

CONCERNING THE NAME *ANTHOCARIS COLORADENSIS*
HY. EDWARDS WITH DESIGNATION OF A NEW SUBSPECIES
(PIERIDAE)

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Rocky Mountain populations of *Euchloe ausonides* Lucas found east of the continental divide have long been given the subspecies designation *coloradensis*. During a study of speciation in butterflies of the Black Hills of South Dakota and coniferous forest relicts on the western Great Plains, the original description and type specimens of *coloradensis* were found to lend considerable ambiguity to that name. Edwards' (1881) original description of *coloradensis* emphasized dorsal characters of the wing which are generally useless when large series of Rocky Mountain material are considered. Likewise, the two syntype specimens labelled "Colorado" by Edwards and now in the American Museum of Natural History type collection were the only Rocky Mountain representatives in Edwards' hands at the time of the description. Further, one of them represents a minority morph when the larger view of Rocky Mountain *E. ausonides* is considered.

Thus, in describing a new subspecies from conifer forest relicts on the western Great Plains, I am first rediagnosing the name *coloradensis*, based on eastern Rocky Mountain populations in Colorado and Wyoming (Opler, 1968).

Euchloe ausonides coloradensis (Hy. Edwards)

Anthocaris coloradensis Hy. Edwards, 1881, p. 50.

Anthocharis (sic) *ausonides*: Cary, 1901, p. 310.

Anthocharis (sic) *ausonides* var. *coloradensis*: Beutenmüller, 1892, p. 168; 1898, p. 241.

Synchlœ ausonides coloradensis: Dyar, "1902" 1903, p. 7.

Euchloe ausonides coloradensis: Barnes & McDunnough, 1917, p. 3. Barnes & Benjamin, 1926, p. 7. Klots, 1930, p. 154. Leussler, 1938, p. 76. Defoliart, 1956, p. 98. Brown, Eff, and Rotger, 1957, p. 181. Puckering & Post, 1960, p. 8. dos Passos, 1964, p. 49. Opler, 1968, p. 69. Shields, Emmel, & Breedlove, 1969 (1970), p. 31. Ferris, 1971, p. 15. Johnson, 1972 (1973), p. 28.

Euchloe belia var. *belioides* race *montana* Verity, "1905-1911," p. 339.

Euchloe ausonides montana: Barnes & McDunnough, 1917, p. 3 (placed as synonym of *coloradensis*).

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Diagnosis. Distinguishable from *E. a. ausonides* Lucas and the following subspecies by a combination of traits: Under surface, hindwings: (1) green patch between veins RS and M₁ usually isolated on both wings, sometimes only on one; located more caudodistally toward marginal green patch between veins M₁ and M₂, not usually joined to more basad markings as on new subspecies. (2) White patches along inner angle generally invaded by white ground color, not recognizable as six alternating large and small smoothly edged patches as on new subspecies. (3) Green marbling less invaded by white ground color than on *ausonides*, more than on new subspecies. Under surface, forewings: (4) black crescent, distal end discal cell, at largest touching both veins R₂ and M₃. Upper surface, forewings: (5) apical area, black patterning darker than *ausonides* and new subspecies.

Male. Upper surface of the wings: white; forewings, dark apical-subapical markings: discal cell, distal end, black crescent. Hindwings darker in areas where "marbling" occurs on under surface.

Under surface of the wings: white; forewings, olivaceous apical-subapical markings; discal cell, distal end, black crescent. Hindwings white with green "marbling" incised by white ground color; distal green patch between veins M₁ and M₂ usually isolated, white surrounding it.

Length of forewing: 20 mm (male type).

Female. Wing characters identical with male.

Length of forewing: 21 mm (female type).

Male genitalia (Fig. 2). Tegumen flattened dorsally; uncus long, gradually tapered, often exceeding posterior end of valvae; valvae, apex directly slanted anteriorly toward dorsal articulation, anterior margin slightly concave, aedeagus, phallobase, noticeable "two-step" structure.

Female genitalia (Fig. 2F). Not useful for infraspecific diagnosis.

Early stages. Not specifically studied in relation to nominate *E. ausonides*, see Opler, "1974" (1975).

Food plant. In Colorado, *Arabis*, *Descurainia* (Cruciferae) (Shields, Emmel, & Breedlove "1969" (1970)); *Arabis*, *Sisymbrium*, *Erysimum* (Cruciferae) (Remington (1952)).

