E. wrightii* Torr. ex. Benth. ssp. *taxifolium* (Greene) Stokes, *Teucrium glandulosum* Kell., *Lotus nudatus* (Greene) Greene, *L. cedrosensis* Greene, and *Haplopappus venetus* (H.B.K.) S. F. Blake ssp. *tridentatus* (Greene) Hall. On the rocky slopes down the canyon toward its mouth and below the old mine, we collected other special plants like the white-wooly *Viquiera lanata* (Kell.) A. Gray, *Cryptantha maritima* (Greene) Greene var. *cedrosensis* Greene, *Rhus lentii* Kell., *Xylonagra arborea* (Kell.) Donn.-Smith ssp. *arborea* with bright-red flowers, *Penstemon cedrosensis* Kell., *Zizyphus parryi* Torr. var. *microphylla* (I. M. Jtn.) M. C. Jtn., *Verbesina hastata* Kell., *Salvia cedrosensis* Greene, *Verbena lilacina* Greene, *Astragalus fastidius* (Kell.) M. E. Jones, *Harfordia macroptera* (Benth.) Greene and Parry with its strange, inflated, red-veined bladdery bracts, the pink-flowered, thick-trunked elephant-tree, *Pachycormus discolor* (Benth.) Coville var. *veitchiana* (Kell.) Gentry, *Leptodactylon veitchii* (Parry ex A. Gray) Wherry, the coastal *Mentzelia adhaerens* Benth., and other more wide-ranging, woody or herbaceous species. The numerous cacti and *Agave sebastiana* were merely photographed, not collected. A hot sailor's shower and an abundance of langoste cocktail during the happy hour made up somewhat for our soaked, sore, miserable condition (though I am still trying to recover from the bad cold that

hit me upon my return to Claremont).

The next day early saw us at Hassler Cove of Isla San Martin, northwest of Cabo and Bahia San Quintin. The skiffs landed us at the small, largely deserted fishing village to work our way south across the Sand Spit to the harbor frequented by the easily spooked harbor seals. A hike north of the village along the lava rocks of Hassler Cove enabled us to see and collect about 35 species of island plants in the maritime desert scrub dominated by cacti, three species of *Lycium*, and the showy, glaucous, huge rosettes of *Dudleya anthonyi* Rose. The flora of this small, round, volcanic island, 0.9 mile square in area, is very similar to that of the volcanic rocks of the San Quintin Bay area, with such special plants as *Amauria rotundifolia* Benth., *Amsinckia inepta* Macbr., *Phacelia ixodes* Kell., *Solanum palmeri* Vasey & Rose, *Dudleya cultrata* Rose, *D. anthonyi* and the abundant and ubiquitous *Euphorbia misera*. Dune and salina species are abundant on the San Spit and *Phyllospadix torreyi* S. Wats abounds below tide line.

On the evening of Feb. 5 we stopped briefly at Ensenada to be checked by Mexican customs and turn in our tourist visas, then headed north past the Coronado Islands to San Diego. At eight a.m., after assuring the U.S. customs people that we were American citizens, we berthed at Fisherman's Landing, and promptly unloaded our gear. Ken and I barely rescued some of our baggage already loaded onto the tour bus and apparently headed toward Denver. I was happy to pile three large presses and three holding or field presses, with some 182 collection numbers, mostly in duplicate or multiples, into my car and head for my driers at Claremont. Best of all, I was handed a healthy check for my efforts as second naturalist on this rigorous cruise. I heartily approve of being paid to take an expensive vacation to Mexico.

SCB PLANT SALE

April 13, 1985, Saturday, 8:00 a.m.
Rancho Santa Ana Botanic Garden
1500 North College Avenue
Claremont, California

This will be our 11th annual sale of California natives. We will have an outstanding stock of plants available. There is usually a crowd of buyers at the opening and the choice plants go fast, so be there early for the best selection.

There will also be a wide assortment of botanical books for sale. Combine the sale with a visit to the garden--80 acres of natives with many at peak bloom at this time of year. See you there.

WE NEED HELP!
PLEASE!

PLEASE help by volunteering to be a plant salesperson at the SCB Plant Sale on April 13. We need cashiers as well as people with some knowledge of native plants and their use in landscaping to answer buyers' questions. Please be there by 7:30 a.m. If you can help, please call Geoff Smith at 714-871-8000, ext. 371 (work) or 714-441-1049 (home). You may also call and leave a message that you can help at the Biology Office at CSUF, 714-773-3614.

SOUTHERN CALIFORNIA BOTANISTS NOW A TAX EXEMPT, NON-PROFIT CORPORATION

Southern California Botanists has been incorporated as a non-profit California corporation and has qualified as an exempt organization under United States Internal Revenue Code Section 501(c)3 and the comparable California statutes.

All assets of the voluntary association founded in 1927 have been transferred to the non-profit corporation.

All donations to Southern California Botanists now qualify as tax deductible gifts on California and United States Income Tax Returns.

The Directors are pleased to announce the consummation of this plan and believe this formalizing of our status is another important step.

PUBLICATION OF THE FLORA OF SAN DIEGO COUNTY

The Flora of San Diego County, by R. Mitchel Beauchamp, is scheduled to be published 15 July 1985. Pre-subscription purchases are now being accepted to off-set the publication cost. The publication will be an annotated checklist of native and established exotic vascular plants known to occur or to have occurred in San Diego County. The publication will have diagnostic keys but no illustrations. It is intended as a companion volume with Munz's *Flora of Southern California*. The book has been in preparation since 1970 and represents a revision of the 1949 Checklist by Ethel Bailey Higgins. The book will be soft bound with a 6" x 9" format, and should involve 250 pages. Pre-subscription price is $18. Payments should be sent to R. Mitchel Beauchamp, P.O. Box 985, National City, 92050 (tel. 619-477-2095). An over-run of only about 25% will be made in excess of pre-publication orders, for which reason post-publication availability may be limited.

SPRING OPEN HOUSE

Rancho Santa Ana Botanic Garden
1500 North College Avenue
Claremont, CA 91711

Saturday, April 27, 1985
9 am to 4 pm, free admission

Rancho Santa Ana Botanic Garden will open its Library and world renowned Herbarium to the public for the first time since the Garden was relocated in Claremont in 1951. There will be guided tours of these facilities and demonstrations of the programs associated with a botanic garden whose emphasis is directed towards research, education, conservation, and public service in California botany.

Displays and demonstrations will be located throughout the 87 acre Garden. These will highlight the desert and coastal gardens, cultivar collections, wildflowers and home demonstration garden.

Talks are scheduled during the morining at 10 a.m. and 11 a.m., and in the afternoon at 2 pm and 3 pm in the main auditorium.

FIELD TRIPS AND EVENTS

April 13, Saturday *SCB Plant Sale, 8 a.m.* See page 11 for details.

April 14, Sunday *Pine to Palms Trip.* 8 a.m. to dusk. Meet at the S.E. corner of Ramona Expressway and US-215 (formerly US-395) south of Riverside (approx. 3 miles south of March Air Force Base). Caravan from Hemet through the San Jacinto Mountains on Hwy. 74 with stops at several plant communities. Bring a sack lunch and comfortable walking shoes. For further information, contact Geoff Smith evenings at (714) 441-1049.

April 20-21 *Mojave Desert-Barstow Area.* Andy Sanders will lead this Santa Monica CNPS chapter field trip to the high desert. Call Andy Sanders (714) 787-3601 for details.

April 27 *Starr Ranch.* John Little will lead this trip to Caspers Regional Park for a walk to the Starr Ranch Audubon Sanctuary. Meet at 9:30 in the day use lot of Caspers Regional Park. Call Dave Bramlet (714) 549-0647 for details.

May 1 *SCB student grant proposals due.* See announcement in this issue for details.

May 4 *Chiquito Basin trip.* Call Dave Bramlet at (714) 549-0647 for details.

May 11, Saturday *SCB field trip to Otay mountain.* Call Dave Bramlet for details.

May 18, Saturday *Joint Orange County Cahpter of CNPS and SCB field trip to Mesa de Burro vernal pools.* Call Dave Bramlet for details.

June 1, Saturday *San Mateo Marsh.* Call Dave Bramlet for details.

June 8, Saturday *SCB field trip to Picacho del Diablo.* Call Dave Bramlet for details.

June 22, Saturday *Riverside chapter of CNPS trip to the San Bernardino Mountains.* Call Andy Sanders at (714) 787-3601 for details.

ELECTION RESULTS: (Editor's Note: Thanks for taking the time to vote. A total of 109 ballots was received. The election results are as follows:

Mona Myatt (Pres.)	108 votes	Gene Jones (Director)	108
Barry Prigge (1st V.P.)	109	R. John Little (Director)	106
Dave Bramlet (2nd V.P.)	108	Andy Sanders (Director)	103
Sherry Schmidt (Sec.)	108	Leo Song (Director)	106
Allan Romspert (Tr/Mem)	108	Robert F. Thorne (Dir.)	106
Jack Burk (Director)	106	David Walkington (Dir.)	104
Don Coughlin (Director)	105		

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BACK ISSUES OF CROSSOSOMA

Back issues of CROSSOSOMA are available at six (6) dollars per volume plus one dollar for postage and handling. Inquiries should be addressed to: Editor--CROSSOSOMA, Department of Biological Science, California State University, Fullerton, CA 92634.

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CROSSOSOMA is published bimonthly (February, April, June, August, October and December) by Southern California Botanists, a non-profit association. Dues are on a calendar year basis. Regular $6.00. Students and Retirees $4.00. Groups $10.00.

We thank all those who promptly remitted their 1985 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

PLEASE HELP RECRUIT SCB MEMBERS

The Board of Directors of the Southern California Botanists has a problem facing us this year. We will either have to raise our membership dues or increase our membership number. Please pass the membership form (below) on to a friend who might be interested in the Southern California Botanists.

The total membership on our mailing list at this time numbers 423. The paid membership at this time is 292. Please check your mailing label for the status of your membership. The number to the right of your mailing label indicates the year through which your dues are paid.

Thank you for your past support in our program of field trips, student grants, symposia, pot lucks and especially our publication, Crossosoma. I know we can look forward to an even better year.

Alan Romspert
Membership-Treasurer

The purpose of the SOUTHERN CALIFORNIA BOTANISTS is the study, preservation and conservation of the native plants of California and the education of the public to the value of the native flora and its habitats. It is a non-profit association formed in 1927.

Membership benefits include: Various field trips throughout the state led by competent field botanists and biologists; a yearly plant sale featuring native California species; an annual symposium on various aspects of the California vegetation; the SCB journal, CROSSOSOMA; discounts on botanical and natural history books.

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SCB COMING EVENTS

April 13	SCB Plant Sale, Rancho Santa Ana Botanic Garden
April 14	Pine to Palms Trip.
April 20-21	Mojave Desert-Barstow Area CNPS Trip
April 27	Starr Ranch
May 1	SCB Student Grant Proposals Due
May 4	Chiquito Basin Trip
May 11	Otay Mountain Trip
May 18	CNPS and SCB Trip to Mesa de Burro Vernal Pools
June 1	San Mateo Marsh Trip
June 8	Picacho del Diablo Trip
June 22	CNPS Trip to the San Bernardino Mountains

SOUTHERN CALIFORNIA BOTANISTS
Rancho Santa Ana Botanic Garden
1500 North College Avenue
Claremont, CA 91711

CROSSOSOMA

SOUTHERN CALIFORNIA BOTANISTS
Rancho Santa Ana Botanic Garden, Claremont CA 91711

Crossosoma Vol. 11, No. 3
Issue Editors: Robert F. Thorne and Barry Prigge
Managing Editor: C. Eugene Jones June, 1985

This issue of *Crossosoma* includes a partial listing of botanical books available to SCB members at a 10% discount. Please note, when you order your books, that you are a member of SCB.

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Elliot, W.R. & Jones, D.L.
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Elliot, W.R. & Jones, David L.
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Lord, Ernest E. & Willis, J.H.
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Coyle, Jeannette and Roberts, Norman
A Field Guide to Plants of Baja
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Humphrey, Robert R.
The Boojum and its Home
Idria columnaris and its environment climate, soil topography and its relation to other vegetation, associated life forms. Baja background. 90 photos. $8.95

Zwinger, Ann
A Desert Country Near the Sea
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Evans, Doris
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140 full color photographs, pocket size book, fantastic variety of cacti and succulents in natural habitat. Soil conditions. How to grow indoors. $5.95

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The Cacti of the US & Canada
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Benson, Lyman
The Cacti of Arizona
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425 herbs, descriptions, habitats, cultivation, chemical composition, uses. 300 color photos, line drawings, glossary, conversion tables, organizations, bibliography. $12.95

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Sherry Schmidt, Secretary, S.C.B.

I was born in Northridge, California, and moved to Yorba Linda in 1969. At that time Yorba Linda was dominated by rolling hills and Orange County still had orange groves. How quickly things change! I used to love to walk in the hills between Yorba Linda and Carbon Canyon. My early interest in plants began on those walks as I tried to identify the edible plants of the area. However, I was often disappointed by the taste of the so-called edibles that the edible plant books raved about. So much for being a vegetarian. I presently live in Silverado Canyon and I still take walks in the hills. I have given up on edible plants though.

My favorite outdoor activity is backpacking. I spend as much time as possible during the summer months in the Sierra Nevada mountain range. My interest in biology stemmed from a curiosity about the animals and plants I encountered there. I pursued that interest by attending Fullerton College, which offered a number of field courses in biology and field botany. I received my first formal introduction to the plants of Southern California in those courses.

I continued my education at University of Montana where I received my B.A. When I returned to California, I found that a B.A. did not guarantee a job, especially when one lacks practical experience. I decided to pursue a master's degree at California State University, Fullerton, which I finally completed last May. My research was conducted in the Cottonwood Basin of the Sierra Nevada on the ecology of two species of shooting star, *Dodecatheon jeffreyi* and *Dodecatheon redolens*. It was a perfect excuse to spend two summers in the backcountry!

Although the emphasis of my graduate degree was in Botany, I consider myself more of a general biologist than a botanist. Presently, I am a part-time instructor at CSUF and Mt. San Antonio College. As a "freeway flier" I have had a chance to teach a number of courses including human anatomy and physiology, health science and general botany. I hope to have a full-time teaching position in the future. I also hope to have a chance to initiate a series of field courses which would enable students to learn about the natural history of local areas and perhaps develop an environmental awareness.

