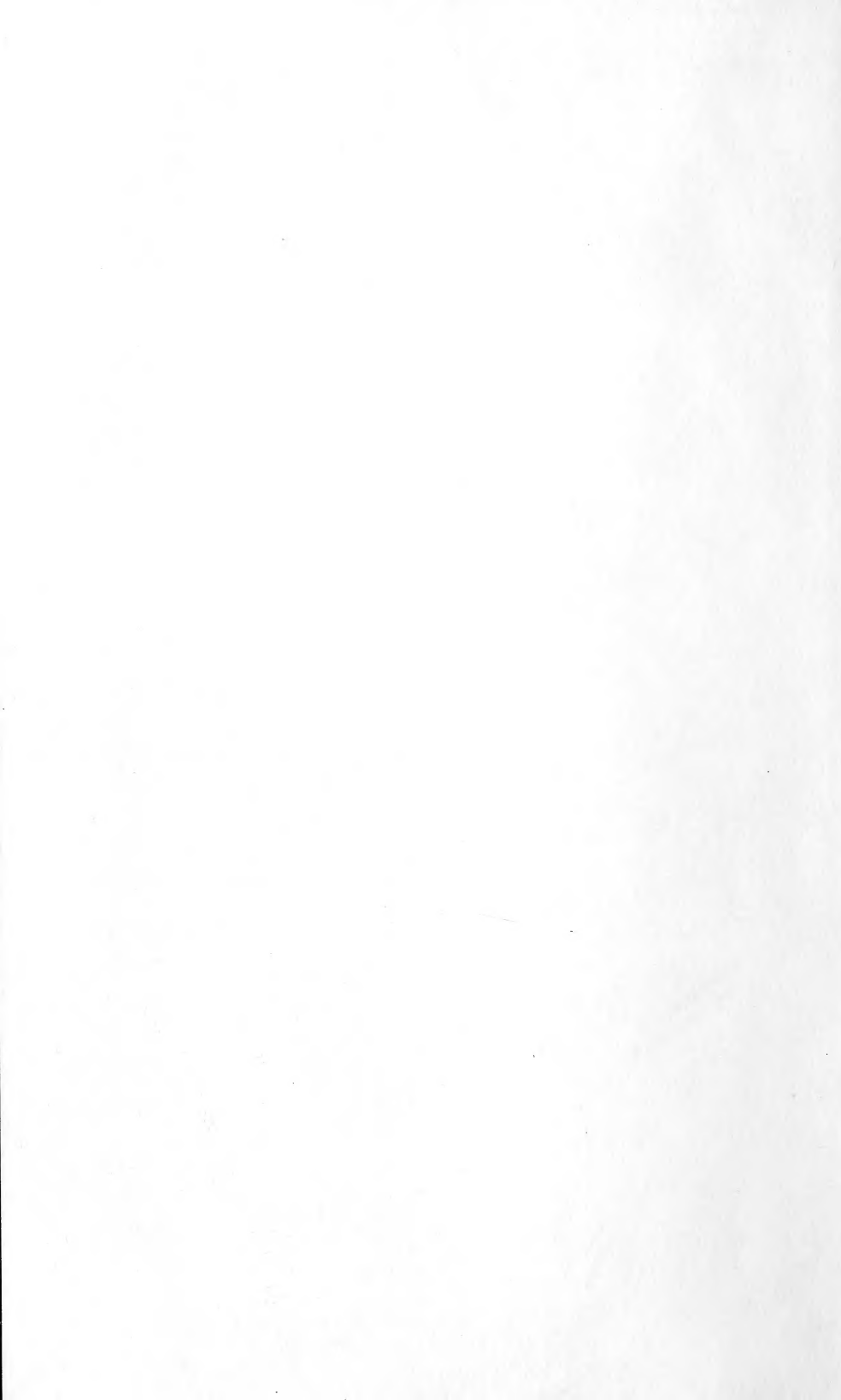
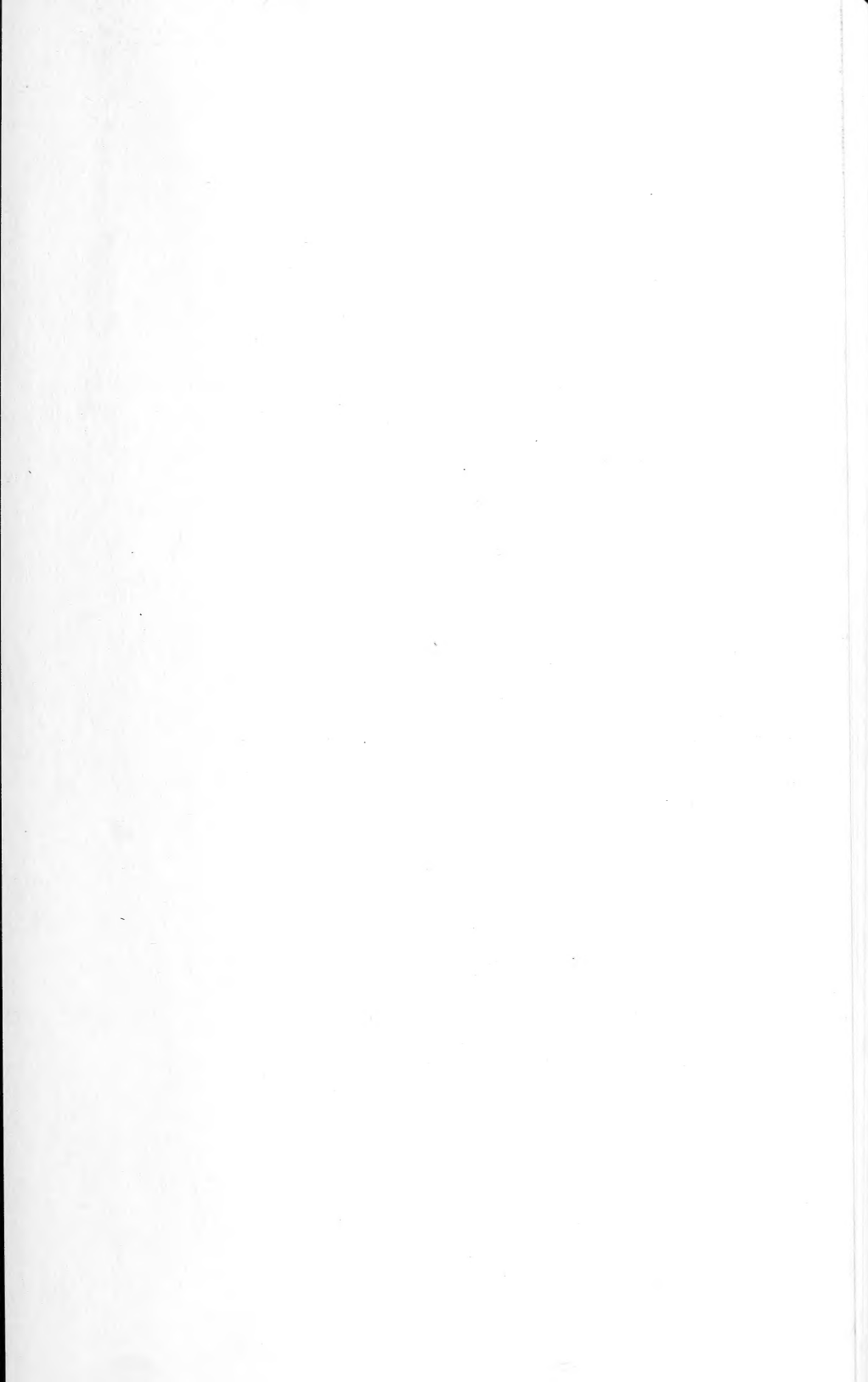




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J. H. S. Clarke

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13 March 1968



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LEPIDOPTERA OF THE CENTRAL BRAZIL PLATEAU. II. NEW GENERA, SPECIES, AND SUBSPECIES OF HESPERIIDAE

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This paper represents the first supplement to our previous list of *Rhopalocera* of the Brazilian planalto central (Brown & Mielke, 1967). Two genera, and 17 species and subspecies of *Pyrginae* and *Hesperiinae* are herein described as new categories.

Wing measurements are from base to apex; generic characters outlined in the catalogue of Evans (1953, 1955) are generally omitted from the descriptions of new species. The drawings of valvae may reflect some distortion caused by pressing the preparation to the bottom of a Petri dish with a cover slip. The author made all drawings and photographs of the types.

Unless otherwise stated, the types are deposited in the collection of the author, Department of Zoology, Universidade Federal do Paraná, Curitiba, Brazil.

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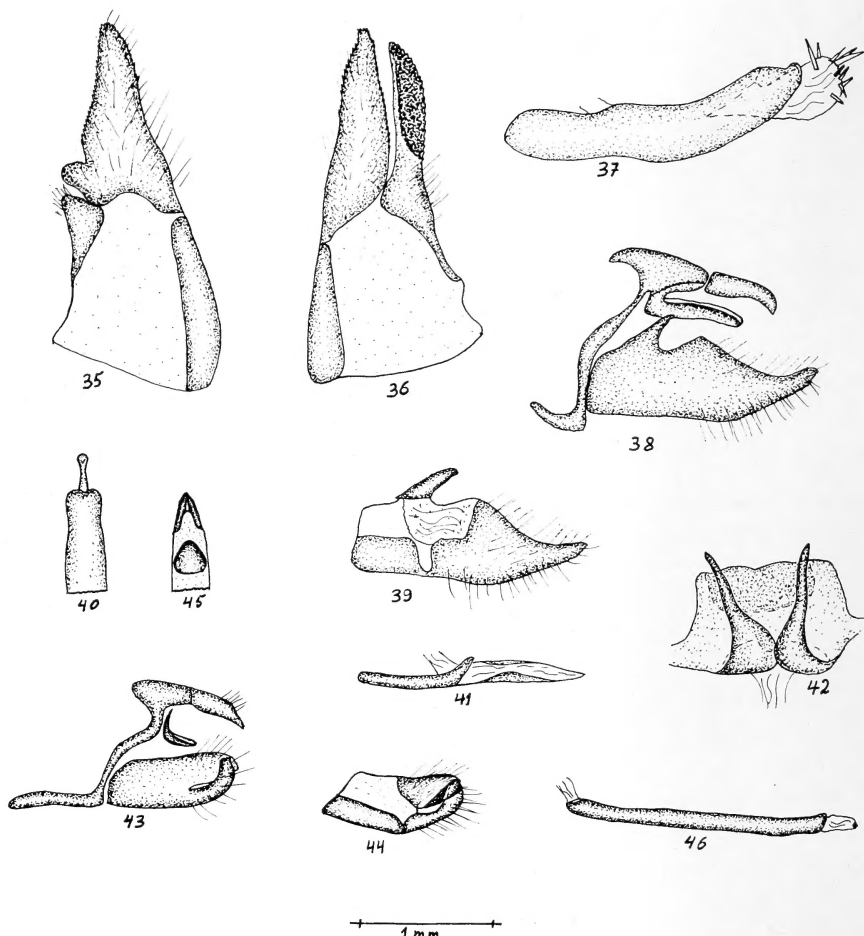
The author thanks the Brazilian Conselho Nacional de Pesquisas for aid in the form of a fellowship, which made this study possible, and Dr. Keith S. Brown, Jr., who translated this paper from the Portuguese.

Myrinia catua Mielke, new species

Figs. 1, 2, 35-37

Male. Length of forewing: 22.5 mm. Antennae externally brown and internally yellow. Nudum composed of ten to twelve segments. Head, vertex light brown, frons with a white spot. Genae white. Palpi white ventrally, light brown dorsally. Thorax and abdomen light brown dorsally, ventrally (with exception of pectus, which is white) gray. Legs with femora whitish, light brown distally.

Dorsal surface of forewing divided in two by a discal line, from vein 1 to vein 4, where it is dislocated slightly toward the external margin, continuing until it reaches the costa in space 9, proximal area more or less uniformly dark chocolate



EXPLANATION OF PLATE V

35) *Myrinia catua*, Holotype male, right valva, inner surface; 36), same, left valva, inner surface; 37) same, lateral view of aedeagus; 38) *Quadrus zolus*, Paratype male, genitalia, lateral view; 39) same, right valva, inner surface; 40) same, gnathos and uncus, ventral view; 41) same, aedeagus, lateral view; 42) same, Allotype female, ostium, ventral view; 43) *Dardarina para*, Paratype male, genitalia, lateral view; 44) same, right valva, inner surface; 45) same, gnathos and uncus, ventral view; 46) same, aedeagus, lateral view.

brown; base a little lighter; end of cell with two black ocelli, one above the other, each with a central white dot; distal area light chocolate brown, darkening at the termen in spaces 1a-4.

Ventral surface of forewing with the same line from vein 1 to costa, lighter; apex and two thirds of costal margin more yellowish, and termen a little darker.

Dorsal surface of hindwing of the same color as forewing. Base, termen and irregular discal band from space 1c to 6, dark brown.



EXPLANATION OF PLATE I

1) *Myrinia catua*, Holotype male, dorsal; 2) same, ventral; 3) *Ouleus fridericus candangus*, Holotype male, dorsal; 4) same, ventral; 5) *Quadrus zolus*, Holotype male, dorsal; 6) same, ventral; 7) *Quadrus u-lucida parabius*, Holotype male, dorsal; 8) same, ventral; 9) *Dardarina para*, Holotype male, dorsal.



10



11



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17



18

EXPLANATION OF PLATE II

10) *Dardarina para*, Holotype male, ventral; 11) *Radiatus bradus*, Holotype male, dorsal; 12) same, ventral; 13) *Peba striata*, Holotype male, dorsal; 14) same, ventral; 15) *Vidius felus*, Holotype male, dorsal; 16) same, ventral; 17) *Cymaenes laza*, Holotype male, dorsal; 18) same, ventral.

Ventral surface of hindwing same color as ventral surface of forewing, with discal band as on the upper side but somewhat fainter.

Genitalia of male similar to *M. myris*, from which it is most easily distinguished by the number of cornuti on the vesica, in *catua*, 10, in *myris*, 6. The two species

are dissimilar, externally *catua* being larger, much lighter overall, and lacking violet iridescence and possessing white genae.

Holotype male, Paracatú, Minas Gerais, Km. 482.5 Belo Horizonte-Brasília, Aug. 22, 1965, collected by K. Brown (holotype no. 9660).

***Ouleus fridericus candangus* Mielke, new subspecies**

Figs. 3, 4

Male. Length of forewing: 14–15 mm. Very similar to *O. fridericus riona* Ev., from which it is distinguished by the light designs being more restricted, and by the tornal half of the ventral surface of the hindwing which is pure white and not just the posterior one-third whitish as in *O. f. riona*.

Holotype male, and four male paratypes, Jardim Zoológico, Brasília, Distrito Federal, Feb. 21, 1966, collected by O. Mielke (holotype no. 8856). Four paratypes in collection of author. One male paratype, Campinas, Goiânia, Goiás, December 1937, and one paratype (lacks abdomen), Rio Preto, São Paulo, April 1930, both collected by R. Spitz, in the collection of the Departamento do Zoologia, Secretaria de Agricultura do Estado de São Paulo.

Ouleus fridericus fridericus occurs in northern South America (Columbia, Venezuela, the Guianas, Peru, northern Brazil: Amazonas, Pará), while *O. f. riona* is found around the southern borders of the planalto of Brazil: Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro, Guanabara; Paraguay; Argentina: Misiones; and Bolivia: Santa Cruz, Yungas, La Paz.

***Quadrus zolus* Mielke, new species**

Figs. 5, 6, 38–42

Male. Length of forewing: 15–16 mm. Antennae brown with yellow scales on the ventral side of the club and apiculus. Head white with a transverse black line, vertex black with a white spot behind the insertion of the antennae. Genae white. Second segment of palpi white ventrally, black laterally and distally. Third segment black with some ventral white scales. Collar orange. Thorax and abdomen brown dorsally, blue-white ventrally. Legs brown, with inner surface of femora and tibiae bluish.

Dorsal surface of forewing light brown with faint violaceous iridescence, crossed by two dark brown lines: one submarginal, curved, from tornus to the costal margin in space 8; the other from the middle of the inner margin to space 4, where curved proximally, reaching space 8 and including 3 small apical hyaline spots in spaces 6–8 and two additional small discal hyaline spots in spaces 2 and 3; apical spot in space 7 a little dislocated toward the base; marginal line and base darker; distal half of cell occupied by a subrectangular black patch which includes two hyaline spots, one above the other, at times occurring one more at the inferior distal angle; a further hyaline spot in space 11 above the two hyaline spots in the cell.

Ventral surface of forewing with the same spots and black cellular patch as on the dorsal side, with the latter more diffuse, general shade is lighter, especially in spaces 1a, 1b, and the base of 3; proximal third of costa blue in spaces 11 and 12;

small discocellular area lighter than on dorsal surface; double whitish spot in space 1b, and another smaller one on the margin of the same space.

Dorsal surface of hindwing same color as the forewing. Base, two lines and marginal line darker; discal line from internal margin to space 6, submarginal line from space 1c to 6; base seems to be a continuation of the discal line of the forewing.

Ventral surface of hindwing entirely blue except for marginal line and marginal area of spaces 4-7, which are brown, and space 1b which is blue-white.

Female. 16mm. Spot behind insertion of antennae orange instead of white, and forewings more rounded than male.

Holotype male, allotype female, and two male paratypes, Jardim Zoológico, Brasília, Distrito Federal, Feb. 21, 1966, collected on flowers of "Gervão" (*Stachytarpheta* sp., Verbenaceae), collected by O. Mielke. (holotype no. 8890).

***Quadrus u-lucida parabus* Mielke, new subspecies**

Figs. 7, 8

Male. Length of forewing: 16-17 mm. Dorsal and ventral surfaces of forewing and upper surface of hindwing similar to *u-lucida*, but darker; vitreous spots identical, except that of space 8 absent. The large difference is on the ventral surface of the hindwing; the posterior half is white and not blue-white as in the *u-lucida*, with which we made comparisons, white area is larger, covering spaces 1a-3 in the male and up to 4 in the female, no dark margin in these spaces as in *u-lucida*, only the fringe and a small spot on the anal angle (1b) are darker.

Genitalia similar to *u-lucida*.

Female. Length of forewing: 17.5 mm. Forewings less produced.

Holotype male, Paraopeba woods, Minas Gerais, Feb. 27, 1966, collected by O. Mielke. Allotype, female, Jardim Zoológico, Brasília, Distrito Federal, Feb. 21, 1966, collected by O. Mielke (holotype no. 8885).

Nine male paratypes: one male, Jardim Zoológico, Brasília, Distrito Federal, Feb. 21, 1966; one male, Sobradinho woods, Brasília, Distrito Federal, Feb. 22, 1966; two males, Fercal, Ribeirão da Contagem, Distrito Federal, Feb. 23 and 25, 1966; four males, Estação Florestal de Experimentação, Paraopeba, Minas Gerais, Feb. 19 and 27, 1966. The eight paratypes above collected by O. Mielke are in the collection of the author. One male, Ferrobél, Serra, Belo Horizonte, Minas Gerais, June 3, 1966, collected by K. Brown. Deposited in the collection of K. Brown.

Quadrus u-lucida u-lucida is known from areas south of the range of *Q. u. parabus* (Brazil: Rio Claro, São Paulo, Paraná, Pelotas, Rio Grande do Sul; Paraguay; and Argentina: Misiones).

***Dardarina para* Mielke, new species**

Figs. 9, 10, 43-47

Male. Length of forewing: 9-10 mm. Antennae black, shaft ringed with white

next to club. Head brown with a few whitish hairs. Palpi white with long black scales. Genae white. Collar, shoulder covers and tegulae brown with some yellow scales. Thorax and abdomen brown with yellow scales, ventrally whitish, more accentuated on the pectus. Legs yellowish with femora of first and second pairs whitish.

Dorsal surface of forewing dark brown, more accentuated at the base, with whitish spots covered by brown scales, principally in the discal area, spaces 1b, 2, and the cell; a subapical line in spaces 6-8, two adjacent dots in spaces 4-5 (between the apical dots and the termen) and an isolated dot in space 3 (between the dots of spaces 2 and 4); fringe gray.

Ventral surface of forewing of the same shade as upper; same dots, sharper, however, with a large spot in space 1b; space 12 ochreous; terminal line and veins near apex yellow; four additional very small submarginal dots distal to the dots in spaces 4-5 and 6-8;

Dorsal surface of hindwing brown, like the forewing, discal area somewhat ochre.

Ventral surface of hindwing brown with marginal line and vein 1a yellow; design very complicated, for there are no lines, but rather randomly spaced spots; space 8 with some yellow scales, as all the ventral surface of the hindwing; space 7 with 3 whitish dots, the most distal being smaller and surrounded by a brown patch; space 6 with whitish triangular base, one tiny dot of the same color in a marginal brown patch; spaces 4-5, brown at the base, with 4 small whitish dots distally, two above and two below (divided by vein 5); cell brown proximally, distally with a whitish spot, discocellular yellowish; space 3 with central whitish spot; space 2 with 2 whitish spots, one basal and the other median; space 1c with a central and 4 distal whitish spots, these in pairs one above the other; this design is quite variable in intensity; there are examples in which the whitish is reduced, and at times a very faint bluish tint occurs, principally at the costa.

Female. Length of forewings: 9-10 mm.

Holotype male, allotype female, and five paratypes (4♂♂, 1♀), Paraopeba woods, Minas Gerais, Feb. 27, 1966, collected by O. Mielke (holotype no. 8951). Allotype, and five paratypes in the collection of the author. The type series was collected on grass in a clearing in the forest interior.

Radiatus Mielke, new genus

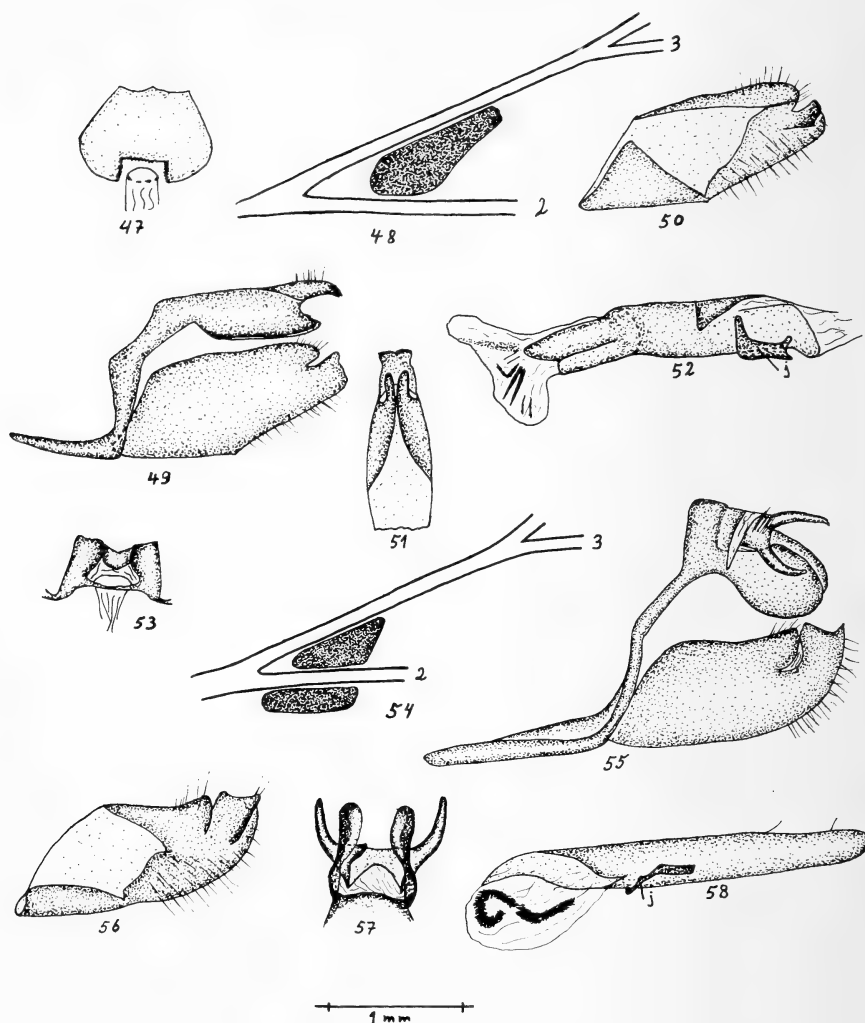
Genus near *Callimormus*. Wings produced as in *Callimormus alsimo* (Moeschler). Antennae slightly longer than half the length of costa. Club slender, apiculus long. Nudum 0/10. Shaft dark brown, yellowish under club and apiculus. Subtriangular stigma at the base of space 2 (see figure 48). Tibia of second pair of legs spined. Third segment of palpi long and slender. Eye dark red. Vein 5 curved at the base. Cell of hindwing equal to half of wing length. Yellowish veins on underside. Genitalia very different from *Callimormus*.

Type of genus: *Radiatus bradus* Mielke, described below.

Radiatus bradus Mielke, new species

Figs. 11, 12, 48-53

Male. Length of forewing: 13.5 mm. Ground color dark brown. Antennae with internal faces of club and apiculus yellowish. Head with yellowish scales on the vertex near eyes, and a line between the antennae. Genae white. Second segment of palpi, collar, shoulder covers and tegulae with some yellowish scales. Legs yellowish internally; thorax whitish ventrally; abdomen with diffuse whitish line on the pleura and four sharper lines ventrally.



EXPLANATION OF PLATE VI

47) *Dardarina para*, Paratype female, ostium, ventral view; 48) *Radiatus bradus*, Holotype male, stigmatal area of right forewing; 49) same, genitalia, lateral view; 50) same, right valva, inner surface; 51) same, gnathos and uncus, ventral view; 52) same, aedeagus, lateral view; 53) same, Allotype female, ostium, ventral view; 54) *Peba striata*, Paratype male, stigmatal area of right forewing; 55) same, genitalia, lateral view; 56) same, right valva, inner surface; 57) same, gnathos and uncus, ventral view; 58) same, aedeagus, lateral view. *j* = *juxta*.

Dorsal surface of forewing with a small yellow dot in space 1b (in male) and some yellow scales along the subcosta, reaching the apex in the male; fringes gray.

Ventral surface of forewing with a weak violet iridescence at the apex; marginal line black, submarginal line yellowish; veins at the apex and costal margin yellowish; large whitish spot in space 1b.

Ventral surface of hindwing with a faint violet iridescence with exception of space 1b and the inferior half of 1c; fringes and marginal line as with forewing; submarginal line made up of small yellowish cones; veins yellowish, including discocellular and a line from the base across the middle of the cell and thence to the external margin; a lighter diffuse line divides space 1c into two parts; four discal dots in spaces 2, 3, 6, and 7; space 1b and inferior half of 1c with diffuse yellowish scales.

Female. Length of forewing: 13.5 mm.

Holotype male, Sobradinho woods, Brasília, Distrito Federal, Feb. 22, 1966, collected by O. Mielke. Allotype, female, Sobradinho river, Brasília, Distrito Federal, Feb. 22, 1966, collected by O. Mielke (holotype no. 8964). Allotype in the collection of the author.

***Peba* Mielke, new genus**

Genus near to *Callimormus* Scudder, differing from this principally by the shape of the brand and the male genitalia. The stigma consists of two parts (one above the other), the first triangular at the base of space 2, the second a bar in space 1b below vein 2. The uncus, seen from above, reminds one of the horns of a Dutch bull and the gnathos of two vertical plates fastened by one edge. Antennae a little longer than half the length of the costa. Club slender and apiculus long. Yellow at base of club and under apiculus. Shaft plain. Nudum $\frac{9}{10}$. Third segment of palpi long and slender. Tibia of second pair of legs spined. Veins on ventral surface of wings yellowish.

Type of genus: *Peba striata* Mielke, described below.

***Peba striata* Mielke, new species**

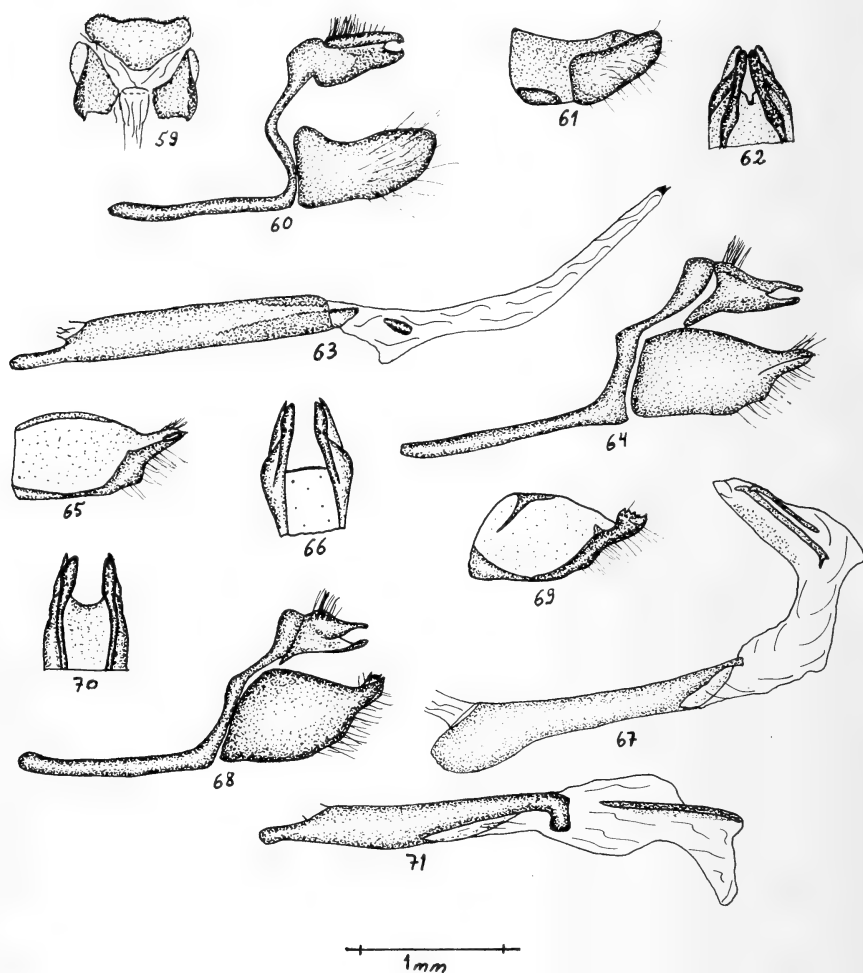
Figs. 13, 14, 54-59

Male. Length of forewing: 11-12 mm. Ground color dark brown. Antennae as described for the genus. Head with diffuse yellow scales dorsally. Genae white. Palpi with yellow scales on the second segment, lighter at the base. Collar, shoulder covers and tegulae with some yellow scales. Thorax and abdomen gray ventrally. Legs yellowish internally.

Dorsal surface with vestigial dots in discal, apical and cellular areas in the form of some yellow scales in spaces 1a, 1b, 2, 3, 6, 7, 8, 9, 10, and the end of the cell; variable, all of these scales never appear together in a single specimen, fringes lighter.

Under surface of forewing with weak violet iridescence on the costal margin and apex; spaces 1a and 1b lighter; gray patch in the middle of space 1b; terminal line black, and submarginal line very weak, yellowish; veins of costal margin, at apex, radius and discocellular yellowish.

Ventral surface of hindwing like the costal margin and apex of the ventral surface of the forewing; fringes, marginal and submarginal lines as on the forewing except the submarginal line sharper; veins yellowish, including discocellular, and a line from the base to the middle of the discocellular, continuing to the termen; a yellowish line in space 1c from base to termen, dividing the space into two parts, the one



EXPLANATION OF PLATE VII

59) *Radiatus bradus*, Paratype female, ostium, ventral view; 60) *Vidius felus*, Holotype male, genitalia, lateral view; 61) same, right valva, inner surface; 62) same, gnathos and uncus, ventral view; 63) same, aedeagus, lateral view; 64) *Cymaenes laza*, Holotype male, genitalia, lateral view; 65) same, right valva, inner surface; 66) same, gnathos and uncus, ventral view; 67) same, aedeagus, lateral view; 68) *Cymaenes chapa*, Holotype male, genitalia, lateral view; 69) same, right valva, inner surface; 70) same, gnathos and uncus, ventral view; 71) same, aedeagus, lateral view.

closer to the internal margin possessing yellowish scales and the other with a small yellowish streak, the beginning of a series of discal dots in spaces 2-7, those of spaces 4 and 5 generally absent; space 1b without violet iridescence.

Female. Length of forewing: 11-12 mm.

Holotype male, allotype female, and six paratypes (3♂♂, 3♀♀), Paraopeba woods, Minas Gerais, Feb. 27, 1966, collected in forest clearings, by O. H. H. Mielke (holotype no. 8961). Allotype, and six paratypes in the collection of author. One additional male paratype, Paraopeba woods, Minas Gerais, June 6, 1966, collected by K. Brown. Deposited in collection of K. Brown.

Vidius felus Mielke, new species

Figs. 15, 16, 60-63

Male. Length of forewing: 12.5 mm. Antennae brown; shaft checkered, base of club and apiculus whitish ventrally. Head with whitish scales, principally before and behind insertion of antennae. Palpi whitish with brown hairs, more accentuated on the distal part of second segment; third segment brown. Genae and collar whitish. Shoulder covers and tegulae brown. Thorax and abdomen brown dorsally, grayish ventrally. Legs grayish.

Dorsal surface of forewing; ground color brown, with yellow opaque spot in space 1b and hyaline discal spots in spaces 2 and 3, and apical spots in spaces 6, 7, and 8 (of space 7 slightly closer to base); two spots, one above the other, in the distal half of the cell; narrow black marginal line; fringes gray.

Ventral surface of forewing with the same spots as upper side; lighter at the costa (from base to apical spots), in the distal half of spaces 1a and 1b, and from apex to space 3, entering spaces 4 and 5, forming an isolated patch of dark brown between the apical spots and the marginal area of the apex; marginal line black.

Dorsal surface of hindwing with the same shade as forewing. Discal and basal areas lighter, and divided by a line of the ground color (corresponding to the band on the under side).

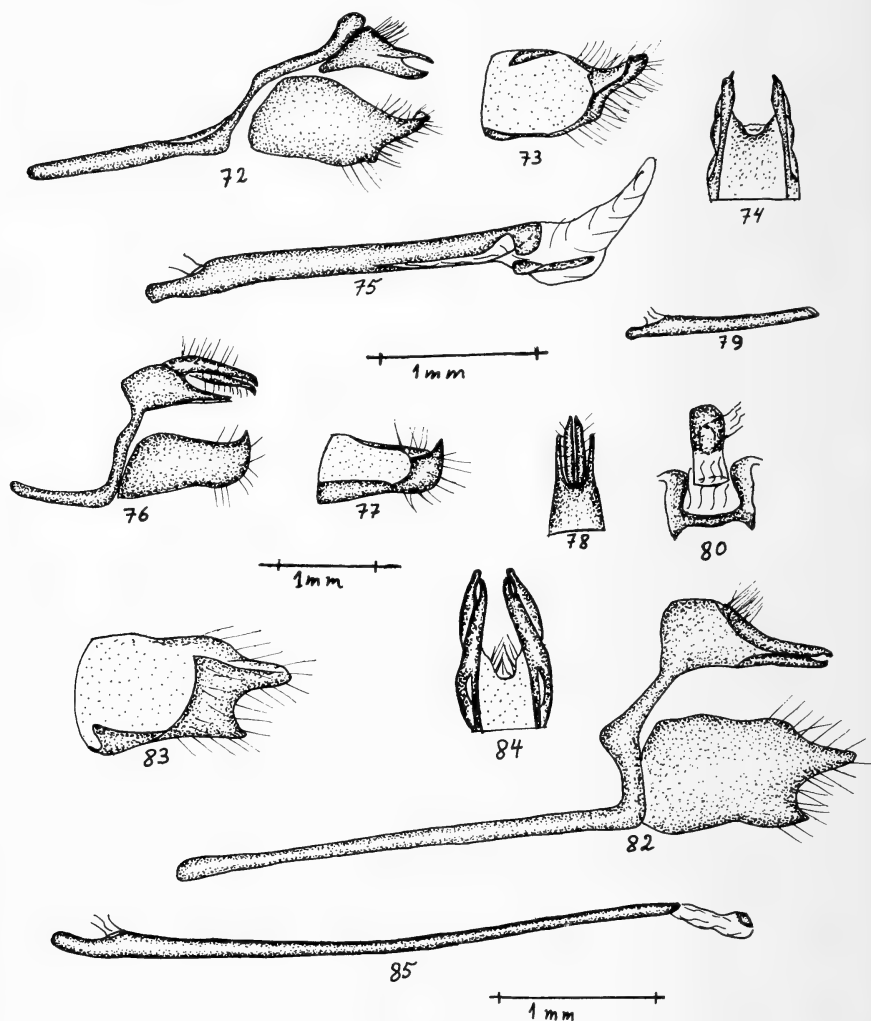
Ventral surface of hindwing light brown with spaces 1a, 1b, internal half of 1c, and the termen medium brown; a dark brown discal band from middle of space 1c to the end of space 7, where it is widest, touching the cell; spots of the same darker color at the base, in the middle of space 7 (largest), in the middle of the cell, and submarginally in the spaces 1c-3; all pattern elements bordered by fine whitish lines. Marginal line black.

Holotype male, Km. 222, Belo Horizonte-Brasília highway, Município Felixlândia, Minas Gerais, Feb. 20, 1966, collected at edge of woods, by O. Mielke (holotype no. 9095). One male paratype, Murtinho, Mato Grosso, December, 1920, collected by R. Spitz, in the collection of the Departamento de Zoologia, Secretaria de Agricultura, São Paulo.

Cymaenes laza Mielke, new species

Figs. 17, 18, 64-67

Male. Length of forewing: 13 mm. Dark brown. Antenna shaft checkered yellow, yellow under the club and apiculus. Head with white scales anterior to insertion of antennae; second segment of palpi brown and white; genae and collar whitish. Thorax and abdomen grayish ventrally. Legs grayish. Dorsal surface of



EXPLANATION OF PLATE VIII

72) *Cymaenes riba*, Holotype male, genitalia, lateral view; 73) same, right valva, inner surface; 74) same, gnathos and uncus, ventral view; 75) same, aedeagus, lateral view; 76) *Lerema veadeira*, Holotype male, genitalia, lateral view; 77) same, right valva, inner surface; 78) same, gnathos and uncus, ventral view; 79) same, aedeagus, lateral view; 80) same, Allotype female, ostium, ventral view; 82) *Morys sobra*, Holotype male, genitalia, lateral view; 83) same, right valva, inner surface; 84) same, gnathos and uncus, ventral view; 85) same, aedeagus, lateral view.

forewing with the termen and apex a little lighter; discal whitish spots in spaces 2 and 3, apical spots in spaces 6 and 7, all being very weak; fringes gray.

Ventral surface of forewing black with the same spots as upper side, and with a diffuse patch in space 1b below the discal spot of space 2; small black circular spot in space 4 and another smaller in space 5, forming part of the discal spots; basal half of costa yellowish; apical area to space 4 and marginal part of space 3 gray; marginal line black.

Dorsal surface of hindwing with diffuse ochreous scales in the basal two-thirds; fringes gray.

Ventral surface of hindwing gray as the apex on ventral surface of forewing; discal area a little lighter, limited proximally by an irregular black line consisting of small dots of the same size in spaces 1c-4, smaller in 5 and 6, and distally by another much fainter line in the same spaces; black spot in the middle of space 7; marginal line black.

Holotype male, Jardim Zoológico, Brasília, Distrito Federal, Feb. 21, 1966, collected within the forest, by O. H. H. Mielke (holotype no. 9152).

***Cymaenes chapa* Mielke, new species**

Figs. 19, 20, 68-71

Male. Length of forewing: 13 mm. Ground color dark brown. Antenna shaft checkered yellow; yellow under the club and apiculus. Head with white scaling anterior to insertion of antennae. Second segment of palpi brown and white. Genae white. Thorax and abdomen grayish ventrally. Legs grayish.

Dorsal surface of forewing with a weak indication of discal yellow spots in spaces 2 and 3, and apical in spaces 6-8 (the latter more visible); fringes gray.

Ventral surface of forewing black with apex and large diffuse patch in space 1b gray; marginal line black.

Dorsal surface of hindwing with basal and discal areas a little ochreous; fringes gray.

Ventral surface of hindwing grayish-brown; marginal line black; discal spots as in *Cymaenes gisca* Ev., but very faint, being bordered internally by very sharp black spots in spaces 1b, 2, 3, 4-5 (larger), and 6, and externally by spots forming a very weak irregular line in spaces 2-6; sparse yellowish scales, with the exception of space 1b.

Holotype male, Chapada de Contagem, Brasília, Distrito Federal, Feb. 23, 1966, collected within the forest, by O. H. H. Mielke (holotype no. 9062).

***Cymaenes riba* Mielke, new species**

Figs. 21, 22, 72-75

Male. Length of forewing: 11.5 mm. Antennae brown, shaft checkered yellow, yellow under the club and apiculus. Head dark brown with white scales principally before and behind the insertion of the antennae. Palpi whitish with brown and ochreous hairs. Thorax and abdomen brown dorsally, grayish ventrally. Legs grayish.

Dorsal surface of forewing dark brown with diffuse ochreous scales between the discal and apical spots, and the base, more accentuated in the basal half of the costa; discal opaque yellow spots in spaces 2, 3, and 4 (much reduced), and apical in spaces 6, 7, and 8 (smaller); fringes gray; fine black marginal line.

Ventral surface of forewing with discal area and internal margin black; costal area ochreous from the base to the apical spots (these being weakly indicated), turning grayish in the apical area; marginal black line from space 1b to 4, com-



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EXPLANATION OF PLATE III

19) *Cymaenes chapa*, Holotype male, dorsal; 20) same, ventral; 21) *Cymaenes riba*, Holotype male, dorsal; 22) same, ventral; 23) *Lerema veadeira*, Holotype male, dorsal; 24) same, ventral; 25) *Morys sobra*, Holotype male, dorsal; 26) same, ventral; 27) *Adlerodea mineira*, Holotype male, dorsal.

posed of small cones in spaces 5-7, all being separated by the yellow veins of the apex and termen.

Dorsal surface of hindwing ochreous in basal and discal regions; marginal area dark brown; fine black marginal line; fringes gray.

Ventral surface of hindwing ochreous, more accentuated at the costal margin; spaces 1a, 1b, 1c, and cell more grayish; discal band of gray spots in spaces 2-6, continued in space 7 by a little spot; veins 2, 3, 4, 6, and 7 more yellowish at the termen; marginal black line composed of streaks in spaces 1b-3, and spots in spaces 4-5 (larger), 6 (medium) and 7; fringe gray.

Holotype male, Fercal, Ribeirão da Contagem, Brasília, Distrito Federal, Feb. 25, 1966, collected in the woods, by O. H. H. Mielke (holotype no. 8954).

Lerema veadeira Mielke, new species

Figs. 23, 24, 76-81

Male. Length of forewing: 13 mm. Antennae brown, shaft checkered, yellowish under club and apiculus. Palpi yellowish with brown scales. Head, collar, shoulder covers, tegulae, thorax, abdomen and legs brown.

Dorsal surface of forewing light brown. Stigma gray internally and bordered superiorly by a black line; around stigma, scales with yellow sheen; small weak opaque yellow spots in spaces 3, 6, and 7; fringe gray.

Ventral surface of forewing with costa and apex broadly ferruginous brown, remainder dark brown; yellow spots as on upper surface; fine black marginal line from space 2 to apex.

Dorsal surface of hindwing of the same shade as forewing; fringe gray.

Ventral surface of hindwing of the ferruginous brown of forewing apex; space 1b dark brown; black marginal line from space 2-7; small yellowish discal spots in spaces 1c-6, forming an irregular line.

Female. Length of forewing: 13 mm. Forewing more rounded, without apical spots; ferruginous brown darker, and more diffuse on ventral surface of forewing.

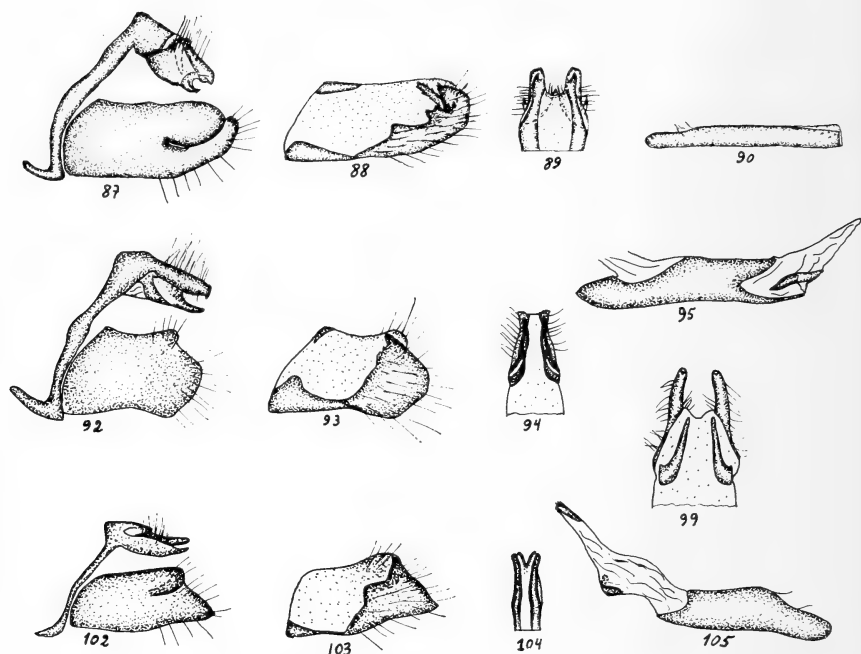
Holotype male, Chapada dos Veadeiros, Goiás, no further data. Allotype, female, Paracatú, Minas Gerais, 1000 m., Aug. 12, 1920, no further data. Holotype and allotype in the Museu Nacional, Rio de Janeiro, as #s 62741 and 59209.

Morys sopra Mielke, new species

Figs. 25, 26, 82-86

Male. Length of forewing: 12 mm. Species externally identical to *Morys subgrisea subgrisea* (Mab.), of which we also collected two specimens mentioned in the previous paper (Brown & Mielke, 1967), and have examined a further five specimens in the Departamento de Zoologia, Secretaria de Agricultura, São Paulo. In *subgrisea*, the small opaque apical spots may be absent, as is the case with the present species. The author's determination of *subgrisea* is based on the description by Lindsey (1925) of *Vorates tupaci*, which was included in the synonymy of *Morys subgrisea subgrisea* (Mab.) by Evans (1955). The great difference between *subgrisea* (= *tupaci*) and the present species is in the male genitalia (see Figures 82-86).

Holotype, male, Sobradinho woods, Brasília, Distrito Federal, Feb. 24, 1966, collected in the cerrado, by O. H. H. Mielke (holotype no. 9030).



EXPLANATION OF PLATE IX

87) *Adlerodea mineira*, Holotype male, genitalia, lateral view; 88) same, right valva, inner surface; 89) same, gnathos and uncus, ventral view; 90) same, aedeagus, lateral view; 92) *Cynea conta*, Holotype male, genitalia, lateral view; 93) same, right valva, inner surface; 94) same, gnathos and uncus, ventral view; 95) same, aedeagus, lateral view; 99) *Oeonus brasus*, Holotype male, gnathos and uncus, ventral view; 102) *Panoquina confusa*, Holotype male, genitalia, lateral view; 103) same, right valva, inner surface; 104) same, gnathos and uncus, ventral view; 105) same, aedeagus, lateral view.

***Adlerodea mineira* Mielke, new species**

Figs. 27, 28, 87-91

Male. Length of forewing: 15 mm. Ground color dark brown. Antenna shaft with a longitudinal yellow streak ventrally, dilated at the base of each segment; base of club yellow ventrally. Head with whitish hairs and green and red iridescence; genae whitish. (Palpi missing). Thorax and abdomen whitish ventrally and legs with whitish hairs.

Dorsal surface of forewing with a few yellow scales in basal two-thirds of costal area and sparse yellow hairs in distal two-thirds of space 1a and near the base of space 1b; fringe gray.

Ventral surface of forewing lighter in costal and apical areas, and these covered with diffuse whitish scales.

Dorsal surface of hindwing with area of yellowish hairs covering the basal half and internal margin; fringe gray.

Ventral surface of hindwing covered with whitish scales; four black spots in spaces 2, 3, 4-5, and 6, the last two being larger.

Holotype male, Estação Florestal de Experimentação, Paraopeba, Minas Gerais, Feb. 27, 1966, collected by O. Mielke (holotype no. 9033).

Cynea conta Mielke, new species

Figs. 29, 30, 92-96

Male. Length of forewing: 13 mm. Antennae brown, yellow under club, yellow streak under apiculus. Nudum 4/9. Antennae longer than half the length of costa. Head with green iridescence and whitish scaling anterior to insertion of antennae. (Palpi missing). Genae white. Collar, shoulder covers and tegulae light brown. Thorax and abdomen light brown dorsally, whitish ventrally, principally on the pectus. Legs brown externally and whitish internally. Tibiae of second pair of legs with spines.

Wings blackish-brown dorsally, lighter ventrally.

Dorsal surface of forewing with brand in space 1b covered by hairs, as in the generic description by Evans (1955); termen a little lighter; two white spots in spaces 2 and 3, that of space 2 larger and distal of the origin of vein 3 and below the discocellular.

Ventral surface of forewing black at the base, with a yellow streak between Sc and R, occupying the basal third of the wing; long erect scales in the basal half of the cell; spots as on upper side; gray area in distal half of space 1b.

Dorsal surface of hindwing with weakly ochreous hairs basally.

Ventral surface of hindwing with termen and internal margin lighter; basal two-thirds of wing with weak violet iridescence; weak discal spots in spaces 2, 3, and 4.

Holotype male, Fercal, Ribeirão da Contagem, Brasília, Distrito Federal, Feb. 25, 1966, collected by O. Mielke (holotype no. 9093).

Oeonus brasus Mielke, new species

Figs. 31, 32, 97-101

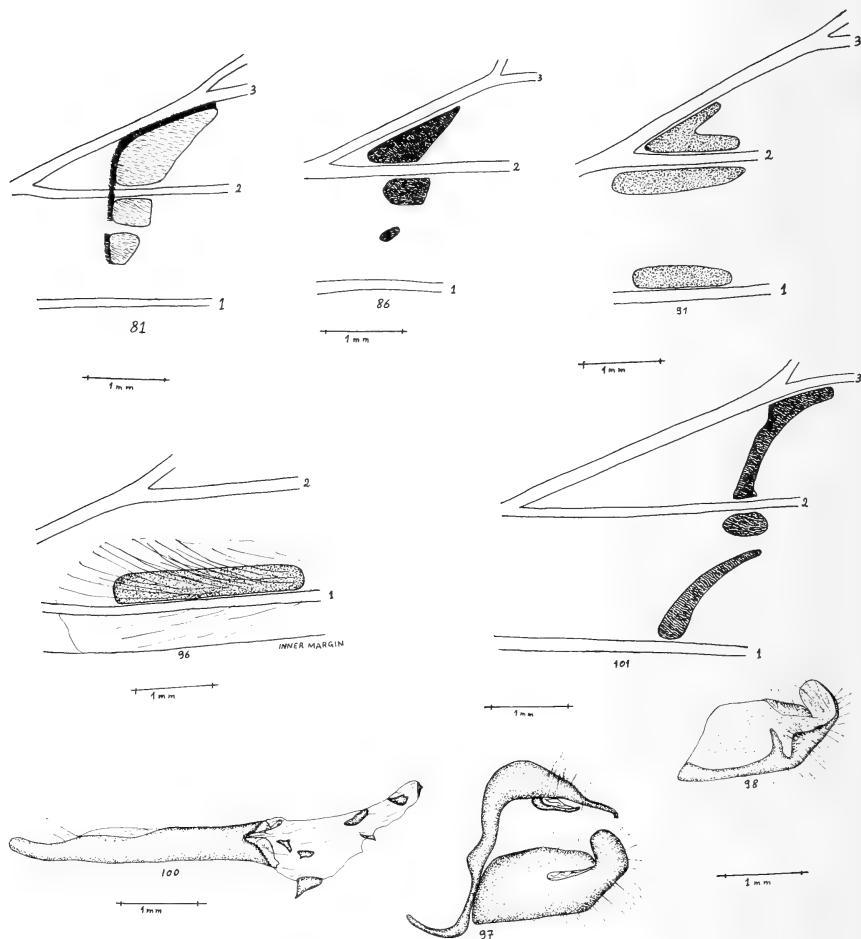
Male. Length of forewing: 16 mm. Antennae brown, shaft checkered on upper half, yellow under base of club. Nudum 8 8. Head brown with ochreous scales. Second segment of palpi yellowish with some brown scales, whitish at the base; third segment brown. Collar and genae whitish. Shoulder covers and tegulae brown with ochreous hairs. Thorax and abdomen brown dorsally with ochre-green hairs at the base of abdomen; whitish ventrally. Legs ochreous. Tibiae of second pair of legs with spines.

Dorsal surface of forewing dark brown, a little yellowish in basal area; more accentuated in basal two-thirds of space 12; yellow spots in spaces 1b (inferior half), 2 (divided in two by brown scales), 3, a small spot in space 6, and a small diffuse spot in the inferior part of the cell, above stigma; stigma consisting of three parts: one at base of vein 3 to vein 2 (internal to spot in space 2), a subrectangular part below vein 2, and a part from vein 1 curved above the spot of space 1b; fringe gray.

Ventral surface of forewing black with apical and costal areas ochreous, more accentuated in proximal half; yellow spots as on upper side, that of space 1b broader and more diffuse.

Dorsal surface of hindwing brown as forewing; base and discal area a little ochreous; yellow spots in spaces 2 and 3; fringe as on forewing but larger at the anal angle.

Ventral surface of hindwing ochreous with spaces 1a and 1b darker; yellow spots



EXPLANATION OF PLATE X

81) *Lerema veadeira*, Holotype male, right forewing, stigmatal area; 86) *Morys sobra*, Holotype male, right forewing, stigmatal area; 91) *Adlerodea mineira*, Holotype male, right forewing, stigmatal area; 96) *Cynea conta*, Holotype male, right forewing, stigmatal area; 97) *Oeonus brasus*, Holotype male, genitalia, lateral view; 98) same, right valva, inner surface; 100) same, aedeagus, lateral view; 101) same, right forewing, stigmatal area.

in spaces 1c, 2, 3, and inferior angle of cell; three fine yellow lines from spot in space 1c to termen.

Holotype male, Sobradinho woods, Brasília, Distrito Federal, collected in forest, Feb. 22, 1966, by O. H. H. Mielke (holotype no. 8991).



EXPLANATION OF PLATE IV

28) *Adlerodea mineira*, Holotype male, ventral; 29) *Cynea conta*, Holotype male, dorsal; 30) same, ventral; 31) *Oeonus brasus*, Holotype male, dorsal; 32) same, ventral; 33) *Panoquina confusa*, Holotype male, dorsal; 34) same, ventral.

Panoquina confusa Mielke, new species

Figs. 33, 34, 102-105

Male. Length of forewing: 16-17 mm. Externally coincides completely with the description of *Panoquina trix* Ev., being distinguished from this by male genitalia (see figs. 102-105). The author does not have any specimens of *P. trix* for a more detailed comparison.

Dorsal surface of forewing with opaque elongated yellowish spot in space 1b, hyaline white spots in spaces 2, 3, 4, 6, 7, and in the cell above internal angle of hyaline spot in space 2.

Ventral surface of forewing with the same spots, that of space 1b being broader; black basally.

Dorsal surface of hindwing with the spot of discal band of under side visible in spaces 2-5.

Ventral surface of hindwing with discal band in spaces 2-5 (paratype) or 6 (holotype); violet iridescence.

Holotype male, paratype male, Km. 222, Belo Horizonte-Brasília highway, Felixlândia, Minas Gerais, Feb. 20, 1966, collected by O. Mielke (holotype no. 8984).

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THYMELICUS LINEOLA (HESPERIIDAE) IN INDIANA

Since the discovery of the first European skipper, *Thymelicus lineola* (Ochsenheimer), in North America around 1910, its distribution across the country has been noted with interest. Clench (1956, *Lepid. News*, 10: 151) gave a summary of its occurrence in North America, reporting the species in Ontario, Toronto, Michigan, New York, and Ohio. The last thorough paper on the distribution of this butterfly is that by Burns (1966, *Canad. Ent.* 98:859), Burns included Michigan, Ohio, New York, Pennsylvania, Maryland, New Jersey, and Connecticut in this country, plus New Brunswick, Ontario, and British Columbia in Canada. More recently the species has also turned up in Illinois (Irwin, 1968, *J. Lepid. Soc.*, 22:21).

On June 22, 1967 I collected one male *Thymelicus lineola* in a grassy pasture in North Manchester, Wabash County, Indiana. A female was collected in the same field on July 1, 1967. Both specimens were captured while at rest in the grass.

I am grateful to Dr. Frederick H. Rindge, Curator of Lepidoptera of the American Museum of Natural History, New York, for help with the literature and confirmation of my identification of the species as *Thymelicus lineola*.—ERNEST M. SHULL, 402 Wayne St., N. Manchester, Indiana

THYMELICUS LINEOLA (HESPERIIDAE) IN ILLINOIS

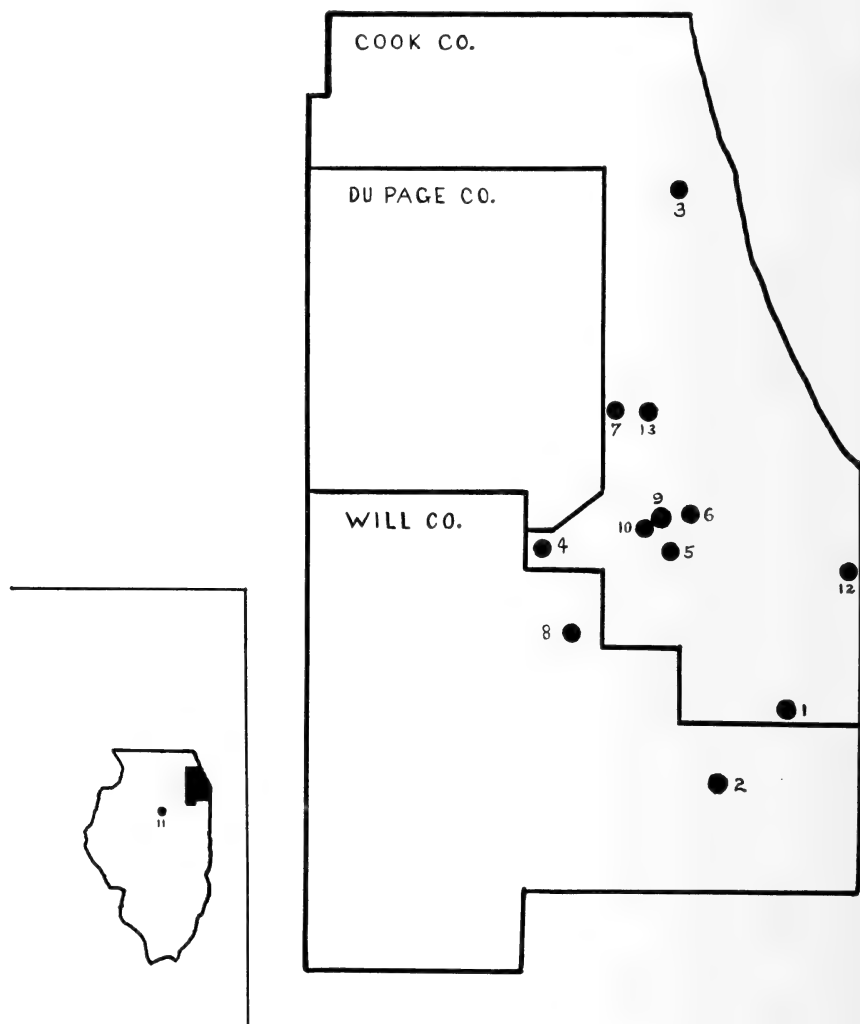
RODERICK R. IRWIN

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Range expansion of the introduced skipper *Thymelicus lineola* (Ochsenheimer) in North America has been well documented since its presence was first recognized in 1910. Burns (1966) summarizes these accounts and presents a complete bibliography. He points out that the rate of expansion of *lineola* into new territory has shown a notable increase in the last fifteen years. In some areas it has become so abundant as to constitute an agricultural pest requiring the application of control measures (Arthur, 1966). In emphasizing that the actual range of the species is doubtless already much more extensive than published reports indicate, Burns appeals for further description and study of the process of its invasion of new areas while it is still under way. He does not, however, mention its occurrence in Illinois; for although it has been present in that state at least since 1957, and is now an apparently well-established resident, no previous account of its existence there has been published. For the same reason, Heitzman (1963) was misled into stating that the capture of a specimen at Culver, Indiana on June 23, 1962, by F. S. Badger represented a western range extension in the United States.

