A REVIEW OF THE *AMBLYSCIRTES* WITH THE DESCRIPTION OF A NEW SPECIES FROM MEXICO (HESPERIIDAE)

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Genus *Amblyscirtes* Scudder 1872

Generotype *Hesperia vialis* Edwards

Amblyscirtes Scudder, Rept. Peabody Acad. 1871, 75 (54), 1972.
Stomyles Id. op. cit. 76 (55). Generotype *Pyrgus textor* Hubner.
Mastor Godman, Biol. Cent.-Am., Rhop. II. 567, 1900. Generotype *Mastor anubis* Godman.
Epiphyes Dyar, Jn. N. Y. Entomol. Soc. XIII, 132, 1905. Generotype *Pamphila carolina* Skinner.

Antennae short, approximately ½ costa; shaft checkered, white under the club; club stout, ¼ shaft; apiculus obtuse from thickest part of club, short equal width of club; nudum 4/6. Palpi cylindrical, upturned; second segment with shaggy vestiture, third segment slender, smooth, and vertical, almost as long as second in most species. Mid and hind tibia spined. Males with either brands or a stigma on the upper side of the primaries. Primaries in most species similar in both sexes. Costa flattened; apex rounded-rectangular; outer margin strongly rounded except toward anal angle; cell about two-fifths as long as wing. Secondaries rounded, in most of the species longer through cell than in most of the related genera. Genitalia rather peculiar in that the saccus and aedoeagus, in most species, are very long, extending nearly to the thorax.

There are 31 species in the genus *Amblyscirtes*, and for the present I do not recognize any subspecies. Biological and distributional data as well as basic morphological characteristics indicate to me that several previously recorded subspecies actually represent valid species and are thus treated in this review. The members of this genus are placed into four groups by Evans and I follow his arrangement. The first group is the Exoteria Group which is characterized by the presence of more or less ochreous scaling on the upper surface of the wings and by the presence of at least grey scaling on the lower surface of the secondaries. A cell spot or spots may or may not be present. The second group is the Aesculapius Group which is characterized by being greyish-brown to black, with a well marked single or double cell spot on either the upper or lower surface of the primaries, and discal spots or grey scaling on the lower surface of the secondaries. The third group is the Vialis Group which is characterized by being greyish-brown to black, with no cell spot on the primaries, and by having discal spots or greyish scaling on the lower surface of the secondaries. The fourth group is the Phylace Group which is character-

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ized by having no markings on the lower surface of the secondaries. There is considerable diversity superficially among members of this genus, however with the exception of *simius* Edwards there is a remarkable similarity in the male genitalia of all of the species. Often worn specimens are very difficult to identify even after an examination of the genitalia due to this great consistency in basic form.

The genus *Amblyscirtes* reaches its greatest development in the southwestern part of the United States with Texas being the metropolis as 13 species have been recorded from that state. There have been two species recorded from Canada, 22 from the United States, 19 from Mexico, and one from Cuba. Records from Central and South America are lacking indicating that this is strictly a North American genus.

Key to the Species

1a. Under surface of secondaries marked with at least grey scaling; usually apical spots present 2
1b. Under surface of secondaries unmarked; apical spots absent 27
2a. Upper surface with more or less ochreous scaling 3
2b. Upper surface without ochreous scaling, greyish-brown or brownish-black 12
3a. Primaries with a pale cell spot; 15–20 mm wide 4
3b. Primaries without a cell spot; 13–14 mm wide 9
4a. Under surface of primaries cell brown; cilia checkered; a distinct broken stigma present 5
4b. Under surface of primaries cell orange; cilia checkered or uncheckered; an indistinct broken stigma or brands present 8
5a. Under surface of primaries have a suffused white discal area in space 1b 6
5b. Under surface of primaries lacks suffused white discal area in space 1b 7
6a. Cilia white, faintly checkered; primaries 15–18 mm wide; distinct white discal and cell spots on lower surface of secondaries ..... *folia*
6b. Cilia sordid white, uncheckered; primaries 20 mm wide; indistinct yellowish spots in spaces 2 and 3; lower surface of secondaries uniform chocolate brown with faint indication of yellowish discal spots ..... *raphaeli*
6c. Cilia brown; primaries 16 mm wide; white discal spots present on lower surface of secondaries ..... *insulae-pinorum*
7a. Cilia distinctly checkered brown and white; distinct white spots present on primaries and lower surface of secondaries; primaries 15–18 mm wide ..... *exoteria*
7b. Cilia indistinctly checkered light brown and white; all spots on both wings indistinct or absent; primaries 18–20 mm wide ..... *immaculatus*
8a. Cilia white, uncheckered; apex on lower surface of primaries and of lower surface of secondaries grey, overscaling the usual white markings; indistinct broken stigma present; primaries 13 mm wide ..... *simius*
8b. Cilia checkered light and dark brown; grey overscaling on apex and lower surface of secondaries sparse; distinct brand present against cubitus and between origins of veins 3 and 2 and under vein 2; primaries 13 mm wide ..... *cassus*
9a. Maculation on primaries and lower surface of secondaries usually prominent, especially the apical spots 10
9b. Maculation on primaries and lower surface of secondaries reduced and in some cases nearly absent 11

10a. Maculation on primaries and lower surface of secondaries prominent, with an ochreous spot or spots in space 1a and sometimes 1b on the upper surface of primaries; maculation on lower surface of secondaries usually clear white; brands between origins of veins 3 and 2 and under vein 2 inconspicuous ..... *aenus*

10b. Maculation on primaries and lower surface of secondaries somewhat reduced with no spot in space 1a or 1b; maculation on lower surface of secondaries never clear white, usually dusky; brands prominent on upper surface of primaries ..... *erna*

10c. Maculation on primaries reduced, prominent on lower surface of secondaries, often clear white; generally ground color darker than in above two species; brands prominent on upper surface of primaries ..... *linda*

11a. Lower surface grey; heavy grey overscaling on lower surface of secondaries; cilia sordid white; coloration on upper surface pale brown; brands on primaries conspicuous ..... *oslari*

11b. Lower surface dark brown; grey overscaling very sparse on lower surface of secondaries; cilia dusky; maculation ochreous on upper surface of primaries; brands inconspicuous ..... *fluonia*

12a. A distinct single or double cell spot on upper or lower surface of primaries .. 13

12b. No cell spot on upper or lower surface of primaries 20

13a. Brands present on upper surface of primaries 14

13b. Grey stigma present on upper surface of primaries; primaries 11 mm wide; cilia usually plain brown; maculation on primaries faint or absent; lower surface of secondaries dark brown, overscaling sparse, with distinct tiny white discal and cell spots present ..... *elissa*

14a. On the upper or lower surface of the primaries there is a distinct white spot in space 1b 15

14b. On the upper or lower surface of the primaries there is an obsolete olive spot in space 1b, or it may be absent; cilia checkered; maculation on primaries above olive scaled; brands under cubitus and vein 2 inconspicuous; on the lower surface of the secondaries there is a heavy grey overscaling causing the white markings to be blurred; primaries 13 mm wide ..... *samoset*

15a. Cilia checkered 16

15b. Cilia not checkered 19

16a. On the lower surface of the secondaries there is distinct grey scaling and small white spots; veins are concolorous with rest of wing 17

16b. No distinct spots on upper surface of secondaries; on the lower surface of the secondaries grey scaling absent; veins more or less white on the lower surface of the secondaries, with the discal spots united into a band; primaries 14 mm wide; brands inconspicuous ..... *aesculapius*

17a. There is a small white cell spot and discal spots on the upper surface of the secondaries; on the upper surface of the primaries there are spots in spaces 4 and 5; on lower surface of secondaries there is an extra spot in 1c under origin of vein 2 18

17b. No spots on the upper surface of secondaries; on the lower surface of the secondaries there is grey overscaling with more or less distinct white spots present; there may or may not be an ochreous spot in space 1b on the primaries; brands inconspicuous; primaries 13 mm wide ..... *texanae*

18a. Small, primaries 13 mm wide, pale in coloration; upper and lower cell spots large and usually fused on primaries; brands narrow under cubitus and vein 2; on the under surface of the primaries the costa and apex, as well as the entire under surface of the secondaries, densely overscaled with violet-grey scales ..... *prenda*

18b. Larger, primaries 14 mm wide, darker in coloration; upper and lower cell spots small, seldom fused; narrow brands under cubitus and vein 2 in-

distinct; violet-grey overscaling greatly reduced on lower surface of wings ... *tolteca*

19a. Primaries 13 mm wide; brands distinct under cubitus and vein 2; on the lower surface of the primaries the costa and apex is heavily overscaled with dull yellow as is the entire lower surface of the secondaries; indistinct rusty brown maculation on the lower surface of the secondaries ... *carolina*

19b. Primaries 13 mm wide; brands distinct under cubitus and vein 2; dull yellow overscaling on lower surface of wings sparse or absent, with the ground color rusty brown; maculation on lower surface of secondaries dull yellow and distinct ... *reversa*

20a. Cilia white, not checkered; primaries 13 mm wide; brands short and fairly broad under cubitus and vein 2; maculation on upper surface of primaries conspicious, extending into space 1b; there are discal spots on the upper surface of the secondaries; on lower surface of secondaries there is heavy greenish overscaling with the usual whitish discal spots present ... *nereus*

20b. Cilia more or less checkered; no spot in space 1b on the primaries; no spots present on the upper surface of the secondaries ... 21

21a. Lower surface of secondaries abnormal, variegated with large white, dark brown and greenish patches; primaries 12 mm wide; brands long and narrow under cubitus and vein 2; apical spots prominent on primaries, other maculation reduced ... *nysa*

21b. Lower surface of secondaries normal with grey scaling and white spots usually present or at least indicated ... 22

22a. On the lower surface of the secondaries the grey overscaling is heavy and the white discal spots are conspicuous and dark edged; primaries 12 mm wide; brands short and fairly broad under cubitus and vein 2 ... *eos*

22b. On lower surface of secondaries the grey overscaling is sparse and the white discal spots are poorly defined or absent ... 23

23a. Apical spots on primaries abnormal, increasing in size from space 6 to space 8, an additional spot in space 9, and white streaks on the costa at the ends of spaces 8–11; primaries 13 mm wide; very short brand present under vein 2; spots in spaces 2 and 3 on primaries indistinct or absent; on lower surface of secondaries grey overscaling indistinct, with only the slightest indication of discal spots ... *vialis*

23b. Apical spots on primaries normal, dots in spaces 6, 7, and 8, and no streaks on the costa ... 24

24a. Usually prominent spots in spaces 2 and 3 on the primaries ... 25

24b. Usually no spots in spaces 2 and 3 on the primaries ... 26

25a. Spot in space 2 rounded on the primaries; upper cell spot on primaries often present; primaries 12–14 mm wide, not produced; brands well developed, against cubitus and a long streak under vein 2; on lower surface of secondaries grey overscaling fairly heavy, with the discal spots sordid white to dusky ... *celia*

25b. Spot in space 2 V-shaped on the primaries; no upper cell spot on primaries present; primaries 12–14 mm wide, produced; brands well developed under cubitus and vein 2; on lower surface of the secondaries the grey overscaling is sparse, with the discal spots grey and often rather indistinct ... *belli*

26a. Primaries 11 mm wide; brands reduced to a tiny dash above vein 2 against the cubitus; apical spots present on primaries; grey overscaling fairly sparse on lower surface of secondaries, with greyish, indistinct discal spots present ... *alternata*

26b. Primaries 12–14 mm wide; long brand present under vein 2; no maculation present on the upper surface of primaries; on lower surface of primaries indistinct apical spots are present; on lower surface of secondaries there

Figs. 1, 2. *Amblyscirtes raphaeli* n. sp. Holotype male. Candelaria Loxicha, Oaxaca, Mexico, 7 August 1969 (E. C. Welling; A. M. N. H.)

may be present some scattered white scales and the slightest indication of of discal spots ..... *florus*

27a. Palpi below orange or yellowish white 28

27b. Palpi below black with ochreous hairs intermixed; cilia on primaries yellowish-white, on secondaries dark brown; narrow stigma broken at vein 2 and extending just below that vein ..... *anubis*

28a. Cilia sordid white in the males, sordid white to grey in the females; palpi below orange in the males, yellowish-white in the females; males have a broad and short brand covering vein 2 near its origin on the primaries ..... *phylace*

28b. Cilia orange in both sexes; palpi below orange in both sexes; males have a narrow broken grey stigma from origin of vein 3 to vein 1 ..... *fimbriata*

Exoteria Group

1. *Amblyscirtes folia* Godman 1900

Synonym: *tutolia* Dyar 1913: Mexico.
Type locality: Mexico.
Distribution: MEXICO. Colima: Salada, VI-67. Guerrero: Acahuizotla, IX-60; Chilpancingo; Mexcala, VII-5-56; Tierra Colorado, IX-61. Jalisco: Ajijic, IX, X-65, 66; Lake Chapala, VI.