Types. In the American Museum of Natural History collection (AMNH): type, male, "Colorado"; type, female, "Colorado." In his description of *coloradensis*, Edwards implies that he possessed only two specimens at the time of his description but knew of, or had seen, others. The collection of the American Museum of Natural History contains two specimens labelled by Hy. Edwards as male type and female type. Because the female type does not accurately represent the *coloradensis* morph I hereby designate the male type as the lectotype.

Distribution. By present diagnosis and material examined: Rocky Mountains of Colorado and Wyoming east of the continental divide. Varying somewhat westward in Colorado and blending into *a. ausonides* in western Wyoming (Ferris, 1971; Opler, 1968).

Flight period. Early June–September (in Colorado (Brown, Eff, & Rotger, 1957)).

Remarks. 126 specimens were submitted to character analysis (see Discussion). 20 male and 10 female genitalia were examined.

***Euchloe ausonides palaeoreios* Johnson new subspecies**

(Figs. 1 & 2A, D)

Anthocharis ausonides: Cary, 1901, p. 310.

Euchloe ausonides ausonides: Puckering & Post, 1960, p. 8.

Euchloe ausonides coloradensis: Leussler, 1938, p. 76. Johnson, 1972 (1973), p. 28.

Diagnosis. This subspecies can be differentiated from *E. a. coloradensis* by a combination of traits: Under surface, hindwings: (1) green patch between veins RS and M₁ usually heavily joined with median green patch between veins M₁ and

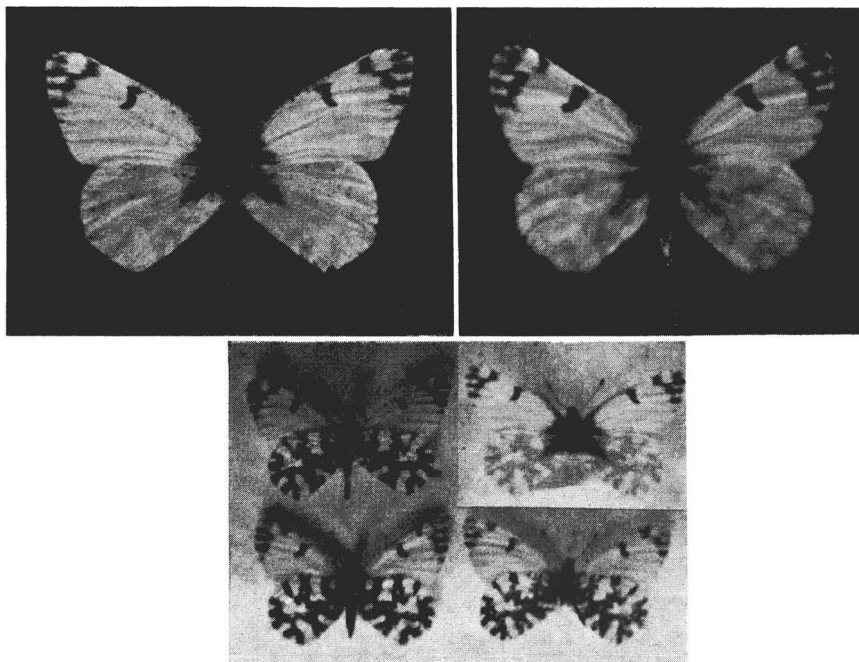


Fig. 1. *E. a. palaeoreios*, n. subsp. Top upper left: upper surface of the wings, holotype, male. Top upper right: upper surface of the wings, allotype, female. Bottom, center (variation in under surface of the wings): top left, under surface of the wings, paratype male, Black Hills near Sundance, Wyoming; top right, same, upper surface of the wings; bottom left, under surface of the wings, allotype, female; bottom right, under surface of the wings, holotype, male.

M_2 (along cell) on one, or more often both wings and located more cephalobasad on the wing. (2) White patches along inner angle most often appear as six smoothly edged patches alternating large and small. (3) Edges of green marbling quite entire and noticeably smooth. Under surface, forewings: (4) black crescent, apical end, discal cell, nearly always broadly edging veins R_2 and M_3 with black, sometimes extending to vein CU_1 . Upper surface, forewings: (5) apical area black patterning lighter and less extensive.

Male. Upper surface of the wings: white; forewings, dark apical-subapical markings; discal cell, distal end, expansive black crescent. Hindwings darker in areas where "marbling" occurs on undersurface.

