Symposium Program

39th Annual Southern California Botanists Symposium:

Origin and Relationships of the California Flora: Was Raven Ravin'?

October 20th, 2012

8:00 am Registration

9:00-9:15 am Introductory Comments (Naomi Fraga SCB President)

9:15:10:00 am Dr. Connie Millar, Senior Scientist, USDA Forest Service, Pacific Southwest Research Station —Geologic, Climatic, and Vegetation History of California

In the same way that learning details of one's family history – the environments, traditions, and life-ways of our ancestors – helps us to understand and appreciate the modern human condition, so does knowledge of the historic contexts of landscapes help us to deeply understand the diversity and ecology of modern flora and fauna. I narrate a story of the geologic and climatic origins of the California region, from the emergence of land out of ancient seas, through mountain-building phases, to the ongoing drama of modern geologic forces. Regional and global geologic dynamics interacted with, and influenced changes in, the climate of the California region. Together, sequences of geologic and climatic variability formed the stage influencing the rise of modern flora. Included among the lessons in this narrative is the important role of past climatic change in shaping California's vegetation, both individual species and community associations. Past climate changes have been continuous, and included many quasi-cyclic patterns with nested time scales (decadal to multi-millennial) that interacted complexly. In modern focus on anthropogenic climate change, we often forget that natural climate processes have been ongoing, and that they interact with new climate drivers in complex and changeable ways. In that our native flora developed in the presence of dramatic climate change, many natural adaptations have evolved within species to cope with these pressures. Conservation and management efforts can be most successful when they work in concert with natural adaptive mechanisms.

10:00-10:45 am Dr. Kathleen Kay, Assistant Professor, UC Santa Cruz—Origin and Diversification of the California Flora

The California Floristic Province exhibits one of the richest floras on the planet, with more than 5500 native plant species, approximately 40% of which are endemic. Despite its impressive diversity and the attention it has garnered from ecologists and evolutionary biologists, historical causes of species richness and endemism in California remain poorly understood. Using a phylogenetic analysis of 16 angiosperm clades, each containing California natives in addition to species found only outside California, we show that CA's current biodiversity primarily results from low extinction rates, as opposed to elevated speciation or immigration rates. Speciation rates in California were lowest among Arcto-Tertiary lineages (i.e., those colonizing California from the north, during the Tertiary), but extinction rates were universally low across California native plants of all historical, geographic origins. In contrast to long-accepted ideas, we find that California diversification rates were generally unaffected by the onset of the Mediterranean climate. However, the Mediterranean climate coincided with immigration of many desert species, validating one previous hypothesis regarding origins of CA's plant diversity. This study implicates topographic complexity and climatic buffering as key, long-standing features of CA's landscape favoring plant species persistence and diversification, and highlights California as an important refuge under changing climates.

10:45-11:10 am Morning break

11:10-11:30 am Bart C. O'Brien, Director of Special Projects, Rancho Santa Ana Botanic Garden— Alternative Delineations of the California Floristic Province

Two mapped alternative hypothesis of the California Floristic Province (CFP) will be presented, compared, and contrasted. One data set covers the traditional CFP from southwestern Oregon through cismontane California to northwestern Baja California, Mexico (Raven & Axlerod, 1978). The new data set removes much of comparatively wetter northern territory as well as the higher elevation areas of the Sierra Nevada (O'Brien et al. (RSABG), unpublished). Floristic data at the family, genus, and minimum-rank taxon levels will be presented and discussed for both alternatives. The endemic plants of the two alternatives will be also be presented and discussed.

11:30 am-12:00 pm Naomi Fraga, Conservation Botanist, Rancho Santa Ana Botanic Garden.—Monkeyflower diversity in California

The genus *Mimulus* L. (Phrymaceae) is widely known for its diversity in western North America. However, *Mimulus* s.l. has recently undergone a taxonomic revision resulting in significantly altered generic concepts. Two genera that have been resurrected; *Erythranthe* Spach and *Diplacus* Nutt., account for nearly all of the species diversity in western North American Phrymaceae. The genus *Erythranthe* (Phrymaceae) has recently been a source of floristic novelty, with eight new species described from California. Here I present a taxonomic overview of Phrymaceae, recognition of five new species of *Erythanthe* native to California and Nevada including description of their geographic distributions, habitats, pollination biology, and conservation status. An evaluation of species discovery and its implications for conservation will be presented, with insight from recent taxonomic studies in *Erythranthe*.