This species is readily recognized by the well marked discal and apical spots on the primaries, the whitish streak in space 1b on the lower surface of the primaries, and the clear white discal and cell spots on the lower surface of the secondaries. It occurs in semi-tropical and tropical areas of western Mexico.

2. **Amblyscirtes raphaeli** Freeman, **new species**

MALE (Upper Side). Primaries dark brown, with an indistinct apical spot in space 6. A distinct yellowish spot in space 2, and another similar spot in space 3 situated outward from the spot in space 2. A fairly broad, slightly broken, black stigma extending from space 1 to the end of the cell. Fringes yellowish-white, not checkered. Secondaries dark brown, immaculate. Fringes yellowish-white, not checkered.

MALE (Under Side). Primaries, brown, with the discal spots distinct. Apical spot in space 6 present but very indistinct. A broad suffused yellowish area in space 1b

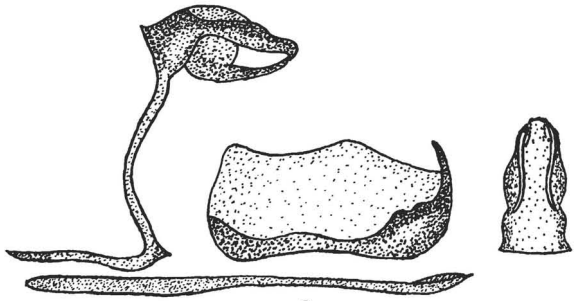

Fig. 3. Male genitalia. *Amblyscirtes raphaeli* n. sp. Paratype. Candelaria Loxicha, Oaxaca, Mexico, 21 July 1969 (E. C. Welling; H. A. F.).

extending from the middle of the space to the outer margin. Secondaries dark chocolate brown, with practically no overscaling present. The slightest indication of three yellowish discal dots, otherwise immaculate.

Thorax dark brown, both above and below. Abdomen dark brown above, somewhat lighter below. Head brown. Palpi brown with yellowish intermixed scales present. Antennae, shaft brown above, below indistinctly ringed with narrow yellow lines; club, basal half greyish above, yellow below, terminal end and apiculus black above, lighter below with the apiculus being tan.

Wing Measurements: Primaries: base to apex, 20 mm; apex to outer angle, 14 mm; outer angle to base, 15 mm. Secondaries: base to end of vein 3, 15 mm; center of costa to anal angle, 14 mm. Total expanse: 39 mm.

Type Material: Holotype. Male, Candelaria Loxicha, Oaxaca, Mexico, 7 August 1969, obtained from Eduardo C. Welling, will be placed in the American Museum of Natural History, New York. There are nine male paratypes, all obtained from Eduardo C. Welling, from the same location, 21 July 1969, 6 August 1971, 11 August 1971, 14 August 1971, 20 August 1971, and 25 August 1971, which will remain for the present in the H. A. Freeman collection.

This new species is the largest known *Amblyscirtes*. Previously *immaculatus* Freeman represented the one with the greatest expanse of wings as the primaries from the base to the apex were 18 mm wide, while in *raphaeli* that distance is 20 mm. *Raphaeli* slightly resembles *immaculatus*, however there are four basic differences: (1) *raphaeli* has discal spots in spaces 2 and 3 on the primaries which are absent in *immaculatus*; (2) *raphaeli* has a yellow apical spot in space 6 which is absent in *immaculatus*; (3) *raphaeli* has on the lower surface of the primaries a broad suffused yellowish area in space 1b which is absent in *immaculatus*; and (4) there are basic differences in the genitalia.

This new species is named in honor of my good friend Senor Raphael Aguirre, manager of Hotel Covadonga, south of Ciudad Valles, S. L. P., who has given me much assistance in my collecting in Mexico.

This distinctive species can be readily recognized by its large size and the chocolate coloration on the lower surface of the secondaries. Ap-

parently this is a jungle species as the known specimens were collected in such a habitat in Oaxaca.

3. *Amblyscirtes immaculatus* Freeman 1970

Type locality: Salada, Colima, Mexico.
Distribution: MEXICO. Colima: Salada, VI-67. Guerrero: Acahuizotla, VII-65.

This species is conspicuous by its large size and the reduction of all maculation. It flies in company with *folia* and seems to prefer semi-jungle areas as its natural habitat.

4. *Amblyscirtes nisulae-pinorum* Holland 1916

Type locality: Isles of Pines, Cuba.
Distribution: CUBA. Isles of Pines.

Evans considered this species to be a subspecies of *folia*, however morphological and biological characteristics indicate to me the distinctness of the two species. Data available indicate this species to be endemic to the Isles of Pines, Cuba.

5. *Amblyscirtes exoteria* (Herrich-Schaffer) 1869

Synonyms: *nanno* Edwards 1882: Arizona. *marcus* Strand 1907: "Delagoa Bay."
Type locality: not known.
Distribution: UNITED STATES. *Arizona.* Apache County: White Mountains, VII-4-51. Cochise County: Carr Canyon; Chiricahua Mountains, VI-28-42; Huachuca Mountains, VIII; Onion Saddle Pass, Chiricahua Mountains, VII-11-60; Paradise, VII-10-60. Graham County: Fort Grant; Mount Graham. Pima County: Madera Canyon, VII-6-10-60, VII-10-15-64; Mount Lemmon, VII-60. MEXICO. Jalisco. Veracruz: Orizaba, VI. Sonora: northern section, VI, VII.

This species can easily be separated from *folia* by the absence of the whitish streak in space 1b on the lower surface of the primaries. Personal observations and recorded data reveal that this species is usually found in semi-arid mountainous regions of Arizona and northern Mexico, and rarely in the mountains of Veracruz.

6. *Amblyscirtes simius* Edwards 1881

Type locality: Oak Creek and Pueblo, Colorado.
Distribution: UNITED STATES. *Arizona*, VI. *Colorado.* Oak Creek Canyon. Baca County: Regnier, VI. El Paso County: Fountain Valley School, V. Larimer County: Ft. Collins, V-18-69. Pueblo County: Pueblo, VII. Saguache County: Saguache, VIII-2-67. *Nebraska.* Sioux County: VII. *New Mexico.* Colfax County: Raton, VII-15-45. Grant County: Silver City, VIII. *Texas.* Armstrong County: Palo Duro Canyon, IV, V-42. Jeff Davis County: Davis Mountains, VII-30-53.

Superficially *simius* resembles other members in its group of *Amblyscirtes*, however its genitalia do not approach the basic genitalic

pattern of other members of this group. This is a species confined to more or less semi-arid mountainous terrain in the western section of the United States.

7. *Amblyscirtes cassus* Edwards 1883

Type locality: Mount Graham, Arizona.
Distribution: UNITED STATES. *Arizona.* Hannegan, VII-6-51. Cochise County: Chiricahua Mountains, VI-28-42, VII-1-51; Ramsey Canyon, VI-28. Pima County: Madera Canyon, VII-9-60, VII-10-64. *New Mexico.* Sandoval County: Jemez Springs, V. *Texas.* Jeff Davis County: Davis Mountains, VI-13-60. MEXICO. Baja California north, VI. Jalisco: Ajijic, X-7-65. Sonora, VI.

Cassus prefers mountainous canyons for its normal habitat, with southern Arizona being the center of distribution. Rarely is it found in northwestern Mexico. The orange cell area on the lower surface of the primaries as well as the double cell spot on the primaries makes this small species easy to recognize.

8. *Amblyscirtes aenus* Edwards 1878

Type locality: Southern Colorado.
Distribution: UNITED STATES. *Arizona.* Cochise County: Chiricahua Mountains, VII-10-60; Paraside, VII-10-60. Pima County: Madera Canyon, VII-6-60, VII-12-64; Mount Lemmon, VII-15-64. *Colorado.* Baca County: Regnier, VI. Boulder County: Boulder, V–VI; Bounder Canyon, VI; gluch south of Jamestown junction, V-31-54; Lefthand Canyon, VI-12-54; Mesa Trail, V-16-54; Six Mile Canyon, V-12-54; north Soda Springs, VI-8-53; Sugar Loaf Mountain, V-29-55. El Paso Canyon: Rock Creek, V-21-32. Jefferson County: Chimney Gulch, VII; Clear Creek Canyon, V-17-29; Coal Creek, VI-14-38; Plainview, 4–6, VII. *New Mexico.* Quay County: Tucumcari, VI-1-42. Sandoval County: Jemez Springs, VI. *Texas.* Armstrong County: Palo Duro Canyon, V-9-42. Brewster County: Alpine, IV-20-62, VI-16-60; Chisos Mountains, VIII-9-61, VII-10-62. Jeff Davis County: Davis Mountains, VI-10-60; Fort Davis, VI-9-42. Palo Pinto County: Palo Pinto, III-31-50. MEXICO. Durango: Rio Nazas Valley near El Rodeo, VIII-18-22-68 (Peter Hubbell), AMNH, (new record for Mexico).

This is a rather variable species as to the extent of the white discal spots on the lower surface of the secondaries. Some specimens have these spots clear white and very prominent, while others may have them dusky and almost obsolete. It occurs rather commonly over the southwestern and midwestern parts of the United States, usually in the mountains.

9. *Amblyscirtes erna* Freeman 1943

Type locality: Palo Duro Canyon, Texas.
Distribution: UNITED STATES. *Kansas.* Barber County: V-5-45. *Oklahoma.* Cimarron County: Black Mesa, V-3-47, V-21-49. Comanche County: Cache, VI-27-42. Woods County: Freedom, IV-21-46. *Texas.* Armstrong County: Palo Duro Canyon, IV-30-44, V-10-42, VII-28-42. Brewster County: Alpine, VI-10-42. Gray

County: Lake McClellan, V-14-44. Roberts County: Miami, VIII-6-42. MEXICO. Tamaulipas: Ciudad Victoria, VIII-15-16-62.