Aliso is an important journal of systematic and evolutionary botany which began in 1948. During the last 36 years, this publication has contained numerous major works by such widely regarded scientists as Philip Munz, Verne Grant, Sherwin Carlquist, Lee Lenz, Richard Benjamin, Robert Thorne, and Ron Scogin.

But now *Aliso* is changing! Beginning in 1985, we will increase the number of pages and issues printed each year, enlarge the size to improve the quality of reproduction of plates, and open our journal to a larger number of non-staff contributors. Two issues containing about 300-400 pages will be published each year rather than a single issue. This will provide new opportunities for publishing outstanding contributions from botanists. If you are interested in learning more about the submission of manuscripts to *Aliso* plesae request a set of instructions for contributors from:

R. K. Benjamin, Editor
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Aliso is a journal devoted to the publication of original papers dealing with botanical systematics and evolution. However, botanical studies relating to cytology, ecology, genetics, geography, morphology, and physiology will be welcomed for consideration by the Editorial Board.

Pre-Publication Announcement

A FLORA OF SAN DIEGO COUNTY

This publication is an annotated distributional listing of native and adventive exotic plant species known to occur in San Diego County, California. Each taxon will be given with known collection sites, the elevational range within San Diego County, associated plant community and region, published chromosome count, as well as synonomy as it relates to San Diego County collections of that taxon. Diagnostic keys will aid in determination of species but no species descriptions will be included, except for those taxa described since 1974.

An introductory chapter will address vegetation and floristic associations within San Diego County, as well as the history of botanical collecting in that region. A vegetation map of San Diego

County, prepared by Thomas A. Oberbauer, will be included as part of the publication.

The book is expected to involve over 250 pages. Over 2000 plant taxa occur within San Diego County.

Pre-publication purchases are needed to support publication costs. Purchases are to be made by check made out to R. Mitchel Beauchamp. Pre-publication cost per copy is $18. Send orders to Pacific Southwest Biological Services, Post Office Box 985, National City, California 92050.

FIELD TRIPS AND EVENTS

June 1 San Mateo Marsh, 9:30 a.m.

Celia Kutcher of the Orange County CNPS will lead this trip into this fresh water marsh. We will explore the marsh in the morning, then lunch on the beach. In the afternoon we will examine coastal strand and riparian habitat. Take I-5 to San Clemente, then turn off at Cristianitos Road. Turn left and park along El Camino Real. Meet in front of the bike path. Bring lunch and water; be prepared for poison oak and some cross country hiking.

June 7-9 San Pedro Martir

By reservation only. Send SASE to guarantee reservation. Call Dave Bramlet at (714) 549-0647 for details.

June 22-23 San Bernardino Mountains

Andy Sanders will lead this Riverside/San Bernardino - Santa Monica CNPS Chapters field trip. Meet at the Mill Creek Ranger Station at 9:30 a.m. Be prepared for overnight camping in Forest Service Campgrounds. Call Andy Sanders (787-3601) for details.

(For information on July and August field trips, call Dave Bramlet.)

PLANT SALE A SUCCESS!!

The SCB Plant and Book Sale held at Rancho Santa Ana Botanic Garden on Saturday, April 13, 1985, was a big success. A special THANKS to Geoff Smith and all the volunteers who made this event run so smoothly. GREAT JOB!

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CROSSOSOMA is published bimonthly (February, April, June, August, October and December) by Southern California Botanists, a California non-profit corporation exempt from taxes under Sec. 501(C)3 of the Internal Revenue Code. Dues are on a calendar year basis. Regular $6.00. Students and Retirees $4.00. Groups $10.00.

We thank all those who promptly remitted their 1985 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

PLEASE HELP RECRUIT SCB MEMBERS

The Board of Directors of the Southern California Botanists has a problem facing us this year. We will either have to raise our membership dues or increase our membership number. Please pass the membership form (below) on to a friend who might be interested in the Southern California Botanists.

The total membership on our mailing list at this time numbers 423. The paid membership at this time is 292. Please check your mailing label for the status of your membership. The number to the right of your mailing label indicates the year through which your dues are paid.

Thank you for your past support in our program of field trips, student grants, symposia, pot lucks and especially our publication, Crossosoma. I know we can look forward to an even better year.

Alan Romspert
Membership-Treasurer

The purpose of the SOUTHERN CALIFORNIA BOTANISTS is the study, preservation and conservation of the native plants of California and the education of the public to the value of the native flora and its habitats. It is a non-profit association formed in 1927.

Membership benefits include: Various field trips throughout the state led by competent field botanists and biologists; a yearly plant sale featuring native California species; an annual symposium on various aspects of the California vegetation; the SCB journal, CROSSOSOMA; discounts on botanical and natural history books.

Dues are for a calendar year. NEW members joining from May through September, please deduct $1.00 from your dues. Those joining in October through December are credited with the following year's dues.

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June 7-9 San Pedro Martir

June 22-23 San Bernardino Mountains

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CROSSOSOMA

SOUTHERN CALIFORNIA BOTANISTS
Rancho Santa Ana Botanic Garden, Claremont CA 91711

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Managing Editor: C. Eugene Jones
August, 1985

HYBRIDIZATION BETWEEN *ENCELIA FARINOSA* GRAY EX TORR. AND *E. CALIFORNICA* NUTT. (ASTERACEAE)

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Department of Biological Science
California State University, Fullerton

INTRODUCTION

The introduction of interspecific hybridization has long been studied, notably by Anderson (1948, 1949, 1951), Epling (1947), and Heiser (1947). Of more specific interest to this study are the works of Kyhos (1967) involving hybridization between *Encelia* and *Geraea*, and the hybrid origin of *E. laciniata* (Kyhos *et al.*, 1981). Bjeldanes and Geissman (1971) investigated chemical constituents in what they considered an F_1 hybrid population of *Encelia farinosa* X *E. californica*, but the morphological characteristics of naturally occurring hybrids were not examined. The purpose of this study was to examine the nature of a group of putative hybrids between *E. farinosa* and *E. californica* by comparing traditional methods of hybrid analysis (Anderson, 1949) with multivariate analysis. Pimentel (1981) compared several methods of multivariate analysis using data from putative hybrids of *Abronia* (sand verbena). A similar comparison of traditional and multivariate analyses has been presented by Adams (1982) for artificial crosses of sunfish (*Lepomis*) and putative hybrids of *Juniperus*.

Morphology and Distribution. A revision of the genus *Encelia* was presented by Blake (1913) and the following discussion is based on that revision. *Encelia farinosa* Gray ex Torr. was first described by Gray (Emory, 1848) and is readily recognized by its dome-like shape, silvery-green leaves, and panicled heads with chrome-yellow ray and disk flowers. It is prevalent in the deserts of the Southwest.

[1] 157 Pammy Way, Grass Valley, CA 95949.

Encelia californica Nutt. was described by Nuttall (1841), and is easily recognized by its bushy habit, green leaves (as opposed to silvery-green), and solitary heads with yellow ray flowers and purple-brown disks. It is found in both Coastal Sage Scrub and Chaparral communities throughout southern California. Figure 1 illustrates the ranges of *E. farinosa* and *E. californica* in southern California. *Encelia farinosa* spreads into western Riverside and San Bernardino counties through low passes in the Transverse and Peninsular Ranges.

MATERIALS AND METHODS

Population Samples. Field studies were conducted from April through June in 1980 and 1981. Five populations from three geographic locations were selected. Detailed locations are given in Troyer (1983). The locations of these sites, with respect to species distribution, are shown in Fig. 1. Herbarium specimens were examined at the Faye MacFadden Herbarium of California State University, Fullerton (MACF) and the Herbarium of Rancho Santa Ana Botanic Garden, Claremont, California (RSA) to aid in determining the ranges of *E. farinosa* and *E. californica*. The Orange County site represented an allopatric population of *E. californica*. This area was part of a typical Coastal Sage Scrub Community. Well-established, mature plants were found on a west-facing slope near, but not noticeably disturbed by, the road cut. The allopatric *E. farinosa* site was located near the Whitewater River in Riverside County. *Encelia farinosa* was growing in abundance on the rocky, east-facing slopes as well as adjacent to the riverbed. An area of sympatry was found bordering the southern edge of Lake Mathews, the terminus of the Colorado River Aqueduct. Population samples were collected at this site of what appeared to be *E. farinosa*, *E. californica* and putative hybrids. The general area was a natural depression surrounded by low hills. *Encelia farinosa* was found growing on flats and slopes surrounding the lake on all but the west side. *Encelia californica* seemed to be limited to an area south of the lake where the putative hybrids were discovered. This area was a disturbed habitat (housing developments within 1800 m) with *Encelia* as the dominant taxon. The surrounding vegetation was distinctly different. Mature plants of both parental species and putative hybrids were found here, along with smaller (younger) examples of parental forms. Occasionally, a putative hybrid was found growing between both parental types. Similarly, *E. farinosa* could be found growing adjacent to *E. californica*, the inflorescences in close proximity, often intertwined. Herbarium specimens of the 50 plants sampled are deposited by collection numbers in the Faye MacFadden Herbarium of California State University, Fullerton (MACF).

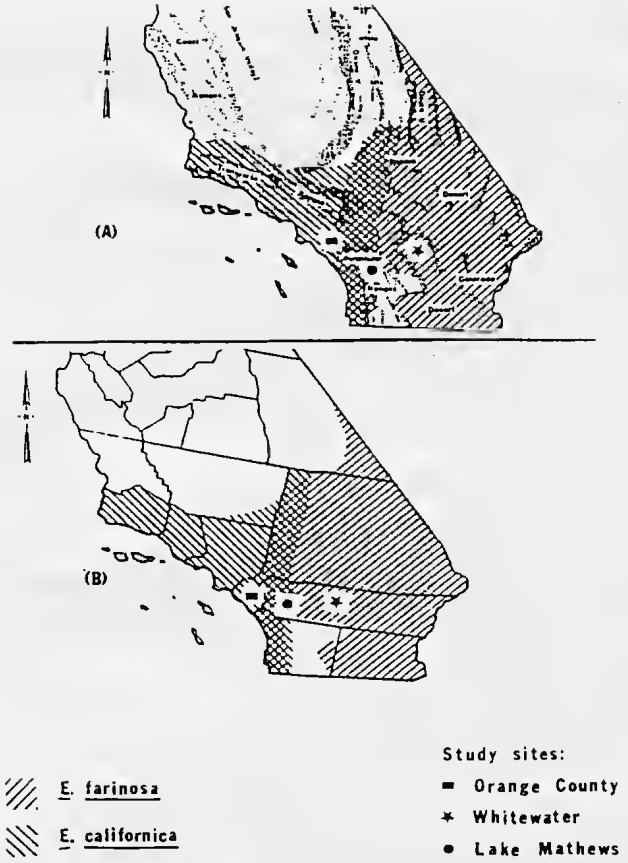


Figure 1. Distribution of *Encelia farinosa* and *E. californica* in southern California, by topography (A) and county (B). Ranges determined from Munz (1974), herbarium specimens, and personal observations.

Comparative Morphology. The two species are easily distinguished in the field. A count was done at the Lake Mathews site to determine the relative frequency of parental forms and putative hybrids. Samples from all five populations were collected and returned to the lab for qualitative and quantitative analysis. These analyses included pollen viability, seed viability and ultraviolet analysis.

Experimental Crosses. Compatibility tests were conducted in the field to corroborate evidence found in the literature that species are self-incompatible (Kyhos, 1967; Hyhos *et al.*, 1981).

Andersonian Methods of Analysis. Following the methodology of Anderson (1949), the five populations were analyzed using hybrid indices and pictorialized scatter diagrams.

Morphometric Analysis. The above methods of hybrid analysis allow a quick summarization of available data, but they only help differentiate organisms into groups (*e.g.*, parental species and putative hybrids), and do not give quantifiable distances between groups Adams (1982). Anderson was aware of these limitations but, at the time, conventional biometric methods were "laborious and inefficient" (Anderson, 1949). We used the multivariate analysis (DISANAL) written by Dr. Richard A. Pimentel, California Polytechnic University, San Luis Obispo, and implemented on the Cyber 730/760, California State University Central Cyber System. The main purpose is ordination, *i.e.*, the placement of individuals into multidimensional space while presenting the resulting relationships in reduced dimensional space (*e.g.*, two or three dimensions) for easier visualization. In statistical terms, ordination presents the maximum amount of information in such a way that relationshps can be viewed from a single diagram in reduced dimensions. DISANAL included Principal Component Analysis (PCA) and Discriminant Analysis (DA). Detailed methodology for these analyses are discussed in Pimentel (1979). A discussion of all of the above analyses with respect to this study is in Troyer (1983).

RESULTS

Analysis of Population Samples. In both allopatric species populations fell within the morphological species boundaries. At the sympatric site a frequency count was taken. Out of 208 mature plants counted and grouped based on qualitative characters at Lake Mathews, 54% (113 plants) were putative hybrids, 24% (49 plants) were *E. farinosa*, and 22% (46 plants) were *E. californica*.

Comparative Morphology. Individuals of *Encelia farinosa* and *E. californica* were readily distinguished in the field. A comparison of all five populations with respect to characteristics is given in Table 1. Some of the most discerning features included leaf characteristics. Leaves of *E. farinosa* were markedly lighter in color, as a result of being covered with soft, thick, white hairs and were, on the average, larger in size than the green, less pubescent leaves of *E. californica*.

Inflorescence type was also useful for distinguishing the two species. In *Encelia californica*, heads were borne solitary at the ends of pubescent peduncles. Heads were presented in cymose panicles on peduncles which were tan in color and nearly glabrous in *E. farinosa*. The same was true of the sympatric species, but the putative hybrids had inflorescences which were either solitary or panicled on canescent to glabrous peduncles. Four of the variants sampled had both solitary heads and cymose panicles. A distinguishing qualitative character of the inflorescences was the color of the disk flower

corollas. *Encelia californica* disks were brown in color, whereas *E. farinosa* had yellow disks. The disk flowers mature centripetally, and at any stage of maturity, *E. californica* disks are all brown, and *E. farinosa* disks are all yellow. In the putative hybrids, the distinction was clear cut in all but two individuals. Intermediates had brown disks with the exception of plants 135 and 139. In these individuals, examined mid-way through disk flower bloom, outer flowers were yellow and inner flowers were brown. Another identifying feature of the inflorescence of the two species was the diameter of the disk. *Encelia californica* disks were larger. Not only were the disks larger, but also the number of ray flowers per head was greater in

TABLE 1. COMPARISON OF ENCELIA CALIFORNICA X E. FARINOSA WITH ALLOPATRIC AND SYMPATRIC PARENTAL SPECIES.

