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Intergradation between *Callophrys dumetorum oregonensis* and *Callophrys dumetorum affinis* in Northwestern U. S. (Lycaenidae)

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Abstract. Populations of *Callophrys dumetorum* from the Washington state area are analyzed using seven wing characters. Samples from the Blue Mountains of Columbia County Washington and Wallowa County Oregon are almost exactly intermediate between *C. d. oregonensis* and *C. d. affinis* (new combination). *C. d. washingtonia* (new combination) from the type locality in Okanogan County in northern Washington is also intermediate, but closest to *affinis*. Eastern Washington specimens from Spokane and Lincoln Counties are intermediate in several traits but are mostly referable to *C. d. affinis*. These populations and *C. d. oregonensis* seem to be stages in the intergradation of *C. d. dumetorum* with *C. d. affinis*.

Introduction

The status of names within *Callophrys (Callophrys)* has been problematical. Tilden (1963) and Clench (1963) made careful studies of *Callophrys*, but they lacked significant samples of *dumetorum* (Bdv.) and *affinis* (Edw.) from the northwest. Scott (1975a), based on small samples collected by Jon Shepard, predicted that *C. dumetorum oregonensis* Gorelick and *C. d. affinis* might be found to intergrade in Washington and that *C. d. washingtonia* Clench is an intergrade population. Adequate samples from Washington have now been obtained by John Justice from four areas of the state. Analysis of these series show a pattern of intergradation between *oregonensis* and *affinis*.

Methods

Individuals were studied from southwestern, northern and eastern Washington, from the Blue Mountains of SE Washington and NE Oregon, and (for *C. d. affinis*) Montana, Wyoming, Nevada, Utah and Colorado. Exact localities and numbers are given in the Appendix. *Callophrys sheridanii* (Carpenter) was caught at most of the localities, but we carefully removed them from the samples before study.

The genitalia do not differ among *Callophrys (Callophrys)* species. The following wing pattern characters were studied because they are the only characters that differ among the samples: 1) dorsal color (gray to completely fulvous); 2) number of cells with white spots on ventral

hindwing (from 0 to 8); 3) shade of green on ventral hindwing (including several shades of green, bluish green, and yellowish green); 4) ventral hindwing fringe (the fringe base varies from brown to nearly white); 5) number of cells with dark (gray to tan) color on anal margin and disc of ventral forewing (from 2 to 4 cells) (the rest of the wing is some shade of green); 6) the shade of color (varying from gray to tan) at the most anterior extension of the non-green part of the ventral forewing; 7) color of the scales on the costal margin of the ventral forewing (from cream colored to light brown). The character states and cross references to a color manual are given in the explanation for Figure 1. If a specimen had some scale loss, it was compared to the reference specimen for each character state with a microscope to compare the intact scale color; if scale loss was extensive the specimen was ignored. Several other characters mentioned by Tilden (1963) that are useful for distinguishing other *Callophrys (sheridanii, viridis* (Edw.), etc.) were found to not vary among (and therefore are not useful for distinguishing) the samples studied in this paper: shape of fore and hindwing, color of the frons, number of white rings on the antennae, and antennal color.

Results

Population phenotypes. Results are shown by histograms (Figure 1). *C. d. oregonensis* from Klickitat and Yakima Counties Washington (type locality Kusshi Creek, Yakima Co. Washington) and *C. d. affinis* from Montana south to Colorado and Nevada (type locality vicinity of Fort Bridger, Wyoming, Brown & Opler, 1970) represent extreme populations in most traits, so the other samples will be compared to them. The eastern Washington (Spokane and Lincoln Counties) sample is intermediate between *oregonensis* and *affinis* in dorsal color and slightly intermediate in ventral hindwing spotting, it is like *affinis* in the ventral hindwing color and fringe, and is more extreme than *affinis* in the three ventral forewing characters; it can be treated as *C. d. affinis*. The Blue Mountains sample (Columbia Co. Washington and Wallowa Co. Oregon), however, is intermediate between *oregonensis* and *affinis* in ventral hindwing fringe, in ventral forewing costa color, and somewhat intermediate in ventral forewing dark color, it is like *oregonensis* in dorsal color and ventral hindwing color, and it is like *affinis* in ventral hindwing spotting and number of ventral forewing dark cells. The Blue Mountains population therefore appears intermediate between *oregonensis* and *affinis*, and cannot be assigned an available name. The sample from Alta Lake in northern Washington (the type locality of *washingtonia* Clench) is intermediate between *oregonensis* and *affinis* in dorsal color, in ventral hindwing spotting, and in ventral hindwing fringe, it is somewhat intermediate but closest to *affinis* in the ventral forewing dark color, and it is like *affinis* in ventral hindwing color, number of dark ventral forewing cells, and ventral forewing costa color. The Alta Lake sample therefore is