Under surface of the wings: white; forewings, olivaceous apical-subapical markings; discal cell, distal end, expansive black crescent. Hindwings white with green marbling little invaded by white ground color, distal green patch between veins M_1 and M_2 usually joined cephalobasad with green patch between M_1 and M_2 .

Length of forewing: 20 mm (holotype); 15 mm–22 mm (\bar{x} = 19 mm), paratype males.

Female. Wing characters identical with male.

Length of forewing: 18 mm (allotype); 21 mm–23 mm (\bar{x} = 22 mm), paratype females.

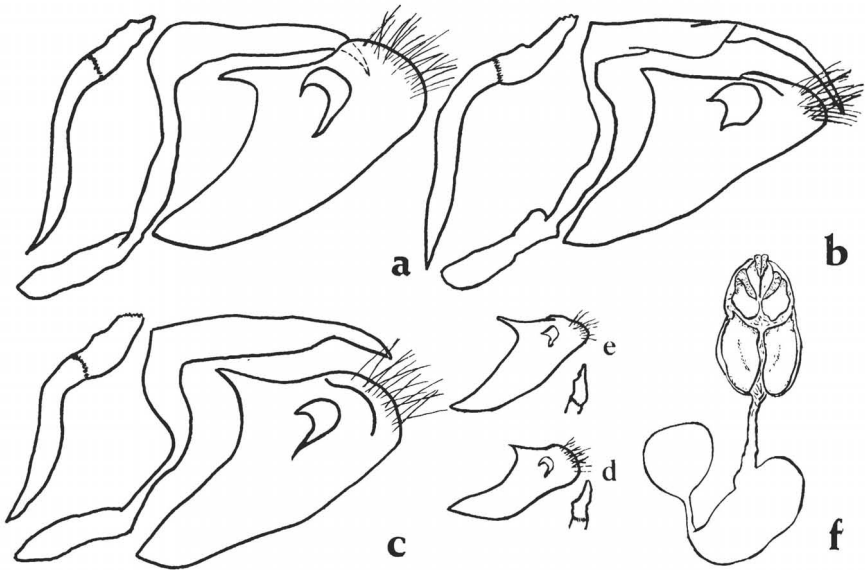


Fig. 2. (A) Genitalia, *E. a. palaeoreios*, n. subsp., holotype (AMNH), lateral view, aedeagus removed. (B) Male genitalia, *E. a. coloradensis*, Hy. Edwards "Colorado" (AMNH, K-27), lateral view, aedeagus removed. (C) Male genitalia, *E. a. ausonides* (Boisduval), Oakland, California (AMNH, K-3), lateral view, aedeagus removed. (D) Valva, lateral view, *E. a. palaeoreios*, Sundance, Wyoming (AMNH, KJ #171b). (E) Same, *E. a. coloradensis*, Laramie, Wyoming (AMNH, KJ #23). (F) Female genitalia, *E. a. ausonides*.

Male genitalia (Fig. 2A, D). Tegumen somewhat humped, rounded dorsally; uncus, apex more toothed than tapered; valvae, anterior margin deeply concave, apex broad, not immediately slanted toward dorsal articulation; aedeagus, phallobase, roughly tapered.

Female genitalia. As typical of the species (Fig. 2F). Not useful for infraspecific diagnosis.

Early stages and foodplant. Not specifically known.

Types. Holotype, male, Spearfish Canyon, near Spearfish, Lawrence Co., South Dakota, 26 June 1939 (AMNH). The genitalia are in vial K. Johnson #4. Holotype and genitalia are in the collection of the American Museum of Natural History. Allotype, female, Spearfish Canyon, nr. Spearfish, Lawrence Co., South Dakota, 26 June 1939 (AMNH). Genitalia are in vial K. Johnson #6. Deposited as above. Paratypes (all Lawrence Co., South Dakota): American Museum of Natural History, males: 3 specimens, near Lead, 24 June 1939; 1 specimen, near Lead, 22 June 1939 (all A. C. Frederick); 2 specimens, Spearfish Canyon, 26 June 1939 (collector unknown); 1 specimen, Spearfish Canyon, 1 July (year unknown) (collector unknown); 1 specimen, Ice Box Canyon, 28 June 1939 (A. C. Frederick). Females: 1 specimen, Custer State Park, 1 July 1962 (F. H. Rindge). Los Angeles County Museum, male: 1 specimen, near Lead, 24 June 1939 (A. C. Frederick); female: 1 specimen, near Lead, 24 June 1939 (A. C. Frederick). Allyn Museum of Entomol-