In the spring of 1964, while examining the collections of the Field Museum of Natural History of Chicago during my studies of the distribution of Illinois butterflies, I was surprised to find a specimen of *lineola* taken in Chicago on July 6, 1960 by Mr. Gregory Nielsen. Believing this to be a new western record for the United States as well as a new state record, I immediately contacted Mr. Nielsen, who was so kind as to make available to me his records of the species, as well as his correspondence with Mr. H. K. Clench in which the latter had given him the following earlier record from Illinois.

The first known observation of *lineola* in Illinois took place June 17, 1957, when Mr. Robert W. Surdick of Pittsburgh, Pennsylvania, took ten specimens and reported "many more seen, all fresh" at Park Forest, in southern Cook County. On June 20, 1957, Surdick took nine more specimens at Monee, in eastern Will County a few miles south of Park Forest, and again reported the observation of many additional fresh examples (Clench, *in litt.* to Nielsen). The apparent density of these populations suggests their existence for at least a year previous to this time.



EXPLANATION OF PLATE

Outline map of the Chicago metropolitan area showing the localities where *Thymelicus lineola* has been taken, with the date of first capture for each. Inset map shows the portion of Illinois depicted in the larger map. The localities are as follows: 1. Park Forest (1957). 2. Monee (1957). 3. Northwest Highway and Merrimac Avenue, Chicago (1960). 4. Lemont (1961). 5. Palos Park (1965). 6. Chicago Ridge (1965). 7. South Bemis Woods near Western Springs (1965). 8. Messengers Woods near Lockport (1965). 9. Country Lane Woods near Willow Springs (1965). 10. Teason's Woods near Palos Park (1966). 11. Streator, La Salle County (inset map) (1966). 12. Burnham (1966). 13. Arie Crown Woods near La Grange (1966).

No further records of *lineola* from Illinois are known until those of Nielsen. Between July 1 and 6, 1960, he captured several specimens along the Chicago and North Western Railway tracks near Merrimac Avenue and the Northwest Highway in Chicago. This is an urban area of small homes and light industry. He did not find it there in subsequent years (personal communication); nor did I observe the species on a visit to the area on July 13, 1964, although this was probably too late for it.

Mr. Norman G. Seaborg of Lockport, Illinois recorded *lineola* from the vicinity of Lemont, in southwestern Cook County, on July 1, 1961. The number of specimens observed or taken and the exact locality were not stated (Seaborg, personal communication).

On June 22, 1965, I returned to Nielsen's locality in northwest Chicago but again failed to find *lineola*. The next day, however, during a routine collecting trip and without *lineola* in mind, I took three males and one female of the butterfly along the tracks of the Norfolk and Western (formerly Wabash) Railway near the depot in Palos Park, Illinois. Later the same day, I obtained another fresh male near the intersection of the same railroad and the Indiana Harbor Belt Railroad in Chicago Ridge, Illinois, about 3½ miles north of Palos Park. This general area is roughly 20 miles south of the Nielsen locality and nearly the same distance north of those of Surdick.

The following day, June 24, I found *lineola* fairly numerous at Chicago Ridge, in a very limited area immediately adjacent to the railroad intersection. Five males and two females were taken and a number of others seen between 3:30 and 7:30 P.M. The majority of individuals appeared to be fresh. On June 25, one male and two females were taken and several others observed. Thereafter no more captures were made, in order to avoid threatening the existence of the colony. On June 26, five individuals were seen; on the 27th, one; July 1, three, and July 2, two. Although the area was observed almost daily for the rest of the summer, no more were seen that year. Some anxiety was felt for the survival of the species due to weed mowing later in the summer and grass fires which swept the area early the following spring.

Other collectors in the Chicago area also found *lineola* in 1965. Mr. Richard Arnold of Hinsdale took one male on June 19 in South Bemis Woods Forest Preserve near Western Springs (Arnold, personal communication). Seaborg reported it from a locality about a mile north of Messengers Woods Forest Preserve, east of Lockport in Will County, on June 18, and from Country Lane Woods Forest Preserve, near Willow Springs, southwest of Chicago, on July 5.

In 1966 both the Palos Park and Chicago Ridge localities were closely observed almost daily after the beginning of June to determine the date of appearance of *lineola*. This proved to be June 18, when a fresh male was taken at each of the two places. Thereafter, observations were limited to the Chicago Ridge area for reasons of convenience. One more male was taken June 19, but by the 20th a virtual population explosion occurred. About seven o'clock that evening, a vast number of *lineola* were found to be present along the N. & W. right-of-way about 200 feet southwest of last year's center of population. As I walked through the grass in which they were resting, scores of them arose, several at each step. Of the 18 individuals taken on June 20, two were females, their appearance having followed that of the males by only two days.

By June 23 *lineola* was still more abundant in the same area, the most of any Hesperiid that I have ever seen. It was present in comparable numbers along the railroad for at least a mile northeasterly, and very probably in the opposite direction as well, possibly as far as the Palos Park station. The species continued in essentially undiminished numbers through the end of June, although by the latter date some were becoming worn.

Meanwhile, *lineola* had been found at another location some 100 miles southwest of Chicago. Mr. Gary McCoy of Streator, Illinois, in southern La Salle County, captured three individuals there on June 20, 1966. I examined these on June 27, and later that day took three more somewhat worn specimens in the same locality. Again the scene was a railroad right-of-way, in this case that of the Chicago, Burlington and Quincy at the north edge of the city. This is at present the southwesternmost point from which *lineola* has been recorded, not only in Illinois but for the entire Great Lakes region.

Still another population was encountered on July 5, 1966, when I saw several *lineola*, of which three were taken, in Teason's Woods Forest Preserve about two miles northwest of the previous locality in Palos Park. This was my first observation of the skipper away from the immediate vicinity of a railroad.

At the Chicago Ridge locality by July 6, the numbers of *lineola* had become noticeably reduced. On July 9, only two were seen; July 10, three; July 13 and 14, one; and thereafter none, although observations were again continued much later.

Additional localities in the Chicago area from which other collectors reported *lineola* in 1966 were Burnham, in southeastern Cook County, where Seaborg captured a single individual on June 30 (Seaborg, per-

sonal communication) and Arie Crown Woods near La Grange, in west central Cook County, where Arnold obtained five males on June 24 (Arnold, personal communication). Both of these collectors also found *lineola* in 1966 in previously reported areas. These additional records bring the total number of localities from which *lineola* has been reported in Illinois to 13, of which all but one (Streator) are in the Chicago metropolitan area.

It will be seen that most of the localities where *lineola* has been found in Illinois are immediately proximate to railroads, giving added credence to the opinion that these carriers may act as agents of transportation of the species to new territories. Arthur (1966) and Burns (1966) believe that hay shipments may play a part in its spread.

I have not as yet found the albinistic form *pallida* Tutt. While other observers have reported that it has constituted a recognizable fraction of the populations they studied, "a few percent" according to Ehle (1958), I found no examples in which the ground color was more than a very little lighter than average.

Although I was able to visit the Chicago Ridge locality almost daily, the time available for observation on most days was very limited, of the order of twenty minutes or less each visit. This fact precluded any meaningful attempt to learn much about the insect beyond its relative numbers and flight period. In its flight habits I found *lineola* strongly suggestive of the related species *Ancyloxypha numitor*, which at times was flying with it; so that more than once I netted a supposed *lineola* only to find it was the former species.

SUMMARY

First found in the Chicago area in 1957, *Thymelicus lineola* is now apparently well established in several localities there and is expanding its range southwestwardly in Illinois. These localities are summarized in the explanation of Plate 1, which is an outline map of the Chicago area showing them. In 1966, which may or may not have been an average year, *lineola* first appeared shortly after the middle of June and quickly reached a peak of abundance during which it virtually swarmed in certain localities. After the beginning of July its numbers began to diminish until by the middle of the month it had disappeared.

ACKNOWLEDGMENTS

I am very grateful to Mr. H. K. Clench for his helpful suggestions and criticism of the first draft of this paper, and for permission to use

the Surdick records of *lineola*. My thanks also to Messrs. Richard Arnold, Gary McCoy, Gregory Nielsen and Norman G. Seaborg for furnishing their records of the species.

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INCISALIA HENRICI IN MANITOBA AND MINNESOTA (LYCAENIDAE)

The known range for *Incisalia henrici* (Grote & Robinson) was extended considerably northwestward when William A. Bergman, Patrick J. Conway and I collected six males (28-V-1967) 10 miles southeast of Richer, Manitoba in the Sandilands Provincial Forest. The forest growth here is principally aspen-birch interspersed with jack pine and a few black spruce muskegs. The soil is shallow and often sandy with bearberry the principal ground cover. *Incisalia polios* Cook & Watson was exceedingly common throughout the area while *Incisalia augustinus* (Westwood) and *Incisalia niphon clarki* Freeman seemed to be generally distributed but less abundant. *I. henrici* was local to one opening in an aspen glade where individuals lit on bare twigs or buds about three feet off the ground. The other three species almost invariably lit on the ground or on low bushes not over a foot high.

This location extends the known range of *I. henrici* nearly 700 miles northwest from where it has previously been recorded in Newaygo and Crawford counties Michigan. However, the range may be continuous as three recent records from Minnesota indicate: John S. Nordin of Webster, South Dakota collected a specimen (16-V-1964) at St. Croix State Park, Pine county; I collected a female at the same location (20-V-1967); and John T. Sorensen of Minneapolis collected a female (16-VI-1967) near Craigville, Koochiching county.

I thought the *I. henrici* from Manitoba possibly might represent an endemic subspecies and I asked Harry K. Clench of the Carnegie Museum to examine them. Clench has advised me that he found no variation from nominate *I. henrici henrici*. One male from Manitoba and the Pine county female were retained in the Carnegie Museum at Pittsburgh. Another Manitoba male is being placed in the Canadian National Collection and a third is retained in my personal collection. The three males collected by Conway and Bergman remain in their personal collections at Aledo, Illinois and Minneapolis.—JOHN H. MASTERS, P.O. Box 7511, St. Paul, Minnesota

STUDY OF FLUORESCENT PIGMENTS IN LEPIDOPTERA BY MEANS OF PAPER PARTITION CHROMATOGRAPHY¹

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Subsequent to the extensive study of organic pigments in Lepidoptera by Ford (1941–1955), very little has been done to advance our knowledge of pigments in butterflies. There have been, however, some specialized investigations by a group of biochemists and geneticists interested in the chemical structure of pteridine compounds (Hadorn, 1962).

Having been interested in butterflies during my youth and as an avocation for over half a century, I have devoted a number of years after retirement in an attempt to continue research on organic pigments in butterflies by employing the comparatively new yet popular technique of paper partition chromatography. Based on studies of fluorescent pigments of many species, genera and families of butterflies on chromatograms, including the distribution of pigments in various parts of the body, I hope this paper will be of interest to fellow lepidopterists.

Sufficient evidence has been obtained to show that the pigments in Lepidoptera and other orders of insects, particularly the fluorescent pteridines, are correlated to morphological taxonomy and that this principle can be a valuable auxiliary aid in systematics.

HISTORICAL REVIEW

Apparently, the first person to study the chemistry of pigments in butterflies was Hopkins (1891, 1895 a, b, c). He discovered two water soluble pigments, leucopterin and xanthopterin, in the wings of white and yellow pierid butterflies, respectively. The chemical structure of these compounds, however, was not known until they were re-examined by Wieland and Schöpf.³ They are regarded as purine compounds and are called pterins or pteridines, the name being derived from the Greek work for wing "pteron." Thirty years after Hopkins' papers, Cockayne (1924) made a study of reactions of butterflies' wings when examined

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³ Darcy Gilmour, in his "Biochemistry of Insects," states that the above biochemists established the structure and synthesized xanthopterin in 1925 and shortly afterwards included the white pigment, leucopterin, as well as isoxanthopterin. However, he does not give a specific reference.

The reference probably is: Wieland, H. and C. Schöpf, 1925. Über den gelben Flugelfarbstoff des citronenfalters (*Gonepteryx rhamni*). *Chem. berichte* 58:2178–2180.—[ASST. ED.]

under ultraviolet light. He revealed fluorescence in certain species and groups and investigated possible relationship between fluorescence and taxonomic position. He found that a significant degree of correlation did exist between fluorescent species and taxonomy. Cockayne's lead was followed 17 years later by Ford (1941, 1942, 1944, 1945, 1947 a, b), whose series of papers and publications represent the first comprehensive study of the nature, distribution and taxonomic importance of pigments in butterflies.

Ford's method of determining pigments consisted of exposing specimens to fumes of chemical reagents that temporarily changed their color. This method is not satisfactory for the detection of pigments other than those in superficial structures such as in the wings. Apparently, paper partition chromatography had not been sufficiently developed to be in general use at the time Ford's work was conducted.

PAPER PARTITION CHROMATOGRAPHY AND PREPARATION OF CHROMATOGRAMS

Since a majority of lepidopterists may not be familiar with the subject of paper partition chromatography, the following discussion will introduce the subject. This should provide full particulars for those interested in paper partition chromatography, particularly as it applies to study and fractionation of organic pigments in Lepidoptera or other insects.

The first principles of chromatography were discovered by a Russian botanist, Michael Tswett in 1906. He fractionated the pigments of plants by pouring a mixture of petroleum ether and chlorophyll into a glass cylinder packed with calcium carbonate. As the solution percolated through the calcium carbonate, various components of chlorophyll were absorbed at different levels.

It was not until nearly forty years later that his technique became recognized as an exceptionally efficient method for the separation and identification of complex mixtures of gases, liquids, or dissolved solids. In recent years the method has attained a high degree of usefulness in both industry and science.

A modification of Tswett's method, using paper, was developed by Consden, Gordon and Martin (1944) and has attained great popularity because of its simplicity, rapidity and high resolving power. The writer is using the ascending modification of this method introduced by Williams and Kirby (1948), a description of which follows:

1. I use Pyrex battery jars (18" × 6") which make excellent containers for making both one way and two dimensional chromatograms.
2. To prepare a sheet of paper for use as a chromatogram I fold a sheet of commercially available Whatman No. 1 chemically prepared

filter paper measuring, approximately, 18" \times 22" into halves (longitudinally). This gives two rectangular sheets 11" \times 18" which is about the right size (when formed into a cylinder) to fit inside a battery jar six inches in diameter. A pencil line is then drawn one inch above and parallel to the 18" margin. This is the "base line" on which tissue samples are to be placed. Another line should be drawn about 13" above and parallel to the base line. This second line is intended to mark the place where the solvent ascends to and is called the "solvent front."

3. Insect tissue is prepared by placing specimens to be processed in a small agate or porcelain mortar together with a few drops of water, and ground to a fine paste about the consistency of thick cream. A small quantity of thoroughly ground paste (tissue sample) is applied on the base line at regular intervals of 25 mm.

4. After the tissue samples are dry the two shorter ends of the paper are brought together (to form a cylinder) and fastened with metal staples. Care should be taken to prevent the two ends of the paper from coming in contact as distortion of solvent flow will result if this occurs.

5. The paper cylinder is now ready to go into the battery jar, but first, a mixture of solvents should be added. For insect pigments, two solvent systems have proven satisfactory, *a*) propanol and one per cent of ammonium hydroxide, (in a ratio of 2 : 1), and *b*) butanol, distilled water and acetic acid, ratio (4 : 5 : 1). Approximately 50-75 ml of solvent is sufficient. After the paper cylinder, or chromatogram has been placed in the jar (the tissue sample end in contact with the solvent) a thick piece of plate glass is placed on top of the jar to prevent evaporation and to maintain a suitable degree of humidity inside the jar. At a temperature of 70°F. \pm the flow of solvent should reach the solvent front, or finishing line, in 12 to 14 hours.

After the solvent front has been reached the chromatogram is removed and allowed to dry. When first removed from the jar, nothing is to be seen on the chromatogram paper. However, when exposed to ultraviolet light a fluorescent column appears, made up of tiers or divisions of different shades of color, each one of which is characteristic of individual components fractionated from the tissue samples by the solvent.

FRACTIONATION OF SOLUBLE PIGMENTS BY MEANS OF PAPER PARTITION CHROMATOGRAPHY

The process of fractionation has been theoretically explained by physicists and chemists, but as this is quite involved the following simplified attempt to explain what makes fractionation work may be more understandable.

As the solvent ascends the paper, by capillary attraction, it passes through tissue samples (spotted on the base line) and thence carries soluble components to various heights on the paper where they are absorbed. This is due to the varying molecular weights and ionic charges of each compound. The particular place of deposit is determined by the chemical nature of fractionated components and is termed the "Rf value" or ratio-to-front. This feature is symbolic because the particular color of fluorescence, together with the Rf value, is of diagnostic significance. On uni-dimensional ascending chromatograms, overlapping or fusion of fractionated pigments may occur. A two dimensional method corrects this difficulty. The fluorescent pattern of freshly prepared chromatograms fades quite rapidly. Therefore, in order to keep a permanent record for study it is necessary to preserve the image of this fluorescent pattern. Colored photographs for projection or enlargements may be made. However, as these are quite expensive, the writer has found it practical to trace the outlines of fluorescent areas and patterns with a soft pencil, while holding a chromatogram before an ultraviolet lamp. Following this, the marked outlines on the chromatogram are retraced on drawing paper. To make the copy as realistic as possible, I fill in, with water color paint, to approximate the fluorescent areas seen on the original chromatogram when exposed to ultraviolet light. With the title and other necessary data added, this replica is available for study and filing for future reference. All the illustrations in this paper were prepared from replicas made in this manner.

OCCURRENCE AND NATURE OF ORGANIC PIGMENTS IN LEPIDOPTERA

Organic pigments in butterflies and other insects consist of two kinds, pigments manufactured in the body as a result of metabolic processes, and those obtained from food consumed during the immature stages and passed on to the adult.

Pteridine pigments and some flavones, anthocyanins and other plant pigments are fluorescent on chromatograms when examined by ultraviolet light. However, melanin, ommochrome pigments, kynurenin, carotenes, and some others are not fluorescent pigments. For this reason they are not discussed further in this paper. Chemical structures of these compounds must be determined by special tests and chemical reagents.

Anthocyanins or Flavones

These are important plant pigments widely distributed in the petals of flowering plants. Adult butterflies acquire their flavones directly

from the food plants of the caterpillar. A classical example of this is the presence of flavones in the wings of the European marble white butterfly, *Melanargia galathea* Seitz, which gets its "marble white" pigment from coltsfoot grass, *Dactylis glomerata*, consumed by the larva. Ford (1945, 1946) found flavones in the wing scales of several unrelated English butterflies by the simple but effective process of exposing mounted specimens to the fumes of ammonium hydroxide which changes areas of the wings containing flavones to a bright yellow shade. The species Ford examined are *M. galathea*, *Coenonympha tullia*, *Erynnis tages*, and *Pyrgus malvae*. The present writer found flavone pigment in the wings of *Pyrgus communis* (Grote), which is similar to the European *P. malvae*. However, no experiments investigating the fluorescent nature of these compounds were conducted.

Some species of satyrids have flavones in the scales of their wings. Dos Passos (1948) was able to rearrange the taxonomic status of two groups of Nearctic *Oeneis*, namely, *O. uhleri* and *O. taygete* by exposing them to the fumes of ammonium hydroxide (28% NH_3), and he concluded that the chemistry of the pigment in the wings of Nearctic *Oeneis* assists greatly in their systematic arrangement.

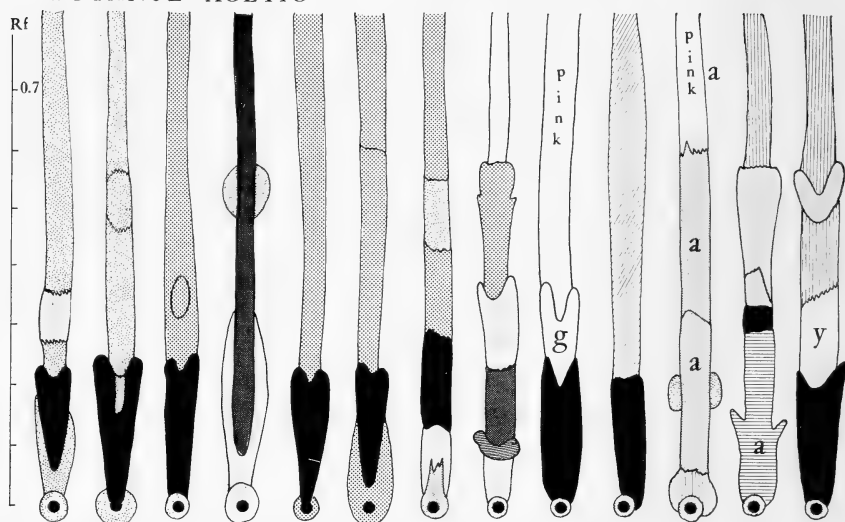
Pteridines

One of the most outstanding characteristics of pteridine compounds is their fluorescence. In addition, they are considered to be the most important and widespread of insect pigments, particularly in the Lepidoptera (Wigglesworth, 1964). Chemically, they are purine compounds, and their skeleton structure was established by Purmann in 1940 as a fused pyrimidine-pyrazine system.

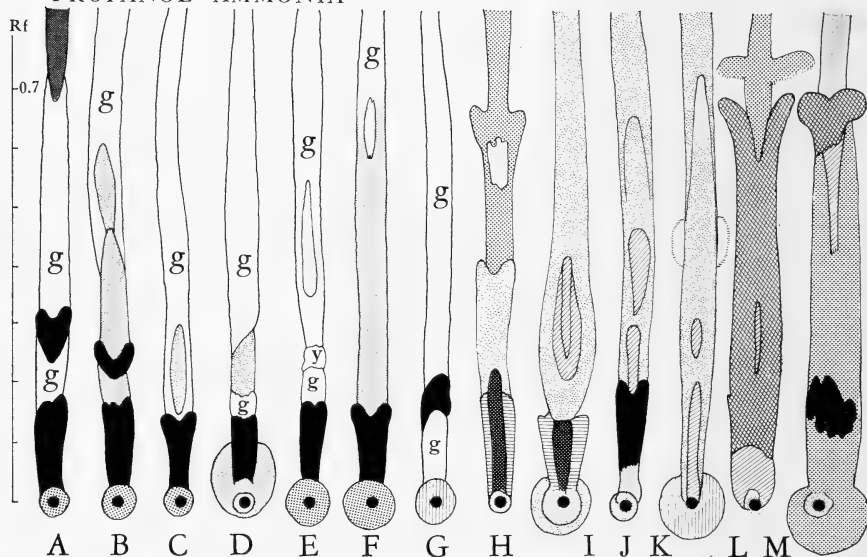
The pteridines are closely related chemically to the flavones, some of which are also fluorescent. In many butterflies and moths pteridines play a special role in the wing scales by assuming patterns of color. In this respect they are prevalent in butterflies of the family Pieridae in which they were first discovered.

The pteridines known to occur in butterflies are leucopterin, erythrop-terin, and xanthopterin. Recently, Watt (1964) isolated the yellow fluorescing sepiapterin in the alfalfa butterfly, *Colias eurytheme* Bdv. This pteridine is photo-labile so that it may be overlooked unless chromatograms are processed in the dark. Another pteridine which is photo-labile is the blue fluorescing biopterin, which I believe occurs in Lepidoptera but which has been overlooked when chromatograms have not been developed in total darkness.

BUTANOL - ACETIC



PROPANOL - AMMONIA



EXPLANATION OF PLATE I

Replicas of unidimensional ascending paper chromatograms obtained from two different solvent systems which show presence of fluorescent compounds in the bodies of thirteen species of Lepidoptera. A. *Euptychia hermes sosybius* (F.), B. *Danaus gilippus berenice* (Cramer), C. *Heliconius charitonius* (L.), D. *Junonia coenia* (Hbn.), E. *Hemiargus ceraunus antibubastus* (Hbn.), F. *Papilio palamedes* (Drury), G. *Calephelis virginensis* (G.-M.), H. *Colias eurytheme* (Bdv.), I. *Phoebis agarithe* (Bdv.), J. *Pyrgus communis* (Grote), K. *Panoquina panoquinoides* (Skinner), L. *Epistor lugubris* (L.), M. *Xanthopaster timais regnatrix* (Grote).

The most prevalent pteridine pigment in butterflies is the bright blue-violet fluorescing isoxanthopterin. Table 1 illustrates the prevalence or absence of this pteridine in three parts of the body of 67 species of North American butterflies.

While it may not be possible to recognize the specific chemical nature of some of the fluorescent pteridine components to be seen on chromatograms, their characteristic grouping (called the pteridine pattern) furnishes supportive evidence of the relationship of pigments to systematic taxonomy. It can be seen on Plate 1 that the pteridine pattern is distinctive of each species, even in intergeneric groups.

My experience has been that the pteridine pattern is not a very satisfactory guide for the differentiation of groups larger than genera, except in such a case as the family Pieridae.

Each of the replicas shown in plate 1 represent original chromatograms prepared with two kinds of solvents, namely No. 1, propanol and ammonium hydroxide and No. 2, butanol, acetic acid and water. Attention is called to this fact because each kind of solvent produces noticeable differences in the fluorescent pattern as well as in the position (Rf value) of fractionated components.

Isoxanthopterin in butterflies

Table 1 is a compilation of the presence or absence of the purple fluorescing pteridine, isoxanthopterin, in the head, body and wings of 67 species of North American butterflies. All the species listed were represented by males with two exceptions, *Speyeria diana* and *Appias drucilla neumogenii*. In most cases, only a single specimen of each species listed was used to obtain the data recorded in this table, consequently a certain degree of latitude should be allowed for probable inaccuracies. However, the prevalence of isoxanthopterin, particularly, in organs such as the head, eyes and antennae of Lepidoptera and other

←

COLOR KEY TO PLATE 1

 g	GRAY		VERY PALE PURPLE		PALE GREEN
	PURPLE		BRIGHT BLUE	 a	" (GRAY)
	" PALE		OLIVE GREEN		BUFF
	PALE BLUE		TURQUOISE		VERY PALE PINK
	PALE BLUE-GREEN		PALE YELLOW-GREEN	 y	PALE YELLOW
 a	" (GRAY)	 a	" (GRAY)		
	BROWN (NR. SPM.)		REDDISH		

TABLE 1. DISTRIBUTION OF ISOXANTHOPTERIN IN BUTTERFLIES¹

	HEAD	BODY	WINGS
Family PAPILIONIDAE			
<i>Parnassius clodius</i> (Menetries)	x	x	0
<i>Battus polydamus</i> (L.)	x	0	0
<i>B. philenor</i> (L.)	x	0	0
<i>Graphium marcellus</i> (Cramer)	x	x	(x)
<i>Papilio glaucus glaucus</i> L.	x	0	0
<i>P. glaucus australis</i> Maynard	x	0	x
<i>P. polyxenes asterius</i> Stoll	x	0	0
<i>P. cressphontes</i> Cramer	x	x	(x)
<i>P. palamedes</i> Drury	x	x	0
<i>P. troilus troilus</i> L.	x	0	0
<i>P. troilus ilioneus</i> J. E. Smith	x	x	0
Family PIERIDAE			
<i>Colias interior interior</i> Scudder	x	0	0
<i>C. eurytheme eurytheme</i> Bdv.	x	x	0
<i>Eurema mexicana</i> (Bdv.)	x	x	0
<i>E. dina westwoodi</i> (Bdv.)	x	x	0
<i>Anteos maerula lacordairei</i> (Bdv.)	(x)	x	0
<i>A. clorinde nivifera</i> Fruhstorfer	x	0	0
<i>Phoebis philea</i> (Johansson)	x	x	0
<i>P. agarithe agarithe</i> (Bdv.)	x	0	0
<i>P. sennae eubule</i> (L.)	x	x	0
<i>Anthocaris midea</i> Hübner	x	x	x
<i>Pieris rapae</i> (L.)	x	x	x
<i>P. beckerii</i> Edwards	x	x	x
<i>Ascia monuste phileta</i> (F.)	x	x	x
<i>Appias drucilla neumogenii</i> (Skinner)	x	x	x
<i>Appias drucilla neumogenii</i> (Skinner) female melanic form	x	x	x
Family DANAIIDAE			
<i>Danaus plexippus plexippus</i> (L.)	x	x	0
<i>D. gilippus berenice</i> (Cramer)	x	0	0
Family SATYRIDAE			
<i>Lethe eurydice</i> (Johansson)	x	x	0
<i>Euptychia cymela cymela</i> (Cramer)	x	0	0
<i>E. cymela viola</i> (Maynard)	x	0	0
<i>E. areolata areolata</i> (J. E. Smith)	x	(x)	0
<i>Oeneis polixenes katahdin</i> (Newcomb)	x	0	0
Family NYMPHALIDAE			
<i>Heliconius charitonius</i> (L.)	x	x	x
<i>H. petiveranus</i> Doubleday	x	x	x
<i>Agraulis vanillae nigrior</i> Michener	x	x	(x)

¹ Symbols indicate relative quantities: x = average; (x) = less than average; 0 = absent.

	HEAD	BODY	WINGS
Family NYMPHALIDAE (Continued)			
<i>Speyeria aphrodite alcestis</i> (Edwards)	x	x	x
<i>S. cybele cybele</i> (F.)	x	x	x
<i>S. diana</i> (Cramer) male	x	x	0
<i>S. diana</i> (Cramer) female	x	x	x
<i>Phyciodes tharos tharos</i> (Drury)	x	x	x
<i>P. batesii</i> (Reakirt)	x	x	x
<i>P. gorgone</i> (Hbn.)	x	x	x
<i>P. mylitta mylitta</i> (Edwards)	x	x	x
<i>P. frisia frisia</i> (Poey)	x	x	x
<i>P. campestris campestris</i> (Behr)	x	x	x
<i>Polygonia comma</i> (Harris)	x	0	0
<i>Vanessa atalanta</i> (L.)	x	x	x
<i>V. virginiensis</i> (Drury)	x	0	0
<i>Junonia coenia coenia</i> (Hbn.)	x	x	x
<i>J. evarete zonalis</i> (C. & R. Felder)	x	x	x
<i>Eunica tatila tatilista</i> Kaye	x	x	(x)
<i>Asterocampa clyton flora</i> (Edwards)	x	0	0
<i>A. celtis celtis</i> (Bdv. and LeC.)	x	0	0
<i>A. celtis alicia</i> (Edwards)	x	0	0

Family LIBYTHEIDAE

<i>Libytheana bachmanii bachmanii</i> (Kirkland)	x	x	0
<i>L. bachmanii larvata</i> (Strecker)	x	x	0

Family LYCAENIDAE

<i>Eumaeus atala florida</i> (Röber)	x	x	x
<i>Atlides halesus halesus</i> (Cramer)	x	x	x
<i>Euristrymon favonius</i> (J. E. Smith)	x	0	0
<i>Strymon melinus melinus</i> Hübner	x	x	(x)
<i>Everes comyntas comyntas</i> (Godart)	x	x	x
<i>Hemiargus ceraunus antibubastus</i> Hbn.	x	x	0
<i>Brephidium isophthalma pseudofea</i> (Morrison)	x	x	x

Family RIODINIDAE

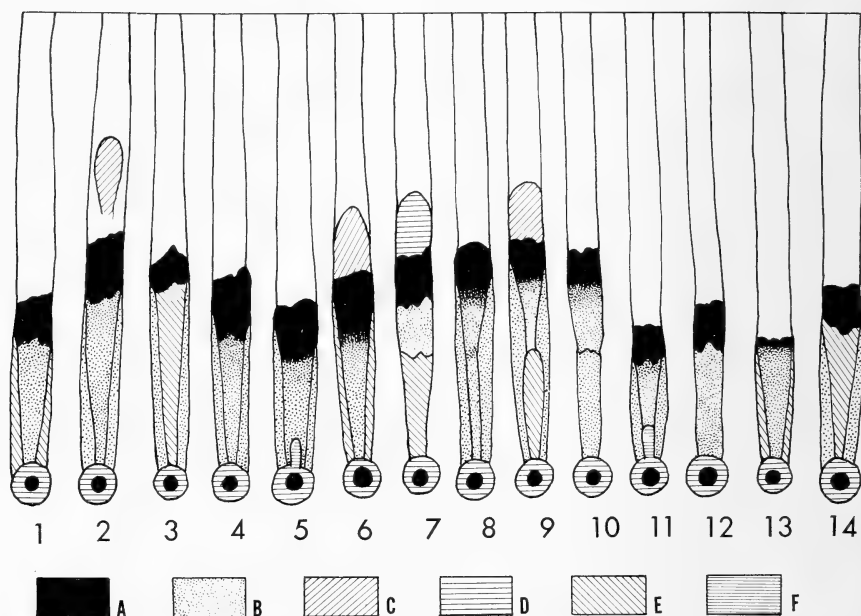
<i>Apodema nais</i> (Edwards)	x	x	0
<i>Lephelisca muticum</i> (McAlpine)	x	x	0
<i>L. borealis</i> (Grote & Robinson)	x	x	x

Family HESPERIIDAE

<i>Phocides pigmalion okeechobee</i> (Worthington)	x	0	0
<i>Thorybes bathyllus</i> (J. E. Smith)	x	x	0
<i>Urbanus dorantes</i> (Stoll)	x	0	0
<i>Hylephila phyleus</i> (Drury)	(x)	0	0

Percent of total

100. 61. 43.



EXPLANATION OF PLATE 2

Replicas of unidimensional ascending paper chromatograms which show presence of pteridines in bodies of fourteen species of butterflies (1-14) belonging to the genus *Phyciodes* and near relatives. Symbols A-F represent the different pteridines demonstrated.

orders of insects, seems to imply that this pteridine component plays an important role in metabolic activity.

*Characteristic Pattern of Pteridine Pigments
in the Genus Phyciodes and Closely Allied Genera*

The purpose of this study was to determine whether species within a genus could be individually differentiated by the character of their pteridine pattern. In order to make sure that the pteridine pattern of a species was a standard one which could be used in comparison between species, a number of specimens of the same species and sex were employed in preparing chromatograms so that a specimen, showing the most characteristic pteridine pattern of a series, could be selected as typical for the species.

The replicas of fourteen species presented in plate 2 may be considered as representing the characteristic pteridine pattern of each species. It will be noted that none of the pteridine patterns are exactly

alike, and none reveal any common pattern or distinction which might characterize a genus. It may be noted, however, that four of the species, 3, 4, 5 and 11, resemble each other quite closely, although they represent different genera or subgenera. It might be inferred by this that their chemical make-up of these compounds shows more similarity than do their taxonomic relationships.

I think there is sufficient evidence in plate 2 to show that with the standardization and consistency of the pteridine pattern for comparative use it is possible to differentiate species within a genus. Caution must be exercised in drawing conclusions, however, because differentiation occurs also in infraspecific categories such as in varieties, mutations, etc. For the determination of mutations in fruit flies (*Drosophila*) by means of paper partition chromatography, see Hadorn (1962).

A number of years ago the status of *Phyciodes tharos* (Drury) and *P. batesii* (Reakirt) was a controversial subject. Some authorities believed that *P. batesii* might be a seasonal form of *P. tharos* while others considered the former to be a separate species. In plate 2 it can be seen that the pteridine pattern of *P. tharos* (No. 4) and that of *P. batesii* (No. 6) are distinct. This helps confirm the contemporary taxonomic status of *batesii* by what might be called "chemotaxonomic testimony or supportive chemical evidence."

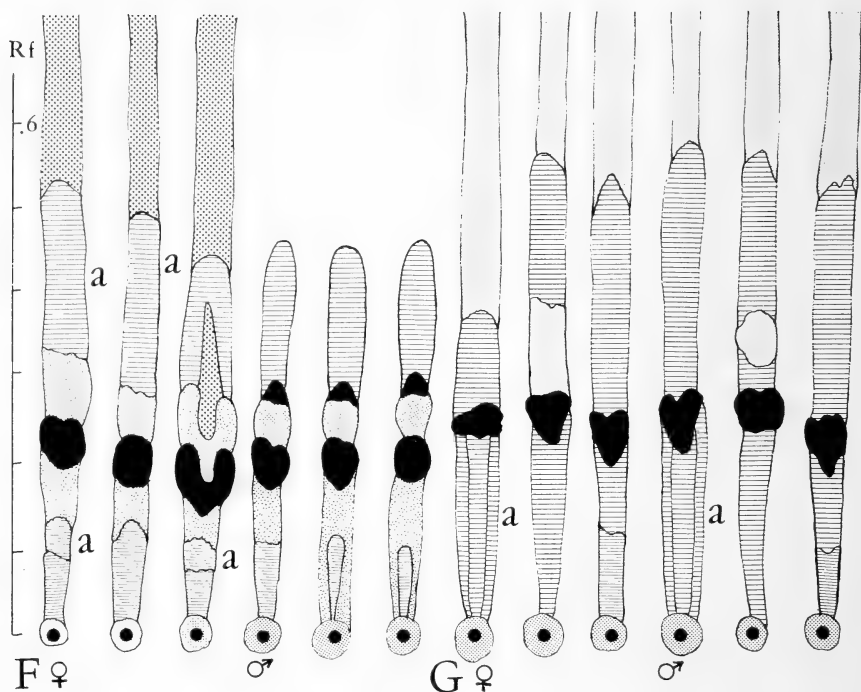
Pteridine pattern of pigments in green geometrid moths

Monochrome replicas of the pteridine pattern of two green geometrid moths (Subfamily Geometrinae), *Racheospila gerularia* (Hbn.) and *Synchlora denticularia* (Wlk.) are presented on plate 3. These show structural differences in the pteridine pattern of both species. While the chemical identity of all the fractionated pigments were not determined, the dark areas, centrally located in the vertical columns of both species, are undoubtedly the ubiquitous pteridine, isoxanthopterin. The pale columns above isoxanthopterin may be xanthopterin, which is relatively uncommon in butterflies other than the Pieridae. The short, pale basal areas (a) may be the xanthopterin of Good and Johnson (1949).

However, the principal point is not the chemical nature of the pigments themselves so much as the character of the fluorescent pigments which shows the relationship of biochemistry to structural morphology and the differentiation of these two species of moths.

Changes of pteridine pattern in the development of an amatid moth

The egg, larva, pupa, and adult of the polka-dot wasp moth, *Syntomeida epilais* (Wlk.), were examined for possible changes during



EXPLANATION OF PLATE 3

Replicas of unidimensional ascending paper chromatograms which show presence of pteridines in bodies of two green geometrid moths. F. *Racheospila gerularia* (Hbn.), G. *Synchlora denticularia* (Wlk.).

its metamorphosis. Experiments with two dimensional paper chromatography showed there are changes in the proportions of the various pteridines from one developmental stage to another.

SUMMARY

This paper is an introduction to the study of fluorescent pigments in Lepidoptera, based on observations made on the fluorescent pigments of a limited number of species of Nearctic butterflies by means of paper partition chromatography. Such aspects as chemistry, distribution in various parts of the body and the relation of pigments to the taxonomic status of species are stressed.

Observations have been made, by the single ascending and two dimensional methods of paper partition chromatography, on well over one hundred species of North American butterflies and a few species of moths. Because of the fleeting nature of fluorescent pigments on freshly

prepared chromatograms, it has been necessary to make carbon copies or colored replicas of all chromatograms in order to have a permanent record for study and for reference filing.

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NOTES ON *EUCHLOE AUSONIDES MAYI* (PIERIDAE) IN ONTARIO

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Syme (1961) reported about the occurrence of *Euchloe ausonides mayi* Chermock & Chermock in Ontario. From his report it can be seen that this species was first taken in Ontario in Malachi (Kenora District, near the Manitoba border) on July 5, 1947, by a summer field party of the Royal Ontario Museum. In 1956 Paim collected the same species on June 1, at Basswood Lake (Quetico Provincial Park, Rainy River District, near the Minnesota border).

To our knowledge of the distribution of *Euchloe ausonides mayi* in Ontario can be added the captures by Syme and Wood along the roadside of Highway 11, 3 to 15 miles east of Beardmore (Thunder Bay

¹ Paper read at the 103rd Annual Meeting of the Ent. Soc. of Ontario, Nov. 3, 1966, in Toronto, Ont.

District) on June 1, 1958; Allin in Sibley Provincial Park (Thunder Bay District) on May 27, 1961; and Hartley in S. Neebing township (Thunder Bay District) on June 11, 1962.

On June 12, 1966, a summer field party of the Royal Ontario Museum worked in Geraldton (Thunder Bay District) and was surprised to find *Euchloe ausonides mayi* in the Geraldton forest on Charles Road. This was the signal to check thoroughly on the Syme localities along Highway 11 between Geraldton and Beardmore. As expected, also along Highway 11 the species had considerably extended its range to the east so that the first *ausonides* were already found $8\frac{1}{2}$ miles east of Jellicoe, i.e. $15\frac{1}{2}$ miles more to the east than in 1958, and from there on many localities along Highway 11 to the west, to shortly before Beardmore where Syme and Wood reported the western limit of the species. The continuation of the distribution between there and Fort William (where Allin took the species again in 1966 at about the same time) and the locality " $8\frac{1}{2}$ miles E of Jellicoe" and Geraldton has yet to be established.

The distribution of the species is clearly connected with the distribution of *Arabis drummondi*, a northern species of *Arabis*. Wherever this plant was found, the butterfly also was found. On June 17, a female was observed hovering over a patch of this plant at the locality "15 miles E of Beardmore." Some eggs were preserved and on June 24, numerous larvae of *E. ausonides mayi* were found on those plants. One caterpillar in the last instar was photographed and with two smaller ones was taken for rearing on June 27. The larger caterpillar was kept on Geraldton *Arabis* and pupated on July 1; the two smaller ones had to be changed over to other species of *Arabis*, e.g. *Arabis divaricarpa*, and eventually died.

This left the question, were these caterpillars also on the *Arabis* in the Geraldton forest on Charles Road? On June 28, the day of our departure a colony of second instar larvae was found on those plants.

A considerable easterly range extension of *Euchloe ausonides mayi* is established herewith. The present writer lived in Geraldton and collected there regularly every year up to 1958 but no *E. ausonides* had been captured up to that time.

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DESCRIPTION OF THE MALE OF *LITHOPHANE*
GAUSAPATA (NOCTUIDAE)

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Until recently, the male of *Lithophane gausapata* Grote was unknown. This species was described in 1883. Quite a few specimens exist in various collections today. With over fifty specimens having been examined in past years, it was astounding to find only females! In the Noctuidae, this is one of the few examples known to the author in which the females are the most commonly represented; usually males are more abundant whenever one sex is predominant over the other. It seems strange that males of *gausapata* have not been collected in the past, and no clear explanation of this situation is yet apparent.

The majority of the individuals examined had been attracted to fluorescent black light; however, a few had been collected at incandescent white light. This species occurs at moderate elevations where a variety of conifers occur, of which one or more species probably provide a larval food source for *gausapata*.

When Grote originally described *gausapata*, he stated "Allied to *Petulca*." Smith (1893, 1900) placed *gausapata* and other *Lithophane* in the genus *Xylina*. Hampson (1906) placed this species in *Graptolitha* along with other species previously referred to *Lithophane* and *Xylina*. Draudt (in Seitz, 1923) followed Hampson in placing *gausapata* near *ferralis* Grote in the genus *Graptolitha*, but the colored plate is misleading as to color. The illustration of *ferralis* is much too brown, even though in the text Draudt states of *gausapata* "is somewhat similar to *ferralis* . . . but without its light costal area, on the dark red-brown ground somewhat irrorated with grey. . . ." One might infer that *gausapata* was brownish, whereas in reality it is greyish. Today *Graptolitha* is considered congeneric with *Lithophane*, the latter having priority.

Lithophane gausapata Grote

Lithophane gausapata Grote, 1883; Papilio 3(4):77.

Xylina gausapata, Smith, 1893; Bull. United States Natl. Mus., No. 44, p. 227. Smith, 1900; Trans. Amer. Entomol. Soc. 27:14, 22.

Graptolitha gausapata, McDunnough, 1938; Mem. So. Calif. Acad. Sci. 1:83.

Male: Ground color of primaries grey, irrorated with whitish scalation; secondaries dull pinkish brown. Head with vertex clothed in brownish, whitish and grey simple hairs and elongate scales; frons clothed with short whitish and brownish

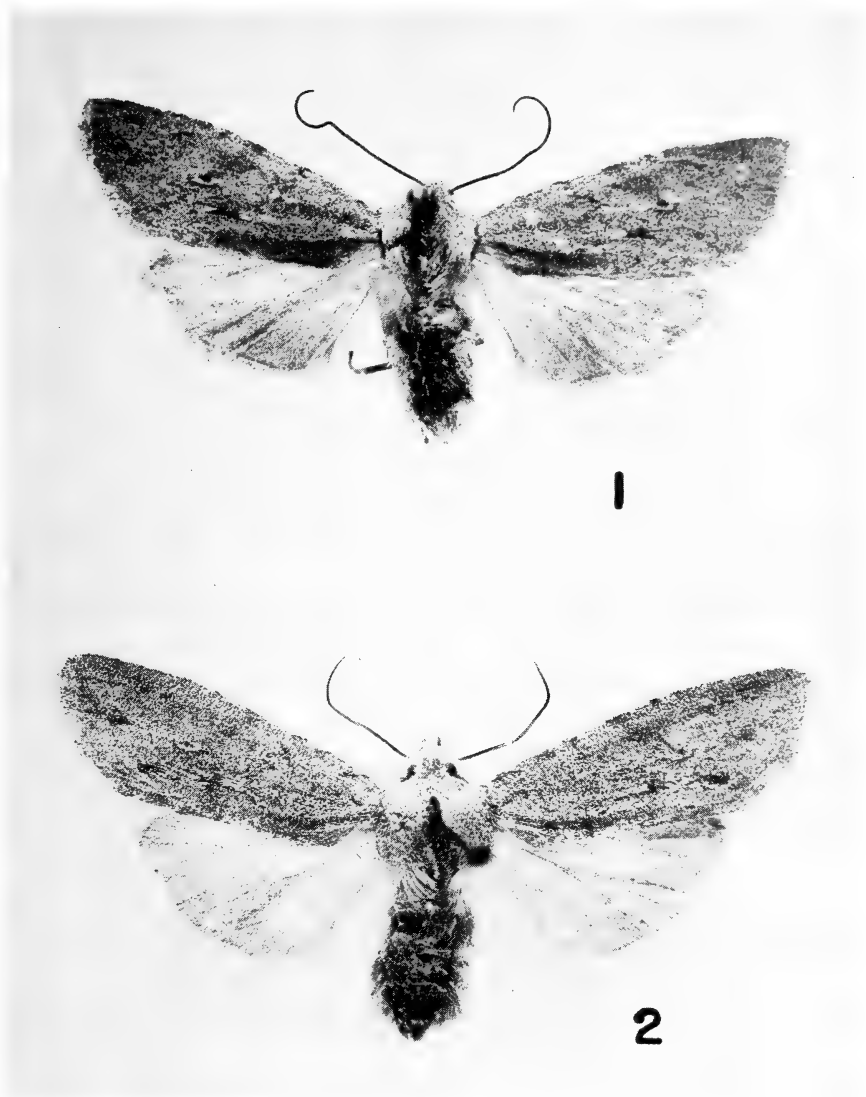


Fig. 1. *Lithophane gausapata*, male. Hat Creek, Shasta County, California, 10 May 1965 (R. R. Pinger). Fig. 2. *L. gausapata*, female. Johnsville, Plumas County, California, 10 April 1964 (Helena J. Pini).

hairs, dorsally with brown band; palpi clothed in whitish and brownish scales and hairs, giving pinkish effect; antennae with scape and pedicle clothed in white scales, flagellar segments dorsally clothed in whitish scales for basal $\frac{1}{8}$ th, thence clothed in brown scales; ventrally weakly fasciculate (under 90 \times); eyes weakly lashed. Thorax with collar weakly represented in maroon; dorsally with spreading, divided

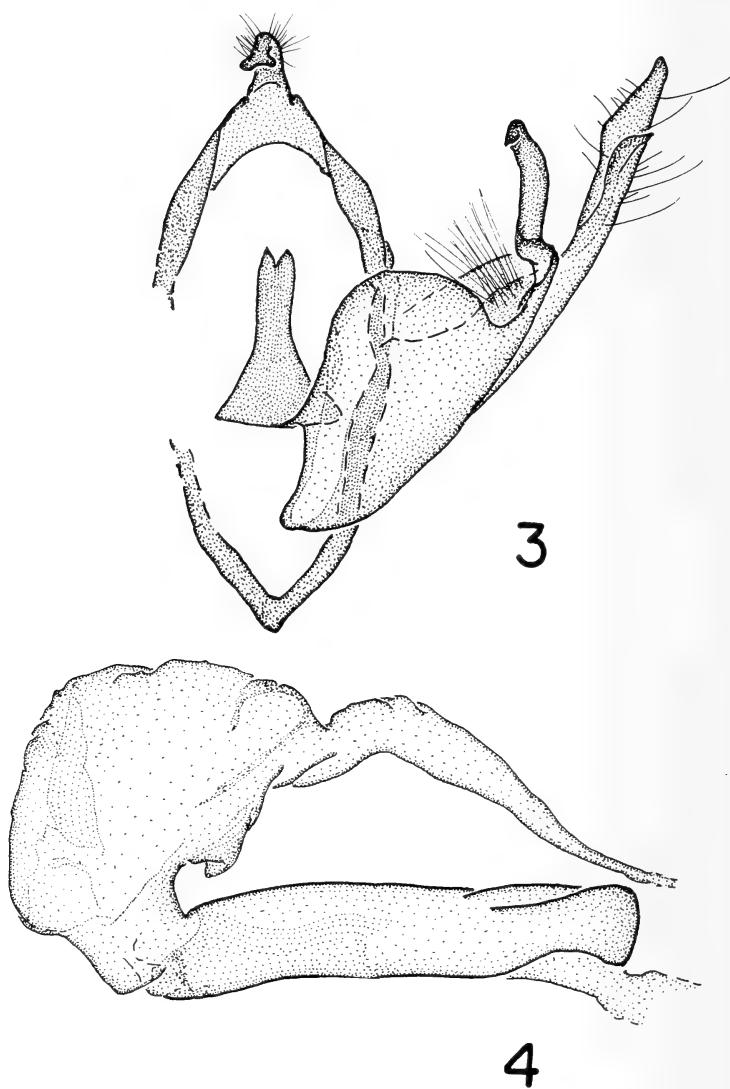


Fig. 3. *L. gausapata*, male genitalia minus aedeagus. Data same as in Fig. 1 (Bauer-Buckett slide No. 65F8-1). Fig. 4. *L. gausapata*, aedeagus of male genitalia. Data same as Fig. 1.

tricolor anterior tufts, basally greyish, preapically maroon, apically white-tipped; disc composed of elongate white-tipped scales with terminal portion of each scale deeply cleft or dentate; ventrally clothed in whitish and pinkish simple hairs; legs clothed in an admixture of whitish and maroon scales and hairs; unguis weakly bifid, ventro-terminally slightly serrate; primaries dorsally greyish, ordinary cross lines weakly defined, or very obscure; basal line represented costally by dark

brownish scalation; basal and transverse anterior areas inner marginally with rust-maroon scalation; transverse anterior line geminate, weakly represented in dark-brown, but one of the more prominent cross lines; orbicular barely discernable, greyish; reniform outlined in dark brown, centrally filled with rust-maroon scales, fading into ground color costally; transverse posterior line serrate, represented costally in brown, thence obliquely outcurved around reniform, thence nearly paralleling outer margin; terminal-subterminal areas greyish, but with pinkish hue; terminal line concolorous with ground color; ventrally quite glossy, costally whitish, remainder of surface dull brown; reniform very weakly represented in dark brown; transverse posterior line weakly represented, or wanting; secondaries dorsally pinkish brown; veins outlined in dark brown; discal lunule weakly represented; fringes pinkish; ventral surface pinkish, discal lunule dark brown, prominent; surface irrorated with maroon scalation. Abdomen dorsally clothed in brownish, maroon, and whitish scales and hairs; ventrally clothed in pinkish and whitish simple hairs. Greatest expanse of forewing ± 17 mm. Genitalia as in figures 3 and 4.

Female: Ground color as in male, but with greater proportion of white scales, therefore appearing light grey; antennae minutely setose-ciliate; ventral surface of wings more irrorated with whitish, therefore appearing washed out, or very light grey; otherwise as in male. Greatest expanse of forewing ± 19 mm.

MATERIAL EXAMINED

The genitalic illustrations were prepared by aid of a bioscope, additions and/or corrections being made by use of a dissecting microscope.

CALIFORNIA: 1 ♀, Nevada City, Nevada County, February, 1954 (E. C. Zimmerman), 1 ♀, March, 1954 (E. C. Zimmerman); 1 ♀, Johnsville, Plumas County, November, 1959 (H. J. Pini); 1 ♀, 5 June 1960 (W. R. Bauer & J. S. Buckett); 2 ♀, 20 May 1963 (H. J. P.); 2 ♀, 25 May 1963 (J. S. B.); 7 ♀, 16-30 April 1964 (H. J. P.); 1 ♀, Idyllwild, Riverside County, 16 April 1952 (C. Hill); 1 ♀, Hat Creek, Shasta County, 12 June 1952 (G. Pronin); 1 ♀, 27 May 1952 (G. Pronin); 3 ♂, 14 ♀, Hat Creek, Shasta County, 5 May-1 June 1965 (R. R. Pinger); 1 ♀, Mather, Tuolumne County, 9 March 1934 (E. Wolthur); 1 ♀, Twain Harte, Tuolumne County, 26 March 1965 (M. Lundgren); 1 ♀, 17 April 1964 (M. Lundgren); 1 ♀, 4,000', 23 May, 1964 (M. R. & S. H. Lundgren). OREGON: 1 ♀, Eugene, Lane County, 1 November 1962 (K. Goeden).

ACKNOWLEDGMENTS

I would like to extend appreciation to my colleague Mr. William R. Bauer for excellent preparation of the genitalic slide. I would like to also thank Dr. Paul Arnaud, Jr. of the California Academy of Sciences for allowing me to examine material contained in that institution.

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THE POPULATION BIOLOGY AND LIFE HISTORY OF *PAPILIO INDRA MARTINI*

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The discovery of a new *Papilio* in a desert locality in which California lepidopterists have collected regularly for over half a century was recently described by the present authors (Emmel & Emmel, 1966). The present paper reports data on the ecology, distribution, and life history of this butterfly, *Papilio indra martini* Emmel & Emmel, obtained from field work in the type locality from 1963 to 1966.

GENERAL REMARKS

The first clue to the presence of a member of the *Papilio indra* complex in the Providence Mountains (eastern Mojave Desert, San Bernardino County, California) was a single variant specimen in the *P. i. pergamus* series in the collection of the Los Angeles County Museum, bearing the label "Providence Mts., 4-5-34." A few weeks after examining this specimen, we visited the Providence Mountains on March 23-24, 1963, to search for adults or a suitable foodplant of the *Papilio*. On March 23, we climbed to one of the high peaks above Bonanza King Mine Canyon on the eastern slope of the range. At the top, a male *P. i. martini* (as later described in the 1966 paper) was observed landing on rocks, but the treacherous terrain prevented its capture. On the following day, we hiked into Gilroy Canyon, about a mile south of the Bonanza King Mine, to look for possible foodplants. In this canyon we found a number of umbelliferous plants which we suspected to be the foodplant. A search of the plants revealed no immatures.

We were able to return to the area on May 9, 1964. The morning was spent collecting in Bonanza King Mine Canyon, where we found a battered *P. i. martini* female resting on the canyon floor. This prompted us to search for immatures on the plants in Gilroy Canyon; there, the suspected foodplant yielded over sixty *Papilio* eggs. These were placed in sleeves of nylon netting over the foodplants for field rearing.

We returned to the area on June 22 of the same year to collect whatever pupae had been formed in the sleeves. This rearing method proved to be somewhat of a failure: less than a dozen pupae were recovered from the original sixty eggs. Some of the factors leading to the low yield of live pupae were: improper pupation site (as in netting folds), pupal

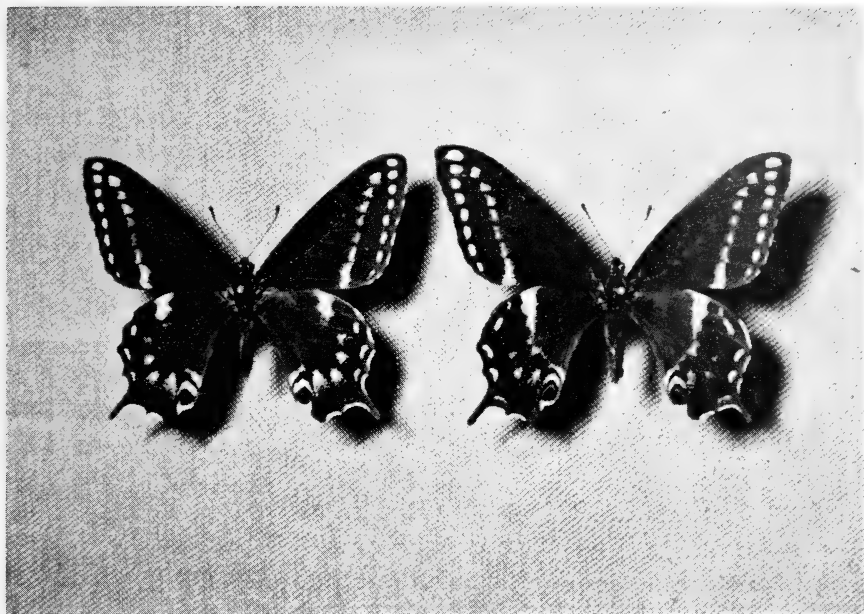


Fig. 7. Dorsal view of a male and female *Papilio indra martini*, reared from larvae collected in the Providence Mountains of California on May 28, 1965. The type specimens previously illustrated (Emmel & Emmel, 1966) had slightly broader bands than this pair.

parasitism, and rodents chewing holes in the sleeves which allowed larvae to escape. A small number of fifth instar larvae were also found in the sleeves. These were taken with us to Donner Pass (7600'), Placer County, California, where they were sleeved out on *Pteryxia terebinthina*, a foodplant of *P. i. indra*. The pupae from these larvae were collected on July 20 when we returned to the Pass.

One of the pupae collected in Gilroy Canyon emerged on July 8, probably within three weeks of pupation, judging from the fact that most pupae were newly-formed when collected on June 22. The remaining pupae emerged in the fall of 1964 and spring of 1965 after several months' refrigeration and subsequent warming at room temperature.

In the spring of 1965 we collected more immatures on May 28, both in Gilroy Canyon and in the south fork of Bonanza King Mine Canyon where more foodplants were found. These were taken back to Stanford University and reared on potted plants of *Tauschia arguta*. Of the resulting pupae, two emerged within 20 days of pupation. The remainder emerged the following spring.

In the spring of 1966, *P. i. martini* was relatively common, after a winter of high rainfall in Southern California. In early April, several lepidopterists collected over a dozen adults and a large number of eggs in the south fork of Bonanza King Mine Canyon. The authors visited the same locality on April 14 to collect two adults and over sixty eggs. These were reared in the laboratory of *Tauschia arguta*; all of the resulting pupae went into diapause. About 20 eggs were sent to David V. McCorkle in Oregon for rearing. Of the pupae obtained by McCorkle, one emerged within several weeks of pupation.

DESCRIPTION OF FOODPLANT

The foodplant was identified as *Lomatium parryi* (Wats.) MacBr., using *A California Flora* by Philip Munz. This identification was verified by comparison of our plants with specimens of *L. parryi* in the Dudley Herbarium at Stanford University. The range of this plant includes southern Utah, southern Nevada, extreme northern Arizona, and the eastern deserts of California. It is typically found in rocky areas in the Pinyon-Juniper zone, from 4000 feet to 8500 feet elevation. The plant closely resembles *Lomatium eastwoodae* (C. & R.) MacBr., the foodplant of *P. i. minori* in western Colorado, except that it is much larger, generally about eight to twelve inches in height. In the Providence Mountains it is found in limestone canyons above 4700 feet elevation. Flowering here occurs in March and April, and the leaves remain green into late August. The plant has a strong odor detectable by a human observer, as do the other foodplants of *P. indra* subspecies.