Character	Allopatric *E. californica* (10 plants)	Sympatric *E. californica* (10 plants)	Putative Hybrids (10 plants)	Sympatric *E. farinosa* (10 plants)	Allopatric *E. farinosa* (10 plants)
Petiole length	0.4-1.5cm(0.9)	0.5-1.5cm(0.9)	0.3-1.7cm(1.2)	0.5-2.0cm(1.3)	1.2-2.2cm(1.8)
Leaves:					
length(inc. petiole)	3.0-6.2cm(4.1)	2.9-5.0cm(4.3)	3.1-8.4cm(5.0)	2.9-8.8cm(5.9)	4.8-8.3cm(6.7)
width	0.7-2.5cm(1.7)	1.0-2.3cm(1.4)	1.2-3.7cm(2.2)	1.2-3.4cm(2.5)	2.2-3.6cm(2.8)
color	green	green	green to whitish	white	white
pubescence	not tomentulose*	not tomentulose	intermediate	tomentulose	tomentulose
Peduncle pubescence	canescent	canescent	canescent to glabrous	glabrous	glabrous
Involucre height	0.4-1.2cm(1.0)	0.5-0.9cm(0.6)	0.6-0.9cm(0.9)	0.3-0.5cm(0.4)	0.05-0.7cm(0.6)
Disks:					
diameter	1.1-2.0cm(1.5)	1.2-1.5cm(1.3)	1.3-1.8cm(1.6)	1.2-1.6cm(1.4)	1.1-1.8cm(1.[illegible])
flower color	brown	brown	brown to yellow-brown	yellow	yellow
Rays:					
number per head	11-27(16)	12-18(15)	8-19(13)	8-13(11)	6-11(10)
length	1.1-2.5cm(1.8)	1.1-1.6cm(1.4)	1.2-2.5cm(1.9)	1.0-1.7cm(1.3)	1.1-1.9cm(1.3)
Cypsela length	0.47-0.62cm(0.53)	0.41-0.63cm(0.53)	0.43-0.63cm(0.51)	0.40-0.49cm(0.43)	0.38-0.62cm(0.48)
Inflorescence type	solitary	solitary	solitary to cymose panicle	cymose panicle	cymose panicle
UV analysis†	"bull's-eye" pattern	"bull's-eye" pattern	absorptive to patterned	absorptive	absorptive
Pollen viability	41.2-97.0%(85.4)	48.8-97.0%(89.1)	68.5-94.8%(87.6)	80.8-99.2%(92.4)	93.5-99.0%(96.9)
Seed viability	63.0-90.0%(78.6)	76.0-97.0%(87.0)	59.0-88.0%(72.2)	77.0-96.0%(87.5)	84.0-92.0%(89.4)

Values in parentheses represent averages

*Appressed-pubescent (Munz, 1974) as opposed to tomentulose condition found in *E. farinosa*.

†See Fig. 2 for explanation.

E. californica. Overall, the inflorescences in *E. californica* were larger, including the height of the involucre.

Pollen Viability. The ranges and averages for percent pollen viability for all five populations are given in Table 1. In all cases, the average pollen viability was well above 80%. Heiser (1947) and Hyhos (1967) consider pollen viability a good measure of male fertility. The putative hybrids ranged in pollen viability from 68.5 to 94.8%, indicating that they are relatively fertile, as are both allopatric and sympatric parents.

Seed Viability. As with pollen viability for male fertility, seed viability provides an estimation of female fertility. Average seed viability was lower in the putative hybrids than in the other four populations, but still above 50% viable.

Ultraviolet Analysis. Analysis of heads for all 50 individuals clearly showed that *E. farinosa* was completely UV absorptive and *E. californica* possessed UV reflective ray flowers and UV absorptive disks to generate the "bull's-eye" pattern. Of the ten putative hybrids, seven were all absorptive, with one of those seven not quite as dark in color. Of the remainder, three were patterned ("bull's-eye" type), though the pattern on one of them was not as distinct. An all UV absorptive flower normally is genetically dominant over a UV patterned flower (head) (C. E. Jones, unpublished data). Since this is the case, one would expect all F_1 hybrids to be UV absorptive. Therefore, the three putative hybrids having UV patterns indicate backcrossing to *E. californica*, the parent with the "bull's-eye" pattern. Figure 2 shows the differences in appearance of the inflorescences in visible and UV light (two second exposure). Photographs (A) show allopatric *E. farinosa* and *E. californica* with plants 137 and 143 in the visible spectrum. There is relatively little difference other than in size. Photographs (B), taken in UV, show a difference, however. *Encelia farinosa* now becomes less distinct (more uniform) because of its UV absorptance. *Encelia californica* takes on a different appearance with UV reflective ray flowers and UV absorptive disks. For the bees, this "new look" simply enhances the visible color difference that is perceived by humans. Note that the intermediates differ. Plant 137 displays the "bull's-eye" pattern, whereas plant 143 is all absorptive, even though in visible light both have brown disks.

Experimental Crosses. The results of the experimental crosses done in the field are inconclusive due to small sample size and difficulties encountered in the field (*e.g.*, plants destroyed by bulldozers). The preliminary findings seemed to indicate some self-compatibility, but overall, outcrossing produced the highest percentage of fruit set in all five populations.

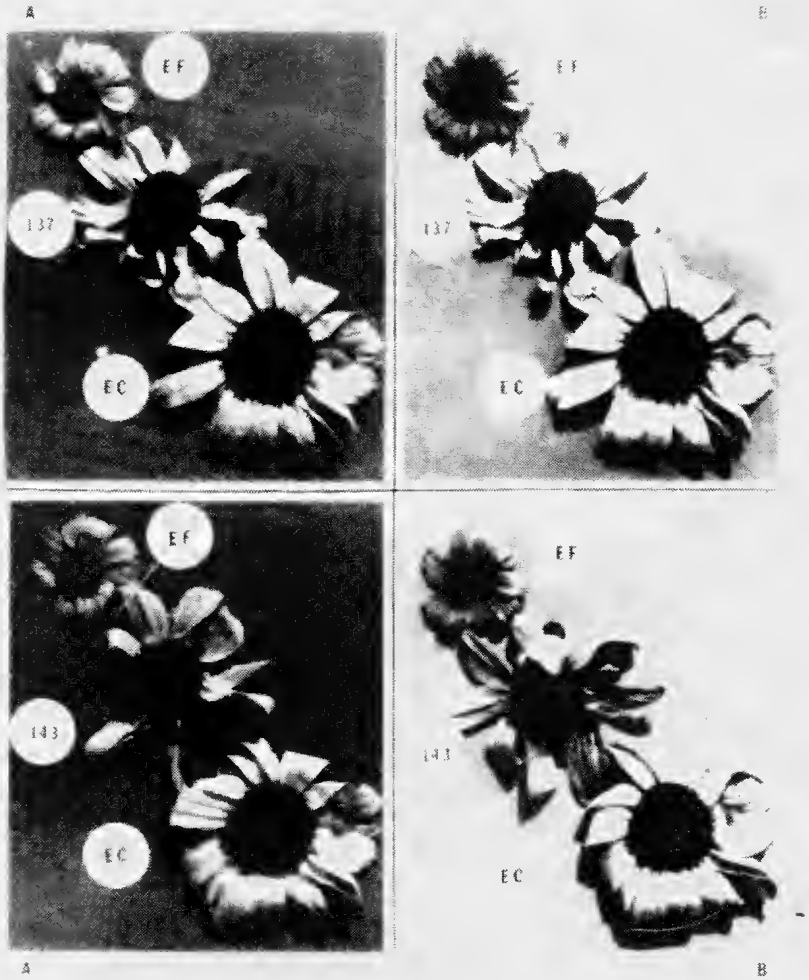


Figure 2. Visible (A) and ultraviolet (B) photographs of allopatric *Encelia farinosa* (EF) and *E. californica* with plants 137 and 143. See text for further discussion.

Andersonian Methods of Analysis. Using the morphological hybrid index techniques of Anderson (1949), frequency versus hybrid index value was plotted. The histogram shown in Fig. 3 compares the hybrid index values for allopatric (A) and sympatric(B) populations and the putative hybrids. When compared with the allopatric populations, the variants show intermediacy with respect to the characters used to determine the index value (see Table 2). There seems to be a trend on the part of the putative hybrids to be more like *E. californica*. In the sympatric populations, the values for both parents reflect a

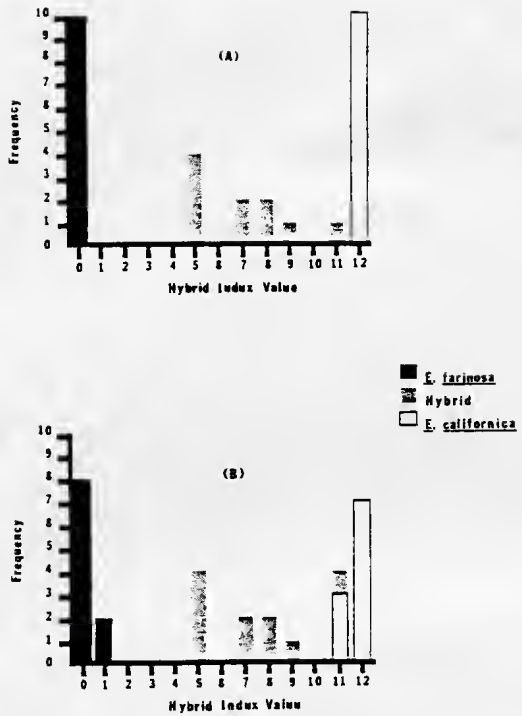


Figure 3. Hybrid index values for allopatric (A) and sympatric (B) populations of *Encelia farinosa, E.. californica* and putative hybrids.

TABLE 2. CHARACTERS USED AND VALUES ASSIGNED TO THEM IN CONSTRUCTING THE MORPHOLOGICAL HYBRID INDEX.

Character	Hybrid index value		
	0	1	2
Leaf Color	white	white to green	green
Leaf pubescence	tomentulose	intermediate	not tomentulose
Disk flower color	yellow	yellow-brown	brown
Inflorescence type	cymose panicle	intermediate	solitary
Peduncle pubescence	glabrous	intermediate	canescent
Ultraviolet analysis*	absorbant	intermediate	"bull's-eye" pattern

0 represents *E. farinosa;* 2 represents *E. californica.*

greater degree of variability. Again, the putative hybrids are intermediate. Plant 139, whose hybrid index value is 11, is rather interesting in that it is closer to *E. californica* than to the majority of the other intermediates.

Table 3 lists the symbols used in the pictorialized scatter diagram (Fig. 4). Allopatric *E. farinosa* and *E. californica* are plotted with the putative hybrids in Fig. 4. Most of the individuals are intermediate not only with respect to leaf width and involucre height, but also with respect to qualitative characters. Plant 139 is indicated by a circle. Once again, it is closely alligned with *E. californica*. Other scatter diagrams (Troyer, 1983) indicate that the putative hybrids are larger than the sympatric *E. farinosa* and *E. californica* populations. This simply may be the results of the effects of heterosis (hybrid vigor) as discussed by Davis and Heywood (1963).

TABLE 3. KEY TO SYMBOLS USED IN PICTORIALIZED SCATTER DIAGRAM (FIG. 4).

Key to Symbols

Leaf color	Peduncle pebescence	Disk color
● white	○ glabrous	○ yellow
◐ intermediate	—○ intermediate	♀ intermediate
○ green	—○ canescent	♀ brown
Leaf pebescence	**Inflorescence type**	✱ "Hypothetical hybrid"
○ tomentulose	○ cymose panicle	
♁ intermediate	○— intermediate	
♁ not tomentulose	○— solitary	

Principal Component Analysis. The results of principal component analysis are given in Table 4 and Fig. 5. Since component scores are uncorrelated, each eigenvector represents an independent pattern of variation. With respect to the data presented here, the first component accounts for 69.0% of the total variation. Size affects the second component, where leaf length and width, and petiole length account for the greatest variation (97.96, 64.83, and 60.90%, respectively). The first four components explain 94.2% of the total variation. Loading of components continues to the fourteenth component, but 99.1% of the total variation is explained by the ninth component. Several qualitative characteristics, especially leaf pubescence (65.69%), disk color (49.42%), and inflorescence type (44.95%), contribute to loading in the fourth component.