Erna was placed by Evans as a synonym of *fluonia* Godman based on a specimen that I sent him plus one in his collection labelled Texas, ex coll Fruhstorfer. This was done without any knowledge of the biology of the two species and insufficient morphological data—actually the two are very distinct. Both *fluonia* and *erna* fly in the mountains just west of Ciudad Victoria, Tamaulipas, Mexico, with *erna* occurring at slightly lower elevation than *fluonia* normally; however, they have been collected together in several locations. *Erna* prefers rocky canyon areas, whereas *fluonia* is usually located in shaded spots on the mountain sides. There are differences in the genitalia; however the easiest point of distinction between the two species is found on the lower surface of the secondaries, as *fluonia* has rather heavy overscaling giving the wing a mottled appearance, while *erna* has very light overscaling giving a uniform appearance to the wing. Usually the discal spots are better defined on this surface of the wing in *erna* as rarely are they discernable in *fluonia*.

10. *Amblyscirtes linda* Freeman 1943

Type locality: Hope Hill Farm, Faulkner County, Arkansas.

Distribution: UNITED STATES. *Arkansas.* Carroll County: Eureka Springs, V-3-64. Faulkner County: Hope Hill Farm, VI, VII; Pinnacle Springs, VII-2-42. *Missouri.* Barry County: Cassville, V, VI. *Oklahoma.* Comanche County: Cache, VII-20-42, VIII-16-42. Washington County: Blue Springs, IV-67.

This species was treated as a subspecies of *aenus* by Evans from which it is very distinct both morphologically and biologically. Morphologically the maculation is very different and the brands on the primaries are more prominent in *linda* than they are in *aenus*. Biologically *linda* is a woods species, whereas *aenus* is confined to more semi-arid, mountainous terrain. In its western range *linda* overlaps *erna* in the Wichita Mountain section of Oklahoma.

11. *Amblyscirtes oslari* Skinner 1899

Type locality: Chimney Gulch, Colorado.

Distribution: UNITED STATES. *Arizona.* Pima County: Tucson, VII-6-60. *Colorado.* Archuleta County: Arboles, VI-25-55; Juanita, V-13-36. Boulder County: Boulder, VI; Boulder Canyon, VI-13-53; Four Mile Canyon, VI-7-53; gulch south of Jamestown Junction, V-31-54; Lefthand Canyon, VI-10-53; Six Mile Canyon, V-29-54. El Paso County: Williams Canyon, VII-7-31. Jefferson County: Chimney Gulch, V-28-18; Coal Creek; Golden, VI. Park County: Mill Gulch, V. *Kansas.* Barber County: IV-28-46, V-27-45. *New Mexico.* Sandoval County: Jemez Springs, VI. *North Dakota.* Slope County: Bad Lands, VI-11-61. *Oklahoma.* Woods County: Freedom, IV-21-46, VI-9-45. *Texas.* Armstrong County: Palo Duro Canyon, IV, V, 42. Baylor County: IV-30-70. Brewster County: Alpine, VI-5-42. Carson County: White Deer, V-20-43. Jeff Davis County: Fort Davis, VI-3-40.

This species has a rather wide range over the midwestern section of the United States. It is readily recognized by the reduced maculation on the primaries and on the lower surface of the secondaries. It seems to prefer semi-arid, rather mountainous terrain for its natural habitat.

12. *Amblyscirtes fluonia* Godman 1900

Type locality: Mexico.
Distribution: MEXICO. Federal District: Zoquiapan, VIII-6-56. Guerrero: Amula; Chilpancingo; Xucumanatlan. Hidalgo: Jacala, VIII-1-63. Jalisco: Ajijic, VIII, IX, 65; Lake Chapala. Michoacan: San Juan Pura, VI-27-47. Morelos: Cuernavaca, VII-28-61. Oaxaca: Oaxaca, VI-22-64. Puebla: Acatlan, VIII-20-64. Tamaulipas: Ciudad Victoria, VIII-62.

Fluonia is readily separated from *erna* by its darker coloration and by the heavy, mottled, overscaling on the lower surface of the secondaries. *Fluonia* usually flies in areas of fairly high elevation. In the mountains west of Ciudad Victoria, Tamaulipas, *erna* usually occurs at an elevation of 2850 feet, whereas *fluonia* occurs from 3600 to 7000 feet. *Fluonia* is fairly common in the state of Jalisco as well as in the general vicinity of Oaxaca, Oaxaca.

Aesculapinus Group

13. *Amblyscirtes elissa* Godman 1900

Type locality: Guerrero, Mexico.
Distribution: MEXICO. Chiapas: Acapetahua, III-60. Guerrero: Acahuizotla, VII-60; Dos Arroyos; Iguala, VIII-51; Rincon; Tierra Colorada. Morelos: Jantepec, VI-42.

This small, dark greyish-brown, species can be readily recognized by the reduced maculation and grey stigma on the primaries, and by the lower surface of the secondaries being dark brown with tiny distinct white discal and cell spots present. Apparently *elissa* is a rather rare species confined mainly to Guerrero and Chiapas.

14. *Amblyscirtes samoset* (Scudder) 1863

Synonyms: *hegon* Scudder 1863: White Mts., New Hampshire. *nemoris* Edwards 1864: Portsmouth, Ohio. *argina* Plotz 1884: "Brisbane."
Type locality: Massachusetts.
Distribution: CANADA. Manitoba: Stone Mountain, VI. New Brunswick. Quebec. UNITED STATES. *Arkansas.* Faulkner County: Hope Hill Farm, IV-13-68. *Connecticut,* Avon, VI. *Georgia.* Fulton County: Indian Trail, Atlanta, IV-14-16-55. *Iowa.* Grinnell. *Maine.* Mt. Desert Island, VI-5-31. Cumberland County: Portland, VI-38. Kennebec County: Augusta, VI, VII. Penobscot County: Enfield, VI-15-37; Passadumkeag Bog, VI-16-40. Piscataquis County: Baxter Park, Mt. Katahdin, VII-2-40. *Massachusetts.* Boston, VI. *Minnesota.* Aitkin, Carlton, Roseau, Lake of the Woods Counties, VI-67. *New Jersey.* Sussex County: Ogdensburg, VI. *New York.*

Tompkins County: Oneonta, VIII-2-68. *Ohio.* Hamilton County: Cincinnati, V-15-38.

This is a rather common and widespread species over the eastern part of the United States and southern Canada. It can be recognized by the general characteristics given in the key to the various species. The only specimens that I have collected came from Arkansas in a wooded area during the spring of the year.

15. *Amblyscirtes texanae* Bell 1927

Type locality: Sunny Glen Ranch, Alpine, Texas.
Distribution: UNITED STATES. *New Mexico.* Quay County: Tucumcari, VIII-25-41. *Texas.* Armstrong County: Palo Duro Canyon, IV-26-43. Brewster County: Alpine, V-31-42, VI-13-60; VI-2-42, VIII-7-61. Jeff Davis County: Davis Mountains, VI-13-60; Fort Davis, VI-11-49.

This species is common in the Alpine and Davis Mountain sections of southwestern Texas. It is most often found in rocky ravines where it flies rapidly for short intervals then abruptly comes to rest on the rocks where it will remain for a short time then repeat the same procedure again.

16. *Amblyscirtes tolteca* Scudder 1872

Type locality: Tehuantepec, Oaxaca, Mexico.
Distribution: MEXICO. Guerrero: Acapulco, VII-36; Acuitlapan, VII-21-56; Iguala, VII; Rio Balsas, VI. Jalisco: Guadalajara, VII. Oaxaca: Candelaria Loxicha, VII-14-71; Tehuantepec, VIII-64. San Luis Potosi: Hotel Covadonga, 6 miles south Ciudad Valles, VI, VII, VIII; Tamazunchale, VII-63, VIII-24-67. Tamaulipas: Ciudad Mante, VI-9-41; Ciudad Victoria, VIII-16-62; El Solto, VIII-19-62, VIII-24-67. Veracruz: Jalapa, VI-64; Orizaba, VIII-67; Presidio, VIII. Yucatan: Valladolid.

Tolteca is primarily a jungle species, however I have found specimens in brush environments in the state of Tamaulipas. In areas of dense vegetation most specimens will be found feeding on flowers that are usually shaded from the sun or else resting in the jungle shade.

17. *Amblyscirtes prenda* Evans 1955

Type locality: Tucson, Arizona.
Distribution: UNITED STATES. *Arizona.* Pima County: Tucson, VI-22-55. MEXICO. Chiapas: Comapapa, VII-24-69. Guerrero: Taxco, VII-1-36. Nayarit: Tepic, IX-64. Sonora: 7 miles southeast of Alamos, VIII-67; Guaymas.

Evans considered *prenda* to be a subspecies of *tolteca*, however from available information *prenda* appears to be a distinct species. Morphologically *prenda* differs from *tolteca* in the maculation, and by being smaller in size and lighter in coloration. There are slight differences in the genitalia. Biologically the two are very different as *prenda* occurs in arid

or semi-arid terrain very often flying in the heat of the day, whereas *tolteca* is a jungle species nearly always found in shaded areas.

18. *Amblyscirtes aesculapius* (Fabricius) 1793

Synonyms: *textor* Geyer 1831: U. S. A. *oneko* Scudder 1863: Connecticut. *wakulla* Edwards 1869; Apalachicola, Florida.
Type locality: North America.
Distribution: UNITED STATES. *Alabama.* Mobile County: Mobile. *Florida.* Orange County: Rock Springs, III-30-38. *Georgia.* Chatham County: Savannah, V-24-51. *Kentucky.* Jefferson County: VIII-9-69. *Mississippi.* Hinds County: Brownsville, IX-2-57; Clinton, VIII-25-56. *Tennessee.* Davidson County: Nashville, VIII. *Texas.* Harris County: Sam Houston National Forest, VI-6-71. Harrison County: Caddo Lake, VIII. *Virginia.* Nansemond County: Dismal Swamps, near Suffolk, VI-8-41; Jerico Ditch, near Suffolk, IX-7-59; Magnolia, VII-17-59; Suffolk, VI-21-40.

This very distinctive species is basically confined to the southern and southeastern part of the United States. It prefers wooded areas for its normal habitat.

19. *Amblyscirtes carolina* Skinner 1892

Type locality: South of Hamlet, Richmond County, North Carolina.
Distribution: UNITED STATES. *North Carolina.* Gaston County: Gastonia, VIII-27-38. Richmond County: Hamlet, VIII. *Virginia.* Nansemond County: Great Dismal Swamps, VII; Suffolk, VII-1-40.

Carolina seems to be confined to the North Carolina-Virginia area. This species is readily recognized by the heavy overscaling of dull yellow on the costa and apex of the lower surface of the primaries and the entire lower surface of the secondaries. The lower surface of the secondaries is indistinct rusty brown. This species is usually associated with swampy areas.

20. *Amblyscirtes reversa* Jones 1926

Type locality: Suffolk, Virginia.
Distribution: UNITED STATES. *Georgia.* Fulton County: Atlanta, V-12-56; Harris Trails, Atlanta, VII-17-55. Rabun County: V-4-55. *North Carolina.* Leland, VI-28-44. *Virginia.* Nansemond County: Suffolk, V-28-45, VI-9-41, VII-20-59, VII-9-44.