HABITAT

The *Lomatium* plants were most common along the canyon bottoms, but were found also in crevices in the canyon walls. The habitat is arid Pinyon-Juniper woodland in the Upper Sonoran Life Zone. This zone extends to the highest peaks of the range, which are over 7000 feet in elevation. The dominant rock is limestone. The topography is one of narrow canyons with steep walls, and precipitous rocky ridges.

ADULT HABITS

The observed *P. i. martini* males were either flying about peaks, or "patrolling" the canyons, presumably searching for females. Females were found in the canyon bottoms, often hovering around the *Lomatium* plants to oviposit. No nectar source was observed.

Emergence of adults begins in late March and apparently continues into late April, as evidenced by our dates of capture or observation of

adults and early stages. *P. i. martini* is apparently partially double-brooded, inferred from the emergence of a small percentage of adults several weeks after pupation; it is especially significant that one of these non-diapausing pupae was reared under natural conditions. We have not visited the type locality during the time (July) a second brood would be flying. From field observation, it is known that *P. i. kaibabensis* and *P. i. minori* are double-brooded (Emmel & Emmel, 1967) and that *P. i. indra*, *P. i. pergamus*, and *P. i. fordii* are single-brooded.

LARVAL HABITS

First- and second-instar larvae remain near the tips of the leaves of the foodplant, where the eggs are laid. Third-instars generally rest on the petioles, but near the outer part of the leaves. The fourth-instar larvae are found on the petioles near the base of the plant when not feeding. When disturbed, second- through fourth-instar larvae drop readily from the plant. The fifth-instars rest among the petioles at the base of the plant; in this position they are almost always completely hidden, exposing themselves only when feeding. Feeding occurs almost entirely during the daylight hours.

DESCRIPTION OF EARLY STAGES

Egg:

The egg is similar in size and shape to that of *P. i. minori* (see Emmel & Emmel, 1964). The diameter when viewed superiorly is about 1.1 mm. The color is a light cream when first laid, and the egg surface is smooth in texture. The eggs are laid singly, near the tips of the *Lomatium* leaves.

Fourth-Instar Larva:

Length: 21–25 mm at maturity. Head: Width of head capsule, 2.1–2.2 mm. Shiny jet black, with a small crescent-shaped orange mark at the center.

Body: The pattern in this instar is extremely similar to that of the fourth-instar larva of *P. i. fordii*, and the range of variation in the larvae likewise corresponds (see Comstock & Martin, 1955). The ground color is jet black. There are four longitudinal rows of tubercles. On the third abdominal segment there is a lateral white dot. On the fourth abdominal segment is located a white "saddle" mark, composed of an irregular row of white spots transversely circling the body. A similar transverse row of white spots is found on the eighth abdominal segment. A white spot occurs on the lateral side of the base of each proleg. The larva may or may not have other white spots present. The legs and prolegs are black.

Fifth-Instar Larva:

Length: 35–40 mm at maturity.

Head: Width of head capsule, 4.0 mm. The head capsule pattern (Figure 5) is very similar to that of *P. i. fordii*. The ground color is black, and the lighter area is a deep orange.

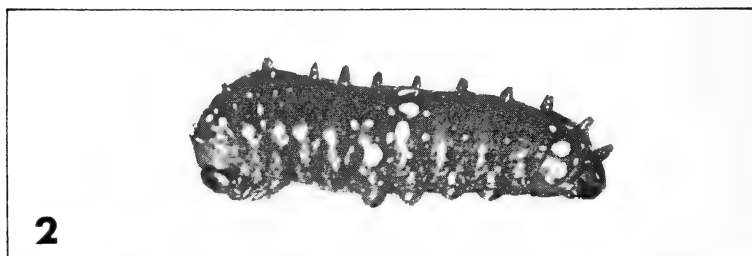
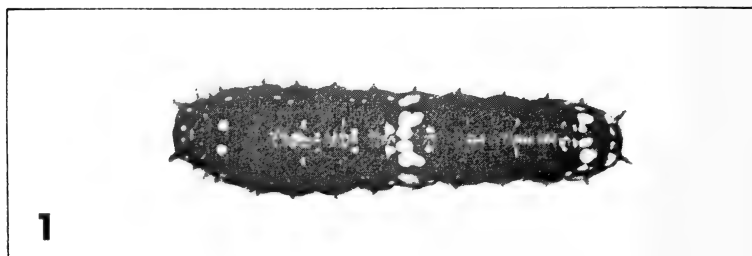


Fig. 1. Fourth-instar larva of *Papilio indra martini*, dorsal aspect.

Fig. 2. Fourth-instar larva of *P. i. martini*, lateral aspect.

Fig. 3. Fifth-instar larva of *P. i. martini*, dorsal aspect.

Fig. 4. Fifth-instar larva of *P. i. martini*, lateral aspect.



Fig. 5. Head capsule pattern of the fifth-instar larva of *P. i. martini*. Dark areas black, light areas deep orange.

Fig. 6. Pupae of *P. i. martini*. From left to right, ventral aspect (first two), lateral aspect, dorsal aspect.

Body: See Figures 3 and 4. The ground color is black. The first and second thoracic segments each have a narrow transverse pink band arching over the anterior half of the segment, ending on either side at the level of the spiracles. The same pattern is found on the succeeding segments; on these the pink band is wider and a pink spot is located laterally at either end of the band; this lateral spot may or may not be connected with the band. Some larvae have salmon-colored, rather than pink, bands. A transverse row of four small, deep ochre yellow dots is located on the posterior edge of each pink band, from the third thoracic segment to the eighth abdominal segment. In some examples these yellow dots are absent. The true legs and prolegs are black; a large white spot is found laterally on each proleg. A white dot is also found ventro-laterally on the first, second, seventh, and eighth abdominal segments; often the thoracic segments have a white dot located ventro-laterally.

The *P. i. martini* last instar larva is distinctive from that of *P. i. fordi* (see figure in Comstock & Martin, 1955), which has WHITE transverse bands. The transverse dots which are deep ochre yellow in larvae of *P. i. martini* are lemon yellow in *P. i. fordi* larvae.

Pupa:

Length: 20.0–28.0 mm. Greatest width at wing cases, 6.8–9.0 mm.

The pupa is morphologically like that of other subspecies of *P. indra*. The ground color varies from a light dull tan, to dull greenish-tan, to dull grayish-tan. The surface is rough, and has scattered marks and splotches of color darker and lighter than the ground color, giving it a vaguely mottled appearance. The wing cases are less mottled and generally darker than the other surfaces, and are often a dull tannish olive green.

KNOWN DISTRIBUTION OF THE SUBSPECIES

P. i. martini has not been taken in any localities outside of the eastern slope of the Providence Mountains. It will likely be found in the New

York Mountains, on Clark Mountain, and in the Granite Mountains north of Amboy, all in San Bernardino County, California; these adjacent ranges have habitats very similar to those in the Providence Mountains.

SUMMARY

The life history and foodplant of *Papilio indra martini* are described from field work in the Providence Mountains, California. The adults differ markedly from *P. i. fordi* adults, yet the ranges of these two subspecies approach within at least 40 miles of each other. The early stages of the two subspecies show a closer affinity, although the body color patterns of the last instar larvae are distinctive. *P. i. martini* apparently has a partial second brood. The food plant is *Lomatium parryi* (Wats.) MacBr. (Umbelliferae). Data on the ecology of the adults and larvae, and known distribution are also given.

ACKNOWLEDGMENTS

The present paper is part of a continuing study of evolution in populations of the *Papilio machaon* complex in North America. The support of the U. S. Public Health Service Population Biology Training Grant to Stanford University is gratefully acknowledged.

We also wish to thank William M. Hiesey, Director of the Division of Plant Biology, Carnegie Institute of Washington at Stanford, for providing research space for culturing foodplants and *Papilio* stocks; the rangers at Mitchell Caverns State Park, Providence Mountains, for sending us useful weather information; and Oakley Shields for supplying specimens and living material for study.

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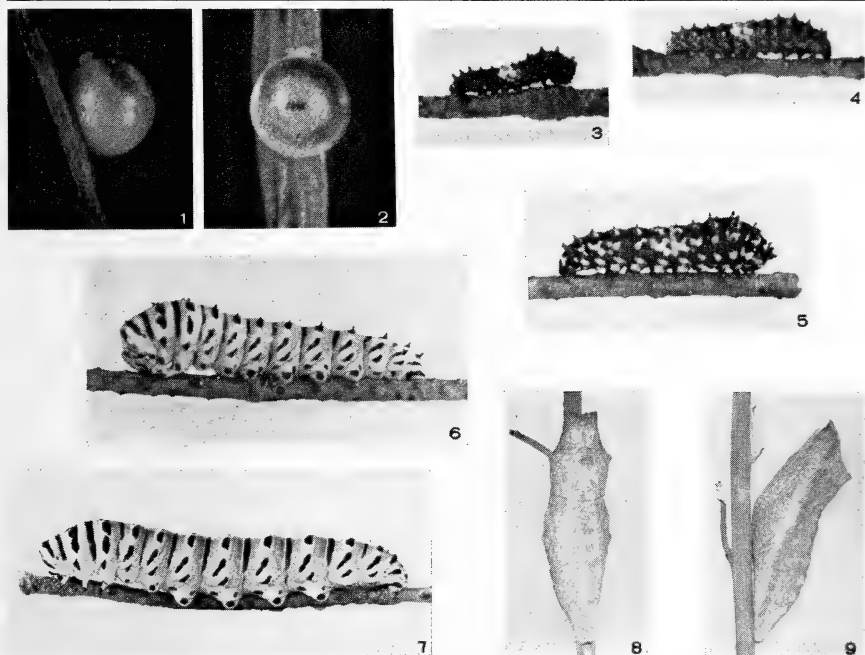
ILLUSTRATED LIFE HISTORY AND NOTES ON *PAPILIO OREGONIUS*

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The life history of *Papilio oregonius* Edwards 1876, described by Newcomer (1964), has not heretofore been illustrated. The accompanying photographs and legends are self-explanatory (Figs. 1-11).

The rearing of large numbers of larvae necessitated the establishment of criteria by which the instars could be quickly and accurately distinguished. The following is a résumé of these characteristics:

Instar	I	II	III	IV	V
Possess Tubercles (Spines)	+	+	+	+	-
Saddle on Segments 6 and 7	+	+	+	-	-
Color of Saddle	Blue-White	Yellow	Yellow	-	-
Predominant Body Color	Black	Black	Mottled Black	Pale Green	Pale Green
Lateral, Black Diagonal Marks	-	-	-	+	+



Figs. 1-9. Early stages of *Papilio oregonius* Edwards. Fig. 1. Egg lateral aspect. Diameter—1.2 mm. Fig. 2. Same dorsal aspect. Fig. 3. First instar larva. Length—5.5 mm. Fig. 4. Second instar larva. Length—8 mm. Fig. 5. Third instar larva. Length—16 mm. Fig. 6. Fourth instar larva. Length—28 mm. Fig. 7. Fifth instar larva. Length—45 mm. Fig. 8. Pupa, dorsal aspect. Length—32 mm. Fig. 9. Same, lateral aspect.



Fig. 10. Adult, ♂ *Papilio oregonius* Edwards, The Dalles, Wasco County, Oregon. 150', 11-VI-62 (S. F. Perkins). Fig. 11. Adult, ♀ *P. oregonius*. Same data (E. M. Perkins, Jr.).



Fig. 12. Spanish Hollow Canyon, .5 mi W. Biggs, Sherman County, Oregon. 250' (looking north toward Columbia River and bluffs of Washington). Fig. 13. Same locale depicting *Papilio oregonius* foodplant (*Artemisia dracunculus*).

Papilio oregonius was originally described on the basis of a single female sent to W. H. Edwards by Henry Edwards (not Morrison) from The Dalles, Wasco County, Oregon (Figs. 10 and 11 are topotypes).

Two broods of *Papilio oregonius* occur in Oregon: adults are on the wing from mid-May to June and from July to mid-September. In Oregon, the authors have encountered *Papilio oregonius* along the length of the Columbia River, east of The Dalles, *i.e.*, in Wasco, Sherman, Gilliam, Morrow and Umatilla counties. Here in arid, sage-covered country it flies about its foodplant, *Artemisia dracunculus* L., or frequents the hot, wind-swept lower canyons, (Figs. 12 and 13). During five seasons of field work captures from flowers (*Cirsium* and *Vicia*) represent less than one percent of our captures.

Occasional records also originate from canyons of the upper plateau, including Jefferson and Baker counties (which represent the southernmost, verified Oregon records).

Some of the finest collecting areas in Oregon have vanished in recent years because of highway construction, floods and rising waters due to new dams along the Columbia River. If the Oregon swallowtail is as hardy and adaptable as its foodplant, *Papilio oregonius* will likely be little affected.

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LETTERS FROM DR. H. H. BEHR TO HERMAN STRECKER¹

F. MARTIN BROWN

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The letters upon which I am reporting are in the Department of Entomology, The Field Museum, Chicago, Illinois. They fall into two groups, 1874–1881 and 1899–1900. The first group was written when H. H. Behr was a busy physician in San Francisco, the second when he was Curator of Entomology at the California Academy of Sciences. Perhaps the most important item demonstrated by the letters is that Behr did not send his butterfly types to Strecker as the latter frequently stated. The specimens in the Strecker Collection at the Field Museum are what Behr thought represented his name for a taxon at the time he made the shipment. From the correspondence between W. H. Edwards and Henry Edwards one draws the conclusion that Behr did not long remember what names he had bestowed upon specimens and that he did not mark any of his material as "type" or with a name. Behr did send to Strecker some, if not all, of the types of the Noctuids he described in 1870.

It is evident from examination of the letterhead dates and the post-marks that many of Behr's letters resided for several days after being written either in his pocket or on his desk. In one case the epistle stayed with Behr for three months after being written. It is not known if among the several thousand letters yet in miscellaneous bundles there are letters from Behr to Strecker that were written between 1881 and 1899. It was around 1881 that many reputable entomologists in the United States stopped their correspondence with Strecker. By then it had been conclusively established that Strecker had ante-dated several numbers of his *Lepidoptera*: *Rhopalocers-Heteroceres* and had admitted this to the Rev. George D. Hulst in writing. Strecker's vituperous comments, especially about Augustus Grote and W. H. Edwards, added to the resentment against Strecker of serious students of insects in this country. This still casts a shadow over the true worth of Strecker's work. In spite of his personal shortcomings he was an able and industrious worker.

None of the 40 letters written by Behr to Strecker is trivial. Strecker's part of the correspondence is not known to me and probably was

¹ This study was made incidental to NSF grants GB-194 and GS-969.

destroyed in the San Francisco fire of 1906. Thus, these notes and comments depend entirely upon Behr's letters. The earliest letter found is dated May 20, 1874. Along with it Behr dispatched a box of Noctuids of which he wrote: "With this you received the Noctuidae in question. You may consider them as a present, or if you like, send me the corresponding species of the East. Not all of them are in good order, but as they are originals of descriptions [types] I thought them of sufficient interest. They were originally destined for a friend for whose loss the science of Zoology mourns." A little further on Behr scratched out a line that contained the name of this friend. From what is visible it appears that the friend was Lorquin, who died in 1873. These Noctuids were, in part or in whole, the types of the names proposed by Behr in 1870 in his only paper upon the family. He was disappointed in the lack of enthusiasm accorded that paper by North American lepidopterists (letter July 10, 1874.) So, instead of continuing with the series he sent the rest of the moths that he had planned to describe to Strecker on June 12, 1874, with permission for Strecker to name and publish upon them.

The letter of August 14, 1874 is an important one and almost undecipherable. In it Behr recounts what he knows about the habits of some 15 Californian Noctuids (*sensu latu*) and lists his holdings of eastern butterflies. The next letter, written September 12th, is even more difficult to read. In it he agrees with Strecker that the multiplicity of names among the Lycaenidae is regrettable. He also states that he has just sent off a box of these to Keferstein in Erfurt. At first glance a letter postmarked December 19 and probably written on the 17th is just unreadable. However I can make out that Behr is sending Strecker the "continuance of my Noctuides."

On March 4, 1875, Behr wrote that he had sent a "little invoice" and still considers himself to be in debt to Strecker. He states further "I will send you all my duplicates of the *Coloradia*² [Saturnidae] genus, but they will not amount to much, neither in number nor in preparation. *Catocala Irene* and *Stretchii* are Unica [unique = type], but I have reliable drawing made by Mr. Stretch of each of them." This suggests that Strecker may have received the types of both *irene* Behr and *stretchii* Behr.

Some thoughts of Behr upon Lycaenidae are included in his letter of August 28, 1875 (mailed on September 3.) "I send you *Rubidus*,

² Behr did not underscore scientific names at any time in his correspondence. I have done so here to conform with current custom.

Pardalis, my *Lorquini* is identical with *Catalina* of Reakirt. All my specimens are from the Sierra. I have not yet found any near S. Francisco. If you are content with bad specimens I send you *Battoides*. The species is alpine and out of the reach of my excursions. *L. Daedalus* perhaps may be identical with *L. Icaroides*, but this wants investigations. I think *Evius* and *Pheres* are local varieties of the same species. (foot-note: "that is of *Pheres*") I have some very intermediate specimens. But in all these conjectures I might be mistaken as it is so very difficult to identify any species from the descriptions given. As to the identity of my *Lorquini* and *Catalina* I am certain as your figure is so true that it cannot be mistaken. *L. Rapahoe* as it is figured in your good work is my *L. Daedalus* and I incline to consider *Daedalus* identical with *Icaroides*. All of these species I can send you a series." From this it can be seen that upon familiar ground Behr's discrimination was good.

In the letter of September 26, 1875, Behr states that he does not know "*L. behrii*" by which, from the context, he refers to *Callipsyche behrii* (Edwards), not the subspecies of *Glaucopsyche lygdamus*. Both of these, incidently, were returned to Behr by Edwards. Next he wrote "*L. Xerces* will be in the box. It is now extinct as regards the neighborhood of S. Francisco. The locality where it used to be found is converted into building lots and between German chickens and Irish hogs no insect can exist beside louse and flea." On December 31, 1875, Behr wrote "When you receive this letter I hope my box of Lycaenidae and a part of the *Smerinthus* [*ophthalmicus* Bdv.] will safely be in your hands. . . . I have sent you all or nearly all my duplicates of Lycaenidae but have not affixed the names to all of them or else it would have been very late before I could have sent them. They arrive late enough at any rate. . . . Not all my Lycaenides are in a good state of preservation, but I send them as they are."

In his first letter of the new year, January 5, 1876, Behr told Strecker, after complimenting him upon trying to reduce the confusion among Lycaenidae, "I am very much afraid that unknowingly I have contributed to the confusion, at least among the Lycaenides, but the real criminal is, there, Boisduval whose correspondence with my friend Lorquin for a considerable time was my guide in determining Californian Lepidoptera." Apparently Strecker next evinced an interest in the genus *Argynnis* for on February 28 Behr wrote "I am so sending you my *Argynnis* duplicates as you expressed a liking for this genus, and at the same time I hope by your assistance [to resolve] some doubts regarding several species of the *Aglaja* type. It is with them as it is with the Californian

Lycaena." These were sent on June 27th. On the 12th of September, Behr advises Strecker not to place too much importance on the amount of silvering on *Argynnis* since it seems to be of no import among European species.

A letter written June 8, 1878, carries the news "Harry Edwards is leaving us. He is an active collector and scientist and I am sorry to leave him. We are but few entomologists and that perhaps is the cause of the good understanding between us. I am arranging at present my Argynnides. There is no doubt that most of our species of the *Aglaja* type are artificial but it is better to distinguish too much than to neglect and the superscription of your letter 'time at last sets all even' refers as well to science as to individual affairs. If you look at the Argynnides of ancient European authors with their *A. Eurybia* [?], *Arsilarche*, *Isis*, *Pasianus* [?], *Pelopia*, *Syrinx*, you will find we are only in the beginning of the process through which they have gone. We are collecting the material and those after us will sift our harvest." Near the end of the letter is this: "It is wonderful how many of our species that formerly were quite common are nearly or entirely extinct, for instance, *Lycaena Xerces*. It is probably the change that takes [place] in our vegetation, whose species are gradually superceded by Australian and other immigrants."

On September 3, 1878, Behr's letter contained "I have a second specimen of a *Chionobas* [*Oeneis*] from the Sierra, of which I received a specimen in very shattered condition 16 years ago. I do not know if since then it has been described. It looks somewhat like *S. Ridingsii* which by the by impresses me as being also more or less belonging to *Chionobas*." [In 1870, W. H. Edwards assigned *stretchii*, a subspecies of *ridingsii*, to *Chionobas*.] This probably refers to *Oeneis ivallda* Mead, 1878. Toward the end of the month Behr received a copy of Strecker's Catalogue which pleased him, especially the large amount of interesting information included. It is as useful today for that information as it was when it was published. It is the only 19th Century catalogue that I use almost daily.

There is a gap until January 7, 1881, when Behr wrote: "I will make a colored sketch of *Neophasia Terlooti* and send it to you. W. H. Edwards is perfectly right, *Neophasia Terlooti* was caught on the Sierra Madre between Mazatlan and Durango and carried from there in a pocketbook by the late Baron Terloot de Popélaire. It is not probable that a man of entomological tastes will enter those dangerous and unsafe regions for a year or two to come. I think I have stated that to Mr. W. H. Edwards and received the answer that the insect probably

extended into southern California. This is not impossible, but as my specimen at present is the only one, very difficult to prove." Time has shown Edwards to be wrong, but the species is known from the Chiricahua Mountains of Arizona. The last of this first group of letters was written February 11, 1881. "I think I will find time to try my painting brush once more. It is now fifteen years that it lay idle. As to species I do not care much to add to my reputation by describing them. If Mr. Grote finds pleasure in describing them, he is welcome to it. It is the progress of science I am interested in, not in affixing my name to a new species."

Behr resumed his correspondence with Strecker after a visit from M. Derkert de la Meillage who had previously been with Strecker in Reading. Apparently Strecker reopened his attempts to get the type of *Neophasia terlooti* but Behr wrote on March 3, 1899, it is "in such shattered condition that it scarcely bears examination, but certainly not transportation." Behr now was 80 years old. His handwriting, never particularly legible, seems if anything a little easier to read! In this letter he said: "As to *Melitaea Quino*, I can comply with your wishes. I think I can send you quite a number of specimens, one of them raised from one of the larvae whose very distinct coloration first pointed out a different species which otherwise probably would have been overlooked up to date." If this specimen can be discovered in the Strecker Collection it will be an invaluable clue to just what insect Behr named *quino*, a question not yet wholly satisfactorily settled. In the next letter, October 29, 1899, we find: "I have sent you last week two specimens of *Mel. Quino* which I suspect very generally is taken for *Anicia* Dbld. Now, I possess a rather shattered specimen of *Anicia* which Dr. Boisduval had received from Doubleday and which he had sent to Mr. Lorquin in S. Francisco. It may be that Doubleday, who probably had but few specimens of both species did not distinguish between the two and that his *Anicia* comprised my *Quino*. But you can easily convince you of the difference if you see the type specimen of *Anicia*. If you wish it, I can send you an *Anicia* very similar to the type, but not in very good order." On November 13th 1899, Behr wrote that he had dispatched "5 *A. Monticola*, 2 *A. Rupestris* probably not distinct from 3 *A. Eurynome*, 4 *A. Epithore*, 3 *A. Nevadensis*, 2 *M. Anicia*, the one with the label agreeing most with the type" and several large moths. It is these *Argynnis* that now stand in the Strecker Collection as Behr's types. They were Behr duplicates. It will be noted that Strecker made no claim to holding the types in his 1878 Catalogue after receiving the earlier shipment of Behr *Argynnis* in 1876.

On January 9, 1900, Alice Eastwood wrote to Strecker that Behr was ill of pneumonia and that he would answer Strecker's letter at a later date. This he did on the 13th. On the 28th he wrote that he would send a "good pair of my *Coronis*." In return Strecker sent some material from the Himalayas which Behr acknowledged on February 9th. On the 14th of March Behr wrote "Hereby I send you 8 *Coronis*, and 6 *Quino*. I thought it advisable to send as many as I could spare to enable you to look at something like a series. If it was not for the upper side, which is so constantly different from that of *Calippe*, I would the species consider identical. But after all, what is a species? Both forms I have observed in their natural haunts and found them different in their habits. *Calippe* haunts the flowers of *Aescalus* [sic] in the suburbs of South San Francisco and the Contra Costa range, especially near Mills Seminary. *Coronis* does not show such predilections, it frequently settles on moist ground near Livermore and seems to develop a preference for *Audibertica*, *Baccharis* and *Solidago*. In both species the ♀ are more rare and fly so late after the disappearance of the ♂ that it always was strange to me, how, where and when do they meet. In regard to *Quino* I have no personal experience. Most of my specimens are from the hills near San Diego. What I sent you is about all I can spare. In regard to *Coronis* I have still a supply."

The last letter from Behr in the Strecker files is dated July 30, 1900. In its entirety this letter reads: "A close inspection of specimens has convinced me that *Lycaena Pheres* Boisd. and *L. Xerces* Boisd. cannot be kept separate as species in the old sense. *Pheres* is very variable and *Xerces* is a rather constant aberration analogous to *Artaxerxes* and aberration of *Astrarche* (*Agestis* J. V.) in Europe. A series of specimens collected by Mr. Cottle has furnished me transitional forms that leave no doubt." *Aricia agestis* Schiffm. now is considered a distinct species from *artaxerxes* Fabr. just as *pheres* Bdv. and *xerces* Bdv. are now so considered.

Throughout the correspondence Behr requested African and South American Lepidoptera in exchange for what he sent Strecker. There is every indication that the exchange was satisfactory to both men. Every time that Behr received a part of Strecker's *Lepidoptera*: *Rhopaloceres-Heteroceres* he commented upon it. Many of the letters contain information that may be of interest and use to a student of Californian Heterocera. This is in such bits and pieces that intelligently extracting it is all but impossible. The entire correspondence is in my file in xerox copies of the originals and they may be used by qualified students.

OVERWINTERING OF MONARCH BUTTERFLIES AS A BREEDING COLONY IN SOUTHWESTERN ARIZONA

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According to Urquhart (1960), monarch butterflies, *Danaus plexippus* (Linnaeus), are known to overwinter in the United States "either as free-flying, non-roosting individuals . . . or as roosting colonies." These individuals apparently do not breed, nor are eggs deposited by previously mated females; rather, they are awaiting the return of warm spring weather to trigger their northward migration, during which the females may begin oviposition.

It was with some interest, therefore, that I found 48 larvae and six pupae of *D. plexippus* on 26 December 1965 at Yuma, Yuma Co., Arizona. Three fresh adults were also caught at this time. The locality was revisited at various intervals, and counts were made of each developmental stage present except ova. These counts were: 4 January 1966, 34 larvae, 11 pupae, 0 adults; 16 January 1966, 14 larvae, 31 pupae, and 9 fresh adults; 22 January 1966, 23 larvae, 28 pupae, and 6 fresh adults; 18 February 1966, 21 larvae, 32 pupae, and 7 fresh adults; 27 February 1966, 8 larvae, 30 pupae, and 11 fresh adults; and 6 March 1966, 0 larvae, 27 pupae, and 7 fresh adults. Adults when caught were marked with India ink to determine whether they would remain in the area, but none were recaptured on later dates.

During this same time period (26 December–6 March), adults could be seen flying about the Yuma area on warm days, but I was unable to determine whether any of these were also propagating. Females in the observation area were seen to oviposit on the foodplants on 16 January and 18 and 27 February. Copulation was not observed. A number of larvae were reared in captivity, none of which were parasitized. A dozen larvae and two pairs of adults (emerged 29 and 30 December, 9 and 14 January) from this colony are in my collection, as is a somewhat worn female caught 30 December at Yuma.

Temperature conditions at Yuma would seem to be favorable to the development of monarchs during the winter months. Urquhart (1960) states that some individuals from an overwintering colony become active at temperatures above 60° F., and that above 70° F. the entire colony becomes active. Table I shows the temperatures for Yuma during the period December 1965–March 1966, inclusive (source: U. S.

TABLE I. DAILY TEMPERATURE DATA FOR YUMA, ARIZONA, FOR DECEMBER 1965-MARCH 1966, IN DEGREES FARENHEIT, RANGE (AVERAGE).

	Maxima	Minima	Averages
December	49-79 (64.0)	35-58 (44.8)	47-65 (54.4)
January	54-73 (63.7)	32-53 (40.6)	45-60 (52.2)
February	55-78 (68.0)	33-54 (42.0)	47-63 (55.0)
March	61-98 (80.8)	35-57 (49.9)	48-77 (65.4)

Dept. of Commerce, Environmental Science Services Administration records.) Freezing temperatures (32° F.) were recorded only on 23 and 24 January.

The foodplant being utilized by the monarchs at Yuma during the observation period has been identified as *Asclepias tuberosa* L. by the Herbarium of the University of Arizona, Tucson. This plant is not native to the Yuma Desert; Kearney and Peebles (1960) give the range of *A. tuberosa* in Arizona as "Apache County to Coconino County, south to Cochise, Santa Cruz, and Pima counties, 4,000 to 8,000 feet, mostly in . . . pine forests . . ." Yuma is at an elevation of less than 150 feet above sea level. The *A. tuberosa* plants were growing in a garden. It would be interesting to learn whether monarchs can or do utilize species of *Asclepias* native to the Yuma region as foodplants during the winter. Kearney and Peebles record *A. albicans* Wats., *A. subulata* Decne. [food-plant of *Danaus gilippus strigosus* (Bates)], and *A. erosa* Torr. from Yuma County, but I cannot say whether *Danaus plexippus* could feed on any of them during the winter.

ACKNOWLEDGMENTS

I wish to extend thanks to Mr. Kilian Roever for encouragement, and to Mr. Fred T. Thorne for criticism of the manuscript.

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ANNOUNCEMENT OF 1968 ANNUAL MEETING

The Nineteenth Annual Meeting of the Lepidopterists' Society will be held June 15-18 in Washington, D. C., at the Museum of Natural History. The program will include registration and open house on June 15, a field trip on June 16, and presentation of papers, with a concluding banquet, June 17-18. A discussion of polymorphism will highlight the program, and invitational addresses will be presented by H. B. D. Kettlewell and H. E. Hinton, of England.

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by CYRIL F. DOS PASSOS

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In This Issue

EFFICIENT TRAP FOR NOCTUID MOTHS
NORTH AMERICAN BUTTERFLIES OF LINNAEUS
BUTTERFLIES OF CONTRA COSTA COUNTY, CALIF.
COLLECTING ITHOMIIDAE WITH HELIOTROPE
ERICH MARTIN HERING (1893-1967)

(Complete contents on back cover)

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A BRIEF REVIEW OF THE PRINCIPLES OF LIGHT TRAP DESIGN WITH A DESCRIPTION OF AN EFFICIENT TRAP FOR COLLECTING NOCTUID MOTHS

D. F. HARDWICK

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Recent entomological literature is replete with descriptions of insect light traps and discussions of the relative efficiency of various light sources in "attracting" nocturnal insects. Much has been published on various aspects of light trap design in both England and the United States. Apparently, however, workers in either country have been somewhat oblivious to light trapping investigations carried on by workers in the other. Entomologists in Great Britain, for example, at the time of the proposal of the Robinson trap (Robinson and Robinson, 1950) were apparently unaware that North American entomologists had been using for decades a simple trap consisting of a funnel to which a killing bottle was attached, and above which an unenclosed electric light bulb was suspended. Similarly, North American workers in assessing the value of various light sources have apparently been unacquainted with the 120-150 watt mercury-vapour lamp and its superiority in collecting many nocturnal insects to the ordinary tungsten-filament bulb or to the black light fluorescent tube.

SOME ASPECTS OF LIGHT TRAP DESIGN

Three major factors must be considered in the design of any light trap: the first is an efficient light source, the second is an efficient apparatus for confining the specimens, and the third is an appropriate reception chamber and poison distributing mechanism for killing specimens and retaining them in good condition until they can be recovered for sorting. The last factor is of particular importance if the specimens are for permanent retention in a formal collection.

Light Sources.

Light sources employed in the capture of nocturnal insects have changed through the years. The kerosene lamp was replaced by the gasoline pressure lamp and by the tungsten-filament bulb. In the last couple of decades, the tungsten-filament bulb has been largely replaced by various bulbs and tubes emitting a high percentage of ultra-violet light. The latter have been effective presumably because the spectrum visible to insects embraces shorter wave lengths than that visible to human beings. In North America, the black light fluorescent tube has been most widely employed in light trap construction. Mercury-vapour bulbs of the type suggested by Robinson and Robinson (1950) have not been subjected to comparative tests, and have had only very limited use on this continent. Other types of mercury-vapour bulbs, including one of the spot type (Pfrimmer, 1957) and the General Electric BH 4 (Frost, 1958b) have been tested, but have been found inferior to the black light fluorescent tube. The former bulb projects a cone-shaped beam of limited radius, and the latter bulb does not have the surface brilliance of the bulb suggested by Robinson and Robinson.

The 125-watt, Osram, mercury-vapour bulb, manufactured by General Electric of England, has proved extremely effective in "attracting" noctuid moths in faunal surveys conducted by the author over the last several years. The superiority of a bulb of this type to the tungsten-filament bulb has been demonstrated for the Macrolepidoptera as a whole by Williams (1951), and its superiority to at least one type of black-light tube has been indicated by Heath (1965).

Such results are not, however, universally applicable to all groups of insects. Neither small moths, beetles nor nocturnal parasitic wasps seem to reach the immediate vicinity of the light source in as great numbers as they do with a bulb or tube of lesser surface brilliance. When the Osram bulb is employed, representatives of these groups may be found fluttering or resting near the periphery of the circle of light created by the bulb. Harcourt and Cass (1958) have demonstrated that large numbers of Microlepidoptera may be taken with a relatively obscure light source. Moreover, even within the Macrolepidoptera, response to any particular light source will not be comparable for different groups. Thus in the data presented by Williams (1951), over four times as many specimens of noctuids were taken in the Rothamsted trap when a 125-watt mercury-vapour lamp was substituted for a 200-watt tungsten-filament bulb, but only slightly over twice as many specimens of geometrids were taken by the same substitution.

Any explanation of this differential response will depend on the cause of such response by an insect to a light stimulus. According to the classical theory, insects are "attracted" to light and differing responses among groups of insects may be attributed to different minimal and maximal thresholds of attraction. Thus certain groups may be attracted to a relatively weak light source and cease to be attracted when the light intensity becomes too great.

Robinson and Robinson (1950) and Robinson (1952) suggested another, almost diametrically opposed theory of the light response phenomenon. They suggested that nocturnal insects are actually repelled by light, but that if they are flying sufficiently quickly, they may come close enough to the light source to be "dazzled" by it and are then automatically deflected toward it. They explained the presence of specimens resting or fluttering near the periphery of the lighted area as not having been flying quickly enough to penetrate to the "dazzle" area before being repelled by the light. Such specimens are inhibited from further vigorous movement by a "desensitizing" of the eyes caused by the weak light in the peripheral area. There is much in the Robinsons' proposal that will serve to explain the observed behaviour of insects near a light source. The suggestion that an insect's response is governed only by its speed of flight, however, would seem an oversimplification and certainly some cognizance must be taken of varying thresholds of repulsion and "dazzle" for different species before the Robinsons' theory can be wholly accepted.

Trapping Mechanisms.

Two major types of trapping mechanisms have been employed in the construction of light traps. The two principles involved are exemplified in the box trap and the funnel trap. In the box trap, at least one outer wall of a chamber containing or adjacent to the light source, consists of two panes of glass sloping inward to a narrow horizontal aperture. Once an insect has gained entrance to the chamber by flying inward against one of the panes and through the aperture, it has little opportunity of escaping. The Rothamsted trap (Williams, 1948), although having four glass entrance walls, is essentially of the box type. Beirne (1951) considered a box trap more efficient than a funnel trap in collecting slender-bodied, weakly flying species of moths which are common in the Microlepidoptera and some groups of the Geometridae.

The funnel trap consists basically of a light source suspended over a funnel which leads to a lower chamber. Once in the lower chamber, the insects have difficulty in escaping because of the narrow diameter

of the lower aperture of the funnel. Williams (1951) amply demonstrated the superiority of the funnel trap to the box trap for collecting Noctuidae and many other Macrolepidoptera. Electrically operated fans have been installed in various models of funnel traps in particular effort to capture small insects which do not have sufficient body weight to fall readily through the funnel.

Other trapping mechanisms have been employed. Parker *et al.* (1921) used a wash tub filled with water as a catch basin in early ecological work with the pale western cutworm, *Agrotis orthogonia* Morr. Various types of electrocutor traps, in which insects are killed by short-circuiting an electric current, have been designed and even marketed during the last decade or so.

Baffles. The use of baffles around the light source of a funnel trap has also been the subject of much controversy. The design and coloration of baffles have been discussed at length, and it is evident that the reflection of light from baffles is generally detrimental. However, baffles do eliminate the seemingly endless gyrations about the bulb in which many noctuids engage, and they do deflect into the mouth of the funnel swift flying insects which would otherwise pass within close proximity of the bulb and continue on their way. If the data presented by Frost (1958a) are valid of interpretation, then the use of baffles around the light source increases the catch of noctuid moths by about 25%.

Hoods. A further consideration in the design of a funnel trap is the use of a hood or roof over the light source and the mouth of the funnel, both to protect the bulb from damage and to prevent the catch from getting wet. Usually such hoods are in the form of a shallow inverted cone and are constructed of metal. Beirne (1951) suggested the use of a transparent plastic sheet to roof the trap. Such additions to the trap, however, can only decrease the number of rapidly flying insects taken. Frost (1958b) after conducting tests with both hooded and unhooded traps, concluded that the latter were more efficient in collecting many nocturnal insects. Observations of the behaviour of larger moths, when near a light source, offer a ready explanation. Many specimens descend toward the light at an acute angle, and if the trap is roofed, such an approach path is eliminated. Without a hood, however, the reception chamber of the trap must be provided with an efficient drainage mechanism to eliminate all water entering the funnel. Possible damage to the bulb by rain will probably depend on the nature of the bulb itself. The 125-watt Osram bulb used by the author has withstood several heavy rains in montane

areas of western North America at temperatures close to the freezing point without having either shattered or cracked.

Trap Receptacles.

In the simple funnel trap, which has been used over the last several decades, a quart sealer jar has served as the standard receptacle for specimens flying to the light. Under conditions of heavy flight, however, such a small chamber may have the killing gas largely dissipated by the wing movements of a host of confined moths, and the gas-discharging surface itself may become so insulated with corpses that it can no longer function efficiently. Moreover the confining of specimens within such a restricted space, often causes very active individuals to do excessive damage to themselves and to already moribund specimens in the container. On nights of heavy flight, the quart sealer is of insufficient volume to contain the several quarts of specimens that may be taken in a trap employing a mercury-vapour bulb.

A large receptacle is necessary if specimens are to be maintained in good condition during a heavy flight, or if the trap is used to obtain living insects for experimental work. To obtain specimens in better condition, Edmunds (1961) recommended the replacement of the quart sealer in a simple funnel trap by a cloth sack filled with crumpled newspaper so that specimens could crawl away into various diverticula and remain quiescent until morning. The specimens were then killed with chloroform or ether. In the more commonly employed trap, in which the receptacle also serves as killing chamber, a larger receptacle will require the use of a larger amount of gas-forming chemical and probably a more efficient method of gas production, especially under conditions of low temperature. Heavy flights of noctuids have been encountered by the author when the air temperature was only a few degrees above the freezing point.

Although the use of a large killing chamber greatly reduces the damage that an individual specimen may do to itself, it does not eliminate the damage that may be done to quiescent specimens by still active occupants of the trap. Particularly troublesome to lepidopterists are the many beetles which trample the catch for protracted periods before becoming inactive themselves.

To reduce beetle damage, double-chambered traps have been designed by Common (1959) and by Denmark (1964), the lower chamber of each serving to accommodate the beetles. The trap described by Common is also provided with transparent walls which in themselves evidently provide an effective mechanism for excluding beetles from

the trap. The damage occasioned by beetles may be alleviated in yet another way, however. If the bottom of the killing chamber is compartmentalized, beetle movements are greatly restricted so that the advantage of several discrete receptacles is obtained. Further, if a thin pad of cheesecloth is placed on the floor of the reception chamber, the beetles usually burrow into this or at least become entangled in it so that they are essentially immobilized.

At least two other factors must be considered in the design of a receptacle to contain the specimens diverted to a light source. Firstly, the number of specimens leaving the chamber through the entrance aperture must be reduced to a minimum. This may be accomplished in a funnel trap in two ways: by having a small entrance aperture and by reducing the amount of light entering the killing chamber from the bulb above. Both of these requirements may be met by having a screen-lidded "rain-drain" of sufficient diameter set shortly below the bottom of the funnel. This limits the size of the entrance apertures and also prevents light from shining directly into the killing chamber. Another important factor is the ease with which specimens may be recovered from the trap. If a removable tray is contained in the bottom of the chamber, this may be lifted out with the night's catch intact so that the specimens may be more readily sorted.

Killing Agents. The obviously best method of obtaining a quick "knock-down" is by employing the most rapid-acting poison and by maintaining it at a high level of concentration. Hydrogen cyanide, generated by treating one of cyanide salts with a weak acid solution, acts most quickly and leaves the specimens in a relaxed condition. The material is so excessively toxic, however, that it cannot be left with any equanimity in an unattended trap. This is particularly true of a trap with a large receptacle in which a large amount of poison must be used. Tetrachloroethane, a substance first proposed for light trap use by Williams (1948), makes a reasonable substitute for cyanide if it can be vaporized at a sufficiently rapid rate. Moreover, unlike some of the other anaesthetics, such as chloroform and ether, tetrachloroethane leaves specimens in a nicely relaxed condition. On cool nights, tetrachloroethane does not vaporize well, however; specimens in the receptacle remain active for long periods, and once quiescent may again become active during the sorting process the following day, or even after they have been pinned. Robinson and Robinson (1950) proposed the use of a vaporizer to dispense the tetrachloroethane. A perhaps more effective method of maintaining a lethal concentration of gas, however, is by having a large pad saturated with the chemical in the bottom of the

receptacle with a small heating element located below it. This not only vaporizes the killing agent but warms the whole chamber so that the chemical will remain in a vaporized condition.

LOCATION OF TRAP

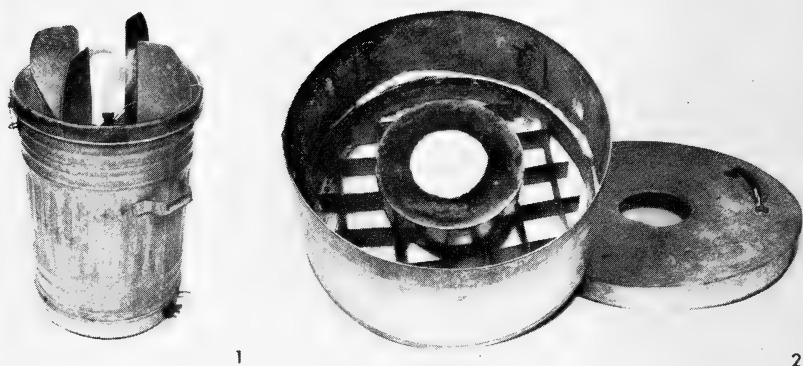
One other factor besides the design of the trap and the nature of the light source must be considered in any light-trapping program. This is the placement of the trap. Nominally a broad open area should prove most effective because it allows the widest field for the penetration of the light from the trap. More confined situations may prove equally productive, however, because of the fact that such situations serve as insect fly-ways in a region otherwise congested with timber or brush.

The height above the ground at which the trap is operated may also affect the response of various insects. The data presented by Frost (1958c), although not conclusive, suggest that within the range of a dozen feet or so the numbers of specimens of groups such as the Polyphaga may be sharply reduced with increased altitude of the trap. In other groups, such as the Noctuidae, however, differing altitudes of the trap cause little difference in the numbers of specimens taken.

AN EFFICIENT NOCTUID TRAP

The light trap illustrated in Figs. 1-3 has been used with good success for collecting noctuid moths during several years of survey work. Minor modifications to the original design have been made from year to year. The outer shell of the trap is a 20-inch high, galvanized steel garbage can to which other components have been designed to fit. The light source (a, of Fig. 1) is a 125-watt, 200-220 volt, Osram mercury-vapour globe manufactured by the General Electric Company of England. It is enclosed by four baffles (b) which extend somewhat above the level of the top of the bulb. The rather sharply sloped funnel (c) situated below the light leads into an inner metal chamber (d). The inner chamber, which serves to confine as much as possible the gas generated, may be lifted out of the shell of the trap once the funnel has been removed.

Within the inner chamber and shortly below the lower end of the funnel is a small screen-lidded container, the "rain-drain" (e) with a tube leading from it down through the bottom to the exterior of the trap; the container receives and eliminates any water entering through the funnel. The screened lid of the "rain-drain" must be sufficiently close to the lower end of the funnel and of sufficiently large diameter



Figs. 1, 2. A light trap designed for the collection of noctuid moths. 1, Exterior view. 2, Reception chamber showing "rain-drain," removable specimen tray, and metal lattice dividing tray into compartments.

that no rain can be distributed on the floor of the reception chamber. A circular, one-half inch thick, disc of sponge rubber (f) is secured to the upper surface of the screened lid of the "rain-drain"; this serves as a cushion for larger noctuids descending into the trap at a sharp angle and at a high rate of speed. Noctuids entering the trap in such a manner collide with the cover of the "rain-drain" with such force that a clearly visible cloud of ascending scales can be seen above the funnel of the trap.

Beneath the basin of the "rain-drain" in the reception chamber is a removable metal tray (g) with a one-eighth inch mesh hardware cloth bottom; the floor of the tray is covered with a thin pad of cheesecloth. A removable metal lattice (h) which divides the tray into a number of compartments rests on the cheesecloth. Below the metal tray, immediately on the floor of the reception chamber, is a one-half inch thick pad of cheesecloth (i), which is saturated with the killing agent, tetrachloroethane.

A hundred-watt heating element (j), the heat from which serves to vaporize the tetrachloroethane, and to warm the reception chamber so that the chemical will remain vaporized, is located in a separate chamber at the bottom of the trap. It is separated from the pad containing the tetrachloroethane only by the thickness of the metal forming the bottom of the reception chamber.

In disassembling the trap to inspect the catch, the funnel is first removed, the reception chamber is lifted from the outer shell and its

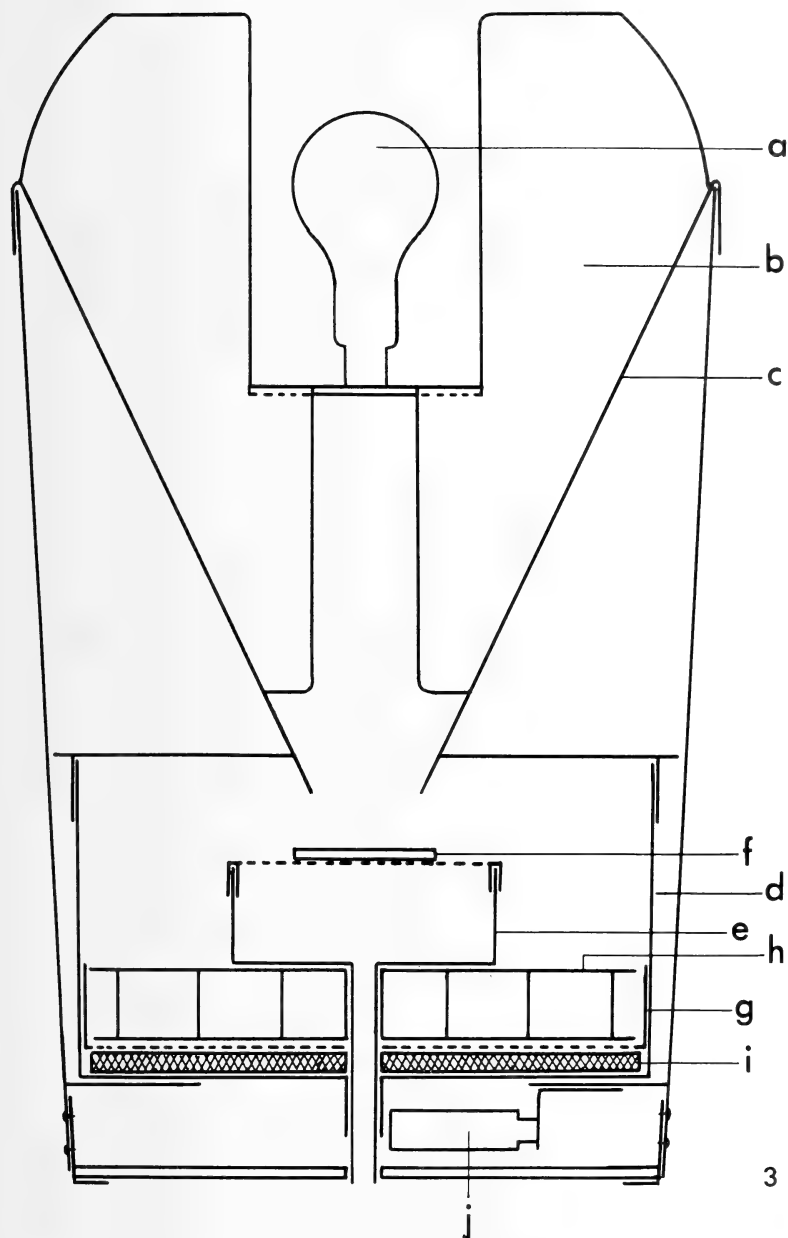


Fig. 3. Vertical section of trap with components in position for operation. *a*) light source; *b*) baffle; *c*) funnel; *d*) inner metal chamber; *e*) screen-lidded rain drain; *f*) disc of sponge rubber; *g*) removable metal tray; *h*) removable metal lattice; *i*) cheesecloth pad; *j*) heating element.

lid removed. The "rain-drain" is then removed so that the tray containing the night's catch may be lifted out of the killing chamber. In a well-ventilated room, the specimens may be sorted and pinned directly from the tray. When reassembling the trap prior to use, the cheesecloth pad in the bottom of the reception chamber is charged with 40 to 50 c.c. of tetrachloroethane.

On nights in which particularly heavy flights are anticipated, a greater concentration of tetrachloroethane vapour may be obtained in the reception chamber by inserting a wad of cheesecloth in the basin of the "rain-drain" and saturating this with the killing agent. One commonly encountered problem, when employing a trap with a large reception chamber in arid areas, is the drying out of specimens before they can be sorted and pinned. This may be alleviated to some degree by maintaining the humidity in the reception chamber at a high level by adding water, in quantity equal to that of the tetrachloroethane, to the pad at the bottom of the chamber and to the wad of cheesecloth in the basin of the "rain-drain." In areas or at times that electrical power is not available for operating the bulb of the trap, the bulb may be removed and a Coleman lamp substituted.

During four seasons of field use, power for operation of the trap was provided by a small 500-watt, 220-volt, gasoline-powered generator. The equipment was transported in a small laboratory-trailer in which bench facilities are available for sorting and pinning material taken in the trap. The trap was operated nightly on the top of the trailer so that the light source was about eight and one-half feet above ground level. This eliminated the creation of a large shadow area when the trap was operated in close proximity to the trailer. As mentioned previously, the altitude probably had little effect on the numbers of noctuids taken in the trap but may have reduced the numbers of specimens representing some other groups.

During a period of 200 nights of operation, the numbers of non-deltoid noctuid moths taken in the trap had a nightly arithmetic mean of 525, and a nightly geometric mean of 198; the maximum catch on any single night was 14,144. In nightly catches of less than 800 noctuids, specimens were in generally good condition. Under circumstances of very heavy flight, however, the killing chamber was evidently so well ventilated by wing movements that the killing gas was severely diluted, and specimens recovered from the trap were often rubbed.

Because of the weight of the trap and its ancillary equipment, the unit described cannot be considered a portable one. Its relatively high efficiency in "attracting" and capturing specimens, and in maintaining

them in good condition, however, may render it of value to workers concerned with various aspects of noctuid ecology.

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LIFE HISTORY OF *DRYAS JULIA DELIA* (HELICONIINAE)

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Although *Dryas julia* (Fabricius) is at times abundant in southern Texas and Florida, little seems to have been published concerning the early stages other than that the larval foodplant is *Passiflora*. Sietz (1921: 400) says, "larva pale grey or grey-brown, the incisions darker, the fore part of the head marked with darker, the spines blackish." He remarks that the pupa is similar in color. Klots (1951) is admittedly even more indefinite: "larva—poorly known; possesses long branching spines." It is the purpose of this paper to give a more exact description.

While collecting near San Antonio, Bexar County, on 24 October, 1966, four strange larvae were found feeding on *Passiflora lutea* (L.) var. *glabriflora* (Fern). The larvae differed in several aspects from those of the *Passiflora*-feeding species known from the area, *Euptoieta claudia* (Cramer), *Agraulis vanillae incarnata* (Riley), and *Heliconius charitonius vasquezae* (Comstock & Brown). An indication as to the identity of the larvae was found when a ♀ *D. julia delia* (Fabricius) was collected later that day. Subsequent emergence of reared adults proved the larvae to be of this species.

LARVA

Head white, with three black triangular spots arranged in an "eyes and nose" pattern, the upper two triangles being inverted, and with two short black protruding spines; thoracic segments with ten spines dorsally, in two tightly-bunched rows of five each; remaining segments with six rows of long, branching, black spines. First three instars similar in color, being light brown with four transverse light bands. Fourth (and final) instar dark brown, marked transversely with a number of fine black lines and spots, and with a light brown stripe mid-dorsally; a broad white stripe laterally, branching diagonally on the fifth, seventh, ninth, and anal segments; stripe further broken by crimson red diagonals on each abdominal segment and by the aforementioned black transverse lines.

PUPA

Similar to *A. v. incarnata* in shape and color, being depressed dorsally and protruding ventrally at the wing cases, and mottled cream-gray-brown; two rows of rectangular, fin-like projections dorsally on the abdominal segments, much more prominent than the conical projections of *incarnata*. Furthermore, *delia* has silver spots in the thoracic depression.

Two of the larvae were first instar and two were second instar when first collected. The latter pupated on 3 November and yielded two females on 12 November. The other two pupated on 6 and 7 November, yielding, respectively, a male on 16 November and a female on 17 November. All of these were reared on *Passiflora incarnata* (L.), *lutea* being unavailable in Houston. A second instar larva found by Roy O. Kendall of San Antonio on 23 October pupated on 6 November and produced a female on 17 November. A mature larva collected by Joseph F. Doyle III of San Antonio on 7 November pupated on 10 November and produced a male on 19 November. Each of these was reared on the original foodplant (*P. lutea*).

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NOTES ABOUT NORTH AMERICAN BUTTERFLIES DESCRIBED
BY LINNAEUS IN THE TENTH EDITION OF
SYSTEMA NATURAE, 1758

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There are in *Systema Naturae* (Ed. X) 18 names of butterflies that today are applied to species found in the United States. Only by tracing the original collectors of the specimens upon which Linnaeus based his names can we determine with some degree of accuracy the meanings of these names. Linnaeus never left Europe. He usually was careful to cite the authority upon which he depended for the authenticity of the animals he included in *Systema Naturae*. Few of the pre-Linnaean writers upon whom he depended had visited and collected in the Americas. Slowly we are learning of the field collectors who supplied the specimens described and figured. In many instances we have concrete evidence that Linnaeus saw or had before him specimens that we would consider today to be the types of his names. In other cases we do not have this assurance.

In the cases of *troilus*, *glaucus*, *polydamas* and *vanillae* the original descriptions are followed with the initials "M. L. U.," *Musei Ludovicae Ulricaе*. These specimens Linnaeus saw at the royal palace of Drottningholm in the collection of the Queen of Sweden, wife of Adolphus Fredericus. After the death of the Queen the collection was neglected and many of the specimens of insects in it were destroyed. In 1803, King Gustaf Adolphus IV presented the remains to the Academy at Upsala, where Linnaeus had been professor. There Thunberg, student of and successor to Linnaeus, listed the material received as "Mus. Gust. Adolph." Fortunately the Swedish artist Karl Clerck painted faithful drawings of 105 species of the butterflies in the Queen's collection. This work was done under the eye of Linnaeus and was published in parts, the first in 1759 and the second in 1764. A third part exists only in manuscript. Clerck's "Icones" was prepared and published by the order of the Queen and never was released to the booksellers of the time. In 1882, P. O. C. Aurivillius published an exhaustive study of the Lepidoptera that had been in the Queen's collection. In this he indicated those names still represented by specimens, and for those the types of which have been lost, he indicated a figure that he considered typical. Unfortunately Aurivillius said nothing about the collectors responsible for the Queen's collection.

For many specimens described by Linnaeus we have following the original description references to older authors and for one particular group of these authors we do have some inkling of the collectors. We also know that Peter Kalm, a student of Linnaeus, journeyed to Pennsylvania, New York and Canada in 1747 collecting plants and some insects (Kalm, 1753). At least some of Kalm's captures were contributed to Her Majesty's collections.

The species that Linnaeus described in 1758 that now are listed from the United States fall into two groups: those that are tropical and enter our southern states and those that are truly North American. The tropical butterflies, *polydamas*, *stelenes*, *sennae*, *vanillae* and *proteus*, were described on the basis of specimens of or drawings published by Madame Merian, and, or, published by Sir Hans Sloane. Madame Merian's material was collected by herself in Surinam during her stay from 1699 to 1702. *Her Metamorphosis Insectorum Surinamensium* . . . (1705) is a sumptuous work, beautifully illustrated with water-colored copper engravings. The butterflies and their preparatory states are fairly well drawn but not accurate in delineation and detail. Many of them can be recognized with no great difficulty, others not. Sir Hans Sloane left England in 1687 for Jamaica in the West Indies where for about fifteen months he served as physician to the governor and spent most of his time studying the natural history of the island. When he arrived home he prepared a two volume work about his travels (Sloane, 1707, 1725). In the second volume he described in detail the butterflies he had collected and illustrated them with copper engravings. I found little difficulty recognizing almost all of the species he enumerated and illustrated.

Perhaps to us the most interesting are the North American butterflies that Linnaeus named in 1758. These are *troilus*, *glaucus*, *ajax*, *antiochus*, *plexippus*, *antiopa* and *euphrosyne*. Also interesting are some that he did not name at that time but for which there was reasonably good support. One of these is *turnus* which he named in 1771. It is the first species of North American butterfly that was figured. Thomas Mouffet, physician, had the honor of this "first." He published it in his *Insectorum sive Minimorum Animalium Theatrum* . . . (1634). The drawing had been made originally by John White, an artist, who was the governor of the second expedition to Virginia sent out to colonize North America by Sir Walter Raleigh. White made the drawing in July or early August of 1587. Holland published a black-and-white plate of the original drawing used by Mouffet at Plate LXXVII in the 1931 edition of his *Butterfly Book*, and gave a brief account of it pages 304-307.

Linnaeus's sources for his North American butterflies of 1758 were these: John Ray (1628–1705), James Petiver (Ca. 1663–1718), Mark Catesby (1679–1749), George Edwards (1694–1773), Queen Louisa's collection and his own.

These four authors of pre-Linnaean works on natural history form an interestingly knit circle that revolved about the dynamic Sir Hans Sloane. Of the lot, the great gatherer of "natural curiosities," as he called them, was James Petiver. We know of 79 correspondents of Petiver who supplied him with material from the West Indies and the British colonies on North America around 1700. They ranged from Hudson's Bay and the Massachusetts Bay colony to Barbados. Petiver's world-wide list of correspondents must have been many times this length. In fact, he was so busy sending out instructions for collecting and preserving natural history material that he had these printed, "*Brief Directions for the Easie Making and Preserving Collections of all Natural Curiosities for James Petiver Fellow of the Royal Society London.*" These directions have been reprinted as Appendix II of Stearns's fine biographical study of Petiver (1952).