Table 5 represents a key to the symbols used in the following ordinations. Figure 5 plots all individuals in all groups, with each group centroid boxed. With respect to the centroids, there are

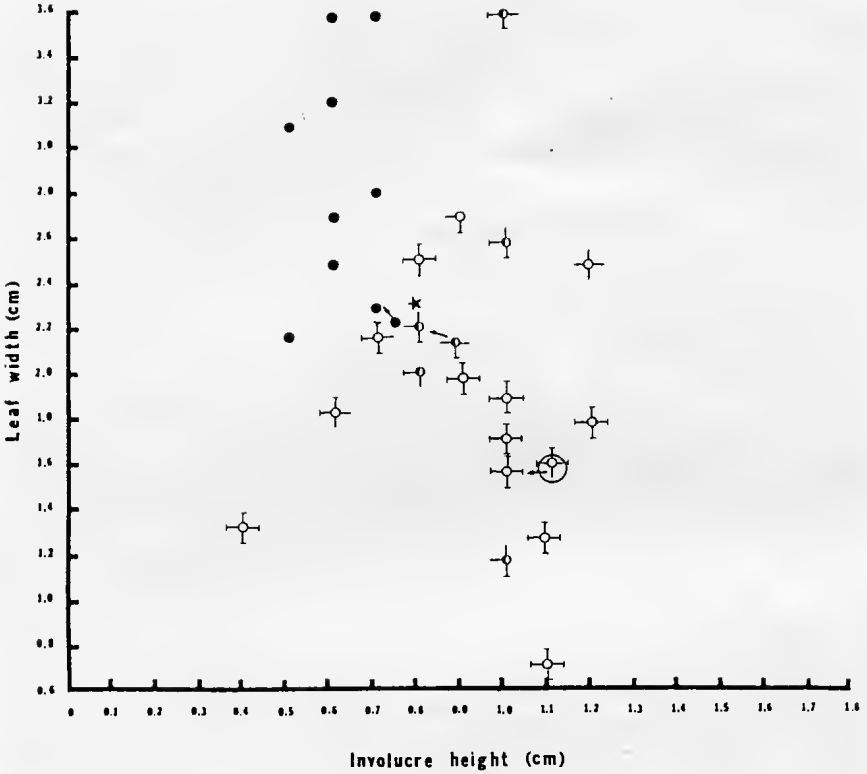


Figure 4. Pictorialized scatter diagram for allopatric populations of *Encelia farinosa*, *E. californica* and putative hybrids. See Table 3 for explanation of symbols.

distinct groups. As in the pictorialized scatter diagrams, plant 139 is highlighted by a circle. Only the ordination of 1 x 2 is shown. In 1 x 3, all individuals lie close to the first axis. Plant 139 is more closely alligned with *E. californica* than with either the other putative hybrids or *E. farinosa*.

The ordination shown in Fig. 5 is explained by basically four eigenvectors: leaf length, leaf width, petiole length, and number of ray flowers. On the first axis, the number of ray flowers has the largest effect on group dispersion, pushing *E. californica* to the left, thus indicating a greater number of ray flowers. This is upheld by actual counts (see Table 1). Along the second axis, leaf size and shape greatly influence the spread of the five groups. Again, size contributes much to the overall outcome of principal component analysis, and in fact, *E. farinosa* tends to have larger leaves than the remaining groups. Along the third axis, involucre height pushes the groups away from the first axis, or contributes

TABLE 4. EIGENVECTORS (DIRECTION COSINES) OF PRINCIPAL COMPONENTS FOR EACH VARIABLE. NUMBERS IN PARENTHESIS REPRESENT PERCENTAGE OF VARIANCE CONTRIBUTED BY EACH VARIABLE TO A GIVEN COMPONENT. SEE TEXT FOR FURTHER DISCUSSION.

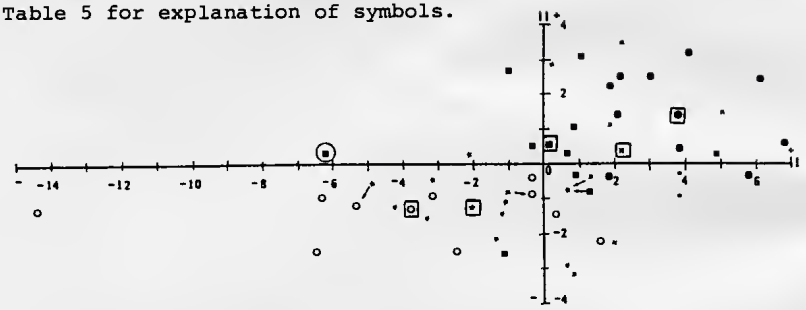
Variable	Component Axes 1	2	3	4	Cumulative percent
Leaf length	0.043(0.84)	0.904(97.96)	-0.101(0.35)	0.064(0.06)	99.21
Leaf width	0.018(0.77)	0.334(64.83)	0.158(4.22)	-0.084(0.53)	70.35
Petrole length	0.030(3.35)	0.249(60.90)	-0.024(0.17)	0.028(0.10)	64.52
Ray flower length	-0.022(3.35)	-0.012(0.25)	-0.042(0.88)	-0.224(11.20)	15.68
Disk diameter	-0.036(33.47)	0.031(6.64)	0.048(4.48)	-0.091(7.23)	51.82
Inolucre height	-0.039(2.03)	0.043(0.65)	0.977(96.21)	0.066(0.19)	99.08
Cypsela length	-0.001(0.08)	0.004(0.84)	-0.006(0.74)	-0.006(0.26)	1.92
Number of ray flowers	-0.995(99.91)	0.051(0.07)	-0.038(0.01)	-0.04(0.01)	100.00
Leaf color	-0.013(1.55)	-0.006(0.07)	-0.028(0.52)	0.297(25.62)	27.76
Leaf pubescence	-0.028(4.23)	-0.048(3.09)	-0.044(0.78)	0.610(65.60)	73.70
Disk color	0.015(5.39)	0.015(1.31)	0.022(0.79)	-0.255(49.42)	56.91
Inflorescence type	-0.020(2.76)	-0.008(0.12)	-0.024(0.28)	0.442(44.95)	48.11
Peduncle pubescence	-0.007(0.42)	-0.020(0.80)	0.008(0.41)	0.289(22.10)	23.73
Ultra violet	-0.037(7.70)	0.017(0.44)	-0.004(0.01)	0.345(22.69)	30.84
Percent trace	69.0	17.8	5.1	2.3	
Cumulative percent	69.0	86.8	91.9	94.2	

TABLE 5. KEY TO SYMBOLS USED IN COMPONENT GRAPH FROM PRINCIPAL COMPONENT ANALYSIS (Fig. 5) AND CANONICAL GRAPH FROM DISCRIMINANT ANALYSIS (Fig. 6).

Key to Symbols

- o allopatric E. californica
- ✦ sympatric E. californica
- ■ putative hybrids
- ⁎ sympatric E. farinosa
- ● allopatric E. farinosa

Figure 5. Component graph from Principal Component Analysis showing group dispersions on 1 x 2 axes. Group centroids are boxed. See Table 5 for explanation of symbols.



to the vertical spread when viewed in three dimensions. To a lesser degree, leaf width also has an effect.

Principal component analysis, with its sensitivity to size, gives a generalized view of shape along with insights into overall variation. Discriminant analysis deals with discriminant space and thus the influence of overall size is reduced.

TABLE 6. SUMMARY OF GEISSER CLASSIFICATION PROBABILITIES. NUMBERS REPRESENT PERCENTAGE "HITS", *I.E.*, NUMBER OF INDIVIDUALS ACTUALLY "BELONGING" TO A GIVEN GROUP.

	Predicted group				
Actual group	1	2	3	4	5
Allopatric *E. californica* (1)*	80	20	0	0	0
Sympatric *E. californica* (2)	20	80	0	0	0
Putative hybrid (3)	0	0	100	0	0
Sympatric *E. farinosa* (4)	0	0	0	90	10
Allopatric *E. farinosa* (5)	0	0	0	0	100

*Numbers in parentheses correspond to predicted group numbers.

Discriminant Analysis. A summary of the Geisser Classification Probabilities is given in Table 6. As shown, 80% of the allopatric *E. californica* individuals are classified with their own group. The remaining 20% are classified with the sympatric *E. californica* individuals. The same is true for the sympatrics (80% hits, 20% misses). This classification is most reasonably explained by variation within a species. From PCA ordinations, one might expect plant 139 to be

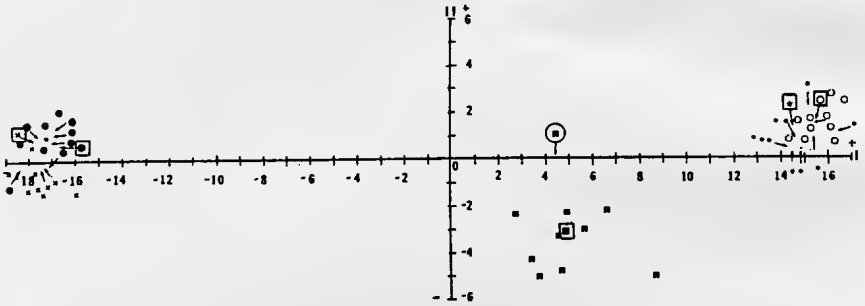
classified with *E. californica*. There is some discrepancy in group loyalty among the sympatric *E. farinosa* population. Ninety percent of the individuals classify to that group, whereas 10% do not and instead classify to allopatric *E. farinosa*. Allopatric *E. farinosa* are 100% loyal to their group.

Table 7 gives the standardized z-scores for each variable in the first three canonical axes. Here, 98.27% of the total variation is accounted for in the first canonical axes. Ten of the 14 variables contribute 80% or above of their individual variances in the first canonical axis. Leaf length, petiole length, and ray flower length greatly contribute to the variation between groups, thereby helping to segregate them. Qualitative characters now have a larger part in

TABLE 7. STANDARDIZED VECTORS (Z-SCORES) FOR EACH VARIABLE. NUMBERS IN PARENTHESES FOLLOWING EACH Z-SCORE REPRESENT THE PERCENTAGE OF THE VARIANCE CONTRIBUTED BY EACH VARIABLE TO A GIVEN CANONICAL AXIS. SEE TEXT FOR FURTHER DISCUSSION.

Variable	Canonical Axes 1	2	3	Cumulative percent
Leaf length	-0.805(85.39)	-1.437(14.23)	-0.919(0.16)	99.78
Leaf width	0.304(68.00)	0.872(29.15)	1.452(2.25)	99.40
Petiole length	0.706(93.87)	0.762(5.71)	-0.204(0.01)	99.59
Ray flower length	0.446(98.97)	0.115(0.34)	0.912(0.60)	99.91
Disk diameter	-0.534(98.51)	-0.277(1.39)	-0.055(0.002)	99.90
Involucre height	0.052(61.52)	-0.107(13.87)	-0.241(1.95)	77.34
Cypsela length	0.085(70.71)	-0.180(16.53)	-0.722(7.37)	94.61
Number ray flowers	0.337(99.06)	0.081(0.30)	0.170(0.04)	99.40
Leaf color	0.514(99.87)	0.075(0.11)	0.194(0.02)	100.00
Leaf pubescence	0.584(99.93)	0.032(0.02)	0.033(0.00)	99.95
Disk color	1.789(99.98)	-0.109(0.02)	-0.056(0.00)	100.00
Inflorescence type	0.810(97.46)	0.570(2.53)	0.244(0.01)	100.00
Peduncle pubescence	-0.072(12.27)	-0.838(87.00)	-0.136(0.06)	99.33
Ultraviolet	0.450(91.37)	0.605(8.62)	-0.117(0.01)	100.00
Percent trace	98.27	1.36	0.21	
Cumulative percent	98.27	99.62	99.83	

Figure 6. Canonical graph from Discriminant Analysis showing group dispersion on 1 x 2 axes. Group centroids are boxed. See Table 5 for explanation of symbols.



the variation in the first canonical axis (*e.g.*, leaf pubescence (99.93%), leaf color (99.87%)), whereas in PCA these do not contribute significantly to the total variation until the fourth axis. By the third canonical axis, 99.83% of the total variation is explained.

Symbols for Fig. 6 are explained in Table 5. Figure 6 represents canonical ordinations for all individuals and group centroids. As would be expected, allopatric and sympatric *E. californica* overlap, as do allopatric and sympatric *E. farinosa*. The putative hybrids are not as tightly grouped, with plant 139 (circled) an outlier.

The spread of the groups in Fig. 6 may be explained as follows. With respect to the first canonical axis, leaf pubescence and disk color have the greatest effect in separating the groups. Cypsela length has a major effect along the second axis, as does peduncle pubescence and, to a lesser degree, leaf length, leaf width, petiole length, and ultraviolet analysis. Disk diameter and inflorescence type act on both the first and second axes. With respect to the first and third canonical axes and their vectors, cypsela length affects the spread within groups more than between groups along the third axis. Leaf width and ray flower length also affect the spread along the third axis. Disk color is a strong separator along the first axis. In addition; petiole length, disk diameter, leaf color, and inflorescence type also have effects along the first axis. Leaf length and ray flower length have effects along both axes.

(Discussion and Conclusions will appear in the next issue of CROSSOSOMA.)

Biographical Sketches of SCB Officers and Directors:

DAVID BRAMLET, SECOND VICE PRESIDENT

I was born in 1954 and grew up in Lynwood, California, a typical suburban community of Los Angeles. However, I was fortunate to be involved in a scouting program which did a lot of backpacking in the local mountains and the Sierra Nevadas. My first interest in botany was trying to identify the plants I observed on these many backpacking trips.

I decided upon biology as a career goal but was uncertain where to specialize. I obtained a bachelor's degree from Cal Poly, Pomona in vertebrate zoology, thinking I could obtain employment with a government agency. When I couldn't find a job, I started graduate school at Cal Poly in entomology, where I thought there were more jobs! About this time my botany courses paid off when I found occasional jobs describing vegetation for EIR's.

Eventually I abandoned school and obtained a seasonal job at a consulting firm in Orange County. The job involved analyzing plant communities for baseline studies for mining projects in some of the most spectacular areas in the West: southeast Alaska, Utah, northeast Oregon, Colorado and even California! So, a lot of my practical knowledge of plants came from the identification of plants and communities required for these projects.

Presently, I am a staff biologist at Harmsworth Associates, a consulting firm in Laguna Hills. Most of our current projects, for local IER's, are much smaller and involve more "armchair" work, although I still feel the job is interesting and challenging.

One of my more enjoyable outdoor activities is participating in the SCB field trips. I feel that the field activities are the real "backbone" of SCB. These field trips allow me to explore new areas, learn new plant taxa and meet some of the "interesting" SCB members. I encourage everyone to make the effort and attend as many field trips as possible. It's worth the effort!

STUDENT GRANTS AWARDED

The SCB Board of Directors has awarded $350.00 to help fund three student research projects. Recipients include: Gary Sampson, CSUF, for a project entitled "Flora of Chino Hills State Park"; Heather Hollis, CSULB, for a study entitled "Santa Catalina Island Floral Composition"; and Mike Cummings, CSUF, for a project entitled "Carbon Balance in Hybrid Oaks." We wish all grant recipients well in their research efforts.

FIELD TRIPS AND EVENTS

August 15 (Thursday) Plant Communities of Northern Baja, Slide Talk

On August 15 Dave Charlton will be presenting a slide show at 7:30 p.m. on the plant communities of Northern Baja. It will be held in the conference room of the herbarium located in the UCR Botanical Garden. Park in parking lot #13.

