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HISTORICAL RECORDS OF THE BUTTERFLY FAUNA AT A COASTAL SAGE SCRUB SITE IN SOUTHERN CALIFORNIA, USA

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ABSTRACT. Surveys of the butterfly fauna at single sites in endangered coastal sage scrub (CSS) habitat in southern California are rare. Here we resurrect historical records of the butterfly species encountered at Hall Canyon, a relatively undisturbed CSS site in the coastal foothills adjacent to Ventura, Ventura County, California, obtained over an eight-year period of collecting and observation from 1955 to 1962. A total of 57 species was recorded from an area of <5 km^2, representing half of the total species presently recorded for Ventura County. Documentation of past species richness at this site provides important background data for assessing future range shifts and changes in butterfly diversity related to urbanization and its effect on the health of the remaining CSS habitat in southern California.

Additional key words: endangered habitat, species diversity, urbanization, Ventura County.

The composition, distributions and life histories of the butterfly fauna of cismontane southern California have been studied extensively for over a century, and early reference works, especially Comstock (1927) and Emmel & Emmel (1973), have documented the butterfly diversity of the region. Numerous publications, popular guides and checklists have also appeared on the butterfly fauna of different counties in southern California, or localized regions within counties, including Santa Barbara (Miller 1985), Los Angeles (Gunder 1930; Mattoni 1990), Orange (Orsak 1978), San Diego (Brown & Bash 2000; Shiraiwa 2009), and the offshore Channel Islands (Meadows 1937; Langston 1981; Miller 1985), to cite just a few. County butterfly records for southern California, as well as for all of the USA and Mexico, are also available online (http://www.butterfliesandmoths.org/) (Opler *et al*. 2010).

Although a wealth of faunal information is now available for the region, and populations of federally listed species such as the El Segundo blue, *Euphilotes battoides allyni* (Shields) (Lycaenidae), and the quino checkerspot, *Euphydryas editha quino* (Behr) (Nymphalidae) are continually being monitored (e.g. Arnold 1986; Mattoni *et al*. 1997; Pratt *et al*. 2001), there is little published information on surveys of the entire butterfly fauna at single localities in southern California. One exception is the study of Shields (1967) who described the faunal composition and hilltopping behavior of butterflies over a two-year period at a single coastal sage scrub (CSS) site in San Diego County. Comprehensive surveys at single sites within the CSS plant community can provide important baseline data for following changes in faunal composition over time that are related to habitat changes, as recently demonstrated for birds (Chase *et al*. 2005). These surveys are especially important in the endangered CSS community in southern California. Although determining the actual extent of CSS loss from anthropogenic sources is complicated by a lack of documentation of the historic vegetation, especially in the Los Angeles basin (Minnich & Dezzani 1998), estimates range from ~40–90% (Klopatek *et al*. 1979; Westman 1981), with much of this loss occurring within the last fifty years. Although estimates of the extent of the loss vary widely, large tracts of relatively intact CSS habitat can be found today in only a few areas of southern California, principally those that have been off-limits to urban development and agriculture, including Camp Pendleton Marine Corps Base and sections of the Santa Monica Mountains, with the remaining patches often being highly fragmented and degraded by domestic livestock grazing, air pollution (ozone and nitrogen oxides) and invasion of exotic plants (Minnich & Dezzani 1998).

The scant published information on the butterfly fauna at single CSS sites in southern California prompted us to review our collecting and observation records from the mid 1950s to early 1960s at Hall Canyon located in the coastal foothills adjacent to the city of Ventura, Ventura County, California (Fig. 1). The study area is privately owned and undeveloped, resulting in CSS habitat that was relatively undisturbed