12:00-1:30 pm Lunch break

1:30-1:55 pm Nancy R. Morin, Flora of North America and Tina J. Ayers, Northern Arizona University —Natural History of *Nemacladus*

California Campanulaceae demonstrate many patterns of evolution and geographic distribution proposed in Raven and Axelrod's seminal publication. The campanuloides are North Temperate in origin and came to California in three separate events, one path resulting in highly restricted species in mesic conditions, another in xeric adapted, often edaphically restricted, annual species. Campanuloides here exhibit changes in breeding system, from highly outcrossed to cleistogamous. The lobelioides most likely came via Mexico from South America, underwent an early radiation resulting in three highly restricted, monotypic genera and a later rapid radiation in Downingia; all are found in mesic or aquatic situations. Nemacladoideae is an ancient lineage not closely related to any other Campanulaceae. It may have originated from an ancestor in the mountains of central Mexico, where Pseudonemacladus occurs. Molecular analysis shows that there are two main clades in the annual Nemacladus, one strictly southern California/northern Baja California, the other ranging north in the Coast Ranges and Sierra Nevada and east and north into the Owen's Valley, White Mountains, and Great Basin. Species differ in overall architecture as well as habitat and substrate, but the greatest diversity is in floral morphology. Flowers may be resupinate or not, highly zygomorphic or nearly actinomorphic, (relatively) large or tiny, strikingly marked or entirely white, with simple or elaborate hairs and nectar glands. Different genera or species of Campanulaceae, including Nemacladus, often co-occur in California. In Nemacladus, rapid diversification may have been made possible by shifts in floral morphology and pollinators, driving speciation.

1:55-2:20 pm Fred M. Roberts Jr., CNPS Rare Plant Botanist San Diego Co. Chapter—

Not all butterflies fly: The genus *Calochortus* (Liliaceae) in southwestern California.

The genus *Calochortus*, the mariposa (butterfly) lilies includes about 70 species found in western North America from British Columbia south to Guatamala with its center of diversity in California. The mountains, foothills, and coastal regions of southwestern California offer 15 species of these delightful wildflowers in an assortment of colors and forms. The classic work of Marion Owenbey divided *Calochortus* into three sections, *Calochortus, Mariposa*, and *Cyclobothra*. All three sections are represented in southwestern California. *Calochortus albus*, unique in our region for its white, nodding, globose flower, persistent basal leaves, orbicular, and three-winged capsule, is our only member of Section *Calochortus*. Most of our species belong to the section *Mariposa*, of which *Calochortus splendens, C. clavatus*, and *C. palmeri* are typical members. Members of *Mariposa* are characterized by membranous bulb coats, leaves that usually wither before flowering, three-angled capsules, and petals that fold inward in the evening. Section *Cyclobothra* is characterized by having leaves that wither before flowering, three-angled capsules, and thick and fibrous-reticulate bulb coats. Most flowers have varying degrees of long hairs on the inner petal face. Ours all belong to the *Weediani* group, which is nearly endemic to the southern Californian Floristic Region. *Cyclobothra* includes *Calochortus fimbriatus, C. plummerae,* and *C. weedi*, each with an amazing diversity of color between individuals. The diversity of *Calochortus* species of southwestern California will be explored, with special attention to the *Weediani* group.

2:20-2:45 pm Genevieve Walden, PhD candidate, University of California, Berkeley—The problem of being common: integrating digital and observational data in a taxonomic revision of *Phacelia* sect. *Ramosissimae* (Hydrophylloideae: Boraginaceae)