John Ray was the oldest of the coterie. He was born in Black Notley, Essex, 29 November 1628 and died 7 January 1704/05.¹ His *Historia insectorum* . . . was published posthumously in London by Churchill in 1710. We know from letters between Ray and Petiver that the latter supplied the founder of modern natural history with plants from all of the continents but Australia. Doubtless he also contributed some insects. Linnaeus cited Ray ("*Raj. ins.*") as an authority for *Papilio ajax*, *sennae* and *plexippus*. It is quite possible that two of Petiver's correspondents in South Carolina supplied the models for Ray's descriptions. These colonial collectors were Edmund Bohun and Mde. Hannah Williams. It is as yet an unsettled point whether or not Petiver added to Ray's manuscript after Ray's death and before it was published. Martin Lister did add an appendix upon British scarabs. Ray's descriptions are not good in the modern sense, but they are not altogether bad. However, some of them misled Linnaeus as will be developed later.

Next in age is Petiver. He was born at Hillmorton, near Rugby, Warwickshire in 1663 or 1664. By 1685, Petiver was established as an apothecary in Aldersgate Street, London, where he died in 1718. No

¹ Dates written thus are Old Style. The year number in England in the Julian Calendar changed on March 25. The second of the two year numbers is the Gregorian year. The day number must be increased by 11 days to change from Julian (Old Style) to Gregorian (New Style) dates during the 18th Century and by 10 days earlier than 1700.

brief synopsis can adequately describe this man. You must read Stearns's account to get the flavor of him. Two of his published works are cited by Linnaeus: *Musei Petiveriani* . . . published in ten parts (1696–1703), and *Gazophylacii naturae* . . . also published in ten parts (1702–1711). In 1758, Linnaeus used for butterflies in which we are interested three references to the *Musei*: with *protesilaus*, *antiochus* and *plexippus*. For reasons that will be developed later I suspect that at least two of the butterflies involved depend upon the same specimens referred to in Ray's posthumous publication.

Mark Catesby, born 24 March 1682/3 at Castle Hedington, Essex, was the only one of Linnaeus's old authorities for North American butterflies who had collected the specimens himself. His *The Natural History of Carolina, Florida and the Bahama Islands* . . . was published in London by Innys. The first volume appeared in 1731, the second in 1743 and an Appendix was published in 1748. Catesby made two trips to the New World, both of them under auspices that gave him entry to the large landholders. His first voyage began on 23 April 1712. He spent almost seven years in Virginia paying a short visit to the island of Jamaica in 1714 and returning home in the autumn of 1719. He set out on his second voyage in February 1721/22 for Charles Town, South Carolina. He wandered over the seaboard of that colony until early in 1725 when he sailed to the Bahamas where he spent almost a year before returning to England in 1726. His *Natural History* was published in fascicles of 20 plates, each with text. All of Catesby's illustrations of butterflies are in color and are associated with botanical plates. His bird plates were the first to pose the birds in natural positions, a technique later exploited by Audubon who probably had been influenced by Catesby's lovely colored engravings. A full account of Catesby recently has been published (Frick and Stearns, 1961). Although Catesby adequately illustrated numerous butterflies, Linnaeus called attention to his work for only three names: *protesilaus*, *antiochus* and *plexippus*.

The youngest of the quartette, and least interesting to us, was George Edwards. He was born 3 April 1694 at Stratford in Essex. Although a painter by training, he was librarian of the Royal College of Physicians, through Sloane's appointment. He published *A Natural History of Birds* . . . in four volumes (1743–1751). Incidental to the bird illustrations are some figures of butterflies. Edwards's life carried him into the Linnaean period for he died on 23 July 1773 in Plaistow. Linnaeus's only reference to Edwards of interest to us is found under *Papilio ajax*.

THE NORTH AMERICAN BUTTERFLIES NOTED IN *Systema Naturae*, Ed. X

p. 459: "Troilus. 5. P. E. alis caudatis nigris: primoribus punctis marginalibus pallidis; posticis subtus maculis fulvis. M. L. U. *Habitat in Indiis*."

Although Linnaeus does not cite any of the pre-Linnaean authors for *troilus*, Petiver (1696–1703:51, no. 523), refers to the species. Unfortunately Clerck did not figure *troilus*. Aurivillius (1882: 12), since he did not find any specimen in the collection of Queen Louisa, designated Cramer's figure (1775–1791, 3: pl. 207, fig. B, C) as *fig. typicae*. We do not know from whom the Queen received her specimen of *troilus*. The fact that Linnaeus stated "*Habitat in Indiis*" is strong evidence that it had not been collected by Peter Kalm who supplied many of the Queen's North American specimens. It may well have been received from one of the Swedish colonists on the lower Delaware River. This would be a reasonable area to suggest for the type locality of *troilus* since it is far enough north of southern Georgia, the type locality of the southern subspecies *ilioneus* Smith. Rothschild and Jordan (1906) did not recognize *ilioneus* as a subspecies of *troilus* but considered the two names to represent the same insect. They did recognize *texana* Ehrmann as a subspecies. It is apparent from the listed localities of the material that they studied (Rothschild & Jordan, 1906: 597) that they had not seen any specimens of *ilioneus* and based their decision upon Abbot's plate (Smith, 1797, I, pl. 2) considering it somewhat exaggerated. Today *texana* is synonymized with *ilioneus*.

p. 460 "Glaucus. 9. P. E. alis subcaudatis nebulosis concoloribus: primoribus macula flava; posticis macula ani fulva. M. L. U. *Habitat in America*.
Alae Posticae Linea transversa fusca bifida; ceterum Troilo similis."

Linnaeus "America" is as vague as it reads. Without reference given to the older authors it appears that Linnaeus felt this species had not previously been known. Clerck's figure (1764, II, pl. 24, fig. 1) fixes the name upon the dark female form of the butterfly later (1771) named *turnus* by Linnaeus. Although Mouffet, Petiver, Ray and Catesby all had figured *turnus*, no mention of these pre-Linnaean authors is associated with its original description. In the *Systema* (Ed. X) Linnaeus referred Petiver's and Catesby's figures to *antilocheus* (see discussion under that name, below). A fitting type locality for *glaucus* is not easily suggested since we do not know from whom Queen Louisa received her specimens. For *turnus* Linnaeus stated "*Habitat in America*. D. Fabricius," meaning from America in the collection of Fabricius. This suggests strongly that Fabricius had acquired the specimen from one of his English friends while living in England during the late 1760's.

The collector could not have been Abbot, who sailed from the New World in 1773. The Scottish surgeon Hunter had visited Charleston, South Carolina, and had collected butterflies there in the early 1760's and Fabricius had visited with him. Thus it is possible that the type of *turnus* came from the vicinity of Charleston. Linnaeus's descriptions in the animal appendix to his *Mantissa Plantarum* are much better than those in the *Systema* (Ed. X) and there is no question about the determination of *turnus*. Thus between Clerck's figure of *glaucus* and this good description the "species" *glaucus* is well founded, although the species takes its name from the restricted female form.

p. 460 Polydamas. 11. P. E. alis dentatis nigris fascia interrupta flava, posticis subtus rubro notatis. M. L. U. Merian. sur. 31, t. 31 Habitat in Hibisco mutabili Americis.

Alae supra fascia lutea e maculis parallelis sagittatis; Posticarum margo subtus maculis 7, linearibus, flexuosis (3), coccineis.

Linnaeus's description and the Merian figure are in conflict. They refer not only to two species but to two different types of *Papilio*. Madame Merian's figure, which includes drawings of the male, female, larva and pupa, clearly represents the species later called *androgeus* by Cramer. To this also may be referred the statement that the "habitat" is "Hibisco mutabili." Sloane figured the Jamaican subspecies of *polydamas* (1725, II: pl. 239, figs. 19, 20), not well, but recognizably. Since Linnaeus was familiar with Sloane's books it is curious that he did not refer to this figure if he meant by *polydamas* what we mean today. Klotz's statement (p. 180) that the type locality for *polydamas* is Cuba follows Rothschild and Jordan and is highly questionable. The Cuban form is somewhat different from that found on the mainland and forms a link between the uniform pattern expressed from Mexico southward to Argentina and the great variety of insular subspecies found in the West Indies. A much more reasonable type locality, in the light of history, is Surinam, the source of so much pre-Linnaean Neotropical material. Unfortunately Clerck did not figure this species. If he had, we would at least know if Queen Louisa's specimen was from the mainland or the islands.

p. 462 Ajax. 26. P. E. alis obtuse caudatis concoloribus fuscis: fasciis flaviscentibus, angulo ani fulvo. Raj. ins. 111. n. 2. Edw. av. 34. Habitat in America boreali.

Linnaeus's brief description and the two conflicting references have caused this name to be applied to two totally different *Papilio*, the one later called *polyxenes* by Fabricius and the other later called *marcellus* by Cramer. Linnaeus's definition of the name describes a tailed *Papilio* with uniformly dark wings across which are bands of yellowish and

with a fulvous anal spot on the hind wing. Ray's description, the first citation in the original description, appears to represent the yellow form of *glaucus* from Virginia. Ray further referred to Mouffet's *Theatrum*, p. 98, where is figured John White's drawing of the butterfly. This species lacks the "angulo ani fulvo." The Edwards figure is a good representation of *marcellus* Cramer. On it the "angulo ani" is bright red, not fulvous. Since Linnaeus referred other drawings and description of *marcellus* to his *protesilaus*, he may have made the mistake suggested by Rothschild and Jordan (1906: 687), and placed the Edwards's reference with *ajax* in error. Aurivillius (1882: 30, 31) pointed out that Linnaeus's description of *protesilaus* might be applied to several species and that Linnaeus (1764: 209) segregated "Varietas α " for which Aurivillius gave Edwards's figure as the "fig. typica" and included in the synonymy some twenty-two uses of the name *ajax* in this respect. Two of these are Linnaeus's use of *ajax* in *Systema Naturae* Ed. X and Ed. XII, in both cases followed by a query, (?). Later in his account (1882: 178) Aurivillius synonymized *ajax* with *polyxenes* Fabricius, and pointed out that this is the insect represented as *ajax* on Clerck's plate 33, figure 3 in volume II. Since these drawings were made under Linnaeus' supervision, such assignment of the name must have satisfied him. Curiously, Aurivillius here nominated Abbot's figure (in Smith, 1797, I, pl. 1) as "fig. typicae" although Smith erroneously called the butterfly *troilus*. Actually, if any figure was to be so named it should have been Clerck's. With three species represented by the original description of *ajax* (*turnus* Linnaeus, *polyxenes* Fabricius and *marcellus* Cramer) the International Commission on Zoological Nomenclature settled the problem in Opinion 286 (12 October 1954) by declaring the name *ajax* Linnaeus 1758 suppressed for purposes of priority but not for homonymy. Thus this name has disappeared from our check-lists except in the synonymy. The involved arguments for this action were set forth clearly by Rothschild and Jordan in 1906 but almost fifty years passed before their action passing over the 1758 name was sanctioned by the Commission.

- p. 463 *Protesilaus* 29. P. E. alis caudatis subconcoloribus albidis: fasciis fuscis: unica subtus sanguinae, angulo ani rubio. *Pet. mus.* 50. n. 502. *Sloan. jam.* 2 p. 218. t. 239. f. 1, 2. *Mer. surin.* 43. t. 43. *Seb. mus.* 1, t. 11. f. 2. *Catesb. car.* 2, t. 100. *Habitat in America septentrionali.*
Simillimus Podalirio *Europae australis & Africae; an satis diversus?*

The insect that now goes under the name *protesilaus* is not found in North America but must be mentioned. The Linnaean description can be applied to any of the white kite-tailed *Papilio*s of the American tropics

(now generally assigned to the genus *Graphium* Scopoli, 1777). None of these enter North America ("America septentrionali"). The fact that Linnaeus described the wings as white and was doubtful that the species differed from *podalirius*, which he described in a footnote on page 463, eliminates what now is called *marcellus* Cramer. In this footnote Linnaeus used the differences found in the larvae to support his designation of two species, *podalirius* and *protesilaus*. Of the five pre-Linnaean references cited, Petiver's refers to *marcellus* Cramer, Sloane's to *marcellinus* Doubleday, Merian's to what we now call *protesilaus* Linnaeus, Seba's to a species of Nymphalid in *Marpesia* Huebner 1818, and Catesby's to *marcellus*. Of these citations only Merian's applies to *protesilaus* in the modern sense, and thus Surinam is suggested as the type locality, in spite of Linnaeus's statement that the butterfly is found in North America. Aurivillius (1882: 29-30) nominated Clerck's figure (1764, II, pl. 27, f. 2) as "fig. typica." since he could not find a specimen in the Queen's collection. This figure is the basis for our current application of the name *protesilaus* and coincides with Linnaeus's *protesilaus* of 1764. Rothschild and Jordan (1906: 713) point out that there is preserved in the Linnaean collection at the Linnaean Society of London a specimen without abdomen that "agrees fairly well with Clerck's figure." This specimen should be considered the type of the name *protesilaus* Linnaeus 1758, although it was not until 1764 that Linnaeus published a description that adequately defined the name.

- p. 463 *Antilochus*. 28. P. E. alis caudatis concoloribus flavis: fasciis margineque nigris, caudis albis longitudine alae. *Pet. mus.* 50. n. 505. *Papilio* caudatus maximus, striis umbrisque nigris. *Catesb. carol.* 2. t. 83. *Habitat in America septentrionali*.

This is the name that should be applied to the yellow form of *glaucus*! It has been relegated to synonymy because Linnaeus was misled by Petiver and in the original description said "caudis albis longitudine alae" thus mixing a not too bad description of the wings of the yellow form of *glaucus* with a less accurate description of the tails of *marcellus*. Catesby's figure that is cited is recognizably a male *glaucus*, or the *turnus* form of the female, with extraordinary tails. As late as 1836 *antilochus* was accepted as a good species from North America. Then Boisduval (1836: 340) wrote "... aussi nous sommes portés à croire que cet *Antilochus* pourrait bien être un *Turnus* dont les queues auraient été artificielles.", thus suggesting that *antilochus* is an artificial species. Aurivillius (1882: 28) called *antilochus* "Species fictitia" believing Linnaeus misled by Catesby. In his *Museum Ludovicae Ulricaе*, (1764: 207), Linnaeus stated that the specimen was collected by Peter Kalm

in North America. Aurivillius could find only male *glaucus* in the Queen's collection.

p. 471 *Plexippus* 80. P. D. alis integerrimis fulvis: venis nigris dilatatis, margine nigro punctis albis. *Pet. mus.* 58. n. 527. *Sloan. jam.* 2. p. 214, t. 239, f. 5, 6. *Catesb. car.* 2. t. 88. *Raj. ins.* 138. n. 3. *Habitat* in America septentrionali. *Alae primores fascia alba, ut in sequente, cui similis.*

The confusion about *plexippus* has been caused by the line added as an appendix to the description. The species that follows *plexippus* is *chrysippus* of which Linnaeus said "*Habitat* in Aegypto, America." and described "P. D. alis integerrimis fulvis margine nigro punctis albis, posticis disco punctis nigris." *Danaus chrysippus* vaguely resembles *gilippus* Cramer with three largish black spots on the disc of the hind wings, which wings are much yellower than on *gilippus*, and with a rather broad, white, subapical transverse bar on the fore wings. The "fascia alba" is not mentioned in the original description of either *plexippus* or *chrysippus*. It is appended to that of *plexippus* and there also directed to *chrysippus*. In the case of *plexippus*, Linnaeus obviously described the North American "Monarch" and referred consistently to it. Then, apparently he saw either what was later called *megalippe* by Huebner from the American tropics, or *genutia* Cramer from the Orient, possibly both. Considering all of these the same species, he had to add the "fascia alba." Similarly he appears to first have described *gilippus*, and then included the "fascia alba" statement to *plexippus* in such a way that his description of *chrysippus* unsatisfactorily covered both *gilippus* and *chrysippus*. The only representative of the *plexippus-genutia* confusion to be found in Linnaeus's own collection is *genutia* labeled *plexippus*. But, we do not know if this was so in Linnaeus's day. A librarian who had charge of the collection after it had been acquired by the Linnean Society of London added specimens and is suspected of having shifted labels. Thus the question cannot be settled by reference to Linnean specimens. Aurivillius (1882: 70) quoting from Linnaeus's notes made when Linnaeus first studied the Queen's collection in 1751 shows that the basis for the 1758 description in the *Systema* was material collected by Peter Kalm in North America (probably Pennsylvania.) He further argued that the emendation made in the *Systema* fixes the name upon the Oriental species. The resultant confusion about the proper application of the name *plexippus* was settled by action of the International Commission on Zoological Nomenclature in Opinion 282 (1 October 1954). There the name is defined by a neotype, the model of Clark's 1941, pl. 71, fig. 1, a male "Monarch," with the type locality fixed as Pennsylvania. This reverts to Linnaeus's original

use of the name *plexippus*. Mr. N. D. Riley, emeritus Keeper of Lepidoptera, British Museum (N.H.), has written me that the Petiver specimen, collected around 1700, is preserved in the museum. It is the North American Monarch. We both wish that it had been designated the type since it is referred to by Linnaeus in the original description.

pp. 476–7 *Antiopa*. 112. P. N. alis angulatis nigris limbo albedo. [six pre-Linnaean references to the insect in Europe are omitted here.] *Habitat in Betula, Salice, etiam in Americae. Kalm.*

There is no question that Linnaeus here is referring to the Mourning Cloak, or Camberwell Beauty. It is interesting that Peter Kalm brought back to Sweden specimens of *antiopa* and that these were used, in part, as the basis of the original description. The type locality for *antiopa* is generally considered to be Upsala, Sweden, where Linnaeus was at work upon his systems of classification. Interestingly, there was no *antiopa* in the Queen's collection. It probably was too plebian to be included!

p. 481 *Euphrosyne*. 142. P. N. alis dentatis fulvis nigro-maculatis: subtus maculis IX argenteis. *Fn. svec.* 782 *Princeps. Pet. mus.* 35. n. 382. *Raj. ins.* 120. n. 7. *Habitat in Europa & America septentrionali. Alae maculis argenteis: posticarum 9: harum 1 disci, 1 baseos.*

The meaning of this name is set by Linnaeus's inclusion of what he had called *Princeps* in his "pre-Linnaean" *Fauna Suecica*, published in 1746. The type locality for *euphrosyne* is Upsala, according to Langer (1957: 200). No subspecies of *euphrosyne* is found in North America. To what did Linnaeus refer when he included "*America septentrionali*" in the distribution of the species? By the time that Linnaeus wrote the 10th edition of the *Systema* he had seen the material brought back by Peter Kalm. This had been collected within the range of *Boloria selene* subspecies and of *Boloria bellona* Fabricius.² Of these only *selene myrina* Cramer or *selene atrostalis* Huard can be considered. The fact that Linnaeus did not include *euphrosyne* in his 1764 book upon the Queen's collection suggests that Kalm may not have collected the material referred to as North American. However, there is a reference to *Papilio euphrosyne* in Kalm's "Travels" (vol. 1, p. 264, Dover Edition, 1966). Under the date March 24, 1749, he noted seeing the species on a walk near Raccoon (now Swedesboro, Gloucester Co.), New Jersey, where he then was living. Petiver's insect may have been the European species or it may have been collected by Hezekiah Usher of the Massachusetts Bay Colony in 1696. If the latter, then Petiver's reference would apply to *selene myrina*. Ray's description may have been based upon Petiver's

² This name must be restored in place of *toddi* Holland. Opinion 517 of ICZN gives Fabricius 1775 priority over Cramer [1775].

material. The under hind wing of *euphrosyne* from Scandinavia bears nine silvered spots and across the disc and at the base some additional white ones. On *selene* and its allies some of the white spots seen on *euphrosyne* tend toward silvering and there are additional white spots in the limbal zone near the costa. The two probably are close enough in appearance so that Linnaeus was not bothered by the slight differences when he grouped the two together. The fact that he never recognized *selene*, although that species is not uncommon in Scandinavia, tends to support his use of *euphrosyne* for both species.

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A DISTRIBUTIONAL ANALYSIS OF THE BUTTERFLIES OF CONTRA COSTA COUNTY, CALIFORNIA

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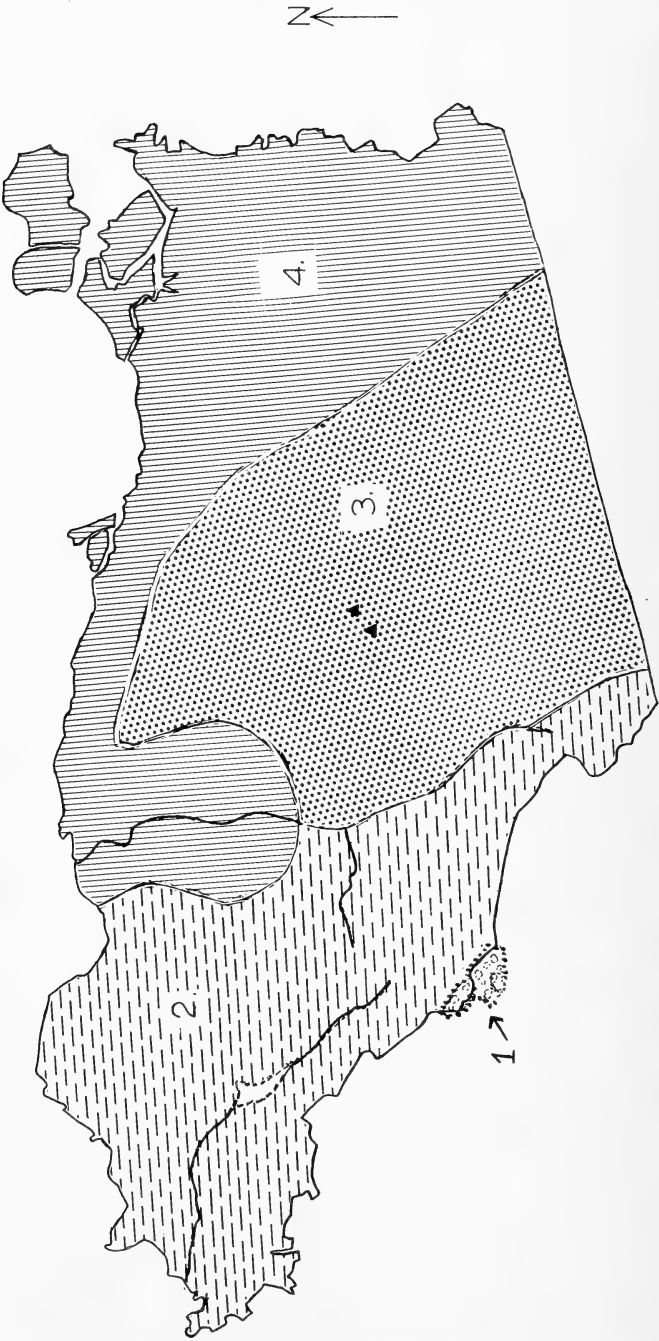
This paper presents geographic and seasonal features of the distribution of the 84 species of butterflies which have been found to occur in Contra Costa County, California. The rhopaloceran fauna of this county is perhaps as well known as that of any other California county due to its proximity to a large population center. A large number of available field records from local collectors has contributed to the completeness of this presentation.

Contra Costa County lies just to the east of San Francisco Bay in central California and is approximately rectangular in outline. It extends about 45 miles from east to west and 20 miles from north to south. The county is an area of low ranges which generally range from 500 to 2000 feet in elevation and whose ridges are oriented along north-south axes. Mt. Diablo (3849') stands at the center of the county and dominates the surrounding landscape. Several valleys run between the ranges, while the eastern third of the county is a plain leading from the foothills of the Diablo Range toward the Central Valley.

The northern boundary of the county is formed by the combined waters of the Sacramento and San Joaquin Rivers whose waters combine and flow to the west to San Francisco Bay through a major gap in the Coast Ranges.

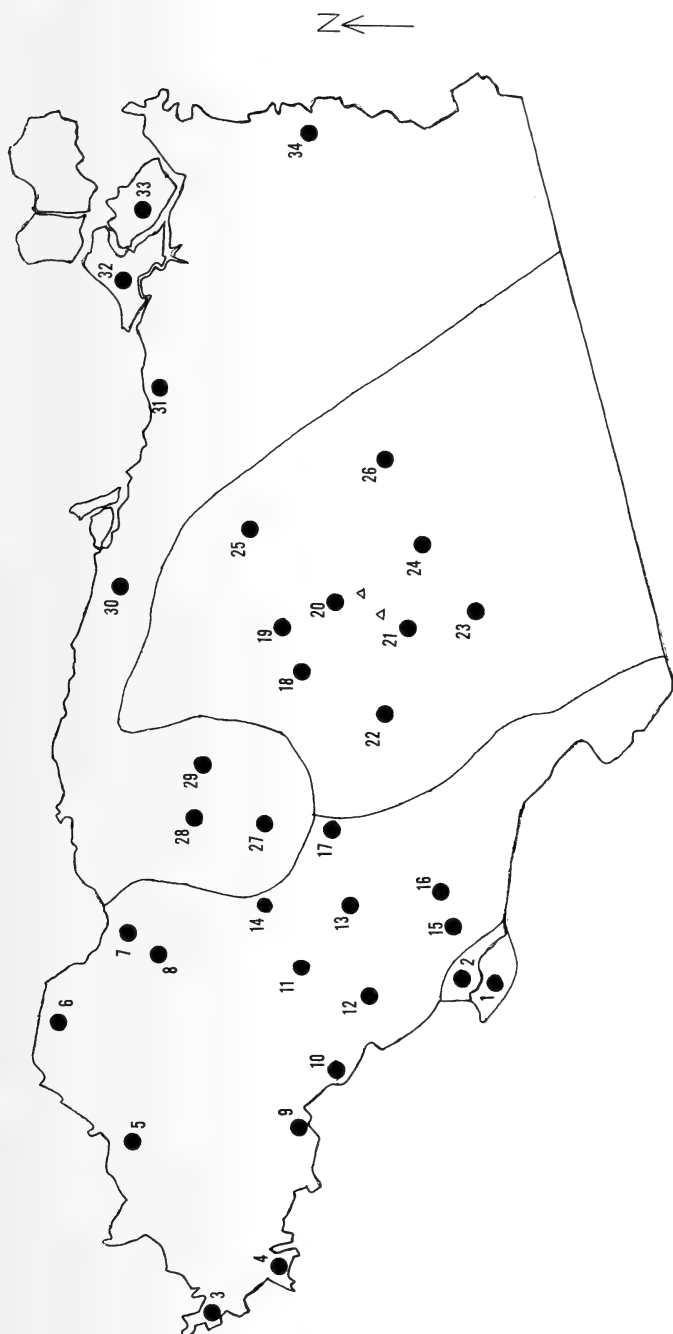
The county possesses a typical Mediterranean climate. The winters are cool and wet while the summers are hot and dry. The rainfall characteristics of the county can be seen by referring to Map 3. The marine influence of breezes and summer fogs from the west moderates temperatures in the western portion of the county. Winter and summer temperature extremes are increasingly greater as one proceeds across the county to the east. The number of days between killing frosts (growing season) varies from 330 days near the bay to 270 days in the eastern portion of the county.

For a detailed description of the topography of the region the reader is referred to Howard (1962), while a discussion of the climatic factors affecting the region is now available (Gilliam, 1966). Excellent dis-



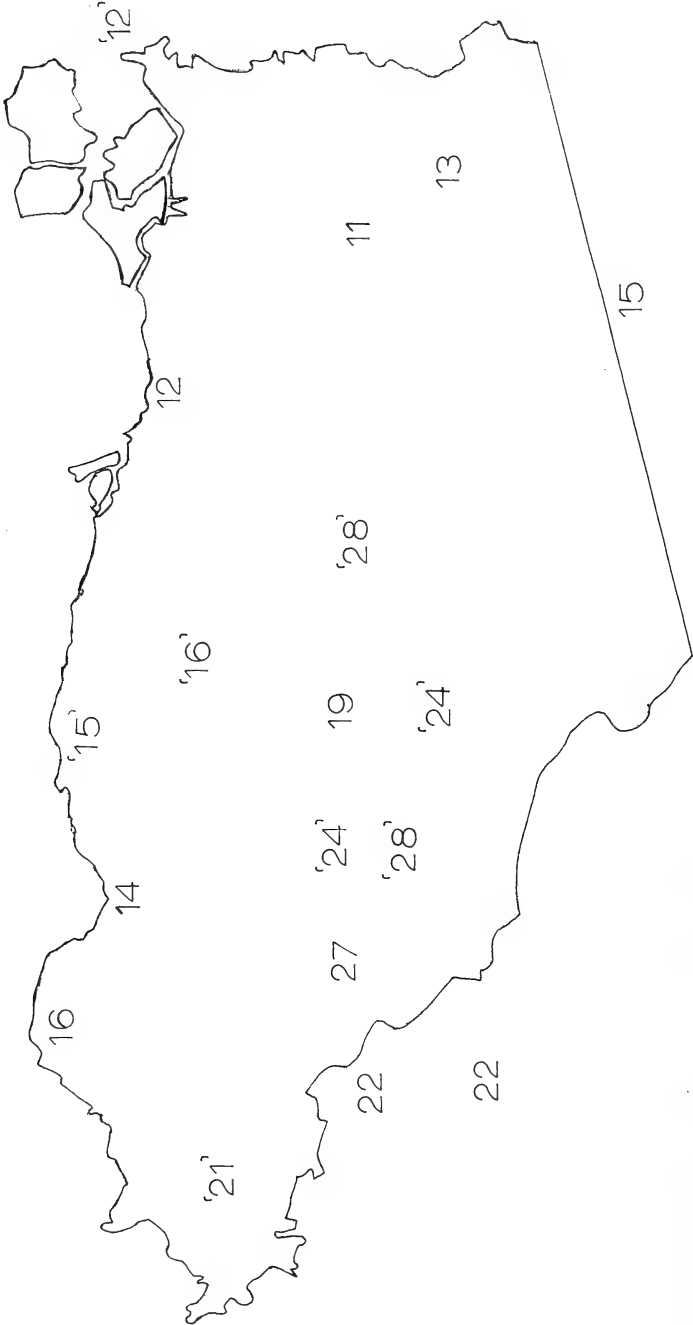
MAP 1

Regions of Contra Costa County. 1. Redwood Association. 2. Outer Coast Range. 3. Inner Coast Range. 4. Valley and Delta.



MAP 2

Collecting localities. 1. Redwood Regional Park. 2. Canyon. 3. Point San Pablo. 4. Point Richmond. 5. Pinole. 6. Crockett. 7. Martinez. 8. Franklin Canyon. 9. El Cerrito and Kensington. 10. Tilden Regional Park. 11. Bear Creek. 12. Orinda. 13. Lafayette. 14. Briones Hills. 15. Moraga. 16. Saint Mary's College. 17. Walnut Creek. 18. Mitchell Canyon. 19. Clayton. 20. Russelmann Park. 21. Mount Diablo State Park. 22. Castle Rock Park (lower Pine Canyon). 23. Blackhawk Ranch. 24. Tassajara Creek. 25. Somersville. 26. Marsh Creek. 27. Pleasant Hill. 28. Pacheco. 29. Concord. 30. Pittsburg. 31. sand dunes east of Antioch. 32. Jersey Island. 33. Bethel Island. 34. Norwood Road (east of Brentwood).



MAP 3

Average annual precipitation for various points within Contra Costa County. Figures in quotes are interpolations from different sources.

cussions of the faunal and floral relationships within the state are to be found in Jepson (1951), Munz and Keck (1959), and Miller (1951). The scientific names for plants follow the usage of Munz and Keck (1959).

Tilden (1965) has enumerated the species of Rhopalocera known from the greater San Francisco Bay region; however, the audience for which his book was intended did not require a detailed distributional analysis of the species involved.

The butterfly fauna of the central coast ranges, from Lake and Sonoma counties south to San Luis Obispo County, the Central Valley of California, and that of the lower western foothills of the Sierra Nevada, is similar enough to segments of the fauna of this county, that principles brought out by this paper should apply to those areas as well.

Williams and Grinnell (1905) were first to report on butterflies of the county. They reported 17 species which were collected on a six day trek from Oakland to Mt. Diablo in 1905. Comstock (1938) described *Apodemia mormo langei* from individuals collected near Antioch, and in 1938, Field described *Habrodais grunus lorquini* from specimens which had been collected on Mt. Diablo. Langston (1964) included a large number of individuals of *Philotes enoptes bayensis* from Pt. Richmond as paratypes in his original description of that subspecies. The possibility exists that some of the Lorquin material from California, which served as types for the many species described by Boisduval and Lucas, was collected in the county.

METHODS

Collection of data: The bulk of the field records presented in this paper are from the field notebooks of Opler, the senior author (1953 to 1965) and Langston, the junior author (1949 to 1965). These notes include sight records for common species. Additional records which were invaluable to this study were taken from the personal collections or notebooks of R. W. Brown, Martinez; T. W. Davies, San Leandro; C. D. MacNeill, El Cerrito; J. A. Powell, Walnut Creek; and G. A. Samuelson (collection now held by F. S. Ruth, Walnut Creek). Data from specimens in the California Insect Survey, University of California, Berkeley, were also utilized. Data cited in the treatment of the genus *Erynnis* by Burns (1964) and in the revision of the genus *Hesperia* by MacNeill (1964) were also incorporated.

Presentation of data: To facilitate the presentation of data for the temporal distribution, each month of the year was divided into three ten day periods (the last period of months not having exactly thirty days is 8, 9, or 11 days). The numbers which appear in these time

Month Species	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
L.eufaila						1	1 2 5 9				
P.melane			2 3 2 15 13 14		7 4 1	1	2 3 3 2 5	4 1 1			
O.sylvanoides					1	3 3 2	8 10 12 14	4 7 3 2			
O.agricola				1 6	9 6 8	2 2					
O.yuma					1	3	1 6 9				
A.campestris			1			2	3 3 1 1				
P.sabuleti			2 2	3 3 2	3	2 4	2 3 3	5 8 5 4	5	1	
H.h.dodgii							1 1 3 2				
H.lindseyi			1 1 5	2 1 4 3	1 1 1						
H.columbia			1								
H.juba			1								
H.phyleus	1		1 4 3 4 4		3 4 7	5 2 4	4 6 12 16 15 10	6 8 11	6 6 6 4 1		
P.catullus			1	1 1 1	1 1 1	3	2 5				
H.ericetorum				1 1			2 2				
P.scriptura			1 5 1 2	1 2 1	1 3 2		2 2 5 1				
P.c.communis	1		2 1 1 2 4 1		4 6 6 1 1	1 1 1 9 5 6 1	1 3 5 3 1 2 1				
E.persius							1				
E.tristis			2 1 6 4 2 3 1 2		2 2 1	1 1 2 3 4 3 5 4	1				
E.properthus	2	1 2 4 12 6 3 9 1			1	1					
B.p.hirsuta		3 3 5 17 6 5 10 4 13 7 5 6 4			6 4	2 1 2 4 2 1	4 1	2			
P.zelicaon	1	2 4 5 8 6 4 2 3 9 5 7 5 2			7 5 2	2 4 5 4 1 2					
P.rutulus		2 5 15 9 12 16 20 17 16 21 7 10 2 5 2 4 11 8 2			2 1 2 2 2 2 1						
P.multicaudata			2 1 2 5 8 4 3 2 2 2 1 1								
P.eurymedon			1	6 4 7 7 8 3 2 2							
P.protodice	1			2 1	1	1	1 2 4 7 1				
P.n.venosa		3 2 1 3 5 4		2 1							
gen.castoria				3 1							
P.rapae	4 14 17 23 24 28 26 11 11 14 20 32 37 19 15 19 6 8 4 9 13 13 16 7 5 7 7 4 3 1				2						
C.eurythema	1 1 2 4 8 10 11 9 4 7 13 16 23 11 4 8				4 8	4 1 2 8 9 13 9 12 10 3 2 1					
C.eurydice				1	1						
A.sara				2 7 5 5 1							
gen.reakirtii	2 2 6 10 17 13 7 11 4 3										

CHART 1

Seasonal distribution of Contra Costa County butterflies (one of three). Records for January and December 21-31 are not included.

periods for each species on Charts 1, 2, and 3 represent the total number of day-locality collections (or observations) which are represented by the collected data. For example, single specimens of a species collected at two localities on the same day would add two to the number; whereas, a species collected in series at one locality during a given day was counted as one.

The number of collected individuals is not accounted for in this paper. Such information is generally lacking in the field notebooks; also, undue bias would be added as common species would be represented by lower numbers relative to their actual abundance. Finally, distortion of the representation of the flight periods of many species would have resulted.

The spatial distribution of butterflies within the county has been treated by dividing the county into four regions which are represented on Map 1 as 1. Redwood Association, 2. Outer Coast Range, 3. Inner Coast Range, and 4. Valley and Delta. Although the mountainous areas of the county all belong to the Mt. Diablo Range fault block complex (Howard, 1962), the presence of the broad alluvial valley of the Walnut Creek drainage (see Map 2) and the occurrence of steep temperature and moisture gradients across the county supports the division of the first three regions. The fourth region is one of recent alluvial desposits and is biotically allied to the central valley of California. These divisions were made on the basis of topographic features and the distribution of plants with the county. The boundaries of the last three regions have a geomorphic basis, while the boundary of the first, *i.e.* Redwood Association, is floral. This inconsistency is justified by the fact that the Redwood Association forms an easily recognizable and continuous unit within the county.

Within the framework described above, 34 localities were chosen to represent all points where butterflies had been collected within the county (see Map 2). Collecting sites in the vicinity of each of these localities were treated with the closest plotted locality. If a species was collected (or observed) at a locality its presence there is indicated by an "X" in the appropriate space on Chart 4 or 5. Variability in abundance of a species at each locality is not considered nor is the fact that the food plants of several species do not occur in some of the localities where the butterflies have been recorded.

Bias: Since only presence or absence at a locality or on a given group of collecting days is taken into account, the only significant bias in the data herein presented is due to the distribution of sampling efforts, both in the temporal and geographic senses. It will be noted that many

Month Species	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
A.lanceolata				1							
E.ausonides	6	5 15	19 24	6 5	2 3 19 13	3 2 2 1					
A.m.mormo							1				
A.m.langei						1	2 8 7	8 2 1			
H.g.lorquini											
A.halesus				2 1 3	1 1 1 1	1 1	1 1	1 1	1		
C.spinetorum		1	1	1	1 2		1				
C.n.muiiri			3 1	4 2							
C.roides		2 1 3	8 7 7	9 3 8	3 1						
C.dumetorum		1 2 3	2 2 3								
S.melinus	1	2 3 6	2 7	2 1 4	9 7 4	5 2 4 1	1 13 9 6	1			
S.californica					1						
S.dryope					2 4	1					
S.auretorum					1						
S.adenostomat.					1 1 3	1 1					
S.saeptum					1 1 1 2 5	3 3					
L.arota					2 1 2 1 1						
L.gorgon					2 3 7 8	2 5 1 1					
L.xanthoides					1 2 14 12 11	13 2 1					
L.hellorides	1	7 1	1	2 6 5 7	2 7 1 3		1 6 3 9 1	3 3 2 1			
B.exilis			1			2	1 3 6 3	2 4 1			
L.marina							2				
H.isola							1				
L.pardalis			1 1 1	4 2 2							
L.acmon			1 4 2	6 3 19 17	11 9	8 3 6 2 5	9 5 3 1	5			
gen"cottlei"	1	2 2 5 5	8 6	1							
E.comyntas		1 1	1	1	3 4 2 1		1 1	2 1			
P.bayensis		2 5 5 12	3 1 2	2 3 6 10 7	3 3 2 1						
G.behrii	4	6 8 6 14	6 4	2 3 6 10 7	3 3 2 1						
C.aeolus											
L.lorquini			1 2 1	14 6 10	7 6 4 6 3 8	3 4 5 4 4 2 1 2					
L.b.californica				4 4 8	7 6 3 2 2	1 2 6 4 1					

CHART 2

Seasonal distribution of Contra Costa County butterflies (two of three).

apparent gaps exist in the temporal distributions of several species for the months of July and August. During this time many collectors are away from the area, and at this time collecting in the area is poor due to drought conditions. Certain localities have been visited primarily during characteristic time for "desirable" species, e.g. late August-mid-September in the River and Delta region for *Ochlodes yuma* and *Apodemia mormo langei*.

SPECIES COMPOSITION

The names used in this paper were taken from dos Passos (1964) with the exception of the names for members of the genus *Hesperia* (MacNeill, 1964) and the names for the Theclini and Lycaenini (Clench, 1961). A complete list of names and authors for the butterflies found in the county is presented below.

HESPERIIDAE

Lerodea eufala (Edw.)
Paratrytone melane (Edw.)
Ochlodes sylvanoides (Bdv.)
Ochlodes agricola (Bdv.)
Ochlodes yuma (Edw.)
Atalopedes campestris (Bdv.)
Polites sabuleti (Bdv.)
Hesperia harpalus dodgei (Bell)
Hesperia lindseyi Holland
Hesperia columbia (Scudder)
Hesperia juba (Scudder)
Hylephila phyleus (Drury)
Pholisora catullus (Fabr.)
Heliopetes ericetorum (Bdv.)
Pyrgus scriptura (Bdv.)
Pyrgus communis (Grote)
Erynnis persius (Scudder)
Erynnis tristis (Bdv.)
Erynnis propertius (Scudder and Burgess)
Erynnis brizo lacustra (Wright)

PAPILIONIDAE

Battus philenor hirsuta (Skinner)
Papilio zelicaon Lucas
Papilio rutulus Lucas
Papilio multicaudata (Peale M.S.) Kirby
Papilio eurymedon Lucas

PIERIDAE

Pieris protodice Bdv. and LeConte
Pieris napi venosa Scudder
 gen. aest. *castoria* Reak.
Pieris rapae (L.)

Colias eurytheme Bdv.
Colias eurydice Bdv.
Anthocaris sara Lucas
 gen. vern. *reakirtii* Edw.
Anthocaris lanceolata Lucas
Euchloe ausonides Lucas

LYCAENIDAE

Apodemia mormo mormo (F. & F.)
Apodemia mormo langei J. A. Comst.
Habrodais grunus lorquini Field
Satyrium auretorum (Bdv.)
Satyrium saepium (Bdv.)
Satyrium adenostomatis (H. Edw.)
Satyrium californica (Edw.)
Satyrium dryope (Edw.)
Callophrys augustinus iroides (Bdv.)
Callophrys nelsoni muii (H. Edw.)
Callophrys spinetorum (Hew.)
Callophrys dumetorum (Bdv.)
Altides halesus estesi Clench
Strymon melinus Hbn.
Lycaena arota (Bdv.)
Lycaena gorgon (Bdv.)
Lycaena xanthoides (Bdv.)
Lycaena helloides (Bdv.)
Brephidium exilis (Bdv.)
Leptotes marina (Reak.)
Hemiargus isola (Reak.)
Plebejus icarioides pardalis (Behr)
Plebejus acmon (West. & Hew.)
 gen. vern. "cottlei" (Grinnell)
Everes comyntas (God.)
Philotes enoptes bayensis Langston
Glaucopsyche lygdamus behrii (Edw.)
Celastrina argiolus echo (Edw.)

NYMPHALIDAE

Limenitis lorquini (Bdv.)
Limenitis bredowii californica (Butler)
Vanessa atalanta (L.)
Vanessa virginiensis (Drury)
Vanessa cardui (L.)
Vanessa carye Hbn.
Junonia coenia (Hbn.)
Nymphalis californica (Bdv.)
Nymphalis antiopa (L.)
Polygonia satyrus (Edw.)
Polygonia oreas silenus (Edw.)
Phyciodes mylitta (Edw.)
Phyciodes campestris (Behr)
Melitaea palla Bdv.

Melitaea leanira F. & F.
Euphydryas chalcedona (Dblly)
Euphydryas editha bayensis Sternitzky
Speyeria coronis (Behr)
Speyeria zerene ssp.
Speyeria callippe (Bdv.)
Agraulis vanillae incarnata (Riley)

DANAIDAE

Danaus plexippus (L.)

SATYRIDAE

Coenonympha californica West.
Cercyonis pegala ariane (Bdv.)
Cercyonis silvestris (Edw.)

Williams and Grinnell (1905) reported *Thorybes pylades*, *Erynnis juvenalis*, and *Scolitantides piasus* from Contra Costa County. MacNeill (personal communication) reports that *T. pylades* most likely occurs in the vicinity of Canyon. The other species may be misidentifications of *Erynnis propertius* and *Celastrina argiolus echo*, two species that should have been common at the time of Williams and Grinnell's trip, but were not reported. Tilden (personal communication) has mentioned that Robert Wind took specimens of *Polygonia faunus rusticus* in the Berkeley Hills some years ago. It will be of interest to find authentic specimens of *T. pylades* and *P. faunus* from the county.

GEOGRAPHIC DISTRIBUTION

Thirty-eight species (46%) are found either in all four regions of the county or are essentially general in distribution throughout the county. A single asterisk indicates species known to be highly vagile or whose distribution within the county is not properly represented by collected adults. A double asterisk indicates species whose native foodplants are found throughout the county. *O. sylvanoides***, *P. sabuleti*, *H. juba**, *H. phyleus*, *H. ericetorum**, *P. communis*, *E. tristis***, *B. p. hirsuta**, *P. zelicaon*, *P. rutulus*, *P. protodice*, *P. rapae*, *C. eurytheme*, *C. eurydice**, *E. ausonides*, *A. halesus***, *C. dumetorum***, *S. melinus*, *S. dryope***, *L. xanthoides*, *L. helloides*, *B. exilis*, *I. acmon*, *L. lorquini***, *L. b. californica***, *V. atalanta***, *V. virginiensis*, *V. cardui*, *V. carye*, *J. coenia*, *N. californica**, *N. antiopa***, *P. satyrus***, *P. mylitta*, *P. campestris*, *A. v. incarnata*, *D. plexippus**, *C. californica*.

The other 46 species (54%) are in some way restricted within the county. These species are listed below in several categories according to the degree in which they are restricted.

Redwood Association (2 species): *S. coronis*, and *P. o. silenus*.

Month	FEB			MAR			APR			MAY			JUN			JUL			AUG			SEP			OCT			NOV			DEC		
Species																																	
Vatalanta	2	1	1	1	1	2	2	2	2	2	2	1	5					1	2	1	1	2	4										
V.virginianis						1	1	1	1	2	1	3	1	1	3	1		1	1	2	1	5											
V.candui		1	1	3	3	1	2	7	1	3	4	2	2	1	2		1	2	2	1	3	2	1	2	2	2	2						
V.carye	7	11	13	16	15	21	21	20	10	15	18	22	28	13	9	10	7	2	4	11	6	7	4	6	6	7	2	6					
J.coenia	2		3	2		1	1			4	4	5	12	8	5	8	1	4															
S.californica		1	1	8	5	5	3	6	1				2	3	2																		
Nantiopa	4	5	8	11	8	8	1	3	1	3	5	13	12	10	2	4	2				1	2	1	3		2							
Psatyrus	1	1	2	3	3	1	4	2	1			1		2	1	4																	
P.silanus			1		1								1																				
P.mylitta			3	6	10	9	9	7		4	1	11	17	9	9	4	2	5	1	3	4	4	4	1	8	3	5						
P.campestris							1		1	1	1	3	3		2	3	2	3	1	4	1	1	6	3	2	2							
M.palla							3	1	3	10	6	9	5	3																			
M.leanira										2	4	1	1																				
E.chalcedona							1	1	11	12	25	12	13	8	3	3																	
E.e.bayensis						1	1	2	3	4	5	2	2	1																			
S.coronis												1	2																				
S.zerene ssp.															1																		
S.callippe											2	5	3	4	1	1																	
A.vanillae	4	3	2			1		2				3				6		1	1	2	5	4	9	7	8	8	1	3	3	5	7		
D.plexippus	1	1	3	3	4	8	14	5	10	5	9	9	14	5	5	5	1	4	3	2	11	11	17	10	11	9	11	6	4	4	1	2	
C.california				2	2	10	14		10	21	21	24	25	19	7	5	2	4	3	4	12	8	9	2	5	4							
C.boopis												1	9	13	14	13	4	4															
C.silvestris													3	3	2	3	2																

CHART 3

Seasonal distribution of Contra Costa County butterflies (three of three).

Outer Coast Range (4 species): *H. harpalus dodgei*, *P. e. bayensis*, *S. zerene* ssp., and *C. p. ariane*.

Redwood Association and Outer Coast Range (2 species): *P. i. pardalis*, and *G. l. behrii*.

Inner Coast Range (13 species + 1 subspecies, 15%): *E. b. lacustra*, *A. lanceolata*, *A. m. mormo*, *H. g. lorquini*, *C. spinetorum*, *C. n. muiri*, *S. californica*, *S. auretteorum*, *S. adenostomatis*, *S. saepium*, *M. leanira*, *E. e. bayensis*, *S. callippe*, *C. silvestris*.

Inner and Outer Coast Range (15 species, 18%)¹: *P. melane*, *O. agricola*, *H. lindseyi*, *H. columbia*, *E. propertius*, *P. multicaudata*, *P. eurymedon*, *P. n. venosa*, *A. sara*, *C. a. iroides*, *L. arota*, *L. gorgon*, *C. a. echo*, *M. palla*, *E. chalcedona*.

Valley and Delta (8 species + 1 subspecies, 10%): *L. eufala*², *O. yuma*, *A. campestris*², *P. catullus*, *P. scriptura*, *E. persius*, *A. m. langei*, *L. marina**, *H. isola**.

SEASONAL DISTRIBUTION

The data on Charts 1, 2, and 3 allow one to define, at least to a limited extent, the seasonal periodicity of some of the butterflies found within

¹ Including Redwood Association.
² A single record in another part of county. *A. campestris* should be found ultimately throughout the county (*vide* C. D. MacNeill).

the county. For most western butterflies, statements pertaining to voltinism have not been accompanied by sufficient data. The treatments by Burns (1964), Langston (1965, 1966), MacNeill (1964), Shields (1966), and Thorne (1963) are notable exceptions.

The apparent length of seasonal flight periods at a locality during any one year is shorter than that indicated on the charts as variability in rainfall and temperature characteristics from one year to the next and between different localities is quite marked.

In Contra Costa County 27 entities (32%) are apparently univoltine: *O. agricola*, *H. h. dodgei*, *H. lindseyi*, *E. propertius*, *P. eurymedon*, *A. m. langei*, *H. g. lorquini*, *C. n. muii*, *C. a. iroides*, *C. dumetorum*, *S. dryope*, *S. adenostomatis*, *S. saepium*, *L. arota*, *L. gorgon*, *L. xanthoides*, *P. i. pardalis*, *P. e. bayensis*, *G. l. behrii*, *M. palla*, *M. leanira*, *E. chalcedona*, *E. e. bayensis*, *S. coronis*, *S. callippe*, *C. p. ariane*, *C. silvestris*.

Species for which there is insufficient data, but appear to be univoltine in other areas of the state, are: *E. b. lacustra*, *A. lanceolata*, *A. m. mormo*, *S. californica*, *S. auretteum*, *S. zerene* ssp. Hence, 37% of the species with the county are univoltine.

According to most writers *N. antiopa* is univoltine, but the fact that adults live for nearly a year masks that conclusion here.

The following species are bivoltine in Contra Costa County: *H. columbia*, *P. n. venosa*,³ *A. sara*,³ *C. eurydice*.

Species which may be bivoltine according to the data herein presented are *O. sylvanoides*, *O. yuma*, *H. ericetorum*, *E. ausonides*, *C. spinetorum*, and *E. comyntas*.

The remaining species typically have three or more emergences of adults per year and adults of many of these species might be collected on any occasion over a wide range of dates. The flight period characteristics or breeding status of the following species within the county is uncertain: *L. eufala*, *P. multicaudata*, *L. marina*, *H. isola*, *N. californica*, *P. o. silenus*.

ANALYSIS OF DISTRIBUTIONAL AND SEASONAL FEATURES

Geographic distribution. Of the 38 species (46%) which have been found in all four regions of the county, five species, *H. ericetorum*, *B. p. hirsuta*, *C. eurydice*, *N. californica*, and *D. plexippus*, do not have food-plants generally distributed throughout the county. The distribution of these species within the county must be explained, at least in part, on the

³ Apparently facultatively bivoltine under favorable conditions, but usually univoltine.

basis of the behavioral tendency of individuals of these species to fly long distances. The food plant of *D. plexippus*, (*Asclepias* spp.), is found only within the eastern half of the county and that of *B. p. hirsuta*, (*Aristolochia californica*), is not found east of the Outer Coast Range region of the county. The breeding area of *H. ericetorum*, *C. eurydice*, and *N. californica* within the county is not known.

Those 11 species marked by a single asterisk in the text are species which are narrow in their choice of foodplants, yet feed on native plants which are widely distributed in the county. Five of these species feed on plants restricted to riparian situations, i.e. *Rubus*, *Urtica*, or *Salix*.

Of the remaining 22 species, almost all are polyphytophagous or will feed on introduced plants which grow readily in disturbed areas.

Of the 46 species (54%) whose distribution is in some way limited within the county, with the exception of four species of uncertain status represented by only one or two individuals, there are three possible explanations, a) distribution of foodplant is limited within the county, b) physiological characteristics of the butterfly do not allow it to occupy all the areas of the county or c) butterfly may have limited vagility, be sedentary, or is displaced by another species in other areas of the county. The first of these explanations can be applied to the distributions of most butterflies within the county. However, study of this problem has not been undertaken and no further comments can be made on this topic.

There is a major difference between the plants of the Valley and Delta region and those of the other three regions. This region includes three major habitats: the delta region, characterized by many sloughs, islands, and a peat-like soil; the Antioch dunes, a small area of "sand dunes" along the San Joaquin River; and an area of alluvial plains and broad valleys adjacent to the river, including the lower portions of the Walnut Creek drainage.

An uneven yet gradual decrease from west to east in the average annual rainfall seems to be the primary cause for the restriction of plant communities to certain areas of the mountainous portion of the county. Some average precipitation figures are shown on Map 3 (Hall, 1886; Hambridge, 1941; U.S. Weather Bureau, 1963; Gilliam, 1966). A factor which emphasizes the effects of these rainfall differences is the occurrence of summer fogs which invade the western third of the county during June, July, and August. The influence of the ocean not only contributes to the moisture availability but moderates temperatures. Hence, the Outer Coast Range and Redwood Association regions of the county have a relatively narrow range of maximum and minimum temperatures throughout the year, while the Inner Coast Range region is characterized by a more

Locality	Rwd Ash	Outer Coast Range															Inner Coast Range										Valley and Delta									
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
Species																																				
L.eufala										X																		X				X	X	X	X	
P.melane		X	X	X			X	X		X	X			X	X		X	X		X	X							X				X	X	X	X	
O.sylvanoides		X	X	X	X					X	X			X				X			X	X						X			X	X	X	X	X	
O.agricola		X	X	X	X		X	X			X	X		X				X			X	X	X													
O.yuma																																				
A.campestris										X																		X				X	X	X	X	
P.sabuleti		X		X						X	X			X			X			X		X						X				X	X	X	X	
H.h.dodgei				X	X																	X	X													
H.lindseyi				X	X																	X	X					X								
H.columbia		X																				X	X													
H.juba										X																		X			X	X		X	X	
H.phyleus		X		X			X			X	X			X	X	X		X			X		X					X		X	X	X	X	X		
P.catullus																									X							X		X		
H.ericetorum										X								X	X										X	X		X	X	X	X	
P.scriptura																												X	X		X	X	X	X	X	
P.communis				X		X	X			X	X					X				X		X						X	X		X	X	X	X	X	
E.persius																											X	X			X	X				
E.tristis		X	X							X			X	X	X			X	X	X	X	X	X					X	X							
E.propertius		X					X						X	X				X	X		X	X	X					X				X				
B.p.hirsuta		X		X	X		X	X	X	X	X		X	X	X	X		X	X		X	X	X					X	X	X		X	X	X		
P.zelicaon		X		X	X		X	X	X	X			X	X				X			X	X	X	X	X			X	X	X		X		X		
Prutulus		X				X	X	X	X	X											X	X	X	X	X											
Pmulticaudata						X												X			X	X	X	X	X		X									
P.eurymedon		X								X	X				X						X		X	X	X				X		X		X	X		
P.prototype																	X																			
P.n.venosa		X	X																		X	X														
gen.castoria										X	X										X							X				X	X	X	X	
P.papae		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
C.eurytheme		X	X		X	X		X		X	X			X	X			X	X		X	X	X	X												
C.eurydice																													X							
A.sara										X	X	X		X	X			X	X		X	X						X								
gen.reakirtii		X	X					X		X	X	X		X	X	X		X	X		X	X	X	X	X			X								
A.lanceolata																																				
E.ausonides		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X			X	X	X				X			X						
A.m.mormo																																				
A.m.langei																																	X			
H.g.lorquini																																				
A.halesus															X																					
C.spinetorum																																				
C.n.muri																																				
C.iroides						X	X			X	X	X		X	X			X	X		X	X	X	X				X					X			
C.dumetorum																																				
S.melinus		X		X	X	X	X		X	X				X	X			X	X		X	X	X					X		X		X		X		

CHART 4

Geographic distribution of butterflies within Contra Costa County (one of two). Occurrence at a locality denoted by (X).

Locality Species	Rwd		Outer															Inner										Valley and									
	Ash		Coast Range															Coast Range										Delta									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34			
S.californica																			X	X		X						X									
S.dryope								X											X							X		X									
S.auretorum																				X																	
Sadenostomat.																			X	X																	
S.saepium																			X	X	X	X															
L.arota								X											X	X																	
L.gorgon				X		X	X			X									X	X	X	X															
L.xanthoides		X	X	X	X	X	X		X	X		X	X					X	X	X	X					X		X	X	X	X	X	X	X	X		
L.helloides	X			X		X			X	X		X	X	X	X				X	X								X	X	X	X	X	X	X	X		
B.exilis	X		X						X																			X	X	X	X	X	X	X	X		
L.marina																												X									
H.isola																												X									
I.i.pardalis	X			X					X	X					X		X																				
I.acmon	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
E.comyntas										X																		X		X		X					
Pe.bayensis				X	X																																
G.l.behrrii	X	X		X	X			X	X	X			X	X	X	X												X		X							
C.a.echo	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								
L.torquini	X	X				X	X		X	X		X	X						X	X	X	X					X	X		X		X					
A.b.californica	X	X				X			X	X									X	X	X	X						X		X		X					
V.atalanta	X	X						X				X	X	X					X	X	X	X						X		X		X		X	X		
V.virginiensis	X		X	X		X	X		X	X			X						X	X	X	X						X		X		X					
V.cardui	X	X	X			X	X	X	X	X	X		X						X		X							X	X			X					
V.carye	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
J.coenia	X	X	X	X	X	X	X		X	X					X				X	X	X	X		X	X	X	X	X	X	X	X	X	X	X			
N.californica	X	X						X	X	X			X	X					X	X	X							X				X					
N.antiopa	X	X		X	X		X		X	X		X	X					X	X	X	X		X				X	X	X	X	X	X	X	X	X		
P.satyus	X	X						X	X	X			X	X														X									
P.o.silenus	X									X																											
P.myllitta	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X					X	X	X		X	X	X				
P.campestris	X		X	X		X	X		X	X	X																	X							X	X	
M.palla	X	X	X			X	X		X	X		X	X						X	X		X															
M.leanira																			X	X																	
E.chalcedona	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X		X	X	X				X		X							
E.e.bayensis																			X	X	X	X		X													
S.coronis	X																																				
S.zerene ssp								X																													
S.callippe																			X	X	X							X									
D.vanillae						X		X		X	X								X									X		X							
D.plexippus	X		X	X	X	X	X		X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
C.t.californica	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
C.p.boopis			X	X				X	X	X	X		X	X																							
C.silvestris																			X	X	X	X															

CHART 5

Geographic distribution of butterflies within Contra Costa County (two of two). Occurrence at a locality denoted by (X).

typical "Mediterranean" climate, *i.e.* cold, wet winters and hot, dry summers.

The Redwood Association region is typified by groves of Coast Redwood (*Sequoia sempervirens*) and other plants that are characteristic of the Redwood Forest as defined by Munz and Keck (1959: 15). The Redwood Association region of Contra Costa County is somewhat unusual as it is not on the immediate coast. This forest is all second growth and lacks a number of the typical plants of the Redwood Forest community and is the only area where this forest grows in the Diablo Range (*sens. lat.*). Its presence here is due to the summer fogs and mild winters. This community is an integral part of the Oregonian biotic province of Dice (1943), while the Inner Coast Range and Valley and Delta regions belong to the Californian biotic province with the Outer Coast Range region acting as an ecotonal area⁴. *P. o. silenus* and *S. coronis* are the only species of butterflies whose presence in the county seems to be dependent upon elements of this plant community.