Reversa has long been considered to be a synonym of *carolina* or at most a form. I believe that actually it is a distinct species due to morphological differences such as the absence or obselete dull yellow overscaling on the lower surface of the wings, and the differences on the lower surface of the secondaries where the ground color is rusty brown and the maculation is dull yellow and distinct. There are also slight differences in the genitalia. This species ranges farther south than *carolina* being found in Georgia as well as in the same areas as *carolina*. I have both species from Suffolk, Virginia.

Vialis Group

21. *Amblyscirtes nereus* Edwards 1876

Type locality: South Apache, Arizona.
Distribution: UNITED STATES. *Arizona.* Graham County: Mount Graham, VI. South Apache. *New Mexico. Texas.* Brewster County: Alpine, III-27-61, VI-2-42, VII-19-51. Jeff Davis County: Davis Mountains, VI-30-60, VII-27-53, VII-30-63, VIII-19-51; Fort Davis, VI-9-11-49. MEXICO. Chihuahua. Sonora.

This is a distinctive species from the southwestern part of the United States and Chihuahua, Mexico. It is found in arid or semi-arid terrain and often in rocky ravines. It will often rest on greyish soil where its coloration blends well with its surroundings.

22. *Amblyscirtes nysa* Edwards 1877

Synonym: *similis* Strecker 1878: New Braunfels, Texas.
Type locality: Texas.
Distribution: UNITED STATES. *Arizona.* Pima County: Baboquivari Mountains, IX-50; Tucson, VII-10-60. *Arkansas.* Carroll County: Beaver, VI. *Kansas.* Douglas County: V-X. Greenwood County: Eureka, IX-1-40. Harper County: X. Montgomery County: V-X. Scott County: X. Shawnee County: VII. Summer County: Caldwell, X-2-41. *New Mexico.* Eddy County: Carlsbad Caverns, VI-10-58. Quay County: Tucumcari, VII-11-42. *Texas.* Armstrong County: Palo Duro Canyon, IV-26-43, V-16-42, IX-2-43. Bexar County: San Antonio, VI, VII, VIII, X. Brewster County: Alpine, VI-5-42; Sunny Glen Ranch, Alpine, VI-2-42. Cameron County: Brownsville, VI-6-71. Carson County: White Deer, IV-VI. Childress County: Childress, VIII-7-41. Comal County: New Braunfels, VI, VIII. Dallas County: Dallas, IV-3-38; Garland, VIII-7-71; Lancaster, VIII-1-41; Vickery, VI-16-40. Gray County: Lake McClellan, V-14-44. Hidalgo County: Pharr, V-30-47. Jeff Davis County: Fort Davis, VII-10-49. Terrell County: Sanderson, VII-12-49. Uvalde County: Uvalde, V-31-42. Val Verde County: Del Rio, VI-5-49. MEXICO. Northern Mesa. Nuevo Leon: Monterrey, VI-10-12-35.

This small species is common over a large section of the midwest and southwestern sections of the United States and on down to the state of Nuevo Leon in Mexico. It is readily recognized by the variegated lower surface of the secondaries. *Nysa* is a familiar visitor to city flower gardens as well as rocky ravines in arid parts of the southwest.

23. *Amblyscirtes eos* (Edwards) 1871

Synonyms: *comus* Edwards 1876: Texas. *nilus* Edwards 1878: Texas. *quinquemacula* Skinner 1911: Las Cruces, New Mexico.
Type locality: Dallas, Texas.
Distribution: UNITED STATES. *Arizona.* Cochise County: Portal, VI-20-63. Santa Cruz County: Nogales, VII-11-64. *New Mexico.* Dona Ana County: Las Cruces, VI. Eddy County: Carlsbad, VII-9-49. *Texas.* Armstrong County: Palo Duro Canyon, IV-17-43, V-1-43. Brewster County: Alpine, VIII-19-57; Marathon, VI-3-40. Carson County: White Deer, VIII-23-41. Culberson County: Guadalupe Pass, VII-9-49. Dallas County: Dallas, VIII-7-50; Garland, IV-10-49; Lancaster, III-21-54. Jeff

Davis County: Davis Mountains, VII-27-53; Fort Davis, VI-11-49. Kerr County: Kerrville, VI-4-49. Palo Pinto County: Palo Pinto, VIII-13-55. Potter County: 15 miles north of Amarillo, VIII-10-41. Val Verde County: Del Rio, VII-12-49. MEXICO. Northern Sonora. Northern Mesa.

Eos is associated with arid or semi-arid regions of the southwest. It can readily be recognized by the clear white, distinctive maculation on the lower surface of the secondaries.

24. *Amblyscirtes vialis* (Edwards) 1862

Synonym: *asella* Herrich-Schaffer 1869: locality not known.
Type locality: Rock Island, Illinois.
Distribution: CANADA. British Colombia, Corfield, Vancouver, VI. Manitoba, Miniota, VI-16-37. Ontario. UNITED STATES. *Arkansas.* Cleburne County: Quitman, VII-12-40. Faulkner County: Enders, VII-12-43; Hope Hill Farm, IV-20-45, IV-26-33, VI-12-40, VI-26-43, VI-27-44, VII-2-42; Pinnacle Springs, VII-1-43. Pulaski County: North Little Rock, VI-2-32. *California.* Sierra County: w. of Downieville, VI-17-67. Trinity County: Yosemite, VI. *Colorado.* Boulder County: Boulder Canyon, VI-19-41; Eldora, VI-24-33; Spring Gulch, VII-1-55. El Paso County: Bear Creek, V-31-32; Broadmoor, V-30-49; North Cheyenne Canyon, V-31-32; Rock Creek, VI-11-30, VII; William's Canyon, VII-7-31. Grand County: Muddy Pass, VII-5-41. Jefferson County: Clear Creek Canyon, V-17. La Plata County: Junction Creek, VI-17-37; La Plata Mountains, VII-6-38. Larimer County: Rocky Mountain National Park, VII-5-35. Park County: Tappan Creek 6 mi. NW of Lake George, V-30-49. *Florida. Georgia.* Fulton County: Indian Creek Road, Atlanta, VI-6-57. *Idaho.* Priest Lake. *Illinois.* Mercer County: Perryton Township, V, VI, VII, 67. Scott County: Rock Island. *Kansas.* Douglas County: Lawrence, IV-6-67. Franklin County: VII-5-54. Greenwood County: Eureka, VIII-28-40. Pottawatomie County: VI. Scott County: VI. *Maine.* Penobscot County: Enfield, VI-11-39, VI-4-40; Passadumkeag, VI-1-36, VI-12-39. Caratumb, VI-2-41. *Minnesota.* Nicollet County: VIII-12-67. *Mississippi.* Tishomingo County: Tish State Park, IV-20-57. *Missouri.* Greene County: Willard, VII-13-38. *New Hampshire.* Randolph. Franconia, White Mountains. *New Jersey.* Woodbury; Elizabeth. *New Mexico.* Sandoval County: Jemez Springs, V, VI. *New York.* Rensselaer County: Berlin, V-30-41. Tompkins County: VI-40. *North Carolina.* Cranberry, VII. *Ohio. Oklahoma.* McIntosh County: Checotah, VII-25-41. *Pennsylvania. Texas.* Dallas County: Cedar Hill, IV-5-42, IV-7-44; Dallas, V-13-37; Garland, VIII-20-71; Lancaster, V-16-41; Vickery, VI-16-40. *Vermont.* Mt. Equinox. *Virginia. Wisconsin.*

This is the most common and widespread species in the genus. In most areas where it is abundant it is usually associated with wooded areas. I have failed to locate specimens in arid or semi-arid habitats. *Vialis* is readily recognized by the distinct apical spots and absence or reduction of other spots on the primaries and by the uniform coloration on the lower surface of the secondaries.

25. *Amblyscirtes celia* (Skinner) 1895

Type locality: New Braunfels, Texas.
Distribution: UNITED STATES. *Texas.* Bexar County: San Antonio, VI-5-56, VII-30-42. Cameron County: Brownsville, VI-8-40, VI-5-71. Comal County: New Braunfels, VI-30-40, VII-2-60. Dallas County: Lancaster, IX-28-40. Hays County:

San Marcos, VI-12-40. Hidalgo County: Mission, VII-15-63, VII-31-45; Pharr, constant. Nueces County: Corpus Christi, VI. Val Verde County: Del Rio, VI-5-49, VII-12-49. MEXICO. Nuevo Leon: Monterrey, VI-19-35. San Luis Potosi: 6 miles south Ciudad Valles (Hotel Covadonga), VI-15-71. Tamaulipas: Ciudad Mante, VI-23-64; Ciudad Victoria, VI-23-64, VII-26-66, VIII-16-62; San Francisco, VIII-64.

This species is usually found in wooded areas, very often in the shade. *Celia* has a rather restricted range as it occurs from the Lancaster, Dallas County, Texas area into northcentral Mexico. I have found *celia* rather abundantly in the vicinity of Monterrey, N. L., Mexico.

26. *Amblyscirtes belli* Freeman 1941

Type locality: Vickery, Dallas County, Texas.

Distribution: UNITED STATES. *Arkansas.* Faulkner County: Enders, VII-12-43; Hope Hill Farm, VI-24-44, VII-24-44, VIII-1-44; Pinnacle Springs, VII-27-43. Pulaski County: Little Rock, VII-21-41, VII-21-43; North Little Rock, VII-5-41. *Georgia.* Madras, VII-23-34. Fulton County: Riverside Drive, Atlanta, V-21-57. *Illinois.* Southern Illinois, VII. *Missouri.* Greene County: Willard, VII-25-29. *North Carolina.* Meck County Road, VII-26-70. *Oklahoma.* McIntosh County: Checotah, VII-25-41. *Texas.* Dallas County: Dallas, IV-12-38, IV-22-40, V-4-40, VII-20-42; Garland, IV-28-68; Lancaster, VIII-16-40; Vickery, VIII-5-40, VIII-16-40.

Belli was recorded as a subspecies of *celia* by Evans, however there are a number of reasons why the two are separate. Biologically their habits are different as *belli* prefers open fields and the edges of woods, whereas *celia* prefers the woods. I have collected both species in the same general area at Lancaster, Texas, where their range overlaps. Morphologically they are easily separated as the males of *belli* have the spot in space 2 on the primaries V-shaped, while *celia* has this spot oval. On the lower surface of the secondaries *celia* usually has the discal spots lighter and more distinct than in *belli* where this area is usually rather dark and hoary. *Celia* often has a cell spot on the primaries which is completely lacking in *belli.* There are slight differences in the genitalia, however genitalic determinations in the genus *Amblyscirtes* are practically impossible with most species due to the fact that the basic pattern is very similar.

27. *Amblyscirtes alternata* (Grote & Robinson) 1867

Synonym: *meridionalis* Dyar 1905: Georgia.

Type locality: Atlantic District, Georgia.

Distribution: UNITED STATES. *Alabama.* Whistler, IX. Houston County: Cowarts. *Florida.* Orange County: Orlando, III-17-42. *Georgia.* Scriven County: IV-9-46, V-18-46. *North Carolina.* Leland, VI-17-45. *Texas.* Smith County: Tyler, IX-5-49; Tyler State Park, III-24-59, IV-5-59.