August 17 (Saturday) Fuller Ridge Trail

Field trip from Fuller Ridge Trail to Deer Springs. It is a moderately strenuous hike through sub-alpine vegetation, including lemon lilies and western azalea. Meet at Lake Fulmar parking lot at 9 a.m. Leader will be Mike Hamilton. Take I-10, get off at 14½ Street to Hwy. 243. For further information, call Dave Bramlet.

August 25 (Sunday) Mt. Baldy Trip

The San Gabriel Mountains CNPS chapter will have a field trip to the sub-alpine habitat of Mt. Baldy Notch on Sunday, August 25 at 9 a.m. The group will meet at the Mt. Baldy ski lift parking lot. From there the group will ride the ski life ($5) to the notch. At this point we will investigate many of the unusual plants in this area. To reach the meeting place take the San Bernardino Freeway east to Euclid (in Upland), to San Antonio Rd. past Baldy Village to the ski lift parking lot. Call Dave Bramlet (714) 549-0647 for details.

September 28 (Saturday) San Bernardino Mountains Trip

8 a.m. A fall trip with the Riverside/San Bernardino CNPS chapter to the aspen grove on Fish Creek in the San Bernardino Mts. The trip will be led by Tim Krantz and should provide some spectacular fall colors. To reach the area go east on the San Bernardino freeway and then north on Orange Ave. (Hwy. 30), then go right (east) on Hwy. 38. Take Hwy. 38 up into the San Bernardino Mts. We will meet at the entrance to the Hart Bar campground. Call Andy Sanders (714-787-3601) for details.

October 19 (Saturday) Annual Potluck Dinner

See details, page 17.

Nobember 17 (Saturday) Annual SCB Symposium

See details, page 17.

DATES FOR YOUR CALENDAR!

This year's potluck will be at the Fullerton College Horticulture Department on Saturday, October 19. This will allow us to take advantage of an outdoor setting if the weather permits. Our speaker for this occasion will be one of our Directors, Geoff Smith. He will have slides from his upcoming trip to British Columbia and Alaska. Knowing Geoff, these will be of great beauty and interest.

The annual SCB Symposium this year will be on Saturday, November 17, 1985. It will be at a new location. We have the opportunity to use the new auditorium at the Fred L. Hartley Research Center of Union Oil Co. in Brea for free. The theme for this Symposium will be "Plants and Pollution." More information will be in the next issue of CROSSOSOMA, which will be the program issue. Get this date on your calendar now as the speakers will have some excellent presentations this year.

The purpose of the SOUTHERN CALIFORNIA BOTANISTS is the study, preservation and conservation of the native plants of California and the education of the public to the value of the native flora and its habitats. It is a non-profit association formed in 1927.

Membership benefits include: Various field trips throughout the state led by competent field botanists and biologists; a yearly plant sale featuring native California species; an annual symposium on various aspects of the California vegetation; the SCB journal, CROSSOSOMA; discounts on botanical and natural history books.

Dues are for a calendar year. NEW members joining from May through September please deduct $1.00 from your dues. Those joining in October through December are credited with the following year's dues. Membership categories are:

☐	Student or retired*	$ 4.00	☐ New member
☐	Individual*	$ 6.00	☐ Renewal
☐	Group or organization	$10.00	

*Includes membership for the rest of the family.

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In addition, I want to give $_____ to help SCB. Make check payable to: SOUTHERN CALIFORNIA BOTANISTS. Mail to Allen Romspert, SCB, Dept. of Biological Science, CSUF, Fullerton, CA 92634.

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We thank all those who promptly remitted their 1985 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

SCB COMING EVENTS

August 15	Plant Communities of Northern Baja, Slide Talk
August 17	Fuller Ridge Trail
August 25	Mt. Baldy Trip
September 28	San Bernardino Mountains Trip
October 19	Annual Potluck Dinner
November 17	Annual SCB Symposium

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CROSSOSOMA

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Issue Editors: David Bramlett and David Walkington
Managing Editor: C. Eugene Jones October, 1984

PROGRAM ISSUE

Pollution Effects on Southern California Plants

Saturday, November 16, 1985

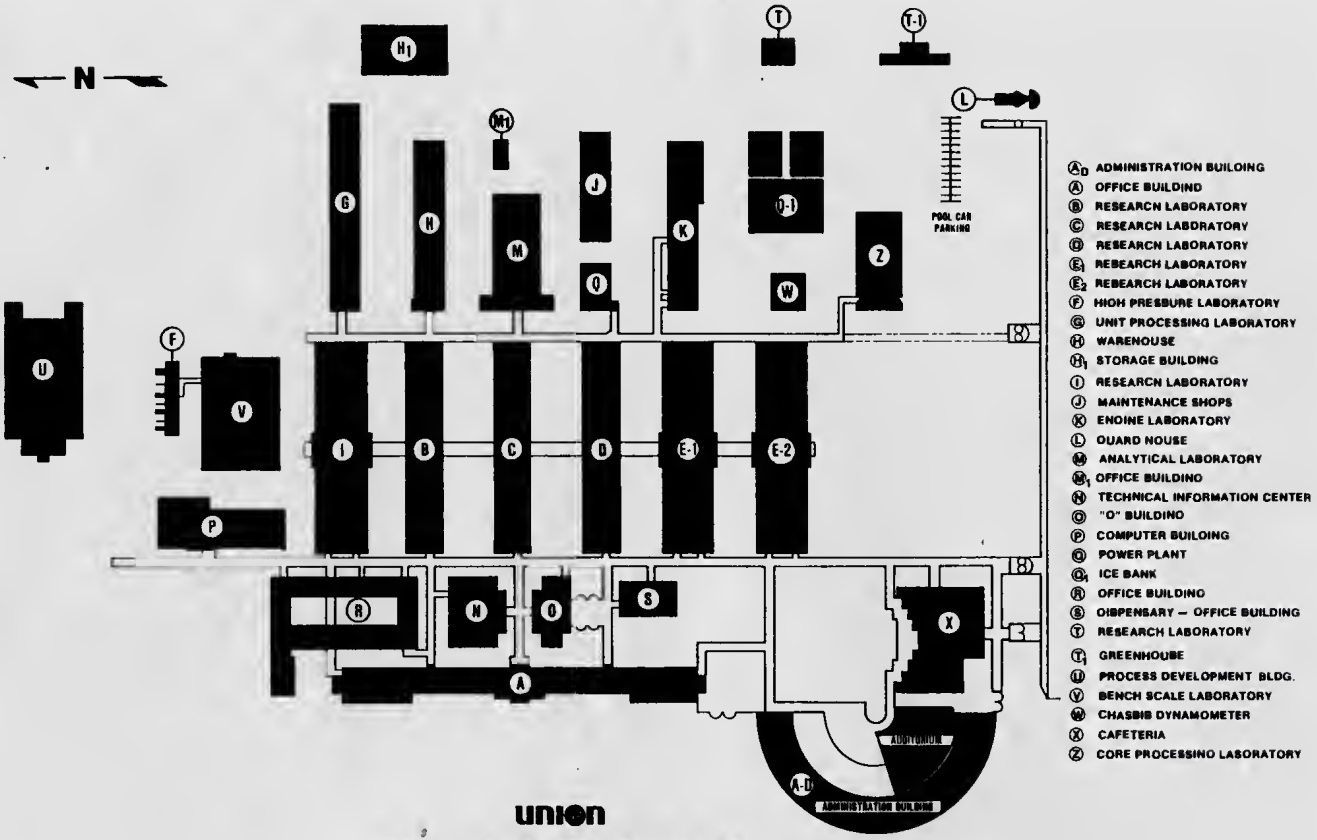
Fred L. Hartley Research Center
Union Oil Co., Brea, CA

Our eleventh annual symposium features five speakers who will address the topic of pollution, i.e. byproducts of human activities and natural processes that are judged to contaminate or reduce conditions to less than pristine, and its effects on plants and vegetation types under the environmental conditions found in Southern California. All five speakers are currently from Southern California. Some are employed by universities while others are associated with utility company research. Our symposium, as well as addressing the terrestrial impacts, will also present marine vegetational effects.

Registration will begin at 8:00 a.m. with the closing remarks at 3:40 p.m. Admission will be $7.00 for current SCB members. If you wish to renew your membership for 1986 and register for the symposium, the price will be $15.00 (1986 membership rates will be $8.00 for individuals). For non-members who wish to attend, the rate will be $16.00, but a 1986 membership which includes December, 1985 will be automatically included.

The location of this year's SCB symposium is the auditorium of the Fred L. Hartley Research Center in Brea at the intersection of Imperial Highway and Placentia Avenue. One may reach the center by exiting off the 57 Freeway on Imperial Highway and traveling east to the center. Ample parking is available and can be reached by exiting off Placentia Avenue into the center and following the signs.

Light refreshments will be available outside the auditorium during the registration period and during the morning and afternoon breaks. A list of lunch places in the area will be provided at the registration desk outside the auditorium. Although each presentation is scheduled to have a question and answer period, you may wish to join the speakers at their lunch spot and query them directly.



union

FRED L. HARTLEY RESEARCH CENTER

PLOT PLAN

I hope you will attend and inform non-SCB members who would be interested about this symposium. This topic is of general interest to many considering the growing reaction of the public and the media to pollution and its potential for affecting all our lives. See you there.

Mona M. Myatt
SCB President

SCHEDULE

8:00 Registration $7.00 SCB members
$16.00 Others
$8.00 SCB membership

8:45 Introduction Mona Myatt, SCB President

9:00 Steven N. Murray, Department of Biological Science, California State University, Fullerton: "Seaweed Communities of Perturbated Southern California Environments"

It is widely recognized that high levels of perturbation result in alterations in species composition and reductions in overall community diversity. For rocky intertidal seaweed communities, historical records strongly suggest the occurrence of such changes along the Southern California coastline during the past 80 years, a period of dramatic growth in the human population. However, until recently our understanding of the changes in the local seaweed flora was limited to floristic considerations. During the past decade, a number of ecological studies have been performed on seaweed communities inhabiting perturbated Southern California environments. These studies have focused on sewage-polluted habitats as well as intertidal environments subjected to sand-scouring and the movements of

unstable cobbles and boulders, and have generated data on seasonal fluctuations in seaweed standing stocks and patterns of succession. Hence, we now have greater knowledge of the ecological effects of perturbation on local intertidal seaweeds assemblages. This paper will provide a review of the suggested historical changes in the Southern California seaweed flora and describe the results of the more recent ecological research on perturbated intertidal habitats. Specifically, the kinds of seaweeds dominating perturbated intertidal systems will be addressed, using as examples studies performed on a sewage-polluted environment at San Clemente Island, and at historically important Whites Point.

9:50 Carl A. Fox, Senior Research Scientist, Research & Development, Southern California Edison Company, Rosemead, CA: "Effects of Acidic Deposition on Vegetation in Southern California"

Deposition of acidic precipitation, particles, and gases has been associated with the acidification of aquatic ecosystems, reduced forest and crop productivity, increased leaching of soils, and deterioration of manmade materials. Studies examining these effects have largely focused on regions in the northeastern United States and eastern Canada where wet deposition is decidedly acidic (pH < 5.0). However, recent data collected in the Los Angeles basin have shown that wet deposition (e.g. rain, fog, mist) is often equally as acidic.

Observation of the direct effects of acidic deposition on vegetation is limited to "simulated" rain experiments usually under laboratory conditions. These experiments have shown that exposure to acidic rain (pH < 3.0) can result in leaf necrosis, premature leaf abscission, increased foliar leaching, chlorophyll degradation, accelerated weathering of epicuticular wax, and a reduction in plant growth. Sensitivity to injury from acidic rain is species specific and appears to depend upon physical and morphological characteristics of the plant which influence leaf wettability, permeability, and surface water retention.

Effects of acidic fog on vegetation are much less known. Researchers in the early 1950's noted that certain fogs occurring at the same time as heavy air pollution episodes were followed by plant responses which differed from that of gaseous pollutants alone. Studies by Thomas *et al.* showed that injury to endive, alfalfa, beet, and spinach occurred following fog conditions of pH 3.0 or less. More recent work in California by Granett and Musselman indicates that lettuce is injured

when exposed to fog of pH < 2.5.

In summary, acid rain as it now occurs in southern California does not appear to be of major concern relative to effects on vegetation given that reported pH values generally exceed 4.0. Measurements of acid fog, however, have been reported as low as 2.15 and may be within the range of potentially causing injury to vegetation. However, there are no reported observations of injury to vegetation attributable to acid fog in the Los Angeles basin.

10:40 BREAK

11:10 Dr. Philip Riggan, USDA, Forest Service, Riverside Fire Laboratory, Riverside, CA: "Interactions of air pollution with Wildland Processes in the Chaparral of the San Gabriel Mountains"

Chronic air pollution and deposition of emission products in the chaparral of southern California have serious consequences for ecosystem function and human health.

Nitrogen deposition in the San Gabriel Mountains, predominantly in dry form, has elevated streamwater nitrate concentrations by one to three orders of magnitude with respect to nearby, relatively unpolluted watersheds and may contribute significantly to existing groundwater nitrate pollution. Accumulated compounds are mobilized after severe fires, which can raise nitrate concentrations above the federal water quality standard.

Within the last year the *Ceanothus* chaparral in portions of the San Gabriel, Santa Monica, and Santa Ana Mountains has suffered a severe dieback that may be linked to a combination of drought stress and air pollution. An explosive fire hazard has been created across an area of 200,000 acres. We are working to elucidate the cause and extent of the dieback and test mechanisms whereby pollution may reduce the capacity of the chaparral to control its internal water relations.

Wildfires periodically ravage large expanses of the chaparral in southern California, often during meteorological conditions that degrade air quality. Land management agencies are developing prescribed burning to manage fire and fire effects. Since fires produce substantial amounts of hydrocarbons, fine particulates, NO_x, CO, and reduced compounds such as NH_3 and HCN, at rates depending on fire severity and accumulated air pollutants, air quality should be a prime criterion for chaparral management.