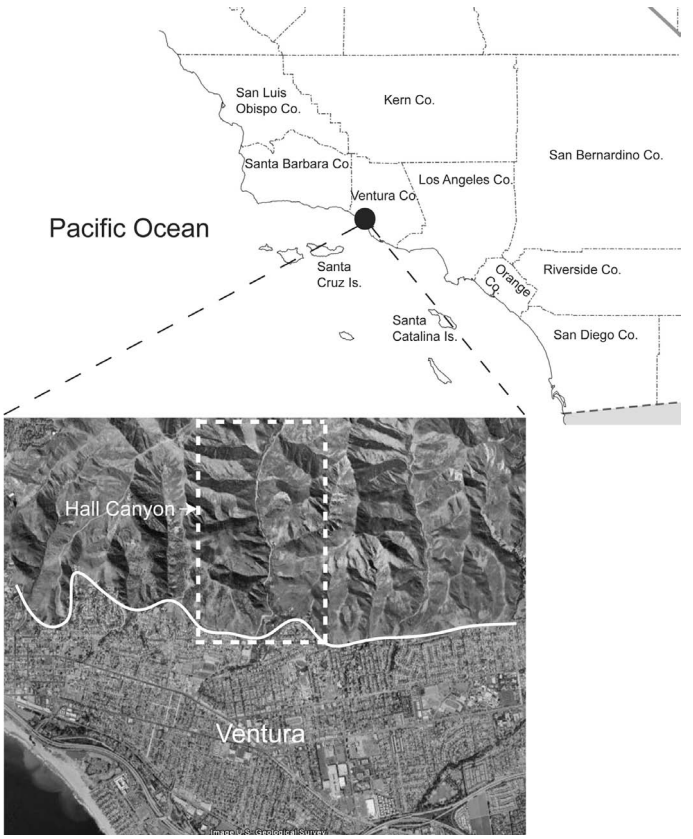

FIG. 1. Map of southern California, USA, showing the location of the survey area in Hall Canyon, Ventura County, California. The expanded portion is a Google™ Earth satellite photograph showing details of the canyon, enclosed by white dashed lines, as of September, 2007. The solid white line shows approximate limits of urban development in the city of Ventura adjacent to the Hall Canyon region; the almost complete absence of development in the coastal foothills is visible.

at the time of our study. During this time, the general public was allowed entrance to the canyon. Today, however, access is restricted. As far as we are aware, no other comprehensive single-site butterfly survey has been reported for Ventura County.

MATERIALS AND METHODS

Study area. Butterfly records were obtained for the Hall Canyon area (Fig. 1) from 1955 to 1962. Hall Canyon is ~3 km in length and ~1 km wide, and is surrounded by coastal foothills and ridges reaching elevations of ~180–335 m above sea level (asl). The mouth of the canyon (34° 16' 50" N; 119° 15' 30" W) is located ~2.5 km from the Pacific Ocean. Prince Barranca drains the canyon during periods of rainfall, but there is no permanent water flow. The elevation of the canyon floor ranges from ~55 m asl at the mouth to ~120 m asl at the upper end. The vegetation type is what has been termed the Venturan floristic association of the southern California CSS plant community, an association that occurs from cismontane San Luis Obispo County to Los Angeles County (Westman 1983; Davis *et al*. 1994). Except for a narrow paved two-lane road in the canyon, and some exposed pipelines, the CSS plant community was relatively undisturbed at the time of our study. The area is subject to periodic wildfires, and in the late spring sheep were brought to the canyon on a temporary basis to graze. A satellite view of the Hall Canyon area with Google™ Earth (Fig. 1) suggests that the canyon remained relatively undisturbed as of September 2007, and most probably remains so to this day. The climate is Mediterranean, typical for coastal southern California, with mild summers and cool winters. Average annual rainfall based on data from 1892 to 2001 is 38.66 cm (= 15.22 in.; Ventura County Public Works Agency).