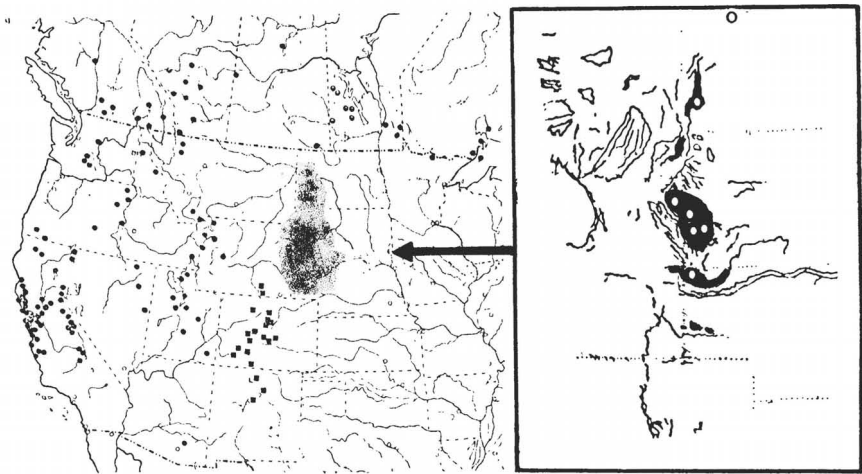


Fig. 3. Distributional and post-Pleistocene relationships of *Euchloe ausonides* subsp. Left: Distributions of *E. a. ausonides* (circles), *E. a. coloradensis* (squares), and *E. a. mayii* (half-open circles) in continental United States and southern Canada. Eastward, in United States, pepper-dotted configuration shows probable maximum extent of post-Pleistocene conifer forest on the present-day western Great Plains: darkly blackened areas—upland climax conifer forest, lightly dotted areas—pine-juniper open woodland. Right: Inset of area on western Great Plains, showing western North Dakota, South Dakota, and Nebraska, plus Colorado, Wyoming, and Montana. Blackened areas show present montane conifer forests surviving on the Great Plains; black lines show present distribution of scarp woodlands in same region. Known localities of *E. a. palaeoreios* are indicated by white dots. Left of figure adapted from Opler (1968) by permission.

ogy, male: 1 specimen, Terry Peak, 24 June 1939 (A. C. Frederick); female: 1 specimen, Terry Peak, 24 June 1939 (A. C. Frederick).

Distribution. The Black Hills of South Dakota and Wyoming, the Pine Ridge of Nebraska (not recently recorded), the Little Missouri River escarpments in North Dakota, and possibly the Lone Pine Hills in South Dakota and Montana, and the Killdeer Mountains in North Dakota. One plains population is known, represented by two specimens from Port Roch (sic) [Port Roche], Saskatchewan, deposited in the AMNH.

Flight period. Dates on specimens range from 5 June–8 July.

Remarks. 26 specimens, 7 male and 7 female genitalia were studied from the Black Hills; 6 specimens, 3 male and 3 female genitalia were studied from Saskatchewan; 28, 3, and 3, respectively from Manitoba; 27, 3, and 3 from Alberta; and 5, 1, and 1 from Ontario (all AMNH). Six specimens, 2 male and 2 female genitalia were studied from Nebraska (Canyon Region north of Harrison, Sioux County), obtained from Ohio State University. I have included in the distribution of this entity only those areas where wing characters and genitalia are very near the description, not areas where the phenotype diverges or possibly intergrades with other taxa or unnamed populations.

Etymology. The name is from the Greek words *palaeos* (old) and *oreios* (of the

mountains), meaning "of the old mountains." It refers to the relict montane areas from which this stock evidently originates (Johnson, 1976).

DISCUSSION

Following the retreat of the Wisconsin glacier, vast climax pine forests connected the present-day Pine Ridge and Wildcat Hills of Nebraska, Black Hills of South Dakota, and escarpments of western North Dakota. They also extended eastward along the present Niobrara River and into east-central Nebraska (Johnson, 1976).

