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After innumerable delays, the Board of Directors would like to publish this article entitled "Plant Succession in the Mojave Desert," by Frank Vasek, which was part of the SCB Desert Symposiu in 1976.

PLANT SUCCESSION IN THE MOJAVE DESERT

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ABSTRACT: Three studies are described showing that plant succession does occur in desert vegetation, that perennial herbs and short-lived shrubs are prominent pioneers, and that some annuals may be members of stable old communities. I. A mature creosote bush scrub community destroyed by excavation of a borrow pit was replaced by populations of short lived perennials. Three reproductive strategies were identified: large populations of pioneer perennials establish from seed (*Euphorbia polycarpa, Encelia frutescens, Stephanomeria pauciflora*); long-lived opportunists establish from seed but persist by continued reproduction via seeds (*Ambrosia dumosa*) or stem joints (*Opuntia bigelovii*); very long-lived perennials establish slowly and eventually attain extreme ages (*Larrea*) perhaps on the order of several millenia. II. On Rabbit Dry Lake, *Kochia californica* and *Suaeda torreyana* seedlings establish in mud cracks on the open playa. Small soil mounds accumulate around the pioneer plants. *Atriplex torreyi* invades small mounds and accumulates larger volumes of organic debris and wind blown soil. Eventually, large mounds coalesce forming giant confluent mounds on which *Atriplex confertifolia, Haplopappus acradenius*, etc. become established. Erosion reduces giant mounds and fills intervening areas with soil forming a "degradation" zone with a more or less continuously distributed xerophytic salt bush scrub vegetation raised above original playa level.
III. Upper Johnson Valley has a creosote bush scrub vegetation characterized by low ground cover, few shrub species and large, ancient creosote clones. Open ground between clones is occupied by numerous annuals. The correlation of a stable, old, shrub community of low species diversity with a rich annual flora and dense annual vegetation suggests that some annuals may comprise adapted components of very old communities. The successional time span in desert vegetation may involve several millenia.

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INTRODUCTION

Desert vegetation is commonly viewed as dynamically homiostatic. That is, changes from a steady state are reversible and a vegetational equilibrium persists for extended periods of time. In deserts then, succession is virtually non-existent (Muller 1940, Pianka 1974, Shreve 1942). Following destruction of the vegetation, the first invaders are climax species or members of the original vegetation and even, according to Shreve, include the individual plants that will comprise the mature community. Shreve explains the absence of succession by the fact that desert plants have no reaction on the environment.

Annual plants are commonly viewed as the first pioneers following disturbance. This view stems from the extensive work on old field succession in eastern United States (see Pianka 1974, Muller-Dumbois and Ellenberg 1974, Whittaker 1970), from studies which show annuals to be the first pioneers on disturbed roadsides in northern California (Frenkel 1970), and from studies of fire annuals in chaparral (e.g. Horton and Kraebl 1955, Sweeney 1956). Thus, two general observations are embedded in the ecological literature: that plant succession does not occur in deserts; and that annuals are the first pioneers following disturbance.

In this paper, I propose to show that succession does occur in desert vegetation but perennial herbs and especially short-lived shrubs play a prominent pioneer role. In contrast, annuals, or at least some constellations of annual species, may be members of stable old communities and therefore probably have evolved intricate highly integrated adaptations for long persistence in stable desert conditions. These ideas will be explored in the context of three specific examples.

SECONDARY SUCCESSION IN A MOJAVE DESERT CHOLLA PATCH

Opuntia bigelovii, the jumping cholla, ranges from the southeast portion of the Mojave Desert through the Colorado Desert to Baja California, Arizona and southern Nevada (Benson 1969, Britton and Rose 1963, Munz 1974).

A magnificent stand of jumping cholla occurs near South Pass at the northwest end of the Sacramento Mountains in eastern San Bernardino County, California (Fig. 1). The cholla population is partly included in a unit of the University of California's Natural Land and Waters Reserve System (Norris 1968, Hay 1972). Most of the cactus population occurs on a gentle south or southwest sloping, rocky bench on which moderate development of desert pavement and desert varnish indicates rather stable soil conditions. General vegetation in the region is a creosote bush scrub community (Munz and Keck 1949) dominated generally by *Larrea tridentata* and locally by *Opuntia bigelovii* (plant nomenclature follows Munz 1974).

Figs. 1-3. Vegetation at South Pass, San Bernardino County, California: Fig. 1. A stand of *Opuntia bigelovii*, with *Larrea tridentata*, on a stable rocky surface.

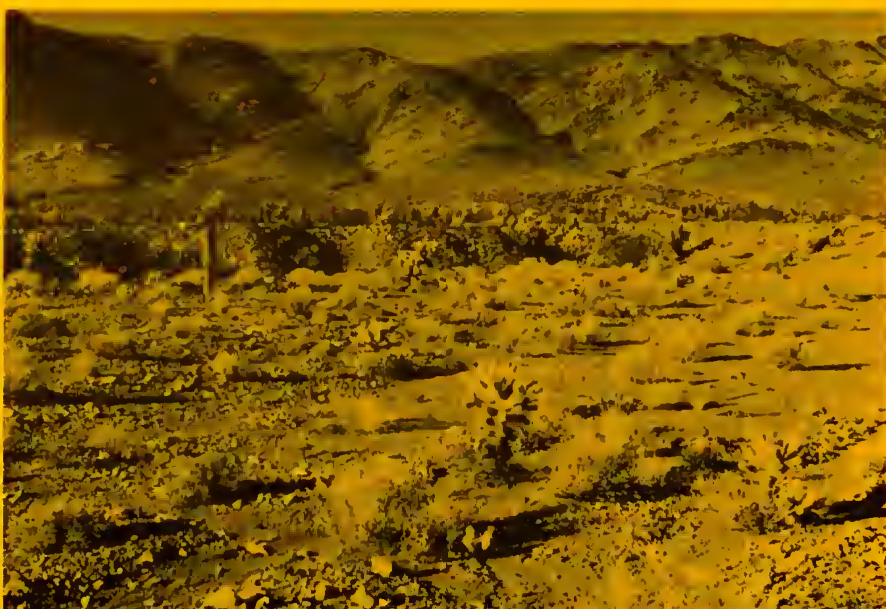

Fig. 2. A borrow pit excavated in 1970, 1971.

Fig. 3. A plant of *Opuntia bigelovii* developed from a fallen stem joint.

Antiquity of the *Larrea* population at this site is indicated by a 585-year-old wood fragment taken from the center of a clonal creosote ring having a bare area 30 cm in diameter (Vasek et al. 1975a, Vasek and Barbour 1976, Sternberg 1976). This clone, therefore, has an average radial growth increment of 0.026 cm/yr. Other creosote clones at the site have central bare areas up to 150 by 60 cm suggesting ages, assuming a standard growth ratc of 0.026 cm/yr, well in excess of 1000 years, and perhaps as much as 2900 years.

A borrow pit (Fig. 2), excavated during highway construction in 1970 and 1971 presents a discordant scar within the otherwise pristine cholla stand. Rock and soil, together with all the vegetation, were removed from an irregular oblong area about 70 m by 30 m, leaving a pit about 1400 m^2 in area and about 1-2 m in depth.

Three soil surfaces may be recognized. A deeply disturbed surface at the bottom of the pit is characterized by a fine-grained, gray soil mixed with rock rubble. The undisturbed surface generally surrounding the borrow pit is a stable, intermittent desert pavement of flattish rocks darkened with desert varnish. An intermediate surface, the sides of the pit, include a mixture of excavation remnants and collapsed excavation cuts.

The vegetation on the three surfaces was analyzed in 1975 by counting and measuring all the perennial plants in temporary circular plots. Two plot sizes were used. Large plots of 10 m^2 and small plots of 5 m^2 were established at intervals of 10 m and 5 m, respectively, along temporary transect lines. Total sample areas were: 300 m^2 on the undisturbed surface (15 large, 30 small plots); 185 m^2 on the narrow sides of the borrow pit (37 small plots); and, 350 m^2 on the disturbed pit bottom (15 large, 40 small plots).

Vegetation of the three surfaces is compared in Table 1. In terms of composition, the undisturbed surface is dominated by *Larrea tridentata, Opuntia bigelovii* and other long-lived species of the creosote bush scrub community. A rather high degree of structural heterogeneity in the mature community is suggested by the relative statures of the constituent species. The range extends from large shrubs *(Larrea, Opuntia)* to small shrubs *(Ambrosia, Krameria)* and low stem-succulents *(Echinocereus)*.

Vegetation on the deeply disturbed surface at the pit bottom is dominated by *Encelia frutescens, Ambrosia dumosa, Stephanomeria pauciflora* and other rather small perennials, most of which probably have relatively short life spans. A rather low degree of structural heterogeneity in this pioneer community is indicated by the uniform stature of the pioneer shrub species. The pit sides have a mixture which includes a few remnant long-lived shrubs *(Larrea, Dalea, Opuntia)* and also numerous smaller, short-lived perennials.

Plant density is greatest in the pit and least on the undisturbed surface but ground cover follows the reverse pattern (Table 1). Although plant reaction upon the environment has not been established, a very substantial shift in species composition and vegetation structure demonstrates the occurrence of plant succession. Secondary succession is clearly indicated by the rather rapid development and high productivity of the pioneer vegetation (Odum 1971).

A survey of the entire pit bottom revealed 46 plants of *Opuntia bigelovii* in 1973 and 66 plants in 1976 (Table 2). The 46 tallest (oldest) plants in 1976 were, on average, about 16 cm taller than they were two seasons earlier (Table 2). Therefore the cholla population on the deeply disturbed soil is under active recruitment and

TABLE 1

Vegetational characteristics in a Mojave Desert cholla patch: A, control samples based on 300 m^2 in undisturbed area; B, intermediate disturbance at sides of borrow pit, samples based on 185 m^2; C, deep disturbance at bottom of borrow pit, based on samples of 350 m^2.

D = density expressed as number of plants per 100 m^2; F = frequency expressed as occurrence per 100 sample plots; C = cover expressed as % ground covered. * = residual plant; ** = both residual and new plants.

	D	F	C
A			
Larrea tridentata	12.33	46.67	10.19
Opuntia bigelovii	25.33	64.44	3.34
Cassia armata	.33	2.22	.26
Yucca schidigera	.33	2.22	.21
Krameria spp.	1.00	6.67	.19
Acamptopappus sphaerocephalus	.67	4.44	.07
Ambrosia dumosa	.33	2.22	.02
Echinocereus engelmannii	.33	2.22	.02
Dyssodia porophylloides	.67	2.22	.01
Total	41.32	113.22	14.31
B			
Ambrosia dumosa	27.57	67.57	3.23
Encelia frutescens	15.14	45.95	2.01
Larrea tridentata*	.54	2.70	1.53
Opuntia bigelovii**	5.94	21.62	1.26
Dalea fremontii*	.54	2.70	.71
Hymenoclea salsola	.54	2.70	.45
Stephanomeria pauciflora	6.49	21.62	.42
Suaeda torreyana	.54	2.70	.08
Acamptopappus sphaerocephalus	.54	2.70	.05
Eriogonum inflatum	1.08	5.41	.03
Euphorbia polycarpa hirtella	12.43	10.81	.01
Erioneuron pulchellum	.54	2.70	t
Total	71.89	189.18	9.78
C			
Encelia frutescens	28.00	83.64	5.59
Ambrosia dumosa	8.86	40.00	1.06
Stephanomeria pauciflora	13.71	54.55	1.04
Opuntia bigelovii	5.43	25.45	.51
Porophyllum gracile	3.71	12.73	.16
Baccharis brachyphylla	.29	1.82	.14
Eriogonum inflatum	8.57	21.82	.07
Dyssodia porophylloides	.57	1.82	.03
Acamptopappus sphaerocephalus	.29	1.82	.03
Euphorbia polycarpa hirtella	18.00	16.36	.02
Erioneuron pulchellum	1.14	5.45	.01
Larrea tridentata	.88	5.45	.01
Total	89.45	270.91	8.67

TABLE 2

Height (cm) of *Opuntia bigelovii* plants in a borrow pit. A = the 46 plants resident in Nov. 1973; B = the 46 largest plants resident in March 1976; C = the 66 plants resident in March 1976; D = the difference between A and B. SD - standard deviation. * also 6 rooted joints (horizontal, without upright stems).

	A	B	C	D
Mean	33.4	49.5	39.6	16.1
Min.	8	25	8	5
Max.	140	145	145	24
N	46	46	66*	46
SD	26.6	25.1	25.9	3.9

is growing in both numbers and plant size. In contrast the cholla plants on the sides of the pit numbered 29 and 26 and averaged 95.3 and 96.0 cm respectively in 1973 and 1975 indicating an essentially stable population. Furthermore, the occurrence of a few new *Larrea* seedlings (Table 1) indicates that other long-lived elements of the vegetation gradually enter the successional process.

The observed species fall into four groups with regard to their responses to disturbance. These responses are summarized by comparing importance values for each species on the three surfaces (Table 3). I. Long-lived shrubs of the mature community respond strongly and negatively to disturbance. *Larrea* and other long-lived shrubs are virtually absent from both the lightly disturbed (except for a few residuals) and the deeply disturbed surfaces. The establishment of new seedlings is rather slow, only two *Larrea* seedlings being observed in the borrow pit in 1975 and three in 1976. These plants, therefore, follow a strategy of gradual, slow establishment and attain considerable longevity. They, therefore, demonstrate a K-syndrome and are probably K-selected (Southwood et al. 1974, Gaines et al. 1974). II. Long-lived opportunistic shrubs are important in the mature community but also have significant pioneering ability. Their positive response is somewhat greater with light disturbance than with heavy disturbance.

Opuntia bigelovii is a long-lived shrub equal to *Larrea* in importance in the community under discussion. It continually manifests opportunistic tendencies by vegetative reproduction. In the mature cholla stand, stem joints fall to the ground, and some strike root, usually a short distance from the "parent" plant.

A survey in March, 1976, indicated that 6% of the fallen stem joints had rooted in both the undisturbed population area and in the

TABLE 3

Importance values for species observed in: A, the undisturbed control area; B, the partially disturbed pit edge; and C, the deeply disturbed pit bottom.

* mostly from residual large shrubs; **both residual large plants and new small plants.

Importance values are calculated from the data in Table 1 by summation of *relative* density, frequency and cover.

	A	B	C
Long-lived shrubs			
Larrea tridentata	136.03	*17.81	3.04
Krameria spp.	8.77	--	--
Cassia armata	4.32	--	--
Yucca schidigera	3.95	--	--
Echinocereus engelmannii	2.64	--	--
Dalea fremontii	--	* 9.48	--
Long-lived opportunistic shrubs			
Opuntia bigelovii	132.95	**32.55	21.34
Ambrosia dumosa	2.60	107.10	36.90
Pioneer perennials			
Hymenoclea salsola	--	7.74	--
Suaeda torreyana	--	3.05	--
Erioneuron pulchellum	--	2.20	3.39
Euphorbia polycarpa hirtella	--	23.11	26.40
Baccharis brachyphylla	--	--	2.61
Porophyllum gracile	--	--	10.73
Eriogonum inflatum	--	4.62	18.49
Stephanomeria pauciflora	--	24.74	47.47
Encelia frutescens	--	65.87	126.44
Other			
Dyssodia porophylloides	3.33	--	1.61
Acamptopappus schaerocephalus	5.43	2.71	1.39

disturbed borrow pit. Evidently the changed soil conditions did not affect rooting frequency. Since fallen joints are usually horizontally oriented, plants derived from them will have acentric or curved stem bases (Fig. 3). In contrast, seedling plants will have straight, vertical stems. Therefore, an estimate of the relative mode of establishment can be made by scoring the frequency of acentric vs. straight stem bases. In the undisturbed population, 74% of the plants clearly had been established from stem joints, 12% had straight stems and 14% could not satisfactorily be scored.

The higher incidence of seedling establishment in the pioneer population suggests limited dispersal ranges for stem joints. Seed dispersal and seedling establishment may be the primary mode of initial invasion and subsequent population growth may increasingly follow a vegetative mode. The vegetative mode appears more important in the mature population. Despite an apparent colonizing advantage conferred upon *Opuntia* by its strategy of vegetative reproduction, other species are even more successful pioneers and establish large populations more rapidly, as discussed below.

Ambrosia dumosa is a long-lived plant (Muller 1953) common in mature creosote bush scrub communities (Vasek et al. 1975a and 1975b). Its low importance value in the community under discussion may indicate an intermediate longevity as compared with probable extreme longevity in *Larrea*. In any event *Ambrosia* assumes a pioneer role of first order importance with slight disturbance and of lesser importance with heavy disturbance. The relative difference on the two types of surface is greater than comparable differences in *Opuntia*. Greater response by *Ambrosia* to slight disturbance than to heavy disturbance was also noted by Davidson and Fox (1975) and by Vasek et al. (1975a and 1975b).

Ambrosia follows a different strategy than does *Opuntia*, namely establishment strictly by new seedlings. Although the details differ, both *Opuntia* and *Ambrosia* apparently follow a strategy of continual or frequent reproduction within the mature community. However, *Ambrosia* is more common on sandy soils or other slightly unstable substrates and rather uncommon on stable, rocky soils.

III. Pioneer perennials are short-lived herbs and shrubs that respond strongly and positively to disturbance by dramatic increase in population size. Several shrubs like *Hymenoclea salsola* and *Suaeda torreyana*, and perhaps *Acamptopappus sphaerocephalus*, show greater response to slight disturbance than to heavy disturbance (Table 3). The perennial herbs *Euphorbia polycarpa hirtella* and *Erioneuron pulchellum* respond about equally well to both slight and severe disturbance. The remaining species respond more strongly to severe disturbance (Table 3). *Encelia frutescens* is especially important as a pioneer on the deeply disturbed surface with *Stephanomeria pauciflora* being a distant second in importance. The long-lived opportunistic (Group II) *Ambrosia dumosa* ranks a respectable third (Table 3). These pioneer perennials clearly follow a strategy of large scale, rapid establishment following disturbance. They, therefore, demonstrate r-syndromes and probably are r-selected (Southwood et al. 1974, Gaines et al. 1974).

IV. The fourth category includes *Dyssodia porophylloides and Acamptopappus sphaerocephalus* for which the response pattern is not clear. *Acamptopappus* exhibits opportunistic tendencies somewhat similar to *Ambrosia* and *Opuntia*. It may be a long-lived ooportunist but its relative longevity has not been satisfactorily assessed.

TABLE 4

Mound height and area in four vegetation zones from Rabbit Dry Lake plays toward the lake edge, and vegetational composition above the dry lake shore line (zone V). RD = relative density; SD = standard deviation.

Zone		Mound height (cm)				Mound area (m^2)			
		min	max	mean	SD	min	max	mean	SD
I	A. Kochia californica	1	26	7.47	7.31	.01	1.57	.28	.45
	B. Suaeda torreyana	4	18	10.25	5.06	.01	1.06	.27	.34
	C. Kochia and Suaeda	4	35	21.33	10.91	.06	2.83	1.43	.97
	Total	1	35	11.10	9.17	.10	2.83	.51	.73
II	Atriplex torreyi	25	40	33.33	6.06	1.33	12.16	6.50	3.78
III	Atriplex torreyi Atriplex confertifolia Haplopappus acradenius Stanleya pinnata	70	130	93.33	20.46	150.80	824.67	346.88	218.50
IV	Atriplex confertifolia Haplopappus acradenius Stanleya pinnata	15	100	40.00	31.78	.39	21.21	7.32	9.89

Zone		RD		RD
V	Atriplex c onfertifolia	.63	Suaeda torreyana	.03
	A. Torreyi	.09	Haplopappus acradenius	.02
	A. polycarpa	.07	Eurotia lanata	.02
	A. canescens	.04	Hymenoclea salsola	.01
	Acamptopappus sphaerocephalus	.04	Lycium (2 spp)	.02
	Artemisia spinescens	.03	Oryzopsis and Hilaria	+

Figs. 4-7. Vegetation at Rabbit Dry Lake, San Bernardino County, California: Fig. 4. Small plants of *Kochia californica* established on the open dry lake bed.

Fig. 5. A large mound with *Atriplex torreyi.*

Fig. 6. A confluent mound with two conspicuous plants of *Atriplex torreyi.*

Fig. 7. The top of a confluent mound with *Atriplex confertifolia* and *Haplopappus acrandenius.* Two other giant mounds can be seen in the middle distance.

PRIMARY SUCCESSION ON A MOJAVE DESERT DRY LAKE

The salt pan or playa of many dry lakes is usually salt-encrusted and non-vegetated. Away from the center of the playa, intermittent patches of halophytes may occur on soil mounds which increase in size toward the edge of the dry lake (Fig. 8). The pattern of vegetation on mounds of various sizes was studied at Rabbit Dry Lake, west of Lucerne Valley in the western Mojave Desert. Five zones based on vegetation and mound size are described in the following sections. The zones are not quite mutually exclusive owing to the continuous nature of the processes under description and to the occasional reversal by degradation or erosion of a developing mound.

I. Small mound or *Kochia-Suaeda* zone: Seedlings of *Kochia californica* and sometimes *Suaeda torreyana* occasionally become established on the open playa (Fig. 4). As these plants grow, they accumulate sand, silt, and organic debris among their many stems at ground level. These soil mounds range up to 28 cm in height and up to 2.8 m^2 in area. More *Kochia* mounds than *Suaeda* mounds were found (Table 4) suggesting that *Kochia* establishes more readily. However, *Suaeda* seems to accumulate slightly larger mounds. The largest mounds in this zone have both *Kochia* and *Suaeda*. They average about twice the height and 5 times the area of mounds with only one species, suggesting that single plant mounds grow by accumulation and then merge or coalesce into larger mounds. The average for all mounds in this zone is about 11 cm in height and 0.51 m^2 in area (Table 4).

II. Large mound or *Atriplex torreyi* zone: *Atriplex torreyi* occurs on larger soil mounds, usually with some *Suaeda torreyana*. These mounds range from 25 to 40 cm in height and mostly from 3 to 12 m^2 in area (Table 4). Apparently, *Atriplex torreyi* establishes on small mounds accumulated by *Kochia-Suaeda*, and then itself accumulates even larger amounts of soil material (Fig. 5). *Atriplex torreyi* was not observed on the playa or on very small mounds except in one instance where a large mound had clearly been eroded away exposing a large *Atriplex* trunk at playa level. Another mound had been eroded around the edges leaving a large *Atriplex* shrub on a high mound of small area (1.33 m^2). These erosional events, perhaps aided by vehicular impact, extend the ranges of observed height and area and thus contribute to overlapping mound size classes.

III. Confluent mound or *Atriplex-Haplopappus* zone: *Atriplex torrei* accumulates sandy soil material up to a height of about 1.3 m above playa level. At the same time, the mounds also grow horizontally and become confluent, thus increasing dramatically in area. Some mounds are over 70 m long. Mound areas range from 150 to 825 m^2 (Table 4). Heights are greatest toward the playa and decrease to about 0.7 m away from the open playa. The vegetation conspicuously includes *Atriplex torreyi* (Fig. 6), especially on the higher mounds near zone II. However, *Atriplex confertifolia*, *Haplopappus acradenius*, and *Stanleya pinnata* increase in relative biomass (Fig. 7) on the lower portions of confluent mounds, usually away from zone II. The decrease in *Atriplex torreyi* suggests that death of these large shrubs may open areas in mound vegetation for erosion, thus explaining the decrease in mound height. *Suaeda torreyana* also occurs on most confluent mounds and one plant of *Artemisia spinescens* was also observed. The entire spectrum of plant species indicates an increase in species richness and an increase in structural complexity of the vegetation on large confluent mounds.

IV. Degradation or *Atriplex confertifolia-Haplopappus* zone: A heterogeneous mixture of mounds of various sizes in zone IV resembles the tops or remnant parts of the long confluent mounds of zone III. The decrease in mound height noted in zone III continues into zone IV. Erosion or degradation of large mounds produces miscellaneous smaller mounds and also partly buries mound remnants in their own debris, thus accounting for the decrease in height above playa level. Mound degradation proceeds with zone IV becoming a more or less level plain toward the edge of the dry lake. The absence of *Atriplex torreyi* from most of zone IV is the most notable vegetational feature.