Collecting and observations. Flight activity for butterfly species observed in the canyon was typical for cismontane southern California (Emmel & Emmel 1973; Mattoni 1990), occurring mainly from February through August. Thus, most of our collecting efforts and records are for this period. Because flight periods for butterfly species are well documented for southern California, we provide specific data only for a few species that were either rarely seen or present at unusual times. Collecting was typically carried out

between ~0900–1300 h and was focused mainly on the canyon floor, although the surrounding hills were often sampled. Usually the entire 3 km length of the canyon was traversed, but systematic sampling in specific transects (e.g. Longcore *et al*. 2004) was not attempted. The haphazard and opportunistic sampling strategy used here, termed "convenience sampling" (Anderson 2001), precludes statistical analysis of the data, and has been criticized on these grounds, but our focus was not on determining population sizes and trends over time of individual species, but rather on obtaining an estimate of species diversity. A conservative estimate of overall collecting effort for each author over the eight-year period is ~230 h. This estimate is based on the 78 recorded collecting trips logged by EP [16 (1958), 21 (1959), 29 (1960), 7 (1961) and 5 (1962)], and assumes an average of ~3 h per trip.

Species were identified using Comstock (1927). We have assigned the species of the problematic *Pyrgus albescens* Plötz / *P. commuis* (Grote) complex (Hesperiidae) to *P. albescens* based on geographic distributions given in Burns (2000). The nomenclature of Pelham (2008) is followed throughout (i.e. the spelling of the original specific epithet is retained and not changed to conform to the gender of the genus name). Where a change in the name of a genus suggested by Pelham (2008) might present confusion, we also include the replaced name in parentheses. Voucher specimens for most species reported here are found either in the personal collection of EP, which is now deposited in the Santa Barbara Museum of Natural History (SBMNH), Santa Barbara, California, or the personal collection of PMJ.

Results and Discussion

In our survey, we recorded 57 species of butterflies at the Hall Canyon study site of <5 km^2 (Table 1), a relatively high value for species richness given that only 115 species are presently recorded for Ventura County (Opler *et al*. 2010). The butterfly diversity for Ventura County itself is also notable given that about 167 butterfly species have been recorded for the entire southern California region, including the desert areas (Emmel & Emmel 1973). The high biodiversity of butterflies in such a small geographic area [Ventura County represents only about 3% of the land area of southern California as defined by Emmel & Emmel (1973)] can be attributed to the diverse biotic communities present, encompassing coastal sand dune habitats to Canadian Zone conifer forests. Of the 57 species recorded at Hall Canyon, 37 of these were also noted by Shields (1967) at Dictionary Hill near Spring Valley in San Diego County, a CSS site where 46 species

Table 1. List of butterfly species recorded from Hall Canyon from 1955–1962. Nomenclature follows Pelham (2008).

HESPERIIDAE
- *Erynnis funeralis* (Scudder & Burgess, 1870)
- *Pyrgus albescens* Plötz, 1884
- *Heliopetes ericetorum* (Boisduval, 1852)
- *Panoquina errans* (Skinner, 1892)
- *Hylephila phyleus phyleus* (Drury, 1773)
- *Polites sabuleti sabuleti* (Boisduval, 1852)
- *Poanes melane melane* (W.H.Edwards, 1869)
- *Ochlodes sylvanoides sylvanoides* (Boisduval, 1852)
- *Ochlodes agricola agricola* (Boisduval, 1852)

PAPILIONIDAE
- *Papilio zelicaon* Lucas, 1852
- *Papilio rutulus* Lucas, 1852
- *Papilio eurymedon* Lucas, 1852 (1805)

PIERIDAE
- *Nathalis iole* Boisduval, 1836
- *Abaeis nicippe* (Cramer, 1779)
- *Colias eurytheme* Boisduval, 1852
- *Colias harfordii* Hy. Edwards, 1877
- *Zerene cesonia cesonia* (Stoll, 1790)
- *Zerene eurydice* (Boisduval, 1855)
- *Phoebis sennae marcellina* (Cramer, 1777)
- *Anthocharis sara sara* Lucas, 1852
- *Pieris rapae rapae* (Linnaeus, 1758)
- *Pontia beckerii* (W. H. Edwards, 1871)
- *Pontia protodice* (Boisduval & Le Conte, [1830])