The Outer Coast Range designation applies to the hilly areas to the west of the Walnut Creek drainage. This area is typified by the predominance of plants whose distributional affinities lie to the west and north. Some of the more typical plants are *Quercus agrifolia*, *Artemisia californica*, *Mimulus aurantiacus*, *Baccharis pilularis*, *Rubus vitifolius*, *Holodiscus discolor*, *Arbutus menziesii*, *Acer macrophyllum*, and *Umbellularia californica*. Thus, this area contains many components of the Northern Coastal Scrub and Mixed Evergreen Forest plant communities as described by Munz and Keck (1959), although not in pure form. The presence of these can be attributed to the incursion of marine weather through the entrance to San Francisco Bay. *H. h. dodgei*, *H. lindseyi* (North Coast Form: MacNeill, 1964), and *P. e. bayensis*, taxa whose main centers of distribution are also to the west or north, are found only in the Point Richmond-Point San Pablo area within the county.

As one proceeds east toward the Walnut Creek watershed, some plants typical of the Inner Coast Range region appear, *e.g.* *Adenostoma fasciculatum* and *Quercus douglasii*. It is of interest that *P. i. pardalis*, *G. l. behrii*, and *C. p. ariane*, common species in the Outer Coast Range portion of the county, have not been collected in the Inner Coast Range region of the county.

⁴ Axelrod (1959) states that "The Border-Redwood (oak-madrone) Forest represents an ecotone between the Arcto-Tertiary and Madro-Tertiary Geofloras and first became established in central California during the Pliocene."

The Inner Coast Range region is dominated by Mt. Diablo, a hard core of Mesozoic strata which penetrated younger Tertiary strata during the late Pliocene epoch and now attains a height of 3849' (Howard, 1962). This area is now typified by the Foothill Woodland and Chaparral plant communities in essentially the form as described by Munz and Keck (1959). Bowerman (1944) has described the flora of Mt. Diablo in great detail and has compared it to that of the Mt. Hamilton Range as described by Sharsmith (1940). A number of plants have their northern point of distribution in the coast ranges on this mountain, e.g., *Pinus coulteri*, *Juniperus californica*, and *Platanus racemosa*; while a larger number of plants reach their northern limit in the Mt. Hamilton Range and, hence, do not reach Mt. Diablo. Thus, Bowerman views the flora of Mt. Diablo as somewhat depauperate in comparison. *Pieris sisymbrii* Bois., *Philotes enoptes tildeni* Langston, *Philotes sonorensis* (F. & F.), and *Hesperia harpalus tildeni* Freeman occur in the Hamilton Range but have not yet been recorded on Mt. Diablo; while *E. b. lacustra*, *H. ericetorum*, and *A. m. mormo* occur more commonly in the former range. Stebbins (1965) analyzes endemism within the California flora and includes Mt. Diablo as one of the six areas of recent endemism within his Central Coast District. In the context of Contra Costa County, the restriction of 13 taxa to this region underscores the validity of the division of the two coast range areas made in this paper. On the basis of data from adjacent counties, at least two of the entities mentioned above, *P. e. bayensis* and *S. saepium*, may be found in the Outer Coast Range at some time in the future. MacNeill (1964) notes that the population of *H. lindseyi* from Mt. Diablo which he terms "Central Coast" form is distinguishable from the population which occurs in the "North Coastal District." None of the taxa restricted to this region of the county are riparian associates and most feed upon plants adapted to xeric conditions.

Seasonal Distribution. Of the 41 taxa (49%) which are univoltine or bivoltine (heterodynamic) all except *A. m. langei*⁵ occur in the Coast Range portion of the county. The yearly rainfall and temperature patterns of the region combine to be responsible for the occurrence of such a large number of univoltine species. Cold temperatures from November through February prevent the survival of all butterfly adults except those of certain hardy nymphalids. The winter rainfall usually ceases by the end of April and almost all succulent foliage has disappeared by the first

⁵ The food plant of this butterfly, *E. latifolium* ssp., is more typically a plant of the coast ranges and foothills of the Sierra Nevada (the typical subspecies is a plant of the immediate coast of northern California where no populations of *A. mormo* are likely to occur).

of June. Hence, the larval food plants of most species remain in an acceptable state for a relatively short period, despite the fact that the area is frost-free for over ten months of the year. All of these species have a characteristic stage which undergoes a lengthy period of diapause (usually aestival).

The remaining 43 species (51%) which are multivoltine include many possessing the habit of a hibernal diapause, including species whose reproductive capacity is holodynamic and whose development is only slowed by unfavorable weather conditions. Typically, these species feed on plants which grow in disturbed habitats or riparian situations. The Valley and Delta region is able to support multivoltine species since plants are supported throughout the dry season by moisture supplied from the numerous waterways, and from considerable amounts of water utilized by irrigation operations in the area.

SUMMARY

1. To date, 84 species of Rhopalocera are known to occur in Contra Costa County, California.

2. The temporal and spatial distributions of these species are graphically described on the basis of extensive collection records.

3. Multivoltine species must have suitable host material over a sufficient time span for the production of several broods; this implies that in an area with hot, rainless summers that these species must be adapted to a succession of different plants, be capable of feeding on plants which grow in highly disturbed habitats, be associated with riparian habitats, or be limited to the Valley and Delta region of the county.

4. All univoltine species, with the exception of *A. m. langei*, occur in the Coast Range portion of the county.

5. The distributional affinities of the butterflies of the county are described in reference to four regions whose erection is based on floral and topographic features.

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COLLECTING ITHOMIIDAE WITH HELIOTROPE

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Collectors in the tropics depend upon natural and artificial baits to collect Lepidoptera and have developed a wide variety of specialized techniques for this. Yet most of them find it difficult or impossible to obtain adequate samples of Ithomiidae by conventional methods. Confined to the Neotropics, ithomiids are weak-flying butterflies that are easily netted but not readily seen; random collecting with a net alone yields incomplete samples. Ithomiids rarely visit open places or flowers and are not attracted to the usual baits nor even to damp ground. They prefer dark, damp areas in the jungle near water-courses and tend to fly in early morning and towards evening, being relatively inactive at mid-day. Heliotrope (*Heliotropum* sp.), properly used, is an effective bait for ithomiids; but its use has been a secret of a few professional collectors.

I learned of the value of heliotrope as a collecting tool while at El Pao, Estado Bolivar, Venezuela in 1965. Albert Gadou, an experienced collector and my host at El Pao, demonstrated its use on a wooded forest trail near his home. During a week's stay at El Pao many ithomiids were captured at heliotrope along with *Lycorea ceres atergatis* Dlbdy., Hew. & Westw. (Danaiidae) and a dozen or so *Sphecosoma* sp. (Ctenuchidae); these insects were otherwise quite scarce in the area. I returned to Venezuela in 1966 and gathered additional information on the use of heliotrope. *Heliotropum indicus* Linnaeus was collected on the sandy banks of the Rio Caroni where it grows in profusion as a small shrub to a height of 15 inches. The deep purple flowers are clustered on a stalk about six inches long which curls around itself; this appearance has provided the Spanish name for the plant, *rabo de alacran*, literally "scorpion's tail".

Neither the flowers nor the growing heliotrope plants attract ithomiines and it is only after proper preparation that the plant becomes effective. It should be carefully dug up by the roots, tied into small bundles and allowed to dry; after two or three days these bunches are hung up by the roots with the leaves dangling about five feet off the ground. Shaded places along trails or watercourses are best. The bait becomes more and more effective with additional drying (the collector shouldn't be discouraged if he doesn't get immediate results) and will remain so for a long period of time. I saw butterflies attracted to a plant that had been suspended for three or four months.

The ithomiids usually settle among the lowest hanging leaves of heliotrope and rest with folded wings. They may or may not extend the proboscis and not infrequently will slowly pump their wings. Even though they settle among the dried leaves rather than the roots, it is quite important that the roots be present, as bundles without roots attract relatively few individuals. Apparently more males than females are taken at heliotrope, but the ratio is not greater than 2:1. A high ratio of males of other families is expected at conventional baits. For instance, *Papilio* taken at damp sand are nearly 100% males.

A small bundle of heliotrope, properly prepared and in a favorable location may bring in several hundred butterflies per day. My companion, Harold Skinner of Caracas, and I collected perhaps 300 individuals during one productive day along the Rio Clarito in February 1966. More than 70 individuals were found at daybreak on two bundles that had hung here overnight.

My collecting in Bolivar was at the height of the dry season (February and March) when the poorest collecting is to be expected. A total of 125 males and 79 females were taken at the bait, representing 21 species and 14 genera of Ithomiidae. These include 11 males and two females of *Hypothyris vallina colophonia* d'Almeida which was previously known from only three specimens; one male, representing the easternmost record, of *Mechanitis polymnia polymnia* (L.); and a series of *Mechanitis isthmia bolivarensis* Fox, which formed a part of the type series of this subspecies. Heliotrope was also used successfully at Barinas in the Venezuelan Andes during the 1966 collecting trip.

A single individual of *Haetera piera* (L.) (Satyridae) was observed on one bunch of the heliotrope that had fallen to the ground. The heliotrope had been hung out on the trail at the same time that fruit bait was being spread along it and it is likely that this one bundle of heliotrope contained traces of fruit. *Haetera piera* was frequently attracted to fruit baits on the ground.

The attraction of ithomiids to heliotrope cannot be readily explained; as they have no association with the growing plant, and dried heliotrope with roots would not normally be expected to be hanging in the forest. The larval food plants of the ithomiids are exclusively Solanaceae. It is unlikely that the alkaloids or essential oils in heliotrope are similar enough to those in Solanaceae to account for the attraction. The native indians of Venezuela and Brazil know heliotrope as *borejan* (variously spelled *borrajan*, *borojan* and *borrojan*) and it is likely that heliotrope is gathered, dried and used by them in some manner. This could account for the discovery of its attractive properties by collectors.

I am indebted to Harold W. Skinner, in whose company the two

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BOOK REVIEW

GUIDE TO THE GEOMETRIDAE OF CANADA (LEPIDOPTERA). 1. SUBFAMILY STERRHINAE. By W. C. McGuffin. Mem. Ent. Soc. Canada, 50, 1967. 67 pp., 68 color photographs and 44 black and white figures.

This manual is the first in a proposed series designed to "aid in the identification of the Canadian species" of Geometridae, immatures as well as adults. Keys, descriptions, and biological data are presented at the family, subfamily, and generic level. The author recognizes seven genera and 24 species of Sterrhinae as Canadian. He gives brief descriptions of adult maculation and genitalia, and, when known, of eggs, larvae, and pupae. Much of the biological information is the result of his own research. Also included are distribution data for Canada, earliest and latest seasonal records for adult capture, and larval host plants if known.

Illustrations include distribution maps for most of the species; and drawings of such structures as male and female genitalia, hind legs, wing venation, egg, larval head and body chaetotaxy, and pupae. The most outstanding feature of the work, I feel, is the color photographs of the adults. Except for a few "hot" spots on some of the white species, the photographs give excellent representations of the generally faint markings in this group of moths. Many Sterrhinae are polymorphic, and McGuffin illustrates more than one morph in several species.

The work is not a revision, and so does not include reevaluation of the species treated, nor lists of synonymy and exhaustive descriptions. Two errors of a systematic nature bear correction here: the type species of *Scopula* Schrank is *ornata* Scopoli, not *adornata* (p. 11); and *Scopula quaesitata* (Hulst) (p. 20) is an error in determination (held over from McDunnough's 1938 *Check List of the Lepidoptera of Canada and the United States of America*, Part 1). The correct name for the moth described in McGuffin's work as *quaesitata* Hulst is *luteolata* Hulst (1880, Bull. Brooklyn Ent. Soc. 3: 42); the type of *quaesitata* is definitely not a *Scopula*.

The explanations of figures are unfortunately placed all together in a section in front of the 21 pages of illustrations. The reader is bothered in having to refer back to pages 32-34 to learn what species the figures represent. Also in the explanation section, named morphs are referred to as trinomens giving the false impression that they represent subspecies, e.g. *Scopula enucleata mensurata* (Walker).

There will be changes in nomenclature and classification of Canadian Sterrhinae in the future, and I feel some of the treatment of species in this work could have been less skimpy; but by and large the additions to biological information and the copious illustrations make this manual a helpful aid in identifying Canadian species of this difficult subfamily.—CHARLES V. COVELL, JR., *University of Louisville, Kentucky*.

NOTES AND OBSERVATIONS ON THE BIOLOGY AND HOST PREFERENCES OF *VANESSA TAMEAMEA* (NYMPHALIDAE)

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and

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The Kamehameha Butterfly (*Vanessa tameamea* Eschscholtz) was first described by Frederick Eschscholtz in 1821 while on a natural science expedition throughout the South Seas, and according to Zimmerman (1958), it was the first species of Lepidoptera to have been described from the Hawaiian Islands. This species is restricted to the forests of the Hawaiian Islands.

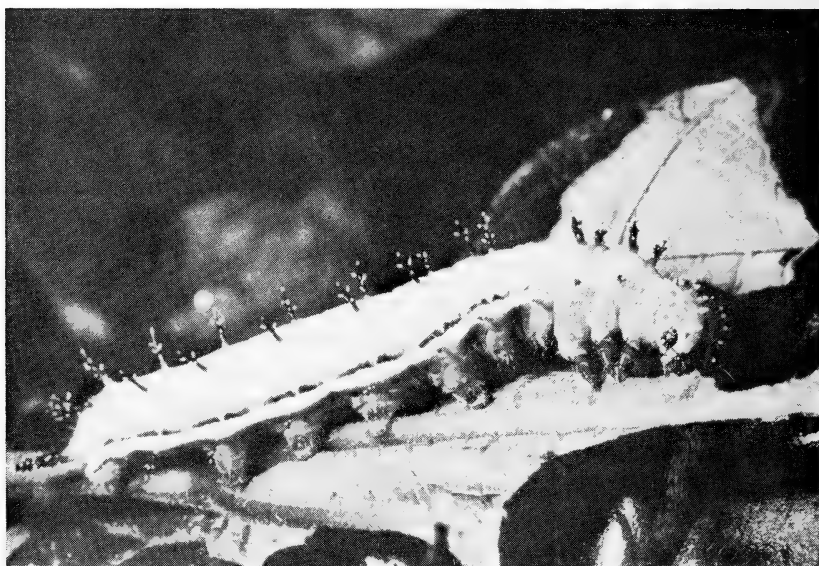
Observations were made on behavior of this butterfly by Wielgus on several trips to the Hawaiian Islands in 1966. Because of extensive cultivation and introduction of alien plants it was necessary to travel to high elevations to encounter the endemic flora where this butterfly occurs.

Some of the closest and most accessible of the native areas are the upper elevations of Mount Tantalus, which is a relatively low peak (2,013 feet) on Honolulu's northern limits. This was found to be an excellent locale for *Vanessa tameamea* in that the principal larval food-plant, *Pipturus albidus* Gray (Urticaceae) was growing on the slopes between 1,400 feet and 2,000 feet. Collecting was quite adequate along these slopes.

The first trip in mid-December, 1965, was primarily an exploratory one but only one *V. tameamea* was seen in flight in a mixed bamboo and broadleaf evergreen forest on the north face of Mount Tantalus at 2,000 feet.

The second trip to Honolulu occurred on January 20, 1966 and the foodplant, *Pipturus*, was located growing along the side of a road on Mt. Tantalus at about 1,800 feet. The plants were situated so that at that time of year the sun did not strike the leaves until 1:00 P.M. At about 11:30 A.M., however, a closer view of one *V. tameamea* was enabled, but it was not captured. *Pipturus* shrubs approximately five to ten feet in height were examined for evidence of larval activity without success.

On February 22 more favorable weather conditions prompted another excursion to the same area. The area came into sunlight between



EXPLANATION OF FIGURE

Fifth instar mature larva of *Vanessa tameamea* Esch.

11:30 A.M. and noon and almost immediately *V. tameamea* began its rapid flight about the *Pipturus*. A female was observed ovipositing on the terminal leaves and was netted. Two others were seen along the trail and one of them, another female, was netted. The third, also a female, was netted after it had alighted.

The fourth trip, in March, was a general collecting trip and no *V. tameamea* were seen in the area previously described.

Between April 17 and 21 another area was explored by following a path on Mt. Tantalus marked "Trail No. 2," which begins at about 1,400 feet elevation on the west face of the mountain, circles around north-eastward and connects with Tantalus Drive on the east at the same elevation. Collecting was begun at 6:00 P.M. with many parts of the trail receiving the last hour of sunlight. A male *V. tameamea* was taken at approximately 1,500 feet. This capture prompted a search for the larval foodplant and one was found a short distance away, growing along the trailside between 1,500 and 1,600 feet. This shrub was not more than eighteen inches in height and was determined by Gorelick to belong to another genus of Urticaceae, *Boehmeria*, appearing to be *B. nivea* (L.) Gaud. The leaf of this species is characterized by a gradual tapering into a long-acuminate apex (Degener, 1957). One fifth instar larva



EXPLANATION OF FIGURES

Comparison of adult females of *Vanessa tameamea* Eschscholtz:

1. Dorsal view, Mt. Tantalus (1,800'), Honolulu, Oahu, Hawaiian Islands, II-22-1966 (R. S. Wielgus, collector).
2. Ventral view, Mt. Tantalus, (1,800'), Honolulu, Oahu, Hawaiian Islands, II-22-1966 (R. S. Wielgus, collector).
3. Dorsal view, reared from larva on *Boehmeria nivea* (L.) Gaud., from Mt. Tantalus Trail No. 2, Honolulu, Oahu, Hawaiian Islands (Emerged: V-7-1966) (R. S. Wielgus, collector).
4. Ventral view, reared from larva on *Boehmeria nivea* (L.) Gaud., from Mt. Tantalus Trail No. 2, Honolulu, Oahu, Hawaiian Islands (Emerged: V-7-1966) (R. S. Wielgus, collector).

was found feeding on a leaf and was taken, along with sufficient numbers of *Boehmeria* leaves for rearing.

Description, fifth instar larva:

Body color pale, chartreuse green, with creamy white lateral stripe beginning at first abdominal segment, extending to anal opening. Head heart-shaped with numerous white-tipped short spines, with a maroon triangular-shaped patch on the front and a black spot at each eye. Second and third thoracic segments each with four black-tipped spines approximately 2.5 mm long; segments II-VIII each with four 1.2 mm spines, green at the bases, red at midpoints and black at the apices. Anal segment with two black spines with red bases approximately 6.5 mm long, projecting backward and giving the appearance of a forked tail. A description of the larval behavior was written by Williams (1928).

The larva was placed in a plastic container with *Boehmeria* leaves and on April 19 another mature larva was found, both were retained for rearing. Unfortunately much of the foodplant dehydrated, but the larvae ate the remaining leaves and the first larva pupated on April 24. Its pale gray-brown, angular chrysalis was suspended from a silken button spun on one of the leaves. The second larva pupated on April 26. The first produced a female on May 5, while a second female emerged on May 7.

Perhaps the most interesting of the observations made on this nymphalid was the variation inherent in the female adults. The reared specimens (fig. 3) were slightly smaller than normal and had a pinkish ground color on the upperside rather than the orange-red of field-captured specimens (fig. 1), while the undersides of the secondaries were olive green (fig. 4) rather than the grayish-brown observed in the field (fig. 2) by Wielgus. Zimmerman (1958) mentioned variation in the species but did not offer any hypotheses as to the causes of such color differences. Whether this variation is hereditary or is due to environmental factors has not yet been determined.

Vanessa tameamea appears to fly much of the year, especially on Mt. Tantalus where the native *Boehmeria* and *Pipturus* occur in vegetative form much of the year. On the mainland, the butterfly might possibly survive on native and Urticaceae introduced from Hawaii, including *Pipturus*, *Boehmeria*, *Urtica* (tends to be misidentified as *Hesperocnide* according to Degener, 1957), *Helxine*, *Pilea*, *Urera* and *Touchardia*. Rearing *V. tameamea* on *Urtica*, *Hesperocnide*, and *Parietaria* from the mainland to observe host preferences would also be of interest. Such transplant experiments involving native Hawaiian flora and fauna are not feasible under current U.S.D.A. regulations unless under strict quarantine. The results that might be obtained from such a study would produce, however, still more knowledge concerning the biology of this impressive Hawaiian nymphalid.

ACKNOWLEDGMENT

T. W. Davies of San Leandro kindly assisted by photographing the larva of *V. tameamea*.

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THE PUPA OF *POLYDORUS ARISTOLOCHIAE* (PAPILIONIDAE)

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Polydorus aristolochiae (Fabricius) is the commonest large-tailed, black butterfly of the Indo-Pakistan Subcontinent. At Tando Jam (25°26' N; 68°32' E) West Pakistan, the pupae were found on *Aristolochia bracteata* L., and other plants. The work was undertaken during the years 1961-63.

Some observations on the prepupal condition, pupation and description of pupa have been recorded by previous workers (Ghosh, 1914; Wynter-Blyth, 1957; and Talbot, 1939). This previous work has not been comprehensive, therefore, some additional observations on pupation of *P. aristolochiae* seem worthwhile. The results of our observations are discussed below.

RESULTS AND DISCUSSION

Prepupal Condition. When about to pupate the larva forms silken padding on the surface where the pupa will be situated. After fixing the prolegs of the anal segment to the pad, it forms a double silken loop around itself in the region of the thorax and then attaches the loops at one point to the substrate. Thus secured, the prepupa "rests" before pupation with the head directed upward and excretes a small quantity of semi-liquid substance. The prepupal period lasts for one or two days in summer and three to four days in winter. Finally the larval skin is cast off and the pupa is produced. These observations are in general agreement with Ghosh (1914).

Pupation. Normally the larvae pupate on the host plant, *A. bracteata* L. The full fed larvae were also observed moving towards larger bushes and trees where they subsequently pupated. This finding is in agreement with Ghosh (1941) and Wynter-Blyth (1957).

In addition to this, curiously enough, all the caterpillars were noted crawling in west and south-west directions only. This may be due to the fact that most of the higher winds at Tando Jam, are south-westerly. In one case, when the area in which the host plant grew were plowed, a few caterpillars were found pupating on the clods. This may be due to a chance occurrence. However, in most cases they find suitable twigs and sticks for pupation sites.



Pupae
Polydorus aristolochiae

Larvae were found pupating on the following bushes and trees in the field.

Akk, *Calotropis procera* (Asclepiadaceae); Karandi, *Abutilon indicum* (Malvaceae); Kir, *Capparis aphylla* (Capparidaceae); Devi, *Prosopis spicigera* (Leguminosae); Ber, *Zizyobus rotundifolia* (Rhamnaceae); Mango, *Mangifera indica* (Anacardiaceae); Babul, *Acacia arabica* (Leguminosae); Wild jute, *Corchorus* spp., (Tiliaceae); Lasora, *Cordia*

myxa (Boraginaceae); Panghara, *Eytherina suberosa* (Leguminosae); Kachnar, *Bauhinia variegata* (Leguminosae).

As observed by Ghosh (1914), the larvae pupated on the sides of rearing jars and cages in the laboratory.

Description of the Pupa. The pupa is obtect. It is arched towards the ventral side, with the posterior end deflexed dorsally (Figure 1). There are a number of ridges and horns on the body of the pupa. On the dorsal surface, in the head region, there is a prolongation of the outer cover to form a transverse ridge. Anteriorly this prolongation forms a hood which by narrowing on the posterior side forms a triangular piece, the anterior angle of which comes out in the form of thin cephalic horns. A pair of thin horns are again developed in the prothoracic region.

The back of the pupa is raised into a ridge-like structure anteriorly which disappears in the region of the metathorax. The wing pads are expanded laterally. A pair of hood-like structures is formed by the wing pads of the forewings; while a pair of smaller semicircular prolongations are formed by the wing pads of the hindwings.

The pupa is deflexed posteriorly with a small depression near the posterior end to which is strongly attached a membranous cremaster.

On the ventral surface of the pupa, the cephalic horns are continued medially to form a continuous ridge. This is followed after some distance by a slightly wavy ridge which continue laterally to the prothoracic horns and finally meets in the middle to form the anterior border of the area enclosing the antennae and eyes. The prothoracic portion is raised and narrows down dorsally forming a tree-branched ridge which gives the appearance of an inverted 'U' with a tail at the base. The abdominal segments are brown in color speckled with dark spots which are surrounded by irregular white patches. Four pairs of spatulate structures are seen on third to sixth abdominal segments, with edges towards the anterior and distal ends. A pair of brown depressions is present on the posterior aspect of these spatulate horns, the outer depression being smaller and becoming very small on the horns of the sixth abdominal segment.

Another structure which keeps the pupa in position is a strong fibrous band secreted by the larva which passes all round the body, just below the thorax and meeting towards the substrate. A similar strong silken band is attached to the posterior end of the pupa, where it forms a strong fibrous pad. This description of the pupa agrees with that given by Talbot (1939).

The earlier writer did not mention the color of the pupa. The author's

observations with regards to color changes follow. The pupa is of light brown color with pinkish tinge immediately after pupation. Later, the color changes to light brown with markings of white and dark shades. The anterior portion comprising of the head, thorax, and wings is of a darker shade than the posterior portion. Prior to the emergence of the adult, the pupa become blackish.

ACKNOWLEDGMENTS

To Jerry A. Powell, University of California, Berkeley, I extend my sincere appreciation for critically editing, correcting, and improving the manuscript.

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A MIGRATION OF *VANESSA CARDUI* (NYMPHALIDAE) IN OHIO

Several observers noted a great increase in the numbers of *Vanessa cardui* (Linnaeus) present throughout Ohio during the spring and summer of 1966. This abundance of *cardui* was quite noticeable in the upper Miami Valley. It was particularly noteworthy because it occurred after several years of relative scarcity.

A migration of *cardui* was observed in western Ohio from June 13 to June 19, 1966. The point of observance was at Minster, Auglaize County. The direction of the flight of the painted ladies was from southwest to northeast. The flight of individuals was rapid, aided during most of the migration by a wind from the southwest.

The week of June 13 to June 19 was abnormally warm, with the temperature reaching 102° on June 18. Below is a table of the maximum and minimum temperatures during the migration, at Minster.

	Max. Temp. °F	Min. Temp. °F
June 13 warm, showers	88	56
June 14 fair and warm	82	60
June 15 showers	74	52
June 16 fair and warm	80	58
June 17 fair and warm	102	50
June 18 fair and warm	94	50
June 19 fair and warm	98	50

The *cardui* flew at a variable height so as to fly only a few feet above fences, or buildings in their path. The flight pattern never varied; the butterflies never veered to avoid an obstacle but simply rose up over it. The flight over open fields was about three feet above the ground level.

The rate at which the *cardui* passed over our line of observation (a width of about 70 feet) was estimated at 12 to 15 individuals per hour during the first days of the migration. Sunday, June 19, 1966 marked a flight peak and also its end. On this windy afternoon the rate of passage increased to 20 to 25 per hour. Few of the *cardui* were observed on any of the days after 4:00 P.M.

A number of specimens of *cardui* captured and examined were old and worn, showing the wear and tear of an apparent long flight. A few of the *cardui* netted were in good condition. A curious phenomenon was noted in connection with the flight of the *cardui*; occasionally they were accompanied by what appeared to be *Polygonia interrogationis* (Fabricius).

Records of *Vanessa cardui* migrating in the eastern United States are few, and little is known concerning the reasons for migration. Host plants are available in western Ohio.

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ADDENDA TO THE LIST OF THE BUTTERFLIES OF MICHIGAN

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"A Revised Annotated List of the Butterflies of Michigan" was published in the Occasional Papers of the Museum of Zoology University of Michigan, Number 617, June 8, 1960 by Sherman Moore. Since *Rhopalocera* collected by myself since 1941 were not included in the list, the seventy entries which follow add to its completeness.

Key: *Zones*: NLP (Northern Lower Peninsula); SLP (Southern Lower Peninsula); county names are given where species have been taken. *Dates*: A date given with a dash (—) following represents the

earliest date captured in zone or with a dash preceding, the latest date of capture in a zone. For clarity, all nomenclature follows dos Passos (1964).

- Lethe portlandia* (Fabr.) SLP: Branch
Lethe eurydice (Joh.) SLP: Branch; —Aug. 24
Euptychia cymela (Cram.) SLP: Calhoun
Cercyonis pegala nephele (Kby.) NLP: Ogemaw. SLP: Branch
Danaus plexippus (L.) SLP: Branch
Speyeria idalia (Dru.) SLP: Branch
Speyeria atlantis (Edw.) NLP: Ogemaw; —Aug. 18
Speyeria cybele (Fabr.) SLP: Branch
Speyeria aphrodite (Fabr.) NLP: Ogemaw. SLP: Branch
Boloria toddi (Holl.) NLP: Ogemaw
Euphydryas phaeton (Dru.) SLP: —July 25
Melitaea harrisii Scud. SLP: Oakland
Melitaea nycteis Dbldy. SLP: —July 25
Phyciodes tharos (Dru.) SLP: Branch
Polygonia interrogationis (Fabr.) NLP: Ogemaw. SLP: Branch
Nymphalis vaui-album j-album (Bdv. and Lec.) NLP: Ogemaw
Nymphalis milberti (Godt.) NLP: Ogemaw. SLP: Branch
Nymphalis antiopa (Linn.) SLP: Branch, Calhoun
Vanessa atalanta (Linn.) SLP: Branch
Vanessa cardui (Linn.) SLP: Branch; May 8—
Vanessa virginiensis (Dru.) SLP: Branch
Junonia coenia (Hbn.) SLP: Branch
Limenitis archippus (Cram.) NLP: Ogemaw. SLP: Branch
Limenitis astyanax (Fabr.) NLP: Ogemaw. SLP: Branch
Limenitis astyanax form *atlantis* Nakahara NLP: Ogemaw
Asterocampa clyton (Bdv. and Lec.) SLP: Branch
Strymon melinus Hbn. SLP: Calhoun
Strymon edwardsii (G. and R.) SLP: —Aug. 1
Feniseca tarquinius (Fabr.) NLP: Ogemaw
Lycaena thoe Guer. SLP: Branch
Everes comyntas (Godt.) NLP: Ogemaw
Glaucopsyche lygdamus (Dbldy.) SLP: Calhoun
Celastrina argiolus (L.) SLP: Branch; Apr. 11—Aug. 31
Papilio polyxenes asterius Stoll. SLP: Branch
Papilio glaucus Linn. SLP: Branch
Papilio troilus Linn. SLP: Branch, Calhoun
Colias eurytheme Bdv. SLP: Branch
Colias philodice Godt. SLP: Branch; May 8—
Pieris rapae (Linn.) NLP: Ogemaw. SLP: Jackson
Pieris protodice Bdv. and Lec. NLP: Ogemaw. SLP: Branch
Epargyreus clarus (Cram.) SLP: Calhoun
Thorybes bathyllus (Smith) SLP: Calhoun
Thorybes pylades (Scud.) SLP: Calhoun
Pholisora catullus (Fabr.) SLP: Calhoun
Erynnis icelus (Scud. and Burg.) SLP: Calhoun
Erynnis brizo (Bdv. and Lec.) SLP: Calhoun, Jackson
Erynnis martialis (Scud.) SLP: Calhoun; May 13—
Erynnis juvenalis (Fabr.) SLP: Calhoun; —July 5
Thymelicus lineola (Ochs.) SLP: —Aug. 2
Poanes hobomok (Harris.) SLP: Calhoun

A COLLECTING TRIP TO NORTHERN QUEENSLAND, AUSTRALIA

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The idea of going to Australia to collect lepidoptera was originated in a London bookstore, some two years ago, when I purchased a book entitled "Butterflies of Australia and New Guinea," written by the Australian lepidopterists' Charles Barrett and A. N. Burns (1951).

I flew from Chicago on April 2, 1966, and arrived in Sydney on April 4. I first went to Melbourne and afterwards flew some 1800 miles north to Cairns, Queensland which was to be my headquarters for the next few weeks.

My collecting started the morning after my arrival in Cairns. I first worked the forested areas near Ellis Beach, some twenty-five miles north of Cairns, where I took *Eurema hacabe phoebus* (Butler) in good quantities as well as other small Yellows. Collecting at Trinity Beach produced large quantities of *Cressida cressida cressida* (Fab.), especially in the early mornings. Later in day, at the same location, fourteen species were taken.

Near Kuranda, along the Barron River and in the rain forests I had good fortune in taking the following:¹

Cressida cressida cressida (Fab.)
Thysonotis hymetus taygetus (Feld.)
Mycalesis terminus terminus (Fab.)
Ornithoptera priamus euphorion (Gray)
Precis orithya albicincta (Butler)
Delias mysis mysis (Fab.)
Delias mysis aestiva (Butler)
Eurema laeta lineata (Misk.)
Eurema candida virgo (Wall)
Eurema hacabe phoebus (Butler)
Neptis consimilis pedia (Fruhst.)
Catopsilia pomona pomona (Fab.)
Pachlioptera polydorus queenslandicus (Roths.)
Cupha prosopis prosopis (Fab.)
Cepora perimale scyllara (Macl.)
Euploea core corinna (Macl.)
Hypolimnas bolina nerina (Fab.)
Taractrocera dolon dolon (Plotz)

In the two week collecting period 250 butterflies and moths were taken. The highlight of the trip was the capture of a male *Ornithoptera priamus*

¹ Determinations were made by the author by referring to Common (1964).

euphorion (Gray). This butterfly was flying thirty to sixty feet above the ground and was out of the reach of my net. After waiting a long time the Birdwing came within reach and was netted.

ACKNOWLEDGMENTS

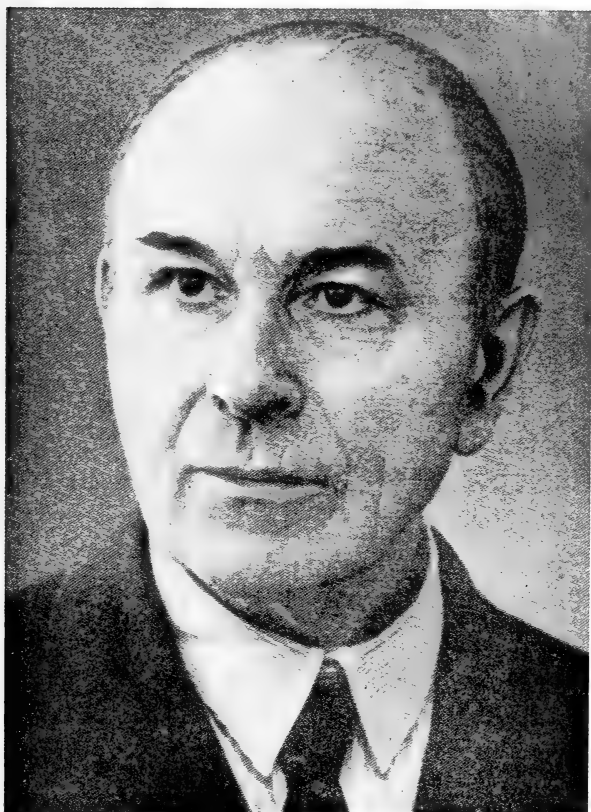
The author is grateful to Dr. Murray S. Upton of the Commonwealth Scientific and Industrial Research Organization of Australia and to Mr. Norman B. Tindale of the South Australian Museum for their advice concerning the planning of the trip. I would also like to thank Dr. G. T. Riegel of Eastern Illinois University for his encouragement and help regarding my first collecting venture into the tropics.

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FIRST RECORD OF LARVAL FOODPLANT IN TEXAS FOR *EVERES COMYNTAS* (LYCAENIDAE)

This is the first record of rearing of the "tailed blue" on any foodplant in Texas. Eggs were collected on *Lespedeza texana* Britton (Leguminosae) at Edge Falls, Kendall County. This plant occurs in calciferous soils of north central and hill country areas of Texas. Ova were collected on 11 September 1967 and an adult emerged 7 October 1967 with a total immature period of 25 days. Cannibalism was noted among the larvae. Feeding was limited to immature seed pods and flower buds. There remains some confusion as to the sub-specificity of the reared example, as it does not compare with the paratypes of *Everes c. texana* R. H. Chermock in the collection of R. O. Kendall. I wish to extend sincere thanks to R. O. Kendall for assistance in preparing this note.—JOSEPH F. DOYLE III, 6127 Thunder, San Antonio, Texas.



ERICH MARTIN HERING (1893-1967)

Prof. E. M. Hering died on August 18, 1967. He worked more than 36 years at the Museum of Zoology in Berlin and his reputation as a renowned entomologist stretched far beyond the borders of his country.

Prof. Hering was born on November 10, 1893, at Heinersdorf (Ost-Sternberg); he was trained originally as a teacher and worked for a short time at a primary school. After a serious injury during World War I he used the time in the hospital to study and to obtain his baccalaureate. He had by this time established contact with the Lepidoptera section of the Museum. After his university study which terminated in his gaining the Ph.D., Prof. Hering accepted a job as an assistant at the Museum in 1921. In 1926 he became Curator, and in 1932 he was given the title of Professor. He was director of the section on Lepidoptera until 1957.

His scientific achievements are numerous, and he published more

than 400 scientific papers and 40 popularized articles on topics of various fields. In addition to the Lepidoptera he concentrated on leaf-mining insects of all orders, particularly on Trypetidae (Tephritidae) and Agromyzidae, as well as on zoological nomenclature. Most of his publications dealt with taxonomy and ecology of insects. He described more than 2,000 taxa.

The core of his scientific work was the study of mining insects, a field in which he attained international reputation. His general book, "Biology of the Leaf Miners," published in 1951, and his treatise on "Determination-tables of the Leaf Mines of Europe," which was published in three volumes in 1957, are the crown of his work. The collection of reared mining insects which Prof. Hering donated to the Museum in 1932 is unique. It contains nearly 2,900 species. Included are the types of 425 species, mainly described by himself. Numerous publications owed their origin to travels which he made to most of the European countries and to Abyssinia (Ethiopia) and Canada.

As a member of the International Commission for Zoological Nomenclature, he contributed substantially. In 1938 he acted at the International Congress of Entomology in Berlin as General Secretary.

Prof. Hering received many honours in his life. He was an honorary member of the International Congress of Entomology (1960), of the British, Belgian and French Entomological Societies, The Lepidopterists' Society, The Viennese Entomological Society, The Zoological-Botanical Association at Vienna, and The International Entomology Club in Frankfurt. The German entomologists honoured him with the Fabricius Medal and further he received the Royal Bulgarian Medal of Merit and the Royal Belgian Medal for Natural Sciences.

His continuous readiness to help, his deep modesty and frankness and his manifold interests in all problems of life made him an ideal scientist and brought him the veneration of everybody who knew him.

—H. J. HANNEMANN, *Institute for Special Zoology and Zoological Museum,
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In This Issue

MATING BEHAVIOR IN BUTTERFLIES

NEW MOTHS FROM TEXAS

LEPIDOPTERA OF THE CENTRAL BRAZIL PLATEAU

EFFECT OF X-IRRADIATION ON PAPILIO

RICHARD M. FOX (1911-1968)

(Complete contents on back cover)

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

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SOME ASPECTS OF MATING BEHAVIOR IN BUTTERFLIES

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Mating butterflies tend to remain nearly motionless. As a result we witness the activity infrequently and our knowledge of it remains extremely limited. Two kinds of mating data, however, are reasonably accessible to the general observer and give promise of increasing value as more records accumulate: the time of day when mating occurs; and the sex of the active (flying) partner. The first requires simply a notation of the time of day. The second is not so simple. In many cases mated pairs must be disturbed deliberately to cause them to fly. The determination of the sex of the one that flies, however, is by no means easy in those species where the sexes closely resemble one another.

For several years each of us has been noting this information as opportunity presented during the course of collecting. In January, 1966, when we went to Mexico as the Carnegie Museum-Catholic University of America Expedition, gathering additional records was on our agenda. Our accumulated observations are given in the present paper. We have added such published records as we have been able to find, but we have made no intensive literature search.

The absolute necessity for accurate reporting (which includes admission of doubt or deletion of a questionable datum) is underscored by the curious paper of Pronin (1964) on this subject. We cite his records, but we consider all of them uncertain and several, which we indicate, are highly questionable. The latter (cf. *Aporia crataegi*, Pieridae; *Danaus plexippus*, Danaidae) contradict several to many others, and cast doubt on the rest of his records. This opinion is reinforced by his numerous unwarranted conclusions and unsupported categorical statements. For

example, he gives (p. 40) a table of the mating times of ten species of butterflies, all periods of an hour or less (and no indication of how many pairs of each species were observed). Immediately following the table he states, "Thus, each species of butterfly . . . has its own definite mating time." The conclusion is certainly not legitimately derivable from his data and is, furthermore, incorrect (see records below of *Pieris rapae*, *Euptychia cymela*, *Erynnis juvenalis*).

In the following list we use these abbreviations: DC, District of Columbia and vicinity; PNR, Powdermill Nature Reserve (9 miles south of Ligonier, Westmoreland County, Pennsylvania); and CM-CUA, Carnegie Museum-Catholic University of America Expedition to Eastern Mexico, 1966. We include in the list only those records in which either the time of day, or the sex of the active partner, or both, is recorded, and add the data of the observation. To save space, and because the precise locality is not of critical importance, we usually give only the state or country in which the observation was made.

PAPILIONIDAE

There are only Pronin's (1964) records of *Papilio machaon* Linnaeus (EUROPE, 1-2 P.M., ♀ flying) and *Papilio multicaudatus* Kirby (CALIFORNIA, 2-3 P.M.).

PIERIDAE

Records are particularly numerous in this family. Mating of pierids apparently takes place in the late morning to early afternoon (but note early morning record of *protodice*). The male is the active partner in nearly all records.

Pieris rapae (Linnaeus)

PENNSYLVANIA (PNR), 6.V.1964, 11:35 A.M. and another 3:35 P.M. (HKC).
IOWA, ♂ flying (LDM).

DC, ♂ flying (Clark, 1932)

EUROPE, ♂ flying (Pronin, 1964)

Pieris napi (Linnaeus)

EUROPE, ♂ flying (Pronin, 1964)

Pieris virginiensis Edwards

PENNSYLVANIA (PNR), 23.IV.1964, 1:20 P.M., ♂ flying; and another 1:30 P.M.,
♂ flying (HKC).

Pieris protodice Boisduval & Le Conte

NEW MEXICO, 21.VII.1963, 9:30 A.M. (HKC).

Aporia crataegi (Linnaeus)

EUROPE, ♀ flying (Pronin, 1964) [record questionable]

Appias d. drusilla (Cramer)

TAMAULIPAS (MEXICO), 9.I.1966, 2:25 P.M., ♂ flying (CM-CUA).

Catacticta n. nimbece (Boisduval)

HIDALGO (MEXICO), 13.I.1966, 12:30 P.M., ♂ flying (CM-CUA).

Colias eurytheme Boisduval

IOWA, ♂ flying (LDM).

DC, ♂ flying (Clark, 1932).

Colias hyale (Linnaeus)

EUROPE, ♂ flying (Pronin, 1964).

Colias croceus Fourcroy

ENGLAND, August 1964, ca. 2:30 P.M. Disturbed on four occasions, the ♂ flying each time (M. Clifton).

Eurema daira (Godart)

VERACRUZ (MEXICO), 16.I.1966, 2:40 P.M. (CM-CUA).

Eurema lisa Boisduval & Le Conte

VERACRUZ (MEXICO), 16.I.1966, 1:45 P.M., ♂ flying (CM-CUA).

TAMAULIPAS (MEXICO), 26.I.1966, 12:55 P.M., ♂ flying (CM-CUA).

GEORGIA, 9.IX.1966: A mated pair was repeatedly disturbed. On the first two occasions the male flew; on the third, the female; on the fourth to sixth, the male. When the female took the lead the cover may have been so dense that the male could not fly (LDM).

FLORIDA, 22.III.1967, 10:55 A.M., ♂ flying (LDM).

DANAIIDAE

With the exception of Pronin's doubtful record, males are the active partner exclusively in danaiids. The observations of Brower *et al.* (1965) are particularly significant, as they were part of an extended study of *D. berenice* courtship behavior and many pairs were observed.

Danaus plexippus (Linnaeus)

IOWA, VII, VIII, afternoon, several pairs, ♂ flying (LDM).

CALIFORNIA, ♀ flying (Pronin, 1964) [record questionable].

NO LOCALITY, ♂ always flying (Urquhart, 1960: 52).

Danaus gilippus strigosus (Bates)

ARIZONA, VIII.1958, afternoon, at least 2 pairs, ♂ flying (LDM).

VERACRUZ (MEXICO), 16.I.1966, 3:30 P.M., ♂ flying (CM-CUA).

Danaus gilippus berenice (Cramer)FLORIDA, betw. 22.VII-11.VIII.1960 and betw. 2.VII-11.VIII.1961, betw. 2-5 P.M. (EST), many records, ♂ always flying (Brower *et al.*, 1965).

SATYRIDAE

Another well represented family. Females, without exception in the records, are the active partners, and matings take place from late morning to mid-afternoon, with a distinct predominance of records in early afternoon.

Cercyonis pegala maritima (Edwards)

MASSACHUSETTS, 27.VII.1964, 1:00 P.M. (HKC).

Cercyonis pegala (Fabricius), subspecies

PENNSYLVANIA, 23.VII.1961, 1:30 P.M., ♀ flying (LDM).

Euptychia cymela (Cramer)

PENNSYLVANIA (PNR), 28.V.1964, 12:45 P.M., ♀ flying; 5.VI.1964, 2:00 P.M.; and 3.VI.1965, 1:30 P.M., ♀ flying (HKC).

Euptychia hermes (Fabricius) complex

VERACRUZ (MEXICO), 18.I.1966, 1:30 P.M., ♀ flying (CM-CUA).

Maniola jurtina (Linnaeus)

ENGLAND, 5.VII.1964, 1:30-3:00 P.M., 2 pairs, ♀ flying (LDM).

EUROPE, ♀ flying (Pronin, 1964).

Melanargia galathea (Linnaeus), *Erebia medusa* Schiffermuller, *Pararge aegeria* (Linnaeus), *Aphantopus hyperanthus* (Linnaeus): all EUROPE, all ♀ flying (Pronin, 1964).

Pierella l. luna (Fabricius)

COSTA RICA, 18.VIII.1963, 11:00 A.M., ♀ flying (LDM).

Pierella helvina incanescens Godman & Salvin

COSTA RICA, 18.VIII.1963, 11:00 A.M., ♀ flying (LDM).

NYMPHALIDAE

There is much diversity in this family in the sex of the active partner. Females clearly predominate, but note the exceptions: *Speyeria nokomis* (sometimes) and *Anartia fatima* (but not *Anartia jatrophae*). Mating time may vary from group to group. The records suggest (hardly forcefully at this point) that *Phyciodes* and *Anartia* may mate in late morning, *Speyeria* in early afternoon, *Nymphalis* in mid afternoon and *Vanessa* in late afternoon.

Euptoieta claudia (Cramer)

NUEVO LEON (MEXICO), 2.VII.1966, 10:30 A.M., ♂ flying (C. J. McCoy, Jr.).

Speyeria cybele (Fabricius)

IOWA, 27.VIII.1956, ♀ flying (LDM).

Speyeria aphrodite (Fabricius)

PENNSYLVANIA (PNR), 8.VII.1965, 12:30 P.M., ♀ flying (HKC).

Speyeria idalia (Drury)

DC, ♀ flying (Clark, 1932).

Speyeria nokomis nokomis (Edwards)

COLORADO, 2.IX.1965, 2:30 P.M., ♂ flying (F. M. Brown). Mr. Brown has since observed a number of mated pairs of this species. On some occasions the male took the lead, on others, the female.

Argynnis paphia (Linnaeus)

EUROPE, VII, ♀ flying (Pronin, 1964).

Phyciodes tharos (Drury)

DC, ♀ flying (Clark, 1932).

PENNSYLVANIA (PNR), 25.V.1961, 12:00 noon (HKC).

NEW YORK, 3.VIII.1966, 1-2 P.M. (Sister M. Celestine).

Phyciodes phaon (Edwards)

TEXAS, 8.VII.1963, 10:00 A.M. (HKC).

Asterocampa leilia (Edwards)

TAMAULIPAS (MEXICO), 8.I.1966, 11:00 A.M., ♀ flying (CM-CUA).

Anartia jatrophae luteipicta Fruhstorfer

TAMAULIPAS (MEXICO), 8.I.1966, 11:00 A.M., ♀ flying (CM-CUA).

Anartia fatima (Fabricius)

COSTA RICA, 6.VIII.1963, 10:00-12:00 A.M., ♂ flying (LDM).

Limenitis bredowii (Geyer)

CALIFORNIA, VIII, 2-3 P.M., ♀ flying (Pronin, 1964).

Vanessa atalanta (Linnaeus)

RUSSIA, V, 4:15 P.M. (Pronin, 1964).

Vanessa cardui (Linnaeus)

RUSSIA, VII, 6:00 P.M. (Pronin, 1964).

Nymphalis antiopa (Linnaeus), *N. polychloros* (Linnaeus), *N. io* (Linnaeus), *N. urticae* (Linnaeus), *Polygonia c-album* (Linnaeus): all RUSSIA, IV, 2-3 P.M. (Pronin, 1964).

LYCAENIDAE

All the reliable records indicate that the female is the active partner in this family. There are, however, several possible exceptions: those of Pronin (1964) which are uncertain; and several, not listed, observed by HKC with sex determination doubtful. Mating time is exceedingly varied, from mid-morning to early evening.

The possible restriction of mating in some species (*crysalus*, *acadica*, *augustinus iroides*) to the hours of early evening is noteworthy and so far known only in this family.

Hypaurotis crysalus (Edwards)

COLORADO, 11.VIII.1962, 7 P.M. (Chambers, 1963).

Satyrrium acadica (Edwards)

MICHIGAN, 22.VII.1951, 6-7 P.M., several pairs; and 24.VII.1951, 6-8 P.M., several pairs (HKC).

CONNECTICUT, evening (*teste* C. L. Remington, Chambers, 1963).

Chrysophanus titus (Fabricius)

PENNSYLVANIA, 22.VII.1961, betw. 12:00-2:00 P.M., ♀ flying (LDM).

Callophrys (Incisalia) henrici (Grote & Robinson)

NEW YORK, 7.IV.1906, 10:30 A.M. (Cook, 1907).

Callophrys (Incisalia) augustinus iroides (Boisduval)

CALIFORNIA (Contra Costa Co.), 24.V.1963, 5:30 P.M. (PDT); 26.V.1963, 5:20-7:45 P.M., 2 pairs (sunset); 30.V.1963, 5:15 P.M. "Although . . . individuals often perched on the tree during midday hours, none were seen mating earlier than 5:00 P.M. (4:00 P.M. P.S.T.)." (Powell, 1964).

Lycaena phlaeas americana Harris

PENNSYLVANIA (PNR), 16.IX.1965, 1:15 P.M. (HKC).

Lycaeides melissa (Edwards)

NEW MEXICO, 23.VII.1963, 2:00 P.M. (HKC).

Plebeius argus (Linnaeus) and *Polyommatus icarus* (Rottemburg)

EUROPE, VII, ♂ flying (Pronin, 1964).

Maculinea arion (Linnaeus)

EUROPE, VIII, ♀ flying (Pronin, 1964).

Everes c. comyntas (Godart)

PENNSYLVANIA, 14.VIII.1952, 6:30 P.M. (HKC).

Everes comyntas texanus Chermock

COSTA RICA, 11.VIII.1963, betw. 11:00 A.M.-1:00 P.M., 2 pairs, ♀ flying (LDM).

VERACRUZ (MEXICO), 16.I.1966, 3:05 P.M., ♀ flying (CM-CUA).

Celastrina pseudargiolus (Boisduval & Le Conte)

MICHIGAN, 29.IV.1951, betw. 11:30 A.M.-1:30 P.M. (HKC).

HESPERIIDAE

As far as records indicate, only the female is the active partner in hesperiids. There is a marked preponderance of records in mid to late afternoon.

Polythrix asine (Hewitson)

COSTA RICA, 3.VIII.1963, betw. 11-12 A.M., ♀ flying (LDM).

Cogia calchas (Herrich-Schäffer)

COSTA RICA, 2.VIII.1963, 3:30 P.M., ♀ flying (LDM).

Erynnis juvenalis (Fabricius)

PENNSYLVANIA (PNR), 25.V.1961, 2:00 P.M. (HKC).

PENNSYLVANIA, 10.V.1964, 1:20 P.M., ♀ flying (LDM, HKC).

MARYLAND, 11.V.1965, 4:00 P.M., ♀ flying (HKC).

Adopaea s. sylvestris (Poda)

ENGLAND, 5.VII.1964, betw. 1:30–3:00 P.M., ♀ flying, 2 pairs (LDM).

Polites peckius (Kirby)

PENNSYLVANIA (PNR), 3.VI.1965, 4:20 P.M., ♀ flying; and 5.VIII.1965, 3:20 P.M., ♀ flying (HKC).

Euphyes conspicua conspicua (Edwards)

DC, ♀ flying (Clark, 1932).

Hesperia columbia (Scudder)

[CALIFORNIA], 2:15 P.M. (MacNeill, 1964:30).

Hesperia juba (Scudder)

WESTERN UNITED STATES, ♀ flying, 2 pairs (MacNeill, 1964:30).

Hylephila phyleus (Drury)

FLORIDA, IX.1962, ca. 4 P.M., ♀ flying (J. N. L. Stibick).

DISCUSSION

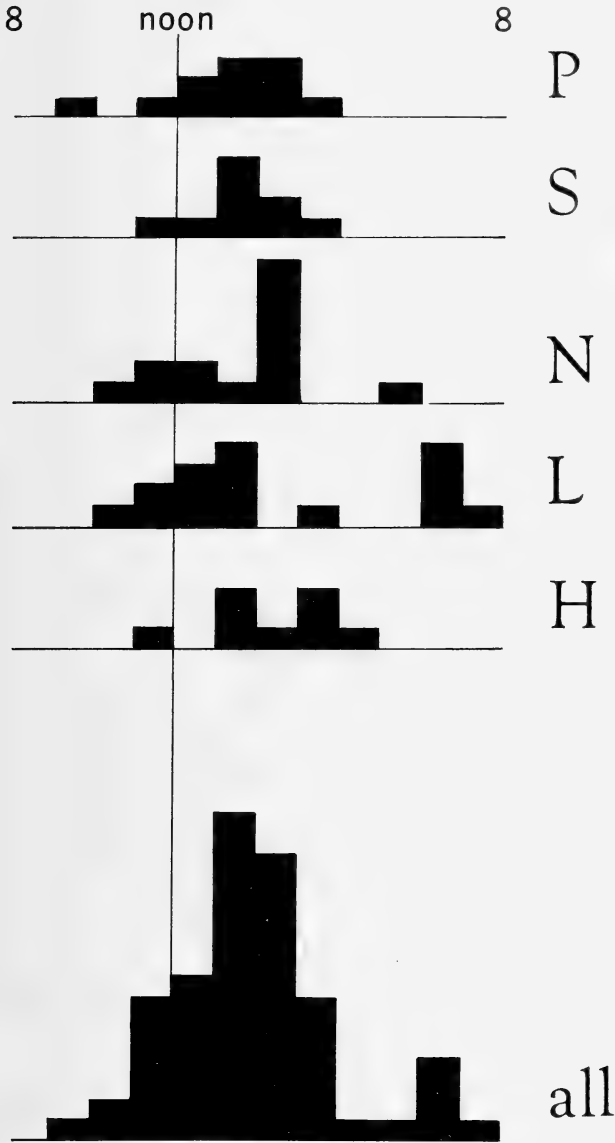
Not surprisingly, more questions are raised than answered by the foregoing data. Even so, a few generalizations are possible and a few thoughts are suggested by the data.

1. Mating time of day. We give (fig. 1) frequency polygons of the observed flight times for each of the major families. They include even rough records, and are not corrected for Daylight Saving Time, so they are crude representations. We intend them to show only (a) that much variety exists; (b) that the Hesperiidæ appear to mate somewhat later, on the average, than others; and (c) that the evening mating of some Lycaenidæ is a significant departure from the norm.

The polygon of combined records (bottom figure) shows a marked peak between the hours of 1:00 and 3:00 P.M., the hottest part of the average day. This, together with the great variability in observed times of some species, suggests that clock, or solar, time may be of less significance in a particular mating than the ambient or antecedent weather. Despite the rarity of observations of mated pairs in the field, it is remarkable how many of the above records consist of two or more pairs seen on the same day, even the same hour. This may be additional indication that appropriate weather conditions are important.

Early evening mating in some lycaenids is well established; and late afternoon mating in some Hesperiidæ also seems to be indicated. The significance of these facts we cannot even guess; nor can we explain the difference between such close relatives as *Callophrys* (*Incisalia*) *henrici* (morning mating) and *C. (I.) augustinus iroides* (evening mating).

2. Mating date: The calendar date on which mating occurs means little by itself; but taken in conjunction with the local flight period of



EXPLANATION OF FIGURE

Fig. 1. Frequency polygons of observed mating times in various families. P = Pieridae; S = Satyridae; N = Nymphalidae; L = Lycaenidae; H = Hesperidae. "all" = sum of all these, plus the Papilionidae and Danaidae. Note: (1) the somewhat later average mating time in Hesperidae; (2) the bimodality of the Lycaenidae, with a significant secondary peak in early evening; (3) the peak of all observations falling between 1-3 P.M., the warmest part of the average day.

the species it may be quite significant. In *Euptychia cymela*, the Powdermill records are all very early in the flight period: mating apparently occurs shortly after eclosion of the tardier sex. This appears to be true also in *Pieris rapae*, *P. virginiensis*, and *Phyciodes tharos*. On the other hand, in *Satyrrium acadica*, *Chrysophanus titus*, and possibly *Hypaurotis crysalus* and *Cercyonis pegala*, the records indicate that mating occurs much later in the flight period, perhaps even towards its end. In *pegala* it may coincide approximately with the first eclosion of the very tardy females, but this is not true in the lycaenids.

3. Sex of the active partner. Some families seem to be quite consistent: Pieridae (males), Danaidae (males), Satyridae (females), HesperIIDae (females). The Lycaenidae also may be consistent (females), but data are too few to be sure. In the Nymphalidae, although females predominate, there are several inconsistencies. Brown's observations that in *Speyeria nokomis* either sex may take the lead may ultimately be found true of many other nymphalids. The behavior of *Eurema lisa* (Pieridae) suggests that even in consistent families the normally passive partner may take the lead in some stress situations.

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PACIFIC SLOPE SECTION—1968 MEETING

The fifteenth annual meeting of the Pacific Slope Section of the Lepidopterists' Society will be held September 6-8, 1968, at the University of California, Berkeley. The program will include a field trip and open house at the museum Friday, September 6; presentation of papers Saturday and Sunday; and a banquet Saturday evening. Collections of the California Insect Survey and library facilities of the Department of Entomology will be available for study. Details of the program will be mailed to all Pacific slope members and to others who request them, in August.

NEW MOTHS FROM TEXAS (NOCTUIDAE, TORTRICIDAE)

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As a retirement hobby, I decided, six years ago, to catalog the moths of Texas. My wife and I have been collecting moths all over Texas for the last four years. As the work progressed, I came to realize that I may have to settle, more modestly, for a "Contributions Toward A Catalog of the Moths of Texas." The number of species in my collection which had apparently never been taken in Texas is quite large, and the number of those which seem to be new to science, particularly from the mountain ranges and desert areas of West Texas, is much larger than I ever expected.

I have been fortunate in interesting several specialists in describing some of these new species: Dr. C. L. Hogue (1965), Mr. McElvare (1966), Dr. E. L. Todd (1966) have described three. Difficult cases are now and, in the future, will be submitted to experts. I have described the male of a fourth species (1966), the female of which was described by Dr. F. H. Rindge (1966).

While getting more material for my intended catalog, I shall describe as many of the new species as I can name without becoming guilty of adding to the confusion which already exists in some genera.

In the present paper, I describe six new noctuids and one tortricid species. All types were collected by A. & M. E. Blanchard.

***Acronicta valliscola* Blanchard, new species**

(Pl. I, fig. 1; Pl. II, fig. 1)

Male: Palpi ascending, first segment white, second segment dark gray to black, except white proximal half beneath and tip, third segment white, sprinkled with black scales.