The vegetation of zone IV is dominated by *Atriplex confertifolia*, *Haplopappus acradenius* and *Stanleya pinnata* in respective order. *Suaeda torreyana* is uncommon. The vegetation is therefore very similar to that on confluent mounds but is more continuously distributed.

V. The area above the dry lake shore line is not strictly part of the dry lake primary succession. However, the vegetation of zone IV grades into that of zone V (above the shore line) and continued succession is a reasonable supposition. Vegetation in zone V is a xerophytic salt bush scrub (Vasek and Barbour 1976) dominated by *Atriplex confertifolia*. It also includes *Atriplex polycarpa*, *A. canescens*, *A. torreyi* (near the shoreline) and about 10 other species as detailed in Table 4.

The continuous variation in mound size between zone I and zone II suggests a pattern of gradual accumulation of soil

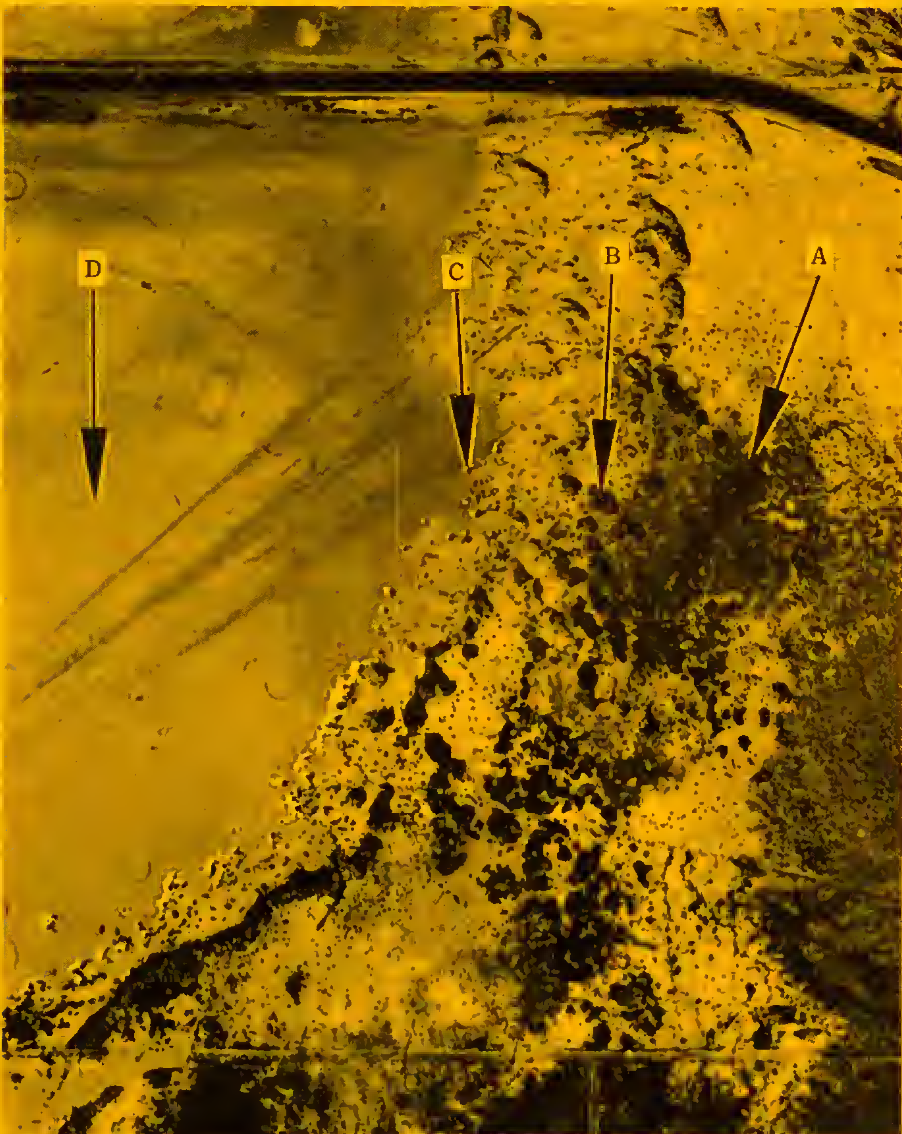

Figure 8. An aerial view of the study area on Rabbit Dry Lake, showing the distribution of mounds of various sizes: A, mound degradation area; B, giant confluent mound; C, large mound with snow (bright white signature) accumulated on west side; D, open playa. Some small mounds show up as tiny specks. Note the difference in soil color between the open playa surface and the "new" playa surface among the soil mounds.

material by small mounds. However, the discontinuous variation between large mounds (zone II) and confluent mounds (zone III) suggests a rapid accumulation of soil material by large mounds. The playa surface is a heavy silty-clay. Small mounds include a layer of red sand above original playa surface and a layer of sandy loam with accumulated organic matter above the sand. Large mounds have the same soil layers and also have a zone of massive root development within the sandy loam layer. Extensive "beds" of organic matter in large mounds include masses of stems (probably from original *Kochia* plants) and masses of *Atriplex torreyi* leaves close to the surface. Confluent mounds have mostly a sandy soil, suggesting primarily an aeloian mode of formation. Larger mounds also have a hard sandy-clay layer above the hard silty-clay layer of the original playa surface. The occurrence of two "playa" surface layers, visible as two surface zones in Fig. 8, supports the observations that the present inter-mound dry lake surface is above the original playa level. In addition, development of mounds westward into the dry lake by accumulation of windblown particles is supported by the observation (Fig. 8) that snow accumulates on the west (windward) side of shrubs. In any event, the several plant species clearly play a role in soil development by trapping inorganic particles and by contributing organic material. Changes in soil characteristics, therefore, evidence a "plant reaction upon the environment" and permit a sequential pattern of at least three plant communities in a primary succession.

THE VEGETATION OF UPPER JOHNSON VALLEY

Upper Johnson Valley is located some twenty miles northeast of Lucerne Valley in the western Mojave Desert. The specific area of concern occupies a low granitic ridge south of the Rodman Mountains at an elevation of about 3500 ft. (1065 m) on Section 25, R3E, T6N. Weathering of the low ridge provides the sole source of material for a gentle (about 3% slope) alluvial fan sloping to the south. Very stable soil conditions and very low rates of erosion are indicated by the absence of water flow channels, by the gentle uniform terrain, and by the fine grained homogenous soil.

Vegetation on this alluvial fan is a creosote bush scrub characterized by low ground cover and low perennial species diversity. Ground cover, comprised mostly of *Larrea tridentata*, is less than 5% and total shrub density is only 8.8 per 0.01 ha (Table 5). In contrast, a more diverse area in Upper Ord Valley, some 10 miles to the northwest, has about three times the number of species, the shrub density, and the perennial ground cover. (Table 5)

TABLE 5

Perennial plant density and ground cover (GC) in: A, Upper Johnson Valley on a stable, sandy alluvial fan; and B, in Upper Ord Valley on active, rocky and sandy alluvial slopes and washes. Based on belt transects totaling 500 m^2 and 400 m^2 respectively. Both localities are in San Bernardino County, California

	A		B	
	Density per $100m^2$	% GC	Density per $100m^2$	% GC
Larrea tridentata	3.20	3.55	4.25	6.09
Ambrosia dumosa	4.80	1.15	4.75	.55
Ephedra nevadensis	.20	.08		
Thamnosma montana	.40	.04		
Machaeranthera tortifolia	.20	.03		
Yucca schidigera			.25	.59
Acacia greggii			.25	.57
Lycium cooperi			2.75	1.64
Krameria parvifolia			1.00	.68
Opuntia ramosissima			.75	.05
Echinocereus englemannii			.50	.02
Eriogonum fasciculatum			.25	.03
Eriogonum inflatum			.25	.02
Hymenoclea salsola			7.50	3.04
Stephanomeria pauciflora			.75	.14
Chrysothamnus paniculatus			.25	.10
	8.80	4.85	23.50	13.52

The low ground cover at the Upper Johnson Valley site means that a lot of open ground area is available for ephemeral plants. An analysis of local and regional checklists compiled over two years (Vasek and Johnson 1975) indicates a poor shrub and perennial herb representation (i.e. few species) but a rich annual vegetation (i.e., relatively many species) at Johnson Valley in comparison with a larger area in Ord Valley and the still larger Lucerne Valley region (Table 6). Probably the richer perennial flora correlates with topographic diversity including unstable land forms.

Upper Johnson Valley also has a relatively dense annual vegetation (Table 7). The proportion of bare plots in Upper Johnson Valley is much less than in any of four nearby areas (Table 7). In addition, the number of species is slightly greater, and the average density of annual plants is substantially greater in Upper Johnson Valley.

Stability of the Upper Johnson Valley substrate was suggested by apparent low erosion rates and gentle terrain. In addition, rather striking longevity of the creosote bush population is suggested by the size and number of creosote clones. Development of clonal creosote rings (Fig. 9) is discussed and illustrated by Vasek et al. 1975a, Vasek and Barbour 1976, and Sternberg 1976. A survey utilizing regularly placed samples from a series of aerial photographs

TABLE 6

Distribution of life forms, and characterization of three areas, in the Western Mojave Desert, San Bernardino County, California.

	Upper Johnson V.	Upper Ord V.	Lucerne V. Region
Area (km^2)	24	164	6400
Growth form			
Shrubs	27	46	49
Per. herbs	8	25	31
Annuals	52	55	73
Relative proportion of annual species	.60	.44	.48
Topographic diversity	sandy fan	sandy fan sandy wash rocky fan rocky wash	sandy fan sandy plain sandy wash silty wash alkali sink rocky fan rocky slope (residual) rocky wash etc.

TABLE 7

Analysis of winter annual vegetation in the western Mojave Desert: Based on direct count of annual plant skeletons remaining in July 1973 in circular plots of 0.1 m^2 at 1 m intervals; * = same area of perennial samples reported in Table 5; adapted from Basek and Johnson, 1975.

	Johnson V. (north) *	Johnson V. (south)	Upper Ord V. *	*Lucerne Valley* Old Woman Springs	*Lucerne Valley* Fire Station
No. of plots	293	204	201	102	251
Area sampled (M^2)	29.3	20.4	20.1	10.2	25.1
% plots bare	10.6	31.4	22.9	39.2	51.0
No. of species	17	10	15	15	11
Total plants	1149	448	325	80	89
Density/m^2	39.2	22.0	16.2	7.8	3.6

(Table 8) indicates that creosote clones of varying sizes are common and generally distributed, with some variability, in the Upper Johnson Valley area. Thus, creosote clones are not rare. They are common features of the vegetation on stable substrates of long duration.

TABLE 8

Frequency and size of creosote rings in Upper Johnson Valley, San Bernardino County, California. Three one-hectare sample areas were located 0.25 km apart across the center of each of six consecutive aerial photographs; the centers of consecutive photographs were separated by a distance of 0.9 km.

Aerial photo number	Size class mid-point (m)						Total
	0.6	1.8	3.0	4.2	5.4	6.6	
485	4	3	1				8
484	15	22	11	3	2	2	55
483	2	12	2	1			17
482	7	10	2				19
481	5	19	7		1		32
480	7	7	6		1		21
Total	40	73	29	4	4	2	152

Average creosote ring covers 4.06 m^2
Average creosote ring density is 8.44 per hectare or 1 ring per 1184 m^2

The very few radiocarbon dates for wood fragments recovered from the central bare area of creosote clonal rings suggest clonal development rates between 0.026 and 0.143 cm per year (Sternberg 1976) for rocky and sandy substrates respectively. Clearly this type of estimate is a very crude approximation and necessary verifying studies are underway. Nevertheless, the age of the larger (with diameters of 6.6 m) creosote clonal rings in Upper Johnson Valley clearly projects to the range of 2,300 to 12,700 years. An average rate of 0.084 cm/year yields an estimate of about 3,900 years.

The rich annual flora and dense annual vegetation of Upper Johnson Valley is correlated with a stable, uniform shrub community of low species diversity and low cover, but of extreme antiquity. This correlation suggests that these desert annuals comprise an integrated and adapted component of very old communities.

DISCUSSION

Shreve (1942) asserts that desert vegetation, upon destruction, is replaced directly via new seedlings of the same original species. This absence of successional change in community composition is explained by the assertion (Shreve 1942) that desert plants have almost a total lack of reaction upon the habitat. Therefore, the absence of progressive developments of soil, microclimate, etc. preclude sequential changes in species populations. If so, then consideration of the characteristics of such changes is not possible.

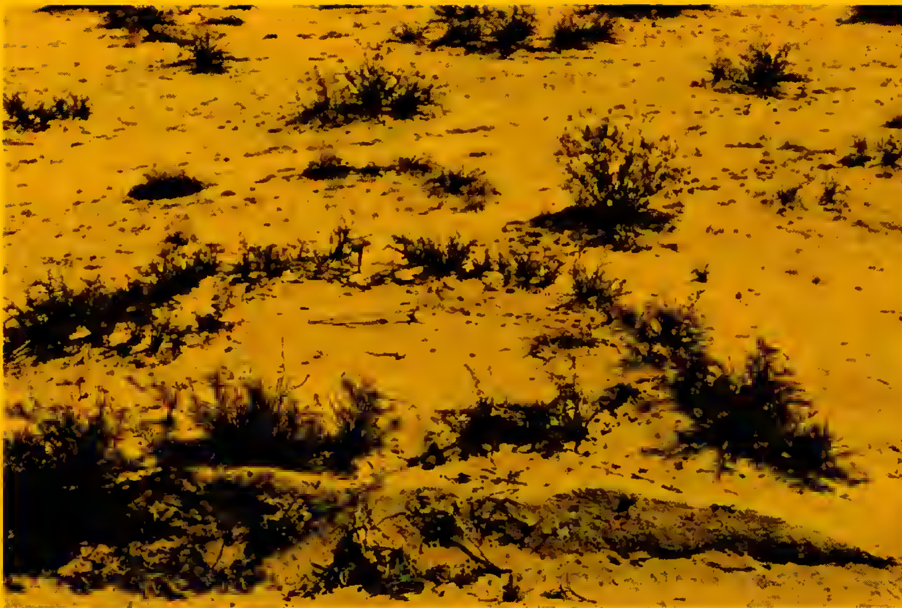

Fig. 9. A clonal creosote ring in Upper Johnson Valley, San Bernardino County, California. Note the meter stick inside the ring.

Furthermore, a careful study of "succession" in the *Larrea-Flourensia* zone of west Texas (Muller 1940) indicated only short term shifts in relative species composition, thus providing direct evidence for dynamic homiostasis in desert vegetation.

However, the three examples described in this paper indicate long term changes in both species composition and vegetation structure. Such changes consititute succession as defined by Pickett (1976).

Successional theory, developed mostly in more or less mesic eco-systems, holds that a number of trends or progressive developments underlie most successional processes (Whittaker 1970):

1) The soil develops depth, organic content and horizon structure;
2) The community increases in height, biomass, and stratification;
3) Productivity increases;
4) The community itself increasingly affects the microclimate;
5) Species diversity increases;
6) In a sequence of population changes along a time gradient, the rate of replacement slows as smaller, shorter-lived species are replaced by larger, longer-lived ones;

7) Stability increases.

Pickett (1976), following Odum (1969), believes that ecosystems undergo five general trends through succession:

1) a shift from producing to maintaining;
2) an increase in structural complexity and diversity;
3) an increase in niche complementarity and selection for competitive ability;
4) a tightening and slowing of nutrient cycling;
5) an increase in self-regulation of the system.

The two lists of trends can be simplified and amalgamated by combining equivalents and by generalizing. For example, both lists include an increase in structural complexity. In further example, Pickett's trend concerning self-regulation appears to be an explanation of the trend regarding a shift from producing to maintaining. Furthermore, his trend regarding the slowing of nutrient cycling may be viewed as a mechanism by which the system is self-regulated. Therefore, three of Pickett's trends can be generalized to the broader concept of the shift from producing to maintaining.

Some trends in Whittaker's list may also be generalized. For example, the trend in soil development might reasonably be combined with the community effect on microclimate. The increase in stability is a logical outcome of the slower replacement of long-lived species than of short-lived species. However, the increase in stability seems logically inconsistent with an increase in species diversity (Johnson et al. 1975) perhaps depending on the time reference.

Both productivity and species diversity clearly increase, but only to a point. However, after long-lived species assume dominance, a large fraction of productivity (biomass) is tied up as standing crop. Productivity declines at some point, as recognized by Pickett in the shift from producing to maintaining. The logical end point of the replacement by long-lived species would be a community dominated by one or a few very long-lived species. Mesic systems such as deciduous forests are considered to undergo succession to climax in a few centuries (Pickett 1976). In contrast, long-lived desert plants such as *Larrea* may live thousands of years, during which time *Larrea* clones spread and species with shorter life spans gradually die out. The ultimate, most stable community may then consist primarily of very old *Larrea* clones and few other shrubs. Instead of other shrubs, extensive populations of annuals occupy the surface between *Larrea* clones of the ancient mature community.

A modified list of trends accompanying plant succession especially in desert vegetation combines the above ideas with those of Whittaker and Pickett.

1) Early stages of succession are characterized by communities of pioneer plants with relatively uniform, low stature and rather short life spans.
2) The community increases in height, structural complexity, stratification, and biomass as the early successional species are replaced by later successional species and by elements of the mature community.
3) Productivity and species diversity increase, as does niche complementarity, as the community increasingly affects the micro-climate and soil development.
4) A shift from producing to maintaining, i.e. a decrease in productivity, occurs as late successional species are replaced by longer-lived climax species.
5) As very long-lived species accumulate biomass, productivity stabilizes at maintenance levels, intermediate long-lived species gradually decrease in population size and extreme stability prevails as selection for competitive ability results in dominance by one or a very few long-lived species.

The successional pattern in the Mojave Desert differs from that in more mesic ecosystems in two major factors: the time span may involve several millenia rather than a few centuries; and the very old, mature community of few shrubs includes extensive and long persistent populations of annual plants.

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USES OF COMPUTERS IN PLANT TAXONOMY

by

Curtis Clark

Just as computers are having a greater impact on our everyday lives, they are becoming increasingly important to plant taxonomists as well. There are four tasks for which computers are already in wide use: classification, data retrieval, identification, and clerical operations.

Classification

Classification is the procedure of grouping plant species into higher categories such as genera, families, and orders. In an attempt to avoid subjectivity and "guesswork" in classification, two different schools of taxonomy have arisen, and each uses computers to assist with classification. *Pheneticists* believe that organisms should be classified based on overall resemblance ("phenetic similarity"); thus, the species in a genus should be more similar in appearance to each other than any are to species in another genus. Phenetic classification relies on mathematical estimates of similarity which are much more quickly performed by computers than by people. *Cladists* believe that organisms should be classified based on evolutionary descent, so that species in a genus should have a more recent common ancestor than the common ancestor they share with members of another genus. Cladists estimate relationship using the degree to which species share evolutionary novelties ("derived characters"), and computers help them arrive at hypothetical evolutionary trees that account for the features of species with the fewest number of changes.

Data Retrieval

Many herbaria maintain lists of all their specimens; these are called accession lists. They are usually in the order in which the specimens are added to the collection. If you wanted to find out how many specimens have been collected in Los Angeles County, or in which counties *Quercus agrifolia* has been collected, you could do so, but it would mean going through the accession list entry by entry. How much nicer it would be if you could hire someone who was fast, dumb, and obedient to do the work for you. A computer is exactly that. In a matter of seconds it can go through the assession list, pull out every entry in which both the words "Los Angeles County" and "*Raphanus sativus*" occur, and print out a list of the specimens of wild radish in their herbarium from Los Angeles County. Further refinements allow the production of county checklists, range maps, and frequency distributions. Of course, all this requires that the accession list be in machine-readable form, on a magnetic disk or tape.

Identification

When you try to identify a plant with a dichotomous key, there is generally only one path to the right answer. Yet we all know species that have identifying features that are never mentioned in the keys. A type of key called a random-access or polyclave key allows the user to pick distinguishing characters randomly, rather than in a fixed order, and the key will indicate other features which must be observed to make the final identification. Manual polyclave keys are usually cumbersome affairs of decks of punched cards and sorting rods. Computerized versions are easier to use--you input distinguishing features and the terminal tells you what to look for next. Like dichotomous keys, computer keys are no better than their authors, but they allow quicker identification and often require fewer characters.

Clerical Operations

Word processors are special-purpose computers that store text and allow changes to be made to certain parts before it is printed. Word processors make those junk-mail letters that have your name, address, and such already incorporated into the typing as if the letter were typed especially for you. Word processors allow easy revision of text, and are in wide use by newspapers, clerical offices, and authors. Herbaria can of course make good use of the regular advantages of word processing in correspondence, producing informative leaflets, etc., but a more specialized use is in the production of labels for herbarium specimens. Herbarium labels include not only the name of the plant, but also the location, the date, the collector, and other information. If several species are collected by one person at one location, and there are several duplicates of each collection, a typist can spend a long time repeating information on each label. Special computer programs ask for label information and store information from previous labels, so locations, collectors, and such need to typed in only once. At the end of a session the program causes the information to be printed out in labels of a standard format.

Because computers can quickly carry out dull, repetitive tasks, they will see increasing use in plant taxonomy. By freeing taxonomists from routine drudgery, they will allow more time to be devoted to the study of plants.

FIELD TRIPS

February 19, 1983 (Saturday)
Fungal Foray

Call Walt Wright for details. (714) 529-4134 or 990-9092.

February 27, 1983
Wild Mushroom Fair

Sponsored by the Los Angeles Mycological Society and the Los Angeles Museum of Natural History, the Wild Mushroom Fair will take place at the L.A. State and County Arboretum (301 N. Baldwin Ave., Arcadia, CA) from 9 to 5 on February 27. The Fair will feature workshops, exhibits, speakers and a bookstore. The public is invited to bring mushrooms and fungi in for identification. Admission to the Arboretum is $1.50 ($.75 for those under 17 and over 65). A donation to the Los Angeles Mycological Society (L.A.M.S.) is suggested. For further information contact Donald A. Feinstein, 609 Milwood Avenue, Venice, CA 90291.

March 11-13, 1983
Yuja Desert Trip

Call Walt Wright for details.

March 11-18, 1983
Boat Trip to San Martin, Cedros and San Benito Islands

Boat trip to San Martin, Cedros and San Benito Islands via Pacific Anglers Fleet leaving from Ensenada on the 68 foot Royal Pacifico. The ship is complete with trained crew, a great cook, an even greater skipper and a totally outstanding naturalist. Fresh water showers are available and the berthing is open bunks. For those who want to "wet a line," bait will be available, along with a willing crew. And yes, we do have fish holds that are ICED! For the convenience, comfort and well-being of all, trips are limited to 22 passengers. Trips are eight (8) days in length and are $695 per person. There are absolutely no other charges to be added. Individual reservations are being taken for a trip leaving on March 11, 1983. Round trip bus service is available to groups. Since the trip is limited to 22 persons, make your reservations as soon as possible by calling or writing Herb and DJ Nordquist, 23045 El Caballo, El Toro, CA 92630, phone (714) 859-4933.

March 25-April 1, 1983
Grand Canyon Trip

Call Walt Wright for details.

April 9, 1983 (Saturday) 8:00 a.m.
Native Plant Sale, Rancho Santa Ana Botanic Garden, 1500 North College Ave., Claremong.

This will be our ninth annual sale of California natives. We have a good stock from the R.S.A. collection plus selections from commercial growers. There is usually crowd of buyers at the opening and the choice plants go fast.

We will also have a wide assortment of botanical books for sale.

We need SCB volunteers to help. Please be there before 8 a.m.

April 10, 1983 (Sunday)
Pines to Palms Trip

Call Walt Wright for details. (714) 529-4134 or 990-9092.

April 15-17, 1983 (Friday to Sunday)
Santa Cruz Island Trip

Call Walt Wright for details.

April 24, 1983 (Sunday)
High Desert Wildflower Field Trip

Call Walt Wright for details.