LYCAENIDAE
- *Lycaena helloides* (Boisduval, 1852)
- *Atlides halesus corcorani* Clench, 1942
- *Satyrium tetra* (W.H. Edwards, 1870)
- *Callophrys perplexa perplexa* W. Barnes & Benjamin, 1923
- *Callophrys augustinus iroides* (Boisduval, 1852)
- *Strymon melinus pudica* (Hy. Edwards, 1877)
- *Leptotes marina* (Reakirt, 1868)
- *Brephidium exilis exilis* (Boisduval, 1852)
- *Cupido* (=*Everes*) *amyntula amyntula* (Boisduval, 1852)
- *Celastrina echo echo* (W.H. Edwards, 1864)
- *Glaucopsyche lygdamus australis* F. Grinnell, 1917
- *Echinargus isola* (Reakirt, [1867])
- *Plebejus acmon* (Westwood, [1851])

RIODINIDAE
- *Calephelis nemesis dammersi* McAlpine, 1971
- *Apodemia virgulti virgulti* (Behr, 1865)

NYMPHALIDAE
- *Danaus plexippus plexippus* (Linnaeus, 1758)
- *Danaus gilippus thersippus* (H. Bates, 1863)
- *Limenitis lorquini lorquini* Boisduval, 1852
- *Adelpha californica* (Butler, 1865)
- *Agraulis vanillae incarnata* (N. Riley, 1926)
- *Euptoieta claudia* (Cramer, 1775)
- *Vanessa virginiensis* (Drury, 1773)
- *Vanessa cardui* (Linnaeus, 1758)
- *Vanessa annabella* (W.D. Field, 1971)
- *Vanessa atalanta rubria* (Fruhstorfer, 1909)
- *Nymphalis californica* (Boisduval, 1852)
- *Nymphalis antiopa antiopa* (Linnaeus, 1758)
- *Polygonia satyrus satyrus* (W.H. Edwards, 1869)
- *Junonia coenia grisea* Austin & J. Emmel, 1998
- *Euphydryas chalcedona chalcedona* (E. Doubleday, [1847])
- *Chlosyne leanira wrighti* (W.H. Edwards, 1886)
- *Chlosyne gabbii gabbii* (Behr, 1863)
- *Phyciodes mylitta mylitta* (W.H. Edwards, 1861)
- *Coenonympha tullia california* Westwood, [1851]

were found in two years of sampling.

In the 1961 season we found that several species whose flight period typically begins in February or later were on the wing in mid-to-late January. These included *Pyrgus albescens* (14 January; *N* = 1), *Colias eurytheme* (14 January; *N* = 6), *Anthocharis sara sara* (15 January; *N* = 1), *Plebejus acmon* (15 January; *N* = 1), *Euphydryas chalcedona chalcedona* (28 January; *N* = 3), and *Coenonympha tullia california* (15 January; *N* = 2). The records for *E. c. chalcedona* are especially noteworthy given that adults of this species usually begin to emerge in April.

Records for several butterfly species at Hall Canyon are based on only a few sightings or vouchered specimens, and thus these species are probably not resident or regular migrants to the area. Two females of *Zerene cesonia cesonia* in the PMJ collection were taken on the same day in the mid 1950s (no date) at the mouth of the canyon. These are apparently new county records. The species is not listed for Ventura County on The Lepidopterists' Society Season Summary website (http://www.flmnh.ufl.edu/lepsoc/) (accessed 14 May 2010) or in Opler *et al*. (2010), although it was found by Ken Davenport just east of Ventura County at Castaic Lake in Los Angeles County on 15 July 2005 [News of the Lepidopterists' Society Vol. 48, Suppl. S1, 2006 (2005 Season Summary)]. *Euptoieta claudia* is only rarely encountered in southern California (Emmel & Emmel 1973) and is listed as a very rare migrant for the Los Angeles area (Mattoni 1990). We recorded three individuals of *E. claudia* during the summer of 1956 or 1957, two sight records (PMJ) and one specimen collected by D. Stover (identification verified by both authors). We recorded only six individuals of *Chlosyne leanira wrighti* over the eight-year period [22 June 1958 (*N* = 1); 3 April 1960 (*N* = 1); 16 April 1960 (*N* = 1); 22 June 1960 (*N* = 1) and 29 June 1960 (*N* = 2)]. Two specimens of *Phyciodes mylitta mylitta* were recorded, both collected on 2 June 1958. Additional sightings by PMJ include *Nymphalis californica*, *Papilio eurymedon*, *Danaus gilippus thersippus*, *Atlides halesus corcorani* and *Adelpha californica*.