Head, collar and thorax covered with bluish white to black scales; vertex behind antennae, collar, and outer edge of patagia darkest.

Upperside of wings—Primaries: mottled bluish white and smoky gray, maculation deep black. Basal line diffuse, marked by a spot on costa and sometimes another on top of basal dash. T.a. line geminate, diffuse or obsolescent, most easily recognized by costal mark of distal component and intersections of both components with basal dash. Median shade an outwardly oblique, diffuse, blackish spot between costa and reniform. T.p. line geminate, outer component easily traced from costa to inner margin; inner component visible only near costa and at intersection with anal dagger mark; intervening space bluish white; in course starting on costa three-fifths the distance from costa to apex, above reniform, squarely outcurved and paralleling costa for half the distance between its inception and apex, then sharply incurved and following a course parallel to outer margin; outer component with a cusp over all veins below R_5 ; tips of cusps sometimes obliterated by over-

flowing of bluish white, leaving only separate black lunules. T.p. line bordered distally by smoky progressively changing, midway to termen, to bluish white.

No recognizable s.t. line. Fringes checkered, white at vein ends and black. Black tips of shorter fringe scales simulate a terminal line. Orbicular large, oval, whitish, circled with black, most heavily on distal half. Reniform large, kidney shaped, smoky gray, circled with black, most heavily on proximal half. The two spots closely adjacent or touching. Basal dash black, heavy, extending well beyond t.a. line. Broad anal dagger mark crossing t.p. line, remaining well separated from basal dash, consisting of two dashes, one along fold, one along Cu₂ with intervening space almost as dark as the dashes. Apical dagger mark lighter than other two, just reaching t.p. line.

Secondaries: white, end of veins and terminal line smoky, fringes white at vein ends, slightly dusky between.

Undersides of wings: Primaries gray, secondaries white, t.p. line showing on both, better on primaries.

Alar expanse: 30 to 34 mm.

Female: outwardly similar to male, except that secondaries show a diffuse smoky t.p. line narrowly bordered distally with white. Terminal space smoky.

Alar expanse: 30 to 35 mm (two specimens only).

Male genitalia: As in Pl. II, fig. 1. Saccus ending in a forked process, vesica armed with about 12 stout, short cornuti.

Female genitalia: Not studied.

Holotype male: Texas, Big Bend National Park, Green Gulch, altitude 5,200 feet, 10 May 1966. Genitalia on Slide A.B. No. 492; deposited in the U. S. National Museum (No. 68159). Twelve paratypes, all taken in Big Bend National Park, either in Pine Canyon (P.C.) or Green Gulch (G.G.): 2 ♂♂ and 1 ♀, P.C., 2 September 1964, (one of these males deposited in the American Museum of Natural History); 1 ♂, P.C., 1 April 1965; 1 ♂, G.G., 3 April 1965; 1 ♂, G.G., 27 June 1965; 1 ♂, G.G., 5 October 1965; 1 ♂, G.G., 14 May 1966; 1 ♀, G.G., 20 October 1966; 1 ♂, G.G., 7 October 1966; 1 ♂, G.G., 11 October 1966; 1 ♂, P.C., 8 April 1967.

The pattern of maculation of *valliscola* is similar to that of *furcifera* Guenée and related species. Most of the species in the *furcifera* group have the reniform and orbicular spots of the forewings connected at their base by a black bar. In *valliscola* the spots are either separated or connected at their middle. The combination of characters of size, dark bluish gray forewings, white hind wings, reniform and orbicular not connected or connected at the middle, and genitalic characters will separate this species from all species in the *furcifera* group. On genitalic characters, *valliscola* is closer to *pruni* Harris. The truncate shape of the distal end of the saccus of the valve is similar in the two species, but *pruni* has a slender ampulla, just basad of the other valve processes and directly below the heavy patch of setae on the dorsal margin of the valve (Dr. E. L. Todd, *in litt.*).

Oncocnemis toddi Blanchard, new species

(Pl. I, fig. 2; Pl. II, fig. 2)

Male and female externally similar.

Head: dark brown; scaled roughly between antennae and back, smooth scaled on front and vertex; eyes large, short gray lashes back of antennae; palpi scaled roughly, white beneath, concolorous with head on top and distal third, third segment very short.

Legs: white with some loose hair; tarsi dark brown, each segment narrowly bordered distally with pure white; foretibia slightly shorter than basal segment of foretarsus, with heavy keeled claw continuing into a fluted plate with sharp pointed outer corner.

Thorax, collar and patagia white.

Abdomen, smooth scaled, shiny white.

Upper surface of wings—Primaries: pure white basad of t.a. line; basal line very fine, black, starting on costa one-tenth the distance from base to apex, outwardly oblique, extending to Cu; t.a. line easily traced from costa to inner margin, simple, black, fine, darker than dark median space, originating on costa one-third distance from base to apex, outwardly oblique to Cu, upright from Cu to inner margin, reaching latter one-half the distance from base to anal angle; t.p. line traceable only from radial vein to inner margin, simple, black, fine, darker than dark median space, outwardly bordered with brownish white, outcurved facing cell, inwardly drawn to fold, then upright to inner margin, reaching latter five-sixths the distance from base to anal angle; s.t. line white, not sharp, irregularly wavy, contrasting with bluish gray, s.t. space and mottled bluish and brownish terminal space, terminal line fine, black, briefly interrupted on veins; fringes concolorous with s.t. space; median space the darkest portion of wing, brown except for pure white region including lower half of abnormally large reniform and wide region between this and costa; costa white from one-half to four-fifths the distance from base to apex; orbicular absent; median shade indicated on costa by small blackish spot, closer to base than middle of white part of costa.

Secondaries: white, a broad brownish band from apex to middle of outer margin; fringes pure white.

Underside: white, except brownish darkening on forewing corresponding to dark region of upperside.

Alar expanse: 21 to 22 mm.

Male genitalia: As in Pl. II, fig. 2 (from Dr. E. L. Todd's Slide No. E. L. T. 2326). Vesica armed with a bunch of numerous short cornuti near distal end and a double row of numerous longer ones at middle of aedeagus.

Female genitalia: Not studied.

Holotype male: Texas, Big Bend National Park, Chihuahuan desert near Dugout Wells, altitude 3,000 feet, 28 September 1965; genitalia prepared by Dr. E. L. Todd, No. E. L. T. 2326, deposited in U. S. National Museum (No. 68165). Paratypes: 1 ♀, same data in U. S. National Museum; 1 ♂ and 1 ♀, same data in the author's collection.

The wing pattern and coloration of this *Oncocnemis* is quite unusual; like many Acontiinae and a few Amphipyrrinae it has a presumed protective resemblance with bird droppings. Dr. E. L. Todd showed me specimens of *Tristyla alboplagiata* (Smith) in the collection of the U. S. National Museum and remarked that although they belong to a different subfamily, they have an amazingly similar pattern to the new

Oncocnemis. The white patch in the outer half of the forewing, in particular, is quite similar in shape and in position.

The male genitalia of *toddi* are rather small, about the same size as that of *O. umbrifascia* (Smith), the valvular process is somewhat similar, but the apex point is more basad in *toddi*. The aedeagus is proportionately smaller in *toddi* than in most other *Oncocnemis* species, the number of cornuti fewer, and the basal ones (vesica not distended) not enlarged as in other species of the genus, (Dr. E. L. Todd, *in litt.*).

I take pleasure in dedicating this species to Dr. E. L. Todd of the Entomology Research Division, U. S. Department of Agriculture.

***Hydroecia auripurpure* Blanchard, new species**

(Pl. I, fig. 3; Pl. II, fig. 3)

Male: Head: Eyes naked, strongly lashed. Antennae strongly bipectinate, pectinations biciliate; upper side closely covered with whitish scales. Tongue fully developed. Palpi porrect, reaching one-half eye diameter beyond descaled front but no farther than its hirsute covering of purplish to yellowish gray scales: first and second segments rough scaled, third segment short, smooth.

Collar, thorax and patagia: with fine, deep mixed vestiture of light yellowish gray scales becoming purple near top, tipped with whitish.

Abdomen: with basal tuft only.

Upperside of wings—Primaries: bright yellow. Basal, t.a. and t.p. lines, orbicular, reniform and claviform spots, all marked in olivaceous. Medium shade more contrastingly marked by mixture of olivaceous and purple scales. Beyond t.p. line, ground color changes progressively to purple through olivaceous.

Costa purple, interrupted by six white spots, backed in places by olivaceous. Basal line traceable as far as anal vein. T.a. line starting on costa near first white spot, one-third the distance from base to apex, irregular, retracted over cell and anal vein. Median shade starting on costa midway between first two white spots, half the distance from base to apex, roughly consisting of two segments forming a right angle with its apex at lower angle of cell; upper segment directed toward anal angle, lower segment nearly parallel to outer margin. T.p. line starting on costa near third white spot, two-thirds the distance from base to apex, with a small cusp over each vein, distally bordered with lighter yellow, reaching inner margin four-fifths the distance from base to anal angle. S.t. line diffusely indicated by thinning of purplish scales over olivaceous distal fifth of wing. Fringes of widely spatulate purple and black scales. No terminal line. A very small white dot at vein ends. Orbicular round, very large. Claviform large, nearly as wide as long. Reniform large, subrectangular, leaning by its lower side on median shade, well separated from t.p. line.

Secondaries: Sprinkled with yellowish gray and purple tipped scaled; purple scales more abundant in outer third of wing, separated from basal two-thirds by vaguely indicated lighter yellow line. Terminal line purplish brown, fringe of narrower scales than that of primaries, concolorous with outer third of wing.

Underside of wings—Primaries: yellowish gray, more heavily sprinkled with purple toward costa, apex and upper half of outer margin, terminal line brownish, fringe lighter than above. T.p. line indicated in purplish distally bordered with yellow. Secondaries similar to primaries, somewhat lighter.

Alar expanse: 28 to 32 mm.

Female: similar to male, except antennae simple.

Alar expanse: 31 to 32 mm.



EXPLANATION OF PLATE I

1. *Acronicta valliscola*; 2. *Oncocnemis toddi*; 3. *Hydroecia auripurpure*; 4. *Neperigea mephisto*; 5. *Oxycnemis franclemonti*; 6. *Grotella margueritaria*; 7. *Eucosma graziella*.

Male genitalia: As in Pl. II, fig. 3. Vesica armed with three large cornuti shaped like horseshoe nails.

Female genitalia: Not studied.

Holotype male: Texas, Big Bend National Park, Green Gulch, 5,400 feet, 11 October 1966; genitalia on Slide A.B. No. 483, deposited in U. S. Museum (No. 68160). Eighteen paratypes, all taken in Big Bend National Park at the following dates and places: 1 ♀, Basin, 3 October 1965; 5 ♂♂, 2 ♀♀, Green Gulch 2 to 7 October 1965; 7 ♂♂, 3 ♀♀, Green Gulch, 11 October 1966.

About half the paratypes are as brilliantly colored as the type. The other half, even though they are perfectly fresh, are paler, more powdery and certainly not quite so pretty.

Concerning the relationship between *Hydroecia auripurpura* and other species, I will quote from a letter that I received from Dr. J. G. Franclemont: "The only species at present placed in *Hydroecia* with which this one (*auripurpura*) can be compared is *repleta* Bird. From this it can be distinguished by its coloration, ground color golden yellow with the outer third suffused with rosy purple, that of *repleta* nearly an even dark brown; the reniform, claviform, and orbicular without white scales and inconspicuous in *auripurpura*, with white scales and large in *repleta*. The male genitalia of *auripurpura* differ from those of *repleta* by the very broad uncus, narrow and linear in *repleta*, the long digitus on each valve, short and obtuse in *repleta*, and three cornuti in the vesica, *repleta* with two."

***Neperigea mephisto* Blanchard, new species**

(Pl. I, fig. 4; Pl. II, fig. 4)

Male and female externally similar.

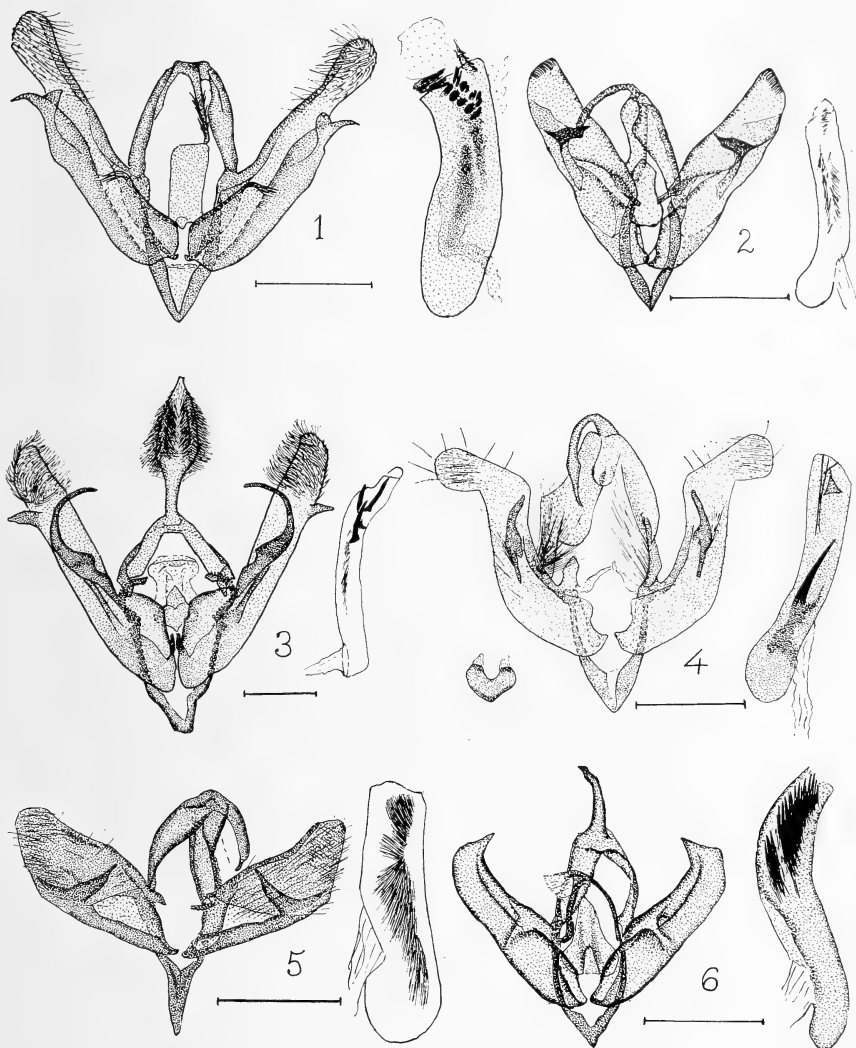
Head: dark reddish brown; palpi ascending to middle of front; tongue fully developed; antennae simple, shortly ciliated in male.

Collar, concolorous with head.

Thorax and patagia covered with gray scales, whitish at top; posterior tufting slightly darker.

Abdomen: gray above; each segment broadly bordered distally with creamy white; underside concolorous with these lighter bands.

Upside of wings—Primaries: cream colored, sprinkled with reddish and brown scales; basal line single, brown, diffuse, very close to base. Most prominent feature a dark brownish black median shade which has invaded most of the space between t.a. and t.p. lines; t.a. line with no inner component, outer component invisible, obscured in dark brown of median area; t.p. line with no outer component, inner component invisible, obscured in dark brown of median area; both lines traceable only by their light component, lighter than background, lacking sprinkling of reddish and brown scales. T.a. line starting on costa at basal one-fourth, excurved over cell, then upright to inner margin, reaching half distance from base to anal angle. T.p. line starting on costa at distal three-fifths, inwardly oblique, acutely angled outwardly before reaching radial vein, curving widely around large reniform, below which slightly recurved to reach inner margin at distal four-fifths. S.t. line vaguely indicated only near apex and anal angle by light spots. Area between t.p. line and outer margin heavily sprinkled with dark brown scales, never as dark as median space, always much darker than basal area. Three light spots on costa mark ends of three branches of radial vein. In light specimens the area above



EXPLANATION OF PLATE II

Male genitalia: 1. *Acronicta valliscola*; 2. *Oncocnemis toddi*; 3. *Hydroecia auripurpurea*; 4. *Neperigea mephisto*; 5. *Oxycnemis franclemonti*; 6. *Grotella margueritaria*.

reniform between t.p. line and innermost of these dots forms a rectangular patch concolorous with background. Terminal line dark brown, discontinuous, mostly lost in dark filling of terminal area. Fringes lighter than terminal area. Reniform, a dark crescent concolorous with median space, surrounded by kidney shaped whitish line. Orbicular absent.

Secondaries: whitish, becoming progressively fuscous distally, fringes dirty white.

Underside of wings—Primaries: cream colored, sprinkled with light brownish scales. Fringes concolorous.

Secondaries: dirty white.

Alar expanse: 26 to 28 mm.

Male genitalia: As in Pl. II, fig. 4. Vesica armed with a cornutus one-third as long as aedeagus.

Female genitalia: Not studied.

Holotype Male: Texas, State Wildlife Management Area, north of Van Horn, Sierra Diablo, Culberson County, altitude about 5,500 feet, 22–23 June 1965; genitalia on Slide A.B. No. 514; deposited in U. S. National Museum (No. 68161). Paratypes: 3 ♂♂ and 5 ♀♀, same data.

Neperigea mephisto is very close to *N. continens* (Hy. Edw.). The dark head and collar of *mephisto* contrast with the lighter thorax. In *continens*, the head, collar and thorax are substantially concolorous. The median space of the primaries is much darker in *mephisto*, contrasting markedly with the light subterminal space. The t.p. line of *continens* is darker than its median space and denticulate; the t.p. line of *mephisto* is lost in the dark median space and smooth. The males of *N. mephisto* have white secondaries; the secondaries of *continens* are light fuscous.

The male genitalia of *continens* are more heavily sclerotized. Both species show a cucullus at approximately right angle to the valvula, but the overhang of the cucullus is about equal to the width of the valvula in *mephisto* instead of at least twice the width of the valvula in *continens*. The spines of the corona are much weaker and not so numerous in *mephisto*. The juxta of *continens* has two elongated lobes, one on each side of the aedeagus; these lobes are shorter and triangular in *mephisto*.

Both species have a pair of hair pencils in two lateral grooves, one on each side, at the base of the abdomen.

***Oxyenemis franclemonti* Blanchard, new species**

(Pl. I, fig. 5; Pl. II, fig. 5)

Male: Eyes naked, unlashd, palpi ascending, reaching middle of front; first two segments appearing bladelike because of long, laterally appressed, black, white tipped scales; third segment short. Tongue fully developed. Antennae simple. Front smooth, white. Vertex with loose, black, white tipped scales.

Collar tawny, narrowly bordered with black at base and top. Thorax tawny; posterior tuft black. Patagia tawny, bordered with black. Foretibiae shorter than metatarsi, armed with strong inner claw and weaker outer claw. Both claws, on preparation of denuded foreleg appear to be part of the tibia.

Abdomen smooth scaled, whitish above, slightly darker beneath.

Upper surface of wings—Primaries: dark gray, consisting of blackish scales narrowly tipped with white. Basal line well defined, black, starting close to base of wing, briskly outcurved to a sharp cusp on cell, another smaller cusp on fold,

then drawn in to base of wing at inception of A. T.a. line geminate, inner component difficult to trace on most specimens; outer component starting on costa at basal one-third, reaching inner margin at basal one-third, wavy and indefinite in between; what appears to be darkest and most excurved loop, in fold, probably represents the claviform. T.p. line reduced to its inner component, black, distally bordered with gray, starting on costa a little beyond middle by well marked black spot, sharply outcurved and paralleling costa not quite to apex, then incurved and serrated with sharp cusps on R_5 , M_1 , M_2 , M_3 , touching or almost touching reniform by deep incurve between M_1 and M_2 , touching it again at lower angle of cell, finally parallel to outer margin in general course with a cusp on Cu_2 and one on A. Terminal line black. Fringe gray. S.t. space and terminal space concolorous, all veins accentuated in black; short, black, intervenular dashes butting on s.t. line which is vaguely indicated by a few white scales. Orbicular large, round with gray center, circled with whitish, circled again with black. Reniform large, oval, slightly constricted on outer side, consisting of small tawny spot backed on inner side by gray crescent, both tawny spot and crescent circled with whitish and black. Four white spots on costa, near ends of Sc , R_1 , R_2 and R_3 . Cells R_2 and R_3 and part of cell R_4 filled with white and grayish scales forming with more white scales on outer edge of reniform an easily recognizable gray fascia. T.a. space and t.p. space concolorous, somewhat darker than outer third.

Secondaries: pure white except blackish along outer margin and at vein ends. Terminal line black in its upper three-fourths; fringe white.

Undersurface of wings—Primaries: shiny gray, costa blackish, t.p. line indicated by dark dashes on veins. Long, fine, loose hair under cell, terminal line black; fringe white.

Secondaries: white except near apex, terminal line black, fringe white.

Genitalia: As in Pl. II, fig. 5.

Female: Similar except much more extended white patch at outer edge of reniform, sometimes invading reniform forming a prominent whitish fascia. One female shows a similarly colored fascia along fold. Genitalia not studied.

Alar expanse: 30 to 34 mm.

Holotype male: Texas, Big Bend National Park, Green Gulch, altitude 5,400 feet, 3 April 1965, genitalia on Slide A.B. No. 163; deposited in the U. S. National Museum (No. 68162). Paratypes (22): 1 ♂, Sierra Diablo Wildlife Management Area, north of Van Horn, Culberson County, Texas, 22–23 June 1965, and 16 ♂♂, 5 ♀♀, all taken in Big Bend National Park: 1 ♂, Dugout Wells, 28 September 1965; 3 ♂♂, 1 ♀, Government Spring, 29 September 1965; 2 ♂♂, Grapevine Hill, 2 October 1965; 1 ♂, Oak Spring, 6 October 1965; 2 ♂♂, 3 ♀♀, Dugout Wells, 3 October 1966; 5 ♂♂, 1 ♀, Chihuahuan Desert near Nugent Mountain, 8–9 October 1966; 2 ♂♂, Chihuahuan Desert near Nugent Mountain, 6 April 1967.

Oxycnemis franclemonti is closely related to *O. subsimplex* (Dyar), but the new species is larger, its hindwings are whiter with generally more prominent markings. The t.p. line of the forewing of *franclemonti* is definitely indented toward base beyond the reniform spot. There is no such indentation in *subsimplex*. The genitalia are similar except that the valvae of *subsimplex* are longer; the process on the inner face located farther out on the valve (apical third to apical fourth), the

spined tip of the process directed more or less toward the apex of the valve, not directed basad; the vinculum broader and stouter than in *franclemonti*, but about the same length; the cornuti of the aedeagus smaller in size and more numerous, (Dr. E. L. Todd, *in litt.*).

***Grotella margueritaria* Blanchard, new species**

(Pl. I, fig. 6; Pl. II, fig. 6)

Male: Head: palpi short, first segment drooping, roughly scaled, white; second segment longest, upturned, roughly scaled, white beneath, blackish above; third segment short, closely scaled, porrect, white beneath, gray above. Tongue fully developed. Front with typical *Grotella* hollowed out process; external ring constituted below by infraclypeal plate, semielliptical, as wide as front, and above by corneous, semicircular wall not quite reaching vertex. This outer ring interrupted in three places: ends of infraclypeal plate and notch at vertex. Central process obliquely truncate, slightly hollowed out. Space between external wall and central process thickly covered with rough, yellowish white scales; vertex white.

Thorax, collar and patagia white. Legs creamy white, except tarsi ochreous gray, each segment broadly ringed distally with creamy white. Foretibia with a heavy inner claw and about five medium spines above; on outer side a shorter claw and about two medium spines above; midtibia spined; hindtibia unspined.

Abdomen untufted, ochreous white above, lighter below.

Upside of wings—Primaries: creamy white with dark brown to black spots. Basal line represented by two spots, one near costa, one in cell. T.a. line consisting of five spots approximately in a straight line except fourth spot in cell Cu_2 , drawn in and accompanied by a supplementary spot basad of it. T.p. line sigmoid consisting of 11 interveinal spots, starting on costa at about distal three-fourths; spot 4 in cell R_5 outermost, at about distal four-fifths; spots 4, 5, 6 and 7 in a straight line subparallel to outer margin; spots 8, 9, 10 and 11, almost in a straight line, upright to inner margin at distal two-thirds; spot 5 in cell M_1 heaviest; spots 7 and 11 in cell M_3 and anal cell weakest and almost obsolete. S.t. line almost exactly parallel to t.p. line, consisting of almost as many spots; no spot in anal cell, spots between radial veins weak, confluent, tending to diverge toward apex. One weak spot represents the reniform. Terminal line absent; fringes checkered, black between veins, concolorous with background near vein ends.

Secondaries: ochreous white, concolorous with abdomen, becoming fuscous in a wide band along outer margin, fringes and inner margin concolorous with background of primaries.

Undersurface of wings—Primaries: ochreous, a large blackish spot corresponds to almost every pair of spots of the t.p. and s.t. lines. Fringes as above.

Secondaries: ochreous white with a row of submarginal spots extending three-fourths of the way from apex to anal angle.

Alar expanse: 26 to 27 mm.

Female: Maculation similar, slightly darker. Ten females caught in October have an alar expanse of 27 to 29 mm, one female caught in August measures only 25 mm.

Male genitalia: As in Pl. II, fig. 6. Vesica armed with a bunch of numerous, small cornuti.

Female genitalia: Not studied.

Holotype male: Texas, Big Bend National Park, Chihuahuan Desert near Nugent Mountain, altitude 3,000 feet, 8 October 1966. Genitalia on Slide A.B. No. 479; deposited in the U. S. National Museum (No. 68163). Paratypes (13): 2 ♂♂, 11 ♀♀, all taken in Big Bend National

Park, some labeled Dugout Wells, some labeled "near Nugent Mountain," but both places are in the Chihuahuan desert and less than two miles apart. The dates are: 1 ♀, 7 August 1964; 1 ♂ and 5 ♀♀, 8 October 1966; 1 ♂ and 5 ♀♀, 9 October 1966.

Grotella margueritaria differs markedly in appearance from all described *Grotella* species. *G. soror* (B. & McD.) and *G. tricolor* (Barnes) resemble it most in pattern of maculation and ground color of wings, but it is larger than both. *G. margueritaria* completely lacks the orange third color of *tricolor* between the t.p. and s.t. lines. The s.t. line of *G. tricolor* is made up of spots extremely unequal in size and intensity, that of *margueritaria* is much more equal and smoother in course. The s.t. line of *G. soror* completely lacks spots in Cells M₂, M₃ and in the fold; *G. margueritaria* lacks the spots which *G. soror* shows in the terminal space near the ends of Cu₁ and Cu₂. Of 14 specimens before me, only one shows a faint apical spot in the s.t. space near the apex where *G. soror* has a heavy spot.

***Eucosma graziella* Blanchard, new species**

(Pl. I, fig. 7; Pl. III, figs. 1-4)

Male and female: outwardly similar except that the male has a costal fold and longer cilia on antennae.

Head: Tongue minute, hidden between palpi; denuded palpus showing long, flattened second segment, short cylindrical third segment; first and second segments clothed with long white scales, some with dark spot near tip, forming decumbent tuft far exceeding end of third segment.

Uppersurface of wings—Primaries: white mottled with gray and light tawny. Pattern of maculation as in pl. I, fig. 7. Most prominent feature, a large, dark brown to almost black spot straddling fold, constricted basally over fold. Remainder of maculation mostly between end of cell and termen, in part concolorous with spot in fold. Costa heavily sprinkled with black. Terminal line white; fringes white, obscurely checkered with gray.

Secondaries: light tawny, darker toward apex; terminal line tawny, fringe white.

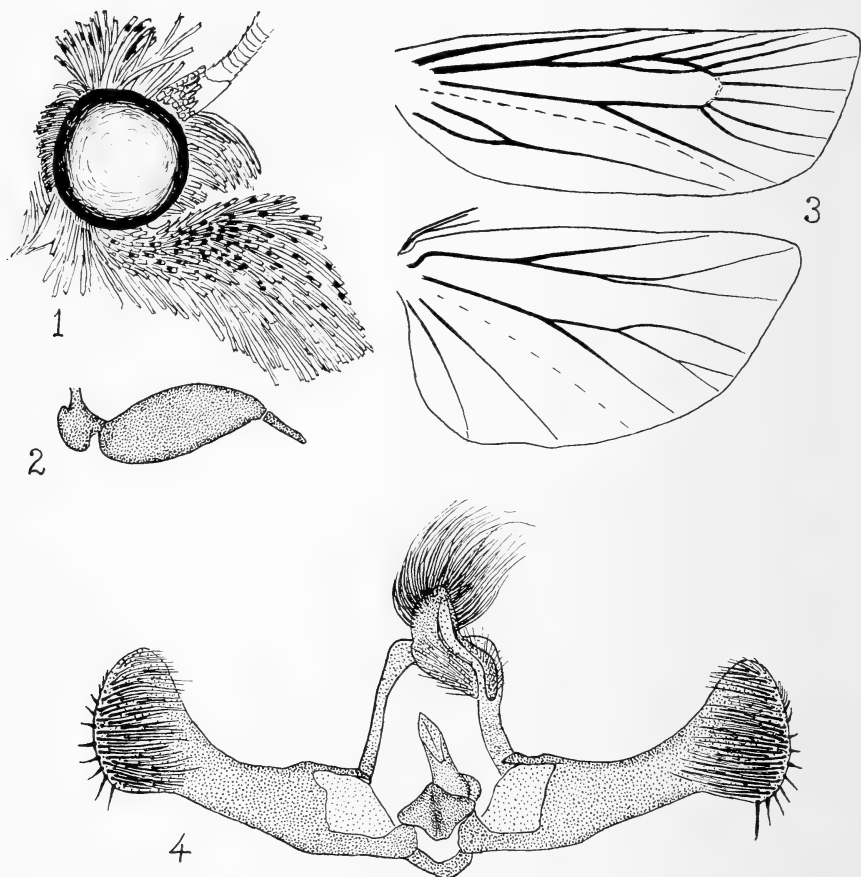
Underside of wings—Primaries: smoky to blackish fringe white. Secondaries: almost white.

Alar expanse: 28 to 31 mm.

Male genitalia: As in pl. III, fig. 4.

Female genitalia: Not studied.

Holotype male: Texas, Big Bend National Park, Green Gulch, 11 October 1966; genitalia on Slide A.B. No. 481; deposited in U. S. National Museum (No. 68164). Paratypes (21): 1 ♂, Big Bend National Park, Grapevine Hill, 2 October 1965; 1 ♂, Big Bend National Park, Oak Spring, 4 October 1965; 1 ♂, Big Bend National Park, Green Gulch, 5 October 1965; 1 ♂, Fort Davis, 9 October 1965; 1 ♂, Big Bend National Park, Dugout Wells, 3 October 1966; 1 ♂, Big Bend National Park, Government Spring, 6 October 1966; 11 ♂♂ and 1 ♀, Big Bend National Park, Chihuahuan Desert near Nugent Mountain, altitude



EXPLANATION OF PLATE III

Eucosma graziella: 1. profile of head; 2. denuded palpus; 3. wing venation; 4. male genitalia.

3,000 feet, 8-9 October 1966; 2 ♂♂ and 1 ♀, Big Bend National Park; Green Gulch, 11 October 1966.

Eucosma graziella has been compared to its nearest relatives in the genus by Dr. Don R. Davis, Curator of Lepidoptera, in the U. S. National Museum. "Separating *E. graziella* from all other olethreutids is a very simple task since the species resembles no other in maculation. I know of no other species that possesses a pale gray forewing with similar markings. The broad, crescent-shaped black spot at the base of the cell is unique for this species. The male genitalia of this group is often not very diagnostic; however, your species seems to be readily separated

from the other species of North American *Eucosma*. On the basis of the male genitalia, it resembles *Eucosma denverana*, *E. agassizii* and *E. gilletteana*. Your species can be separated from these three by the fact that the cucullus is broader and more triangular . . . the cucullus of *E. graziella* resembles that of *E. fofana*."

ACKNOWLEDGMENTS

As I dispose only of a limited collection of Texas material, it is much easier for me to describe the particular features of a new species than to find out and state the relationship of the described species to existing taxa. This paper would not have been possible without the invaluable help which I received, for this most difficult part of the job, from Dr. Don R. Davis, Curator, Division of Lepidoptera, U. S. National Museum, from Dr. E. L. Todd, Entomology Research Division, ARS, Department of Agriculture, and from Dr. J. G. Franclemont, Professor of Entomology, Cornell University.

My thanks are also due for the loan or gift of specimens of *Grotella soror*, for comparison purposes, to Dr. Franclemont, Mr. McElvare and the Los Angeles County Museum, also to Mr. S. A. Hessel for examining and comparing a paratype of *H. auripurpurea*.

I wish to express my sincere gratitude to the personnel of Big Bend National Park, where most of the insects were taken and to the personnel of the Texas Park & Wildlife Department, particularly of the Sierra Diablo Wildlife Management Area, in which one of the types and several paratypes were taken.

My light traps are similar to the ones designed by Mr. J. P. Hollingsworth, Agricultural Engineer, doing research for the Department of Agriculture, at College Station, Texas. The two-transistor converters used in feeding the 15-watt fluorescent black light from 12-volt car batteries were designed by Mr. C. O. Schafer who was my colleague at Schlumberger Ltd. before I retired. I want both of them to find here the expression of my sincere thanks.

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AN EXTREME EXPERIMENTAL ABERRATION OF *VANESSA CARDUI* (NYMPHALIDAE)

During the past four years I have been subjecting pupae of *Vanessa cardui* (L.) to a lowered temperature of 36°F., the temperature of my refrigerator, to produce aberrations. By process of elimination I have found the "prime time" for chilling the pupae to be between 45 and 90 minutes after the larvae pupate, then leaving them chilled for about 14 days. The mortality rate averages 20% (excluding parasites) for 14 days and climbs with lengthened duration. Longer chilling durations, in turn, produce more extreme aberrants.

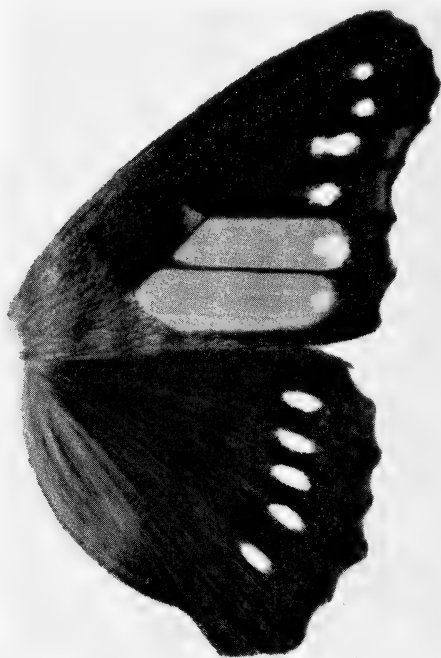


Figure 1.—Wing pattern of an experimental aberration of *Vanessa cardui* (L.) produced by chilling the pupa.

The figure is copied from a colored pencil illustration made from the wings of a specimen which failed to emerge after having been subjected to chilling for 14 days. It is *V. cardui*, form "elymi" Ramb., but very extreme.

The collector should always be at hand when the butterflies are ready to emerge (the majority emerge eight days after removal from the refrigerator) as they frequently need help emerging. However, knowing when to help is a real test. Specimens usually die prior to distending the wings if left alone (as the specimen figured did).

The advantage of this experiment is its simplicity. Only mature larvae ready for pupation are needed, eliminating foodplant complications.

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LEPIDOPTERA OF THE CENTRAL BRAZIL PLATEAU.
III. PARTIAL LIST FOR THE BELO HORIZONTE AREA,
SHOWING THE CHARACTER OF THE SOUTHEASTERN
"BLEND ZONE"

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In our first paper on the Rhopalocera of the *cerrado* area of the Brazilian plateau (Brown & Mielke, 1967), we mentioned the existence of a narrow zone at the southeastern edge of this region which, while possessing a fauna closely allied with that of the true planalto, showed also a strong infusion of elements typical of the southeast coastal mountain area of Brazil (*Serra do Mar*) which were absent in the *cerrado*. This intermediate area is distinguished from that part of the planalto treated in Part I by the presence of a richer soil and more regular rainfall, with corresponding substitution of the dry, scrubby *cerrado* with a lush open grassland (*campo*, or, if mixed with scrub, *campo cerrado*). The forest is about as restricted in the two regions, occurring mainly along watercourses and around springs (*mata ciliar*). The frequent admixture of *cerrado* flora with the *campo* of the blend zone results in the presence of many species of butterflies allied with the region more to the north; but the predominance of the richer-soil *campo* in conjunction with the heavy moist riverside forests permits the existence of a variety of forms typical of the *Serra do Mar*, which do not pass farther to the northwest and are thus absent from the list in Part I.

We have undertaken to make a representative list of Rhopalocera from some relatively well-collected areas within this blend zone, in order that its mixed nature and influence of the *Serra do Mar* might be appreciated. The zone covers a rather narrow strip running from the northern part of the state of Minas Gerais (where it meets the northeastern arid thorn forest) southward through this State and across the middle of São Paulo (see Figure 1). As herein delineated, the blend zone reaches a fairly sharp northwestern limit at the start of the true *cerrado* unmixed with *campo* (see Part I). Its southeastern limit comes at the edge of the more mountainous and well-watered area of the *Serra do Mar*, where dense forest thrives even on hilltops away from



permanent watercourses; this is perhaps an average of 150 kilometers southeast of the northwestern border with the cerrado.

The elevation of the blend zone is about 600 to 1400 meters, corresponding to the median elevation of the central plateau in general. However, the proximity of the zone to the higher mountains on the southeast coast blurs the sharply distinct wet and dry seasons typical of the cerrado, and rain may be expected in any month of the year (though naturally more rain falls during the hotter summer months which give almost all of the rain to the cerrado to the northwest). The winters, while generally cooler than those in the cerrado, do not include the frosts which occur in the more mountainous areas of the Serra do Mar. These climatic factors permit the existence of elements of fauna typical of the cerrado together with others typical of the Serra do Mar. However, many species of the Serra do Mar do not enter the blend zone, being restricted by the border of the general heavy damp forest with the area of campo and mata ciliar.

The only large city in the blend zone is Belo Horizonte, capital of Minas Gerais, situated at 850 meters elevation in a large bowl surrounded by iron-rich hills, and having a population of nearly one million and a large federal university. The Belo Horizonte area (including the suburbs of Serra and Barreiro which have city water forest reserves, the more distant communities of Brumadinho, Lagoa Santa and Sete Lagoas, and the rolling hilly area known as Serra do Cipó, "Liana Mountains") is quite well-collected, and we (especially KB) have collected considerable material there during the past year. We have gathered our own records, the material in the collection of the Museu Nacional in Rio de Janeiro, and the collections known to us in Belo Horizonte (mostly made by students in zoology courses of the University and University High School, with considerable material also collected by Mr. Ney Carnevalli and Mr. João Evangelista da Silva of the teaching staff of these courses), and herewith present a representative list for the Belo Horizonte area, as being typical of the blend zone. We have also considerable material from other areas in the zone; it agrees well with that from Belo Horizonte, with some additional species being present from both north and south but not changing the overall pattern as set forth below. It must be emphasized that the following list is representative and could not claim to be complete; within each family grouping, the esti-

←

MAP: Tentative formulation of the boundaries of the "Blend Zone" in relation to nearby faunal regions. The Serra do Mar includes occasional intrusions of cerrado flora and fauna, as the Cerrado includes occasional islands of "campo" and of heavy Serra do Mar-type forest.

mated number for a complete list for the blend zone is given, with the percentage of this number that we have recorded. This percentage is high (60–100%) for Papilionidae, Pieridae, and various subfamilies (except Satyrinae) of Nymphalidae, but low for Satyrinae, Riodininae, Theclinae, Plebejinae and Hesperidae (20–50%; the latter were in general not collected by the students). We do not plan to publish supplements in order to render this list more complete, as it is presented merely as support for the faunal character of the blend zone and not as a local fauna. However, further observations of ecological interest and perhaps comments on other sections of the blend zone may form part of future communications within this series.¹

The nomenclature and order of the list follow that of Part I in this series; determinations were made by the authors and by Dr. Romualdo Ferreira d'Almeida, whom we wish to thank for his extensive assistance. The approximate abundance of species in the Belo Horizonte area is given following a standardized scale: a (abundant), present in many areas, several dozen often caught in a day's collecting; c (common), present in many areas, almost surely caught in an average day's collecting in the area; u (uncommon), not surely a part of an average day's catch, but regular and to be expected in at least some localities; and r (rare), only one or two specimens known to, caught or seen by the authors. Seasonal data on the species are included if significant variation has been noted between the seasons, but many species show little difference in occurrence at different times of the year. An asterisk (*) in the list marks species seen in the Museu Nacional or student collections with which the authors have no personal experience in the area covered. A double asterisk (**) indicates a few species in the student collections which, while probably from the Belo Horizonte area, may conceivably come from areas in which the students reside outside of the blend zone. Essentially all species not asterisked are in the collection of KB.

NYMPHALIDAE

MORPHINAE: Total 2 out of probable 3, 67% (third is *menelaus*).

Morpho achillaena paulista Fruhst., 1912: c

Morpho anaxibia anaxibia (Esper, 1798): u, Feb.–March

¹ We also have seen and collected a fair number of identifiable Spingidae, Dyscematidae, Saturnoidea and other Heterocera from the Belo Horizonte area; these likewise show a mixture of forms typical of the cerrado and others of the Serra do Mar, including (as with Rhopalocera) a number of species evidently not present in Parapoeba at the southeastern limit of the cerrado (see Part I). We do not judge these records to be of sufficient completeness or interest to be included in this paper, especially as we have only begun work on the Heterocera of the cerrado; however, we will be glad to provide information on them to interested persons.

SATYRINAE: Total 12 out of estimated 50, 24%.

- ***Pierella nereis* (Drury, 1782): r
- Taygetis virgilia* (Cr., 1779): u
- Taygetis celia* (Cr., 1782): u
- Pareuptychia ocirrhoe ocirrhoe* (F., 1777): u
- Hermeuptychia hermes hermes* (F., 1775): c
- Pharneuptychia pharella* (Butl., 1866): u
- Yphthimoides angularis* (Butl., 1867): u
- Yphthimoides celmis* (Godt., 1823): u
- Paryphthimoides* (?) *vestigiata* (Butl., 1867): u
- Haywardina stelligera* (Butl., 1874): r
- Argyreuptychia* (?) *terrestris* (Butl., 1866): r
- Godartiana muscosa* (Butl., 1870): c

BRASSOLINAE: Total 9 out of estimated 15, 60%.

- Brassolis sophorae laurentii* Stich., 1925: c
- **Narope cyllarus* Westw., 1851: r
- Opsiphanes batea* (Hbn., 1821): u, summer
- Opsiphanes cassiae lucullus* Fruhst., 1907: u
- Opsiphanes invirae remoliatu* Fruhst., 1907: u
- Opsiphanes quiteria meridionalis* Stgr., 1887: r
- Eryphanis reevesii* (Dbldy., 1849): r
- Caligo illioneus illioneus* (Cr., 1776): c
- Caligo arisbe* (Hbn., 1825): u, summer

DANAINAE: Total 3 out of probable 4, 75% (the fourth, *Ituna ilione*, is known from Carmo do Rio Claro, Minas Gerais, in the western tip of the blend zone)

- Danaus* (*Danaus*) *erippus* (Cr., 1775): c
- Danaus* (*Anosia*) *gilippus gilippus* (Cr., 1775): c
- Lycorea ceres ceres* (Cr., 1776): c

ITHOMIINAE: Total 19 out of estimated 25, 76%.

- Hypoleria plisthenes* d'Almeida, 1958: u
- Hypoleria salonina* (Hew., 1855): u
- Pseudoscada erruca* (Hew., 1855): u
- Pteronymia carlia* (Schaus, 1902): u
- Episcada carcinia* (Schaus, 1902): u
- Episcada sylvo* (Geyer, 1832): u
- Dircenna dero* (Hbn., 1823): c
- Dircenna rhoeo* Feld., 1860: r
- Aeria olena* (Weym., 1875): a
- Oleria aquata* (Weym., 1895): u
- Placidula euryanassa* (Feld., 1860): u, somewhat seasonal
- Ithomia agnosia agnosia* Hew., 1854: c
- Ithomia drymo drymo* Hbn., 1816: u
- **Hypothyris laphria* (Dbldy., 1847): r
- Hypothyris daeta* (Bdv., 1836): u
- **Sais rosalia rosalinde* Weym., 1890: r, local
- Mechanitis lysimnia* (F., 1793): c
- Mechanitis polymnia casabranca* Haensch, 1905: c
- Tithorea harmonia pseudethra* Butl., 1873: r

ACRAEINAE: Total 6 out of probable 8, 75%; all highly seasonal.

- **Actinote conspicua* Jord., 1913: r
- Actinote surima* Schaus, 1902: c
- Actinote pyrrha* (F., 1775): c
- Actinote pellenaea* Hbn., 1821: u

Actinote rhodope d'Alm., 1922: u

Actinote genitrix d'Alm., 1922: u, represents form *moesa* d'Alm., 1925

HELICONIINAE: Total 12 out of probable 15, 80%.

Heliconius (Heliconius) sarae apseudes (Hbn., 1818): u

Heliconius (Heliconius) erato phyllis (F., 1775): a

Heliconius (Heliconius) besckei Mén., 1857: c

Heliconius (Heliconius) ethillus narceus Godt., 1819: c

Heliconius (Eueides) isabellae dianasus (Hbn., 1806): u

Heliconius (Eueides) pavanus Mén., 1857: r

Heliconius (Eueides) alipherus (Godt., 1819): c

Colaenis iulia iulia (F., 1775): c

Dione junio junio (Cr., 1779): u

**Dione moneta* Hbn., 1825: r

Agraulis vanillae maculosa (Stich., 1907): c

Dryadula phaetusa (L., 1758): c, local

NYMPHALINAE, CHARAXINAE: Total 56 out of estimated 80, 70%.

Euptoieta hegesia hegesia (Cr., 1780): r

Phyciodes thymetus thymetus (F., 1787): c

Phyciodes sejona Schaus, 1902: c

Phyciodes lansdorfi (Godt., 1821): u

Phyciodes ithra (Kirby, 1871): c

Chlosyne lacinia saundersi Dbldy., 1847: u

Vanessa virginiensis brasiliensis (Moore, 1883): r

Vanessa myrinna (Dbldy., 1849): u

Junonia evarete evarete (Cr., 1779): c

Anartia jatrophae jatrophae (Joh., 1763): c

**Anartia amatheia roeselia* (Eschsch., 1821): c, local

Metamorpha stelenes stelenes (L., 1758): c

Metamorpha trayja (Hbn., 1823): u

Hypanartia lethe (F., 1793): u

Limenitis (Adelpha) syma (Godt., 1823): c

Limenitis (Adelpha) mincia Hall, 1938: u

Limenitis (Adelpha) poltius Hall, 1938: u

Limenitis (Adelpha) plesaure heredia Fruhst., 1915: c

Limenitis (Adelpha) cytherea herennia Fruhst., 1915: c

Limenitis (Adelpha) thoasa gerona (Hew., 1868): c

Marpesia chiron (F. 1775): u

Dynamine tithia (Hbn., 1823): u

Dynamine mylitta mylitta (Cr., 1782): c

Dynamine artemisia (F., 1793): u

Dynamine agacles (Dalm., 1823): u

Dynamine athemon maeon (Dbldy., 1849): r

**Catonephele sabrina* (Hew., 1852): r

Callicore pygas thamyras (Mén., 1857): u, winter only; may be replaced by *splendens* in summer as on the planalto

Callicore selima selima (Guenée, 1872): u

Callicore sorana (Godt., 1823): c

Diaethria candrena (Godt., 1821): u

Diaethria eluina (Hew., 1852): r

Diaethria clymena janeira Feld., 1862: c

Epiphile hubneri Hew., 1861: u (seasonally common)

Epiphile oreia Hbn., 1823: u

Temenis laothoe bahiana Fruhst., 1907: u

Cybdelis phaesyla Hbn., 1825: erratic, seasonal

Evonyma margarita (Godt., 1823): c seasonally

***Evonyma bechina* (Hew., 1852): r

Mestra hypermestra apicalis (Stgr., 1888): local

Hamadryas ferentina ferentina (Godt., 1821): u

Hamadryas feronia obumbrata (Fruhst., 1916): c

Hamadryas epinome (Feld., 1867)

and/or *iphthime gervasia* (Fruhst., 1916): u

Hamadryas amphinome aegina (Fruhst., 1916): u

Hamadryas laodamia (Cr., 1776): u

Biblis hyperia hyperia (Cr., 1779): c

Doxocopa laurentia (Godt., 1823): local

Doxocopa kallina (Stgr., 1888): r

Colobura dirce (L., 1758): u

Prepona demophon extincta Stgr., 1886: c

Anaea (Zaretis) itys strigosus (Gmelin, 1788-93): u

Anaea (Hypna) clytemnestra hubneri (Butl., 1866): u

Anaea (Memphis) appias (Hbn., 1825): u

Anaea (Memphis) ryphea phidile (Geyer, 1834): c

Anaea (Memphis) otrere (Hbn., 1825): u

Anaea (Memphis) arachne victoria (Druce, 1877): u

LIBYTHEIDAE: 1 out of 1, 100%

Libytheana carinenta (Cr., 1779): r

LYCAENIDAE

RIODININAE: Total 20 out of estimated 80, 25%; all very local.

Hamearis campestris (Bates, 1868): c

Euselasia hygenius occulta Stich., 1919: u

Leucochimona philemon mathata (Hew., 1873): u

Eurybia dardus misellivestis Stich., 1910: u

Eurybia elvina tephrias Stich., 1915: r

Lyropteryx terpsichore terpsichore Westw., 1851: r

Calephelis nilus (Feld., 1861): u

Chalodeta epijessa calicene (Hew., 1866): r

Riodina lycisca (Hew., 1847): c

Lymnas xenia erythra (Mén., 1855): c

Emesis lucinda fastidiosa (Mén., 1855): u

Emesis diogenia Prittw., 1865: u

Emesis ocypore zelotes Hew., 1872 (?): u

Apodemia paucipuncta Spitz, 1930: u

Anatole zygia epone (Godt., 1824): u

Anatole glaphyra modesta Mengel, 1902: u

Nymula calyce calyce (Feld., 1862): c

Nymula phillone (Godt., 1824): u

Stalactis susanna (F., 1787): u

Stalactis phlegia (Cr., 1765): u

PLEBEJINAE, THECLINAE: Total 15 out of estimated 75, 20%.

Leptotes cassius (Cr., 1775): c

Hemiargus ceraunus zachaeina (Butl., 1872): c

Pseudolycaena marsyas (L., 1764): u

Mithras hemon (Cr., 1775): u

**Atlides cosa* (Hew., 1867): u

"*Thecla*" *meliboeus* (F., 1793): c

Rekoa palegon (Cr., 1780): c

"*Thecla*" *crambusa* Hew., 1874: u

Callicista mulucha (Hew., 1874): u

- Callicista thijs* (Hbn., 1832): c
Callicista faunalia (Hew., 1868): c
 "Thecla" *phrutes* Hbn., 1832: r
 "Thecla" *sophocles* (F., 1793): u
 "Thecla" *taramia* Hew., 1868: u
 "Thecla" *aphaca* Hew., 1867: u

A further 15 species of "Thecla" have been collected and still await identification.

PIERIDAE: Total 28 out of probable 32, 88%.

- Eurema* (*Pyrisitia*) *tenella* (Bdv., 1836): u
Eurema (*Pyrisitia*) *leuce* (Bdv., 1836): c
Eurema sp.: local (close to *dina*)
Eurema (*Eurema*) *deva* (Dbldy., 1847): c
Eurema (*Eurema*) *arbela arbela* Geyer, 1832: c
Eurema (*Eurema*) *musa* (F., 1793): r, winter
Eurema (*Eurema*) *phiale majorina* (d'Alm., 1932): r, summer
Eurema (*Eurema*) *albula* (Cr., 1775): c
Eurema (*Eurema*) *elathea elathea* (Cr., 1777): c
Phoebis (*Aphrissa*) *statira* (Cr., 1777): u
Phoebis (*Phoebis*) *neocypris* (Hbn., 1823): r
Phoebis (*Phoebis*) *argante argante* (F., 1775): u
Phoebis (*Phoebis*) *philea philea* (Joh., 1767): u
Phoebis (*Phoebis*) *sennae sennae* (L., 1758): c
Anteos menippe (Hbn., 1819): c
Anteos clorinde (Godt., 1823): c, seasonal
Leucidia elvina (Godt., 1819): c
Ascia monuste monuste (L., 1764): c
Appias drusilla drusilla (Cr., 1777): u
Hesperocharis anguita (Godt., 1819): u
Melete lycimnia paulista (Fruhst., 1907): c
Pereute antodyca (Bdv., 1836): r
Catacticta bithys (Hbn., 1825): r
Archonias tereas (Godt., 1819): u
Dismorphia psamathe (F., 1793): u
Dismorphia thermesia (Godt., 1819): u, local
Dismorphia astyocha Hbn., 1824: r
Pseudopieris nehemia (Bdv., 1836): u

PAPILIONIDAE: Total 12 out of estimated 20, 60%. Almost all species are present only in summer (exceptions noted).

- Battus* (*Parides*) *agavus* (Drury, 1782): u
Battus (*Parides*) *bunichus* (Hbn., 1822): u
Battus (*Parides*) *diodorus* (Hoppf., 1866): c, local (also sparingly in winter)
 **Battus* (*Parides*) *nephalion* (Godt., 1819): r
Battus (*Battus*) *polydamas polydamas* (L., 1758): c (also occurs in winter)
Papilio anchisiades capys (Hbn., 1809): c, erratically seasonal
 **Papilio astyalus astyalus* Latr., 1819: c, local
Papilio hectorides Esper, 1794: c (also occasionally in winter)
Papilio scamander grayi Bdv., 1836: c
Papilio thoas brasiliensis Roths. & Jord., 1906: c, also flies in winter
Papilio torquatus polybius Swainson, 1823: c
Graphium lysithous lysithous (Hbn., 1821): r

HESPERIIDAE: Total 74 out of an estimated 250, 30%

- **Pyrrhopyge pelota* Plötz, 1879: u
 **Elbella menecrates* (Mab., 1878): r

- Mimoniades versicolor versicolor* (Latr., 1823): r
 **Mysoria barcastus barta* Ev., 1951: r
Myscelus amystis epigona H.-Sch., 1869: r
 **Phocides polybius phanius* (Burm., 1880): u
 **Phocides pigmalion hewitsonius* (Mab., 1883): r
Aguna asander asander (Hew., 1867): u
Codatractus aminias (Hew., 1867): r
Urbanus proteus proteus (L., 1758): u
Urbanus esta Ev., 1952: u
Urbanus viterboana alva Ev., 1952: u
Urbanus dorantes dorantes (Stoll, 1790): c
Urbanus teleus (Hbn., 1821): u
Urbanus simplicius (Stoll, 1790): c
Urbanus procne (Plötz, 1881): u
Urbanus chalco (Hbn., 1823): u
Urbanus virescens (Mab., 1877): u
Astraptus fulgurator fulgurator (Walch, 1775): r
Astraptus anaphus anaphus (Cr., 1777): r
Autochton reflexus (Mab. & Boull., 1912): c
Autochton zarex (Hbn., 1818): r
Autochton itylus (Hbn., 1823): u
Ablepsis vulpinus (Hbn., 1820): r
Spathilepia clonius (Cr., 1775): r
Caicella calchas (Herr.-Sch., 1869): r
Sophista latifasciata latifasciata (Spitz, 1930): r
Polyctor polyctor polyctor (Prittw., 1868): u
Nisoniades bipuncta (Schaus, 1902): r
Morvina fissimacula fissimacula (Mab., 1878): r
Viola violella (Mab., 1897): c
Trina geometrina geometrina (Feld., 1867): u
Diaeus lacaena lacaena (Hew., 1871): r
Quadrus u-lucida parabus Mielke, 1968: r
Gindanes brebisson brebisson (Latr., 1824): r
Pythonides jovianus fabricii Kirby, 1871: u
Pythonides lancea (Hew., 1868): u
Sostrata cronion (Feld., 1867): u
Mylon menippus (F., 1776): c
Xenophanes tryxus (Stoll, 1780): c
Antigonus erosus (Hbn., 1812): u
Antigonus liborius liborius Plötz, 1884: r
Zopyrion evenor evenor (Godm. & Salv., 1901): r
Achlyodes busirus rioja Ev., 1953: u
Achlyodes mithradates thraso (Hbn., 1807): u
Grais stigmaticus stigmaticus (Mab., 1883): r
Timochares trifasciata trifasciata (Hew., 1868): r
Chiomara punctum (Mab., 1878): u
Pyrgus oileus orcus (Stoll, 1780): c
Helioptetes macaira orbigera (Mab., 1888): r
Helioptetes domicella willi (Plötz, 1884): r
Helioptetes arsalte arsalte (L. 1758): c
Anthoptus epictetus (F. 1793): c
Phanes rezia (Plötz, 1883): r
Cymaenes gisca Ev., 1955: r
Callimormus saturnus (Herr.-Sch., 1869): u
Vehilius stictomenes stictomenes (Butl., 1877): u

Vehilius clavicula (Plötz, 1884): r
Moeris remus (F., 1798): u
Cobalopsis potaro (Will. & Bell, 1931): u
Vettius lucretius (Latr., 1824): u
Vettius lafresnayeii lafresnayeii (Latr., 1824): r
Vettius artona (Hew., 1868): r
Vettius diversus diversus (Herr.-Sch., 1869): c
Vettius marcus marcus (F., 1787): c
Onophas columbaria distigma Bell, 1930: r
Miltomiges cinnamomea (Herr.-Sch., 1869): u
Cobalus virbii hersilia (Plötz, 1882): u
Perichares philetis adela (Hew., 1867): u
Hylephila phyleus phyleus (Drury, 1780): c
Polites vibex catilina (Plötz, 1886): c
Wallengrenia premnas (Wallengr., 1860): r
Lerodea eufala eufala (Edw., 1869): r
Saliana longirostris (Sepp, 1848): u

The list above contains at least nine species and subspecies (3½% of the total 269 of an estimated 658 total fauna) which are typical of the cerrado area of the planalto, not normally occurring much to the south of the blend zone into the Serra do Mar (*Sais rosalia rosalinde*, *Ithomia agnosia agnosia*, *Evonyma bechina*, *Diaethria eluina*, *Callicore sorana*, *Eurybia elvina tephrias*, *Stalactis phlegia*, *Battus* (*Parides*) *diodorus*, and *Sophista latifasciata*). On the other hand, it contains 33 species and subspecies typical of the Serra do Mar which are absent from the list for the cerrado in Part I (*Pteronymia carlia*, *Episcada carcinia*, *Actinote conspicua*, *Actinote genitrix*, *Heliconius* (*Heliconius*) *sarae apseudes*, *Heliconius* (*Eueides*) *pavanus*, *Limenitis* (*Adelpha*) *syma*, *Limenitis* (*Adelpha*) *poltius*, *Catonephele sabrina*, *Evonyma margarita*, *Doxocopa kallina*, *Anaea* (*Hypna*) *clytemnestra hubneri*, *Anaea* (*Memphis*) *appias*, *Anaea* (*Memphis*) *otrere*, *Pierella nereis*, *Narope cyllarus*, *Eryphanis reevesii*, *Caligo arisbe*, *Opsiphanes batea*, *Euselasia hygenius occulta*, *Emesis lucinda fastidiosa*, *Stalactis susanna*, "*Thecla*" *meliboeus*, *Pereute antodyca*, *Catasticta bithys*, *Battus* (*Parides*) *agavus*, *Battus* (*Parides*) *bunichus*, *Papilio astyalus*, *Papilio hectorides*, *Elbella menecrates*, *Vettius lafresnayeii lafresnayeii*, *Miltomiges cinnamomea*, and *Onophas columbaria distigma*), and a further 14 southern species and subspecies which are to be regarded as marginal in the cerrado, recorded from only one locality (in some cases, dubiously) and generally fewer than five individuals (*Haywardina stelligera*, *Placidula euryanassa*, *Ithomia drymo*, *Pseudoscada erruca*, *Limenitis* (*Adelpha*) *mincia*, *Epiphile hubneri*, *Cybdelis phaesyia*, *Chalodetta epijessa calicene*, *Anatole zygia epone*, *Dismorphia astyocha*, *Eurema phiale majorina*, *Leucidia elvina*, *Graphium lysithous*, and *Papilio scamander grayi*). The total list thus shows about 18% of

species which are typical of southeastern Brazil and reach their normal northwestern limit within the blend zone, appearing marginally if at all within the cerrado portion of the central plateau.