Phacelia (Hydrophylloideae: Boraginaceae) is a well-represented and recognizable group in the California flora. Commonly encountered and characteristic, a flowering phacelia is immediately diagnosable by amateur and professional botanists. The drawback to this familiarity is that people don't generally key, photograph, collect, or otherwise document plants they already know. *Phacelia* sect. *Ramosissimae* is an especially good example of that phenomenon; familiarity reinforces gestalt as a useful, primary method to identify plants, but does not stimulate curiosity about special or distinguishing qualities (e.g., morphology, substrate, distribution). Plant names, some long treated as synonyms, represent testable hypotheses of evolutionary relationships in *Phacelia* sect. *Ramosissimae* and in the California flora in general. Molecular phylogenetic analyses are being used in combination with observational data, museum specimen collections, and the botanical literature to iteratively revise the taxonomy of *Phacelia* sect. *Ramosissimae*. Metadata from herbaria accessions (annotations, georeferencing) and the literature (protologues, revisions, specimen citations) are being used to investigate spatiotemporal patterns of specimen collection, species discovery and description, and taxon sampling in molecular studies. Integrating observational data from archival sources (field notebooks, checklists, unpublished reports) and online citizen scientist contributions (e.g., photographs, occurrence reports) into the taxonomic revision is an important method to corroborate results from phylogenetic analyses. *Phacelia* sect. *Ramosissimae* demonstrates great value for species identification and (re)discovery of plants in California that share this "common" problem, illustrating key concepts of evolution and ecology in the flora, and highlighting connections between observations, fieldwork, museum collections, and molecular analyses in botanical systematics.

2:45-3:10 pm Afternoon break

3:10-3:50 pm Dr. Kristina Schierenbeck, Professor of Botany California State University, Chico—Phylogeography of California.

Raven and Axelrod's seminal work in 1978 provides the foundation on which California phylogeographers have built an examination of the evolution of ancient, recent, native, and migratory taxa to elucidate the major and minor evolutionary events that shaped the distribution, radiation, and speciation of the biota of California. This talk will examine and interpret the evolutionary history of the biota in California in a geological context, and any subsequent patterns in regional diversity that have emerged across combined phylogenies. Indeed, a number of phylogeographic patterns have emerged, some previously identified are expanded and some new patterns are recognized. A survey of the phylogeography of the flora and fauna of California's diverse biota will be provided by major organismal groups and provide a context in which to ask further questions about evolutionary diversification in an area oddly defined by both physical and political boundaries. Life history characteristics such as dispersal ability at each life stage, generation time, reproductive ability, and ecological characteristics such as degree of habitat specialization, competition, predation, mode of propagule dispersal, and availability of habitat or migration corridors all play an important role in the various outcomes for respective clades. The challenge of phylogeographic studies is to assess changes in population structure of once largely distributed populations or expansion from ancestral propagules into present day population structures shaped by geological and geographical processes. Ultimately, summarizing the phylogeography of California provides a context for landscape level conservation efforts throughout the biogeographic provinces that roughly define the state of California.

3:50-4:50 pm Dr. Peter Raven, Missouri Botanic Garden - Origin and Relationships of the California flora

In 1978, D.I. Axelrod and I presented an analysis of the origins and evolution of the flora of California. The California flora represents a mixture of northern, temperate elements with xeric, southern ones, a composition that had been recognized for more than fifty years by that time. We explained the large number of species and high proportion of endemics in the State on the basis of (1) the equable climate that has prevailed in California throughout most of the Tertiary; (2) what we then thought was an elevation of the Sierra Nevada over several million years; and (3) the appearance of a cold offshore current that resulted in the development of a summer-dry climate over about two million years. Reason (1) accounts for the presence of many relict genera and some families, (3) for the many clusters of recently-derived species, as many careful analyses of individual groups have shown. It now appears plausible that the mountains rose earlier than we thought, but both the antiquity of many lines and their diversification into large numbers of species, often annual, are as obvious to us now as they were 35 years ago. To try to drive these complex factors in a single, oversimplified hypothesis, as done for example by Lancaster and Kay, is both futile and misleading, when the explanations for the evolutionary patterns present in different groups are both highly diverse and intrinsically complex.

4:50-5:00 pm closing remarks.

Evening Events

5:00 – 6:00 pm Poster Session and Mixer

6:00 - 9:00 pm Banquet

Keynote Dinner speaker from 7:00-8:00 pm on *Why does it matter whether or not Raven was ravin'*—Dr. Lucinda McDade, Executive Director and Judith B. Friend Director of Research, Rancho Santa Ana Botanic Garden.