Several other species that we recorded deserve special mention. A colony of the coastal species *Panoquina errans* is found at the mouth of the Santa Clara River, only a few kilometers from the mouth of Hall Canyon. However, we also found *P. errans* to be abundant in the summer months at the upper end of the canyon where a semi-permanent water seep supports a stand of its host plant, *Distichlis spicata*. *Echinargus isola* was relatively common in the late 1950s, but apparently disappeared from the study area in the 1960s. Two females of *E. isola* collected in June 1960 at Montecito, ~40 km W. of Ventura in Santa Barbara County, were listed as non-resident, or not a regular migrant, for this region (Miller 1985). Emmel & Emmel (1973) also noted the presence of *E. isola* in unlikely areas of California (Sierra Nevada) during the period of our study, and commented on the dramatic population fluctuations associated with this species in the state.

Three exotic species dependent on introduced food plants were either common (*Agraulis vanillae incarnata* and *Abaeis nicippe*) or periodically encountered (*Phoebis sennae marcellina*) during the study. Emmel & Emmel (1973) noted that *A. nicippe* experienced a reduction in numbers in the Los Angeles area after about 1960, a trend also observed in the Ventura area. This species may now be extirpated from Hall Canyon and surrounding metropolitan Ventura. The fact that the larval food plant, introduced *Cassia* spp., is no longer commonly planted as an ornamental in Ventura probably contributed to the reduction in the population of *A. nicippe*. It is probable that *P. s. marcellina*, which utilizes the same food plant, was affected as well. Another species that was common at the time of our study, *P. zelicaon*, also has experienced a population decline and is now uncommon to rare in the Ventura area. During our survey, we would routinely encounter larvae of *P. zelicaon* on its widespread host plant, wild anise *Foeniculum vulgare*. Because the host plant is still abundant in the area, reduction in numbers of *P. zelicaon* may be related to extensive spraying of insecticides to control invasive exotic insect pests.

At the time of our survey reports of the Citrus-feeding *Papilio cresphontes* Cramer, 1777 (Papilionidae) were beginning to appear from agricultural areas in desert regions of southern California (Emmel & Emmel 1973). This species has continued its range expansion into cismontane southern California, with the first confirmed records for Ventura County reported from Camarillo on 9 May 2007 and subsequently from the city of Ventura on 8 September 2007 [News of the Lepidopterists' Society Vol. 50, Suppl. S1, 2008 (2007 Season Summary)]. Thus it is possible that *P. cresphontes* has now expanded into the Citrus groves present near the mouth of Hall Canyon.

In summary, the inventory of butterfly species presented here documents the species richness at a single site within the Venturan floristic association of CSS from 1955–1962. As an historical record from an endangered plant community in southern California, these data represent an important resource for helping to understand how changes in the health of the CSS ecosystem over time might affect range shifts and changes in butterfly diversity. Substantial habitat

degradation and fragmentation of the CSS have occurred since the time of our study, and the projected continued urbanization of southern California will put additional pressure on remaining CSS habitat. Our data also provide a glimpse of how human activities not directly related to CSS degradation might affect both faunal composition and abundance of butterflies in densely populated urban areas.

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