12:00 LUNCH

1:30 David M. Olszyk, Head, Plant Sciences Section, Statewide Air Pollution Research Center, University of California, Riverside, CA: "Effects of Air Pollution on Annuals and Perennials of the Mojave Desert"

Continued rapid urbanization and industrialization of southern California has raised the potential for injury from air pollutants to native plants. Plants of the Mojave Desert could be especially vulnerable to photochemical smog (primarily O_3) being transported from the Los Angeles area through mountain passes, or to SO_2 being generated by industries in the desert itself. The response of desert species to air pollutants is largely unknown. However, the growth patterns and physiology of desert plants suggest that they would respond to air pollutants differently from crop plants or trees.

Thus, scientists at the Statewide Air Pollution Research Center at the University of California, Riverside, have investigated the effects of O_3 and SO_2 on winter and summer annuals, as well as perennials of the Mojave Desert. The studies have been part of a research program supported by the Southern California Edison Company. Experiments have been conducted primarily at a unique field exposure facility using plots of vegetation near Daggett, California. These studies have indicated that desert plants differ widely in their sensitivity to air pollutants, with *Camissonia claviformis, Camissonia hirtella* and *Cryptantha nevadenses* being the most sensitive annual species, and *Larrea tridenta* being the most resistant species. The species may be useful bioindicators of the presence of high concentrations of O_3 or SO_2 in the desert. In addition to injury responses, University scientists have been investigating the effects of O_3 and SO_2 on important metabolic properties of desert plants including water budget, photosynthesis, and nutrient uptake.

The Mojave Desert studies have provided both important information as to the injury from air pollutants to key species of plants, and background information as to the possible long term effects of air pollutants on plant adaptation to their environment.

2:20 BREAK

2:50 Ahmed A. Elseewi, Research and Development, Southern California Edison Company, Rosemead, CA: "Trace Element Emissions from Fossil Fuel Combustion and Their Effects on Native and Agronomic Plants"

Fossil fuels (coal and oil) contain virtually all naturally occuring elements which, upon combustion, are mobilized in significant quantities into the various segments of the environment.

For most elements, the amount mobilized from coal combustion in power generation greatly exceeds that from the combustion of oil. This paper describes pathways of several inorganic elements released from coal combustion in power generation, examines their fate in the soil-plant-water system, and evaluates associated potential adverse and/or beneficial effects on plants.

Elements mobilized from coal combustion are released either in an atmospheric form or in ash residue form which is collected by various emission control devices. The relative proportions of these forms depend on a number of factors such as the content in coal, the element in question, as well as a number of power plant operating conditions. For example, elements which are easily volatilized at the prevailing temperature of combustion such as sulfur, mercury, selenium, etc. are released mainly in an atmospheric form, unless otherwise captured by additional emission control systems. Fine particles (< 5um) are also released to the atmosphere and they usually contain trace elements at concentrations which are inversely related to particle size.

Deposition of atmospherically-derived element on land is difficult to measure due to the variable patterns of deposition, the small amounts deposited and background noise. Modeling efforts, however, indicate that over the lifetime of a coal-fired power plant, the amounts of most trace elements deposited in the vicinity of the power plant is negligible.

Fly ash, bottom ash, and scrubber sludge residues are, however, produced annually in great quantities and present disposal and management problems. Trace elements of special concern in these residues include boron, molybdenum, and selenium. These residues also contain excessive amounts of soluble salts and are highly alkaline (pH = 12). When incorporated in soil at low to moderate amounts, however, they were observed to produce beneficial effects on a number of agronomic and native plant species. These effects are believed to be due to increased availability of sulfur and other plant nutrients from the residues, and to improved physical properties of the recipient soils. High application rates, however, were associated with reduced growth due to increased salinity in treated soils. Additionally, residue-treated plants were found to accumulate boron, molybdenum and selenium generally in proportion to the amount of residue in soil. The levels of molybdenum and selenium in forage plants were, however, successively reduced as the number of clippings was increased.

The results suggest that residues from coal combustion can be recycled in agriculture as soil amendments for sodic

soils reclamation, as liming agents and as fertilizer substitutes. Care should, however, be exercised to safeguard against potential buildup of certain harmful constituents such as boron, molybdenum and selenium.

3:40 CLOSING REMARKS

FIELD TRIPS AND EVENTS

October 19 (Saturday) Annual Potluck Dinner

This year's potluck dinner will be at the Fullerton College Horticulture Department on Saturday, October 19. This will allow us to take advantage of an outdoor setting if the weather permits. Our speaker for this occasion will be one of our Directors, Geoff Smith. He will have slides from his trip to British Columbia and Alaska. Knowing Geoff, these will be of great beauty and interest.

The dinner will begin at 6:00. The October board meeting will precede the dinner at 5:15. See page 11 for details and reservation information.

October 19 and 20 (Saturday and Sunday) California Botanical Society Graduate Student Meetings

The California Botanical Society Tenth Graduate Student Meetings will be held at the University of California, Santa Barbara, on October 19 and 20. Your assistance in circulating this information to graduate students in botanically related fields would be greatly appreciated. Saturday evening's events include a banquet which will be followed by the keynote address. Fieldtrips to Santa Cruz Island or to a chaparral burn site and the Santa Barbara Botanic Garden are planned for Sunday. For further information, write Kathy Rindlaub, Department of Biological Sciences, UCSB, Santa Barbara, CA 93106 or leave a message at (805) 961-2508.

November 16, 1985 Annual SCB Symposium, Fred L. Hartley Research Center, Union Oil Co., Brea, CA

See details, first page.

December 7 (Saturday) Rancho Santa Ana Botanic Garden Family Day, Claremont, 10 a.m. to 4 p.m.

The theme of this event will be "A Celebration of Trees." Activities and games such as scavenger hunts, self-guided discovery walks, and craft activities will be sponsored throughout the day on the Garden grounds. Videos and movies about trees will be shown in the auditorium of the administration building. Light refreshments will be available. Visitors from toddler age to senior citizen status are guaranteed a day full of fun and learning about the unique trees found in the state of California. The event is free and open to the public.

Rancho Santa Ana Botanic Garden, located off Foothill Boulevard in Claremont, is an 86-acre garden devoted to native California plants. The Garden offers community education classes on a broad range of topics relating to botany, horticulture and the natural history of California. For information: 714-626-1917.

SOUTHERN CALIFORNIA BOTANISTS

Southern California Botanists was founded in 1927 and presently has over 400 members. Our membership includes not only professional botanists, college and universities, arboreta, herbaria and museums, but also many interested laypersons. Our activities include an active program of field trips throughout the year, an annual symposium, lecture series and a potluck dinner. Southern California Botanists book sales offer members hundreds of quality books at substantial discounts. Many books not held in regular stock may be special-ordered. Southern California Botanists supports conservation efforts of many worthwhile groups and organizations.

Crossosoma is the journal of the Southern California Botanists and contains articles of both scientific and general interest. Among the purposes of this journal is the promotion of contemporary issues of conservation, especially in relation to botanical resources. All members are encouraged to submit articles for publication in *Crossosoma*. We are eager to have quality articles on botany in Southern California, and articles, notes and notices of interest to our members. Please submit these to Editor, *Crossosoma*, Dept. of Biological Science, California State University, Fullerton, CA 92634. Authors of botanical articles published receive ten extra copies of the issue.

APPLICATION FOR MEMBERSHIP

Those joining SCB in October through December, 1985, are credited with dues paid in full for 1986. Their memberships are effective immediately, they will receive the December, 1985, issue of *Crossosoma* and will be entitled to discounts on books and admission to the Symposium, etc..

Membership categories are:

_____	Individual (incl. the family)	$ 8.00
_____	Group or organization	15.00

NAME_____ DATE_____

ADDRESS_____

CITY_____ ZIP_____

PHONE___(____)_____

Make check payable to: SOUTHERN CALIFORNIA BOTANISTS

Mail check and this form or your letter to: Membership Chairman, SOUTHERN CALIFORNIA BOTANISTS, Dept. of Biological Science, California State University, Fullerton, CA 92634.

Cynthia Lee Ann Troyer's article "Hybridization Between *Encelia farinosa* Gray ex Torr. and *E. californica* Nutt. (Asteraceae)", begun in the last issue of *Crossosoma*, will be continued in the December issue.

BOARD OF DIRECTORS
SOUTHERN CALIFORNIA BOTANISTS--1985

BACK ISSUES OF CROSSOSOMA

Back issues of CROSSOSOMA are available at eight (8) dollars per volume plus one dollar for postage and handling. Inquiries should be addressed to: Editor-CROSSOSOMA, Department of Biological Science, California State University, Fullerton, CA 92634.

Please state the volumes desired and include payment in your order. Checks should be made to Southern California Botanists.

CROSSOSOMA is published bimonthly (February, April, June, August, October and December) by Southern California Botanists, a California non-profit corporation exempt from taxes under Sec. 501(C)3 of the Internal Revenue Code. Dues are on a calendar year basis. Regular $8.00. Groups $15.00.

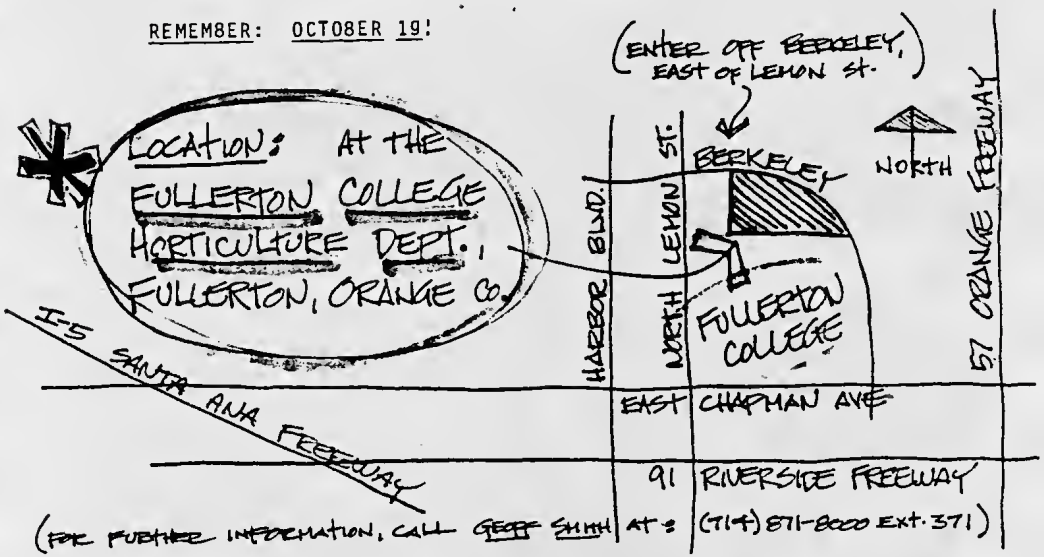
We thank all those who promptly remitted their 1985 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

SOUTHERN CALIFORNIA BOTANISTS
FOUNDED 1927

Pot-Luck Dinner

As usual, the beverage and bread will be provided by SCB. It is suggested that if your name begins with the following letters you should bring enough of the specified dish to serve eight people: A-I, main dish; J-P, dessert; Q-Z, side dish (vegetable, salad, etc.). Be sure to bring your own table service. The October board meeting (at 5:15 p.m.) will precede the dinner. Call Mona Myatt at (818)302-1466 or (818)447-0755 or return the reservation form below if you are planning to attend.

REMEMBER: OCTOBER 19!



BRING YOUR OWN FOOD & UTENSILS
PROVIDE A DISH FOR 8 PERSONS
IF YOU PLAN TO ATTEND, R.S.V.P. BY PHONE OR WRITE TO:

NAME: _____

STREET: _____

CITY _____ ZIP: _____

PHONE: _____

WILL BRING: _____
(MAIN DISH, SALAD, DESSERT, APPETIZERS)

MONA MYATT
6421 N. Golden West Ave
Temple City, Ca. 91780
(818) 447-0755

(TEAR OFF AND SEND THIS PORTION TO:)

SCB COMING EVENTS

October 19	SCB Annual Potluck Dinner
October 19-20	California Botanical Society Graduate Student Meetings
November 16	SCB Symposium
December 7	Rancho Santa Ana Botanic Garden Family Day

SOUTHERN CALIFORNIA BOTANISTS
Rancho Santa Ana Botanic Garden
1500 North College Avenue
Claremont, CA 91711

CROSSOSOMA

SOUTHERN CALIFORNIA BOTANISTS
Rancho Santa Ana Botanic Garden, Claremont CA 91711

Crossosoma Vol. 11, No. 6
Issue Editors: James Bauml and Suzanne Granger
Managing Editor: C. Eugene Jones
December, 1985

HYBRIDIZATION BETWEEN *ENCELIA FARINOSA* GRAY EX TORR. AND *E. CALIFORNICA* NUTT. (ASTERACEAE)

Cynthia Lee Ann Troyer[1]
Department of Biological Science
California State University, Fullerton

(Editor's Note: This is the remainder of the article on hybridization in *Encelia*, the first part of which appeared in the August, 1985, issue of Crossosoma.)

DISCUSSION

Since *Encelia californica* and *E. farinosa* were first described by Nuttall (1841) and Gray (Emory, 1848), respectively, the two species have been treated as distinct entities in such works as Blake's revision (1913) and Munz's flora (1974). These two species have distinct ranges in southern California, *E. californica* being cismontane and *E. farinosa* being transmontane, except for a narrow band of sympatry which occurs where *E. farinosa* makes its way through the low mountain passes along the Transverse and Peninsular Ranges. Chemical evidence of hybridization between *E. californica* and *E. farinosa* has been demonstrated by Bjeldanes and Geissman (1971). Other researchers have found evidence for hybridization in the genus *Encelia*, both interspecific (Clark and Kyhos, 1980; Kyhos *et al.*, 1981) and intergeneric (Kyhos, 1967).

During the course of this study, several morphological characteristics were used to delimit the two species. Differences in leaf characters consistently separated the taxa. Leaves of *E. californica* were found to be smaller, less pubescent and therefore darker green in color. Allopatric *E. farinosa* leaves were larger, densely pubescent and silvery-green. In the field, these differences were striking. Both sympatric populations tended to have smaller leaves than their allopatric counterparts. In *E. californica*, this may be due to the more xeric habitat found at Lake Mathews, in comparison to the majority

[1]157 Pammy Way, Grass Valley, CA 95949.

of its range. *Encelia farinosa* nears the western limit of its range at Lake Mathews. This peripheral habitat may be less than ideal for *E. farinosa* and may contribute to the smallness in leaf size as some response to stress. There is also a decrease in the amount of tomentulose pubescence in these leaves, perhaps a response to a more mesic environment.