CALIFORNIA NATIVE PLANT SALE

A-1 Nurseries will be holding a native plant sale Saturday, March 5, from 8:00 a.m. to 2:00 p.m. Many varieties will be available. A percentage of the profits will be donated to the Southern California Botanists for helping with advertising. For more information call (714) 964-3548. A-1 Nurseries, 10500 Garfield Ave., Huntington Beach, CA 92646. Cross streets are Garfield and Ward.

For a copy of the 1983 native plants catalog, *Plants of the Southwest*, write to Plants of the Southwest, 1570 Pacheco St., Santa Fe, NV 87501.

Erratum: In the December, 1982, issue of *Crossosoma* the photograph of deergrass clumps (page 3) was printed upside-down.

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We thank all those who promptly remitted their 1983 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

COMING 1983 EVENTS (DETAILS WITHIN)

February 19	Fungal Foray
February 27	Wild Mushroom Fair
March 11-13	Yuja Desert Trip
March 11-18	Boat Trip to San Martin, Cedros and San Benito Islands
March 25-April 1	Grand Canyon Trip
April 9	SCB Plant Sale
April 10	Pines to Palms Trip
April 15-17	Santa Cruz Island Trip
April 24	High Desert Wildflower Field Trip

DON'T FORGET TO PAY YOUR 1983 DUES!
See Dec. 1982 issue of *Crossosoma* for details.

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Some Observations of the 'Occidentalis' Segregates of Prickly Pear Cactus (*Opuntia*) Occurring in Orange County

Geoff Smith

Regional urban growth in southern California during the past thirty years has drastically altered or eliminated many of the extensive populations of native prickly pear cacti (*Opuntia*), which formerly were common throughout coastal valley and foothill areas. The largest of the remaining populations occurs in association with coastal sage scrub vegetation or disturbed chaparral locations on dry, sun-exposed slopes between 0 - 500m. elevation (Benson 1969).

One explanation for the high degree of complexity of morphotypes (individual variants) and apparent hybrid swarm characteristics seen at these populations relates to the introduction of the arborescent (2-5m. tall) cultivated prickly pear cactus *O. ficus-indica* during the late 17th - early 18th centuries by Spanish missionaries. The various forms of *O. ficus-indica* rapidly and extensively interbred with varieties of the low-growing (0.1-1m. tall) native prickly pear (*O. littoralis*). Subsequent natural selection by firestorms favored the perpetuation of morphotypes having characteristics intermediate between the original types (Benson and Walkington 1965).

Establishment of prickly pear cacti on the Galapagos Islands demonstrates the weediness or capacity of *Opuntia* to successfully enter a broad spectrum of habitats (Anderson and Walkington 1968). Natural hybridization between three species of *Opuntia* in Texas has led to several types of populations, including hybrid swarms, segregating introgressive populations, and hybrid microspecies (Grant and Grant 1980). The ability of prickly pear cacti to reproduce vegetatively (by stem joints), combined with the weediness of various forms and ease of hybridization, has therefore resulted in the development of the highly complex local populations seen in southern California.

Within the local populations occurring in Orange County, some morphotypes appear to be more phenotypically stable than others. Of major interest is the relationship of "*O. occidentalis*," a name that has been applied to suberect, somewhat sprawling (1-2m. tall) forms of prickly pear cacti occurring in the hybrid swarms. These forms have been designated as "occidentalis-C" and "occidentalis-D" (Walkington 1966). Taxonomic description and placement within the total spectrum of prickly pear cacti in southern California ranks these two morphotypes as "segregates," lacking species or varietal status (Benson 1982).

When this author studied morphological and chemical (flavonoid compound) variations occurring within the introduced mission cacti (Smith 1973), the results indicated that the two segregates (hereafter referred to as occ-C and occ-D) appeared to lack patterns of strong intermediacy which might be expected from crossings of *O. ficus-indica* x *O. littoralis*. In reciprocal crossing experiments between *O. littoralis* and *O. oricola* (an arborescent, 1-3m. tall native species), seed and seedling characteristics consistently resemble those of the maternal parent (Philbric 1963). Seeds of occ-C and occ-D populations are very large compared to those of *O. ficus-indica*, and most closely resemble seeds of *O. littoralis* v. *piercei*, *O. l. vaseyi*, or *O. erinacea* (Smith 1973). This indicates that if occ-C and occ-D are in fact the products of crosses between mission cacti and native taxa, successful genetic transfer in flower fertilization only occurs one-way (pollen from *O. ficus-indica* to pistil of *O. littoralis* varieties). This is in agreement with Philbrick's experiments.

Another factor to consider is comparative chromosome numbers of the prickly pear cacti (*O. littoralis* n = 33, *O. ficus-indica* n = 44 (Philbrick 1963, Pinkava and McLeod 1971). While no data are presently available for chromosome numbers for occ-C or occ-D, it would seem remarkable that the dissimilarity of 33n x 44n could result in distinctive morphotypes which have such widespread distribution throughout Orange County.

In June 1982, this author noted distribution patterns of various *Opuntia* and collected flowers from eleven sites throughout Orange County. Sites were chosen which had extensive populations, and only those morphotypes which fall within taxonomic descriptions (after Benson, 1969) were studied. From these sites a total of approximately 1300 flowers were analyzed for various phenotypic characters obtained from longitudinal sections of the hypanthium. Preliminary results from these measurements strongly indicate that the occ-C and occ-D segregates display characters which are distinct from *O. ficus-indica* and have strong affinities with the varieties of *O. littoralis* (consistent with seed characteristics study discussed above). These results are undergoing computer analysis and will be presented in a following article.

TABLE 1.

Distribution of *Opuntia* variants in Orange Co.

Orange Co. site	approx. elevation	A	B	C	D	li.	au.	va.	pi.	or.
		morphotype (see below for explanation)								
Standard Oil (La Habra)	120-150m.	-	-	+	-	+	+	-	-	+
Esperanza Rd. (Yorba Linda)	120-150m.	-	-	+	-	+	+	+	-	-
Green River (Santa Ana Cyn)	150-250m.	-	-	+	+	+	+	+	-	-
Villa Park Hill (Orange)	150-250m.	-	-	+	+	+	+	-	-	+
Mesa Dr. site (Villa Park)	150m.	+	+	+	-	+	-	-	-	-
El Modeno Hills (Orange)	150-250m.	-	-	+	+	+	+	+	+	+
Silverado Canyon	350m.	+	-	+	+	-	+	-	+	-
Modjeska Ridge	430m.	-	-	+	+	+	+	+	+	-
El Toro Rd. (Irvine Ranch)	230m.	-	-	+	+	+	+	-	-	+
Starr Ranch (Bell/Crow Cyn)	150-500m.	-	-	+	+	+	+	+	+	+
Laguna Beach (Skyline Drive)	230m.	-	-	+	-	+	-	-	-	+
	(n = total no.)	2	1	11	7	10	9	5	4	6
% frequency (n/11 x 100)		18%	9%	100%	64%	91%	82%	45%	36%	55%

(A = *O. ficus-indica*, spineless form; B = *O. ficus-indica*, spiny form; C = *occidentalis*-C; D = *occidentalis*-D; li. = *O. littoralis littoralis*; au. = *O. l. austrocalifornica*; va. = *O. l. vaseyi*; pi. = *O. l. piercei*; or. = *O. oricola*)

Distribution patterns of the *Opuntia* taxa under study (Table 1) reveal that occ-C has the widest range throughout Orange County of all the morphotypes, and that both occ-C and occ-D occur in association with at least one variety of *O. littoralis* at each site. Conversely, *O. ficus-indica* has an extremely limited range (this is to be somewhat expected in view of the fact that urbanization would eliminate a greater percentage of the mission cacti, which inhabit sites more favorable for development). The widespread distribution of the "occidentalis" segregates (particularly occ-C), the uniformity of their seed characteristics, and the discrepancy in chromosome number between *O. ficus-indica* and *O. littoralis*, indicate that more information is needed before an accurate assessment can be made of the position that these prickly pear cacti occupy within the total spectrum of opuntias in southern California. Studies of cross-pollinations, detailed statistical analysis of morphological characters, chromosome number counts, and further biochemical analyses will greatly help in understanding the biology of this complex genus.

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PLANT SALE VOLUNTEERS NEEDED

Our annual plant sale is Saturday, April 9, 1983, at Rancho Santa Ana Botanic Garden, 1500 N. College Ave., Claremont, CA.

The gates open to the public at 8:00 a.m., so we need volunteers on hand at 7:30 a.m. The sale concludes about 1:30 p.m.

This is a very important event for S.C.B.; it provides funds vital for our activities. It is always an interesting day for those who help. Some customers are very knowledgeable, while many are just starting with natives. All are interested, and we always sign up new S.C.B. members. Our books are also on sale.

The Botanic Garden itself will be blooming. It is always a joy to visit. Join us.

BOOK SALES

For over two years Virginia Gardner has diligently and almost single-handedly run our book sales, and we are most grateful to her. She has expanded our sales to include almost every horticultural society in our area.

Commencing February 1, 1983, she is doing business for her own account, but will continue to give 10% discounts to our members and 5% to S.C.B. on sales to our members and at our activities. This enables us to furnish the same service to our members, provides revenue to S.C.B. and relieves us from finding new volunteers to handle books. We hope you will patronize her at:

V T L Books
30026 Avenida Cellestial
Palos Verdes Peninsula, CA 90274

She will appreciate your suggestions of new books to stock.

We recently received an order from Ira L. Wiggins for a copy of Thorne, Prigge and Henrickson, "A Flora of the Higher Ranges and the Kelso Dunes of the Eastern Mojave Desert in California." His comment to us was:

> The work entailed in producing this book was far beyond what many people would think necessary, as I well know from past experiences! I congratulate the authors for the masterly job done in producing this publication, and wish that more detailed studies of similar scope might appear more frequently. I sincerely hope that the supply is not exhausted, and that my order is not too late to be filled!

S.C.B. was truly privileged to provide this publication. We still have a few copies, which may be ordered from V T L Books by sending your check for *$8.50*, which includes the price of *$7.00* and postage and handling of *$1.50*.

PLEASE ATTEND the annual meeting of the Southern California Academy of Science, May 6 and 7, 1983, at California State University, Fullerton. Presentations of papers will be held on Friday, May 6, 1983. The Southern California Botanists will give a cash award of $100.00 for the best student paper in botany.

On Saturday, May 7, 1983, three symposia will be held. These include: An all day symposium entitled "The Biology of the White Shark," co-chaired by Jeff Seigel and Cam Swift, a Saturday symposium entitled "Marine Mammals and Marine Pollution," chaired by Dennis Kelly, and a Saturday afternoon symposium entitled "Marine Mammals and Man," chaired by Bemi De Bus.

Call Margaret Barber at 213-744-3384 for further details.

COMING 1983 EVENTS (Details Within)

April 9	SCB Plant Sale
April 9-10	SCB Palms to Pines Trip
April 16	Native Desert Plant Sale, Living Desert Reserve, Palm Desert
April 24	SCB High Desert Walk
May 6-7	Annual Meeting, Southern California Academy of Science, Calif. State Univ., Fullerton
May 27-30	SCB Trip to Sierra de Juarez
June 10-12	SCB Trip to San Bernardino Mountains

DON'T FORGET TO PAY YOUR 1983 DUES!

See Dec. 1982 issue of *Crossosoma* for details.

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. 9, No. 3
Issue Editors: Curtis Clark and Marvin Chesebro June, 1983
Managing Editor: C. Eugene Jones

MANUSCRIPTS WANTED

Have you ever wondered where the articles in Crossosoma *come from? Well, the truth is, the editors often beg people to write them, or, under the pressure of a deadline, write articles themselves. There is no reason why this should be the case; there are now over 300 members of SCB, and any one of them can write an article for* Crossosoma. *So, in hopes of increasing submissions, here's:*

Everything You Wanted To Know About Writing For *Crossosoma*, But Were Afraid To Ask

"But *Crossosoma* only publishes high-power research papers." Most botanists publish their high-power research papers in high-power research journals. *Crossosoma* is a "low-power" journal--its function is to teach people about plants, not necessarily to report the hottest new findings in plant science. *Crossosoma* publishes both technical and popular articles, with the primary criterion that they interest the members.

"I am a professional botanist. If I publish my research results in *Crossosoma*, it will not add to my publications list, and no one will ever read them, anyway." *Crossosoma* is a "refereed journal"--all manuscripts are reviewed by a panel of editors (your Board of Directors), who try to assure that all manuscripts published are well-written and scientifically sound. Admittedly, a paper in *Crossosoma* is not as prestigious as a paper in *Nature* or *Proceedings of the National Academy of Science*, but then a paper doesn't have to be earth-shaking to be of significant value to other botanists. It's true that *Crossosoma* doesn't have a wide circulation (although it is sent to locations across North America and even to England), but then when is the last time you actually *read* a paper in *Science*?

"I like plants, but I don't know very much botany. I don't think I could write anything that would be interesting to the readers of *Crossosoma*." Do you grow native plants in your garden? Have you been on a trip to an area with interesting plants? Have you ever been involved with a conservation effort to protect native plants or the habitat they grow in? Trained botanists certainly don't have a monopoly on interesting plant lore. Often they are so busy with their own research or with the many other duties of their jobs that they don't have the time to notice many of the interesting and unusual happenings among the weeds next door.

"I've never written an article before, and I'm afraid I'll mess up. What if it is so bad that the editors reject it?" It does happen that articles are rejected, but the usual reason for this is that they are not really about plants and so don't belong in *Crossosoma*. More often, the editors will work with the authors to improve the manuscript. Sometimes this can be a time-consuming process, but the editors want to make sure that every article is not only a good reflection on the journal, but also something the author can be proud of.

"How do I go about submitting an article?" Like most editors, the editors of *Crossosoma* like to see manuscripts typed double-space. That doesn't mean that legible handwritten manuscripts will be rejected; it just means that they may take a lot longer to process. After the editors review your manuscript, one of three things will happen:

1. They will send you a note saying that the manuscript has been accepted without change, or with just a few changes that will be made when it is typed in the final form.

2) They will return the manuscript with suggestions for changes and improvements. Once you have made the changes, you send in the new manuscript. In unusual cases it may require more than one rewrite before a manuscript is ready to be published.

3) They will send you a note saying the manuscript is not suitable for publication in *Crossosoma*, and explaining why.

Articles with drawings, graphs, or photographs are especially welcome. Line drawings and graphs should be in black on a white background, larger than they will appear in the journal, but preferably no larger than an 8½ x 11 inch standard typewriter sheet. Photographs should be good quality black-and-white prints, preferably no larger than 5 x 7 inches.

Manuscripts should be sent to:

Editor, *Crossosoma*
Department of Biology
California State University, Fullerton
Fullerton, CA 92634

Significant Ecological Areas Recognized in the Los Angeles County General Plan

Jene S. McKnight

The Los Angeles County General Plan, adopted by the County Board of Supervisors in November, 1980, recognizes 64 Significant Ecological Areas (SEA's), and Habitat Management Areas. Included in the SEA's are habitats of rare and endangered species of plants and animals; unique habitats; and relatively undisturbed areas of common or typical habitats. Subsequently, the Board adopted an ordinance on January 5, 1982, regulating the use of SEA's.

The county plan first recognized SEA's in 1973 based on an initial inventory prepared by scientists from local institutions and universities including the Los Angeles County Museum of Natural History and UCLA at the request of the County Department of Regional Planning. The initial report identified 81 SEA's including those in National Forests. After the 1973 plan was successfully challenged in court, the county embarked on a complete plan revision, which included a re-evaluation of the SEA's. In 1976 a second study was completed by the firm of England and Nelson, environmental consultants, of Riverside, California. This effort identified 62 SEA's in Los Angeles County, excluding the Channel Islands and the National Forests. Other "habitat management" areas were identified as a result of separate planning studies carried out in the Antelope Valley and the Santa Clarita Valley. The adopted plan includes 59 SEA's, 5 Habitat Management Areas and several SEA Buffer areas which, in combination, cover over 200,000 acres, most of which is private property.

The General Plan establishes a basic policy of preserving significant ecological and habitat management areas. The Plan's Special Management Areas Policy Map depicts these areas which are classified as:

-- Habitats for rare and endangered species of plants and/or animals (Example: Ballona Creek);

-- Habitats of plants and animal species that are one of a kind, or are restricted natural communities, i.e., ecological areas which are scarce on a regional (Southern California) basis (Example: Point Dume);

-- Habitat restricted in distribution (scarce) within Los Angeles County (Examples: Hepatic Gulch, Zuma Canyon, and Malibu Lagoon and Canyon);

-- Habitat that serves as breeding, migrating and nesting grounds limited in availability (Example: Big Rock Creek Wash in Antelope Valley);

-- Areas with unusual variation in biotic communities (Example: Tehachapi Foothills);

-- Habitats with critical wildlife and fish value (Example: San Francisquito Canyon); and

-- Relatively undisturbed habitat of typical natural biotic communities (Example: Tonner Canyon/Chino Hills).

The SEA's cover a wide array of vegetation types and communities. Based on the Thorne system of classification, the consultants found some three dozen biotic communities in Los Angeles County. Some notable plant species include *Coreopsis gigantea* (Point Dume SEA); *Pentachaeta lyonii* (Zuma Canyon SEA); *Dudleya cymosa* subsp. *marcescens* (Upper La Sierra Canyon SEA); *Hemizonia minthornii* (Santa Susana Pass SEA); *Berberis nevinii* (Tujunga Valley/Hansen Dam SEA); *Chorizanthe spinosa* (Edwards Air Force Base SEA); and *Galium grande* (SEA #62).

The intent of the Plan is to "preserve these resources in an ecologically viable state" for "public education, research and other non-disruptive outdoor use." In most cases SEA's were defined so as to be self-contained. In a few cases SEA Buffers were identified. As the name implies, buffer areas are designed to protect SEA's from encroachment by incompatible activities.

The Land Use Element of the Plan identifies compatible land uses for SEA's and habitat management areas; establishes design criteria for development in SEA's; and provides a "performance review procedure" for reviewing proposed developments in SEA's including biotic analysis and environmental impact analysis. The Plan's Land Use Policy and General Development Policy Maps also recognize SEA's and habitat management areas.

Mere inclusion of SEA's in the general plan does not ensure their preservation. Protecting biotic resources hinges on the creation of an aware, alert and organized constituency dedicated to their preservation. Protection will require many forms of action. For example, there is currently no program for erection of identification signs or interpretative markers. The first major conflict over the preservation of an SEA recognized by the plan is already under way over the Ballona Wetlands near Marina Del Rey where environmental groups and powerful developers are engaged in a struggle over the future use of this last large undeveloped wetland area in Los Angeles County.

More information about SEA's may be obtained by calling the Department of Regional Planning at (213) 974-6464.

(Mr. McKnight is a member of Southern California Botanists and is a Supervising Regional Planner for the County of Los Angeles.)

This paper is the first in a series of progress reports submitted by previous SCB student research grant recipients.

FOREST TREE DYNAMICS OF THE MIXED CONIFER COMMUNITIES OF SEQUOIA NATIONAL PARK

Progress Report

1 March 1982 - 28 February 1983

by

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Laboratory of Biomedical and Environmental Sciences
900 Veteran Avenue
Los Angeles, California 90024

The following text briefly summarizes the status at the end of the first year of the investigations assisted by a grant from the Southern California Botanists to study Mixed Conifer succession in the southern Sierras.

Field Sampling

Five 66 x 330 square foot permanent plots were revisited in July through October and all tree individuals, living and dead, were mapped and measured. Each sample was chosen for practical logistic reasons and a bias in selection for those with larger Sequoia *(Sequoia gigantea* (Lindl) Decne.) cohorts. Work was carried out alone so there

Table 1

Plot topography and fire history.

Gen. Location	Elevation	Recent fire	Aspect*	Slope*
Redwood Mt.				
RW5	6400	1980	50	30
RW18	6050	1982	90	16
RW25	6200	?**	330 270	30 12
RW28	5840	1968	280	20
Grants Grove				
GT5	6300	?	185	15

* = in polar degrees; ** = last fire predates 1965.

were initial difficulties in boundary relocation, but each plot was rechecked upon completion and pin flags were left on the later visited plots. Four of the sites are on Redwood Mountain (Table 1) and three of them have recently been burned.

Basal circumferences were recorded for all stems greater than Standard Diameter Breast Height (1.6 m in height) and height was recorded in 2-inch increments for all seedling and sapplings below diameter measurement threshold. Subadults were spacially recorded by 10 x 10 ft. blocks (231 per plot) and larger individuals were specifically mapped. Border line individuals were measured and recorded. Those unidentifiable from the original records are later deleted. Since only the Sequoia were originally mapped there is some subjectiveness in inclusion. This year the problem will be remedied with the tagging of all stems of all species.

The general vitality of all sampled trees was visually ascertained and recorded last year but this year several less subjective indices shall be investigated. This year there will also be minimum height measurements of trunk lichens added since it has been suggested (Rundel per. comm.) that they are accurate indicators of snow pack which is the major form of precipitation in the southern Sierras.

Population Structures

The Importance of Local Environment

The sites are similar in specific composition with White Fir [*Abies concolor* (Gord. and Glend.) Lindl.], Sequoia, and Sugar Pine (*Pinus lambertiana* Dougl.), the consistent dominant species (Table 2) but even in this relatively small sample size individuality is apparent in population dynamics. The Incense Cedar (*Libocedrus decurrens* Torr.) had a heavy germination on GT5 despite the scarcity of adults and the low adult basal area in comparison to RW28. The unburned site, RW25, shows little change in individual numbers in contrast to GT5, also unburned, where White Fir also made substantial increases. Sequoia showed robust establishment into recently burned plots (RW5 and RW18); again the site with fewer adults had higher rates of establishment. There are other interesting contrasts in the data which suggest no simple environmental model can explain empirical processes of tree establishment and death.

A larger sampling will be taken this summer with enough replicate environments to perform hypothesis testing of the general theoretical models. Another topic of further work is the long term importance of these germination booms. Seasonal monitoring should help clarify the frequency of germination waves and the intensity of attrition which some ecologists have suggested can result in no long term survivors.

Stability of Undisturbed Forest Communities

The above mentioned Incense Cedar population explosion on one of the undisturbed sites suggests dramatic changes can occur even in a short time span. It is interesting to note that the unburned sites show an increase in basal area for all species and the species density also increased contrary to conventional wisdom. The "thinning release

Table 2

Permanent plot tree densities and basal areas on plots as originally measured as they appear today.

Species		RW5 1967	RW5 1982	RW18 1967	RW18 1982	RW25 1967	RW25 1982	RW28 1967	RW28 1982	GT5 1967	GT5 1982
Sequoia	n	5	49	3	210	12	12	1	2	2	4
	b.a**	320.7	327.8	134.7	135.0	163.9	168.1	7.1	0.0	95.0	99.4
White Fir	n	135	41	77	65	154	161	128	80	47	97
	b.a.	72.3	75.1	31.5	25.1	71.2	76.8	78.7	81.2	20.4	32.0
Sugar Pine	n	24	22	19	6	26	16	8	20	31	58
	b.a.	23.7	20.3	10.4	10.4	3.9	4.0	9.4	12.4	71.9	75.3
Incense Cedar	n	-		-		1	0	91	210	10	786
	b.a.	-		-		0.0	-	16.1	19.5	1.2	2.4
Jeffery Pine	n	-		-		-		-		6	5
	b.a.	-		-		-		-		34.4	36.3
Black Oak	n	-		-		0	2	19	29	0	5
	b.a.	-		-			0.0	8.2	2.6		0.0
Dogwood	n	-		14	24	-		7	1	-	
	b.a.	-		1.8	0.6	-		0.0	0.0	-	
Totals	n	164	112	113	306	193	191	254	342	96	955
	b.a	416.7	423.2	178.5	170.9	239.0	249.0	119.7	115.7	222.9	245.3

* = actual count of living individuals on the plot; ** = total basal of the living trees at STBH.

Table 3

White Fir size distributional changes.