This small species is readily recognized by the general maculation which is characterized by the three apical spots being needle-like points,

and the indistinct discal spots. On the lower surface of the secondaries the wings are uniform dark brownish-black evenly overscaled with small grey scales. Specimens that I have collected were found in the general vicinity of piny woods.

28. *Amblyscirtes florus* (Godman) 1900

Synonym: *mate* Dyar 1923: Guerrero, Mexico.
Type locality: Sierra Madre de Tepic, Nayarit, Mexico.
Distribution: MEXICO. Colima: Comala, VIII-4-67. Guerrero. Jalisco: Ajijic, IX-3-66; La Cumbre de Autlan, VII, VIII-67. Morelos: Jantepec, VI-49. Nayarit: Sierra Madre de Tepic. San Luis Potosi: 6 miles south of Ciudad Valles (Hotel Covadonga), VI-10-66, VIII-6-67. Tamaulipas: Ciudad Victoria, VIII-16-62; 15 miles south of Llera, VII-27-66. Veracruz: Catemaco, VIII-10-67.

This jungle species is characterized by its uniform brownish-black coloration, devoid of any maculation on the upper side. On the lower surface of the wings the primaries have very indistinct discal and apical spots and the secondaries have indistinct discal spots present. I have found *florus* to be rather abundant at times at Hotel Covadonga just south of Ciudad Valles, particularly in the jungle along the Rio Valles.

Phylace Group

29. *Amblyscirtes anubis* (Godman) 1900

Type locality: Mexico.
Distribution: MEXICO. Guerrero: Omilteme; Sierra Madre del Sur. Hidalgo: Apulco, IV-52. Veracruz: Jalapa; Orizaba.

This rather rare species can be recognized by the orange-yellow fringe of the primaries and the concolorous fringe of the secondaries. The palpi are grey in both sexes. There is a narrow broken stigma on the primaries of the males.

30. *Amblyscirtes phylace* (Edwards) 1878

Type locality: Southern Colorado.
Distribution: UNITED STATES. *Arizona.* Cochise County: VIII-99. *Colorado.* El Paso County: Rocky Creek, VII-7-37. Jefferson County: Chimney Gulch; Clear Creek Canyon, V-26-21; Lookout Mountain, VI-25-39. Park County: Mill Gulch, VI-10-21. Teller County: Rosemont, VI-29-32. *New Mexico.* Dona Ana County: Rincon, VI. Sandoval County: Jemez Springs, VI-9-14, VI-26-14. *Texas.* Jeff Davis County: McDonald Observatory, VI-9-49, VII-11-49, VIII-5-62, VIII-10-60. MEXICO. Morelos. Puebla: La Malinche.

This species can be identified by the sordid white fringe of both wings. In the males the palpi are orange, while in the females they are yellowish-white. The males have a broad, short brand covering vein 2 near its origin on the primaries. *Phylace* is usually found in semi-arid mountains.

31. *Amblyscirtes fimbriata* (Plotz) 1882

Synonym: *bellus* Edwards 1884: Southern Arizona.
Type locality: Mexico.
Distribution: UNITED STATES. *Arizona.* Cochise County: Chiricahua Mountains, VI-28-36, VI-26-36; Onion Saddle Pass, VII-12-60; Pinery Canyon, VII-11-60; Portal, VII-10-60; Ramsey Canyon, VI-28-36; Rustlers Park, VI-20-63. *New Mexico.* Sandoval County: Jemez Springs. MEXICO. Las Vigas. Durango: Milpas. Nuevo Leon: Chipinque Mesa, Monterrey, VIII-13-67. Sonora. Valle de Mexico. Veracruz: Jalapa.

This species can be recognized easily by the presence of an orange fringe on both wings in both sexes, also by the palpi being orange in both sexes. The males have a narrow, broken, grey stigma from the origin of vein 3 to vein 1. *Fimbriata* usually occurs in wooded mountainous terrain.

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A REVISION OF THE *COLIAS ALEXANDRA* COMPLEX (PIERIDAE) AIDED BY ULTRAVIOLET REFLECTANCE PHOTOGRAPHY WITH DESIGNATION OF A NEW SUBSPECIES[1]

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This paper presents a study of the distribution and taxonomy of the *Colias alexandra* complex. The role of ultraviolet photography as an aid to taxonomic studies is discussed and is employed in assigning *C. alexandra* populations to various color groups. Visible light characters (pigmentation and facies) are combined with uv reflectance patterns to arrive at the taxonomic conclusions presented. One concludes from this study that some populations of *alexandra* can be assigned to specific subspecies, while others are best listed as clinal or intergrade forms. Based upon uv photography, *C. harfordii* and *C. barbara* are assigned to the *alexandra* complex. As a consequence of recent work by Brown (1973), a new subspecies of *alexandra* is proposed.

Butterfly color patterns are produced by both pigmentation and optical effects. The brilliant prismatic colors associated with many tropical species are produced by visible light interference with the structures of certain wing scales. As shown by Mazokhin-Porshnyakov (1954) and Nekrutenko (1964), certain Coliadinae reflect ultraviolet light from particular wing areas such that interference patterns are produced.

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Ghiradella, Eisner, Hinton, and Silberglied (pers. comm. and in review) have determined that these uv reflection patterns are structural and are analogous to the white-light-produced brilliant irridescent blues in the genus *Morpho*. Silberglied (pers. comm.) has shown that interference of uv light rays in the layered lamellae which comprise the ribs of special wing scales is responsible for the "luminous" patches shown in the accompanying figures. Close spacing of the ribs is indicative of strong uv reflection.

Kolyer & Reimschuessel (1969) reported some scanning electron microscope studies of *Colias eurytheme* Boisduval but did not interpret the structure of the scales. The lamellae are shown in Figs. 2c & d of their paper. A simple method for making uv photographs has been described by Ferris (1972b).

Ultraviolet reflectance photography can be used as a taxonomic aid as suggested by Nekrutenko (1964). Some species of *Colias* are reflective; others are not. Reflection is used here in a relative sense and is applied to fresh undamaged specimens. There is always some reflection of uv light, but only certain species reflect sufficient energy to produce bright patterns. Reflection in *Colias* generally occurs from the discal areas (dorsal) of the secondaries and varies considerably for the primaries. Males of certain species are reflective, while the females of the North American species are non-reflective. Ultraviolet photography of the non-reflective species is of no taxonomic value except to separate reflective and non-reflective species in questionable cases.

Colias alexandra males exhibit a uv reflectance pattern which appears as a luminous patch on the secondaries and is constant in all of the color forms. The term "luminous" is used here to describe the appearance of the reflection pattern in a black-and-white photograph. The amount of reflectance from the primaries varies from insignificant in the pure yellow races to considerable in the orange races. Fig. 3 illustrates the features which separate *alexandra* from other North American *Colias*. Figs. 4–5 illustrate examples of *C. alexandra* as they appear under white light photography and uv photography. A dull background has been used purposely to eliminate spurious uv fluorescence.

Ultraviolet photography is used here to assign *alexandra* populations to various color groups. It shows that several populations which appear yellow to the human eye, exhibit uv interference patterns characteristic of the yellow-orange group. These populations are therefore placed with the yellow-orange group rather than with the "pure" yellow group. Uv photography cannot be used to make assignments at the subspecies level generally, although it does show that *C. barbara* and *C. harfordii* belong in the *alexandra* complex.

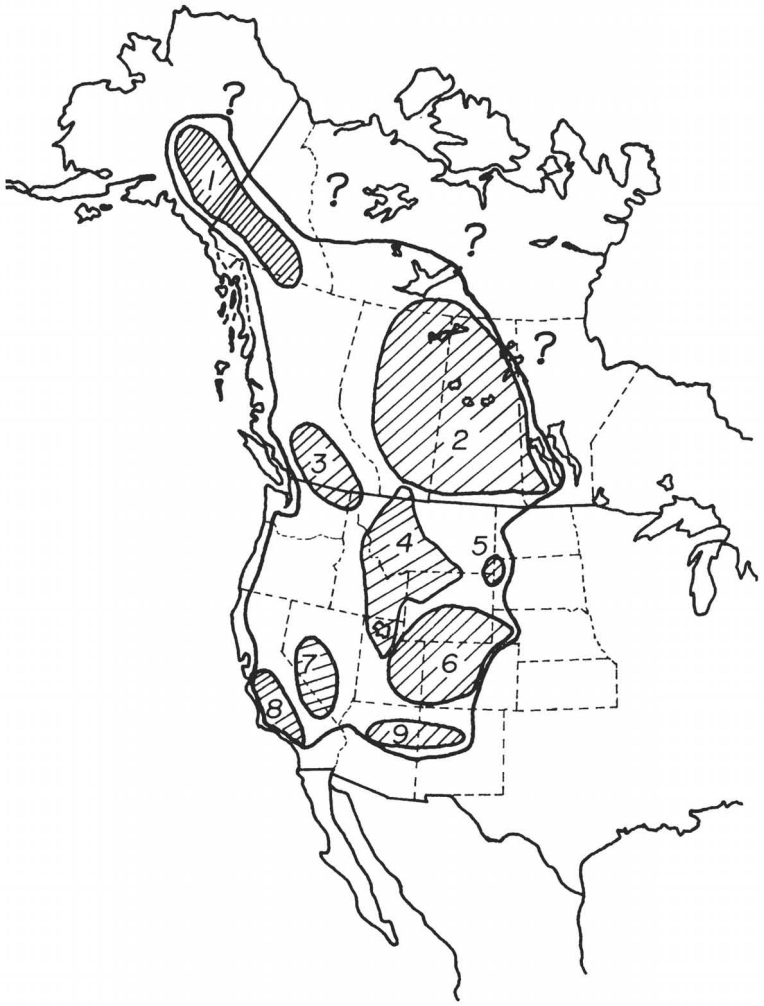


Fig. 1. Distribution of *Colias alexandra* in North America. The outer solid line encloses the known areas in which *alexandra* has been found. The northern boundary is still in doubt as indicated by (?). The shaded areas represent distinct subspecies as follows: 1, unnamed Alaska-Yukon segregate; 2, *christina*; 3, *columbiensis*; 4, *astraea*; 5, *krauthii*; 6, *alexandra*; 7, *edwardsii*; 8, *barbara* and *harfordii*; 9, Arizona-New Mexico segregate. The remaining areas within the boundary represent intergrade forms which cannot be clearly identified as any one given taxon.

Biology

The life histories of several members of the *alexandra* group have been published and are cited in Davenport & Dethier (1937). Larval food-plants are members of the Leguminosae. There is a paucity of specific

hostplant records in the literature, but these records include: *C. alexandra*: *Astragalus, Thermopsis, Trifolium repens* (Davenport & Dethier, 1937); *Astragalus serotinus* (Opler, unpublished); *A. miser* (Shields, et al., 1969). *C. christina*: *Trifolium* (Davenport & Dethier, 1937). *C. harfordii*: *Astragalus* (Davenport & Dethier, 1937); *A. antisellii* (Locoweed) (R. C. Priestaf, 1972, pers. comm.). Davenport & Dethier list additional authors who have reported hostplant preferences for *alexandra.*

Colias alexandra is found in a wide variety of habitats. Generally it frequents open areas, and in forested land is found in clearings and along roads or cuts. Males may be found at puddles along dirt roads where they sometimes congregate in large numbers. Some of the subspecies are common in open sagebrush regions (Upper Sonoran Desert), while others frequent the Transition Zone (aspen-conifer association), and still others are found in meadows or clearings in the Canadian Zone. In the Far North, *alexandra* appears to prefer open clearings in the taiga (spruce-scrub biome). Pigmentation in the adults does not appear to be correlated with habitat. To some extent, correlation with latitude exists, with more orange color appearing in the north.