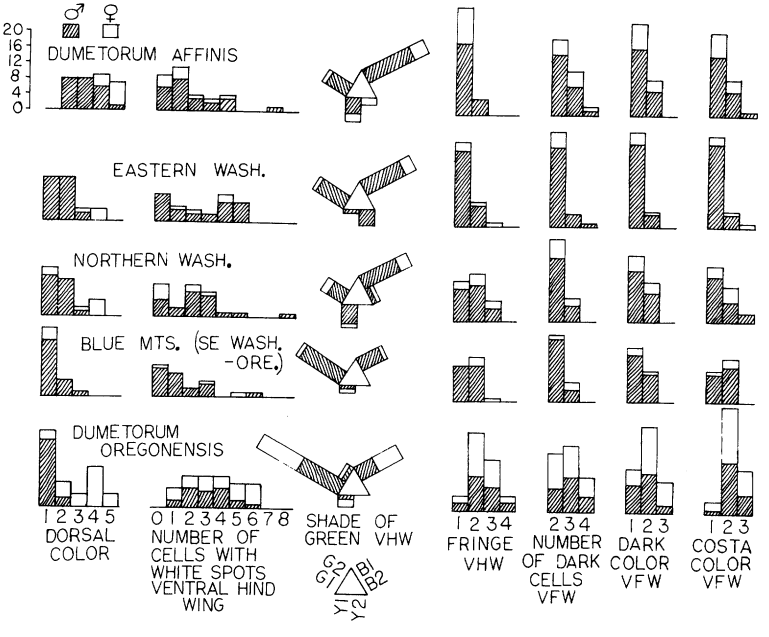

Fig. 1. Histograms showing the number of individuals of each sex from each sample which have each character trait. Colors are from the Color Harmony Manual 1958 (chip number and formal name of color given in parentheses). Character states are 1) dorsal color (1-gray; 2-slightly orange; 3-half orange; 4-mostly orange; 5-completely orange except the margins (chip #5 1a, orange)); 2) number of cells with white spots on ventral hindwing (from 0 to 8 cells have white spots); 3)shade of green on ventral hindwing (G1 green (chip #24 1c, parrot green); G2-dark green (chip #24 ne, pea green); B1-slightly bluish green (chip #23 ia, light paris green); B2-bluish green (chip #22 ia, brite mint green); Y1-slightly yellowish green (chip #24 ia, light lime green); Y2-yellowish green (chip #24½ ia, brite chartreuse)); 4) fringe of ventral hindwing (1-very light, nearly white; 2-dark band at base of fringe thin, tan in color; 3-dark band thicker, browner; 4-dark band thick and brown); 5) number of cells in anal angle and disc of ventral forewing which have dark non-green color (varying from gray to orangish) (from 2 to 4 cells have dark color); 6) color of this dark area on ventral forewing (1-gray (chip #5 ca, pale peach); 2-very slightly tan (between chips #5 ca & 5 ea); 3-slightly tan (chip #5 ea, peach pink))—(ssp. *dumetorum* not treated in this paper also varies to chip #5 ga, peach, and chip #5 nc, burnt orange); 7) color of the costal margin on ventral forewing (1-cream; 2-ochre; 3-brown).

intermediate as well but appears closer to *affinis* than to *oregonensis*. A few individuals from Alta Lake are bluish green ventrally similar to individuals of *viridis* from coastal California.

Behavior. At Alta Lake *C. sheridanii* flies about three weeks earlier than *C. dumetorum washingtonia*. *C. sheridanii* is found mostly in gullies and hillsides at Alta Lake, whereas *C. dumetorum washingtonia* males perch on prominent shrubs on hilltops, where they evidently wait for females; two copulating pairs of *washingtonia* were found on the hilltops. At Alta Lake female *washingtonia* were found to be rather generally distributed. West of Davenport *C. dumetorum* nr. *affinis* perched on low (1-2 m tall) mounds in fairly level sagebrush habitat. In the Blue Mountains of Oregon *C. dumetorum* occurred on a mountain ridge with sagebrush and *Eriogonum*. *C. d. affinis* males commonly perch on sagebrush shrubs on hilltops.

