

## TWO CALIFORNIA CHECKERSPOT BUTTERFLY SUBSPECIES: ONE NEW, ONE ON THE VERGE OF EXTINCTION

DENNIS D. MURPHY AND PAUL R. EHRLICH

Department of Biological Sciences, Stanford University, Stanford, California 94305

**ABSTRACT.** The *Pedicularis*-feeding ecotype of *Euphydryas editha* occurring in the inner Coast Range to the east and south of San Francisco Bay, California, is described as a new subspecies, *E. e. luestherae*. The impact of the California drought of 1976-78 on the new subspecies was less severe than its impact on *E. e. bayensis*. In addition human activities have greatly reduced the amount of habitat suitable for *E. e. bayensis*. The combination has pushed *E. e. bayensis* close to extinction.

Lepidopterists have traditionally considered populations of *Euphydryas editha* (Boisduval) in the San Francisco Bay area to represent two subspecies, *E. e. baroni* Edwards to the north of the Bay, and *E. e. bayensis* Sternitsky on the San Francisco peninsula and in the inner Coast Range to the east and south.

The populations lumped in *E. e. bayensis*, however, represent two separate ecotypes (Ehrlich et al., 1975) which also are phenetically distinct. One set of populations occurs in islands of serpentine grassland in chaparral areas. The primary oviposition plant is the annual *Plantago erecta*, and *Orthocarpus densiflorus* serves as a key secondary foodplant, permitting larvae to survive to diapause size after the *Plantago* senesces. Populations are controlled in a largely density-independent manner by early spring rainfall and *Orthocarpus* abundance. Competition for larval food is absent. Adults are relatively sedentary since larval foodplants and adult nectar sources co-occur.

In contrast the other ecotype is dependent on *Pedicularis densiflora* for oviposition and larval development. Populations occur on slopes where the *Pedicularis* grows as a hemiparasite in the shade of shrubs. There are secondary foodplants (*Castilleja*, *Collinsia*), but none plays an important role in the dynamics of the *Euphydryas* populations. Regulation of population size is often density-dependent, with larvae starving in some years after *Pedicularis* plants are defoliated (White, 1974). Adults are more mobile than those of the *Plantago* ecotype, since nectar sources usually do not co-occur with the larval foodplant (Gilbert & Singer, 1973).

The two ecotypes responded differently to the California drought of 1976-78. The *Plantago* ecotype suffered more or less uniform declines; at least one and possibly several populations went extinct from the combined effects of drought and cattle grazing on their habitats. The surviving populations have been extremely slow in recovering. Some populations of the *Pedicularis* ecotype remained relatively un-

changed in size (Poza, San Luis Obispo Co.), while others nearly disappeared (Del Puerto Canyon, Stanislaus Co.—DP). In contrast to the slow increase of populations of the *Plantago* ecotype since the return of normal rainfall, the Del Puerto Canyon population has increased very rapidly (Ehrlich, Murphy & Sherwood, in prep.).

The type locality of the Bay checkerspot, *E. editha bayensis*, was Hillsborough, California (Sternitsky, 1937), a location near EW on the map (Fig. 1). This name therefore is properly applied to the *Plantago* ecotype. The *Pedicularis* ecotype to the east and southeast of San Francisco is a new subspecies described below.

### *Euphydryas editha luestherae* Murphy and Ehrlich, new subspecies

LuEsther's Checkerspot

**Diagnosis.** This new subspecies is phenetically distinguishable from *Euphydryas editha baroni* and *bayensis* by the overall lighter appearance of the dorsal aspect of the wings due to more extensive red and yellow scaling. Transverse rows of black, red and yellow are found on both dorsal and ventral wing surfaces. Along the outer margin of the upperside of the forewing is a narrow row of red spots bordered on the inside by black, then basal a row of yellow chevrons, then a wider band of black, then a row of yellow spots, followed again by a narrow band of black. The next band is red and is found approximately one-third the distance from the margin to the base of the wing in the postmedian region. Its color and extent is the key character for visually distinguishing this form from other northern California subspecies.

In *E. editha luestherae* this red band is very well developed, being much wider than those rows surrounding it; in some individuals, particularly females, the red band may be lightly suffused with yellow at basal and posterior margins. *Euphydryas editha baroni* and *bayensis* tend toward extreme reduction of this red band or heavy suffusion with, or replacement by, yellow scaling. In less than 2% of nearly 1000 individuals of subspecies *baroni* and *bayensis* before us is this central band of the forewing red and uninterrupted as in subspecies *luestherae*. Of 120 individuals of *luestherae* examined, 7 (5.9%) have interruptions in the diagnostic red band. In light of the great plasticity of wing phenotype within populations of this species, this may be considered a very strong diagnostic character.