Site		Number per size class													
		0	4	8	12	16	20	24	28	32	36	40	44	48	52
RW5	1967	48	42	19	9	5	4	2	3	1	1	0	0	1	0
	1982	13	0	4	6	5	4	2	3	0	2	1	0	1	0
RW18	1967	47	4	14	3	2	3	1	3	0	0	0	0	0	0
	1982	57	1	0	1	0	2	1	0	3	0	0	0	0	0
RW25	1967	73	43	15	6	4	6	2	1	2	0	1	0	1	0
	1982	129	4	4	5	4	3	6	2	1	1	1	0	1	0
RW28	1967	43	24	15	14	16	10	4	1	1	0	0	0	0	0
	1982	26	7	6	8	18	7	4	2	0	2	0	0	0	0
GT5	1967	12	14	12	5	2	0	0	1	1	0	0	0	0	0
	1982	63	10	6	9	4	3	0	0	2	0	0	0	0	0
Total	1967	223	126	75	37	29	23	9	9	5	1	1	0	2	
	1982	228	22	20	29	31	19	13	7	6	5	2	0	2	

effect" is only casually suggested by the data and statistical analysis will soon be conducted.

Individual Species Population Structure

The best represented species, White Fir, was sufficiently encountered to facilitate individual size dependent trends in mortality. As conventional theory predicts, mortality was highest in smaller classes (Table 3), but the low survivorship appears truncated instead of the expected "j" shaped curve. The mortality rates do not clearly differ between burned and unburned plots. All samples had heavy mortality restricted to the trees less than 12" diam. SDBH and trees of larger size seem to have near 100% survivorship. It may also be inferred from the data that vigorous growth commonly persists in larger sized trees and only the largest White Firs (48" class) failed to show increment growth.

Mathematical projections will be applied to the White Fir data in the near future and there will also be made available this summer a large slab data base for age-size regression modeling.

Work in Progress

A general reader write-up of the data is underway and in that format I will introduce some of the Giant Sequoia results which suffer too small a sample size for formal analysis but still are interesting in what they suggest.

ANNOUNCEMENTS

Desert Enthusiasts Take Note:

The long-awaited text to accompany the map "Biotic Communities of the Southwest" by David E. Brown and Charles H. Lowe, issued in 1978, has finally arrived in the form of a special 342 page issue of DESERT PLANTS. The text, edited by Brown, is entitled Biotic Communities of the American Southwest--United States and Mexico, and is numbered v. 4, nos. 1-4, 1982 in the DESERT PLANTS series.

Available for only $13.95 postpaid from the Boyce Thompson Southwestern Arboretum (P.O. Box AB, Superior, AZ 85273) the text also stands well alone for those not owning the map, and describes the southwest communities of Southern California, Arizona, New Mexico and parts of adjacent states, as well as parts of Mexico and Baja California.

Work was begun on this text in 1977 to discuss the biomes represented on the map, and both plants and animals are discussed, using both scientific and common names. It is arranged by major community types, such as tundra, woodland, scrub, grassland, desert scrub and wetland, and promises to be of major interest to SCB members. The 48 by 60 inch color map is still available while supplies last, free of charge from: Publications Distribution, Rocky Mountain Forest and Range Experiment Station, USDA Forest Service, 240 West Prospect, Fort Collins, Colorado 80526.

King Clone Preserve

This proposed preserve is to protect the rings of *Larea tridentata* (Creosote Bush) in the Lucerne Valley, San Bernardino County. Frank Vasek of University of California Riverside, estimates them to be 11,700 years old, making them the oldest living organisms.

Southern California Botanists donated $250.00 to the acquisition of this land. This is in keeping with our past contributions to the acquisitions of Santa Cruz Island, the Jepson Prairie Preserve and the Baldwin Lake Preserve.

SCB Plant Sale a Success!

The recent SCB plant sale, held at Rancho Santa Ana Botanic Garden on April 9, was a big success. Gross sales of the featured native plants reached nearly $2400.00, up $500.00 from last year.

Special thanks are due to Directors Geoff Smith and his wife Judy, Trudy Ericson, Marvin Chesebro, and Bob Thorne, as well as members Barbara Joe Hoshizaki, Bill Lee, Phil Pack, Gayle Baker and staff member Walter Wisura of Rancho Santa Ana Botanic Garden, for helping make this sale so successful! Good job!

SCB Student Research Grants Announced

For the second year, Southern California Botanists has awarded grants to students for research in floristics, taxonomy, or ecology. This year's recipients are as follows:

Nancy C. Clark, "A Comparative Study of the Morphology of Phyllary and Peduncle Trichomes in *Encelia* and Related Genera"--$195.00. Ms. Clark is working on her Master's degree at Calfornia State Polytechnic University, Pomona.

Mitch Cruzan, "Some Factors Affecting Pollen Tube Growth Rates in Tree Tobacco: A Proposal"--$150.00. Mr. Cruzan is completing his Master's degree at California State University, Fullerton.

Jayna Evanoff, "Plant-Plant Associations Identified and Classified"--$100.00. Ms. Evanoff is beginning graduate studies leading to a Master's degree at California State University, Fullerton.

Florence H. Nishida, "*Inocybe* Species (an Agaric Basidiomycete) in the Foothill Oak Woodland Community of the San Marcos Pass, Santa Barbara County, California"--$100.00. Ms. Nishida is a Museum Associate at the Los Angeles Natural History Museum. She will be beginning her Master's degree program at California State University, Los Angeles, next fall.

Edith A. Read, "Pollen Dispersal of *Salvia carduacea* Benth. (Lamiaceae) by Honeybees and Native Bees"--$150.00. Ms. Read is working on her Master's degree at California State University, Full.

The recipients of the awards will be publishing their results in *Crossosoma* at the completion of their projects.

Board Meeting Briefs

Starting with this issue, the Board of Directors of the Southern California Botanists will report significant actions taken by the board on behalf of the membership at each monthly board meeting.

January meeting: held at California State University, Fullerton

1. Election results verified and accepted.
2. Suzanne Granger and Jim Bauml appointed by the board to fill vacancies resulting from resignations from the board.

February meeting: held at CSUF

1. The board decided to send letters to 267 people who had not paid their dues in 1981 and/or 1982.
2. Ginny Gardner has signed a contract and taken over book sales from SCB. She has purchased the SCB book inventory.
3. Decision made to give $200.00 to Drs. Thompson and Prigge

of UCLA to pay for retyping of "Flora of Santa Monica Mountains."

4. Fliers soliciting applications for Student Grants have been sent out.

March meeting: held at Rancho Santa Ana Botanic Garden

1. Received payment from Virginia Gardner for purchase of SCB books. This money has been set aside in money market account.
2. Board contributed $250.00 toward purchase of land to preserve land around King Clone, the oldest living organism on earth. King Clone is a creosote bush circle.
3. Announced that book entitled "Handbook of Experimental Pollination Biology," which resulted in part from the Pollination Symposium sponsored by the SCB held in 1980 at CSUF, will be available about May 27, 1983.

April meeting: held at L.A. County Arboretum

1. Board decided to award student grants for botanical research to Florence Nishida, Nancy Clark, Mitch Cruzan, Edith Read and Jayna Evanoff. Grants ranged from $100-$195. See p. 10.
2. Paid membership as of 17 March 1983--312 members.

FIELD TRIPS

June 10-12 (Fri-Sun) Wildflower Trip to San Bernardino Mountains.

Leaders: Tim Krantz and Bob Thorne. For further information, call Walt Wright in the afternoon at (714) 641-8820.

July 1-4 (Fri-Mon) SCB Tetracoccus Ridge Hike.

We will meet in Death Valley National Monument at Wildrose Campground at 9:00 Saturday morning, July 2. From there we will drive to Aguereberry Point (elev. 6433 ft.) where a short but arduous hike will take us to Tetracoccus Ridge, home to *Tetracoccus ilicifolius, Arctomecon merriami, Astragalus panamintensis, Penstemon calcateus, Enceliopsis nudicaulis, Gilia ripleyi, Cercocarpus intricatus, Buddleja utahensis,* and many other interesting and endemic plants.

To reach Wildrose Campground, go north on Highway 395 to the Trona Road cutoff just north of Johannesburg, proceed to Highway 178 and turn right towards Trona. Stay on Highway 178 through Trona into Panamint Valley, where the road is called Trona-Wildrose Road, until you reach the Wildrose Canyon turnoff. The campground is located at the junction of Highway 178 and the road to the charcoal kilns. Since it is the Fourth of July weekend, Wildrose Campground may be full; other campgrounds in the area are Thorndike and Mahogany Flat, past the Charcoal Kilns on a dirt road that may be in poor repair, and Emigrant Campground at Emigrant Junction north of Aguereberry Point. Camping is also possible outside the National Monument in the Panamint Valley. Be sure to bring water and charcoal or firewood. For more information, call Alan Romspert (714) 733-2428 or 3614, or Curtis Clark (714) 598-0215.

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 1983 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

COMING 1983 EVENTS (Details Within)

June 10-12	Wildflower Trip to San Bernardino Mts.
July 1-4	SCB Tetracoccus Ridge Hike.

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CROSSOSOMA

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Crossosoma Vol. 9, No. 4
Issue Editors: Robert Folger Thorne and Barry Prigge
Managing Editor: C. Eugene Jones August, 1983

EFFECTS OF PRESCRIBED BURNING IN COASTAL SAGE SCRUB COMMUNITY AT SAN ONOFRE STATE PARK, CALIFORNIA

by
Earl Lathrop, Bradford Martin
and Daniel Blankenship

Following the assumption that fire suppression is counter to ecological balance in nature (Biswell 1974), San Onofre State Park conducted a prescribed (experimental) burn December 7 and 8, 1981 at three sites (totaling 15 hectares [ha]) in coastal sage scrub, the dominant community of the park (Thorne 1976). The main purposes of the burn were twofold: 1) test to see if light intensity burning would reduce the exotics which had invaded the coastal sage scrub, while enhancing the native vegetation; 2) to determine if wildlife (small rodent populations) would recover from the effects of the burn.

Methods

Identical pre- and post-burn data on vegetation structure (Lathrop and Martin 1982) and rodent populations (Wirtz 1982; Blankenship 1982) were compared for the first year's regrowth, sampled December, 1982, twelve months after the burn. In addition, rodent and seedling populations were also sampled four months following, in April, 1982.

Twenty-one permanent 8m x 8m quadrats were set up in the burn sites, to sample the three artitrary subdivisions (associations) of the coastal sage. These were: 1) typical coastal sage scrub, consisting mainly of California sagebrush (*Artemesia californica* Less.) and bush monkey flower (*Diplacus puniceus* Nutt. 2) exotic, consisting of anise (*Foeniculum vulgare* Mill.), tree tobacco (*Nicotiana glauca* Grah.) and castor bean (*Ricinus communis* L.); and 3) brush, with coyote brush (*Baccharis pilularis* DC. ssp. *consanquinea* (DC.) C.B. Wolf., bladderpod (*Cleome isomeris* Greene) and lemonadeberry (*Rhus integrifolia* Nutt.) Brew. & S. Wats.

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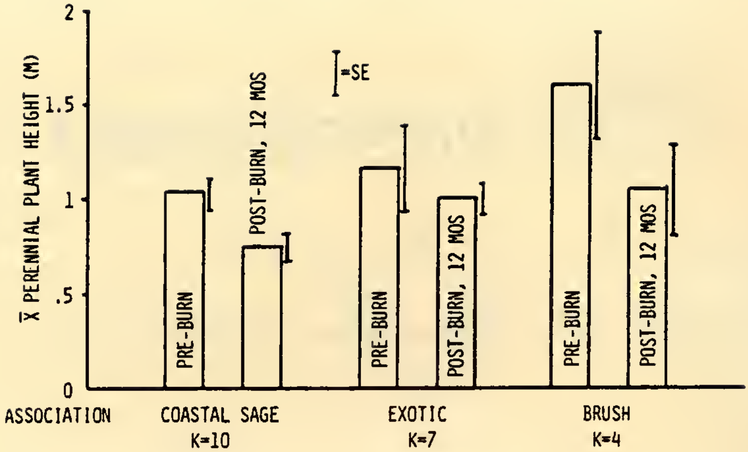

Fig. 1. Mean ($\bar{X}$) perennial plant height (m) in pre- and post-burn quadrats (K) at San Onofre State Park, California.

Measurements taken in the quadrats within each association were: 1) perennial plant height (m) and density (no/ha); and 2) seedling density (no/ha) (Cox 1980). Rodents were sampled by saturation trapping in line transects (Cox 1980) at the three association sites (700 trap nights each for pre- and post-burn samples).

Results

Comparisons of the post-fire data with those of pre-burn show several significant changes due to the prescribed burning in December, 1981. The canopy height of the native shrubs was reduced (Fig. 1) while some of the weedy annual elements (i.e. mustards, *Brassica nigra* (L.) Koch. and *B. rapa* L. ssp. *sylvestris* (L.) Janchen.) greatly increased in height and density. Shrubs increased in density in both the coastal sage and brush associations but decreased in density in the exotic association, twelve months following the burning (Fig. 2). Seedlings of the main perennial plant species significantly increased at both the 4 and 12 month post-fire sampling dates (Fig. 3).

Trapping efficiencies for rodents were 17% and 10% for pre- and post-burns respectively. The most abundant rodents sampled in the pre- and post-burn transects were the white-footed mouse (*Peromyscus eremicus, P. boylli* and *P. maniculatus*) and the western harvest mouse (*Reithrodontomys megalotus*). The pocket mouse (*Perognathus californica*) and the common house mouse (*Mus musculus*) were less abundant but also present. They were found mostly in the exotic association transects. The wood rat (*Neotoma lepida*) was found only once, in a pre-burn transect in coastal sage. Diversity of the small mammals (7 species total) was little affected by the burning.

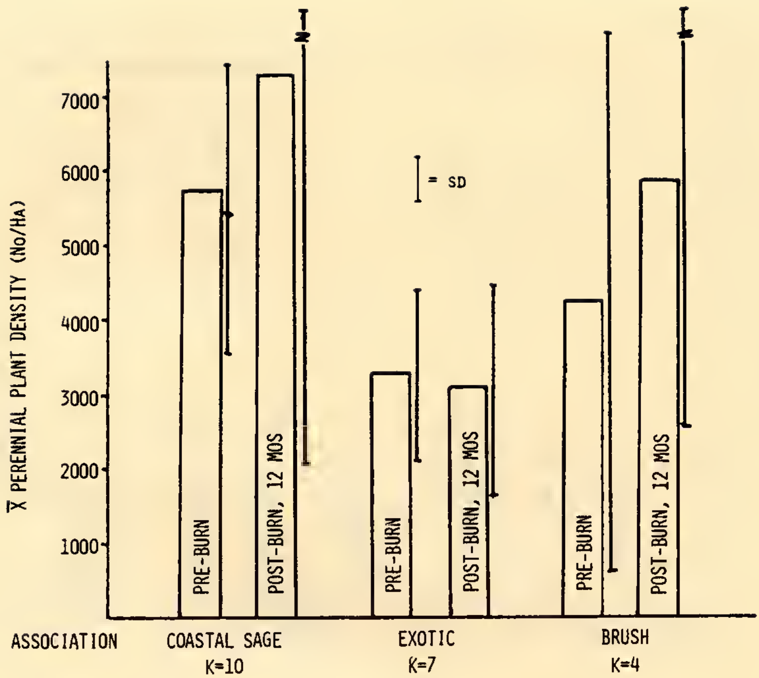

Fig. 2. Mean perennial plant density (no/ha) in pre- and post-burn quadrats at San Onofre State Park, California.

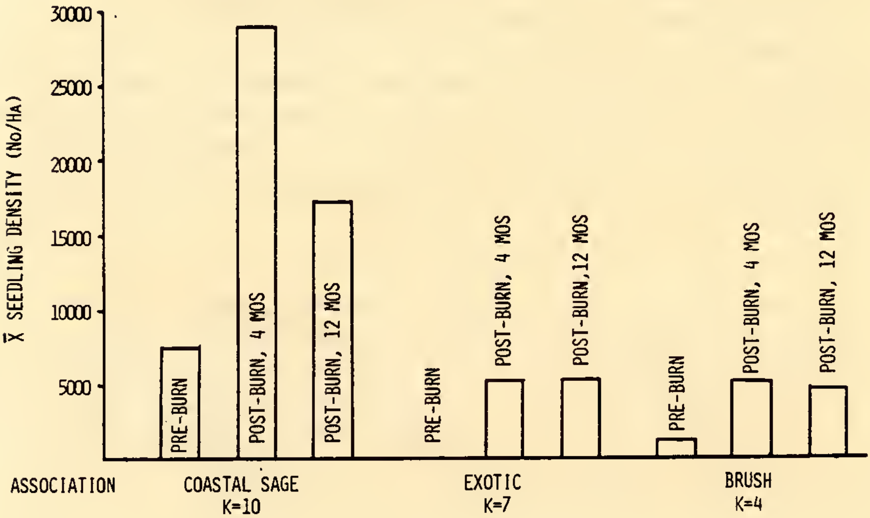

Fig. 3. Mean perennial plant seedling density (no/ha) in pre- and post-burn quadrats at San Onofre State Park, California.

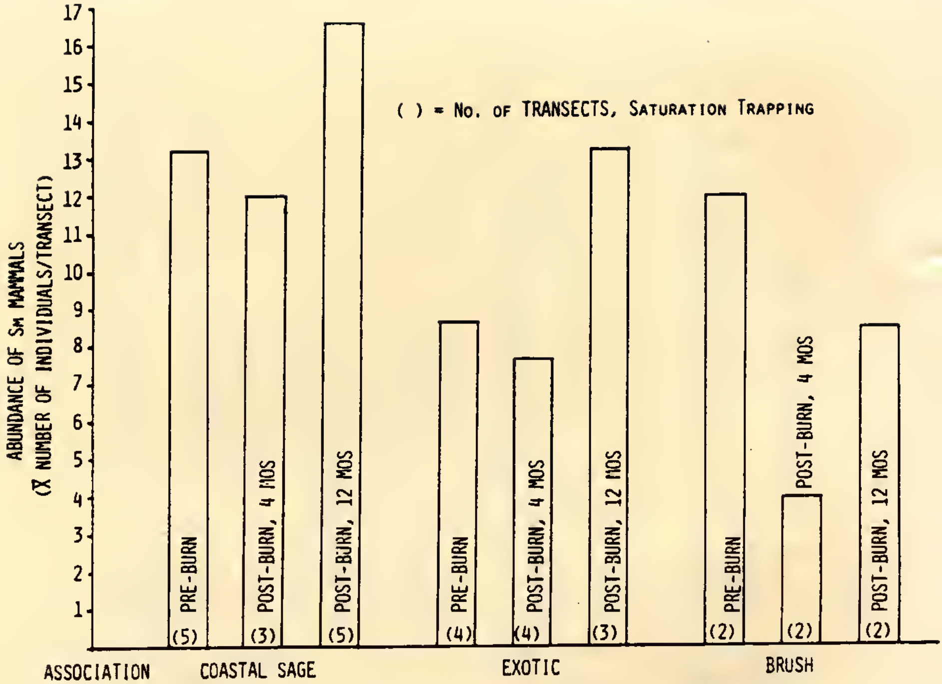

Fig. 4. Mean abundance of small mammals (rodents) in pre- and post-burn sample transects at San Onofre State Park, California.

Population abundance of the rodents was slightly reduced in the coastal sage and exotic association and considerably reduced in the brush association four months following the burn (Fig. 4). However, after the initial decrease in population abundance following the burning, the populations increased to a level above that of pre-burn sampling after 12 months, except for the brush association. Even here, however, the increase in abundance at 12 months was significant (Fig. 4).

Conclusions

The overall perennial vegetation cover and canopy height decreased as a result of the burn. However, the main purpose of the project was fulfilled in that the exotics were somewhat reduced in density while the native shrubs were enhanced (increased in number, primarily through seedling growth and resprouting). Seedling density of the dominant species tended to increase. When taking into consideration the many seedlings generated by the fire, many of the shrub species may even further increase in density in the near future. However, there is a tendency for the initial increase in native shrub seedlings, following fire, to decrease after some months (Fig. 3).

Another purpose in this project was somewhat successful in that the rodent sampling data tends to indicate that the small mammals can make a comeback after the initial decrease in abundance following the burning.

While the data of this project suggests that the exotics can be reduced somewhat by prescription burning, while not adversely affecting the native shrubs or small mammals, it is suggested that the park official try repeated burning in an attempt to see if the exotics could be permanently reduced or eliminated.

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Earl Lathrop is a Professor and Bradford Martin and Daniel Blankenship are graduate students in the Department of Biology, Loma Linda University.

FIELD TRIPS AND EVENTS

August 5-7 (Fri-Sun) San Gabriel Mountains.

Call Walt Wright in the afternoon at (714) 641-8820 for details.

August 26 - September 5 Cabo San Lucas

Call Walt Wright for details.

October 8 (Sat) Annual SCB Pot Luck Dinner.

Mark this date on your calendar NOW! Details will be announced in October issue of Crossosoma. Plan to attend! A great time is had by all who attend.

Mortonia utahensis, an interesting shrub of the eastern Mojave Desert

by

Barry A. Prigge
Mildred E. Mathias Botanical Garden -- Herbarium
University of California
Los Angeles, California 90024

Mortonia utahensis (Cov. ex Trel.) A. Nels. (Fig. 1) is an evergreen, nonsucculent shrub of the Celastraceae, a family unfamiliar to most southern California botanists. *Mortonia* flowers are borne in a terminal thyrsoid inflorescence, 14 to 50 mm long and 10 to 15 mm wide. The flowers are small (5 to 7 mm in diameter) and whitish with five sepals, petals, and stamens and one pistil with five stigma lobes. The stamens are alternate with the petals and are borne on a cupulate disk. Except for the stamens being alternate with the petals, the flowers are similar to those of some species of the Rhamnaceae, a family that is often considered to be closely related to the Celastraceae although the relationship of the Celastraceae is probably with the Icaçincaeae (Thorne 1976, Hartog & Baas 1978). Despite the small, nonshowy flowers, *Mortonia* is an attractive shrub because of the persistent thick leaves that stand out against the whitish stems. It is up to 1.5 m tall and is pleasantly, although faintly, aromatic. It is restricted to limestone substrates of canyon bottoms and rocky slopes. In California it is known from the Clark, Mesquite, Kingston, Nopah, and Grapevine Mountains where it occurs in desert calcicolous scrub, desert wash scrub, and pinyon-juniper woodland.

Mortonia utahensis

What makes this plant of particular interest is its ability to grow in extremely arid habitats and its restriction to calcareous substrates. Unlike most desert shrubs, *Mortonia* leaves persist for several years and are capable of functioning whenever soil moisture is adequate. Although one might expect xeromorphic plants to use water more conservatively than mesomorphs, when water is available, the contrary is true (Maximov 1929, 1931). However, xeromorphic leaves can withstand greater water stress than mesomorphic leaves and are able to reduce transpiration to almost zero when under severe water stress. Some of the anatomical features of *Mortonia* leaves that are thought to contribute to high rates of transpiration are isolateral construction, amphistomaty, and densely packed mesophyll (Prigge 1983). These features are characteristic of high light habitats and result in greater rates of photosynthesis and CO_2

fixation (Mott et al 1982). The concomitant result of CO_2 uptake is loss of water. Features that prevent transpiration and occur in *Mortonia* leaves are a very thick cuticle, thick epidermis, and a rigid stomatal apparatus with subsidiary cells protruding below the guard cells to enhance closure of the stomata (Prigge 1983). Surprisingly there are no stomatal crypts or sunken stomata that are usually considered typical of xeromorphic leaves.

Since transpiration from leaves is the driving force for pulling water up through the plant, the wood anatomy presumably has to complement the leaf anatomy, i.e. capable of withstanding water tensions generated by transpiration. In *Mortonia* the wood is extremely well adapted to withstanding high tensions in the water column, and Walter (1971) has measured tension of 57 atm. in a related species, *M. scabrella* in southeastern Arizona. As Carlquist (1975) has discussed, woods that have short and thick walled vessel elements with tertiary helical wall thickenings and small diameter are well adapted to withstanding high water tension, and *Mortonia* has all these features. High vessel density, which is also characteristic of *Mortonia* woods, give the plant a safety factor in the event some vessels become incapacitated due to the formation of an embollism in the water column resulting from high tensions. Also the tracheids can transport water and because their end walls are not perforated any embollism that might occur in a tracheid is restricted to the tracheid cell.