Discussion

In this paper we treat *affinis* as a subspecies of *dumetorum* because the two are allopatric entities that seem to be connected by various intermediate populations, thus qualifying as subspecies. The biology and adult behavior of both are similar as well (Scott, 1975a). *C. d. washingtonia* is one of the intergrade populations, but it is most similar to *affinis*. The Blue Mountains sample is almost exactly intermediate between *oregonensis* and *affinis*, although two characters are closest to *oregonensis* and two others are closest to *affinis*. The simplest explanation of these findings is that these populations are not reproductively isolated and represent subspecies rather than species. We have studied only intergradation between *C. d. oregonensis* and *C. d. affinis*. *C. d. oregonensis* is an intermediate of sorts itself, however, since it too is intermediate between *C. d. dumetorum* and *C. d. affinis* in several characters including dorsal color, shade of green on ventral hindwing, number of dark cells on ventral forewing, and the shade of gray to brown on ventral forewing (Gorelick, 1968; Scott, 1975a).

A population tentatively assignable to *C. d. dumetorum*, because it appears identical to California *dumetorum*, occurs in the Puget Sound area of Washington (we examined 3 from Belfair, 200', Mason Co. Washington, 12 May 1970, coll. Jon Pelham).

To be complete we should mention that *C. d. affinis* appears to blend with "*apama*" (Edw.) *homoperplexa* Barnes & Benj., so that *homoperplexa* and *apama* are almost certainly subspecies of *dumetorum* also. *C. dumetorum homoperplexa* is nearly identical to California *C. dumetorum* in wing pattern (*homoperplexa* was not named until 1923, over fifty years after its discovery, because lepidopterists labeled it *dumetorum*), which suggests that *homoperplexa* and *apama* are subspecies of *dumetorum*, because most Lepidoptera species are based on morphological similarity. Another point of similarity is that *dumetorum* and *homoperplexa* are the only *Callophrys (Callophrys)* that are polyphagous: *dumetorum* feeds on *Eriogonum* (Polygonaceae) and *Lotus* (Leguminosae), *homoperplexa* on

Eriogonum and *Ceanothus* (Rhamnaceae) (many ovipositions seen in 1980 by J. Scott). Furthermore, intergrade populations between *homoperplexa* and *affinis* seem to occur in south central Wyoming (specimens in the American Museum), in the Gunnison-Delta-Mesa County area of western Colorado, and in southern Utah. Larger samples are needed from these areas to better document the intergradation. *C. d. washingtonia, C. d. affinis* and some *C. d. dumetorum* populations tend to mate on hilltops, whereas some *C. d. dumetorum* populations (especially in southern California) and *C. dumetorum homoperplexa* tend to mate in gully bottoms (Scott, 1975b).

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Appendix: Localities Studied

C. d. oregonensis individuals were from the type locality and vicinity in southern Washington: Satus Pass, Klickitat Co., 17 May 1970, 17 m, 18 f; Mill Creek, Yakima Co., 17 April 1970, 2 m, 2 f; Kusshi Creek, Yakima Co., 17 May 1970, 1 f; Fort Simcoe, Yakima Co., 17 May 1970, 1 f (all J. A. Justice). *C. d. washingtonia* individuals were from the type locality in northern Washington: Alta Lake, Okanogan Co., 2 May 1970, 1 f, 6 May 1970, 4 m, 1 f, 7 May 1970, 6 m, 1 f, 23 May 1970, 5 m, 1 f, 11 June 1967, 5 m, 3 f (all J. A. Justice). A third sample was from eastern Washington: 4 mi. NW Fairchild Air Force Base, Spokane Co., 31 May 1970, 3 m, 1 f; 6.4 mi. N. Davenport, Lincoln Co., 31 May 1970, 21 m, 2 f (all J. A. Justice). A fourth sample was from the Blue Mountains of southeastern Washington and adjacent northeastern Oregon: Trail 2138 from Godman Springs, Columbia Co. Washington, 8 July 1970, 2 m; Skyline Road S. of Godman Springs, Columbia Co. Washington, 8 July 1970, 2 m; 1-5 mi. N. of Bear Canyon Campground, Wallowa Co. Oregon, 9 July 1970, 3 m, 1 f; Forest Service Road N-50, 15 mi. SW Troy, Wallowa Co. Oregon, 21 June 1970, 12 m, 2 f (all J. A. Justice). The sample of *C. d. affinis* was from southwestern Montana (1 m, 1 f), northwestern Wyoming (3 m, 2 f), central Nevada (4 m), northern Utah (1 m, 3 f), and western Colorado (14 m, 3 f), all collected by J. A. Scott and J. A. Justice.