The Journal of Research on the Lepidoptera 22(4): 254-261, 1983(84)

Biosystematics of the *Euphydryas* of the Central Great Basin with the Description of a New Subspecies

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Abstract. The taxonomic status of Great Basin *Euphydryas* is discussed. Widespread *E. anicia wheeleri* oviposits on *Castilleja chromosa* in pinyon-juniper habitats. *E. editha lehmani* also oviposits on *C. chromosa* and co-occurs with *wheeleri* in a more restricted distribution. Additional populations of *E. editha* occur in alpine habitats in the Toiyabe, Schell Creek, and Snake Ranges of Nevada. These butterflies oviposit on *Castilleja lapidicola* and are described here as a new subspecies, *Euphydryas editha koreti*.

Introduction

In many otherwise well-curated collections of butterflies in major institutions in North America there exists considerable confusion surrounding the taxonomic status of Great Basin *Euphydryas*. Specimens of two species, *Euphydryas anicia* (= *chalcedona*, Scott, (1978) and *E. editha*, are commonly misidentified as one another. There are several reasons for this mix-up including 1)the subspecific names themselves, which refer to both people and places, 2)confusion over the type localities and the geographic distribution of subspecific taxa involved, 3)the great phenetic similarity of the two species where they are sympatric, and 4) the broad sympatry and synchrony of both species, coupled with the ecological and genetic differentiation of one species *E. editha* into two distinct ecotypes.

The purpose of this paper is to unravel some of this taxonomic confusion, first, by identifying the taxa involved, their distributions and what is known of their host plant associations, and, second, by naming a new subspecies of *Euphydryas editha* which is ecologically, genetically and phenetically distinct. A large part of the overall confusion stems from the previously unnamed status of this ecotype.

Distributions

Two ruddy, moderate-sized checkerspot butterfly species are found in the widespread pinyon-juniper-sage scrub of the central Great Basin at elevations between 1600 m and 2500 m. Both species are univoltine, passing winter in diapause as fourth instar larvae, and flying between mid-

May and late June. The two butterflies have distinct but broadly overlapping distributions. *Euphydryas anicia wheeleri* ranges from central Utah (including the Deep Creek and Stansbury Ranges and the western Wasatch Plateau) west to western Nevada (the Stillwater Range, White Mountains, and the Sweetwater Range) where it blends morphologically with what is known as *E. chalcedona macglashanii*, and south from northern Nevada's Pequop Mountains to the Wilson Creek Range, also in Nevada. The distribution of *Euphydryas editha lehmani* is considerably more restricted (Fig. 1). It co-occurs with *E. anicia* in the Toiyabe, Monitor, Toquima, White Pine, Egan, Schell Creek and Snake Ranges of Nevada (the county records of these butterflies are listed by Harjes, 1980). *E. editha gunnisonensis* occurs east of the Wasatch Plateau of Utah and is virtually identical to *lehmani* in all characteristics.

On the high alpine slopes of Wheeler Peak in the Snake Range a small "*nubigena*-like" *Euphydryas editha* ecotype is found at elevations nearly 1500 m above the pinyon-juniper belt. Populations of this butterfly are known only from alpine areas of the Snake Range (Wheeler Peak, Bald Mountain, and the Moriah Table), Schell Creek Range (North and South Schell Peaks) and Toiyabe Range (Bunker Hill). It may also occur in the as yet uncollected alpine of the Deep Creek Range in Utah.