Mortonia has a unique strategy for a desert shrub. It appears that the evergreen habit enables it to take immediate advantage of rainfall, unlike drought deciduous plants that probably cannot take full advantage of available water until leaves are formed. Even creosote bush [*Larrea divaricata* (Sesse & Moc. ex DC.) ssp. *tridentata* (Sesse & Moc. ex DC.) Felger & Lowe], which appears evergreen, loses many of its leaves during and after periods of severe drought. The leaves that persist are nonfunctional and are lost after rain has made possible resumed growth of the immature leaves and buds (Runyon 1934). Furthermore, it appears that *Mortonia* can generate or withstand higher tensions than most plants and is probably able to take up water from the soil when other plants cannot. With the high rates of transpiration, *Mortonia* presumably does not use water efficiently (CO_2 assimilated/H_2O transpired) but uses water as rapidly as possible before it is lost to neighboring plants, evaporation, or percolation.

Restriction of *Mortonia* to calcareous substrates is poorly understood, and the chemistry of the soil in relation to *Mortonia* has not been studied. Perhaps phosphorous toxicity at acid or neutral soil pH contributes to the exclusion of *Mortonia* from noncalcareous soils as suggested for creosote bush (Musick 1978).

Mortonia may also be restricted to calcareous soils because competition from other species is less intense, perhaps because calcareous soils are generally considered to be more xeric than igneous substrates (Muller 1947, Rzedowski 1957). Thus, *Mortonia* is restricted to calcareous substrates in a manner similar to that serpentine endemics (Kruckeberg 1954).

Further work on the physiology of *Mortonia* and edaphic factors in the distribution of *Mortonia* would probably be rewarding studies and are necessary to have a better understanding of this rare shrub.

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We thank all those who promptly remitted their 1983 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

ANNOUNCEMENTS

SCB presents a $100.00 award for the best botanical paper presented at the Southern California Academy of Sciences Annual Meeting held this year at California State University, Fullerton on May 6-7, 1983. This year's recipient is Christopher M. Kearney of California State Polytechnic University, Pomona for his talk entitled, "β-1,3-glucanase induction by tobacco mosaic virus (TMV) and abiotic local lesions." The 10 student papers presented at this year's meetings were all very high quality research efforts. Congratulations to all participants! A brief abstract of Mr. Kearney's paper is presented below:

β-1,3-glucanase is an enzyme which hydrolyzes callose, a polysaccharide formed during the wounding response of plants. Others have found that β-1,3-glucanase greatly increases in activity with the appearance of necrotic local lesions of TMV on the leaves of *Nicotiana glutinosa*. Since callose deposition has been postulated as a localizing barrier to viral spread in plants, this study was undertaken to examine how enzymatic activity is related to lesion expansion and necrosis in *N. glutinosa* infected with TMV. Enzyme activity and lesion size both increased with increasing temperature when inoculated plants were incubated at 16°, 20°, or 24°C. At 28° and 36°C, viral spread was more rapid and formed large irregular lesions and a mosaic, respectively, but enzymatic activity was lower. To check the effects of necrosis on enzymatic induction, abiotic, necrotic local lesions were made chemically and mechanically. Only low enzymatic activity resulted. In conclusion, high β-1,3-glucanase activity is associated with restricted viral necrotic lesions, but not with systemic viral symptoms or with the types of abiotic necrosis examined here.

BOARD MEETING BRIEFS

May meeting: held at Cal Poly Pomona.

- The Board is attempting to assemble full sets of *Crossosoma*. President Al Romspert is sorting through back issues of *Crossosoma* that are stored in the "archives" at CSUF. If necessary, an appeal will be made to the membership to obtain missing copies.
- Trudy Ericson, Membership chairperson, reported that there were 388 members of SCB through 19 May 1983.
- SCB donated a prize of $100.00 for the best botany paper presented at the Southern California Academy of Sciences meeting. Christopher Kearney won the prize.

- Preparations are being made for the annual October symposium. A tentative topic has been selected and potential speakers are being contacted by various members of the Board.
- Al Romspert volunteered to write a letter to the BLM advising them of SCB's support of Mary De Decker on the Desert Advisory Committee.
- The Board voted to donate $25.00 to the Natural Resources Defense Council, Inc. to help them in their legal battles to save EPA. The Board also voted to send the Mono Lake Committee $25.00.

BIOGRAPHICAL SKETCHES OF SCB OFFICERS AND DIRECTORS

The Board of SCB decided to publish in Crossosoma *brief biographical sketches of the officers and directors of the organization. This is intended to acquaint the membership with its administration. The first two sketches that appear in this issue are for Alan Romspert, President, and Robert Folger Thorne, Second Vice-President, who "volunteered" to go first.*

Alan Romspert, President, SCB

I was born in Pomona, California, in 1945. At that time Pomona had orange and walnut groves, and if Mount Baldy had snow on it, one could see it every day. By the time I reached the seventh grade, I had become enamored with the discipline of marine biology. My interest continued during my military service, part of which was spent in Viet Nam. After the army, I re-entered California State College at Fullerton and diversified my biological interests into the areas of herpetology and ecology.

Before my military service, I had received an AA from Mount San Antonio Junior College in 1965 and completed my BA in 1970 in biology at CSF. I continued in graduate school, acquiring a master's in biology with an emphasis in environmental physiology. Two papers were published on amphibian physiological adaptation to arid environments.

After graduating in 1975, I immediately began teaching part time at junior colleges, including Compton, Cypress and Santa Monica. In 1979 I began working as the Desert Studies Coordinator for the California State University Desert Studies Consortium by whom I am currently employed. As the coordinator I oversee the use of the Desert Studies Center in the east Mojave Desert by the seven State University campuses in the consortium as well as other educationally oriented classes and groups. I am also involved in the renovation of the old structures and construction of new buildings at the center.

After a dismal start in my first course in plant taxonomy, taught by Ira Wiggins in 1966, I repeated the course in 1972. During that course, I participated in a field trip to the Panamint Mountains. I continued my visits to the Panamint Range, which delineate the west side of Death Valley, and began a collection of plants to compile a flora of this fascinating group of mountains. This has spurred my interest in the botany of deserts which, in conjunction with my studies of herptiles, provides a continued investigation of our local deserts with the hope of future trips to the other deserts of the world.

Robert Folger Thorne, Second Vice-President, SCB

Bob Thorne, second vice-president and long a member of the board of SCB, has held other ranks in the club, including the presidency. A native of New Jersey, he grew up in Florida, was educated at Dartmouth and Cornell, and came up through the professorial ranks at the University of Iowa. Since 1962 he has been Taxonomist and Curator of the Herbarium at the Rancho Santa Ana Botanic Garden and Professor of Botany in the Claremont Graduate School at Claremont. He is also Curator of the Pomona College Herbarium, now completely integrated with the RSA Herbarium.

Bob's principal interests are angiosperm phylogeny (classification) and geography. His system of classification of the Angiospermae has received considerable attention, especially in Claremont, and he modestly considers it the most realistic, i.e., most nearly phylogenetic, system yet devised, though he admits to minor imperfections and convergences that ultimately will be spotted and corrected. Among other phyletic efforts, he has expanded our Crossosomataceae by adding *Forsellesia*, formerly misplaced in Celastraceae. He has also suggested homes for our Bataceae (in Sapindineae of Rutales), Ceratophyllaceae (in Nelumbonales), Fouquieriales (in Theiflorae), Juglandaceae and Myricaceae (in Rutales), Paeoniaceae (in Paeoniales of Annoniflorae), Simmondsiaceae (in Euphorbiales), etc. He thinks his most unpopular, though correct, phyletic decisions have been to place Apiaceae in Araliaceae, Asclepiadaceae in Apocynaceae, Fabaceae in Rutales, as Fabineae near Sapindineae, and Moraceae and Cecropiaceae in Urticaceae.

His chief hobby is botanical exploration. He has worked on floras in various parts of the world, including Australia, New Caledonia, New Guinea, the Southeast, Iowa, and Mexico. In California he has concentrated on the offshore islands, eastern Mojave mountains, and Santa Ana, San Gabriel, and San Bernardino ranges. His next major floristic effort will be a flora of northwestern

Baja California. His most expensive hobbies, he claims, are stamp collecting and travel and books.

FIELD TRIP SYNOPSIS

Foray to the Sierra Juarez of Baja California

Southern California Botanists and the Santa Monica Chapter of the Audubon Society mounted a foray to Laguna Hanson National Park in the Sierra Juarez of Baja California over the long weekend terminating on Memorial Day, May 27-30. Among the field trippers, led by Walton Wright and travelling in six vehicles, ornithologists greatly outnumbered botanists. The Rancho Santa Ana Botanic Garden contingent, Walter Wisura and the author with Wayne Steinmetz and Dave Charlton, operated independently but did contact the others socially at the Laguna along with a group of naturalists from San Diego led by Dr. Jan Victoria of the San Diego Museum of Natural History. The Park was heavily populated over the weekend with almost as many Alta as Baja Californians.

The Rancho group reached the Laguna about 6 p.m. on Friday, travelling via Tijuana, Ensenada, Ojos Negros, Coyote, Rancho El Rayo, and Aserradero. With almost no visitors there yet, we had our choice of campsites. The Laguna Hanson area is a beautiful, open, parklike forest of Jeffrey pines (*Pinus jeffreyi* Grev. & Balf. in A. Murr.) with a scattering of four-leaved pinyons (*P. quadrifolia* Parl. ex Sudw.) and several species of oaks (*Quercus peninsularis* Trel., *Q. chrysolepis* Liebm. and *Q. turbinella* Greene) surrounding a beautiful, shallow, picturesque lake perhaps a mile long and about a quarter-mile wide and about a mile above sea level. The whole area is very reminiscent of the Big Bear and Holcomb Valley areas of the San Bernardino Mts. with many of the same species present, along with more austral, including a number of endemic, species. Aquatics, of course, abounded in the lake and on the soggy margins and gladdened the heart of this aquatic-oriented botanist, frustrated generally by the rather arid surroundings in which he is now resident. Among the more exciting aquatics that he was soon harvesting were species of *Callitriche*, *Carex*, *Ceratophyllum*, *Elatine*, *Eleocharis*, *Lilaea*, *Limosella*, *Mentha*, *Mimulus*, *Montia*, *Myosurus*, *Polygonum*, *Potamogeton*, *Ranunculus*, *Rumex*, *Veronica* and *Zannichellia*. Other aquatics reported from the Laguna were not yet in evidence at this early stage of the growing season.

The pine forest about the lake was quite floriferous, with much of the color supplied by such showy wild flowers as species of

Astragalus, Castilleja, Chaetopappa, Cirsium, Erysimum, Frasera, Hesperochiron, Hulsea, Ipomopsis, Layia, Lesquerella, Linanthus, Linum, Lotus, Lupinus, Mimulus, Oenothera, Penstemon, Sidalcea, and *Streptanthus*. Especially showy were *Ipomopsis tenuifolia* (A. Gray) V. Grant, *Linum lewisii* Pursh, *Lupinus excubitus austromontanus* (Heller) C. P. Sm., *Penstemon centranthifolius* Benth., and *P. clevelandii* A. Gray. The bouldery, granitic ridges back from the Laguna, some of them impinging on the shore or emergent as islands, harbored a fairly dense montane chaparral with a variety of species of *Adenostoma* (especially *A. sparsifolium* Torr. in Emory), *Amelanchier, Arctostaphylos, Ceanothus, Cercocarpus, Garrya, Keckiella, Lonicera, Mahonia, Pinus* (especially *P. quadrifolia*), *Prunus, Quercus, Rhamnus,* and *Symphoricarpos*, along with interesting crevice dwellers like the rock ferns, *Cheilanthes, Pellaea,* and *Pityrogramma*, the succulent *Dudleya abramsii* Rose, and such herbs as *Arabis sparsiflora* Nutt. in T. & G., *Aquilegia formosa* Fisch. in DC., *Heuchera leptomeria peninsularis* R., B., & L., and *Potentilla saxosa* Lemmon. Grasses were prominent, particularly species of *Bromus, Deschampsia, Melica, Muhlenbergia, Poa,* and *Stipa*, along with the usual introduced weedy annual grasses.

After a day and a half of collecting around and in the lake, we drove back down the western slopes of the Sierra Juarez, collecting along the way, especially in the red-shanks chaparral. There we added to our collections a number of species not present or scarce in the higher montane chaparral. Among them were *Acacia greggii* A. Gray, *Acourtia microcephala* DC., *Adenostoma fasciculatum* H. & A., *Arctostaphylos glauca* Lindl., *A. pungens* H.B.K., *Argemone munita* Dur. & Hilg., *Ephedra californica* S. Wats., *Eriodictyon trichocalyx* Heller, *Lathyrus laetiflorus alefeldii* (White) Brads., *Lycium andersonii* A. Gray, *Ribes indecorum* Eastw., *Rhus ovata* S. Wats., *R. trilobata quinata* Jeps., *Sambucus mexicana* Presl. ex DC., *Solanum xanti* A. Gray, and *Trichostemma parishii* Vasey, along with numerous, often showy herbs. Beyond Ojos Negros toward Ensenada, the chaparral became ecotonal with sage scrub, and additional woody species were in evidence: *Aesculus parryi* A. Gray, *Eriodictyon sessilifolium* Greene, *Fraxinus trifoliata* (Torr.) Lewis & Epl., *Malacothamnus densiflorus* (S. Wats.) Greene, *Malosma laurinum* (Nutt. in T. & G.) Nutt., *Ornithostaphylos oppositifolia* (Parry) Small, *Paeonia californica* Nutt. in T. & G., *Rhamnus crocea* Nutt. in T. & G., and *Romneya coulteri* Haw.

In addition to our enjoyment of the scenery, hiking, swimming, and camping, our botanical efforts were highly profitable. Besides numerous kodachromes of plants and vegetation, we collected some 340 numbers of more than 300 species of 65 different vascular plant families. We saw representatives of several other families not in flower or fruit. More than a dozen of the species collected are not included in the recent "Flora of Baja California," by Ira L. Wiggins, among them *Amelanchier utahensis* Koehne, *Carex globosa* Boott, *Dicentra chrysantha* (H. & A.) Walp., *Elatine californica* A. Gray, *Gnaphalium luteo-album* L., *Hesperochiron californicus* (Benth.) S. Wats., *Juncus bryoides* F. J. Herm., *J. tiehmii* Ertter, *Montia fontana amporitana* Sennen, *Myosurus aristatus* Benth. ex Hook., *Prunus virginiana demissa* Nutt., *Rhamnus ilicifolia* Kell., *Scribneria bolanderi* (Thurb.) Hack. (apparently new for the peninsula), *Sitanion longifolium* J. G. Sm., and *Taraxacum laevigatum* (Willd.) DC., most of them surely indigenous in the Sierra Juarez. This would seem to indicate the need for furhter intensive botanical exploration of north-western Baja California.

We returned to Claremont via Ensenada and Tecate being but little delayed late Monday afternoon at that latter border crossing. The roads due north from Laguna Hanson were impassible to normal vehicles, the road having been washed out, reportedly, in a couple of places by a stream in flood. Our only regrets over the long weekend were that more SCB members did not particpate on the foray.

Robert F. Thorne
Rancho Santa Ana Botanic Garden
Claremont, CA 91711

ANZA BORREGO COMMITTEE NEEDS YOUR HELP!

To grow from nothing to being an outstanding conservation organization in a little over a decade is the good fate of the Anza Borrego Committee of the Desert Protective Council. The A.B.C., as it is known by its members, is not in competition with Friends of the Earth or the Sierra Club. Instead it has a very limited objective, namely, to reduce the private inholdings within the ultimate boundaries of the Anza-Borrego Desert State Park, thereby simplifying Park administration and eliminating possible undesirable developments within the Park.

In the beginning, owners of the desert property within the Park were asked if they would donate their land as a tax write off. If not, would they accept a small purchase offer? As success grew, so did incoming funds. Copying "Save the Redwoods League," a "Desert Garden" Program was accepted by the public and was effective in raising funds. The sum of $55.00 was chosen as the donation for one Desert Garden of two acres, a sum big enough to be a worthy memorial or honorarium, yet small enough to be affordable by most persons. Of course no sum is too small to be welcomed by the

Committee. No title or deed is acquired to a specific piece of land, but a permanent record of gifts is kept at the Anza-Borrego Park Visitor's Center. Keep it in mind the next time you visit that part of the desert.

In thirteen years, over $130,000.00 has been raised by the Committee. As to larger parcels of land, the Committee works cooperatively with other organizations. On August 20, 1971 the Department of Parks and Recreation informed the A.B.C. that it had passed the 1000 acre mark. The snowball continues to grow, if such a metaphor can be applied to the desert. In thirteen years, the A.B.C. has acquired by outright purchase, or is responsible for gift donations of more than seven square miles of land inholdings within Anza-Borrego Desert State Park, land worth close to $400,000.00.

So successful has been the A.B.C., that it is being held up as a model. The Desert Protective Council recently established a Coachella Valley Ecological Reserve Foundation to solicit land donations. "If you think it can't be done, look at the Anza-Borrego Foundation!"

It is interesting to note that one of the Park Department District Superintendents who had been cooperating with the A.B.C., upon his retirement, continued as an active citizen member of the Committee.

For additional information write: Mrs. Howard Allen, Chairman of A.B.C., 3780 El Canto Dr., Spring Valley, CA 92077.

COMING 1983 EVENTS (Details Within)

August 5-7	San Gabriel Mountains.
August 26 - September 5	Cabo San Lucas
October 8	Annual SCB Potluck Dinner.

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

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POLLEN DISPERSAL AND THE POLLINATION ECOLOGY of *Salvia carduacea* Benth. (Lamiaceae)

by Edith Read*

Introduction

Salvia carduacea (thistle sage) is a spring annual found patchily distributed in the Mojave and Colorado deserts. It blooms from about the end of March to the beginning of June, and attracts a variety of bird, bee, and moth visitors. Its dense aromatic pubescence, lavender bilabiate flowers, and red pollen intrigue the casual observer. However, little is known of its pollination ecology. The primary purpose of this study was to determine whether or not the introduced honeybee, *Apis mellifera* L., affects pollen dispersal in populations of this plant species. However, a second goal of the study was to learn more about its pollination biology. Consequently, presence or absence of a UV floral pattern, nectar composition, compatibility, and variation in flower morphology were investigated. The following report briefly discusses the methods and results of my study.

Study sites

During the spring season of 1983, most data were collected from two populations of *S. carduacea* near Red Mountain, California (T29S. R41E.S27 and S34) at an elevation of about 950m in San Bernardino county. An additional site within Anza-Borrego Desert State Park (T13S.R5E.S14) provided some additional data and qualitative observations of flower visitors during the springs of 1982 and 1983.

General plant and flower morphology

A typical individual of *S. carduacea* consists of three to four verticellate inflorescences arising from a basal rosette of pubescent thistle-like leaves (Fig. 1). On average, its height as measured from the rosette to the tip of an inflorescence is one to two feet, but in a good year (such as occurred in 1983 at Red Mountain) an

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*Edith is now a graduate student at University of California, Irvine, working on her Ph.D. This present work was completed as part of her Master's degree program at California State University, Fullerton, and was supported in part by a grant from S.C.B.

individual may produce ten or twelve inflorescences and reach a height of four feet. The protandrous *S. carduacea* flowers are bilabiate, with the lower lip possessing a white fringe.

S. carduacea flowers are typical of the genus by possessing two sets of stamens, two long and exerted, and two short located at the entrance to the floral tube. However, the species is somewhat atypical in that all four anthers are fertile and bear viable pollen. Upon staining fresh pollen with cotton blue, I found percent viability of pollen from the short stamens (± 2 S.E.) to be 99.4 ± 1.3 and from the long stamens to be 94.0 ± 9.6 (Read, 1983).

Fig. 1. *Salvia carduacea.* From Wiggins, 1980

Visitors to S. carduacea.

For both years at both study sites, many individuals of *Hyles lineata* (white-lined sphinx moth) were observed visiting *S. carduacea* during the day early in the blooming period, but as the season progressed their visits became restricted to a few hours before and after dusk. They hovered before the flowers while feeding on nectar. Close observations of their hovering position revealed no evidence thay they contacted the anthers, although Visco (1968) reports that they do. However, I found no pollen on captured individuals, and Visco reports a similar finding. I assumed that their role in pollination of *S. carduacea* was minor.

Hummingbirds also visited the flowers with some frequency. *Calypte costae* (Costa's hummingbird) was observed in Anza-Borrego, and visits by *Calypte anna* (Anna's hummingbird) were observed in lower frequency at Red Mountain. Like *H. lineata*, the birds did not appear to hover in a position such as to contact the reproductive parts of the flowers. Pat Flannigan, a naturalist at Anza-Borrego, reports (personal communication) that male *C. costae* establish territories around the plants and visit them so frequently that they may be important pollinators. However, the fact that they pollinate *S. carduacea* flowers remains to be determined.

As a group, the most abundant flower visitors at both sites for both years were bees of the families Apidae, Anthophoridae and Halictidae (Table 1). The role of bees smaller than 1 cm in length as pollinators was not determined due to the difficulty of following

Table 1. Observed Hymenopteran visitors to *S. carduacea* flowers in April and May of 1982 and 1983.

Study Site	Species	Sex of Individuals Collected	Length (cm)	Type of Food	Abundance
Anza-Borrego	Family Anthophoridae				
	Anthophora dammersii Timb.	M	1.3	nectar, pollen	++
	Anthophora salazariae	M	0.9	pollen	+
	Synhalonia primiveris Timb.	F	1.4	nectar, pollen	++
	Family Halictidae				
	Evylaeus 2 spp.	F,F	0.5,0.8	pollen	++
	Family Apidae				
	Apis mellifera	--	--	pollen	+
Red Mountain	Family Anthophoridae				
	Anthophora dammersii Timb.	M,M,M	1.5,1.5,1.3	nectar, pollen	++
	Anthophora crotchii Cress.	F	1.4	nectar, pollen	++
	Synhalonia californica var. *deserticola* Timb.	F	1.3	nectar, pollen	++
	Exomalopsis sp.	F	0.5	pollen	++
	Centris sp.	M	1.5	nectar, pollen	+
	Family Apidae				
	Bombus crotchii Cress.	2 workers	1.6,1.6	nectar, pollen	++
	Bombus californicus (F. Sm.)	1 worker	1.1	nectar, pollen	++
	Apis mellifera	2 workers	1.0,1.2	pollen	++

Notes: Lengths were measured from mandibles to tip of the abdomen.
Abundance: ++ more than 25 individuals
+ less than 25 individuals

these small visitors between plants. However, they were frequently observed to contact the stigma of a flower from which they had just collected pollen and to spend considerable time at a single plant. I would expect that they freqently self-pollinate the plants and have a relatively restricted foraging range.

The larger bees contacted stigmas with their faces as they landed on flowers, and (with the exception of *Apis*) also with their abdomens as they fed on nectar. The short-tongued *Apis* (honeybee) were observed by myself and Visco (1968) to attempt collecting nectar by entering the floral tube. However, the restricted diameter of the tube prevented the bees from successfully obtaining nectar, and subsequent foraging was directed to pollen collection.

Influence of Apis mellifera on pollen dispersal

The question of whether or not *Apis* influences pollen dispersal within a plant population in ways different from those of native bees (such as bumblebees), can be answered by a quantitative study of the bees' foraging behavior. Four variables were measured for bees visiting field populations of *S. carduacea*: flight distance (distance flown between two plants); flight direction (angle between flight paths and compass direction); visitation rate (time to visit two plants and number of flowers visited per minute); amount of pollen deposited on a virgin stigma by a single visit. (For details of methodology regarding these variables, see Read, 1983).