A further distinguishing character is found on the venter of the forewing which in *Euphydryas editha luestherae* is heavily suffused with brick red across the basal two-thirds of the wing, disrupting the overall checkered appearance of the total underside characteristic of other North Coastal subspecies. This broad continuous area of red scaling is actually more similar to that found in coastal populations of *Euphydryas chalcedona* and is a particularly good character for discriminating *luestherae* from other *editha* subspecies in the Bay area, though less so in more southern locations.

We have found no consistent genitalic differences between the subspecies.

**Types:** Holotype ♂: California, Stanislaus Co., Del Puerto Canyon, 22 mi W of Patterson, 12 May 1973 (R. W. Garrison).

Allotype ♀: Same data. Types deposited in the American Museum of Natural History (AMNH).

Paratypes: 37 ♂♂ and 38 ♀♀. California: 2 ♀♀, Mt. Diablo, Contra Costa Co., 19 May 1951, T. W. Davies; 6 ♂♂ and 6 ♀♀, Mines Road, Alameda Co., 23, 27 April 1947, T. W. Davies; 25 ♂♂ and 24 ♀♀ Del Puerto Canyon, Stanislaus Co., various dates May 1971, 1973 and 1979, several collectors; 6 ♂♂ and 6 ♀♀ Poza, San Luis Obispo Co., 7 May 1974, P. R. Ehrlich. Pairs of paratypes deposited at the California Academy of Sciences, and United States National Museum. The remainder of the type series is retained in the collection of the junior author at Stanford University. This collection will eventually be transferred to AMNH.

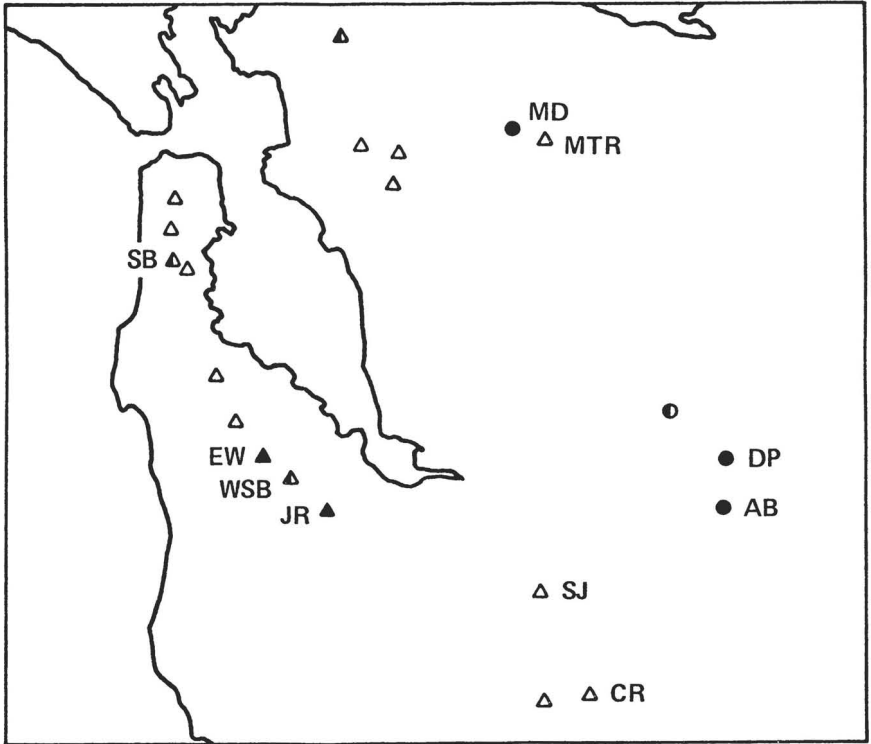


FIG. 1. San Francisco Bay area *Euphydryas editha*: populations with circles—ssp. *luestherae*; with triangles—ssp. *bayensis*. Filled symbols indicate extant colonies, half-filled indicate status unknown, and empty indicate known extinctions. Initials designate sites presently under active study by the Stanford group.