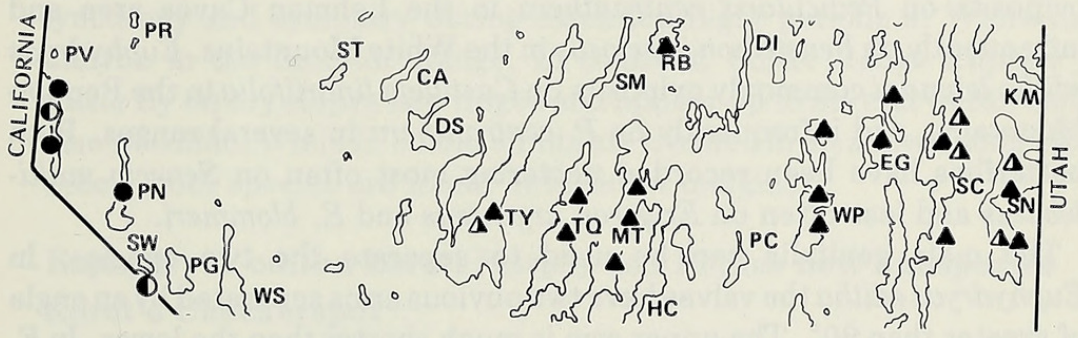

Fig. 1. Distribution of Central Nevada *Euphydryas editha* subspecies: filled circles - *E. editha monoensis*, half-filled circles - *nubigena*, filled triangles - *lehmani* and half-filled triangles - *koreti*. Initials provide identification of ranges for use with conventional map (i.e. EG = Egan Range, PN = Pine Nut Mountains, etc.).

Nomenclature

Most of the confusion arises from numerous samples collected in the Wheeler Peak area of the Snake Range. Here *Euphydryas anicia wheeleri* is common near Lehman Caves, at about 2200 m, while the most frequently collected *E. editha* in the area is taken high, at above 3700 m, on Wheeler Peak. This high elevation insect is not *lehmani*, though the name has been often applied to it.

Like the mountain itself, the naming of *Euphydryas anicia wheeleri* was a

memorial to George M. Wheeler, the leader of a series of U.S. Geographic surveys of this area in the late nineteenth century. The butterfly was named in 1881 by Henry Edwards from specimens taken by members of the expedition. The type locality of *E. anicia wheeleri* iss "Southern Nevada" and was inferred by Bauer (1975) to be from somewhere west of Belmont, Nye County, Nevada, at least a couple of hundred miles from Mt. Wheeler.

Jean Gunder (1929) described *Euphydryas editha lehmani* from specimens provided by Frank Morand also from the immediate vicinity of Lehman Caves, Nevada. The types, in the American Museum of Natural History, are labeled Mt. Wheeler, White Pine County, Nevada. However, the phenotype and capture date, VI-4-29, clearly imply a location low on the mountain. The latinized suffix indicates that this *E. editha* subspecies also was named for the person, Absolom Lehman, an early local resident, rather than the place.

Biology

Through much of their ranges *Euphydryas anicia wheeleri* and *E. editha lehmani* oviposit nearly exclusively on *Castilleja chromosa*, a widespread paintbrush, which is apparently hemiparasitic on the ubiquitous sagebrush, *Artemisia tridentata*. In addition, *Euphydryas anicia* frequently oviposits on *Pedicularis centranthera* in the Lehman Caves area and infrequently on *Penstemon speciosus* in the White Mountains. *Euphydryas editha lehmani* commonly oviposits on *Castilleja linariifolia* in the Pequop Mountains, and infrequently on *P. centranthera* in several ranges. Both butterflies have been recorded nectaring most often on *Senecio multilobatus* and less often on *Erigeron argenteus* and *E. blommeri*.

The male genitalia can be used to separate the two species. In *Euphydryas editha* the valvae have two obvious arms separated by an angle of greater than 90°. The upper arm is much shorter than the lower. In *E. anicia* this angle is considerable less than 90° and the upper arm nearly approaches the lower in length (see Ehrlich and Ehrlich, 1961 and Dornfeld, 1980). Other more superficial characters (listed in order of value) can be used with some confidence to differentiate *E. anicia* and *E. editha* in the Great Basin:

1. A row of white spots on segments 2-7 are found in the dorsal part of the plural region of the abdomen of most *E. anicia*. These may be limited to fewer segments or, rarely, may be totally obscured. *E. editha* never have these spots.