Table 2 presents statistics regarding foraging behavior of *Apis* and the larger native bees. No statistically significant differences were found for flight distance or flight direction. Flight distances were significantly correlated with interplant spacing for all bees, and flight directions were randomly distributed. Significant differences were found in time spent to visit plants and flowers, with *Apis* spending more time at the plants. This latter behavior probably reflects the more time-consuming task of collecting pollen rather than nectar. The large Anthophorids spent the least amount of time at the plants.

Interestingly, there was little statistical indication that the size of the floral display affected bee foraging behavior; the mean number of flowers visited was two for all groups, despite the fact that the number of flowers available on a plant ranged from one to 155. However, these results were obtained from study plots with relatively dense arrays of plants, and the bees may visit greater numbers of flowers when they visit more isolated plants. Close spacing of self-compatible plants, while perhaps increasing competition for resources between plants, may confer a reproductive advantage on the plant due to the reduced probability of a bee visiting many flowers per plant. Consequently, I hypothesize that close interplant spacing promotes outcrossing in self-compatible plants; future

Table 2. Basic statistics for variables in foraging behavior of three major groups of Hymenopteran visitors to *S. carduacea* at Red Mountain study site, 1983.

Bee Group	Variable	N	X ± 2 S.E.	Range	F	Correlations $r_{5\ cm}$	$r_{90°}$
Apis	Flight distance (m)	52	.36 ± .11	.04-2.10		.570**	.337 NS (n=42)
Bombus		52	.44 ± .14	.04-2.45	.86 NS	.707**	.502** (n=44)
Anthophoridae		52	.50 ± .19	.07-3.45		--	--
Apis	Turning angle (°)	26	107 ± 22	0-180			
Bombus		26	94 ± 23	0-180	.64 NS		
Anthophoridae		26	109 ± 14	38-178		r_{infl}	r_{plnt}
Apis	Number of flowers/ plant visited	46	2 ± 0.3	1-6		.479*	.053 NS
Bombus		52	2 ± 0.3	1-5	1.15 NS	.207 NS	-.001 NS
Anthophoridae		46	2 ± 0.3	1-8		.400 NS	.156 NS
Apis	Time/2 plants (sec)	26	26.7 ± 5.5	11.7-70	7.17**		
Bombus		26	24.0 ± 8.7	6.3-100.6			
Anthophoridae		26	11.0 ± 3.5	3.8-16.5	SNK - Anthop. significantly different from and		
Apis	Number of flowers/ minute	26	12.0 ± 1.4	6-20			
Bombus		26	18.0 ± 2.5	9-36	19.68***		
Anthophoridae		26	22.0 ± 2.9	2-34	SNK - All means significantly different		

* $p \leq .05$
** $p \leq .01$
*** $p \leq .001$

Notes: F: Univariate one-way ANOVA
SNK: Student Neuman-Keuls multiple range test.
Pearson product-moment correlation coefficients:
$r_{5\ cm}$ - distance to nearest plant within 5 cm on either side of flight path.
$r_{90°}$ - distance to nearest plant within 90° on either side of flight path.
r_{infl} - number of flowers available on inflorescence.
r_{plnt} - number of flowers available on plant.
NS: not significant at $p \leq .05$

experiments should test this hypothesis.

No significant differences were found between *Apis* and *Bombus* in their frequency distributions of pollen deposition (Fig. 2). The mean number of grains deposited per visit ± 2 S.E. was 3 ± 2 (range 0 to 16) for *Apis* and 5 ± 2 (range 0 to 28) for *Bombus*. In Fig. 2, note that the majority of individuals in each group deposited less than four pollen grains per visit. Since *S. carduacea*

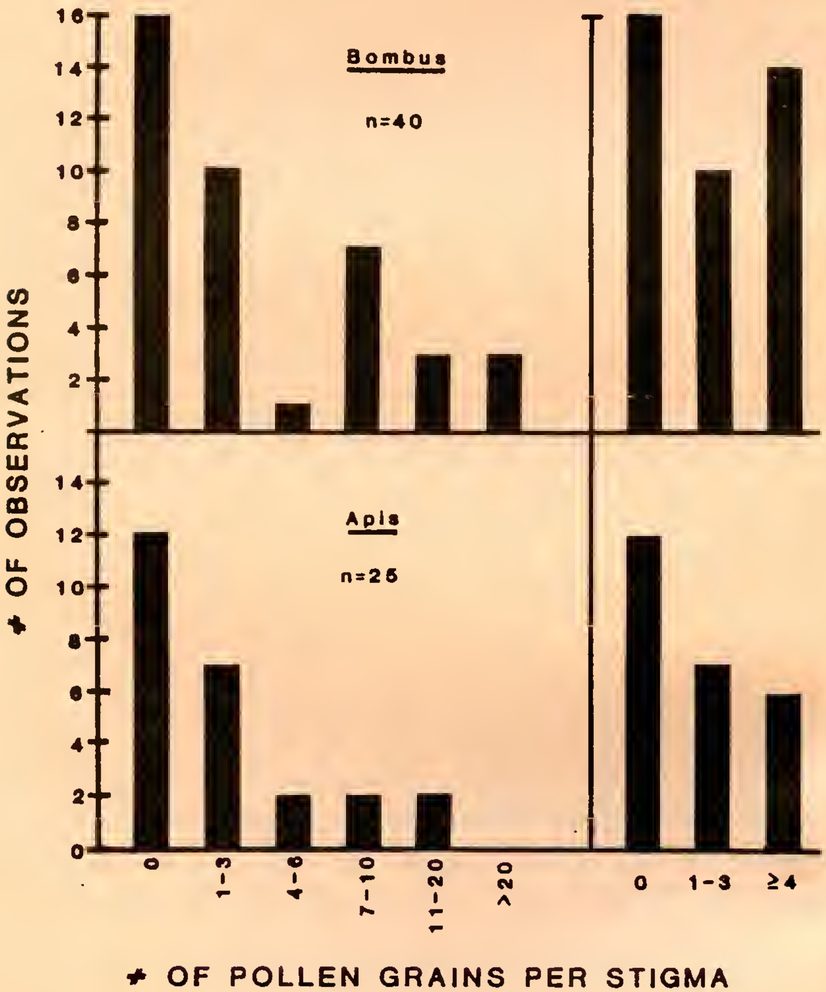

Figure 2. Pollen deposition frequency distributions for *Apis* and *Bombus*.
Left pair of histograms: G = 5.25 NS
α = .05
Right pair of histograms: G = 0.9040 NS
α = .05

has the typical family character of four ovules per flower, and only one pollen grain is assumed necessary to fertilize one egg, it follows that the majority of *S. carduacea* flowers must receive more than one visit by *Apis* or *Bombus* to achieve full seed set. Data for the Anthophorids were not obtained due to their insufficient visitation frequency at the time of data collection.

In comparing the above behavioral data for *Apis* to that of native bees, especially *Bombus*, I found no significant differences affecting the ways in which pollen is dispersed. The longer mean visitation time for *Apis* does not appear to affect the mean amount of pollen it deposits on a single visit to a flower. Results of a discriminant analysis of the behavioral data (Read, 1983) revealed no significant differences among *Apis*, *Bombus* and the Anthophorids in behavior when the time variable was deleted. However, by increasing the number of pollinators available, *Apis* is increasing pollinator service to the *S. carduacea* populations.

Hand pollinations of greenhouse-grown plants

Controlled experiments were performed to determine the extent to which *S. carduacea* sets seed in the absence of biotic pollinators, and the degree to which maternal sibling crosses influence seed set. The spatial separation of pollen presented on the long versus the short stamens and the consequent differences in the location of pollen deposition on a bee, suggest that they may contribute differentially to seed set. Crosses were performed to test this hypothesis. It was also of interest to perform interpopulation crosses to discover any effect of reproductive isolation on seed set.

Seeds collected in May were sown in December, 1982. Seedlings were transplanted into 4" pots when three pairs of leaves were produced, and were raised until bloom time outside of the greenhouses at Calif. State Univ. Fullerton. The plants were transferred to an isolation room within a greenhouse before actual bloom. Crosses were performed using a toothpick, and except for the experiment determining seed set with pollen from the short stamens, pollen from the long stamens was used.

From 315 Anza-Borrego seeds sown, 11% survived as seedlings and achieved bloom, whereas 3.5% of 449 Red Mountain seeds resulted in blooming plants. In general, once seedlings were obtained, their cultivation presented no problems.

All seeds produced a mucilaginous substance around their seed coats within two hours after immersion in water. *Salvia columbariae* (chia) seeds produce a similar substance. Sand particles effectively cover the seed when the mucilage is present and may be an adaptation to reduce granivory by diurnal granivores (Fuller and Hay, 1983).

At the seedling stage and throughout the lives of the plants, the two populations differed distinctively in vegetative features.

Leaves of the Anza-Borrego plants had more pubescence and more finely serrated margins than leaves of Red Mountain plants. However, during the blooming period, there were no apparent differences in their flowers.

Results of the hand pollination experiments (Table 3) show that *S. carduacea* is self-compatible, with no significant differences in seed set between maternal sibling and nonsibling crosses, or between interpopulation and nonsibling crosses. However, flowers left untreated produced significantly fewer seeds than the equivalent intrafloral cross. The seeds produced resulted from the occasional event that a style becomes positioned close to the long stamens such that opening of the stigma lobes next to the anthers results in self-pollination. This result agrees with those of Visco (1968) and Visco and Capon (1970). I observed this phenomenon occurring in field populations as well.

Results of seed viability tests (Table 3), performed with a 1% solution of tetrazolium chloride, suggest some influence of maternal sibling factors present in the Anza-Borrego population. In the Red Mountain population, some influence of pollen origin (whether from the long or short stamens) appears to exist. However, all crosses were performed using pure pollen loads and in the future, relative pollen tube growth from mixed loads (e.g. pollen from the long and short stamens present on the same stigma) should be examined.

Nectar composition and its adaptive significance

Spots of nectar collected from field plants at Red Mountain were placed on filter paper and sent to Herbert and Irene Baker at UC Berkeley for analysis (see Baker and Baker, 1983, for an explanation of their methodology). Results are shown in Table 4.

There appear to be no significant changes in nectar composition over eleven hours, although there appear to be changes from the male to the female stage (a period of 24 to 36 hours). Flowers in the male stage (producing pollen with the style appressed to the upper lip of the flower) seem to be higher in their relative proportion of sucrose than flowers in the female stage (pollen mostly gone, style parallel with the longer stamens and stigma open). However, any adaptive significance of this physiological change is unclear.

The nectar is sucrose-dominant to sucrose-rich, a quality characteristic of the Lamiaceae as a whole (Baker and Baker, 1983). Such a feature is also consistent with long-tongued bee, hawkmoth, or hummingbird pollinated flowers in general. This fact, coupled with the "landing platform" provided by the wide lower lip of the flower, and the flower's lavender color, suggest that *S. carduacea* is adapted for pollination by non-hovering animals, namely bees. In addition, the spatial separation of the reproductive parts, plus observations that bees smaller than 1 cm tend to forage mainly on the pollen of

Table 3. Results of hand pollination and seed viability experiments.

Treatment	Anza-Borrego N	$\bar{X} \pm 2$ S.E.	N	Relative % Viable[a]	Red Mountain N	$\bar{X} \pm 2$ S.E.	N	Relative % Viable[a]
Intrafloral self	14	2.6 ± .6	16	18	12	2.1 ± .8	15	14
Interfloral self	13	2.7 ± .7	14	16	12	1.6 ± .7	5	23
Sibling cross	13	2.7 ± .8	9	12	10	2.2 ± .6	14	17
Nonsibling cross	19	2.8 ± .8	14	18	21	2.2 ± .6	6	20
Inter-pop. cross	23	3.0 ± .6	15	19	12	1.7 ± .8	8	18
Cross using pollen from short stamens	22	3.0 ± .6	15	16	11	2.2 ± .9	7	8
No treatment	13	.5 ± .5	b	b	8	.5 ± 1.0	b	b

[a]Calculated as: $\dfrac{\text{\% viable of sample}}{\Sigma \text{ \% viable, all samples from A.B. or R.M. group}}$

[b]For seed viability experiments, seeds from the "no treatment" and "intrafloral self" pollination experiments were combined.

Table 4. Results of nectar analysis, *Salvia carduacea* flowers. ND = not detectable; NT = not tested; TR = trace.

Stage	Male		Female	
Time collected	1130	1800	1130	1800
Proportions:				
sucrose	.529	.587	.383	.421
glucose	.471	.413	.617	.579
fructose	ND	ND	ND	ND
Ratio $\frac{S}{G + F}$	.912	1.144	.789	.661
Amino acids				
alanine	NT	NT	NT	+
glycine	NT	NT	NT	+
proline	NT	NT	NT	+
valine	NT	NT	NT	TR
Phenolics	slight+	+	?	TR
Alkaloids	NT	ND	NT	NT
Protein	ND	ND	ND	ND
Organic acids	NT	ND	ND	ND

Figure 3. *Salvia carduacea* flowers in unfiltered sunlight.

Figure 4. *Salvia carduacea* flowers photographed with a UV-transmitting filter.

the flower and not contact the stigma when landing, suggest adaptation to bumblebee-sized pollinators (including the larger Anthophoridae).

UV floral pattern

Work with *Apis mellifera* and various plant species has shown that the insects can see into the ultraviolet portion of the light spectrum, and that the flowers of plant species exhibit patterns of contrasting color intensity when viewed in ultraviolet light. Consequently, the presence of a UV floral pattern in flowers is thought to have adaptive significance regarding their pollination by insects (Kevan, 1983). As yet, a relatively small variety of plant species has been examined for the presence of a UV pattern.

To discover if *S. carduacea* flowers exhibit a UV pattern, they were detached from the plant and placed against a white background in bright sunlight. Photographs in the UV were taken using a 35 mm camera with an 18A Wratten UV transmitting filter. Best results were obtained with Tri-X film at 12 to 16 seconds exposure time. Transplanted individuals from the Red Mountain site were used.

Comparison of flowers photographed in visible light (Fig. 3) to those photographed with the UV filter (Fig. 4) shows that *S. carduacea* has a UV floral pattern. The lower lip of the flower and the long stamens are absorptive (dark), and the upper lip is reflective (light) with an absorptive midvein. The short stamens are also reflective, having the effect of forming a triangle around the entrance to the floral tube. Further study of the UV floral pattern of these flowers should include more quantitative measurements, such as the degree of absorption or reflection in terms of wavelengths. However, at least in this brief study, *S. carduacea* flowers appear to have a nectar "guide pattern" in the UV, a character consistent with 42% to 68% of zygomorphic flowers examined by other workers (Kevan, 1983). Since many species in the Lamiaceae appear to be pollinated principally by bees (Faegri and van der Pijl, 1979), an extensive study of UV floral patterns in this plant family in the future might further elucidate the adaptive significance of such patterns.

Variation in reproductive morphology

Some morphological variation exists concerning the stamens of plants within the Red Mountain population. In 1982 one plant was observed to have six stamens on all flowers, rather than the typical four, whereas, another individual was observed with twelve stamens on all flowers. All stamens bore pollen. A different variation observed in 1983 is shown in Figure 5. The flowers of several plants had a greater separation of the long stamens (1.5 cm) than the more typical 1 cm separation. This type of variation may indicate a past or future adaptation to large pollinators, such as the *Xylocopa* species (carpenter bees) observed to occasionally visit *S. carduacea* at the Anza-Borrego site (Visco and Capon, 1970). Alternatively, such a wide space between the longer stamens may reduce or eliminate the incidence of self-pollination by increasing the distance between anthers and stigma.

Evolutionary relationships among the *Salvia* species remains unclear. Epling et al. (1962) reports *S. carduacea* to have a chromosome number of n = 16, one of the highest in the Audibertia section. The other species in the section possessing n = 16 is *S. californica*, an endemic shrub of Baja, California. These authors suggest a close

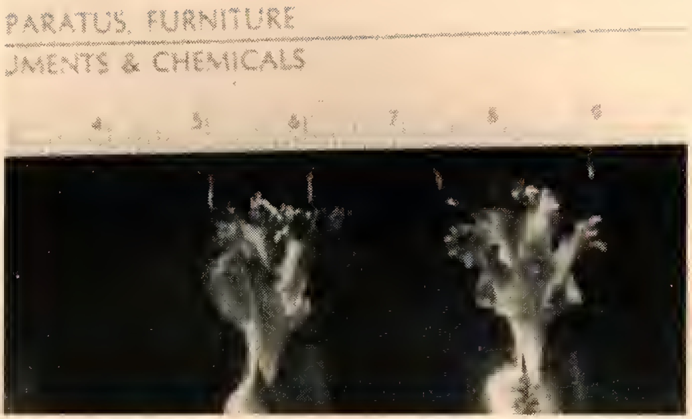

Figure 5. Example of variation in spatial position of the long stamens, *S. carduacea* flowers from a population at Red Mountain, California.

relationship between the two species, supported by an additional similarity in their leaves. A detailed analysis of floral and vegetative variation within the two species, in addition to their comparative pollination biology, would be of interest.

Summary

Apis mellifera does not appear to be significantly altering the ways in which pollen is dispersed within the *S. carduacea* population studied, but through its numbers it increases pollinator service. The entire pollination ecology of this plant deserves further study to discover any adaptive significance of its UV floral pattern, sucrose-dominant to sucrose-rich nectar, variable stamen morphology, and self-compatibility.

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ANNUAL POTLUCK DINNER AND PROGRAM

Olney Dining Hall
Pomona College, Claremont, CA
Saturday, October 8, 1983

Dinner will be served at 6:00 p.m. After dinner C. Eugene Jones will present a short slide program on the pollination systems that exist among the flowering plants (or what you always wanted to know about plant sexuality!).

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 six people: A-I, main dish; J-P, dessert; O-Z, side dish (vegetable, salad, etc.). Be sure to bring your own table service.

To reach the dining hall, exit from I-10 at Indian Hill Blvd. Go north (left) to Bonita Ave. Turn right and go to the first road on the right (not labelled). Turn right and Olney Dining Hall will be on your right just beyond Harwood Dorms. Use available parking lots. Any questions should be addressed to President Al Romspert at (714) 773-2428. SCB books will be available.

PLEASE COME! This is always a most enjoyable evening.

The October Board of Directors meeting (at 5:15 p.m.) will precede the Potluck Dinner.

ANNOUNCEMENT OF COMING SCB SYMPOSIUM

The subject for the Southern California Botanists Symposium this year is Baja California. We hope this topic is of broad enough interest to attract a large percentage of our membership. The symposium will be held on November 5, 1983 in the Heritage Room of the UCI Center at University of California Irvine. We are happy to co-sponsor this year's symposium with the new Orange County chapter of the California Native Plant Society and the Department of Ecology and Evolutionary Biology at UCI.

We have received confirmation from most of the speakers contacted about presenting a paper at the symposium. Topics vary from offshore island vegetation to historic and current use of plant materials by the natives. We hope to have a program together within a month with more information on the speakers and their topics.

Hope to see you there this year.

Alan P. Romspert
SCB President

BIOGRAPHICAL SKETCHES OF SCB OFFICERS AND DIRECTORS

C. Eugene Jones, First Vice President and Managing Editor of *Crossosoma*, SCB

Born in Columbus, Ohio, in 1942, I came to California in 1969 to take an academic position in Biology at California State University, Fullerton. During these past 14 years at CSUF I have been involved with the creation and development of the Fullerton Arboretum. This 25 acre botanical garden grew out of an idea conceived by a group of faculty and students in the fall of 1970. From its inception until it officially opened to the public in October of 1979, I served as the director. I made the decision that 10 years with any project is enough and in June of 1980 I went back to academia on a full-time basis. Since 1969, I have served as Director of the Faye MacFadden Herbarium at CSUF. This facility is housed in our Science building and contains nearly 25,000 vascular plants and about 17,000 non-vascular specimens.

I was introduced to Biology by my second grade teacher, Miss Walburn. She planted the seed of interest in nature which remained dormant until my junior year in college. At that time I was a pre-law major and varsity football player at Ohio University in Athens, Ohio. However, after taking a zoology course with Dr. Seibert (a vertebrate zoologist) and a botany course with Professor Vermillion (a mycologist), I was hooked. The seed not only germinated but grew and matured through graduate school at Indiana University in Bloomington, Indiana, where I worked with Dr. Charles Heiser in Plant Taxonomy.

During my graduate career a lifelong interest in the coevolutionary relationships that exist between the flowering plants and their animal visitors was kindled. In particular, I have worked on various aspects of the pollination process including the biological significance of ultraviolet floral patterns and post-pollination floral changes, pollination energetics, floral mutualism, and reproductive biology in the native Hawaiian flora. Along with R. John Little, another SCB Board member, I edited the recently published (June, 1983) book entitled "Handbook of Experimental Pollination Biology."

I am married (Teresa) and have three children, Douglas (14), Philip (12) and Beth (6)..

BOARD MEETING BRIEFS

June Meeting: Held at Rancho Santa Ana Botanic Garden

- Field trip to Sierra de Juarez area was a success in terms of the bloom encountered and birds seen.
- Field trip to Baldwin Lake area in San Bernardinso Mts. was not a success because no one showed up; however, the area was beautiful and there was lots in bloom.
- Pasadena City College was decided on for our symposium. (Note: This was later changed to the University of California at Irvine, UCI).
- Potential symposium speakers are still being contacted.
- SCB incorporation papers were drawn up by Marv Chesebro; all directors will sign.
- The Board received letters from Nishita and Clark thanking SCB for grants they had received.
- The Board voted to send $60.00 to the Hawaii Chapter of the Nature Conservancy to help preserve a 5,000 acre nature reserve on Maui.

July Meeting: Postponed until August.

August Meeting: Held at CSUF

- Various aspects of the symposium were discussed including potential locations and speakers.
- SCB is contemplating purchasing a permanent display that we could set up at symposia, plant sales, etc.
- Various options were discussed for where SCB could hold their annual plant sale, instead of RSA Botanic Gardens, and the possibility of having two sales per year. Ideas are pending.
- SCB won't have a sale this fall but will have one in the spring (1984) at a place to be announced.
- Board voted to send the Natural Resources Defense Council $25.00 for the Acid Rain Action Project; and to send the Planning and Conservation League of California $25.00 to become a member.

FIELD TRIPS AND EVENTS

October 8 (Saturday):	Potluck Dinner. See page 13 for details.
November 5 (Saturday):	SCB Symposium on Baja California. Watch for details in a special symposium issue of *Crossosoma* coming soon.
November 18-27:	Trip to northwestern coast of Mexico to San Blas. Call Walt Wright for details, afternoons at 714-641-8820.
December 4 (Sunday):	Tide Pool Trip. We'll have good -1.2 negative tide, so plan to attend. Contact Al Romspert for more details, 714-773-2428.

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 1983 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

COMING 1983 EVENTS (Details Within)

October 8	SCB Potluck Dinner
November 5	SCB Symposium, UCI
November 18- November 27	Trip to northwestern coast of Mexico to San Blas
December 4	Tide Pool Trip

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. 9, No. 6
Editor: C. Eugene Jones November, 1983

PROGRAM ISSUE

Baja California: A Curious Peninsula

Saturday, November 5, 1983
University of California, Irvine

The Ninth Annual Symposium of the Southern California Botanists will cover different aspects of that diverse peninsula, Baja California, Mexico. This year the Symposium is cosponsored by the California Native Plant Society, and the Cooperative Outdoor Program and Department of Ecology and Evolutionary Biology of the University of California, Irvine.

The number of researchers that have investigated the many secrets of Baja California is legion. We have selected six who promise to provide an enlightening view of only a few of the subjects that could be addressed. The underlying theme is the vegetation of Baja California with a diversity of topics in different geographical locations on the peninsula. It is intended that the audience will receive a good overview of this curious peninsula.

The Symposium will be held in the Heritage Room of the University Center at the University of California, Irvine, on November 5, 1983. Registration will begin at 8 a.m. and the close of the symposium will be about 5 p.m. General admission will be $5.00 for SCB and CNPS members and $10.00 for non-members. Non-members may join the Southern California Botanists for $4.00 (students) or $6.00 (individuals) at the Symposium, thus acquiring membership in our organization in addition to the Symposium for only $9.00 and $11.00 respectively.