Distribution and Taxa

The *C. alexandra* complex is widely distributed in western North America (Fig. 1). Three distinct color forms are recognized: yellow, yellow and orange, and orange, in addition to clinal forms in which specimens from a given geographic location vary from yellow into almost pure orange (Ferris, 1972a). Currently recognized taxa belonging to the *alexandra* complex are indicated below according to visible-light color (pigmentation).

YELLOW POPULATIONS—TAXA

Colias alexandra alexandra Edwards, 1863 [T. L. Front Range, west of Denver, Colorado].
Colias alexandra edwardsii Edwards, 1870 [T. L. Virginia City, Storey Co., Nevada].
Colias alexandra emilia Edwards, 1870 [T. L. Oregon]. See discussion below.

YELLOW-ORANGE POPULATIONS—TAXA

Colias alexandra astraea Edwards, 1872 [T. L. Yellowstone Lake, Wyoming].
Colias alexandra christina Edwards, 1863 [T. L. Slave River Crossing, N.W.T., Canada].

ORANGE POPULATIONS—TAXA

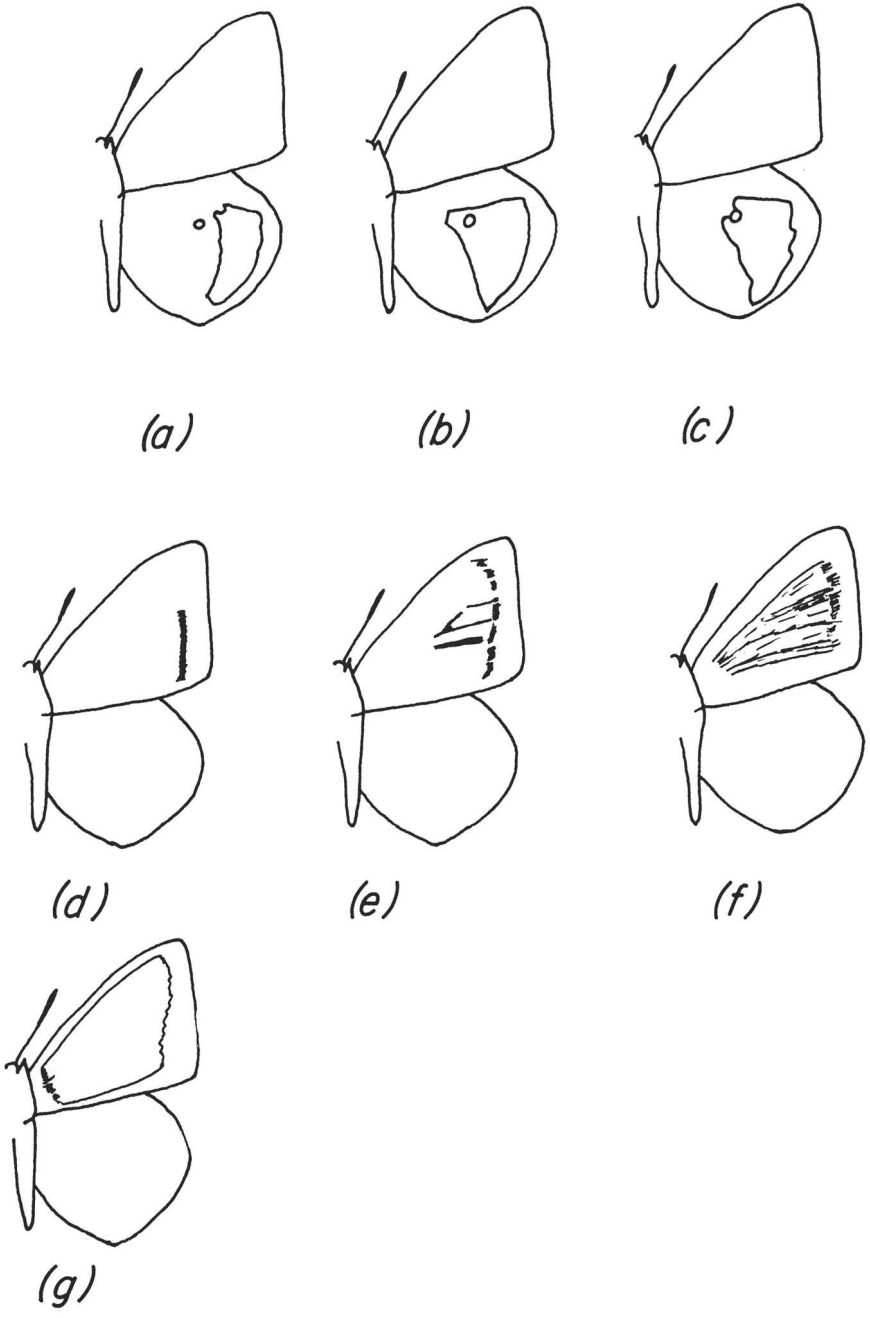
Colias alexandra krauthii Klots, 1935 [T. L. Black Hills, 12 miles west of Custer, Custer Co., South Dakota].

The taxon *alberta* Bowman has been omitted as it appears to describe a hybrid situation and suppression of this name has been recommended

Fig. 2. Distribution of *Colias alexandra* isolates. Open circles—yellow populations; half-open circles—yellow-orange populations; solid circles—orange populations.

(Ferris, 1972a). This and other possible *alexandra* crosses are discussed in the paper cited.

When long series of *alexandra* of a given subspecies or from a given locality are examined, one notices substantial variation in pigmentation and, in the females, maculation. Some individual males from yellow-orange races appear yellow under white light. When photographed under uv illumination, they exhibit luminous patches on the primaries which


(a)
(b)
(c)
(d)
(e)
(f)
(g)

are characteristic of the yellow-orange group. In the current study, uv photography is used to assign various races or populations to one of the three designated color groups. Race or population should not be inferred as synonymous with subspecies. The uv patterns for each group are discussed below.

There is considerable variation in uv reflectance pattern as well as in pigmentation. The former is illustrated by the accompanying figures. Only *C. a. alexandra* and *C. a. krauthii*, the poles so-to-speak, exhibit minimal variation. The angle at which uv radiation strikes the wing surfaces affects the reflection pattern (Nekrutenko, 1965). If specimens are flat-mounted and illuminated as suggested by Ferris (1972b), this problem is minimized.

In the following paragraphs, reference is made to various isolated populations. These represent clinal and intergrade forms which do not merit subspecific recognition. Localities are shown in Fig. 2.

YELLOW POPULATIONS—DISTRIBUTION

Arizona, California, Colorado, Nebraska, Nevada, New Mexico, Oregon (isolate), Utah, Wyoming, Montana (?).

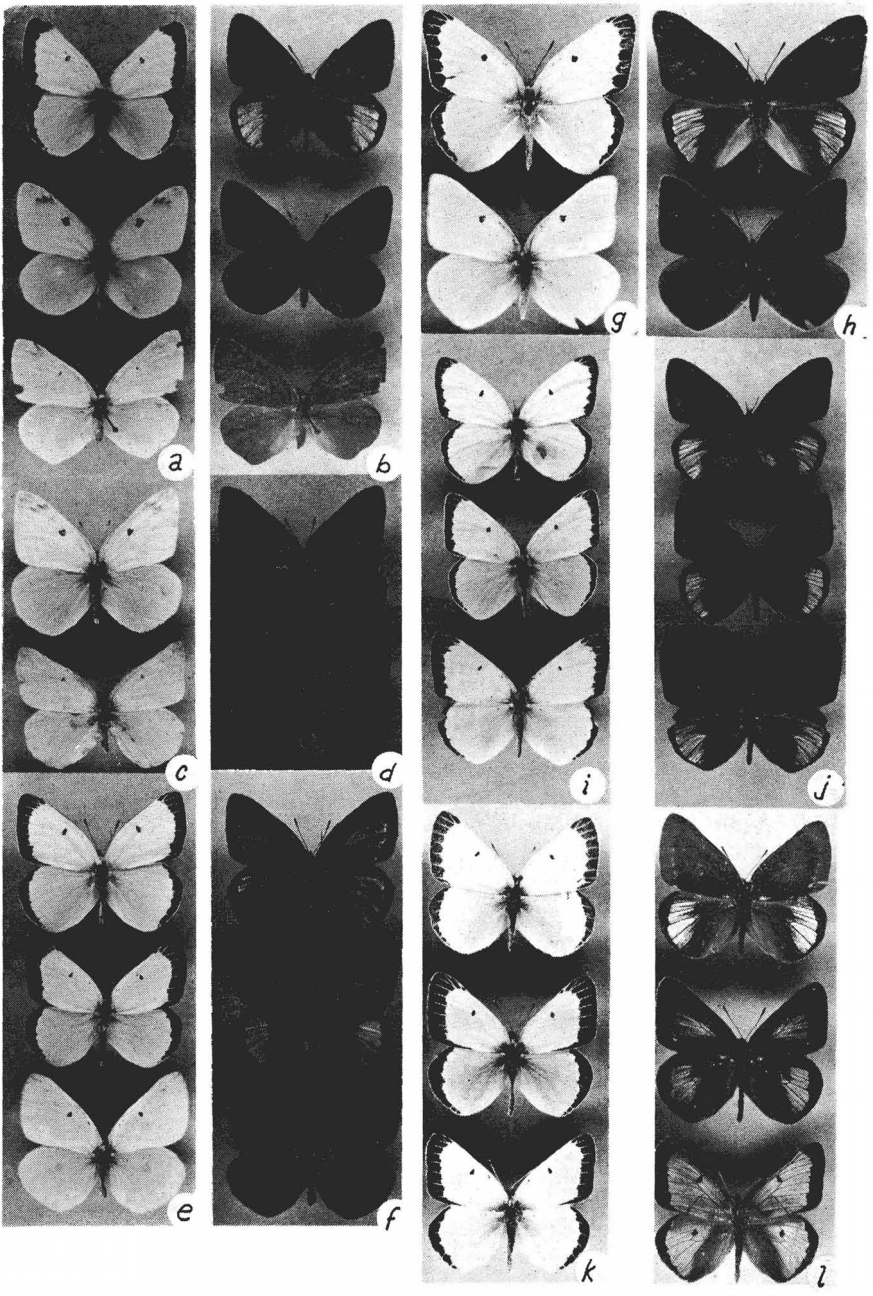
The yellow races are distinguished by lacking forewing luminosity (or exhibiting only a trace at most) under uv illumination and by having yellow (concolorous with the ground color) discal spots on the dorsal surface of the secondaries in the males. This definition differs from previous ones which included populations that have orange discal spots. Generally the orange-spotted specimens exhibit forewing luminosity.