2. *E. anicia* are significantly larger than *E. editha*. Mean forewing length of 20 male *E. anicia* from the Monitor Range is 20.5 mm (s.d.=1.0); Toquima Range, 19.8 mm (s.d.=0.6); Roberts Mountains, 21.8 mm (s.d.=1.0) and Quinn Canyon Range, 20.5 mm (s.d.=0.9). Forewing length of 20 male *E. editha* from the Monitor Range is 17.3 mm (s.D.=1.1); Egan

Range, 17.6 mm (s.d.=0.9); Spruce Mountain, 17.7 mm (s.d.=0.7) and White Pine Range, 16.8 mm (s.d.=0.9). From the Monitor Range, *anicia* are larger than *editha*, $p<<0.0001$. Pooling the 80 individuals of each species from 4 different ranges, *anicia* are also larger than *editha*, $p<0.0001$.

3. Cell CU2 of the forewing is largely solid red on the ventral surface of *E. anicia*. Markings are normally completely lacking in the extra-mesial and mesial bands and first and second over-innermarginal spots (see Burdick, 1958). Only the marginal section of this cell usually is marked with cream or yellow. In contrast the CU2 cell of *E. editha* is well marked with black, red and yellow or cream spotting.

4. The male forewing is distinctly more acute at the apex in *E. anicia* than *E. editha*. The specimen of *E. anicia wheeleri* illustrated in Howe (1975) is not typical in this regard (nor in ground color, the specimen being extremely dark); the forewing shapes of the illustrated males of *E. chalcedona corralensis* and *E. anicia morandi* in the same volume are closer to typical *wheeleri*.

5. Where sympatric, *E. anicia* normally fly slightly earlier than *E. editha* resulting in a condition on the average more worn in the former species. The overlap of flight in both time and space, includes nearly complete synchrony and sympatry during extended flight periods at White Sage Canyon in the Monitor Range. In contrast, Snake Range *Euphydryas anicia* fly on dry slopes and ridges and appear up to several weeks earlier than *E. editha*. While *E. editha* adults are isolated in meadows along Baker Creek, both species are found at meadow margins.

Euphydryas editha koreti Murphy and Ehrlich **new subspecies**
Koret's Checkerspot

Diagnosis. The key characteristic separating this subspecies from others in the Great Basin is size. Twenty males from the Snake Range have a mean forewing length of 14.4 mm (s.d.=1.2) and from the Schell Creek Range 15.4 mm (s.d.=0.9), significantly smaller than other Great Basin *Euphydryas*.

As in all individuals of this species, the dorsal and ventral surfaces of the wings are marked with transverse rows of red, yellow and black spots (Fig. 2). The best character for discriminating this new subspecies from other alpine *E. editha* is on the dorsal hindwing. The outer row of spots (the marginal band) is red as in all *Euphydryas*. This row is bordered basad by a narrow black band, then by a band of yellow spots or chevrons (the submarginal band) in most individuals. (This submarginal band is normally red in Sierra Nevada *E. editha nubigena*.) The next band inside (extramesial band) is red, the next (mesial band) is yellow but may be suffused with red though not to the extent or in as many individuals as *nubigena*. In most *nubigena* all three outer bands of the hindwing are red.

Forewing markings are less consistent but show a similar trend toward increased yellow spotting. Again the outer marginal band is red. The next inner band is yellow, sometimes suffused with red. (In nearly all *nubigena* this second band is red.) A

Fig. 2. *Euphydryas editha koreti*, Murphy and Ehrlich, male above, female below.

broad dark band separates this from a third, wider band of yellow spots. (These spots though yellow are comparatively reduced in *nubigena*.)

Hindwing interspot bands are usually complete, relatively thick and very dark brown to black. Both dorsal and ventral wing markings of *koreti* are as a result more clear, well separated and well defined than those of any other alpine *Euphydryas* including *E. anicia eurytion, E. editha nubigena, remingtoni, lawrencei* or *beani*.

TYPES: **Holotype male:** Nevada, White Pine County, Ridge south of Bald Mtn., 16 July 1980 (G.T. Austin).

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

Paratypes: 70 ♂♂ and 16♀♀. Nevada: *White Pine Co.*, 5♂♂, Ridge above Stella Lake, 11,000', 30 July 1979, G.T. Austin; 32♂♂, 9♀♀, Ridge south of Bald Mtn., 16 July 1980, G.T. Austin; 6♂♂, 2♀♀, Bald Mtn., Snake Range, 24 July 1969, P. Herlan; 21♂♂, 4♀♀, summit North Schell Pk., Schell Creek Range, 17 July 1980, D.D. Murphy; *Lander Co.*, 4♂♂, Mahogany Canyon, [Toiyabe Range], 2 August 1971, P. Herlan; 6♂♂, 1♀, Bunker Hill, Toiyabe Range, 22 July 1982, B.A. Wilcox.