The remaining species are found in both the Serra do Mar and the cerrado (many being spread over much of tropical America), with the exception of *Hypoleria plisthenes* which may be endemic to the blend zone and certainly has its metropole within it.

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EUSTIXIA PUPULA (PYRALIDAE) ON CRUCIFERAE

The food plant of *Eustixia pupula* Hübner seems to be unrecorded in the literature, and the species is not cited in various reviews of insects associated with Cruciferae (Hering 1932, Pimentel 1961). During an investigation of the biology of *Pieris* in ruderal situations at Philadelphia, Pa. in 1965-66, a small pyralid larva was encountered repeatedly, but infrequently, on various wild and cultivated Cruciferae in the Eastwick section. An individual taken from *Lepidium virginicum* L. (Virginia peppergrass) on August 27, 1966, and confined in a small box spun an opaque cocoon incorporating leaf debris two days later and eclosed as *E. pupula* during the first week of November. Larvae were also found on cultivated cabbage, *Brassica oleracea* L. cultivars., and on *B. nigra* (L.) Koch. A larva was taken on the latter plant at Ithaca, N.Y., August 21, 1967. It is a leaf feeder, and on cabbage has been found on the undersides of leaves on the outer part of the head. *E. pupula* is uncommon at light and the larvae appear hardly common enough to warrant consideration as possible pests. Dates of adult captures at Philadelphia are May-

mid June and late July–mid August, indicating two generations outdoors. The reared individual noted above would presumably have overwintered as the pupa.

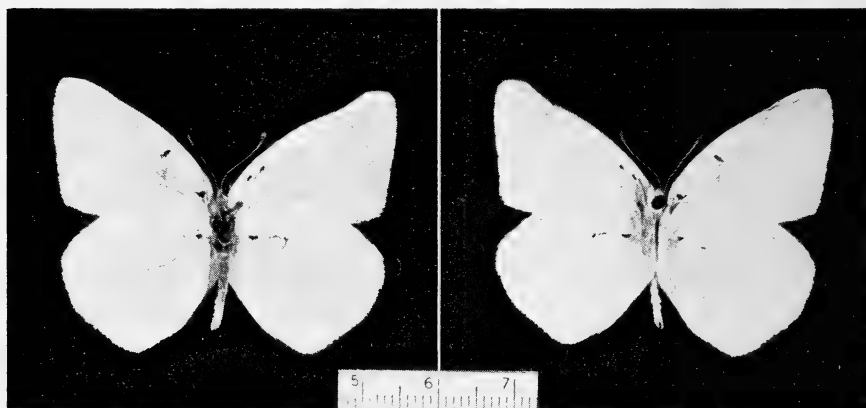
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AN ABERRANT *COLIAS* FROM MINNESOTA (PIERIDAE)

An unusual male *Colias eurytheme* Boisduval was captured at Fort Snelling, Hennepin County, Minnesota, on August 6, 1966, by Dr. Mance Brackney of Minneapolis. The specimen is completely devoid of melanin (black pigmentation) on the wings, but it is not albinic, as yellow, orange and pink pterin pigmentation is well developed. Dorsally the wing margins (usually black) are a pale yellow in contrast to orange basal and discal areas that lack black clouding. Ventrally the butterfly is pale yellow and has neither the typical greenish cast nor the black



Aberrant male *Colias eurytheme* Boisduval, Hennepin County, Minnesota Left: dorsal view; right: ventral (actual size).

spots in the limbal area. The cell spot on the primaries is colorless (almost transparent) while the cell spot on the secondaries only lacks black rings on the ventral side to be normal. The pink wing fringes are present. The body and antennae of the butterfly are typical.

The specimen is retained in Dr. Brackney's private collection.—JOHN H. MASTERS, Box 7511, Saint Paul, Minnesota

NEW RECORDS, RANGE EXTENSIONS, AND FIELD DATA
FOR COLORADO BUTTERFLIES AND SKIPPERSJAMES A. SCOTT, SCOTT L. ELLIS, AND DONALD EFF
Lakewood, Hotchkiss, and Boulder, Colorado

In the decade since the publication of *Colorado Butterflies* by Brown, Eff, and Rotger, 13 species of butterflies and skippers new to Colorado (marked with *) and many range extensions in Colorado have been discovered. Additional records for rare or little-known species, and many foodplant records, are also included in this report. Changes in nomenclature have been largely avoided. Abbreviations of collectors used in the records are: SLE (Scott L. Ellis), JAS (James A. Scott), DE (Donald Eff), and SJ (Samuel A. Johnson).

NYMPHALIDAE

Euptychia pyracmon Butler (= *henshawi* Edwards, Ehrlich & Ehrlich, 1961). Lee Miller collected a specimen which he believes to be this species in Don Eff's front yard in Boulder on July 24, 1957. This record is only the second for the State and the first for the northern portion.

Euptychia dorothea (Nabokov). Don Eff collected this species on Flagstaff Mountain, Boulder Co., July 22, 1961. It is common in Fremont and El Paso counties from about July 15 to August 18.

Oeneis alberta oslari Skinner. This arctic, formerly recorded only from South Park, is now known to range south to Fremont County and north to Middle Park. It occurred commonly in Devil's Hole, Echo Canyon, Fremont Co., June 10, 1965 (Glenn Scott). Eff and Ellis have taken it commonly in high grass growing in sage flats near lodgepole pines in Grand Co.: 1 mi. W. of Tabernash, 9,000 ft., May 26 (1963) to June 27 (1962) (DE, SLE); Fraser, 1966 (DE).

Danaus gilippus (Cramer). A small colony of this species was established for one year in an alkali seep where milkweed is common, in Stingley Gulch, 6,000 ft., Delta Co., August 1959 (SLE). Other sightings on the western slope are: Unaweep Can., 10 mi. E. Gateway, and nr. Paradox, Montrose Co., both August 13, 1966 (SLE, SJ). Specimens were taken at Salida, Fremont Co., July 11, 1966, and seen in Boulder, September 23, 1966 (both JAS).

Heliconius charitonius vazquezae Comstock & Brown. Lee Miller collected one specimen in Strain Gulch, south of Morrison, Jefferson Co., July 25, 1957.

Speyeria idalia (Drury). One worn female was collected at Indian Park, west of Sedalia, Douglas Co., August 24, 1961 (W. Cobban), in

the foothills of the Front Range. It was caught in a grassy meadow within a ponderosa pine forest.

Speyeria cybele carpenterii (Edwards). This subspecies has been taken north of the San Juan Mountains in several localities, primarily in the Uncompahgre and Dolores River drainages. Specimens are known from the LaSal Mountains in extreme western Montrose County. Localities are: Owl Creek Pass Road, 8,000 ft., Ouray Co., July 28, 1963 (SLE); Tabeguache Creek, 8,000 ft., Montrose Co., August 2, 1964 (SLE).

Speyeria aphrodite byblis (Barnes & Benjamin). The name *byblis* is used here to denote western slope *aphrodite* because of the smaller size and lighter color of these specimens as compared to eastern slope material. Although it probably occurs elsewhere, Ellis has not seen *byblis* in any areas other than the Rabbit Ears Pass area in Routt Co. and the North Fork and Gunnison River drainages of Gunnison and Delta cos. *S. aphrodite byblis* is extremely common on Highway 135 east of Somerset in Gunnison Co., and along the Leroux Creek Road at about 7,500 feet in Delta Co. (both SLE).

Speyeria nokomis (Edwards) has been taken in three localities in western Colorado, two of which are wet, freshwater, sedge seeps. A single worn female was taken on Rogers Mesa, 5,850 ft., Delta Co., August 25, 1959 (SLE), and established colonies have been discovered by Ellis near the Dolores River in Mesa Co., 6,200 ft., and in the Paradox Valley in Montrose Co., 5,200 ft.

Brown (1965: 47-54) has shown that the type locality for *nokomis* is probably in southeastern Utah or southwestern Colorado, rather than "Hayden and Sneffels Mts." in Ouray County.

Speyeria mormonia eurynome (Edwards). This montane species was taken at two places on the plains by Scott, a worn female at Lakewood, Jefferson Co., in September, and another worn female in Boulder, October 8, 1965.

* *Boloria epithore chermocki* Perk. & Perk. Several localities in the southwestern mountains have been discovered to harbor this species. The nearest states where it has been previously recorded are Montana and Idaho (Perkins & Perkins, 1966). Brown (*in litt.*) gives the following Colorado records: Rico, Dolores Co., August (Frank Clay Cross); Ironton Meadows, Ouray Co., June 18, 1961 (S. F. Perkins).

Boloria eunomia caelestis (Hemming), previously recorded only from the eastern slope, has been taken in Gunnison County: 5 mi. south of Tincup on Willow Creek, 10,700 ft., July 19, 1964 (SLE).

Euphydryas anicia alena Barnes and Benjamin, occurs in Moffat County. Captures were made 5 miles south of Maybell, on Lay Peak,

and 10 miles west of Craig, on June 13, 1965 (JAS). They were caught on sage-covered hilltops, with the more common *editha*, from which they are very distinct. Ellis discovered a curious population of *anicia* on the Black Mesa Road, Grand Co., 9,500 ft., on July 15, 1963, in which two forms, one black and one red, fly together and show little phenotypic blending.

* *Euphydryas editha* (Boisduval). This species, although previously unrecorded from Colorado, has been found to be widely distributed in western Colorado, including Moffat County, transition zone localities in the Gunnison and Uncompahgre River drainages, Middle Park, and the San Juan Mountains. The species is remarkably constant throughout its range in Colorado. F. M. Brown, who is studying San Juan Mountains specimens, thinks that this material represents a population most closely related to *lehmani* Gunder among described species.

DELTA CO.: Carl Smith Reservoir, 8,000 ft., June 15, 1958 (SLE). GRAND CO.: 1 mi. W. of Tabernash, 9,000 ft., June 27, 1962 (SLE, SJ); Gore Pass road, June 27, 1962 (SJ). GUNNISON CO.: Almont, July 6, 1957 (DE); Curecanti Creek, 8,000 ft., June 21 (1962) to June 25 (1961) (SLE); Coal Creek, 7,500 ft., June 23, 1964 (SLE); Black Mesa Road, 8,000 ft., July 29, 1965 (SLE). MOFFAT CO.: Lay Peak and 10 mi. west of Craig, June 13, 1965 (JAS). MONTROSE CO.: 25 Mile Ranger Station, 8,500 ft., July 16, 1965 (SLE). OURAY CO.: Owl Creek Road, east of Ridgeway 5–6 miles, first two weeks of June (F. M. Brown). SUMMIT CO.: Green Mountain Reservoir, June 25, 1962 (W. Cobban).

Chlosyne fulvia (Edwards). This checkerspot has been found in several localities in the Arkansas River drainage system on the eastern slope. The two specimens figured by Brown *et al.* (1957: 80) are quite unlike specimens which Scott and Johnson have taken on the eastern slope. The latter are similar to western slope specimens. At Pueblo the foodplant is *Castilleja integra* (Scott, 1968) growing on gypsum-rich shale. Although some of Johnson's specimens have been taken at granitic soil sites, *fulvia's* distribution in association with gypsum should be investigated. Eastern slope records:

EL PASO CO. (all SJ): Star Ranch, 6,000 ft., late May and late August; Highway 115 near main entrance to Fort Carson; Ute Pass, 9,000 ft., May 29, 1965. FREMONT CO.: gypsum quarry on Fleming Mountain, July 12, 1965 (JAS); Box Canyon, July 6, 1966 (JAS). PUEBLO CO.: Rock Canyon anticline north and south of the Arkansas River, and Wild Horse Park, May, July, and August (three broods) (JAS).

Western slope specimens probably should not be called *cyneas* (Godman & Salvin) in view of their similarity to eastern slope material. Ellis has found that a dwarf *Castilleja* is the foodplant. Eff's and Ellis' records for the western slope follow.

DELTA CO.: Nr. confluence of Gunnison and Smith Fork rivers, 5,500 ft., May 19, 1963 (SLE); Black Ridge, 6,000 ft., June 5, 1965 (SLE); gypsum claims 5 mi. southeast of Austin, 6,000 ft., June 3, 1965 (SLE). MESA CO.: Black Ridge, 7,000

ft., May 17 to 30, 1961 to 1965 (DE, SLE, and David Bauer); Colo. Nat. Mon., May 17, 1961 (DE, D. Bauer). Ellis believes that the dryness of these localities precluded any August captures.

* *Chlosyne acastus* (Edwards). This species was first taken in Colorado by Mr. Hugo Rodeck in the San Luis Valley. Since then it has been found to be widespread throughout the Upper Sonoran Zone of western Colorado. It is often very abundant, at times swarming, at lower elevations in Delta, Mesa, Rio Blanco and Moffat counties (SLE, JAS), where it is generally distributed on shale hills and into the juniper-pinyon belt on the mesas at about 7,500 feet. Ellis has found *acastus* closely associated with a species of *Erigeron*, and believes this may be the foodplant. ALAMOSA Co.: Mosca Pass Trail, Great Sand Dunes Nat. Mon., June 25, 1955 (H. Rodeck). MESA Co.: Saddle Rock Campground, May 14, 1960 (DE); Trail of the Serpent (both localities in Colo. Nat. Mon.), May 18, 1961 (David Bauer).

Chlosyne damoetas (Skinner). Ellis has found this species to be extremely common in the San Juan Mountains, particularly in the Wilson Peak area of San Miguel Co., in July and August. Don Eff records it from Copper Lake in Gunnison Co., July 18, 1960. It is now recorded from the Sangre de Cristo Mountains on Galena Peak, Fremont Co., July 14, 1966 (Kathy Scott). It was previously unrecorded from the western slope.

Phyciodes picta Edwards. One northern record has been found. Bob Pyle took the species at the Highline Canal, Arapahoe Co., early June, 1965, on the eastern plains.

Phyciodes pallida (Edwards). Brown (1966: 443-448) has restricted the type locality of *pallida* to Flagstaff Mountain, Boulder County, and according to priority, *pallida* is the name that should be applied to material from the Colorado Front Range. Bauer (in Ehrlich & Ehrlich, 1961) has presented evidence for considering *pallida* as separate from *mylitta* (Edwards). *P. pallida* was taken on September 7, 1966, in Clear Creek Canyon one mile west of Golden, Jefferson Co. (JAS). This specimen represents the first record of a second brood of *pallida* in Colorado.

Phyciodes texana (Edwards). A worn specimen caught in Italian Gulch, near Coaldale, Fremont Co., June 27, 1966 (Kathy Scott) represents the second record for the state.

Junonia coenia (Hubner). Several specimens were taken in the northern part of the state by Jim Eff, on Chautauqua Mesa, Boulder, October 5, 1957. This is the second record from northern Colorado.

* *Marpesia petreus* (Cramer). This species was taken as a stray in southeastern Colorado. William H. Howe caught a battered individual

on alfalfa near Olney Springs, Crowley County, August 31, 1958, the first state record.

LYCAENIDAE

Apodemia mormo mejicanus (Behr). Specimens from the Rock Canyon Anticline, Pueblo County, and specimens from Fremont County, are closest to the subspecies *mejicanus*. The name *cythera* (Edwards) should not be applied in Colorado (Opler & Powell, 1962).

Atlides halesus (Cramer). Ellis has found this species in several areas of the North Fork River drainage, particularly in Leroux Creek in Delta County. The species seems to be associated with mistletoe growing on juniper in this area. Specimens have been taken from mid-May to late August.

Satyrium acadica coolinensis Watson & Comstock. This species has been found in association with serviceberry (*Amelanchier*) in Delta and Gunnison counties. A female was observed to oviposit on serviceberry rather than willow, its reported host, although the species has been found on willow along the Smith Fork River in Delta County. The species flies during an extremely short period in late July. It particularly visits flowers of a small *Chrysothamnus*.

DELTA CO.: Leroux Creek, 7,500 ft., July 27, 1962; Hubbard Creek, 7,500 ft., July 22, 1962. MONTROSE CO.: Highway 92 near Crystal Creek, 7,800 ft., July 15, 1962. GUNNISON CO.: W. Muddy Creek, 8,500 ft., July 27, 1964 (all SLE).

Satyrium sylvinus (Boisduval) is occasionally very common in Delta and Gunnison counties. It may be found in almost any willow-bordered stream between 5,000 and 7,000 feet in the North Fork Valley, and is commonly found in the Dolores and Uncompahgre drainages. Adults fly from mid-July to late August (SLE).

Satyrium liparops aliparops Michener & dos Passos. At Lakewood, Jefferson County, on the plains, this species feeds on box elder (*Acer negundo*). Larvae, pupae, and adults have been found on small trees growing in a lush gully. Adults fly in late June and early July. More than a third of the specimens in this colony, especially females, have a reddish flush on the dorsal surface of the forewing. The 1965 season's summary of the *News of The Lepidopterists' Society* erroneously listed the locality as Fremont County. *S. liparops* is rather widespread through the oak belt in Routt, Delta, Gunnison, and Garfield counties. Nearly all the specimens Ellis has caught have been taken in oak thickets, although specimens were taken on box elder on the Smith Fork River in Delta County. Nearly all specimens from these areas have rusty patches on the forewings of both sexes, although to a lesser extent on females.

Satyrrium fuliginosum semiluna Klots. Ellis and Johnson have taken this species in large numbers on dry sage hillsides with various species of *Eriogonum* in abundance, but the foodplant could not be determined.

GRAND CO.: Highway 40 near Big Muddy Creek, June 28, 1962 (SLE, SJ); Beaver Creek, July 3, 1963 (William Cobban). MOFFAT CO.: 2 miles southeast of Craig, June 13, 1956 (DE). ROUTT CO.: 4 mi. north of Hayden, June 29, 1962 (SLE, SJ); shrubby hill just west of Steamboat Springs, July 11, 1962 (JAS).

* *Tmolus azia* Hewitson. One specimen of this species was collected by Jim Eff on Chautauqua Mesa, at Boulder, on July 16, 1957. A possibility that might account for its fresh appearance appears to be that some Texan, many of whom spend their summers at Chautauqua, unknowingly transported a larva or pupa there.

Callophrys spinetorum (Hewitson). This species seems to be rare on the western slope. In the Black Ridge area of Mesa County, *spinetorum* may be associated with a mistletoe growing on *Pinus edulis*. Shields (1966) gives records from Gunnison, Mesa, and La Plata counties.

Callophrys apama homoperplexa Barnes & Benjamin. A female was observed to oviposit on *Ceanothus fendleri* on Chautauqua Mesa, Boulder, May 30, 1966 (JAS).

* *Callophrys affinis* (Edwards). Although *C. affinis* had been suspected as a Colorado resident, collection records have not appeared until recently. Eff took a fresh specimen one mile west of Tabernash, 9,000 ft., May 30, 1966, and Ellis caught what appears to be *affinis* near Basalt, Eagle Co., in early June. Tilden (1963) gives four records from the eastern slope.

Callophrys eryphon (Boisduval). Ellis has found this species in association with *Pinus edulis* in Delta County, and in association with *Pinus contorta* on Rabbit Ears Pass in Routt County.

Lycaena editha montana Field. Recently this species has been collected commonly throughout Routt and Grand counties on the western slope. Now it may be counted as an eastern slope resident, having been collected at Tuxedo Park, Rocky Mountain National Park, August 10, 1934 (G. H. and J. L. Sperry, in AMNH), and at Fort Collins, Larimer Co., July 8, 1960 (Ed Marker).

* *Lycaena mariposa penroseae* Field. Bob Pyle of Denver, Colo., in correspondence with Scott, wrote about this species: "The data for *Lycaena mariposa* are as follows: Fort Collins, Colorado, July 8, 1960, Ed Marker. It was caught in a weedy meadow near the city limits, and Ed told me it was flying in profusion, along with *L. editha*." Judging from this record, the species could occur also on the western slope in the northern part of the state.

Lycaena nivalis browni dos Passos. Eff has found this mainly western slope insect twice on the Corona Pass Road, Boulder Co., on the eastern slope, on June 30, 1963, and July 11, 1962.

Glaucopsyche lygdamus oro Scudder and *Scolitantides piasus daunia* (Edwards) have both been observed to oviposit on lupine, probably *Lupinus argenteus* Pursh, near Boulder.

Everes comyntas valeriae Clench. Females have been observed ovipositing on *Astragalus flexuosus* Dougl. near Boulder. Only four of 64 males collected in Boulder and Jefferson counties has the orange lunule on the upper surface of the hind wing, so *valeriae* is presumably the northern Colorado representative.

Philotes spaldingi Barnes & Macdunnough. Rotger has reported to us that the food plant is *Eriogonum racemosum* Nutt.

Philotes enoptes ancilla Barnes & Macdunnough and *P. battoides centralis* Barnes & Macdunnough. Rotger (*in litt.*) reports *Eriogonum umbellatum* Torr. as the foodplant for *battoides centralis*, and Scott has taken 120 specimens of *ancilla* on or near *E. umbellatum*, so probably this is the foodplant for both species. Assuming the same foodplant for both, perhaps interspecific competition has made the two species almost completely allopatric in Colorado; only one verified record is known where the two species occur together. *P. enoptes* occupies the northern, and *battoides* the southern half of the state west of the plains.

* *Philotes rita coloradensis* Mattoni. This species, a new record for the state, has been found to be abundant in the San Luis Valley, in the Wet Mountain Valley, along the Arkansas River in the mountains, and occurs on the plains east of Colorado Springs (Mattoni, 1966). Oviposition deep in the flowers has been observed on *Eriogonum effusum* Nutt. in Fremont and Lincoln counties, and adults occur on this plant in Saguache County. Possible records of this species from Cheyenne and Prowers counties are given by Brown *et al.* (1957: 173). It is a prairie species; it typically occurs with *Pyrgus scriptura*; *Yvretta rhesus* (Edwards) flies in the same localities in May. *P. rita* often flies with *P. battoides centralis* until the end of July.

CHAFFEE CO.: Chalk Creek Trout Farm, August 11, 1965 (JAS). CUSTER CO.: and FREMONT CO.: many localities in the Wet Mountain Valley around Westcliffe, northwest to the Arkansas River around Cotopaxi, July 18 to August 23, 1965 (JAS). EL PASO CO.: west from Kendrick, in roadcuts along highway 94, to 15 miles east of Colorado Springs, August 21, 1964 (R. Mattoni) (Mattoni, 1966). LINCOLN CO.: south of Kendrick, August 21, 1964 (R. Mattoni) (Mattoni, 1966) (type locality). SAGUACHE CO.: 2 miles southwest of Villa Grove, 18-19 July, 1966 (Kathy Scott).

Plebejus acmon lutzi dos Passos. This feeds on *Eriogonum*, presumably *E. effusum*, near Westcliffe in Custer County, as does *Philotes rita*.

Whereas *rita* deposits eggs singly inside the perianth, *acmon* deposits eggs singly on a pedicel.

PIERIDAE

Colias scudderi ruckesi Klots. This subspecies was collected by Richard Holland near Whiskey Pass, Costilla Co., August 9, 1964.

Phoebis sennae (Linnaeus). A single specimen of this migratory sulphur was taken on Rogers Mesa, Delta Co., July 24, 1964 (SLE). *P. sennae* is seen regularly in the fall in Boulder and Jefferson counties.

Anthocaris sara inghami Gunder. This subspecies, rather than *julia* Edwards, occurs at lower elevations on the western slope. In Delta County, Ellis found *inghami* common in the pinyon-juniper belt along Leroux Creek, from mid April to late May, 1961-62, and in Smith Fork Canyon. Eff found it at Black Ridge, Mesa Co., May 13, 1960.

Euchloe creusa (Doubleday). This butterfly has been found widely distributed in the western part of the state. Northern records follow.

MOFFAT CO.: 5 miles south of Maybell, and 10 miles west of Craig, Lay Peak, June 13, 1965 (JAS). MESA CO.: Black Ridge, May 11-22, 1961-66 (DE). DELTA CO.: common (SLE).

Colias caesonia (Stoll). One specimen was taken on Flagstaff Mountain, Boulder Co., June 15, 1958 (Jim Eff).

Pieris beckerii Edwards. Several eastern slope records for this species have been found. Gordon and Henrietta Thayer of Boulder found it in Deer Creek Canyon, 7½ miles north of Boulder on Highway 7, April 19, 1958. It occurs along the Arkansas River in Fremont County (JAS), and it is common near Pueblo in late May and August (JAS).

* *Ascia monuste* (Linnaeus). The first definite capture of this species in Colorado was at Fountain Valley School, El Paso County, 1957, by F. M. Brown.

Neophasia menapia (Felder & Felder). In Fremont, Montrose, and Ouray counties many captures have been made among pinyon pine (*Pinus edulis*) with no other species of pine present, so probably pinyon pine serves as a foodplant.

PAPILIONIDAE

Papilio bairdii Edwards. *P. bairdii* and the form *brucei* Edwards and so-called subspecies *hollandii* Edwards have been found on the eastern slope and on the plains. A specimen of *brucei* in the University of Colorado Museum from the summit of Two Buttes, Prowers County, August 10, 1957, was caught by Dr. Hugo Rodeck. Scott found all three forms flying together in gulches and on hilltops in Fremont County between

Cotopaxi and Salida. Larvae and eggs were found on *Artemisia dracuncul* Linnaeus. Form *bairdii* constituted 70%, *brucei* 26%, and *hollandii* 4% of the sample. Raymond Jae caught a specimen in his back yard in Denver, September 1, 1963, which appears to be a hybrid between *brucei* and *polyxenes*. This record, and captures of *brucei* from southeastern Wyoming on the plains (DeFoliart, 1956), indicate that *brucei* is widespread over the eastern part of Colorado. On the western slope the only new record is a specimen of *bairdii* from Cedar Mesa near Currant Creek, Delta Co., June 17, 1960. This specimen may represent a spring brood in Colorado; all other Colorado specimens are of the long second brood, which has been recorded on the wing from July 16 to August 27.

Papilio bairdii oregonius Edwards. Specimens taken by Hugo Rodeck at Harper's Corner, Dinosaur National Monument, Moffat Co., 7,600 ft., July 15-16, 1949, tend toward *oregonius* rather than *brucei*. As *oregonius* has been recorded from "southern Nebraska" (Kent Wilson, in Ehrlich & Ehrlich, 1961), perhaps it also occurs on the plains in northeastern Colorado.

Papilio nitra Edwards. This swallowtail, thought possibly to be a hybrid between *P. zelicaon* Lucas and *P. polyxenes* Fabricius, has been found to be generally distributed at the edge of the Front Range north to Laramie, Wyoming. Records are: Jarre Canyon, Douglas Co. (JAS); Mother Cabrini Shrine, Jefferson Co. (RJJ); Chautauqua Mesa (DE), top of Green Mountain (JAS), and north of mouth of Boulder Canyon, (John Justice), the latter three in Boulder County; from May 1 to about June 5. It always flies with *zelicaon*, but in Scott's experience, never with *polyxenes*. Where *polyxenes* and *zelicaon* fly together, as in Coal Creek, Jefferson County, apparently *nitra* is not present. A natural mating of a male *zelicaon* with a female *polyxenes* was observed on Table Mountain, Jefferson County, May 20, 1966 (JAS), so hybridization cannot be ruled out.

Papilio indra minori Cross. Ellis has taken this subspecies in the canyons below the Black Canyon National Monument, at the confluence of the Gunnison and Smith Fork Rivers, 6,000 ft., Delta County, from May 19, 1963, to June 5, 1965. Thomas C. Emmel has taken the subspecies on the south rim of the Monument. Here the foodplant may be *Lomatium grayi* Coult. & Rose growing on the canyon walls. Emmel & Emmel (1964) give *Lomatium eastwoodae* (C. & R.) Macbr. as the foodplant for Mesa County. Dark *minori*-like specimens should be expected all over the western mesas. Brown *et al.* (1957: 214) figure a female *minori* as *bairdii*.

HESPERIIDAE

Erynnis telemachus Burns. Burns (1960) has given the name *telemachus* to the species called *plautus* by Brown *et al.* (1957: 256).

Erynnis brizo (Boisduval & Le Conte) and *burgessi* (Skinner). These two names as used in *Colorado Butterflies* refer to *brizo burgessi* according to Burns (1964). Typical *brizo* does not occur in Colorado. Burns gives a record of *b. burgessi* from Glenwood Springs, May 8 (USNM), which is a northward extension of the recorded range on the western slope.

Erynnis persius fredericki H. A. Freeman and *lucilius afranius* (Lintner). Scott observed several females of *afranius* ovipositing on *Lupinus* in Gregory Canyon, Boulder County, in the spring of 1966, and Samuel A. Johnson observed a female of one of these species ovipositing on grass on Chautauqua Mesa, Boulder County.

Pyrgus xanthus Edwards has been found in small numbers flying over gravel beds near streams.

CHAFFEE CO.: 5 mi. west of Buena Vista, 9,000 ft., May 16 and June 8, 1965 (SJ). EL PASO CO.: Beaver Crk., Rampart Range, 9,000 ft., May 22, 1966 and July 4, 1965 (SJ). GUNNISON CO.: Curecanti Crk., 8,500 ft., June 21, 1962 (SLE). MONTROSE CO.: Cottonwood Crk., Uncompahgre Plateau, 8,200 ft., June 4, 1961 (SLE). SAN JUAN CO.: Howardsville, July 3, 1965 (JAS).

Pyrgus scriptura (Boisduval). This species occurs in the San Luis Valley, in the Wet Mountain Valley, and on the northeastern plains. It is a prairie species.

CUSTER and FREMONT COUNTIES: Wet Mountain Valley from Westcliffe northwest, July 18 to August 20, 1965 (JAS). SAGUACHE CO.: 2 miles southwest of Villa Grove, July 18–19, 1966 (Kathy Scott). WELD CO.: Black Hollow Oil Field, June 30, 1964 (JAS).

* *Heliopetes ericetorum* (Boisduval). This species was taken 3 miles east of Somerset, Gunnison County, July 6, 1962, by D. S. Chambers (genitalia examined).

Pholisora mejicana (Reakirt). This skipper was taken in Kerr Gulch, Fremont County, June 22, 1966, and July 30 and August 26, 1965 (JAS), where it was flying with *Pholisora catullus* (Fabricius).

Pholisora alpheus (Edwards) occurs in areas where shale or other rock is sparsely covered with vegetation. A northward extension to Moffat County may now be reported.

DELTA CO.: Big Gulch, Redlands Mesa, 5,800 ft., May 31, 1964 (SLE). MOFFAT CO.: 10 mi. west of Craig, June 13, 1965 (JAS). OURAY CO.: Billy Creek, 7,000 ft., June 26, 1965 (SLE). PUEBLO CO.: 1 mi. north of Pueblo, August 5, 1962 (JAS). OTERO CO.: La Junta, July 7, 1966 (Glenn Scott).

* *Pholisora libya lena* (Edwards). This skipper has been found in association with the Mancos Shale in Delta County, usually flying singly on steep, nearly barren hillsides, although the species is attracted to *Helianthus* and *Chrysothamnus* when these plants are in bloom. Adults emerge from mid-June to late August. June specimens are much darker than late August specimens.

DELTA CO.: North Fork Gunnison River, 3 mi. south of Hotchkiss, 5,500 ft., June 10 to August 25, 1962 (SLE). MESA CO.: near Escalante siding, 5,000 ft., July 6, 1962 (SLE).

* *Ancyloxypha numitor* (Fabricius). Dr. Hugo Rodeck caught a specimen in tall grass in a wet meadow below Two Buttes Reservoir, Baca County, August 10, 1957, on the plains in the southeast corner of the state.

Yvretta rhesus (Edwards). Captures in southeastern Wyoming by Defoliart indicate that this species could occur on the plains in northern Colorado. It occurs in the Wet Mountain Valley, as Cockerell caught a specimen at Westcliffe, May 25, in Custer County.

Oarisma edwardsii (Barnes). This Colorado rarity was taken by Samuel Johnson at Rock Creek, El Paso County, June 26, 1965.

Stinga morrisoni (Edwards). This skipper has been found in the Arkansas Valley, and an additional northern record has been discovered.

EL PASO CO.: Beaver Crk., Rampart Range, late May-June 27, 1962-66; Star Ranch, late May-June 21, 1962-65; Williams Canyon, June 14, 1965 (all SJ). CHAFFEE CO.: 5 mi. W. Buena Vista, June 8, 1965 (SJ). FREMONT CO.: just southeast of Bear Creek, near Salida, June 15, 1966 (JAS); 1 mile northeast of Swissvale, June 20, 1966 (JAS). JEFFERSON CO.: top of Genesee Mountain, June 6, 1966 (JAS).

Hesperia juba (Scudder). *H. juba* has been found on the eastern slope, where it has two broods.

BOULDER CO.: 3 mi. into Lefthand Can., May 23, 1962 (JAS); Gregory Canyon, May 19-29 (SJ, JAS). DOUGLAS CO.: mouth of Jarre Can., May 12, 1962 (JAS). JEFFERSON CO.: Lakewood, August 21-September 15 (JAS); Jefferson County Dump south of Golden, September 1, 1965 (JAS); Clear Crk. Can. 1 mi. west of Golden, September 7, 1966 (JAS).

Hesperia nevada (Scudder). This skipper occurs in the northwestern corner of the state in Moffat County, where it was taken by Scott at the localities listed for *Euphydryas editha* from that county. Most of the specimens have much wider white bands on the ventral surface of the secondary than specimens from Park County.

* *Hesperia ottoe* Edwards. Long thought to occur in the state, *ottoe* was found by Dr. Url Lanham at Marshall, Boulder County, July 7, 1961. The specimens, genitally determined as *ottoe*, are in the University of Colorado Museum.

Hesperia comma (Linnaeus). MacNeill (1964) has clarified the status of populations in this species, with the result that four names are recognized in Colorado; *ochracea* Lindsey and *manitoba* (Scudder) on the eastern slope, *colorado* (Scudder) on the higher mountains, and *uricola* Boisduval on the western slope.

Polites sabuleti (Boisduval). In the San Luis Valley, where it was previously reported (Brown *et al.*, 1957), *sabuleti* is locally common from Fort Garland north to the Great Sand Dunes National Monument (F. M. Brown). Ellis has found the species to be extremely common throughout low grassy areas in Delta and Mesa counties, on the western slope. It also occurs in alkaline seeps. Females have been seen to oviposit on lawn grass in many areas. *P. sabuleti* is double brooded, flying in June and in August. Surprisingly, a specimen has been taken in the Arkansas River Valley, on the eastern slope, on a hilltop at the mouth of Kerr Gulch, Fremont County, June 18, 1966 (JAS).

Polites coras (Cramer). Don Eff has taken a specimen in Bluebell Canyon, Boulder County, August 31, 1965. This record is the second for Colorado.

Ochlodes yuma scudderi (Skinner). This skipper has been found in a few isolated alkaline seeps in Delta County, and in an extensive freshwater seep in Mesa County. Specimens taken in Colorado seem to be darker than typical *yuma yuma* from California, giving the name *scudderi* validity. All specimens Ellis has seen have been flying in August; no indication of a June brood has been found. Ellis' records follow.

DELTA CO.: Leroux Creek, 5,700 ft., August 11, 1960; Austin, 5,400 ft., August 1958; North Fork of the Gunnison River, 3 mi. south of Hotchkiss, 5,600 ft., August 25, 1962. MESA CO.: Unaweep Canyon, 10 mi. east of Gateway, 6,200 ft., August 15, 1964 to September 4, 1965. MONTROSE CO.: near Paradox, August 13, 1966 (SJ).

Atrytone delaware lagus (Edwards). A specimen of this rare skipper was captured at Deer Creek, Jefferson County, July 21, 1962 (JAS), and others were caught in Boulder County in Bluebell Canyon, July 4, 1958 and July 24, 1957 (DE), and on Flagstaff Mountain, Boulder County, July 19, 1958 (DE).

Amblyscirtes simius Edwards. This skipper was recorded previously from only the southern plains, but now has been found in the northern part of the State on Round Butte, Larimer County, June 29, 1964 (JAS), and in the Arkansas River Valley, one mile up Bear Creek near Salida on summits of low hills, June 15-19, 1966 (JAS). It is a prairie species, occurring only on the summits of low knobs.

MEGATHYMIDAE

Megathymus streckeri (Skinner). A range extension of this species from the San Luis Valley into the Gunnison River Valley has been reported. The record is two miles east of Sapinero, Gunnison River, 7,200 ft., Gunnison County, June 28, 1964 (SLE).

Megathymus yuccae navajo Skinner. This species occurs in the San Luis Valley, as indicated by a record from Rock Creek Ranch, Rio Grande County, near Monte Vista (larvae collected April 28, emerged May 13-15) (SJ).

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AN EXTRAORDINARY SWARM OF BUTTERFLIES IN COLORADO

The summer of 1966 was for me a busy season which provided little opportunity for extensive collecting; hence every free weekend saw a hurried attempt to reach fruitful locales. On one such outing *Speyeria cybele charlotti* (Barnes) was sought near Somerset, Gunnison County, Colorado, where it had been taken in 1961. Jo Anne Pyle, Mrs. Helen L. Lemmon, and H. W. Pyle accompanied me on the trip.

We left Denver on July 2, spending the following day in the vicinity of the Rocky Mountain Biological Laboratory near Gothic, hiking to the alpine basin of Copper Lake. This six-mile journey took us through Canadian and Hudsonian forests and was punctuated by the capture of a striking aberration of *Agriades glandon rustica* (Edwards) and numerous other specimens, and at Copper Lake, *Erebia magdalena magdalena* (Strecker), *Microtia damoetus* (Skinner), and *Lycaena cupreus snowi* (Edwards) were taken. *M. damoetus* was flying in great profusion.

Between Kebbler Pass and Somerset on July 4, *Speyeria callippe* ssp. and *S. atlantis* ssp. were visiting thistles (*Cirsium* sp.), but *S. c. charlotti* was represented by a solitary male, thus marking my second failure to guess this species' emergence mechanism. One year earlier, the thistles and butterflies had vanished by August 1, although on that date in 1961 both sexes in fair condition had been abundant. As moisture conditions varied considerably between occasions, this was likely correlated with the insect's inconsistent appearance.

Next, we traveled to the Black Canyon of the Gunnison in Montrose County. In August, 1964, Charles Dudley and I had fine collecting at the South Rim of the Canyon; species taken included *Euptychia dorothea* (Nabokov), *Neominois ridingsi stretchii* (Edwards), *Cercyonis behri masoni* (Cross), and many Lycaenids, including *Hypaurotis crysalis citima* (Hy. Edwards) which fluttered above the oaks in the canyon lips.

Unfortunately, few butterflies were present during our 1966 visit, and we left somewhat disappointed with the day's results. Thus somewhat dulled to our late afternoon surroundings, we were supremely shocked when, as we drove along the canyon rim road, nearing the highway access, we were confronted with the largest aggregation of butterflies that I have yet encountered. Alerted first by the flicker of blue wings, we scrutinized a tiny arroyo by the roadside, which was lined with blooming milkweed (*Asclepias* sp.). Here, within 100 feet of the car, were myriad blues and other small butterflies. We stirred them, and found ourselves in the midst of an azure fog, as thousands of blues took flight. When they resumed their flower visitation in a minute or two, the milkweed could not be recognized for the heaped butterflies. Those which were not imbibing nectar perched still on the leaves. Effective collecting was accomplished only with forceps, as a swing of the net yielded only battered wings. Following is a list of species comprising this astounding assemblage, in order of relative abundance. (*Icaricia icarioides* accounted for 50–60% of the individuals present): *Icaricia icarioides lycea* (Edwards), *Lycaena heteronea heteronea* (Boisduval), *Lycaeides melissa melissa* (Edwards), *Callophrys apama apama* (Edwards), *Philotes enoptes ancilla* (Barnes and McDunnough), *Lycaena dorcas florus* (Edwards), *Phyciodes campestris camillus* (Edwards), and *Agriades glandon rustica* (Edwards).

In all cases, males were at least twice as abundant as females, except for *L. m. melissa*, in which the females dominated. Each species ranged from fresh to very worn, with the exception of *L. h. heteronea*, which was freshly emerged.

We remained in this amazing locality until past 6:00 P.M. (M.D.T.), selecting specimens but never losing our initial astonishment. Driving home we juggled estimates, trying to arrive at a reasonably accurate interpretation of the phenomenon we had observed. Our consensus could not be finalized to a greater degree of precision than "many thousands," although my own estimate proclaimed "At least ten thousand, and perhaps a hundred!"—ROBERT M. PYLE, 6015 N.E. 64th St., Seattle, Washington.

THE EFFECT OF X-IRRADIATION ON THE LARVAE OF *PAPILIO POLYXENES ASTERIUS* (PAPILIONIDAE)

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The effects of X-irradiation on the larvae of insects has been studied with many species, but few studies on the effect of X-irradiation on the larvae of Lepidoptera have been reported. The purpose of this report is to show an unusual degree of sensitivity of young larvae of *Papilio polyxenes asterius* Stoll to X-rays. Whereas *Drosophila* larvae exposed to 4000r and 6925r of X-rays were able to pupate (Villem, 1946), the larvae of *P. polyxenes asterius* exposed to single doses of 1500r, 3000r, 4500r, and 6000r failed to pupate and died within 17 days. Seventy-nine percent of the larvae used as a control in this experiment survived and pupated.

MATERIALS AND EXPERIMENTAL METHODS

One hundred and ten ova were obtained from Mr. Robert A. Colborne of Columbus, Ohio. These ova had been deposited on *Anethum graveolens* L. by a female on August 29, 1966. One hundred and three larvae emerged on September 2. Two more larvae emerged on September 3, and the remaining five ova did not hatch. Clear plastic boxes, measuring 5" \times 5" \times 1½", were used to rear the larvae. Air holes were drilled in each box, which housed 20 of the newly emerged larvae. They were reared on *Daucus carota* L. The 103 young larvae were allowed to mature at their normal rate until September 10. At this time, the eight-day-old larvae were divided into five groups: four groups of 20 to be irradiated and one group of 23 larvae served as a control. All the larvae were in their second instar at the time of irradiation. On the eighth day of life, the four groups of larvae were irradiated at dosages of 1500r, 3000r, 4500r, and 6000r. Irradiation factors were 250 Kv, 15 MA, no filter, dosage rate = 233r/10sec., target distance = 17 cm. Radiation was carried out with a Phillips machine and at a temperature of 72°F. Since the irradiation rate was 233r/10sec., the time required to administer 1500r was 65 sec., 3000r in 2 min. 10 sec., 4500r in 3 min. 15 sec., and 6000r in 4 min. 20 sec. Precautions were taken to avoid "backscatter." The larvae were irradiated in the open, clear plastic boxes and afterwards transferred to new boxes and fresh foodplant.

RESULTS

None of the irradiated larvae of the four groups survived to pupate. The greatest losses were suffered by the four irradiated groups the day

immediately following irradiation. From this point, the individual groups suffered their losses at different rates. All larvae were dead by the 17th day after irradiation and all died in their second or third instar. The majority of the larvae that lived past the first day died while in the process of moulting. The larvae were observed periodically with a dissecting microscope at 30 \times for external effects of the X-irradiation. No gross visible signs of radiation burns were observed on any of the larvae. The body length was periodically measured. For the first seven days after irradiation, the average length of the larvae of all five groups was as close as ± 2 mm. But after the seventh day following irradiation, the larvae of the irradiated groups averaged 3–8 mm. less than the length of the control larvae. The rates of survival of the 3000r, 6000r and control groups are graphed in Figure I. No true regularity among the five groups was observed.

DISCUSSION

The effects of X-irradiation on the larvae of Lepidoptera has been reported in the available literature only once, by Whiting (1950). However, considerable research has been carried out and reported on the effects of X-irradiation on the larvae of other insects.

Villee observed that the larvae of *Drosophila* could tolerate 6925r of X-rays and pupate. After the puparium was formed, only minor malformations developed in the adult *Drosophila*. In *Habrobracon* females, Clark (1961) observed that 3000r delivered to the larvae did not interfere with survival and pupation, but did reduce the life span of the subsequent adults from a normal of 25–29 days to six days.

Whiting (1950) showed that a dose of 40,000r of X-rays prevented pupation of the flour moth *Anagasta* (= *Ephestia*) *kühniella* (Z.), many individuals of which continued to live in the larval form for up to 40 days, *i.e.* 37 days after the control larvae pupated. In contrast, the larvae of *Papilio polyxenes asterius* in our experiment failed to survive even the lowest dose of 1500r X-rays. All the larvae of the four irradiated groups (1500r, 3000r, 4500r, and 6000r) expired by the 17th day after irradiation in the second or third instar. It would be plausible to assume that even a much smaller total dose of X-rays, in the vicinity of 750–1000r would be lethal for the larvae of *Papilio polyxenes asterius*, since the larval time period for development to pupation is on the average 28–30 days.

The radiation responses which we have observed in our experiment appear to be of two types, an early and a latent. The early responses appeared immediately, within one day after irradiation, and the latent effects developed when the moulting stage began. The explanation for

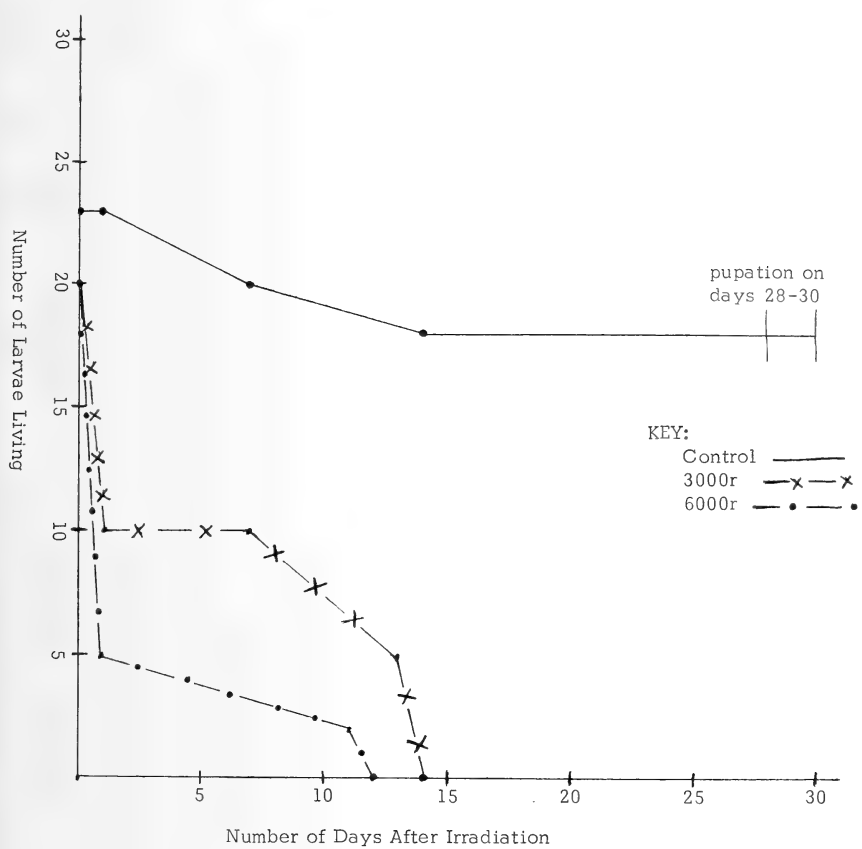


Fig. I. Rates of survival of irradiated larvae of *Papilio polyxenes asterius* Stoll.

the latent damage and death may rest upon the observation that “when insects pass from one instar to another by going through a moulting process, there is a brief period of intense mitotic activity, and if the insect is irradiated prior to moulting, visible damage and death may not show up until moulting occurs” (Baldwin and Salthouse, 1959a,b, 1961). In our observations, the majority of the larvae which survived the first day after irradiation died while in the process of moulting. It has been proven that the precise stage which suffered the most radiation damage was the metaphase (one of the stages of mitosis); at dosages which prevented moulting, division proceeded normally until metaphase and then ceased (Baldwin and Salthouse, 1959c). Joly and Biellman (1958) using *Locusta migratoria* L. found that the timing of irradiation could interfere with moulting. They found that if the insects were irradiated

before moulting, then that particular moult succeeded but further moults were prevented. However, if the irradiation preceded a moult by a sufficient time, then that moult was blocked. The studies of Bergonie and Tribondeau (1906) help to explain the latter phenomenon. They found that (1) the sensitivity of cells to irradiation is directly proportional to their reproduction activity and inversely proportional to their degree of differentiation; and (2) after insects hatch from the egg, very little cell division occurs during larval life. The cell division and differentiation of tissues occur instead during the embryonic development of the egg, so that in larval life, growth occurs primarily by enlargement of cell volume without an increase in cell number. Short bursts of mitotic activity occur just before moulting and in later stages of pupation (when pupal forms occur).

The explanation for the unusual degree of radiation sensitivity of the larvae of *Papilio polyxenes asterius* is under study. This degree of sensitivity does not hold for all species of butterflies since our comparative studies with *Colias* using comparable single dosages of X-rays show that the larvae are much more resistant to X-irradiation than the *Papilio polyxenes asterius* larvae. Many larvae of the *Colias* survived the exposures to X-rays, pupated, and formed adults with a variety of abnormalities and a shortened life span.

SUMMARY

An unusual degree of sensitivity to moderate doses of X-rays occurs in the larvae of *Papilio polyxenes asterius*. By contrast, the larvae of *Drosophila*, *Habrobracon*, *Locusta*, *Anagasta*, and *Colias* are much more resistant to X-irradiation. Therefore, the general statement that larvae of all insects are quite resistant to X-irradiation does not hold true.

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APPARENT PARTIAL COURTSHIP BETWEEN *MEGATHYMUS*
YUCCAE COLORADENSIS AND *M. STRECKERI*
(MEGATHYIMIDAE)

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On April 23, 1966, while collecting on the west slope of South Sandia Peak at an elevation of approximately 6,200 feet, about three miles south of Embudito Canyon, Bernalillo County, New Mexico, I saw two *Megathymus* apparently engaged in a courtship flight. As I approached in the hopes of capturing them, the larger one lit on a bare patch of soil and the smaller one immediately lit beside it, about one inch away. I had approached close enough to identify them both, and was surprised to discover that the large *Megathymus* was a female *Megathymus streckeri* (Skinner) and the small one was a male *Megathymus yuccae coloradensis* Riley. An attempt to capture them was delayed to see what would happen. The female *M. streckeri* remained passive with her wings tightly closed. The male *M. y. coloradensis* fluttered its wings for a moment, then curved its abdomen so that the tip touched the tip of the female *M. streckeri*'s abdomen. The female responded by flying up with the male in close pursuit. At this point I captured them.

The behavior of these two individuals is similar to the mating behavior described for *Agathymus* in Arizona by Roever (1965), but differs in several aspects. In the mating procedure of *Agathymus polingi* (Skinner), the female fluttered her wings while the male was passive. This is the opposite of the behavior of the *M. streckeri* and the *M. y. coloradensis*. There is the possibility that the male or the female discovered that the other individual was not of their species and responded ac-

cordingly. This view was also suggested by Mr. Kilian Roever (*in litt.*) after he had read the author's manuscript. He stated "The sexual attraction does not necessarily appear to be mutual because the female did not accept the male during the period of observation. The attraction was primarily by the male to the female." It would seem highly improbable that a mating between these two species would ever occur naturally. They do appear similar enough to attract each other's attention, even if only for a moment. Roever (1965) says: "Territorial males rarely left their perches to investigate ovipositing females, *Agathymus* of other species, or other insects passing through their territory." "In the few cases where males left their perches to investigate ovipositing females they returned to the perches after approach(ing) no closer than two or three feet." Assuming that females of another species would have little more attraction than ovipositing females of the same species, the behavior of these two individuals is, to say the least, unusual.

Another factor is that *Megathymus streckeri* is usually temporally isolated from *Megathymus yuccae* by two or three weeks. Last year (1966), however, both species were flying at the same time. Seasonal isolation is probably the main isolating mechanism between these two species, but this is not always true, as pointed out by Roever (*in litt.*), "In an attempt to find out where the isolation mechanism is that isolates *streckeri* and *yuccae* as species our information is limited to mechanisms that prevent interspecific crosses. Although (a) seasonal isolation is generally true it is not always the case as your observation indicates." In the cases where seasonal isolation is not the isolating mechanism, it is probably the behavioral pattern of the adults that is the isolation factor.

It is interesting to note that the food plant of both species here is the same, *Yucca baileyi*, although *Megathymus yuccae* also uses *Yucca baccata*.

The author is indebted to F. M. Brown, Fountain Valley School, Colorado Springs, Colorado; Kilian Roever, Phoenix, Arizona; and Richard Holland, Albuquerque, New Mexico, for reading the manuscript and offering their encouragement.

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BIOLOGICAL NOTES ON THREE PYRGINAE IN NEW YORK (HESPERIIDAE)

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THORYBES BATHYLLUS (Smith)

This species is recorded definitely from New York only on the coastal plain (Staten I., Long I., Forbes 1928) and has not been recorded from Ithaca, and there are no central New York specimens in the Cornell collections. One was taken and another seen on June 20, 1967, on Mt. Pleasant, a hill east of the city of Ithaca, Tompkins Co., in company with numerous *T. pylades* (Scudder). On July 4, despite cloudy weather, both species were abundant on the south slope of nearby Turkey Hill, and ten *bathyllus* were collected. Another was taken at the Turkey Hill locality on July 10. Diligent searching failed to produce any evidence of a second brood of either species.

Females of both species were ovipositing on the two July dates on *Desmodium rotundifolium* (Michx.) DC., a common plant of dry old fields on the oak-chestnut soils south and east of Ithaca, often associated with redroot, *Ceanothus americanus* L. and deerberry, *Vaccinium stamineum* L. *Erynnis martialis* (Scudder) was common at the Turkey Hill site with the *Thorybes* and appeared to be associated with the *Ceanothus*.

Forbes (1960) suggests that *T. bathyllus* has greatly increased in abundance in Massachusetts in recent years, implying a northward range expansion. It was more numerous on Turkey Hill than I have seen it in southeastern Pennsylvania, where it is bivoltine (Shapiro, 1966).

PYRGUS COMMUNIS (Grote)

On June 17, 1967, a female of this species was observed "skipping" around low weeds behind a construction site on the Cornell University campus, apparently seeking an oviposition site. She returned repeatedly to a plant of *Chenopodium album* L. about three inches tall, ignoring many other plant species (*Lepidium*, *Setaria*, *Ambrosia*), and finally laid an egg near the tip of one of the small leaves near the top of the plant. The plant was potted and brought indoors where the egg hatched June 23, but the larva refused to feed and died within 48 hours. *P. communis* oviposits commonly on *Malva moschata* L. and *M. neglecta* Wallr. (*M. rotundifolia* auct.) and all stages are easily found and reared on these plants. Several attempts were made to induce newly hatched

larvae from eggs laid on *Malva*, and older larvae, to feed on *Chenopodium*, but it was always rejected. The "mistake" by the June 17 female is of special interest as a number of other Pyrginae, including the genus *Pholisora*, routinely feed on Chenopodiaceae.

P. communis is abundant throughout the southern Finger Lakes region of New York, occurring in disturbed "dump-heap" habitats and in fallow fields. It has also been reared locally on garden hollyhock (*Althaea*). It appears to be at least partially triple-brooded (June 1—October 17).

PHOLISORA CATULLUS (Fabricius)

Larvae of this species were taken from *Celosia argentea* var. *cristata* (L.) Ktze. (cockscomb, Amaranthaceae) and *Chenopodium paganum* Reich. (Chenopodiaceae) at Ithaca. The larvae from *Celosia* accepted *Amaranthus hybridus* L. (pigweed) and fed to maturity on it. Two larvae from *C. paganum* refused to accept *Atriplex patula* L. (Chenopodiaceae).

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VARIATIONS OF *CERCYONIS PEGALA PEGALA* (SATYRIDAE) IN NEW JERSEY

JOSEPH MULLER

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I found Mather's article on *Cercyonis pegala pegala* (Fabricius) in the *Journal* (1966, vol. 20, p. 186) interesting, and believe it would be advisable to publish a somewhat similar diagnosis of *Cercyonis* specimens from New Jersey.

All specimens herein mentioned were caught on the southern coastal plain of New Jersey from Cape May, the most southern tip of New Jersey, (situated about as far south as Washington, D. C.), north to Chatsworth (Burlington County). The localities and collecting data are given below and the variations described.

No published record appears to exist of any catches of *Cercyonis pegala pegala* in New Jersey prior to this paper. Klots (1951: 72) mentions New Jersey as a blend zone only. Coastal specimens have heretofore been listed by Comstock (1940: 60) as *alope* (Fabricius).

The material examined consists of 48 specimens from the southern coastal plain, collected in about even numbers by Mr. F. Rutkowski and myself.

LOCALITIES AND DATA (numbers of specimens given in parentheses):

Cape May: (1) July 26, 1958; (8) July 19, 1961; (20) July 16, 1966; Bass River State Park (near Harrisville Pond, 60 miles north of Cape May): (5) July 16, 1966; New Gretna (about the same distance from Cape May): (2) July 16, 1966; Chatsworth (about 70 miles north of Cape May): (8) August 11, 1966; (4) July 16, 1966.

There are only four females in the lot, each with equally large ocelli in the yellow patch on the upper side of the primaries. They are included among the data from males below.

Variations in ocelli near the upper outer margin of the primaries:

	Two equal-sized ocelli (3 mm)	Lower ocellus smaller (1¾ mm)	Lower very small (1 mm)	One ocellus (2¼ mm)
Cape May (31 specimens)	17	5	6	3
Chatsworth & New Gretna (17 specimens)	13	2	2	0

Variations of the ocelli on the upper side of the secondaries:

	Two ocelli	Three ocelli	None
Cape May	2	3	1
Chatsworth	2	3	0

Nine specimens from Bass River and Chatsworth all show the yellow patch light yellow and ground color on upper outer margin of the primaries and underside of the secondaries much lighter. The ocelli on underside of secondaries vary from 2 to 6. Two of the 9 specimens have 2 ocelli; 4 specimens have 5 ocelli; and 3 have the ocelli large.

Variation in phenotype shown by *Cercyonis* specimens from Bass River State Park and Chatsworth, in color and ocelli, show a gradual blending from *C. pegala pegala* into *C. pegala alope*. This indicates that the blend zone starts about 60 miles north of Cape May.

The above descriptions show that the New Jersey population of *pegala* is variable in the size of ocelli. Specimens with one ocellus are scarce (3 in 48).

Curiously, all butterflies in Bass River State Park rested only on tree trunks, while those caught at Cape May were collected in open grassy meadow mixed with brush.

I want to thank Dr. Cyril F. dos Passos for determining my specimens.

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MASS ONE-DIRECTIONAL FLIGHT OF CLOUDLESS SULFURS (PIERIDAE) IN ALABAMA AND MISSISSIPPI

A large flight of cloudless sulfur butterflies (*Phoebis sennae eubule* (L.)) was observed between 11:00 A.M. and 1:00 P.M. September 10, 1967 in west central Alabama and extending into Mississippi. This flight was unidirectional, moving toward the southeast, and was noted while the writer traveled westward from Tuscaloosa, Alabama, on U. S. Highway 11. That portion observed covered an airline distance of more than 80 miles. The flight bore many of the characteristics of migrating populations of this species previously described by other workers, namely a steadfast one-directional bearing, a rather uniform height of between five to ten feet above trees, ground and other surfaces, and steady but rapid forward speed estimated at five miles per hour. Williams (1937) referred to regular migrations of *P. sennae eubule* (which he called "The Traveling Butterfly") occurring in a southward direction in Georgia, Alabama, Arkansas, South Carolina, and New Jersey. These apparently occurred in a north to south movement in the fall, but the return spring flights were less well documented.

Although the number of insects was nowhere near the larger migrating hordes noted by other workers for the cloudless sulfur, several hundred individuals could be seen crossing the highway at a time along a distance of one quarter mile. This approximate density extended to the town of Eutaw, Alabama, where the density began to thin. The flight was, therefore, more abundant along its eastern edge, with the greatest number of individuals noted just west of the intersection of the Black Warrior River and U. S. 11 (U. S. 45). The western edge of the observed flight extended just westward of Meridian, Mississippi, where it was thinly populated, with just a few individuals per quarter mile of road.