These conifer areas had formerly been mixed with prevailing boreal forest at the beginning of the glacial retreat (11–12,600 years ago) but became predominant about 10,000 years ago as the boreal forests were destroyed. Climax pine forests then became centered on the western uplands of these states and connected westward to the Rocky Mountains through moist pine-juniper woodland. Thus, an eastward region of the Rocky Mountain environment was present at that time. However, a gradual trend toward aridity eventually cut off these eastern forests from their western allies and eventually from each other, leaving all as sub-climax pine woodlands except the climax-forested Black Hills. This trend was gradual at first, a slow drying and decimation of the moist savannahs lasting perhaps 5–7000 years. However, an arid cycle (supplemented by fire) beginning about 2000 years ago rapidly isolated the present relicts themselves, which have continued to decline.

Because of this, the subspecies *palaeoreios* just described is distinct from Rocky Mountain *E. a. coloradensis* and, similarly, does not bear the relationship to Canadian prairie populations that might be inferred from present-day geography. Thus, the new name *palaeoreios* helps define both *E. a. coloradensis* and the divergent phenotype from the Ridings Mountains of Manitoba represented by the name *E. a. mayii* (Chermock & Chermock).

It has not been my intention to introduce confusion into the identity of Canadian prairie populations by naming *palaeoreios*. I believe the geographic origin of *palaeoreios* is distinct from both *E. a. coloradensis* and Canadian prairie populations which probably have a more northern origin. Thus, I have included Canadian material in its distribution only where the genitalia are almost identical to topotypical dissections. The former climax forests, spoken of above, had widespread pine-juniper savannah extensions, of which the central Nebraska "arm" has been the only one studied by paleobotanists (Johnson, 1976). These former extensions are now plains, but the distinct affinity of their remaining montane butterflies to those in the scattered relict scarp woodlands is clear.

The frequencies of six traits, in 132 specimens from six populations,

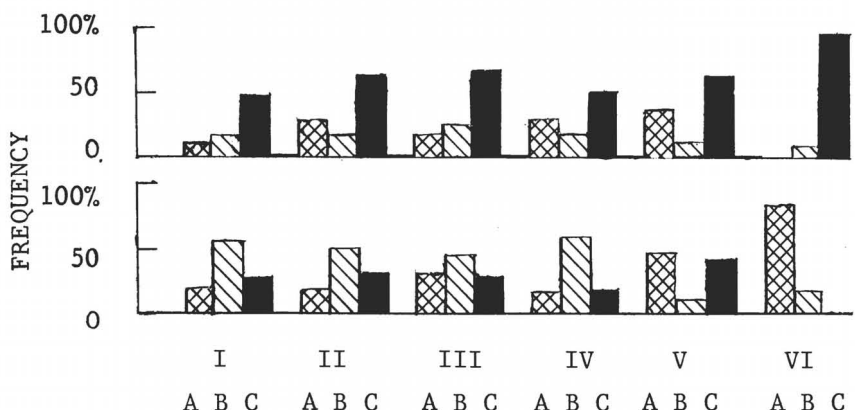


Fig. 4. Frequency distributions of six traits in two major wing characters in *Euchloe a. coloradensis* and *E. a. palaeoreios*. Six populations are analyzed: (I) Rocky Mountain National Park, Colorado ($n = 39$); (II) Gunnison County, Colorado ($n = 14$); (III) Custer County, Colorado ($n = 20$); (IV) Edwards' Type Series ($n = 10$); (V) Laramie, Wyoming ($n = 23$); (VI) Black Hills, South Dakota, Wyoming ($n = 26$). Categories: (bottom) Relationship of patch between RS and M_1 with that median between M_1 and M_2 —(A) These patches joined on both wings, (B) one wing, (C) neither wing. (top) Relationship of patch between RS and M_1 with that marginal between M_1 and M_2 —(A) These patches joined on both wings, (B) one wing, (C) neither wing.

are compared in Fig. 4. In the new entity, the marked relationship of (1) joining of the patch between RS and M_1 with that median between M_1 and M_2 , and (2) its cephalobasad location away from any joining with the marginal patch between M_1 and M_2 is clear. These frequencies also show how the Edwards female type did not accurately represent the *E. a. coloradensis* morph. This problem has been solved by the designation of a lectotype. The exact number and subsequent location of specimens Edwards knew of at the time of the description are unclear. However, a total of 10 specimens in the American Museum of Natural History Collection bear his handwriting and the label "Colorado." These have been included in the above analysis to place his apparent idea of the name in a more realistic perspective. This, and the rediagnosis, should make the name *coloradensis* much more meaningful for future workers; the new name *palaeoreios* serves to separate *coloradensis* from the distinct scarp woodland and prairie population which has a distinct eastern origin.

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