YELLOW-ORANGE POPULATIONS—DISTRIBUTION

California, Idaho, Montana, Nevada (Elko, Nye, Washoe Cos.), Oregon, Utah, Washington, Wyoming, Alberta, British Columbia, Manitoba, Northwest Territories, Saskatchewan. Recently a single orange-discal-spotted male *alexandra* was collected by M. S. Fisher (Parker, Colorado) in Elbert Co., Colorado, an eastern plains region of the state. Further collecting is necessary to ascertain if this specimen is from a yellow-orange isolate with possible affinity to the Black Hills *krauthii*, or a hybrid with *philodice* or *eurytheme*. Undoubtedly other yellow-orange isolates, not shown in Fig. 2, will be found as collectors penetrate into little-collected areas.

←

Fig. 3. General extent of luminous patches as they appear on the wings of the males in the *Colias alexandra* complex. Hindwing patches in (a) yellow group; (b) orange group; (c) yellow-orange group. The discal spots, shown as open circles, are generally black in uv photographs. Forewing patches in (d) transition yellow to yellow-orange populations (submarginal band); (e) some yellow-orange populations (submarginal band and portions of some cells near veins); (f) other yellow-orange populations (central portion of wing generally reflects with some dark areas); (g) orange populations (wing reflects almost uniformly except for marginal areas).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Some of the yellow-orange races appear yellow under visible light, except that the discal spot on the dorsal surface of the hindwings is orange. Individual male specimens may show a dark yellow or a pale yellow-orange flush discally and limbally on the upper side of the secondaries and females may exhibit considerable orange. Under uv illumination, luminous patches appear on the forewings. Individuals of *C. a. astraea* may appear to be pure yellow except for the orange discal spot, but this subspecies as a whole ranges from yellow to orange. For this reason, populations with orange discal spots in the males are classified in the yellow-orange group based upon uv patterns and not visible light (pigmentation) appearance.

Southern Alberta appears to represent a complex blend-zone region. In the area from Calgary to Banff and east of the Rocky Mountains, specimens can be taken which represent *alexandra, astraea, christina*, and *krauthii*. It is frequently possible to collect two or three good "subspecies" at the same locality. This situation is typical of the intergrading which occurs in the *alexandra* complex and is the reason for the restricted ranges shown in Fig. 1.

Northern Utah specimens, especially from Tooele and Wasatch Counties, tend toward both *astraea* (in the males) and *christina* (in the females). The latter frequently show an overwashed orange coloration.

Specimens of *alexandra* from Nevada have generally been determined to be subspecies *edwardsii*. A small series in the collection of the Los Angeles County Museum of Natural History taken by A. O. Shields in Jett Canyon, Toiyabe Range, Nye Co., Nevada is clearly from a yellow-orange population. The discal spots (dorsal secondaries) are orange in both sexes and distinct luminous patches show on the forewings of the males under uv light. Some specimens from the same locality are phenotypically *edwardsii*. Peter Herlan (Carson City, Nevada) has found yellow-orange populations in Elko and Washoe Counties as well. The occurrence of these isolates is as yet unexplained.

California specimens from Lassen (Blue Lake area, Warner Moun-

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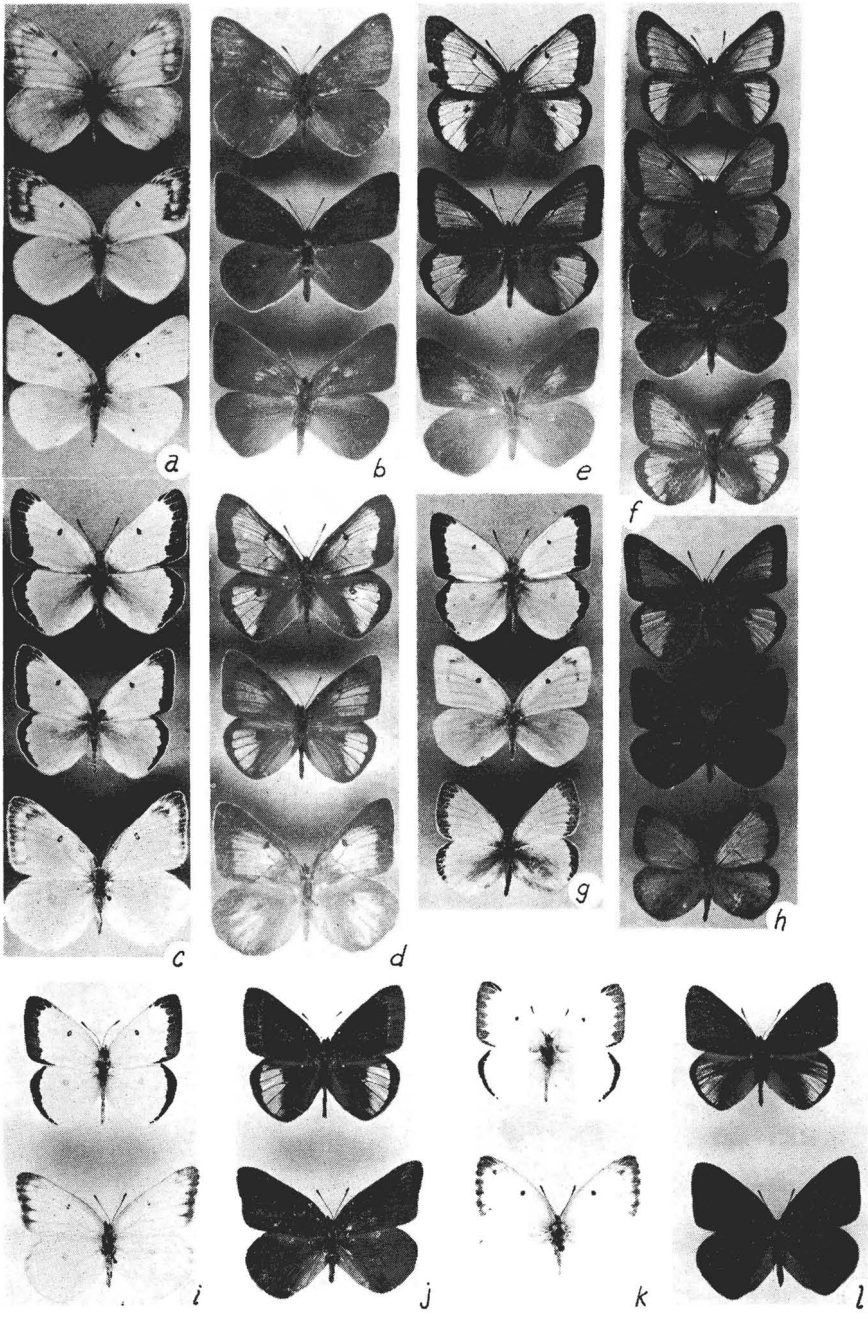
Fig. 4. Specimens of *Colias alexandra* photographed under white (left) and ultraviolet (right) light. **a** & **b**, *C. a. alexandra*, Albany Co., Wyoming; ♂, normal ♀, white ♀. **c** & **d**, ♀ ♀ of *C. alexandra*; top, Tooele Co., Utah; bottom, Catron Co., New Mexico. **e** & **f**, *C. alexandra*; top ♂, Boundary Co., Idaho; bottom pair, S of Golden, British Columbia. **g** & **h**, *C. alexandra*, pair from Utah; ♂ Tooele Co., ♀ Wasatch Co. **i** & **j**, ♂ ♂; top, *C. a. "emilia,"* Okanogan Co., Washington (see text); middle, *C. a. edwardsii*, Lander Co., Nevada; bottom, segregate, Apache Co., Arizona. **k** & **l**, ♂ ♂ of *C. a. astraea*; top, Sublette Co., Wyoming; middle, S of Seebee, Alberta in blend-zone region; bottom, Sheridan Co., Wyoming (orange form).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tains) and Modoc Counties show the orange discal spot in the males and considerable orange scaling in the females. Under uv light, luminous patches show on the forewings of the males.

Oregon specimens are similar, with the exception of a population from the Canyon Creek area, Ochocho Mountains, in Crook Co. The males from this region are similar to material from British Columbia, but the females show considerable dark bordering as in *occidentalis* Scudder. Some are quite similar in pattern and color to this species. Perhaps some hybridizing has occurred, but this is speculation. *C. occidentalis* is a non-reflective species.

The northern Idaho—southern British Columbia segregate is a large insect, generally larger than nomenotypical *alexandra*. This is described as a new taxon below. At first, it can be mistaken for *gigantea* Strecker because of the forewing apical rounding, but its habitat is forest clearings and roads, not bogs. McDunnough (1928) called this butterfly *Eurymus emilia*. Initially, one would place the population with the yellow races, but the discal spot is orange and the forewings exhibit luminous patches under uv illumination (Fig. 4f; Fig. 6e, f). This butterfly does not fit Edwards's description of *emilia*, and F. M. Brown (1973) has shown that *emilia* is synonymous with *edwardsii* which has page priority.

ORANGE POPULATIONS—DISTRIBUTION

South Dakota, Wyoming, Montana (?), North Dakota (? reported by Opler, unpublished), Alberta, Manitoba, Yukon Territory, Alaska.

A butterfly has been collected in the Yukon Territory (along the Alaska Highway) and in Alaska which appears to be a member of the *alexandra* complex (Fig. 5f–h). In many respects, it is similar to *Colias hecla* Lefèbre, but the underside and the uv reflectance pattern from the upperside place it tentatively as *alexandra*. Private correspondence with other collectors indicates that F. H. Chermock may have intended to name this population.

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Fig. 5. Specimens of *Colias alexandra* photographed under white (a, c, g, i & k) and ultraviolet (b, d, e, f, h, j & l) light. **a** & **b**, ♀♀ of *C. a. astraea*; top, Johnson Co., Wyoming; middle and bottom, S of Seebee, Alberta in blend-zone region. **c** & **d**, *C. a. krauthii*, Lawrence Co., South Dakota; top, orange ♂; middle, ♂ showing some yellow; bottom, ♀ (note the luminous patches on the female). **e**, *C. a. christina*; top, ♂, Riding Mtns., Manitoba; middle and bottom, pair, S of Seebee, Alberta in blend-zone region (note slight luminous patches on forewings of ♀). **f**, *C. alexandra* (?); 3 ♂♂ and 1 ♀, Yukon Territory. **g** & **h**, *C. a. christina*; top, ♂; middle, ♀; both S of Seebee, Alberta in blend-zone region; *C. alexandra* (?); bottom, ♂, Steese Highway mile 111, Alaska. **i** & **j**, *C. a. harfordii*; pair, Kern Co., California. **k** & **l**, *C. a. barbara*; Santa Barbara Co., California.

Pure orange races of *alexandra* have been reported from the area near Beulah, Manitoba, and Pocohontas, Alberta. These may be referable to the taxon *krauthii*. The Alberta specimens superficially resemble *krauthii*, but are considerably smaller.

Taxonomic Studies

Colias alexandra barbara H. Edwards, new combination
Colias alexandra harfordii H. Edwards, new combination

In 1877, Henry Edwards published a paper in which he proposed names for two *Colias* from California. These are the taxa *barbara* [T. L. Santa Barbara, California] and *harfordii* [T. L. Havilah, Kern Co., and Contra Costa Co., California]. They have stood as distinct species until P. A. Opler (unpublished) placed *barbara* as a subspecies of *harfordii*, although Talbot (1935) listed *barbara* as a form of *harfordii*. Edwards did indicate that both insects were related to *alexandra*.