Pairs of paratypes deposited at the AMNH, California Academy of Sciences, Los Angeles County Museum, and the United States National Museum. The remainder of the type series is in the private collection of George T. Austin, in the collection of the junior author at Stanford University, and in the Nevada State Museum, Carson City, Nevada.

This subspecies is named in honor of the late Joseph Koret, in deep appreciation of his support, through the Koret Foundation, of our research.

Discussion

This new subspecies is an ecological analogue of *Euphydryas editha nubigena* from the central Sierra Nevada, occurring abundantly on alpine and subalpine mountaintops and ridges. Females of *E. e. koreti* exclusively oviposit on *Castilleja lapidicola*, a dwarf paintbrush resembling the larval host of more northern *nubigena* populations, *Castilleja nana*. Both subspecies, by virtue of habitat, fly late into the summer. *E. editha koreti* rarely appear before July even in extremely dry years, and often fly well into August in wet years. Adult males may hilltop well above and away from oviposition sites on ridge saddles and summits. Both sexes may be found nectaring as low as the upper margins of the pinyon-juniper forest. Nonetheless, the more than a month difference in peak flight times, larval host choice differences, and up to one mile vertical separation of habitat centers presumably are effective in keeping *E. editha koreti* and *E. editha lehmani* from exchanging genes.

Some preliminary genetic information is available on *Euphydryas editha koreti* (Wilcox, Ehrlich and Murphy in prep.). *Koreti* populations exhibit the highest fraction of monomorphic loci among some 60 populations of

the species sampled across more than a dozen named subspecies. This condition, which has been viewed as indicative of a high degree of isolation, fits our understanding of the geographic distribution of *koreti*. Populations of this subspecies are few in number and extremely isolated in Great Basin Ranges. And, the likelihood of genetic exchange between populations or of natural colonizations of now uninhabited alpine areas, given this present distribution, is vanishingly small.

The genetic distance, as determined by Rogers' index (1972), among alpine Great Basin and Sierra Nevada *Euphydryas editha* populations for 20 structural gene loci shows generally more similarity among the Basin and Sierran groups of populations than between them. However, whether *Euphydryas editha koreti* has a polyphyletic origin is not clear. A scenario where lower elevation populations of *E. editha lehmani* gave rise to extremely convergent high elevation forms independently in each range seems unlikely but not impossible. However, that analysis awaits completion of locus by locus comparisons of high and low elevation populations which are in progress.

The survival of this new subspecies probably has benefitted from the relative inaccessability of its habitat which is distant from urban areas and is topographically extreme. It thus has low potential for agriculture, grazing or most development. But threats to the critical habitat of *E. editha koreti* do exist. The ranges of this region are thought to have substantial mineral potential. For this reason the Schell Creek Range was denied wilderness designation and the Snake Range slated for "further planning" despite the overwhelming biological and scenic value of the regions (USDA, 1979). Clearly, the present atmosphere in the U.S. Department of Interior makes the possibility of creating a Great Basin National Park, as was once proposed for the Snake Range, effectively zero. The combined effects of the extremely narrow range limits of this newly described subspecies and a potential mineral rights free-for-all in its habitat poses a very real threat to Koret's Checkerspot.

Acknowledgments: We thank George T. Austin of the Nevada Museum, Las Vegas, for providing much of the museum material for this study; his generosity and intimate knowledge of Nevada butterflies has been of immeasurable value in our ongoing studies of Great Basin butterflies. Bruce A. Wilcox and Oakley Shields provided some of the specimens for electrophoresis. Pam Higby provided expert isozyme analysis at Langmuir Labs at Cornell University. Karin Mahr kindly aided in preparation of this manuscript. Support for this study came from NSF grants DAR 80-22413 and DEB 78-22413.

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