Parking will be in Lot P4 at the unmetered slots with lot P5 being used if there is an overflow of vehicles for Lot P4 (see map, next page). Approved parking stickers will be sent to pre-registered attendants or provided at the door for individuals who register at the Symposium.

The following is a list of the times, titles and abstracts submitted by the speakers. Following each talk there will be a

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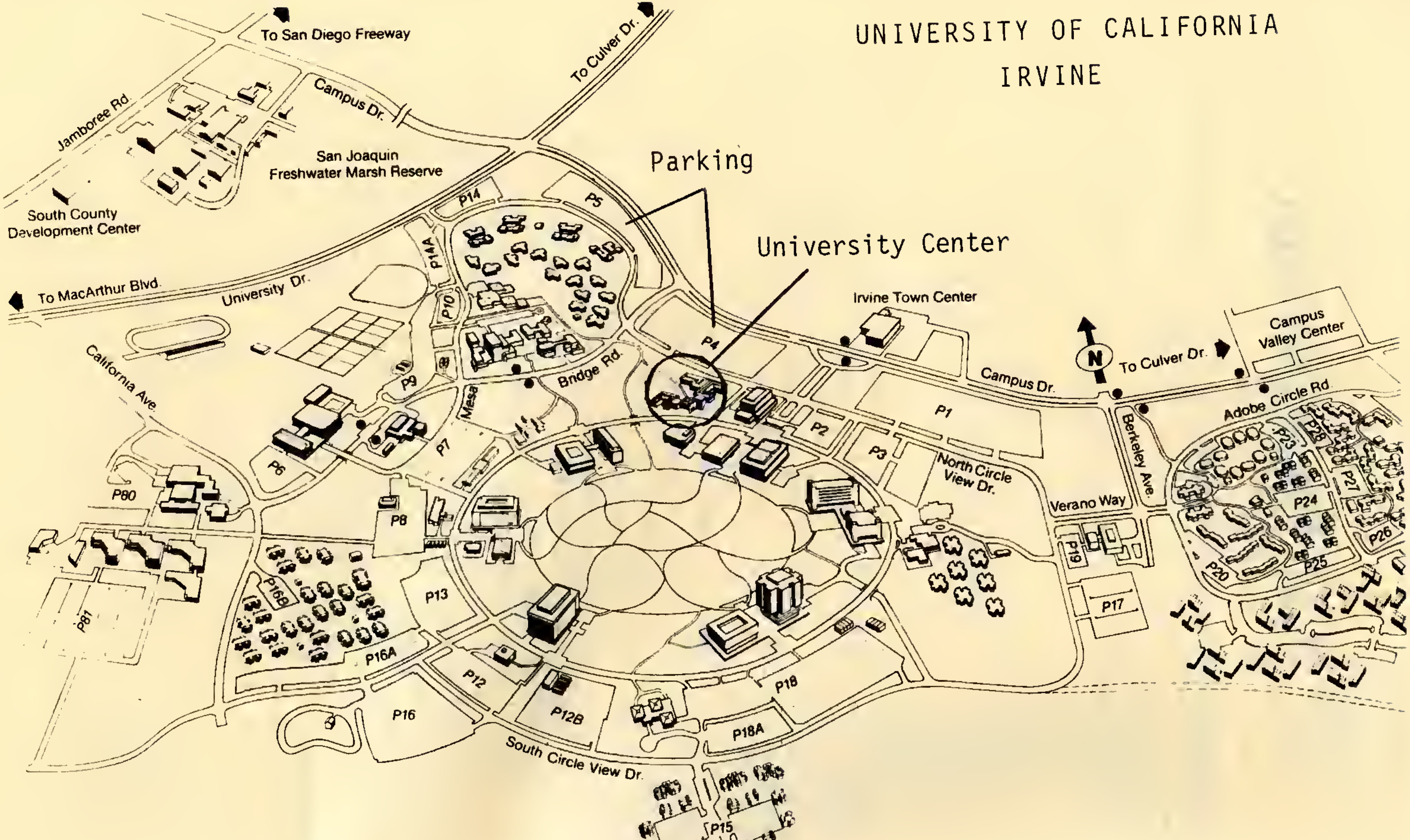

brief period for questions. Beverages and donuts will be provided at the morning break and beverages at the afternoon break.

SCHEDULE

8:00	Registration	$5.00 SCB and CNPS members $10.00 Others $6.00 SCB Membership
8:30	Introduction	Alan Romspert, President, SCB

8:45 Robert Thorne, Rancho Santa Ana Botanic Garden
"The Vegetation of Baja California"

Baja California is a narrow Mexican peninsula, varying from 30-240 km wide, stretching some 1300 km southeasterly from the southern Alta California border to Cabo San Lucas. It is separated from mainland Mexico by the Colorado River and the Gulf of California, and is divided by the 28th parallel into two states, Baja California Norte and Baja California Sur. The peninsula has a backbone of block-fault mountain ranges, including the Sierras de Juarez, San Pedro Mártir, Giganta and Victoria among others, and reaching 3096 meters in La Providence of the Sierra San Pedro Mártir. Many islands of varying sizes lie at varying distances off both the Gulf and Pacific Coasts.

After general comments about physiography, climate and soils, the flora of more than 3000 species in 128 indigenous and a few additional introduced families is briefly discussed with some consideration of the considerable Pacific species endemism (possibly 25%) and 20 endemic genera. Most attention is devoted to the vegetative covering of the peninsula illustrated by Kodachrome slides arranged by major vegetative region and their dominant plant communities. Coverage of the island and coastal communities is left to other speakers. Especially noteworthy in the Californian regions are the inland sage scrub, chaparral, oak woodland, vernal pool ephemeral and other aquatics, and coniferous forest communities; in the Sonoran desert region the creosote bush scrub, microphyll woodland, sarcocaulescent woodland, sarcophyllous woodland or scrub communities; and in the Cape region the mangrove swamp, deciduous thorn scrub and oak-pinyon woodland communities.

9:45 Annetta Carter, University of California, Berkeley
"Plants and Man in the Sierra de la Giganta of Baja California Sur, Mexico"

The principal plants utilized by the Indians are discussed and illustrated--the food plants as well as some of those which had other uses. Some of these are still utilized by the local people. Other native plants, which had not met the needs of the now nearly extinct aborigines who were hunters, fishers and gatherers, have been utilized by their successors.

10:45 Break

11:15 Homer Aschmann, University of California, Riverside
"Plants in the Aboriginal Subsistence Pattern in Baja California"

Except in the northern portion of the peninsula the numerous Indian population was effectively extinct before the mid-nineteenth century so knowledge of their subsistence pattern must come from eighteenth century missionary accounts. There are ethnographic data on the northern Indians, collected in the 1920's, that indicate a pattern similar to that in Southern California. In both areas plant materials seem to have supplied nearly two thirds of the diet.

Wherever they occurred, *Agave* spp. formed the core of the diet. Some species could be eaten any time of the year. Other plants, notably the *pitahaya dulce*, were available for only a short season, and the annuals such as grasses and amaranths were available only in years with heavy, appropriately timed rains. The Baja California Indians, pressed by this situation, identified a remarkable number of edible plants that provided alternative items of subsistence, particularly in bad years and the normally lean spring season.

12:15 Lunch

1:30 Ralph Philbrick, Santa Barbara Botanical Garden
"Plants of Baja California Islands"

A look at various plants of the Pacific Coast islands off Baja California contributes to an understanding of how these islands are floristically related.

Ferns, conifers, buckwheats (*Erigonus*), live-for-evers (*Dudleya*), island mallows (*Lavatera*), cacti (including *Opuntia*), white popcorn flowers (*Cryptantha*), goldenbushes

(*Happlopappus*), and chicories (*Malacothrix*) each have their own pattern of island distribution and evolutionary history.

A composite view of such plants and the associated vegetation show each island most closely related to neighboring islands. Los Coronados, Todo Santos, San Martin and San Geronimo (on limited evidence) form a loosely connected group. Guadalupe is geographically and floristically isolated. The islands off Punta Eugenia (San Benito, lower elevations portions of Cedros and Natividad) show affinities to each other. Asuncion is vegetated with only a few kinds of plants and these are too widespread to indicate affinities. Magdalena and Santa Margarita both have major southern and subtropical components.

2:30 Break

3:00 Philip Rundel, University of California, Los Angeles
"Community Structure, Diversity and Physiological Response along Vegetational Gradients in the Central Vizcaine Region of Baja California"

Complex gradients of vegetation change near Catavina in the central Vizcaine Region of Baja California result from variations in geological substrate, slope aspect and moisture availability. Distinctive plant communities can be identified for north-facing rocky slopes, south-facing rocky slopes, upper bajada slopes, lower bajada slopes, wash border and wash bottoms. Vegetational boundaries are commonly diffuse. Both species diversity and growth-form diversity of perennial plants may be correlated with physiological parameters of substrate and water availability. Diversity is greatest on rocky slope communities both on the basis of total species present and species equitability. Physiological measurements of plant water potential indicate divergent strategies of water use between plant growth-forms, with highest water potentials in CAM succulents (e.g., cacti and agaves) and non-CAM stem succulents (e.g., *Pachycormus*, *Bursera*, *Fouquieria*), and lowest water potentials in evergreen shrubs (*Larrea*, *Simmondsia* and *Viscainoa*).

4:00 Richard Vogl, California State University, Los Angeles
"The Salt Marsh and Transitional Vegetation of Estero and San Quintin Bays, Baja California, Mexico"

The general vegetation of the littoral areas and adjacent uplands will be discussed qualitatively and quantitatively. Ecological relationships will be stressed.

(Editor's note: As usual, Dr. Vogl's presentation will be both visually and scientifically interesting.)

5:00 Closing Remarks

BOARO OF DIRECTORS
SOUTHERN CALIFORNIA BOTANISTS - 1983

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 1983 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

FIELD TRIPS AND EVENTS

November 18-27: Trip to northwestern coast of Mexico to San Blas. Call Walt Wright for details, afternoons at 714-641-8820.

December 4 (Sunday): Tide Pool Trip. We'll have good -1/2 negative tide, so plan to attend. Contact Al Romspert for more details, 714-773-2428.

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, 1983, are credited with dues paid in full for 1983. Their memberships are effective immediately, they will receive the October, 1983, and December, 1983, issues of *Crossosoma* and will be entitled to discounts on books and admission to the Symposium, etc.

Membership categories are:

____ Student or retired* $ 4.00

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COMING 1983 EVENTS (DETAILS WITHIN)

November 18-27	SCB trip to San Blas, Mexico.
December 4	SCB Tide Pool Trip.

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VEGETATION RESPONSE TO OFF-ROAD VEHICLE USE IN THE CALIFORNIA DESERT

Earl W. Lathrop, Candace E. Horsley
and Randall R. Iwasiuk

INTRODUCTION

The purpose of this study, which was sponsored by the Bureau of Land Management, was to study the effects of off-road vehicles (ORV) on perennial vegetation in the California Desert Conservation Area (CDCA) as a basis for predicting the effects of off-road vehicle use. The specific objective was to attempt to contribute information which would help to answer questions such as: what kinds of recreational impacts occur; how does the intensity of recreational use relate to the extent of plant response.

The study, undertaken August, 1977 - June, 1978, utilized aerial photographic and ground transect data as the primary methods of analysis of vegetation response. Study areas were located in aerial photographs for both test (disturbed) and control (undisturbed) sites. The ideal control was a comparable photo before disturbance, usually the years 1952 or 1953. In cases where such a control photo was lacking, a site on the test photo that was in an undisturbed location with the same vegetation type and physiognomic character as the test site was used as a control. Dates for the test photos were usually early to late 1970's. Transparent dot and plot grids were calibrated for each photo for the purpose of measuring total density and cover of perennial vegetation in test and control plots (Lathrop 1978). Cover measurements represent the percent of the ground which is covered by the crown canopy of the perennial herbs and shrubs. Density is expressed as an index or number of individual plants per unit area, usually per hectare (ha) which is equal to 2.47 acres. On-site ground transects were taken to supplement photo analysis, and in a few cases (Afton and Jawbone Canyons; Stoddard Valley), only ground measurements were taken because of the unavailability of aerial photographs. Ground measurements, like the aerial photo analysis, were used primarily to calculate density and cover, using standard formulae for such calculations (Whittaker 1975). While absolute values of aerial photo measurements of vegetation were not directly comparable to similar ground measurements due to resolution of the aerial photographs, relative values were comparable. Photographic analysis tended to give trends in the results similar to those of the on-site ground measurements. This study did not attempt any cost prohibitive experimental manipulations but rather depended upon interpretation of recent and past experiments inadvertently performed. Eighteen situations were compared in nine study areas (Fig. 1) to provide representative vegetation, geographic and use characteristics. For summary purposes, off-road vehicle use intensity was divided into three arbitrary categories: (A) heavily used weekend areas; (B) motorcycle races, ORV activity on dunes and in washes; (C) General Patton's World War II (WWII) tank maneuver areas (Table 1).

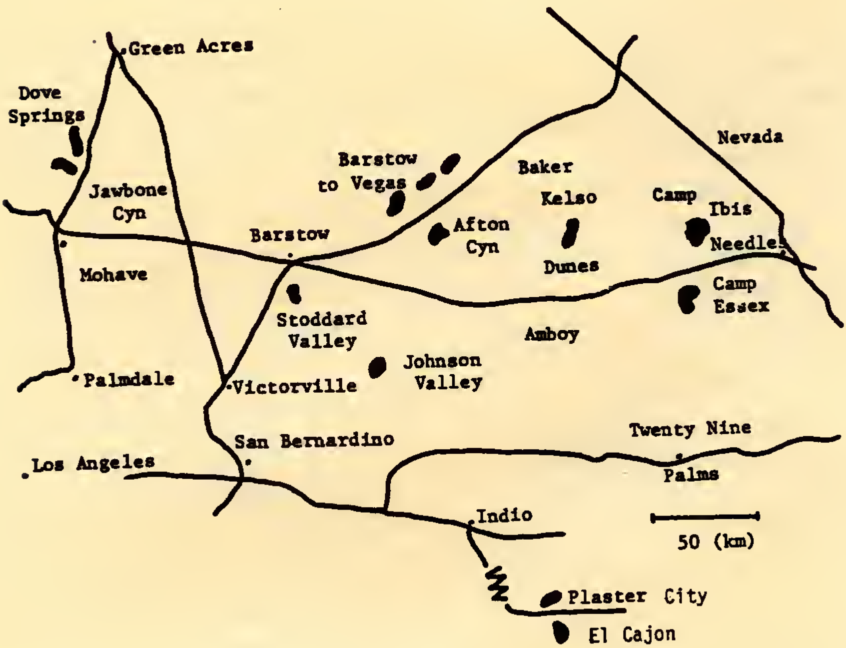

Fig. 1. The Mojave Desert region of Southern California showing the locations of the study areas (●). The Plaster City site, of the Colorado Desert, is inset at the bottom of the map. Local highways (—) and other land marks are indicated.

Table 1. Use intensity types for study areas.

Use type	Response	Topography	Study areas
A. Concentrated recent and current activities, no time for vegetation recovery. Heavily used week-end areas	Forms denuded (roads and trails) and large expanses of bare ground (pit areas and some hillsides)	Steep hills, valleys, level trails	Jawbone Cyn. Dove Springs Stoddard Valley Johnson Valley Afton Cyn. Plaster City pit areas.
B. Past to recent concentrated to dissipated use. Short periods of time for recovery. Motorcycle races, ORV activity on dunes and in washes	Tracks in sand, displacement of surface sand, creation of trails, some denuded strips	Broad, flat sandy to rocky expanses, dunes, washes	Kelso Dunes Plaster City races
C. Past concentrated use in localized areas. Long period of time for recovery. Patton's tank manuevers	Denuded roads and tent areas, walkways etc. Tracks with much soil compaction	Flat to slightly inclined fans, gravely sand Not inviting to ORV.	Camp Ibis Camp Essex

In recent years the delicate desert ecosystem has been challenged by increased use. Thousands of dune buggies, motorcycles and four-wheel drive vehicles flood the desert on weekends (Luchenbach 1975). The use of motorized vehicles has greatly affected the vegetation on one million acres of California desert and has reduced ground cover by 60 to 70 percent in some areas of regular use (Sheridan 1979). Extensive damage can be inflicted in a few hours if use is sufficiently intense. A Kern County motorcycle race with 700 entrants considerably reduced the vegetation on a 2km square area in a single day (Vollmer et al. 1976). Off-road vehicle activities have become increasingly popular as whole families are participating together, each often with his or her own dirt bike or other similar vehicle. Associated with these activity areas are "pit areas" where racers, hill climbers, off-road vehicle drivers in general and spectators park their vehicles, causing the greatest amount of disturbance in a small area. After several gatherings the pit area is usually bare of vegetation and the soil is greatly compacted. The degree of damage to vegetation is dependant upon the number of vehicles and extent of use (Davidson and Fox 1974).

RESULTS

A. Heavy ORV use, week-end areas.

<u>Jawbone Canyon</u>: Three steep hillsides in cheesebrush scrub (Johnson 1967), each with different degrees of use intensity, were

measured by ground line transects (length, 200m) along with the attendant pit area in an alkali sink community (Thorne 1976). Results (Table 2) show a proportional decrease in percentage cover for hillsides with sparse, moderate and dense trails respectively when compared to the nearby undisturbed control hillside. Density was also decreased in the three test hillsides. Likewise there was a substantial decrease of vegetation density and cover in the pit area.

Table 2. Linear density index (I) and mean cover (%) of perennial vegetation of three motorcycle hill climbing areas of Jawbone Canyon, 24 km northeast of Mojave, Kern County, California, May 21, 1978. (N) = no. of plants in the transect.

Site	(N)	(I)	Cover (%)
Hillside, sparse trails	38	.19	11.31
Hillside, moderate trails	42	.21	8.36
Hillside, dense trails	20	.15	4.65
Hillside, control	73	.36	17.48
Pit area	18	.09	2.64
Pit area control	83	.50	28.89

Dove Springs: Line transects were run on three similar hillsides in Dove Springs Canyon, 38 km northeast of Mohave. Two of the hillsides were completely denuded of vegetation and the third had a density index of .2 compared to the control index of .56. Cover was 7.8% compared to the 21.9% cover of the control site. The N of the partially denuded hillside was 40 compared to an N of 113 of the control hillside. Five hillsides with moderate to heavy ORV use, which occurred progressively into Dove Springs Canyon, were analyzed by aerial photography. Identical sites were measured for density before (October 15, 1952) and after (May 27, 1973) use by ORV (Table 3).

Table 3. Mean density of 5 hillsides and 3 pit areas of Dove Springs before and after use by ORV. K = number of plots (.04ha) sampled.

Site	(K)	(N)	Density (no/ha) 1952	1973
Hillsides	900	12,242	340	
	900	6,562		182
Pit areas	630	6,972	328	
	639	3,432		131

Three associated pit areas were compared in the same manner. Summary results, shown in Table 3, indicate a significant decrease in density of perennial vegetation in the before and after photos.

Stoddard Valley: Ground measurements in creosote bush scrub (Thorne 1976) and in alkali sink vegetation indicated a reduction of both density and cover due to ORV activity in this area (Table 4).

Table 4. Density and cover means for perennial vegetation in ORV use sites in Stoddard Valley, 4 km southwest of 8arstow, San 8ernardino, County, California. Ground transect plots (K) measured May 14 and 28, 1978.

Sites	K	N	Density (no/ha)	Cover (%)
Creosote bush scrub				
Pit area	30	120	8.79	-
Hillside trails	20	80	175.05	.39
Raceway	31	124	108.19	.07
Control	30	120	1168.20	5.31
Alkali sink				
Pit area	30	120	2.42	.18
Control	30	120	416.63	9.38

Johnson Valley: Similar photographic analyses were made here as in Dove Springs. The mean density from eight randomly selected transect lines radiating from the center of the large pit area of this region was 97/ha for the November 26, 1952 photos and 52/ha for the May 28, 1977 photos.

Afton Canyon: Ground transect comparisons of an undisturbed hillside control with a hillside with heavy ORV use shows a respective reduction in density/ha from 1425 to 315 and a corresponding reduction in % cover from 5.5 to 1.3. The nearby pit area had a density/ha of 49 compared to the control of 1912, with a similar drop in % cover.

Plaster City: Analyses of 3 large ORV use areas with flat to rolling topography, approximately 2 km northwest of Plaster City, Imperial County, California, were done using before (May, 1953) and after (November 26, 1972) aerial photographs. Density (no/ha) was calculated from counts of perennials in 270 .04ha plots (k) for each year of each of the 3 areas sampled. Area 1 had a reduction in density/ha of 106 to 96; area 2, 140 to 113; area 3, 228 to 84.

B. Motorcycle races, sand dune activities.

El Cajon motorcycle club race: This race was held December 3, 1972 in the Yuha Desert in Western Imperial County, California, 5.5 miles east of Ocotillo, with 215 motorcycles participating in the 4 lap race totaling 82.8 miles. Three sets of aerial photographs were analyzed for this event, April 18, 1953, November 26, 1972 and December 12, 1972. This permitted an evaluation of vegetation change over a 19 year period prior to the race and again immediately before and after the race. In one area of the race route which had seen some ORV activity prior to the race, the vegetation density was calculated for the period of 1953 to 1972, but prior to the race. The resultant negative change in density was only 2.5%. The identical site was similarly measured immediately before and after the race. For the short period of time, there was a reduction in density/ha of nearly 20%. Three other sites along the December 2, 1972 race route were also measured on the before and after photos with a resultant average reduction in density from 1,173/ha in the November 26, 1972 photos to 723/ha in the December 12, 1972 photos, an average decrease of 38 percent.

The November 30, 1974 Barstow, California to Las Vegas, Nevada motorcycle race was also studied for vegetation response via aerial and ground measurements. The five study sites were located on the first fourth of the course which lies on the north side of Interstate 15 (Fig. 1). The "Hound and Hare" motorcycle race studied was the last legally-held race of eight annual events. More than 3000 riders participated, divided into two heats of 1500 bikes each. The 1974 race had been changed somewhat from previous races (Luckenbach 1975). Photo analysis of perennial vegetation at two raceway sites, utilizing low level aerial photographs of before (November 26, 1974) and after (December 5, 1974) the race, indicated that density was reduced by half as a result of the one day race (2,311/ha to 1,290/ha and 2,946/ha to 1,415/ha for the two sites respectively). Ground measurements in the same vicinity as the two aerial photo sites indicated a decrease in density from 2,688/ha to 1,402/ha in the control and raceway sites respectively and a corresponding reduction in cover from 5.1% to 1.6%. The second ground site had a decrease in density from 2,247/ha to 1,779/ha with a corresponding drop in cover from 14.3% to 4.4% in the control and raceway sites respectively.

Kelso Dunes: Aerial photographic comparisons of before (April 5, 1953) and after (June 9, 1974) use by recreational vehicles in the Kelso sand dunes, near Kelso, San Bernardino County, California, indicate a reduction in density of about one half. Three transects across the foredunes showed reductions in density (no/ha) of 40 to 23, 30 to 16 and 36 to 20 respectively. Four similar transects along the desert floor at the base of the dunes, which included some pit areas and trials, showed reductions in density/ha of 104 to 52, 116 to 58, 61 to 27 and 45 to 23 in the 4 sites respectively.

C. General Patton's camps.

These impacts were assessed in three use categories: tank tracks in the maneuver areas; roadways, used primarily by jeeps and trucks; tent areas, cleared areas for walkways and utility purposes. The data generated from these areas was compared to data gathered from adjacent undisturbed control sites. The study consisted of two phases. First, aerial photographs were analyzed to determine recovery rates between 1953 to 1974 at the sites which were disturbed by Patton's maneuvers from 1938 to 1942. The second phase of the study was an on-site ground analysis of differences between the disturbed and control sites to detect the extent of recovery from the original disturbance over a period of approximately 37 years.