Based upon uv photographs (Fig. 5i–l), it appears that the affinity of both butterflies is with *alexandra*. These subspecies appear to represent an intermediate situation. The uv reflectance from the forewings is reduced to a trace, as in the yellow populations, but the secondary discal spot is orange, as in the yellow-orange populations.

Additional justification for this assignment lies in range and foodplant. *C. a. edwardsii* is considered rare in California, although it is locally common in nearby Nevada (Lander Co.). Another population (previously discussed) is found locally in Lassen and Modoc Counties. Since *alexandra* is known to the north of central California, it seems odd, based upon geology, ecology and geography, that it should not occur centrally and along the coast of southern California. The southern and middle coastal areas and part of the central portion of the state are the areas in which *barbara* and *harfordii* occur. As noted earlier, *harfordii* uses *Astragalus* as a larval hostplant, which is also true of *alexandra*. Thus from the uv reflectance pattern, range, and hostplant affinity, it appears reasonable to assign *barbara* and *harfordii* to *alexandra*.

Colias alexandra columbiensis Ferris, **new subspecies**

Brown's treatment of *emilia* (1973) leaves the British Columbia race of *alexandra* without a name. The name *columbiensis*, derived from the type province, is proposed for this butterfly. This subspecies differs from other *alexandra* subspecies in that the apices of the forewings are definitely rounded suggesting *gigantea*. The uv reflection pattern in the males places this insect in the yellow-orange group. Comparison with other

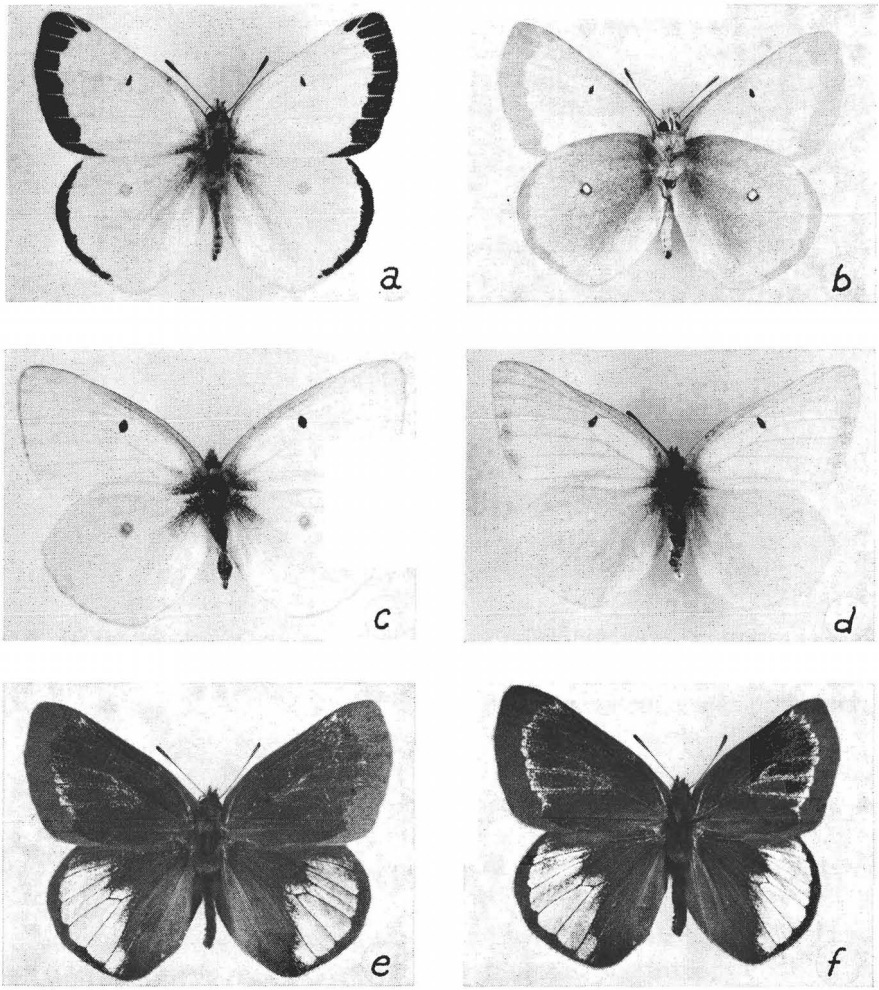

Fig. 6. *Colias alexandra columbiensis* Ferris: a, male holotype (upperside); b, same (underside); c, yellow female paratype (upperside); d, white female paratype (upperside); e, uv photograph of male holotype; f, same, but with specimen tilted to show full extent of forewing pattern on upperside.

members of this group shows that *columbiensis* differs from *christina* in that the forewings of the males show no orange color. It differs from *astraea* by being much larger, paler yellow in overall color, and is totally different in the females. *Columbiensis* females are pale yellow or white with nearly immaculate borders and generally show a large orange discal spot on the upperside of the hindwings.

In the males, the dorsal ground color is bright lemon yellow. Some specimens exhibit a dark yellow to orange flush in the discal and limbal areas of the hindwings, but do not show the pronounced orange markings which frequently occur in *astraea* and always in *christina*. The secondary discal spot is orange. The black borders are generally narrower than in nomenotypical *alexandra*. The primary cell-end spot is quite narrow. Ventrally the ground color is yellow with a slight orange flush. There is a dusting of black scales (sometimes heavy) on the secondaries. The secondary discal spot is bordered with dark pink scales and has a pearly center. Occasionally there is a satellite spot. The wing fringes are pink with some yellow as in *astraea*.

The females are dimorphic as is the case with other races of *alexandra*. Both yellow and white forms occur, as well as intermediates. The yellow females have a lemon yellow ground color frequently overwashed with pale orange, less pronounced dorsally than ventrally. In the white forms, there may be pronounced yellow-orange overwashing. Dorsally in both forms, the dark bordering varies from absent to slight. The primary cell-end spot is distinct (more so than in the males). The secondary discal spot is bright orange in the yellow forms and varies from orange to white in the white forms. Ventrally, the females are generally similar to the males, although there is a heavier overscaling of dark scales and the ground color is lighter in the white forms.

This subspecies is generally larger in size than the nominate species. The forewing costal margin length of the holotype male is 26 mm, 29 mm for the yellow female, and 28 mm for the white female shown in Fig. 6. In some males from northern Idaho, the costal margin length is 32 mm. Male specimens of *C. a. alexandra* examined from the Front Range (Rocky Mtns.) area measured 23 to 25 mm.

The holotype and two female paratypes are shown in Fig. 6. In addition, the uv reflection pattern of the holotype is presented. It is typical of the yellow-orange group.

Type Series. The type series consists of 6 males and 13 females. Because of the female dimorphism, no allotype is designated.

Holotype ♂. The specimen bears two labels. The locality label is machine printed black on white, with the exception of part of the date which is handlettered in black ink, and carries the following data: Anderson Lake/D'Arcy, B.C./17 June 1926/J. McDunnough. A second red label, machine printed in black is inscribed: Colias alexandra/columbiensis Ferris/Holotype Male.

Paratypes. 5 ♂♂, same data as holotype. 1 ♀ (white), same data as holotype. 9 ♀♀, 100 Mile House, B.C.: 28 June 1938, 4 ♀♀ (white); 29 June 1938, 1 ♀ (yellow); 30 June 1938, 3 ♀♀ (1 yellow); 4 July 1938, 1 ♀ (white), leg. J. K. Jacob and G. S. Walley. 2 ♀♀ (white) Lac la Hache, B.C., 5 July 1938, leg. G. S. Walley. 1 ♀ (white) Canin Lake, B.C., 24 June 1938, leg. G. S. Walley.

Distribution. This subspecies is found in British Columbia south to Washington

(Okanogan Co.) and northern Idaho (Boundary Co.). To the southeast of this region, it intergrades with *astraea* and to the south (southern Washington, Oregon, and northern California), it intergrades with *edwardsii* and possibly *harfordii*. The Canadian Rocky Mountains appear to form an effective barrier against any significant intergrading between *columbiensis* and *christina*. Specimens collected in the Bitterroot Mtns., Ravalli Co., Montana exhibit characters associated with both *astraea* and *columbiensis*.

Colias alexandra columbiensis is figured in Holland (1931), Plate LXVIII, figs. 22, 23, as *C. emilia*. The orange discal spot in the male is poorly reproduced. The specimens shown were collected by Greene in 1894 at Osyoos, British Columbia and are in the Carnegie Museum collection. They came to Holland from W. H. Edwards who labeled them as *emilia*, even though they do not fit his description of the taxon. Wright (1907) also figures *emilia*, Plate XI, fig. 92, but at least two of the examples shown are probably *philodice eriphyle* Edwards.

The type series for *columbiensis* is placed in the Canadian National Collection, Ottawa, Ontario.

CONCLUSIONS

It is suggested that the taxa associated with the *Colias alexandra* complex be arranged as follows:

Colias alexandra alexandra Edwards
Colias alexandra edwardsii Edwards
Colias alexandra harfordii H. Edwards
Colias alexandra barbara H. Edwards
Colias alexandra columbiensis Ferris
Colias alexandra astraea Edwards
Colias alexandra christina Edwards
Colias alexandra krauthii Klots

Unnamed races which possibly merit nomenclatural recognition:

Colias alexandra Arizona-New Mexico Segregate (yellow population).
Colias alexandra Yukon Territory-Alaska Segregate (orange population).

The arrangement is roughly according to pigmentation. The taxa *alberta* and *emilia* are omitted for the reasons set forth above. Other aspects of the *alexandra* complex have been treated by Ferris (1972a).

Ultraviolet reflectance photography has been used in this study to assign the various *alexandra* populations to specific color groups. It has also been used to identify *barbara* and *harfordii* as members of the *alexandra* complex.

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THE GENETICS OF FORE AND HINDWING COLOUR IN CROSSES BETWEEN *DANAUS CHRYSIPPUS* FROM AUSTRALIA AND FROM SIERRA LEONE (DANAIDAE)

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Unlike most warningly colored species, the butterfly *Danaus chrysippus* (L.) is known to be polymorphic in large parts of its range. Before one can understand the reason for this it is necessary to determine the genetic control of the forms. Recently we obtained a stock of *D. chrysippus* from Sydney, NSW and another from Sierra Leone. This paper gives preliminary results obtained by crossing the two races.

MATERIALS AND METHODS

The material from Australia, which was sent to us as living butterflies by post, was monomorphic and typical f. *chrysippus* of the race *D. c. petilea* (Fig. 1a). The ground colour of these butterflies is tawny orange tending to nutbrown towards the costal margin of the forewing. The hindwing upperside is bordered by black, sometimes with a vestige of white spotting close to the hindwing border. The apical third of the forewing upperside is black, with a variable subapical bar of white spots.

The specimens from Sierra Leone, f. *alcippus*, differed from the Australian ones in that the ground colour was more orange and most of the hindwing was covered by a patch of white scaling (Fig. 1b, c). The pale areas of the forewings were of two types—those with a narrow costal border of nutbrown pigmentation similar to the Australian butterflies (Fig. 1b) and others in which the nutbrown extended over most of the forewing (Fig. 1c). There was not enough orange on the hindwing to determine whether its hue differed in the two Sierra Leone forms.

Hybrids between the two races were obtained by allowing the males