The purpose of this study was not only to investigate the characteristics of naturally occurring putative hybrids between *E. californica* and *E. farinosa*, but also to analyze the data obtained by two methods: the traditional Andersonian techniques and multivariate techniques.

From the hybrid index values, it is apparent that the hybrids are intermediate between the two parents, although they do tend to be more like *E. californica*, with at least plant 139 (index value = 11) suggesting extensive backcrossing. The sympatric populations generally resemble the allopatric populations in index value. Recall that this index is based on only 6 of the 14 total variables considered in this study.

The pictorialized scatter diagrams reveal some interesting trends. Both the allopatric and sympatric populations of *E. californica* are fairly distinct from the allopatric and sympatric *E. farinosa* populations, with minor overlapping. The sympatric populations are smaller than the allopatrics with respect to leaf width and involucre height, probably stress related. Figure 4 graphically illustrates the possibility of heterosis in the hybrid population. Once again, the hybrids have a tendency to lie more closely to *E. californica*. This may be interpreted as introgression (Anderson, 1949) occurring toward *E. californica*.

In summary, hybrid indices and pictorialized scatter diagrams suggest that *E. californica* and *E. farinosa* are hybridizing, that the resulting hybrids are intermediate and larger than the parents, and that some introgression is occurring. Whereas Andersonian methods of analysis do not deal with all the variables considered in this study, they do have merit as preliminary research tools. However, several factors influence relationships, including those which the researcher may never discover. As Anderson (1949) stated "The human mind is inefficient in judging variation in more than one variable at a time." Thus, the methods used above are limited by the constraints of the mind and its inability to conceptualize relationships in multidimensional space. The multivariate techniques used in Principal Component Analysis and Discriminant Analysis provide access to more powerful statistical tools for the discrimination of within- and between-group differences in potential hybridization problems.

Principal component analysis seems to corroborate the results of the scatter diagrams. Allopatric and sympatric *E. californica* populations vary somewhat from one another, as do allopatric and sympatric

E. farinosa populations. The hybrids, when viewed in 1 x 2 and 1 x 3 space, remain intermediate. The eigenvectors primarily responsible for separating the groups are leaf length and width, petiole length, and the number of ray flowers per head in 1 x 2, and involucre height and leaf color in 1 x 3. With the exception of the petiole length and involucre height, the characters delimiting the five groups in PCA are also good characters for field identification. As shown in Fig. 5, plant 139 falls within the range of *E. californica*.

One of the advantages of PCA is that it allows for the consideration of all measured variables and treats them as independent patterns of variation. The ordinations reveal any grouping and the resulting eigenvectors give insights into the general effect of each variable. With this in mind, the results of PCA are similar to the results indicated by the scatter diagrams, *i.e.*, gene exchange seems to be occurring, resulting in the production of hybrid individuals.

Discriminant analysis (DA) is the next logical step since it helps justify the multigroup component analysis of PCA (Pimentel, 1971). When data are submitted to DA, variation within and between groups now can be better understood by studying the influence of intercorrelated canonical vectors working in discriminant space. This "independence" from size is demonstrated by the fact that qualitative characters (*e.g.*, disk color, and leaf and peduncle pubescence in Fig. 6) have effects on the ordination of the groups, as do shape-oriented characters such as leaf length and width. With respect to these ordinations and the influences of the canonical vectors, basically, there are still three groups: *E. californica*, *E. farinosa*, and intermediates, which ordinate closer to *E. californica*. These three groups are supported by the Geisser classification probabilities. Plant 139 is loyal to the hybrid group and is more closely aligned with this group in the canonical ordinations, even though in Fig. 6, plant 139 is an outlier. Because of the decrease in the influence of size and its functioning in discriminant space, DA seems to provide a better method for defining groups and explaining variations.

CONCLUSIONS

From data presented here, it is apparent that there is morphological evidence for hybridization between *Encelia californica* and *E. farinosa*. The narrow region of sympatry found at Lake Mathews is a classical example of the Andersonian "hybridized habitat," *i.e.*, a disturbed habitat, somewhat intermediate between the habitats of the allopatric parents (Anderson, 1949). The literature abounds with examples of morphologically intermediate forms (hybrids) where areas of sympatry occur in man-made or nature-caused disturbed habitats (Epling, 1947; Heiser, 1947; Anderson, 1949; Anderson and

Stebbins, 1954; Kyhos, 1971; Clark and Kyhos, 1980; Kyhos *et al.*, 1981).

In general, these hybrids are restricted to small, disturbed areas and are not found in undisturbed areas of sympatry (Kyhos, 1971; Kyhos *et al.*, 1981). Lake Mathews is more xeric than the Coastal Sage Scrub and Chaparral communities in which *E. californica* is generally found, and more mesic than the desert area of Whitewater Canyon, where *E. farinosa* abounds. Thus, it may be classified as an intermediate habitat. The hybrids are intermediate to one degree or another in all morphological variables measured, and seem to exhibit heterosis when viewed in reference to the sympatric parents. There is also morphological evidence for introgression, since in all methods of analysis, the hybrids tend to lie closer to *E. californica*.

The hybrids examined were generally fertile with respect to both pollen and seed viability. The high percentage of pollen viability infers that backcrossing may occur and succeed, provided there is sufficient seed viability. Seed viability was slightly lower in the hybrids than in the allopatric and sympatric groups which may indicate a reduction in female fertility due to hybridization.

All methods employed for morphological data analysis support the hypothesis that *E. californica* and *E. farinosa* hybridize. The results of the Andersonian techniques, PCA and DA demonstrate that there is an intermediate group. Each method of analysis may be viewed as a series of steps, each one more complex and statistically powerful than the preceding one. Hybrid indices are the most simplistic, using coded character values to illustrate graphically the frequency and degree of intermediacy (*i.e.*, hybrid index value) of a particular individual. Pictorialized scatter diagrams allow for quick summarization of the variation within and between groups, but fail to examine all measured characteristics, or examine relationships and distances between certain variables. Limited as these methods are they still provide a "quick method for roughing out the problem" (Anderson, 1949). Where Anderson's methods end, those discussed in Pimentel (1979) begin. Principal Component Analysis examines relationships between individuals in given groups and allows for generalizations to be made concerning the nature of such relationships. Discriminant Analysis allows for examination of the variation between groups with the influences of size removed. In both PCA and DA, not only are ordinations given, but one can also explore the reasons for variation by examining the eigenvectors of PCA and the canonical axes of DA. This reason for variation, or amount of variance contributed by any particular variable is something which cannot be accomplished by Anderson's methods.

In summary, traditional and modern methods of morphological data analysis support the hypothesis that hybridization is occurring between *E. californica* and *E. farinosa*. These hybrids are for the most part distinct, with some evidence of introgression toward *E. califor-*

nica. Characters which serve to delimit the species in the field also serve to separate them with respect to PCA and DA vectors. Although *E. farinosa* and *E. californica* have been shown to be interfertile by Bjeldanes and Geissman (1971) and that pollinator discrimination is lacking, more information on the reproductive biology of these taxa is necessary before a statement concerning their specific status can be made. Experimental crosses must be performed and the resulting hybrids compared with those examined in this study. Pollinator behavior should also be explored in an effort to determine if there are reproductive barriers between the two parental species and the hybrid. Reciprocal transplants of seedlings may yield information concerning the variation in leaf pubescence and overall size and shape of the plants and the effects of stress on the parental forms at the Lake Mathews site. With the data available now, it can only be concluded that the species hybridize, the hybrids are relatively fertile, exist in a disturbed habitat, and provide a means for exchange of genetic material between *E. californica* and *E. farinosa*.

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PROGRESS REPORT: Pollen labelling with liquid fluorescent dyes.

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The purpose of pollen labelling is to enable a researcher to follow pollen flow from a source plant to other plants in the population. To date, effective labelling of pollen grains *in vivo* has been relatively unsuccessful. The problem has been to find a way of marking individual grains without significantly altering their external morphology or floral qualities that affect pollinator behavior. Traditional techniques (reviewed by Handel, 1983) are either expensive and hazardous (radioactive isotopes) or inexpensive but unreliable (fluorescent powder). However, the advantage of the radioactive isotope method over that of fluorescent powder is that the marker is incorporated into the grain itself, rather than dusted on the surface. In the latter case, grains may or may not be carried by pollinators in the same manner as untreated grains (but see Waser and Price, 1983). The ideal labelling method, then, would have the advantage of the radioactive isotope method but none of its hazards or expense to the researcher. Cell biologists, confronted with a similar problem, have turned to liquid fluorescent dyes.

Currently I am investigating two fluorescent dyes as candidates for pollen labelling. The first is Cellufluor (formerly Calcofluor White M2R, Polysciences, Inc.). Cellufluor is a water-soluble "optical brightener," the term applied to a class of compounds used by detergent manufacturers for enhancing fabric color (Zahradnik, 1982). It has been used by biologists for studies of cellulose synthesis in bacteria and fungi (Haigler and Benziman, 1982; Darken, 1962), and of cellular structure in higher plants (Hughes and McCully, 1975). I have found that dilute solutions of Cellufluor in distilled water (10^{-5}% to 10^{-3}%, by weight) will stain pollen grains when injected directly into flower buds through the corolla. The stain is visible

when the pollen is viewed with an epifluorescent microscope. However, the method probably relies on passive diffusion of the Cellufluor through the anther wall, and as a result not all pollen grains are necessarily stained unless the solution is maintained in the bud for several hours. Injection of the solution into the vasculature of the bud does not improve staining. Despite this problem of reliability, I have successfully stained grains of *Raphanus sativa* and *Nicotiana glauca* by this method. I am presently working to improve the reliability of the technique, as well as investigate its effects on pollen grain morphology and floral characters.

The second candidate is Fluorabora-T (Polysciences, Inc.), which is water-soluble but has affinity for hydrophobic compounds. I am currently investigating this dye as an alternative to Cellufluor.

Fluorescent dye methods can potentially combine the accuracy of isotope labelling with the simplicity of fluorescent powder. With continued effort, I think that the prospect is great for developing a simple but reliable pollen marking technique in the near future.

ACKNOWLEDGEMENTS

This project is funded through a grant from Southern California Botanists. Their patience and financial assistance has been greatly appreciated.

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The Southern California Botanists would like to say a special "Thank You" to Pat Hansen, who is leaving the Fullerton area. She has done an outstanding job in typing and setting up the Crossosoma issues for the last four years. Thanks again for a job well done.

FURTHER BOTANICAL ADVENTURES IN NORTHWESTERN BAJA CALIFORNIA

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Since our whale-watching expedition to the Laguna San Ignacio and various onshore Pacific islands in early February, we have made six more botanical exploration trips into our neighboring Mexican peninsula, usually accompanied by Dave Charlton, Walter Wisura, or Steve Boyd, all fellow members of the Southern California Botanists. Most of the trips have been relatively uneventful, aside from our nearly stepping on an irate rattlesnake, getting stuck in deep sand in a wash, destroying a steel-belted radial tire with a sharp rock, facing a startled wild-cat, viewing some of the most spectacular scenery in the Southwest, being lulled to sleep under the stars at night by serenades from neighborly coyotes, owls, and poorwills, and discovering or rediscovering some of the rarest plants in Mexico. We picked up perhaps 5000 specimen sheets of some 1600 numbers, including up to a dozen new species for Baja California and a few species, like *Cercocarpus ledifolius* Nutt. and *Fremontodendron mexicanum* Davids., not seen often or not for many years in Baja California. We suffered no ill effects other than seriously frayed nerves now and then, sore muscles and leg cramps from excessive hiking and climbing, and occasional critical shortages of cerveza, ice, "extra" (lead-free gasolene), and spare tires. Our botanical efforts were primarily directed toward survey of the rich vernal coastal flora resulting from adequate rains in western B.C. this spring, the relatively rare vernal pool plants of the coastal mesas, the encroaching desert flora in Paso San Matias and Valle de Trinidad, and the flora of the chaparral-clad western slopes and montane conifer forests of the Sierras de Juarez and San Pedro Martir.

Possibly informative, if not entertaining, would be an account of our longest trip, June 17 through June 22 with Dave Charlton, Steve Boyd and Prof. Rolf Dahlgren of the University of Copenhagen, Denmark, and Lund, Sweden. We had enticed Prof. Dahlgren to spend a week with us in the Californias after his visit to a botanical gathering at the Missouri Botanical Garden in St. Louis by promising to take him into Baja California and to show him there some angiosperm families new to him along with the fabulous cirios, cardons, other cacti, succulent Dudleyas, and other B.C. novelties. After a reasonably early start from the Rancho Santa Ana Botanic Garden in the heavily packed garden van, we reached one of our favorite vernal ponds at Chichihuas on the Mesa del Tigre south of La Mision de San Miguel de la Frontera. The early vernal-pool flora was largely gone at this late date, especially the *Pilularia americana* A. Br., *Callitriche longipedunculata* Morong,

Downingia cuspidiata (Greene) Greene, *Elatine californica* A. Gray, and *Myosurus minimus* L. var *apus* Greene, and other goodies that we had collected there in April, but we still managed to glean some fading *Lilaea scilloides* (Poir.) Haum. for Rolf, along with *Eryngium parishii* C. & R., *Malvella leprosa* (Ortega) Kerapov, *Navarretia fossalis* Moran, and other species requiring desiccation of the pools before flowering.

Passing through Ensenada and beyond Ojos Negros, we skirted various forest fires, mostly burning in the chaparral on the western slopes of the Sierra de Juarez, to reach the Laguna de Juarez (Laguna Hanson) in the Parque Nacional de Constitucion de 1857 in late afternoon with adequate time for botanizing and a refreshing swim in the lake. The laguna, still full of water though less extensive and shallower this year than in 1983 and 1984, is most scenic, being bounded by open, park-like forest of Jeffrey pine, further enhanced by emergent boulder-strewn, granitic sierritas. It offers the best aquatic-plant collecting in Baja California, and this is always a joy to this frustrated aquatic botanist from the semideserts of southern California. Among the aquatics sampled were *Ceratophyllus demersum* L., *Elatine californica*, *Limosella acaulis* Sesse & Moc., *Potamogeton pusillus* L., *Ranunculus cymbalaria* Pursh ssp. *saximontanus* (Fern.) Thorne, and the severely grazed and rare *Alisma triviale* Pursh, not previously reported from B.C. The three terrestrial botanists concentrated on the flora of the open, pine forest, which was still rich in the park but somewhat past its prime. Walter Wisura and I had collected heavily there a couple of weeks earlier while scouting the terrain and searching out *Pinus coulteri* D. Don on the sierrita to the northwest of the laguna.