The holotype and allotype are taken from the well-known Del Puerto Canyon colony. Paratypes assigned include both the northern limit of this new taxon at Mt. Diablo, Contra Costa Co., California and the suspected southern limits at Pozo, San Luis Obispo Co., California. Colonies are additionally known from Alameda, San Benito and Monterey Counties, and others almost certainly remain undiscovered. *Pedicularis*-feeding populations in Napa and Sonoma Counties are phenetically intermediate to *baroni* and this new subspecies.

We are pleased to name this beautiful denizen of the Inner Coast Range after LuEsther, whose support of the work of our group on population problems and other factors that endanger butterflies and people has been invaluable.

#### The Threat to *E. e. bayensis*

Entire populations or large portions of habitat of *Euphydryas editha bayensis* have disappeared due to various causes including: 1) construction of a major freeway (Hillsborough, San Mateo, Edge-wood—EW in part), 2) subdivision, construction, and introduction of

non-native plant species (Twin Peaks, Mt. Davidson, Brisbane, Joaquin Miller, San Leandro), and 3) the combined effects of drought and livestock grazing (Morgan Territory Road-MTR, Silver Creek—SJ, Coyote Reservoir—CR, Uvas Valley).

A single natural extinction followed by reestablishment and subsequent extinction was recorded in one of three small populations on Jasper Ridge Biological Preserve on Stanford University campus (Ehrlich et al., 1975).

In 1980 the status of two populations was doubtful. Several trips to San Bruno Mountain (SB) yielded no adults, and we fear that population may be extinct. And, towards the end of the flight season, massive construction operations destroyed most of the remaining habitat of the Woodside population (WS)—making its survival extremely doubtful.

It seems likely that populations of *E. e. bayensis* have always been subject to periodic extinctions from natural causes (weather fluctuations, fires) and were subsequently reestablished by migrants from other populations. In 21 years of work at Jasper Ridge, for example, we recorded a single transfer from the Woodside population 6.4 km away (Ehrlich et al., 1975). However, the number of islands of habitat suitable for this ecotype is now greatly reduced, and the distance between them increased. The Edgewood population is threatened by the development of a golf course, and over the long term it seems unlikely that Jasper Ridge alone can maintain the ecotype (an additional dry year in the last drought sequence might well have exterminated the two remaining populations there—Ehrlich et al., 1980). It should also be noted that while populations of the *Plantago* ecotype that go extinct may be recolonized by individuals from extant populations of the same ecotype, it is not possible on an ecological time scale for individuals from a different ecotype to repopulate vacated *Plantago* habitat. Thus *E. e. bayensis*, once extinct, cannot be reestablished by migration from *E. e. luestherae* populations (Gilbert & Singer, 1973). The two subspecies are clearly separate evolutionary entities.

The Bay Checkerspot is already an endangered butterfly. This sad situation is all the more distressing since its populations are among the best known—ecologically and genetically—of any invertebrate. We are attempting to get official protection for *E. e. bayensis* and are designing some experiments to recolonize areas of suitable habitat that are now vacant. We hope that all lepidopterists will leave the remaining colonies of *Plantago* ecotype undisturbed. All populations are being closely monitored, and those involved in reestablishment experiments will be especially vulnerable. We have dried specimens

taken in the past which we will make available on an exchange basis to collectors who do not have *E. editha bayensis* in their collections.

#### ACKNOWLEDGMENTS

This work has been supported by a series of grants from the National Science Foundation, the most recent of which is DEB76-03873A02.

#### LITERATURE CITED

- EHRlich, P. R., R. R. WHITE, M. C. SINGER, S. W. MCKECHNIE & L. E. GILBERT. 1975. Checkerspot butterflies: a historical perspective. *Science* 188: 221-228.
- EHRlich, P. R., D. D. MURPHY, M. C. SINGER, C. B. SHERWOOD, R. R. WHITE & I. L. BROWN. 1980. Extinction, reduction and stability: the responses of checkerspot butterflies to the California drought. *Oecologia (Berl.)*, 46: 101-105.
- GILBERT, L. E. & M. C. SINGER. 1973. Dispersal and gene flow in a butterfly species. *Am. Nat.* 107: 58-73.
- STERNITSKY, R. F. 1937. A race of *Euphydryas editha* Boisduval (Lepidoptera). *Canad. Entomol.* 69: 203-205.
- WHITE, R. R. 1974. Foodplant defoliation and larval starvation of *Euphydryas editha*. *Oecologia (Berl.)* 14: 307-315.