Camp Ibis: Aerial photographic analyses show that recovery is most pronounced in the tent areas for density while tank tracks show a slight negative change in density but significant increase in cover during the period between photographs. Roadways show only slight positive change in density and cover. Ground measurements show density levels distinctly lower in track and roadway transects than in tent areas and control transects. Cover of the control was 7.5%, compared to 4.1, 2.6, and 1.2% in tent area, tank tracks, and roadway respectively.

Camp Essex: Recovery, as determined from the aerial photographs, is greatest in the tent area while tank tracks and roadway transects exhibit slight differences in density over the 21 year period. Density values for ground measurements follows the pattern discussed for ground transects in Camp Ibis in that tank tracks and roadways again show the lowest densities, 803 and 820/ha respectively compared to the control of 2644/ha. The tent area had a density of 1202/ha. Tank tracks and roadways also had the lowest covers, 3 and .01% respectively compared to 4.5% cover of the tent area and 9% for the control.

CONCLUSIONS

In general, the impacts of recreational uses, primarily by off-road vehicles, upon the California desert perennial plants and their habitats cause negative responses. The degree of negative impact on plants varies with conditions and intensity of use. Concentrated current or recent vehicle use in localized areas (heavily used week-end areas) tends to create the greatest reduction in vegetation cover, averaging 59% negative impact, of the sites studied (Fig. 2A). One

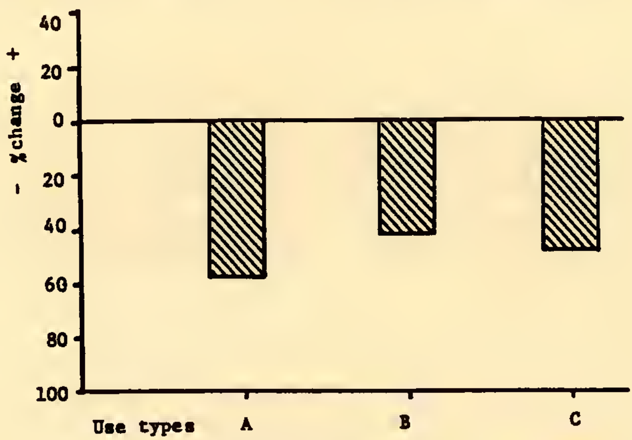

Fig. 2. Mean percent change of perennial vegetation in relation to use intensity types (Table, ABC) as summarized from aerial photographic and ground transect data from nine study sites (Fig. 1) in the CDCA.

time or infrequent motorcycle races, with dissipated activity (not all following the same tracks) and with several years time allowance for vegetation recovery, reduce vegetation cover by an overall average of 42% (Fig. 2,B). Concentrated but distant past use (Patton's training camp) with many years for recovery show a reduction of vegetation in between the previous two response types, of 50%. (Fig. 2,C).

Ground measurements of percentage composition show differences between disturbance and control areas, indicating not only reduction of cover and density but also alteration of both plant stability and diversity. Stability tends to be reduced when dominance of long-lived perennials is reduced or altered. The data from both aerial photographic analysis and ground transects indicate negative response by perennial vegetation to most types and degrees of recreational vehicle use intensities as studied in the sample sites (Fig. 1) of the CDCA.

In light of the results of this study and those of others who have measured the impact of ORV's on the California Desert (Berry 1973; Bureau of Land Management 1975; Burry, et al. 1977; Kuhn 1974; Webb, et al. 1978; Wilshire and Nakata 1976; Wilshire and Webb 1978, etc.) it is imperative that this type of recreation be carefully regulated to minimize damage to the desert ecosystem. Current practices and future plans of the Bureau of Land Management, United States Forest Service, and other similar agencies include designation of specific areas for ORV activity, establishment of desert wilderness areas and other regulations which should help prevent the spread of this type of damage to the desert vegetation.

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PLANT RESPONSES OF UTILITY CORRIDORS IN THE MOJAVE DESERT

Earl W. Lathrop and Edwin F. Archbold

The original construction of utility corridors involves major disturbance to soil and vegetation along their pathways. No quantitative or qualitative estimates of such disturbances to vegetation in the Mojave Desert of California were available prior to 1975 when three studies were made by Vasek et al. (1975a) on one pipeline, Johnson et al. (1975) on highways, and Vasek et. al. (1975b) on two powerlines, all in the Mojave Desert. A study in the Mojave Desert, conducted May, 1978 to February, 1979 (Lathrop, 1979), enlarged the work of these researchers by reporting comparable studies on five pipelines, seven powerlines, and two aqueducts (Table 1, Fig. 1). A similar study on utility construction effects on vegetation and soils of the Colorado Desert, California, has been reported to the Bureau of Land Management by Clark (1979). These studies have contributed much to an understanding of the effects of utility

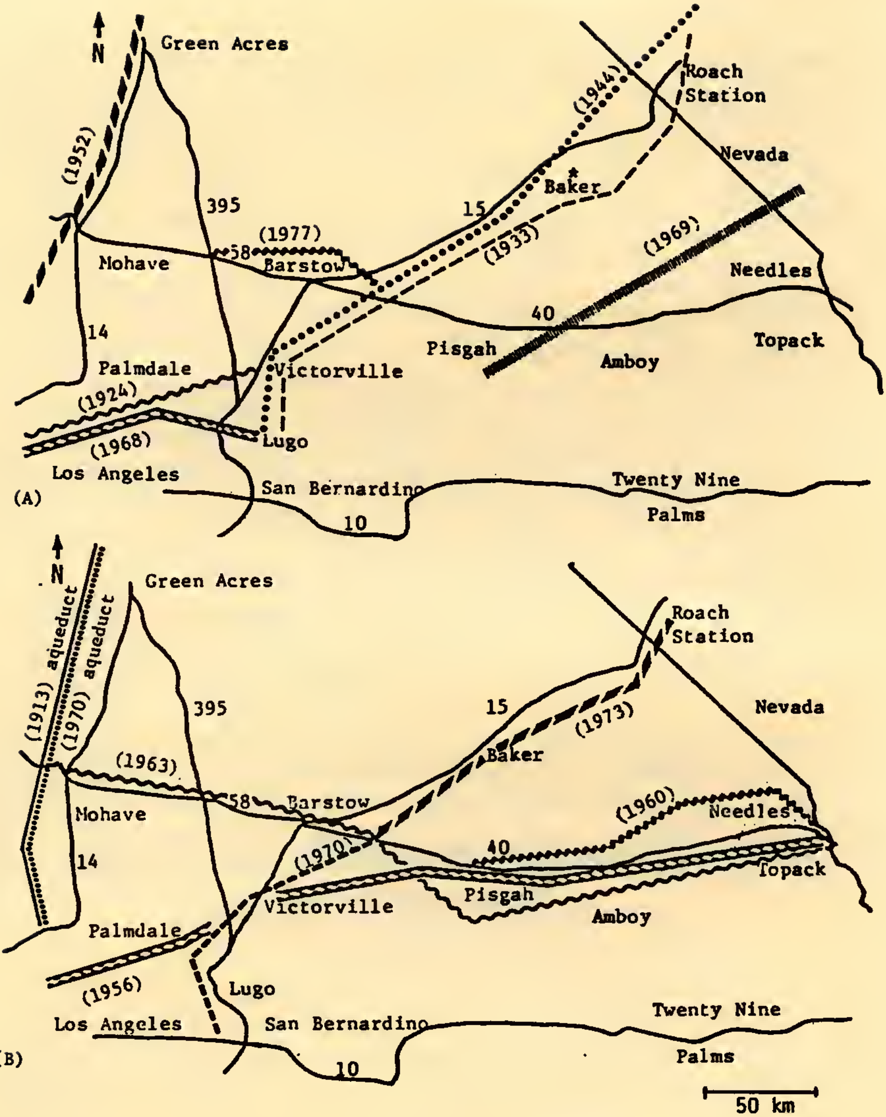

Fig. 1. The Mojave Desert region of California showing the paths of the powerlines (A), pipelines and aqueducts (B) studied (Lathrop 1979). Local highway (—) and other landmarks are shown. Year of construction is shown in parentheses for each corridor.

construction on desert vegetation.

This paper discusses the results of the recent study by Lathrop and reviews the previous literature of Vasek et al. and Johnson et al. (Table 1). These articles have the same theme of "impacts of utility construction on the productivity, diversity and

Table 1. Summary of utility corridor studies of the Mojave Desert.

Author	Corridor	Ownership	Yr. of construction
Vasek et al., (1975a)	pipeline (Pisgah to Lucerne Valley)	So. Cal. Gas Co.	1960
Johnson et al., (1975)	powerline service rd.	So. Cal. Edison	1937
	Cal. hwy.	Cal Trans	1958
Vasek et al., (1975b)	powerline	So. Cal. Edison	1937, 1970
Lathrop (1979)	pipeline	So. Cal. Gas Co.	1956, 1960 (Needles to Pisgah)
	pipeline	Pac. Gas & Elec. Co	1963
	pipeline	Cal-Neva Co.	1970, 1973
	powerline	Los Angeles Dept. Water & Power	1924, 1944, 1952
	powerline	So. Cal. Edison	1933, 1958, 1969 1977
	aqueduct	Los Angeles Dept. Water & Power	1913, 1970

stability of perennial vegetation in the Mojave Desert, California". Methods used and basic parameters measured were similar, permitting comparison of results.

METHODS

Disturbance due to utility construction activities are mainly: clearing of land within right of ways for access roads, pylons of powerline towers, and for operation of machinery during construction; trenching, piling, and refilling operations of pipelines and aqueducts. Study areas were selected at intervals along each corridor over representative topography, soils, and vegetation types. Comparisons within a study area consisted of uniform application of belt transects ($200m^2$) in control (undisturbed) and disturbed sites for each corridor. For all corridors, the *control transect* was placed in undisturbed vegetation 50m to one side of the utility right of way and parallel to it.

To test for disturbance, transects were placed in locations representative of the different types of disturbance. For powerlines this consisted of: *wire transect*, midway between the pylons and directly under the central transmission wire; *pylon transect*, directly under the pylon; *roadedge transect*, placed along the edge of the access road. Pipeline transects were placed: *berm transect*, along the pipeline right of way where trench soil had been piled and then scraped away to refill the trench; *trench transect*, directly over the pipeline where trenching had produced the most severe disturbance; *roadedge*, as in powerlines. The disturbance transects of the two Los Angeles aqueduct corridors were: *right of way transect*, along the edge of the access road. No transects were placed in the region of the aqueduct equivalent to the trench of the pipelines because construction methods precluded this, mainly due to lack of or too little soil over the aqueduct conduit itself.

Primary comparisons were made among the classes of transects at each study site. Secondary comparisons were determined from differences between corridors (year of construction) and among the study sites along a corridor.

Basic measurements and data gathered at transect sites were used to determine *productivity*. Values used were mainly: density, or the number of plants per transect plot (#/200m^2); % ground cover and biomass (kg/m^2). Measures of relative biomass were used to calculate estimates of *diversity*, or how well the control and disturbed samples were represented by a variety of species (Hurlburt, 1971, McIntosh, 1967 and Whittaker, 1975). *Stability* was determined from a variety of quality orientated measurements: 1) analysis of variance (Sokal and Rohlf, 1969); 2) relative biomass and % ground cover in relation to relative age span of perennial species (Vasek, Johnson, Lathrop); 3) transect similarity (Phillips, 1959); and 4) regression analysis (Brower and Zar, 1977).

RESULTS

Evaluation of the several measurements and parameter estimates permit evaluation of differences due to construction in the various transects, corridors and study areas (Table 2). *Productivity:* ground cover (%) and biomass (kg/m^2) are almost always lower in the disturbed transects representing the different classes of construction, than in the control transects along the total pipeline and powerline corridors. This was also the case for the 1970 aqueduct but the 1913 aqueduct transects showed little variation. Density tended to show increase along roadedges of pipelines and in all three disturbed transects of powerlines. Primary comparisons of density showed little variation on the 1913 aqueduct but indicated a decrease in the disturbed transects of the 1970 aqueduct. *Diversity:* primary comparisons of diversity were reduced in all disturbed transects compared to controls in summaries of all pipeline and powerline corridors. Diversity values are variable, however, when considering ranges between years of corridor construction. Diversity measures were lower in the disturbed transects of each aqueduct, compared to its control. Secondary comparisons show higher diversity values among the paired respective transects of the 1913 aqueduct than for the 1970 system. *Stability:* there are variable results for both pipeline and powerline corridors but the disturbed transects of the 1913 aqueduct have greater values of

Table 2. Perennial vegetation along utility corridors by year of construction and transect, mean values. K = number of sites for each of the 4 types of transects (3 for aqueducts); R = number of species per site; GC = ground cover; LL = long lived species.

Transect	K	R	Total GC(%)	%GC byLL	Density (#/200m^2)	Biomass (kg/m^2)
PIPELINES						
1958	8					
Control		8.1	4.5	76	99	.062
Berm		5.4	2.8	54	118	.040
Trench		5.1	2.5	46	98	.025
Roadedge		4.4	3.5	55	108	.049
1960	6					
Control		6.3	4.0	78	83	.09
Berm		4.7	2.0	63	80	.018
Trench		4.7	2.3	69	82	.022
Roadedge		3.8	2.0	49	58	.018
1963	8					
Control		3.9	3.2	57	110	.042
Berm		3.7	3.1	43	91	.041
Trench		3.2	2.2	53	68	.021
Roadedge		3.7	2.8	36	140	.300
1970	7					
Control		4.4	3.4	95	110	.042
Berm		2.3	.6	60	91	.041
Trench		2.9	.7	46	68	.021
Roadedge		2.9	1.1	69	140	.030
1973	6					
Control		3.2	2.8	84	42	.085
Berm		3.2	.8	78	42	.011
Trench		4.5	1.3	71	55	.008
Roadedge		4.0	2.1	78	47	.023
POWERLINES						
1924	7					
Control		7.1	4.8	64	97	.075
Wire		8.1	4.0	64	95	.045
Pylon		8.0	4.4	71	127	.052
Roadedge		6.6	4.6	74	77	.051
1933	7					
Control		4.1	3.6	85	60	.056
Wire		4.3	3.3	84	77	.042
Pylon		3.1	2.7	93	98	.033
Roadedge		4.3	2.9	92	89	.034
1944	10					
Control		5.3	3.5	86	76	.068
Wire		4.5	3.8	90	102	.054
Pylon		4.3	3.6	85	80	.059
Roadedge		4.5	4.0	92	98	.065
1952	8					
Control		5.7	6.2	87	121	.090
Wire		5.1	5.9	80	113	.082
Pylon		5.5	3.8	89	78	.063
Roadedge		5.1	4.0	87	68	.052
1968	5					
Control		9.6	5.5	55	76	.087
Wire		9.0	4.4	48	82	.080
Pylon		6.4	5.1	49	74	.074
Roadedge		7.6	3.5	57	85	.059
1969	7					
Control		5.8	4.7	92	80	.090
Wire		5.4	3.5	75	109	.089
Pylon		3.6	3.7	94	131	.045
Roadedge		3.9	3.7	78	112	.050

Table 2. contd

Transect	K	R	Total GC(%)	%GC byLL	Oensity (#/200m^2)	Biomass (kg/m^2)
1977	6					
Control		4.8	3.6	94	70	.065
Wire		5.0	2.7	92	104	.052
Pylon		5.2	1.5	88	52	.021
Roadedge		5.7	3.7	94	103	.061
AQUEDUCTS						
1913	11					
Control		9.7	7.0	53	203	.074
Right of way		7.0	7.1	65	175	.053
Roadedge		6.0	6.9	65	162	.078
1970	15					
Control		7.9	5.8	53	152	.067
Right of way		5.1	2.8	35	76	.030
Roadedge		3.9	2.8	43	83	.030

stability than the 1970 system. All years of the pipelines except 1973 and the years 1933 and 1944 of the powerlines had lower values of stability in disturbed plots. Analysis of variance tests, which were used to test for the degree of recovery of vegetation among the various years of construction were significant for two corridor sets. The 1913 and 1970 aqueducts and the 1924 and 1977 powerlines reached significance at the 5 percent (p.05) probability for paired corridors (years). This test indicated that only these two older lines have recovered enough to show significant stability when compared to the control vegetation. It is of interest to note that Vasek et al., (1975b) reported NS (not significant) for his analysis of variance comparing 1937-1970 powerlines. Lathrop (1979) also showed NS for time spans within the range reported by Vasek et al.

CONCLUSIONS

There were some differences in results between Lathrop and Vasek and Johnson which were evidently due to the greater range of time spans between corridor years and the increased number of corridors sampled (Lathrop 1979). The mean total percent ground cover of corridor study sites, for example, is low compared to Vasek, and Johnson (Table 1). Lathrop (1979) reports a mean % ground cover for 425 transect sites of 3.67 with a standard deviation (sd) of 2.60. Vasek et al., (1975a and 1975b) report mean ground covers of 6.40% for 40 sites (sd=5.60) and 19% for 54 sites (sd=10.74) respectively. The difference can perhaps be explained by the fact that the corridors by Vasek et al. were mostly in creosote bush scrub through Lucerne Valley where vegetation cover is generally greater than in the desert at large. The larger number of corridors of Lathrop (1979), which represented a greater geographic range (Table 1, Fig. 1), would also have a tendency to cut down the average ground cover.

Differences in ground cover, however, do not affect the relative values which are sought in an evaluation of disturbance due to construction practices.

In comparing overall results with those of Vasek and Johnson, their conclusions regarding relative enhancement of vegetation due to construction in some transects and drastic disturbances in others, seem to compare favorably with the findings of Lathrop (1979). The additional corridors, sampled over a wider range of years and physical settings increase the evaluation potential of these articles for management purposes.

In overall and long-term effects of utility corridor construction, there are variable effects of enhancement of vegetation along roadedges, slight enhancement under wires of powerlines and over trenches of pipelines. Areas under pylons of powerlines seem to receive the greatest damage and also show the most variation in vegetation recovery (Vasek et al., 1975a, 1975b, and Johnson et al., 1975). Significant recovery is noticeable where the time span has allowed for considerable regrowth of the older corridor (Lathrop, 1979). Depending on soil type, land form and other physical features of disturbed sites, vegetation recovery progresses at variable rates and stages (Table 3).

Table 3. Mean percent change ($\overline{X}\Delta\%$) of perennial plant biomass at disturbed transect sites compared to the control transect sites for total corridors sampled. Pos, Neg, = positive and negative change respectively; SE = standard error of the mean; K = number of transects.

Total pipelines (6)

Values	Berm		Trench		Roadedge	
	Pos	Neg	Pos	Neg	Pos	Neg
K	3	32	2	34	8	28
Mean	93.66	63.42	84.0	68.35	35.34	60.21
SE	47.32	5.12	71.63	4.01	13.9	4.96

Total powerlines (7)

	Wire		Pylons		Roadedge	
	Pos	Neg	Pos	Neg	Pos	Neg
K	17	33	11	39	12	38
Mean	40.88	36.36	70.91	48.97	110.08	46.38
SE	7.57	3.88	29.33	3.54	31.14	3.80

Total aqueducts (2)

	Right-of-way		Roadedge	
	Pos	Neg	Pos	Neg
K	7	19	5	21
Mean	65.86	68.16	112.4	58.09
SE	37.58	3.83	30.83	6.70

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NATIVE PLANT SEED PROGRAM

Once again, the New England Wild Flower Society is offering for sale freshly collected seeds and spores of over 100 native plants.

This program, an adjunct of the Society's world-wide botanical garden seed distribution, is intended to further the use of native plants in the home landscape. The program will continue on a year-to-year basis as long as the demand for seed remains strong.

Members of the New England Wild Flower Society will receive, in January 1984, a list of seeds available, and all orders must be received by March 1, 1984.

Non-members wishing to receive the Seed Sales List should mail a stamped, self-addressed business (#10 size) envelope by February 1, 1984 to SEED SALES, 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.

WEIR CANYON WALKS OPEN TO THE PUBLIC IN DEC. 1983.

No facilities. Bring water and protective clothing. Walk could be cancelled if fire danger is high (dry and windy weather). No fires or smoking permitted. Directions: Take the Riverside Fwy (91) to Imperial Highway exit. Drive south on Imperial to Nohl Ranch Road and turn left. Drive two miles to Serrano Ave. and turn left. Drive almost one mile to Hidden Canyon Road and turn right. Park along and meet at the end of Hidden Canyon Road. Meeting time is 8:00 a.m. on Saturday, December 10. For update information contact Ferne Cohen of Sea and Sage Audubon at 543-6148 or Gordon Ruser of Sierra Club at (714) 541-0944.

BIOGRAPHICAL SKETCHES OF SCB OFFICERS AND DIRECTORS

Trudy R. Ericson, Treasurer and Membership Chair of SCB

Native Texans, my husband and I moved to Long Island, N.Y. in 1954. Two years later we moved to the San Fernando Valley and became "native Southern Californians." We have lived in Orange County since 1960.

In 1967 I entered California State University, Fullerton, as a freshman, majoring in biological science with emphasis in botany and taxonomy. I received a B.A. in 1974 and an M.A. in 1979.

During my undergraduate and graduate years I worked as curator of Faye A. MacFadden Herbarium at CSUF, a job in which I was very interested and therefore, thoroughly enjoyed. I have very fond memories of those years. In 1979 I joined the secretarial staff of the Biology Department, thus maintaining those ties with those people and things I love most.

Both my husband and I enjoy camping and spend as much time as possible doing this. He is an avid butterfly collector, particularly swallowtails, and I am an avid plant collector so we eagerly look forward to that next trip. I have made extensive collections from California, as well as Oregon, Washington, Idaho, Arizona, Utah, Nevada, and even some from Texas. These are all housed in the herbarium at CSUF.

Although I, just for myself, have enjoyed all the joys and pleasures associated with plant collecting, I hope that my contributions to the herbarium will be an inspiration and of some value to all future botany students.

ANNUAL POTLUCK DINNER AND PROGRAM REPORT

A great time was had by all who attended the annual potluck dinner on Saturday, October 8, 1983, held in the Olney Dining Hall at Pomona College in Claremont, California. The food was, as usual, delicious and the after dinner program on pollination given by C. Eugene Jones was well received.

We'd like to see a larger turnout at next year's dinner, so plan now to attend!

BOARD MEETING BRIEFS

September meeting: held at Los Angeles County Arboretum

* Motion was passed for SCB to print a special "Program Issue" as a mailout in time for the 5 November 1983 Symposium at UCI.
* Symposium fee structure was set at $5.00 for SCB members and for Orange County Chapter CNPS members. Fee for all others will be $10.00.
* Motion passed to hold the SCB Fall Plant Sale at Fullerton College. Thanks are due to Geoff Smith for making this possible. Houseplants and native plants will be sold at this event.
* SCB will soon make available to all members a membership card. This will facilitate rapid identification of members at SCB functions and help with those much needed discounts! Gene Jones is working on this one.
* Motion was passed to have SCB co-arrange field trips with the Orange County Chapter CNPS and the Riverside-San Bernardino County Chapter CNPS for 1984. Representatives of each group will meet in December to work out a schedule. Walt Wright was appointed by President Al to serve as the SCB liaison with the two CNPS chapters. It is felt that such comingling would be beneficial for all three groups, and that we can thereby have some well attended, interesting, and fun field trips.
* ATTENTION FIELD TRIP BUFFS: Your input is wanted on ideas and desires for field trips in 1984. Tell Walt Wright or President Al where you would like to go for day, weekend, or week-long field trips.
* The Orange County Chapter of CNPS presented the SCB Board with a check for $300.00 to help co-sponsor the SCB Symposium. The funds were provided by a special motion of the CNPS State Board.

FIELD TRIPS AND EVENTS

December 4 (Sunday)	Tide Pool Trip. We'll have good -1.2 negative tide, so plan to attend. Contact Al Romspert for more details (714) 773-2428.
December 10 (Sat.)	Weir Canyon. See page 17 for details.

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 1983 dues. All others, please send your checks. This Journal can only be sent to members whose dues are current.

COMING 1983 EVENTS (Details Within)

December 4 Tide Pool Trip

December 10 Weir Canyon Walk

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