We had a choice campsite along the bouldery shore of the laguna and our usual gourmet meal prepared by master chef Dave Charlton. The night was pleasant and sleep restful except for an occasional unpleasant whiff from a nearby dead coyote. Mostly the breeze was kind to us and blew the scent elsewhere. After a hearty breakfast, we resumed our explorations of the sierra by driving south toward Santa Catarina. The dirt road was passable in most places and more or less well marked by ORV enthusiasts. However, one broad sandy wash at noon caused a sinking feeling in four wheels and four hearts. A previous vehicle or two had obviously suffered a disastrous encounter with the same wash and the rutted embankment. After an hour or two of shovelling, road-building with denudation of an acre or so of sagebrush, strategic positioning of sleeping mats, brush, roots, and logs, much sweating and much consumption of cold cerveza and other potables, and considerable pushing by the rest of us, Dave drove the van with a flourish out of the wash and up the embankment to relatively hard ground. The cheers were spontaneous, and we all climbed

aboard and headed with fingers crossed toward Highway 3. We ultimately did reach the pavement south of Santa Catarina after a few wrong turns due to faulty navigation by this former professional navigator (aerial, that is). After stripping a marsh-filled roadside borrow-pit along the highway near San Salvador of much of its emergent vegetation, we headed toward Ensenada to refuel (with cerveza, ice, "extra", etc.) and to push on to the dunes at San Antonio del Mar west of Colonet, our second-night campsite. Rolf got his swim in the Pacific and a chance to get acquainted with the dune flora.

Much of the following morning was devoted to exploration of the completely desiccated large vernal pools on Colonet Mesa. Among the more interesting species collected there were *Ambrosia pumila* (Nutt.) A. Gray, *Hemizonia perennis* Keck, *Marsilea vestita* Hook. & Grev., *Nama stenocarpum* A. Gray, *Solanum rostratum* Dunal, *Verbena bracteata* Lag. & Rodr., and *Orcuttia californica* Vasey, this last rare grass growing in great profusion. On April 1 Dave Charlton and I had taken more than 70 numbers from these same vernal pools, including such specialties as two varieties each of *Myosurus minimus* and of *Plantago bigelovii* A. Gray, two or three species each of *Hordeum, Phalaris, Navarretia, Plagiobothrys, Psilocarphus,* and *Spergularia,* plus *Anagallis minima* (L.) Krause and *Elatine brachysperma* A. Gray.

By noon we had proceded well up the gravelled San Telmo road toward the Parque Nacional San Pedro Martir, stopping three miles below the entrance to collect flowering specimens of *Dendromecon rigida* Benth. ssp. *rigida, Fremontodendron californicum* (Torr.) Cov., and *Pholisma arenarium* Nutt. ex Hook., the last most exciting to Rolf because a member of the endemic American family Lennoaceae. The chaparral here at 1675 m elevation seems to be composed largely of *Adenostoma fasciculatum* H. & A., *A. sparsifolium* Torr. in Emory, *Prunus ilicifolia* (Nutt.) Walp. ssp. *ilicifolia, Ceanothus greggii* A. Gray ssp. *perplexans* (Trel.) ined., several species of *Arctostaphylos* (including *A. peninsularis* Wells), *Rhamnus*, and *Quercus* (including *Q. dunnii* Kell. and *Q. wislizenii* A. DC. var. *frutescens* Engelm.), *Garrya grisea* Wigg., and *Eriodictyon angustifolium* Nutt.

We reached an excellent campsite at Vallecitos off the observatory road near a junction of two streamlets at the foot of a bouldery slope in open forest of Jeffrey and lodgepole pine at about 2430 m elevation. Before supper we had time to glean some 60 numbers of the fascinating montane forest flora of the Sierra San Pedro Martir, many of the species endemic to that range or at least to the mountains of northern B.C. They are too numerous to list here, but I am planning to prepare this fall a preliminary florula of the high country of the range above 2000 m. I have already 366 species in that

annotated list, and I expect the total may reach 375 or even 400 of the 1830 species presently known to occur in northwestern B.C. That latter number is rapidly being increased also.

The following morning we drove to the parking lot of the Observatorio Astronomico Nacional del Universidad Nacional Autonomo de Mexico, from whence we were kindly driven by the custodian to the peak at 2840 m where he turned us loose to botanize at our leisure on the rocky rim of the Canon del Diablo. There under the Jeffrey and lodgepole pines, white firs, quaking aspens, and peninsular oaks, and such montane shrubs as *Arctostaphylos patula* Greene ssp. *platyphylla* (A. Gray) Wells, *Holodiscus microphyllus* Rydb. ssp. *sericeus* (Ley.) *ined.*, *Philadelphus microphyllus* A. Gray ssp. *stramineus* (Rydb.) C. L. Hitchc., *Quercus cedrosensis* C. H. Mull. *vel aff.*, *Ribes cereum* Dougl., and *Symphoricarpos parishii* Rydb. *vel aff.* were such cushion- or mat-formers, as *Selaginella asprella* Maxon., *Antennaria rosea* Greene, *Eriogonum wrightii* Torr. ex Benth. ssp. *oresbium* (Reveal) *ined.*, *Heterotheca martirensis* Moran, *Linanthus melingii* (Wigg.) V. Grant, *Sphaeromeria martirensis* (Wigg.) Holmgren, Shultz, and Lowrey, and *Stephanomeria monocephala* Moran, most of them endemic there. Other perennials of the rock outcrops, also largely endemic, included *Allium eurotophilum* Wigg., *Dudleya pauciflora* Rose, *Echinocereus pacificus* (Englem.) Britt. & Rose, *Galium wigginsii* L. T. Dempster, and *Hedeoma martirensis* Moran. Perhaps the best find of the day was made by Steve Boyd who rediscovered on a rocky ridge east of the observatory several shrubs of *Cercocarpus ledifolius*, apparently not collected since C. Heller took it in 1902 somewhere in the sierra. We also added several species in the Vallecitos area to the known flora of Baja California: *Juncus mertensianus* Bong. ssp. *gracilis* (Englem.) F. J. Herm., *Luzula comosa* E. Meyer, and *Veronica serpyllifolia* L. ssp. *humifusa* (Dickson) Syme ex Claph. *et al.*, and rediscovered *Carex douglasii* Boott, forming a turf at the main campsite south of the ford on the observatory road. More recently a striking addition to the flora of B.C. was the discovery by Dave Charlton and Dave Bramlet of a specimen of pine drops, *Pterospora andromedea* Nutt., on the pine-clad slopes of Cerro Botella Azul (Bluebottle Peak). This relative of the locally more common ericoid *Sarcodes sanguinea* Torr. has long been sought in the high sierra.

Pleased with our botanical haul in the coniferous forests of the parque nacional, we headed downslope on June 20 to collect in the chaparral below the park entrance and in the coastal live oak woodland at Oak Junction at about 1750 m elevation. On the Rancho San Jose (Meling Ranch) at about 650 m we picked up 35 more collections from the wide, sandy wash along a small, flowing, shallow stream, many of the species not seen at all in the foothills above. More aquatics were taken from the Rio San Telmo below San Telmo before we headed

south up Highway 1 to El Rosario.

Our last campsite was in the Viscaino Desert 15 miles beyond El Rosario in the midst of cirios *(Fouquieria (Idria) columnaris* (Kell.) Curran), cardons *(Pachycereus pringlei* (S. Wats.) Britt. & Rose, and numerous other cacti and rosette succulents. Here we were guarded by several handsome, dark Harris hawks, who seemed to prefer to perch in the tall cirios above us. We used up much film the next morning on the local slopes, where we counted about ten genera of cacti in addition to *Fouquieria columnaris, F. splendens* Engelm., and other plants startling to the European eye.

We also stopped briefly in the salt marshes west of San Quintin Bay to allow Rolf to collect flowering material of *Batis maritima* L., representative of another family new to him. Our final, luncheon, stop was at about 100 m elevation at Los Malcriados about 9 miles south of Maneadero where we collected a number of the endemic chaparral species of B.C. Our most exciting find there in a shallow arroyo tributary to an unnamed dry rio was the very rare *Fremontodendron mexicanum*, apparently rarely seen south of the border. After crossing the border at Tijuana in late afternoon and stopping for a good Mexican meal in Escondido to celebrate our successful foray and to give Rolf a taste of Mexican food north of the border, we returned to Claremont about 6 p.m. Saturday evening. Rolf flew back to Copenhagen early Monday pleased with his visit to Baja California and laden with 35-mm film casettes and preserved material of several families not previously seen by him in the field.

FIELD TRIPS AND EVENTS

January 25, Saturday Torrey Pines State Park 9:30 a.m.

This trip will examine the unique Torrey pine, known only to grow in the reserve and Santa Rosa Island. We will also look for Shaw's agave, mission manzanita, San Diego mahogany and jojoba. To reach the reserve take the San Diego Freeway, I-5, south to Carmel Valley Road, just past Del Mar, and go west to Highway S-21. Turn left, go past the lagoon and keep in the far right lane. We will meet in the parking lot just after the park entrance.

Editor's Note: This is my last issue of Crossosoma. I have enjoyed being the Managing Editor of Crossosoma since 1982, but I will be on sabbatical this spring and will be unable to continue as the Editor. Thanks to all of you for your help!

WILDFLOWER SEEDS AVAILABLE

Gardeners wanting to grow wildflowers or ferns from seeds or spores can select from the more than 100 varieties offered by the New England Wild Flower Society in their *1986 Seed-Sale List.*

By offering for sale a large number of native plant seeds, the Society hopes to encourage gardeners to use more wildflowers in their home landscapes. This program is an adjunct of the Society's world-wide botanical garden seed distribution effort.

All requests for seed lists must be received by March 1 because seed sales close March 15. Requests will be filled in the order received. Send a self-addressed, $.39-stamped envelope (#10, business size) to Seeds, New England Wild Flower Society/Garden in the Woods, Hemenway Road, Framingham, MA 01701. No requests for lists will be honored without the stamped envelope.

Members of the New England Wild Flower Society will automatically receive the seed list in January 1986.

JUST OFF THE PRESS!

Santa Ana Mountains Trail Guide, by Kenneth S. Croker (new, revised and enlarged edition). Retail Price: $6.50. 40% discount to retailers (50% discount for orders of 50 or more). Whale & Eagle Publishing Co., 2783 Mendoza Dr., Costa Mesa, CA 92626, (714)546-7016.

AHS ANNOUNCES SECOND WILDFLOWER REDISCOVERY AWARDS

The American Horticultural Society presented its second Wildflower Rediscovery Awards to five individuals who rediscovered populations of species that were thought to be extinct, or found new populations of extremely rare species.

Amsinckia carinata, a small annual herb in the Boraginaceae, or borage family, was rediscovered in Malheur County, Oregon, by Elaine Joyal. This rare species had not been seen since its original discovery by John Leiberg in 1896. Joyal, who rediscovered *A. carinata* in June 1984, used information from the label on a herbarium specimen to identify the pages of Leiberg's field notebooks that referred to his discovery. Once she obtained copies of the appropriate pages from his journals and field notebooks, which are housed in the Smithsonian Institution archives, Joyal had the clues she needed to search for *A. carinata*. Joyal discovered several populations of the species, which seems to occupy a unique ecological niche; it grows in rocky soil and is intolerant of disturbance. The species is threatened by grazing, agriculture, and general surface disturbance.

Reid Schuller, a plant ecologist with the Washington Natural Heritage Program in Olympia, Washington, located *Arenaria franklinii* var. *thompsonii* in Adams County, Washington. The species, commonly known as Thompson's sandwort, was previously known only from populations in Oregon along the Columbia River. All of the Oregon populations were presumed extinct, because nearly all of the species' habitat had been flooded behind dams. Thompson's sandwort had not been seen since 1955, and had never been recorded in Washington. Schuller discovered a large population growing in stabilized sand dunes.

Haplopappus insecticruris was rediscovered by Steve Caicco of the Idaho Natural Heritage Program. The species, which is found only in the state of Idaho, had not been seen since the 1940's, despite several intensive searches in the last 10 years. Following Caicco's discovery in 1984, the Idaho Natural Heritage Program hired Vince Lee to make another thorough search for the species. Lee discovered 82 populations located in three Idaho counties. Botanists have now determined that *H. insecticruris* is much more common than they previously had thought, and the species is no longer considered endangered or threatened.

Jackie Poole of the Texas Natural Heritage Program in Austin, Texas, discovered a large population of *Hoffmannseggia tenella* (approximately 10,000 plants) in a cemetery in Kelberg County, Texas. The species, commonly called slender rush-pea, was previously known from only four individuals located at a single site. The discovery of this important new population is very significant, because it indicates that the species is not as endangered as experts had previously believed.

All of the recipients received certificates and rewards from the American Horticultural Society's Wildflower Rediscovery Project Fund.

The American Horticultural Society, a national non-profit organization for gardeners, is vitally interested in the conservation of plants. Experts estimate that one-tenth of the species and varieties of plants native to the continental United States are in jeopardy. To increase awareness of endangered plants and to promote plant conservation, the Society instituted its Wildflower Rediscovery Project and publishes its Endangered Wildflowers Calendar. Funds from the calendar sales are used to fund conservation projects such as the Wildflower Rediscovery Project. Public response to both the Wildflower Rediscovery Project and the calendar has been overwhelming.

The 1986 Endangered Wildflowers Calendar is now available by mail for $6.95 ($6.25 for AHS members) including postage and handling. Send check or money order (made out to AHS) to: Wildflower Calendar, AHS, P.O. Box 288, Mount Vernon, VA 22121.

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We thank all those who promptly remitted their 1985 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

SCB COMING EVENTS

January 25, 1986 Torrey Pines State Park

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