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SOME OBSERVATIONS ON AND DESCRIPTION OF *POLYDORUS ARISTOLOCHIAE* (PAPILIONIDAE)

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Polydorus aristolochiae (Fabricius) is the commonest large-tailed, black butterfly of the Indo-Pakistan region. At Tando Jam (25°26' N; 68°32' E), West Pakistan, adults were found on *Aristolochia bracteata* L., and other plants, and the following observations were made during 1962-63.

Descriptions and longevity of the adult have been recorded by previous workers (Witt, 1909; Ghosh, 1914; Anthram, 1924; Talbot, 1939; and Wynter-Blyth, 1957). More comprehensive observations on the description, longevity, and sex ratio of *P. aristolochiae* is presented below.

DESCRIPTION OF THE ADULT

Most earlier workers have not mentioned details of the color and pattern of the hindwing spots, a description of which follows.¹

Ground color black; a curving row of three to four white spots in interspaces between the veins in lower discal area, beyond cell, followed at anal angle by an irregular, elongate spot of whitish or reddish, with a black center; a submarginal row of six or seven dull to bright red, crescent-shaped spots in vein interspaces, usually dusted with some black scales. Underside with the white, lower discal spots as on upperside; the submarginal red spots larger than on upperside, varying in shape, either triangular or elongate, with or without a black dot in them.

LONGEVITY OF ADULT

To study longevity of adults and effect of food on longevity, 45 pairs of butterflies were caged in the laboratory between March, 1963 to November, 1963. They were provided flowers of rose (*Rosea indica*), *Lantina Cameron*, and host twigs (*Aristolochia bracteata* L.) as possible sources of nutrition, in addition to cotton wool soaked in glucose solution or different chemicals. The results are given in table 1.

It was found that females lived slightly longer than the males. The food apparently had no significant effect on the longevity of the adults. The males lived from three to 12 days and the females from three to 18 days. The results obtained in the laboratory are in general agreement with those of Ghosh (1914), but the life of adult ranged to considerably longer at Tando Jam.

SEX RATIO

One batch of 140 and another batch of 16 pupae were collected on

¹ An excellent description of both dry-season and wet-season forms, with colored plates, is given by Moore (1902, *Lepid. Indica*, Vol. V, p. 178; pl. 441-442)—Ed.

TABLE 1. FOOD MATERIAL SUPPLIED TO MALES AND FEMALES OF *P. aristolochiae*.

Food Supplied	Month 1963	No. of Pairs	Longevity in Days	
			Male	Female
1. Jaggery with host twigs and Lantana flowers	March	6	3-4	0-4
2. Honey with host twigs and Lantana flowers	March	6	3-4	0-4
3. Glucose, Peptone & host twigs	Nov.	9	3-6	3-9
4. Fructose with host twigs	Nov.	12	3-12	9-16
5. Dextrose, host twigs and Lantana	Oct.	6	3-4	4-6
6. Dextrose, host twigs and Rose	Nov.	6	6-9	7-18

November 10 and December 1, 1962 respectively. The pupae were kept in two cages in the laboratory in anticipation of adult emergence. The results are summarized in Table 2.

It can be seen that 22 pupae failed to produce adults. This may be a normal mortality level or the pupae may have been injured in handling. The data show that the proportion of males was slightly higher, the ratio being slightly less than 7 : 5.

ACKNOWLEDGMENT

To Jerry A. Powell (University of California, Berkeley), I extend my sincere appreciation for correcting and improving the manuscript.

TABLE 2. EMERGENCE OF *P. Aristolochiae* ADULTS FROM FIELD-COLLECTED PUPAE.

Month of Collection	Month of Emergence	Male	Female
November, 1962	February, 1963	7	4
	March	12	14
	April	23	20
	May	29	10
	June	1	2
	July	—	1
	August	1	1
December, 1962	December, 1962	1	1
	January, 1963	—	1
	February	—	—
	March	3	—
	April	—	1
	May	1	1
	TOTAL	78	56

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COLOR VARIANT OF *CALLOSAMIA PROMETHEA*
(SATURNIIDAE) IN NEW YORK

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Distinct color variants exist within many species of insects and it is interesting to detect in nature examples of appearance and increase of such morphs for a particular species in a region where they have not previously been found. For eight successive years (1957-1965), I have collected cocoons of *Callosamia promethea* (Drury) from three counties in southern New York State: Ulster, Westchester, and Nassau counties. Within each of these regions, which are roughly 50 miles apart, cocoons were taken at six different localities, covering an approximate area of 150 square miles per county. Almost invariably collected on *Prunus*, yearly samples of 75 cocoons were obtained for each county giving a total of 225 per year or 1,800 cocoons sampled for the eight-year period. Adult emergence indoors was recorded yearly by county and the sex ratio consistently revealed slightly more males (53-57%) for the eight years in all three counties.

The most interesting result of this survey, and the subject of this paper, was the repeated appearance of an apparently distinct color variant of females from cocoons collected in Ulster County (the most northern of the three) during the final three years. Normal females of

promethea are dull red-brown in wing background color sometimes with a slight orange tint (Forbes, 1923). The variant females were bright orange-brown with the same markings as in normal females of *promethea*. Specimens of the variant did not vary much within and between years. Although difficult to determine precisely, males did not appear to be aberrant for coloration and markings. Variants formed 10% of the emerged females in 1963, 25% in 1964, and 30% in 1965.

My initial impression was that the color variants were actually females of *C. angulifera* Walker, a species known to occur in New York. Females of both species are similar in markings, although *angulifera* has the bright orange-brown color observed in the variant. My initial supposition proved to be erroneous after careful comparative examination of many specimens of both species (using *angulifera* adults reared from cocoons obtained from a dealer). Holland (1903) states that males of *angulifera* have large, angulate discal spots (similar to those of females of both species), while males of *promethea* lack these markings. None of the males emerging from the collected cocoons had these diagnostic markings. Furthermore, the most conspicuous difference between females of both species is that the large, angulate spot of the forewing usually touches the postmedial line in *angulifera* (Holland, 1903; Forbes, 1923). None of the orange-brown moths had this marking. Finally, larvae of *angulifera* characteristically spin cocoons which fall to the ground while cocoons of *promethea* are usually securely attached to branches (Holland, 1903). All cocoons collected were of the latter type.

The color variant has not been obtained from cocoons collected in the other two counties. All cocoons were kept in the same room under the same conditions of temperature and relative humidity and all were collected during December. Ruling out gross sampling error, it is conceivable that the color variant of *promethea* is new to Ulster County and that it has been increasing in frequency. Sampling error may have been minimal since cocoon collections were made only where the species is very abundant and the area covered was large for each county and did not vary much over the eight years. Breeding experiments, to elucidate a possible genetic basis of the variant, were not performed.

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RECORDS OF TWO SPECIES OF EXOTIC LEPIDOPTERA CAPTURED IN CALIFORNIA

PAPILIO DEMOLEUS L.

This widely distributed citrus-feeding species was represented in a student collection that was presented in partial fulfillment of a course at San Jose State College. The specimen was taken in the student's back yard. There seems to be no doubt of the authenticity of the capture. The labels read: "Palo Alto / Santa Clara Co. / Calif., 4.IV.64" and "Bryan Osborne / Collector." As nearly as can be ascertained this specimen belongs to the population found in Africa, rather than to the Indo-Australian race, but this is not easy to establish from a single specimen. The specimen is in the collection of J. W. Tilden.

CERAMIDIA VIRIDIS (Druce)

There are at hand four specimens of this syntomid moth, two of which, from the collections of the California Insect survey and determined by J. A. Powell, are quite surely this species. One bears the labels: "Berkeley, Cal. / May 1960," "A. Berryman / collr.," and "Emerged late May '60 / Reared from / cocoon on Banana / from Safeway Mkt." The empty cocoon and pupal exuviae attached to a bit of banana peel are pinned below the specimen. The second specimen is labelled: "Auburn / Placer Co. / Calif. IX.7.60" and "J. Osgood / Collector." There is no label stating the source but the cocoon and exuviae are attached to a bit of banana peel below the specimen.

The other two specimens, in the collection of J. W. Tilden, do not seem to fit the description of *C. viridis* as well as the two preceding specimens, yet do not fit descriptions or illustrations of other species of *Ceramidia*, and are tentatively placed as *C. viridis* pending further information. One bears the labels: "Milpitas / Santa Clara Co., / Calif. 8.XI/65," and "In Kitchen / leg. R. Hennessey." The other bears labels reading: "Palo Alto / Santa Clara Co., / Calif. 27 Feb. 66," "From Cocoon on / Bunch of Bananas," and "R. B. Blake / Acc. No. 85."—J. W. TILDEN, *San Jose, California*.

BOOK NOTICE

ANNOTATIONES RHOPALOCEROLOGICAE, by Charles F. Cowan, F.R.E.S. 20 pp. Privately printed. 29 Feb. 1968. Price, 12/6, paperbound.

Francis Hemming died before his monumental study "The Generic Names of Butterflies and their Type-species" was published. It was inevitable that under such conditions certain errors escaped correction. Col. Cowan has studied Hemming's volume with meticulous care and has brought to light a variety of errors. He also has been able to add all of the generic names published, but not included by Hemming, through 1964. The Addenda lists 10 additional names, including one that is proposed for an ill-founded one for an African taxon. The I.C.Z.N. rulings that affect generic names of butterflies are reviewed through the end of 1967. Cowan discovered and here corrects about 190 errors in the text of Hemming's work and its index. These corrections are supported by a series of numbered explanatory notes.

A valuable contribution of Cowan is the dating of two Felder papers published in 1861. One of these was presented in 1860 but not published for 14 months.

Cowan's discussion of the genera proposed in these papers is most informative and affects certain Neotropical names.

Four Nearctic genera are affected by publication or ruling not mentioned in Hemming's volume. These are *Erynnides* Burns, 1964, type-species *Nisoniades propertius* Scudder & Burgess, 1870; *Lephelisca* Barnes & Lindsey, 1922, invalid; *Adopacoides* Godman, 1900, valid; *Athanassa* Scudder, 1873, type-species *Melitaea texana* Edwards, 1863.—F. M. BROWN, *Colorado Springs, Colo.*

BOOK REVIEW

WINGS IN THE MEADOW, by Jo Brewer: 187 pp. + xviii, illustrated by Henry B. Kane: 1967. Houghton Mifflin Co., 2 Park Street, Boston, Massachusetts. Cloth. \$4.95.

Wings in the Meadow is the story of the annual sequence of events involving the monarch, *Danaus plexippus* (Linnaeus). The story begins with the arrival of "Danaus the mother" in a Massachusetts meadow belonging to Mr. Stevens, the main character of the book's subplot. The life of the story's hero, "Danaus the son-Danaus of the Golden Wings" begins on May 22nd as one of eleven eggs laid by Danaus the mother in Mr. Stevens' meadow. From this day the life of Danaus the son is followed until his death on an ocean beach on September 10th. Simultaneously, the passing of the season is followed in the meadow with Mr. Stevens becoming increasingly perceptive of the natural world on his doorstep. The last 25 pages of the text are a treatment of the final movement of Danaus' brethren and progeny to their winter refuge in the south.

The imaginative and faithful black and white illustrations of Mr. Kane occur at frequent intervals and nicely compliment the material treated in the text. A preface by John C. Downey, Carbondale, Illinois and a brief glossary of technical terms directed to the lay reader supplement the text.

This book is a notably successful first attempt at popularized documentary natural history writing rather in the style of Rachel Carson. *Wings in the Meadow* was a challenge to its author to write. It will now be a pleasurable challenge to lepidopterists of all ages, as well as the layman, to read and assimilate. For this book's purpose will not be to be read once and forgotten, but to be the subject of repeated analytic readings. Mrs. Brewer was not content to present a mere travelogue of *Danaus*, but instead she has produced a book packed with concepts normally treated in advanced textbooks. Topics revolving around ecology, developmental physiology, behavior, and evolution have received considerable attention. Mrs. Brewer's field observations were combined with material from a number of respected reference works listed by her on pages 179 to 181. The author was able to adapt advanced ideas to a form which will be understandable to the enlightened lay reader and yet retain its impact.

Jo Brewer was particularly successful in her attempts to avoid vitalistic writing and to refuse the temptation to make anthropomorphic comparisons: however lapses occur in her descriptions of the behavioral actions of *Danaus*. For example on page 101 we find "He (Danaus) flew frantically back and forth trying to escape, but all his skills and wiles were of no use . . ." Mrs. Brewer's descriptions of facets of the story which deal with ecology, morphology, and physiology were most successful.

There is much of value in *Wings in the Meadow* for persons interested in any aspect of lepidopterology as Jo Brewer's ability to convey the essence of complex natural phenomena to her reader is remarkable.—PAUL A. OPLER, *University of California, Berkeley, California.*

HESPEROCHARIS LONGSTAFFI (PIERIDAE) REDISCOVERED IN VENEZUELA

JOHN H. MASTERS

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The type series of *Hesperocharis longstaffi* Dixey (1915) in the Hope Collection, Oxford University, consists of one male and two females collected by Dr. G. B. Longstaff (January 9–11, 1913) at La Guaira, Distrito Federal, Venezuela at 1,000 and 1,300 feet elevation. These have been virtually the only known specimens. In August, 1966, a series of three males and 13 females was collected at flowers in the backyard of the Harold Skinner residence in Los Dos Caminos, Estado Miranda, Venezuela, at the base of El Avila, the highest peak (7,000— feet) in the Venezuelan coastal range. The high ratio of females to males in this series may indicate that females are less wary and easier to catch, because most of the specimens were taken by hand by a young lad in the Skinner household. Because the type series was collected in January, a watch was kept for a second brood in January 1967 and a single male was captured on January 5. Probably the breeding grounds of *H. longstaffi* are somewhere on El Avila. The summit has been often collected but the steep slopes are not accessible. Perhaps a movement owing to exceptional population density forced some individuals to lower elevations where they could be collected.

Harold Skinner had previously collected a series of *longstaffi* somewhere near Caracas in the late 1950's, but did not record the data. A few years later this series was identified at the Central University of Venezuela at Maracay as *Heliochroma crocea* Bates. Two of these specimens are retained at Maracay under this name and two remain in Skinner's collection. A search of other Venezuelan collections has revealed only one additional specimen, a male from Turin. Estado Portuguesa is in Rudolf Feige's collection in Caracas. A canvass of the large institutional collections in the United States has not revealed any specimens.

Aside from its rarity, *H. longstaffi* is of special interest because it belongs to that group of insects for which Butler proposed the genus *Heliochroma*. The type species for *Heliochroma* is the little known *idiotica* Butler; other species presumably allied with it include *crocea*, *longstaffi* and *jaliscana* Schaus. *Heliochroma* has sometimes been held as a valid genus, and sometimes has been treated as a synonym of *Hesperocharis* Herrich-Schaeffer or *Daptonoura* Butler. Most revisers have been handicapped by the lack of specimens for study. Sexual



EXPLANATION OF FIGURE

Hesperocharis longstaffi Dixey, Los Dos Caminos, Venezuela, August 1966. Top row (uppersides) male left, female right. Bottom row (undersides) male left, female right. Natural scale.

dimorphism seems to be the crux of this generic confusion, as females have a wing shape characteristic of *Hesperocharis*, while the males have tapered apices suggestive of a relationship to *Daptonoura* (see figures). Dr. Alexander B. Klots' (*in litt.*) is of the opinion that Butler's *Heliochroma* was founded solely on females and should be treated as a synonym of *Hesperocharis*. F. Martin Brown has examined a female of *H. longstaffi* from my series and is of the opinion that it belongs to the subgenus *Hesperocharis*. The question is not fully resolved and may be eventually settled by detailed field work and life history studies.

Talbot (1934) retained *longstaffi* as a subspecies of *Hesperocharis crocea*. This may be correct as *crocea* and *longstaffi* are indeed similar, and *crocea* is Central American. *H. crocea* is easily separated from *longstaffi* by having an orange suffusion on the dorsal secondaries.

I am depositing a pair of *H. longstaffi* in the Carnegie Museum at Pittsburgh and two females in the American Museum of Natural History

at New York. Harold Skinner is placing a pair in the collection of the Central University of Venezuela at Maracay. One male and three females are being retained each in my collection and in Harold Skinner's collection in Los Palos Grande.

I am grateful to Richard M. Fox, A. B. Klots and F. M. Brown for their helpful suggestions. I am especially indebted to H. W. Skinner for supplying collection data and specimens for study.

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WINTER SURVIVAL OF *PIERIS RAPAE* AT THE PAS, MANITOBA

There seem to be no records in the literature as to how far north in North America *Pieris rapae* (L.) can survive the winters.

I was much surprised to have a male *Pieris rapae* emerge in the house on May 3, 1967, from a chrysalid found outdoors one week before. The chrysalid was one of three found attached to the cement foundation of the house. It was attached six inches from the ground, next to a plot of ground in which cabbage had been grown the preceding season. The chrysalid here would have been exposed to seven months of winter, with the temperature regularly dropping to -40 degrees F. for the better part of a month.

One of the chrysalids had dried out and the third, though apparently living, was eaten by a Carabid beetle. The emerged specimen is in the writer's collection labelled "1st recorded winter survivor, The Pas, Manitoba, May 3rd, 1967."

Pieris rapae is common in gardens at The Pas and has been so for the past 30 years. I have always assumed it to arrive freshly from the south each spring, not being able to survive our severe winters. The present record shows that this species is adapted to our climate and can survive the winters in the pupal state.

This species is at present absent from the Lynn Lake area and likely in other northern settlements of Manitoba. I propose to document its rate of spread northward.—WALTER V. KRIVDA, P. O. Box 864, The Pas, Manitoba, Canada.

RICHARD MIDDLETON FOX (1911-1968)

Dr. Richard Middleton Fox, currently the world's authority on Ithomiidae, died suddenly in Pittsburgh, Pennsylvania, on April 25, 1968. Dr. Fox was born in Morrisville, Pa., on April 15, 1911. He is survived by his wife, Jean Walker Fox, and a son and daughter by his first marriage.

Fox's education was interrupted by depression and war. He studied at Swarthmore ('29-'32), University of Pennsylvania ('40-'41—AB with Honors) and University of Pittsburgh. The last institution granted him his M.S. (Zoology) in 1947 and Ph.D. in 1948. During World War II, Dick Fox served in the Pacific as operations officer on an amphibious-group staff and later became Commanding Officer of LSM 177. He retired from the U. S. Naval Reserve as a Lt. Commander in 1960.

With the exception of his military service, Fox's life was divided between teaching and entomological research. Before the war he was engaged in research at the Academy of Natural Sciences in Philadelphia (1935-1941) and Reading, Pa., Public Museum (1941-1942). From 1946-1948 Fox was on the faculty at University of Pittsburgh which he rejoined in 1960. At the time of his death he was Adjunct Professor of Biology in the Graduate School. From 1949 to 1954 he was Associate Professor of Zoology at Colorado College in Colorado Springs. In 1954 he and his wife Jean moved to Liberia where he was medical entomologist and acting director of the Liberian Institute (1954-1957) and then director of field research for Riker Laboratories, Inc. (1958-1959). Upon returning to this country Fox became Associate Curator, Section of Insects and Spiders, Carnegie Museum in Pittsburgh, Pa., which position he held at the time of his death.

I first became aware of Dick Fox in the late 1930's when I returned from a year-long collecting trip to Ecuador, and he asked to study my Ithomiids. From that time on our friendship grew. We argued the philosophy of taxonomy, reviewed each other's work before publication, and in general enjoyed each other's company in the field, laboratory and at home. Fox wrote numerous papers about butterfly taxonomy, the most important of which are his now closed series of monographs upon the Ithomiidae. He was meticulous and tolerated no slovenly work among those associated with him. Perhaps his most important contribution is the textbook on entomology that he prepared with his wife, also an accomplished systematist and morphologist. To my knowledge this is the only non-economic entomological text published in this country. He and Jean spent years of loving care to make it as

sound and complete as is humanly possible. Reinholt published their "Introduction to Comparative Entomology" in 1964.

Lee Miller's as yet unpublished study of the genera and higher categories of the world fauna of Satyridae was carried out under Fox's critical eye. When I last was with him, a few weeks before his death, he was guiding Maria Etcheverry, the well-known Chilean lepidopterist, through a similar study of the Nymphalidae.

The Fox family had planned to spend this past winter and spring in London working at the British Museum where Dick was familiar with the collections as he was with those at the Carnegie. A heart attack, his second, last fall put him into the hospital and prevented him and Jean from making that trip. His many friends at the British Museum will miss him as much as we here who were associated with him. He was a man who made friends slowly but enjoyed life, a musician of ability, an artist of no mean talent and above all, a superb, well-rounded scientist and teacher.

F. MARTIN BROWN, *Colorado Springs, Colorado*

The following bibliography of scientific writings of Richard M. Fox is complete to mid-1967.

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INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

A.(N.S.)80

Required six-month's notice is given on the possible use of plenary powers by the International Commission on Zoological Nomenclature in connection with the following names listed by case number:

(see, *Bull. zool. Nomencl.* 24, pt. 5, 7 December 1967):

1801. Suppression of *Argynnis chlorodippe* Villers & Guenée, 1835 (Insecta, Lepidoptera)
 1815. Validation of *Pachyrhynchus* Germar, 1824 (Insecta, Coleoptera)
 1822. Type-species for *Lasioptera* Meigen, 1818 (Insecta, Diptera)
 1829. Suppression of *Polanisa* Walker, 1875 (Insecta, Hymenoptera)
- (see, *Bull. zool. Nomencl.* 24, pt. 6, 18 January 1968)
1827. Type-species for *Solenius* Lepeletier & Brullé, 1834 (Insecta, Hymenoptera)

Comments should be sent in duplicate, citing case number, to the Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London S.W.7, England. Those received early enough will be published in the Bulletin of Zoological Nomenclature.—W. E. CHINA, *Acting Secretary*.

HELEN LEE LEMMON (1916-1967)

Helen Lee Lemmon was born in Seattle, Washington, on February 3, 1916, and lived subsequently there and in Denver, Colorado. By her marriage to Robert H. Pyle she had four children, with whom she made her home in Denver. Her second marriage was to Phil Lemmon of California.

Nature was a dormant love for Mrs. Lemmon throughout her early life. When this writer, her son, developed an active devotion to natural history, she did the same. Mrs. Lemmon was intensely interested in the Lepidoptera, later in fungi (she was affiliated with the Denver Mycological Society), and committed of what spare energies she had to conservation.

"Mom L.", as my collecting friends and I called her, gave very completely of herself to further any project that we undertook. My finest memories of her consist of days in the field, when she constantly made unusual captures, no matter what the locale. Perhaps her finest specimens were a one-quarter gynandromorph of *Colias alexandra alexandra*, an *Agraulis vanillae*, and *Speyeria nokomis*, all taken in Colorado. In preparation is a detailed study of the butterflies of the Highline Canal in Colorado, for which Mrs. Lemmon was a major collaborator. A collection of these butterflies, to be known as the Helen Lee Lemmon Memorial Collection of the Butterflies of the Highline Canal, will be installed and dedicated in the interpretive center of the Highline Canal Nature Trail in Aurora, Colorado, upon its completion.

During her last few summers, Mrs. Lemmon was able to go afield in numerous locales throughout Colorado, and her records are valuable. More valuable were the hours spent collecting with her. Mrs. Lemmon's companions on butterfly jaunts were daughter Susan Kafer and her husband Ted, son H. Whetstone Pyle, Charles Dudley, JoAnne Pyle, and myself. She is survived by these, another son, Thomas, and her mother, Grace P. Miller of Denver. Because of her vigorous and kind encouragement and aid, Mrs. Lemmon's accomplishments will be measured by the continued work her associates will carry out in the realm of biology.

ROBERT M. PYLE, 4105 Brooklyn Ave. N.E., Seattle, Washington

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COMSTOCK, J. A., 1927. Butterflies of California. Publ. by author, Los Angeles, Calif.; 334 pp., 63 pl.

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In This Issue

EVOLUTION AND SIGNIFICANCE OF MULTIPLE PAIRING
FACTORS IN ECLOSION OF PIERIS RAPAE
BUTTERFLIES FROM COAHUILA
CONTINUOUS VARIATION IN CATOCALA
LIFE HISTORY OF CHLOSYPNE FULVIA

(Complete contents on back cover)

15 November 1968

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THE EVOLUTIONARY AND BIOLOGICAL SIGNIFICANCE OF MULTIPLE PAIRING IN LEPIDOPTERA

ROGER W. PEASE, JR.

Department of Biology, College of Wooster, Wooster, Ohio¹

The frequency of pairing in Lepidoptera may be related to population structure (Labine, 1964), to courtship behavior (Marshall, 1901) or to the balance of a polymorphism in a mimetic population (Burns, 1966). In this paper a sample of female *Utetheisa ornatrix bella* (L.) (Arctiidae) from the polymorphic Florida population is analyzed by phenotypic and pairing frequency for evidence of sexual selection; data taken from the literature are summarized; and the importance of mating frequency for the evolution of behavior and of population structure is discussed.

Studies of copulation have shown that in many Lepidoptera the male constructs a sperm containing bag (spermatophore) in the genitalia of the female (Callahan and Cascio, 1963; Callahan and Chapin, 1960; Khalifa, 1950; Norris, 1932; Weidner, 1934). Mating refers to copulation; successful mating requires transfer of at least one spermatophore. Since spermatophores remain in the bursa copulatrix, the number of successful pairings can be ascertained by dissecting the bursa and counting spermatophores. The spermatophore is reported to disintegrate as soon as it is formed in certain Microlepidoptera (Callahan and Casico, 1964: 554). While spermatophore remnants are difficult to count, the hardened duct (collum) through which sperm pass from the spermatophore to the ductus seminalis is retained more or less complete in *Utetheisa ornatrix*, and the number of colli is an index of pairing frequency. At most one spermatophore is produced during a single copulation of this species. Of twelve virgin females mating once in controlled breeding experiments in 1961, all had one and only one spermatophore in the bursa copulatrix.

In the pink bollworm, *Pectinophora gossypiella* (Saunders) (Gelechiidae), spermatophores were formed in 199 of 219 laboratory matings of virgin females (Ouye, *et al.*, 1965, experiment 1). Seventeen of the

¹ Present address: 36 Lincoln Street, New Britain, Connecticut.

20 pairs which did not form spermatophores remained in copulo no longer than 30 minutes. Thus, a certain minimum time is required for spermatophore construction and no more than one spermatophore is formed during a single copulation.

The distribution of spermatophore frequencies in a sample of 89 females of *U. o. bella* collected in Florida is tabulated in Table 1. One bursa was lost in the process of dissection. Fifty-three males were collected with the females. The mean number of spermatophores was 3.489 with standard deviation 2.656. One individual had copulated at least 11 times, and eight had not mated successfully.

Before dissection, the condition (fresh vs. worn) of each specimen was estimated on the basis of external appearance and graded A, B, C, or D. Not unexpectedly, the mean number of spermatophores increases from 1.455 for very fresh (A) individuals to 6.250 for very worn (D) individuals (Table 2). Moths reared under constant conditions (80°F, 12–16 hours light per day) usually mated at night although a few males collected in the field mated in the afternoon by artificial light. Diurnal mating may be an adaptation to the Florida winter season with its cold nights and warm days. A refractory period may follow copulation during which time the male will not mate successfully (cf. Khalifa, 1950: 39, *Galleria mellonella* (L.) (Pyrilidae); Ouye, *et al.*, 1965 experiment 2, *Pectinophora gossypiella*).

The sample was tabulated separately for five wing pattern characters and tested for differences in mean spermatophore number between categories (Table 3). The characters were subdivided into categories as follows: (1) forewing ground color—*yellow* or *orange*, *red orange* and *orange red*, or *red*; (2) the distribution of forewing ground color—*colored* or *streaked*, *intermediate* and *white*; (3) black spotting on forewing—*spotted* or *unspotted*; (4) hindwing black markings—*wide*, *semi* or *narrow*; (5) hindwing ground color—*red*, *pink* and *flush* versus *white* (Pease, 1968).

When the t-test was applied independently to each of the five characters in Table 3, only the difference between the mean number of individuals with spotted *versus* unspotted forewings was statistically significant with probability less than .02 of a difference between the means as large or larger. However, the probability is about $\frac{1}{4}$ that one or more of five independent tests is significant at the .05 level, ($1 - .95^5$). Since the statistical hypothesis was formulated after looking at the data, the result does not favor a hypothesis that wing pattern is a factor determining mating frequency. This is consistent with the observation that this species mates at night and that the bright pigmentation serves as a warning stimulus (aposematic coloration) to potential

diurnal predators. Toxic substances have been found in the haemolymph by M. Rothschild. The species exudes a frothy bubble at the tegulae when seized suddenly (reflex bleeding).

The average number of spermatophores in the tiger swallowtail (*Papilio glaucus* L.), a species with dimorphic females, was greater for yellow females than for dark females in samples from Mountain Lake, Virginia and Baltimore, Maryland (Burns, 1966). The resemblance of dark females to the unpalatable blue swallowtail (*Battus philenor* (L.)) is believed to confer protection from predators whose vision enables them to distinguish the two forms. The population frequencies of dark and yellow females are affected by two antagonistic forces of natural selection (an example of disruptive selection). An extra-specific environmental factor, mimicry, favors the mimetic dark female; an intra-specific factor, sexual selection, favors the yellow female.

The preference of the male tiger swallowtail, which is always yellow, for the yellow female is relatively independent of the frequencies of dark and yellow females. At Baltimore the frequency of dark females is .4483 and the mean number of spermatophores was .3366 greater in yellow than in dark females. At Mountain Lake, Virginia where the frequency of dark females is almost doubled (.8571) the difference in mean spermatophore number between yellow and dark females is nearly the same (.3889) (Burns, 1966 Tables 1 and 2).

The difference in means for spermatophores in dark and yellow forms is significant at the 0.2 level for the sample from Mountain Lake, Virginia and is significant between the 0.2 and 0.3 level for the sample from Baltimore County, Maryland (Appendix 1). The "true" difference between the means is important to the theory of polymorphic populations. The experimental biologist can determine the correct sample size to prove or disprove the theory by using the data given below.

Population parameters for the frequency of dark and yellow forms of the tiger swallowtail and the mean number of spermatophores for each follow (Burns, 1966):

	Mountain Lake, Virginia			Baltimore County, Maryland		
	Frequency of Female Type	Mean number of Spermatophores Per Female	Standard Deviation-(s)	Frequency of Female Type	Mean number of Spermatophores Per Female	Standard Deviation-(s)
Dark	.857	1.694	.781	.448	1.538	.776
Yellow	.143	2.083	1.379	.552	1.875	.619
Combined Data	—	1.750	.890	—	1.724	.702

For an assessment of how many specimens should be collected from each population so that the estimated difference in the average number

TABLE 1. DISTRIBUTION OF SPERMATOPHORES IN FIELD SAMPLES OF VARIOUS LEPIDOPTERA AND EXPERIMENTS ON MATING BEHAVIOR

N—sample size; \bar{X} —mean or average; s^2 —sample variance, mean square or square of the sample standard deviation.

Number of spermatophores	N	0	1	2	3	4	5	6	7	8	9	10	11	\bar{X}	s^2
<i>Utetheisa ornatrix bella</i> (L.) (Arctiidae)—Archbold Biol. Station, Lake Placid, Florida (net collection)	88	8	12	15	20	11	5	4	4	2	3	3	1	3.4886	7.0573
<i>Pseudaletia unipuncta</i> (Haw.) (Noctuidae)—Louisiana Callahan and Chapin (1960) Table 1—p. 779 (light trap)	417	182	107	76	36	14	2	—	—	—	—	—	—	1.0384	1.3447
<i>Peridroma saucia</i> Hbn. (= <i>margaritosa</i> Haw.) (Noctuidae)—Louisiana Callahan and Chapin (1960) Table 2—p. 780 (light trap?)	239	203	16	5	8	6	1	—	—	—	—	—	—	.3305	.8525
<i>Heliothis zea</i> (Boddie) (Noctuidae)—Louisiana Callahan (1958) Table 6—p. 427 (light trap)	1295	519	455	227	77	16	1	—	—	—	—	—	—	.9336	.9338
	N	less than 2					2 or more								
<i>Euphydryas editha</i> (Bdv.) (Nymphalidae)—California Labine (1964)	23	14					9								
	N	0	1	2	3	4	5	\bar{X}		s^2					
<i>Battus philenor</i> (L.) (Papilionidae)—Mtn. Lake Biol. Sta., Virginia Burns, 1966—table 2.	33	0	17	11	3	1	1	1.7273		.9545					
<i>Papilio glaucus</i> L. (Papilionidae) Burns, 1966—table 2.															
Mtn. Lake Biol. Station, Virginia															
dark females	72	0	33	30	8	—	1	1.6944		.6095					
yellow females	12	0	6	2	2	1	1	2.0833		1.9015					
Total	84	0	39	32	10	1	2	1.7500		.7922					
Baltimore County, Maryland															
dark females	13	0	8	3	2	—	—	1.5385		.6026					
yellow females	16	0	4	10	2	—	—	1.8750		.3833					
Total	29	0	12	13	4	—	—	1.7241		.4926					

TABLE 1 Continued

Pectinophora gossypiella—(Saunders)

1. Number of copulations (spermatophores not counted) during the lifetime of individual pairs maintained in laboratory population cages.

No. of copulations	No. of moths in Population Cage: ♂ ♀		N	0	1	2	3	4	\bar{X}	s ²
Lukefahr and Griffin (1957, 1967)	1	1	100	72	16	3	3	1	.3500	.5934
Ouye, <i>et al.</i> (1964) Ouye, (<i>in litt.</i> 1967)	1	1	94	24	50	14	5	—	.9894	.6343

2. Number of spermatophores produced during lifetime exposure to moths of opposite sex under laboratory conditions (Ouye, *et al.*, 1965, experiment 4—table 3; experiment 5—table 4, and Ouye, *in litt.* 1967).

No. of spermatophores formed during lifetime	No. of Moths in Pop. Cage		N	0	1	2	3	4	5	6	7	8	9	10	\bar{X}	s ²
	♂	♀														
Males	3	1	206*	10	19	20	25	41	29	29	16	9	5	3	4.2524	5.3116
Females																
(A) Crowded	75	25	196	3	49	74	45	22	2	1	—	—	—	—	2.2245	1.1186
(B) Uncrowded	1	6	266	8	64	83	69	34	6	1	—	1	—	—	2.3195	1.4334
Combined (A+B)			426	11	113	157	114	56	8	2	—	1	—	—	2.2792	1.2993

* Amends N in experiment 4 and table, Ouye, *et al.*, 1965.

3. Spermatophore formation during the first 24 hours after eclosion of females (Ouye, *et al.*, 1965, experiment 3 table 2, Ouye, *in litt.* 1967).

No. of spermatophores Time exposed to males in population cages	N	0	1	2	3	4	\bar{X}	s ²
15–21 hours	373	89	222	44	16	2	.9812	.5776
9–15 hours	118	65	42	7	4	—	.5763	.5711
3–9 hours	16	14	1	—	1	—	.2500	.6000

4. Distribution of spermatophore number in a sample of females collected at light traps in the vicinity of Brownsville, Texas (Graham, *et al.*, 1965; and Ouye, *in litt.* 1967).

No. of spermatophores	N	0	1	2	3	4	5	6	\bar{X}	s ²
No. of moths	2570	284	1872	332	65	13	3	1	1.0911	.4067

of spermatophores lies within .05 of the “true” value 95% of the time, see Appendix 2.

Disruptive selection in the tiger swallowtail may be an example of evolutionary homeostasis at the population level; that is, constant intra-specific factors of selection counterbalance variable extra-specific environmental factors and tend to restore primitive population conditions.

TABLE 2. *Utetheisa ornatrix bella* IN EACH OF FOUR GRADES OF CONDITION WITH MEAN NUMBER OF SPERMATOPHORES PER FEMALE

Condition	# Individuals	Mean Number of Spermatophores
A	22	1.455
B	32	2.781
C	26	5.231
D	8	6.250

If this is true, when the environment ceases to favor the evolutionary novelty (the dark female), the force of sexual selection will restore a uniformly yellow population. This hypothesis is consistent with the observed correlation between the distribution of the blue swallowtail and a high frequency of the dark female form of the tiger swallowtail.

Data on spermatophore frequency in Lepidoptera are summarized in Table 1. The maximum number of spermatophores counted in a female was 11 (*Utetheisa ornatrix*). The maximum number of spermatophores formed by a male was 11 (*Pectinophora gossypiella*—Ouye, *in litt.* 1967).

The mating habits of the pink bollworm moth (*Pectinophora gossypiella*) have been thoroughly studied (Lukefahr and Griffin, 1957; Ouye, *et al.*, 1964; Ouye, *et al.*, 1965; Graham, *et al.*, 1965; Ouye, *in litt.* 1967). Data are summarized in Table 1. Pairs of moths copulated an average of .350 times during their lifetime in the experiments of Lukefahr and Griffin and .989 times in the experiments of Ouye and his workers (spermatophores were not counted). The two means are different (Appendix 3).

Females mate successfully as many as four times during the first 24 hours after eclosion; males produce no more than one spermatophore in a 24 hour period. The average number of spermatophores formed during the life of a male is 4.252 under laboratory conditions. This is almost double the lifetime average of 2.279 for the combined data of females in crowded (A) and uncrowded (B) population cages. (Table 1, experiments 2 and 3) (Appendix 4).

Thus, while the female pink bollworm moth mates successfully more often in one day, the male can mate successfully almost twice as many times as the female in the moths' lifetimes.

The greater number of spermatophores formed by the male is consistent with a hypothesis that natural selection acts more strongly on the male than on the female. Two factors reduce the male's average under the competitive conditions in the field. Males may compete more actively for females than females compete for males (intra-specific sexual selection). Extra-specific factors of natural selection sometimes

TABLE 3. NUMBER OF INDIVIDUALS AND MEAN NUMBER OF SPERMATOPHORES IN EACH CATEGORY OF THE FIVE CHARACTERS FOR WING PATTERN AND PIGMENTATION IN *Utetheisa ornatrix bella* FROM FLORIDA

Character	Phenotype	Number of Individuals	Mean Number of Spermatophores
1	Colored/streaked	36	3.750
	Intermediate	22	3.136
	White	30	3.433
2	Yellow/orange	76	3.526
	Red/orange red/red orange	10	3.100
	("Redless" Aberration) ¹	2	4.000
3	Spotted	69	3.145
	Unspotted	19	4.737
4	Wide	55	3.618
	Semi	30	3.367
	Narrow	3	2.333
5	Red/pink/flush	82	3.304
	White	4	2.000
	("Redless" Aberration) ¹	2	4.000

¹ Specimens in which the red pigment is missing on both the upper and under surface of the wings.

favor survival of the female at the expense of the male, as for example, when the female is protectively colored. Thus, at the population level, the male's greater reproductive potential compensates for individual competition among males and for the greater risk involved in being a male.

It seems intuitive that the competition for mates affects the distribution of spermatophores formed by the two sexes, perhaps, by increasing the variation in the number of spermatophores formed by the males. However, the design of a practical experiment to collect data, and a method of analysis are a challenge to the ingenuity of the experimental biologist.

In samples of Lepidoptera collected at light traps, the average number of spermatophores varies from 1.0911 (*Pectinophora gossypiella*) to .3305 (*Peridroma saucia* Hbn. (Noctuidae)). The average number of spermatophores in a collection made with a net was 3.4886 for *Utetheisa ornatrix*. These data are not comparable to laboratory data because of the mixed age distribution in feral populations.

Some calculations (by Graham, *et al.*, 1965) suggest that the first mating of the pink bollworm is density dependent, but that multiple paring is density independent. This hypothesis is based on a correlation (or absence of) between the log of the number of moths collected in light traps and (a) the proportion of moths which had mated, (b) the

TABLE 4. SPERMATOPHORE NUMBER IN FALL-WINTER VERSUS THE OVERWINTERING SPRING POPULATIONS OF *D. plexippus* IN CALIFORNIA (DATA FROM TABLE 16, WILLIAMS, *et al.*, 1942)

Date	Location	N	0	1	2	3	4	5	\bar{X}	s^2
Oct. 1938—Feb. 1939	Pacific Grove San Diego El Carrito	38	17	19	2	0	0	0	.605	.353
April 1939	San Francisco	5	0	0	2	0	1	2	3.600	2.300

proportion of once mated or multiply mated moths, (c) the mean number of spermatophores for mated and unmated moths combined, and (d) the mean number of spermatophores for mated moths.

Observations on the sex ratio, migration, spermatophore number, adult activity and mating behavior of the winter population of the monarch butterfly (*Danaus plexippus* (L.) (Nymphalidae)) in California are reported by J. A. Downes (Williams *et al.*, 1942: 160–165). No more than two spermatophores were found in any female until after February (Table 4). Although both sexes migrate, the estimated male: female ratio in the population remaining at Pacific Grove in winter quarters was 1000 to 1 by the second week in May. Females apparently migrate first. Some mating occurs in the hibernating population at Pacific Grove (no reports from November to January, however) even though egg follicles remain unripe until the last week in March.

Species in which both sexes pair several times contrast with those in which the female is prevented from multiple insemination by a sphragis or plug which the male constructs in the genitalia (*Acraea* : Marshall, 1901, 1902, and Eltringham, 1912; *Parnassius* : Eltringham, 1925; *Bombyx mori* L. : Omura, 1938). Marshall hypothesized that differences in courtship behavior separate sphragis building genera (e.g., *Acraea* and *Parnassius*) from many other butterflies, “marriage by capture” (Poulton, 1911) *versus* “marriage by courtship.” In other words, sphragis construction complements a behavior pattern in which the male “grapples” with the female after a rudimentary display; in species with more complex behavior patterns, courtship may be terminated at any of several stages (e.g., Brower, *et al.*, 1965).

Eltringham (1912) suggests that the sphragis may block the release of a chemical attractant which serves to assemble males. If this hypothesis is correct, the “capture” system may represent only the final stages of courtship.

In terms of evolutionary potential, no matter how effective “no” signals

are, the rare male which succeeds in breaking through the defense mechanisms of an already mated female will leave more offspring than the male which does not mate under such circumstances. Unless there is a selective advantage to multiple insemination such as a short life span of sperm or a prolonged oviposition period, the balance between multiple versus single copulation should occur when the effort required to copulate with an already mated female will reduce, first, the probability of insemination of unmated females and, second, the males contribution to the gene pool of the next generation. For multiple insemination to persist under such circumstances, the number of fertile offspring left by the more versatile male should outnumber those left by the virgin inseminator.

If this were not so, the evolution of more effective mechanisms against multiple pairing would be expected.

A relationship between mating frequency and interpopulation gene flow has been suggested (Labine, 1964—*Euphydryas editha* (Bdv.) (Nymphalidae)). Populations in which the female mates before migration and only once can be contrasted with those in which the female mates several times and especially with endemic males after migration. In the first instance, a migrating female produces offspring with a gene complement derived exclusively from the parent population while all offspring produced by migrant males mated to endemic females receive half their genes from the parent population and half from the other. In contrast, if both sexes mate after migration, essentially, all offspring are interpopulation hybrids. Thus, multiple pairing may increase the proportion of hybrid offspring among progeny of migrants and hasten the breakdown of introduced gene complexes. On the one hand multiple pairing may increase variation through recombination between the two gene pools and thereby influence the speed of adaptive change. On the other hand, if the crossing of the two gene pools proves deleterious and non-adaptive, F_1 offspring of migrants will be at a competitive disadvantage even though offspring homozygous for genes from the parent population compete successfully in the new habitat. *Thus, hybridization is an effective strategy on the part of the endemic population for increasing the probability of beneficial combinations, and at the same time, serves to reduce the competitive advantage of a closely related invading species provided that the reproductive potential of the endemic population is great enough to prevent swamping.*

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larger is expected on the basis of chance alone between .7 and .8 of the time).

2. An approximate solution can be found using the following expression for the confidence limits for the difference of two means (Fraser, 1958: 281):

$$\bar{X}_d - \bar{X}_y \pm t_{.05} \left(\frac{1}{DN} + \frac{1}{YN} \right)^{\frac{1}{2}} s$$

$t_{.05}$ —is the t statistic with $N - 2$ degrees of freedom but evaluated here for an infinite number of degrees of freedom since the sample size is large but unknown.

N —Sample size.

D —frequency of dark females in sample.

Y —frequency of yellow females in sample.

s —square root of the variance. Since the variance for spermatophore numbers may differ in the two types of females, an approximate solution is obtained by using the population variance calculated from the combined data.

The solution is obtained by choosing N such that

$$t_{.05} \left(\frac{1}{DN} + \frac{1}{YN} \right)^{\frac{1}{2}} s = .05$$

or

$$N = 400s^2(1.96)^2 \left(\frac{1}{D} + \frac{1}{Y} \right).$$

The answer depends on the relative frequencies of dark and yellow females in the sample. The smallest adequate sample is one in which the frequencies of dark and yellow females are equal (*i.e.*, $D = Y = .5$). When equal numbers of both types of female are collected, 3028 females comprise an adequate sample in Maryland and 4870 in Virginia.

3. Means differ at the .02 level of significance, but variances are equal for the two sets of data.

Lukefahr and Griffin, 1957	$N_L = 100$	$\bar{X} = .350$	$s^2_L = .593$
Ouye, <i>et al.</i> , 1964	$N_o = 94$	$\bar{X} = .989$	$s^2_o = .635$

Hypothesis	Test	Degrees of Freedom	Value of Experimental Statistic	Value of Tabulated Statistic	Significance Level	Conclusion
$\sigma_L^2 = \sigma_o^2$	F-test	93, 99	1.070	$1.59 < F_{.02} < 1.87$	.02	variances equal
$\mu_L = \mu_o$	t-test	192	7.256	$2.33 < t_{.02} < 2.36$	.02	means not equal

4. Data for females in crowded (A) versus uncrowded (B) population cages were tested for equality of means and variances. Combined data for females under both conditions were compared with the data from males for equality of means and variances.

Crowded females (A)	$N_A = 196$	$\bar{X}_A = 2.224$	$s^2_A = 1.146$
Uncrowded females (B)	$N_B = 266$	$\bar{X}_B = 2.320$	$s^2_B = 1.433$
Combined data for females	$N_C = 462$	$X_C = 2.279$	$s^2_C = 1.299$
Males	$N_M = 206$	$\bar{X}_M = 4.252$	$s^2_M = 5.315$

Hypothesis	Test	Degrees of Freedom	Value of Experimental Statistic	Value of Tabulated Statistic	Significance Level	Conclusion
$\sigma_A^2 = \sigma_B^2$	F-test	265,195	1.251	$1.28 < F_{.02}$	.02	variances equal
$\mu_A = \mu_B$	t-test	460	.770	$2.33 < t_{.02}$	.02	means equal
$\sigma_C^2 = \sigma_M^2$	F-test	205,461	4.091	$1.00 < F_{.02}$	.02	variances unequal
$\mu_C = \mu_M$	t'	205,461	11.664	$2.33 < t'_{.02}$	.02	means unequal
(Cockran and Cox)						

LEONARD STEVENS PHILLIPS (1908-1968)

Leonard Stevens Phillips was born December 4, 1908 at Le Claire, Iowa. He died suddenly in Chicago, Illinois, February 13, 1968. He was the son of Clyde and Winifred Phillips. His marriage to Merle Olive Garton took place May 26, 1937. She survives him; there were no children.

He attended the public schools of Le Claire and received his B.A. degree from the State University of Iowa in 1932. He did graduate work there and at the Iowa State University of Agriculture, and received his teacher's certificate from the Iowa State Teachers' College in 1938.

He engaged in private business from 1936 to 1946, then became a laboratory assistant in the Stritch School of Medicine, Loyola University, Chicago, a position which he held until 1950. Following a period as laboratory technician with Swift and Company in Chicago, he became Assistant Biologist at the Illinois Institute of Technology Research Institute. Here he was in charge of the animal room and worked on many projects involving the use of small animals in behavioral studies and biochemical research. In 1965 he joined the Loop City College of Chicago as a laboratory assistant, and in 1967 returned to private business, in which he was engaged at the time of his death.

Leonard was an active and enthusiastic collector of Lepidoptera. He collected personally in every state of the continental United States and

maintained an active correspondence and exchange with fellow lepidopterists throughout the world. He contributed several papers to the pages of this *Journal*; a bibliography is given below. His collection of some 5,600 specimens of worldwide Lepidoptera is being retained by his widow for the present, but will be presented to Buena Vista College, Storm Lake, Iowa.

Among his other interests were collections of pressed plants, minerals, and stamps; woodworking, and amateur art. He was active in Boy Scout, boys' club, and church work. He was a member of the Chicago Entomological Society, and had been a member of the Lepidopterists' Society since 1948.

Leonard's many friends and correspondents will miss his friendly, outgoing personality, his enthusiasm for his avocation, and his willingness to be of service to others.

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THE EFFECT OF BAROMETRIC PRESSURE AND OTHER
FACTORS ON ECLOSION OF THE CABBAGE BUTTERFLY
PIERIS RAPAE (PIERIDAE)

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The literature describes various effects of barometric pressure on insects. For example, there is evidence that slightly reduced pressure increases the rate of development of insects while slightly increased pressure has no positive influence (Wellington, 1946). *Pieris rapae* (L.) is said to lay more eggs when the barometric pressure is low (Stephens and Bird, 1949), while low pressure appears to be disadvantageous to at least one insect activity in that a slight depression is reported to prevent the silkworm from secreting silk (Markovic-Giaja, 1957).

Of particular interest is the assertion that lowering of the barometric pressure is necessary for successful eclosion of butterflies (Pictet, 1933), including *Pieris rapae* and *Pieris brassicae* (L.); it was recorded that 91.3% of 1758 pupae eclosed during atmospheric depression. Also, certain Lepidoptera are supposed to be so sensitive to the effect of barometric pressure that they eclose when the pressure falls only 1.7–3.4 mm of mercury below the daily maximum (Mell, 1939).

The present work is in large part an evaluation of the effect of pressure on eclosion of the subject species by means of observations at ambient conditions and also by controlled experiments.

ECLOSION UNDER AMBIENT CONDITIONS

The pressure in the central area of a typical "high" is about 765–773 mm, while a "low" is normally 743–750 mm (Anonymous, 1960). In the New York City area the mean pressure in summer generally is about 762 mm.

The data of Table 1 are for successive broods in a culture started with eggs laid by *Pieris rapae* taken at Flemington, New Jersey on May 1, 1965. It is apparent that the barometric pressure was relatively high, and certainly not considerably depressed, during eclosion. The impression is that the time of eclosion was controlled simply by the time required for maturation of the pupa (7–10 days, approximately). The possibility would seem to remain that eclosion might be delayed by an unusually high pressure, e.g. 788 mm as recorded in New York City for record highs in 1927 and 1949 (Hansen, 1961), and the effect of extremely high pressures was studied in the experiments discussed below.

TABLE 1. BAROMETRIC PRESSURE DURING ECLOSION UNDER AMBIENT CONDITIONS

Number eclosed	Pupation (day)	Eclosion (day)	Date eclosion started	Conditions during eclosion ¹		
				Relative humidity (%)	Temperature (°F)	Barometric pressure (mm)
38	0-6	9-15	June 6, 1965	38-55	75-90	754-766 ²
51	0-5	14-18 ³	July 11, 1965	49-62	77-87	758-766
37	0-3	7-10	Aug. 11, 1965	48-60	78-89	761-765
16	0-5	9-13	Sept. 16, 1965	60-65	72-84	760-770

¹ The barometric pressure readings are corrected to 0°C and sea level.

² The pressure was in the 759-766 mm range except for the last day.

³ The pupae had been refrigerated from day = 6 to day = 12.

ECLOSION UNDER CONTROLLED CONDITIONS—EXPERIMENTAL

Rearing of larvae.—Larvae were reared in cardboard boxes with gauze windows and fed cabbage leaves from refrigerated heads as in previous work (Kolyer, 1966).

The pupae used for experiment 1 derived from eggs laid on August 6 and 7, 1966 by females taken at Berkshire Valley and Morristown, New Jersey. Pupation took place 17-21 days after the inception of hatching on August 9. The larvae were reared in a room at 73-91°F and 40-70% relative humidity.

The pupae for the remaining experiments were reared from eggs obtained from N. R. Spencer of the U. S. Department of Agriculture (see Acknowledgment). A minor portion of the final-instar larvae evidenced black spots on the integument, but fortunately there was no effect on pupation or eclosion. Pupation took place 26-29 days after the inception of hatching on April 7, 1967. The room was at 67-79°F and 25-34% relative humidity during the larval period. Incidentally, two male adults from this brood were of the canary-yellow form (one eclosed in experiment 2 and one in experiment 5).

TABLE 2. SUMMARY OF EXPERIMENTAL CONDITIONS

Experiment Number	Pressure (mm)	Photoperiod ¹	Relative Humidity (%)
1	735-740 and 765-770 ²	no	43 at 72°F
2	735-740 and 765-770 ²	yes	43 at 72°F
3	690-700 and 790-800 ²	no	43 at 72°F
4	825-830	yes	43 at 72°F
5	ambient	yes	87 at 75°F
6	ambient	yes	43 at 72°F

¹ Diffuse sunlight (from windows with southern exposure) from 7:27 AM to 5:03 PM.

² Cycled from one range to the other every 4 hours and 48 minutes (five times per day).

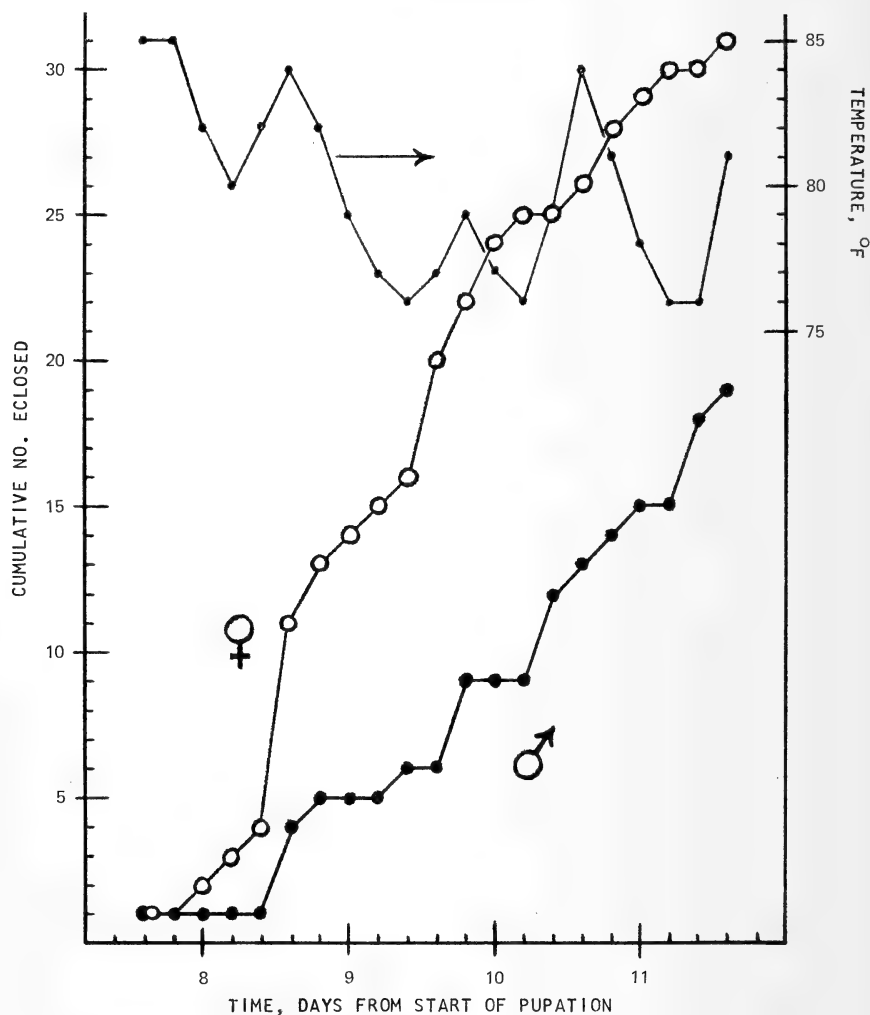


Fig. 1. Apparatus used for experiments 1-4.

Final-instar larvae were sorted quite reliably into males and females by means of the testes visible in the male as done in previous work (Kolyer, 1966), and the sexes were allowed to pupate in separate boxes.

Apparatus and procedure.—The apparatus shown in Figure 1 was used for experiments 1-4 (summarized in Table 2). This consisted simply of two one-liter flasks connected through their side-arms and fitted with a stopcock (and pinch clamp, not shown, for perfect seal) and mercury-containing manometer open to the atmosphere. Gauze was provided in the flasks so that the emerging butterflies could climb up and expand their wings.

Vials (approximately one inch inside diameter) containing saturated potassium carbonate solution in contact with solid potassium carbonate hydrate were suspended inside the flasks to regulate the relative humidity. A value of 42.8% relative humidity at 77°F is given by Stokes and Robinson (1949), and 43% at 72°F was found experimentally by confining a calibrated hygrometer with the potassium carbonate system. The capacity of the system to absorb water was demonstrated by introducing one milliliter of water into a one-gallon jar containing a hygrometer and the regulating system in a 2.5 inch diameter dish. In about five

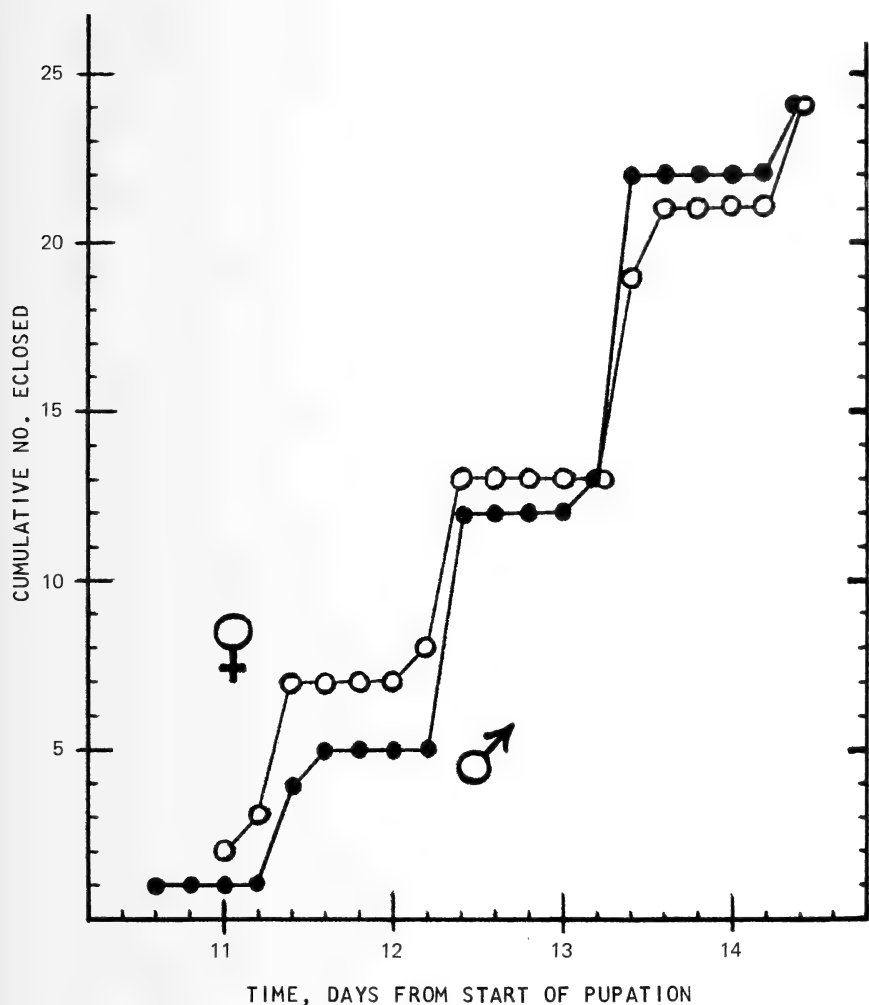


EXPLANATION OF GRAPH 1

Cumulative number eclosed vs. day from start of pupation for experiment 1. A record of temperature is included.

hours the relative humidity had risen to a maximum of 81% and at 50 hours it had fallen back to 50%; in the absence of the system 100% relative humidity was attained about 10 hours after adding the water.

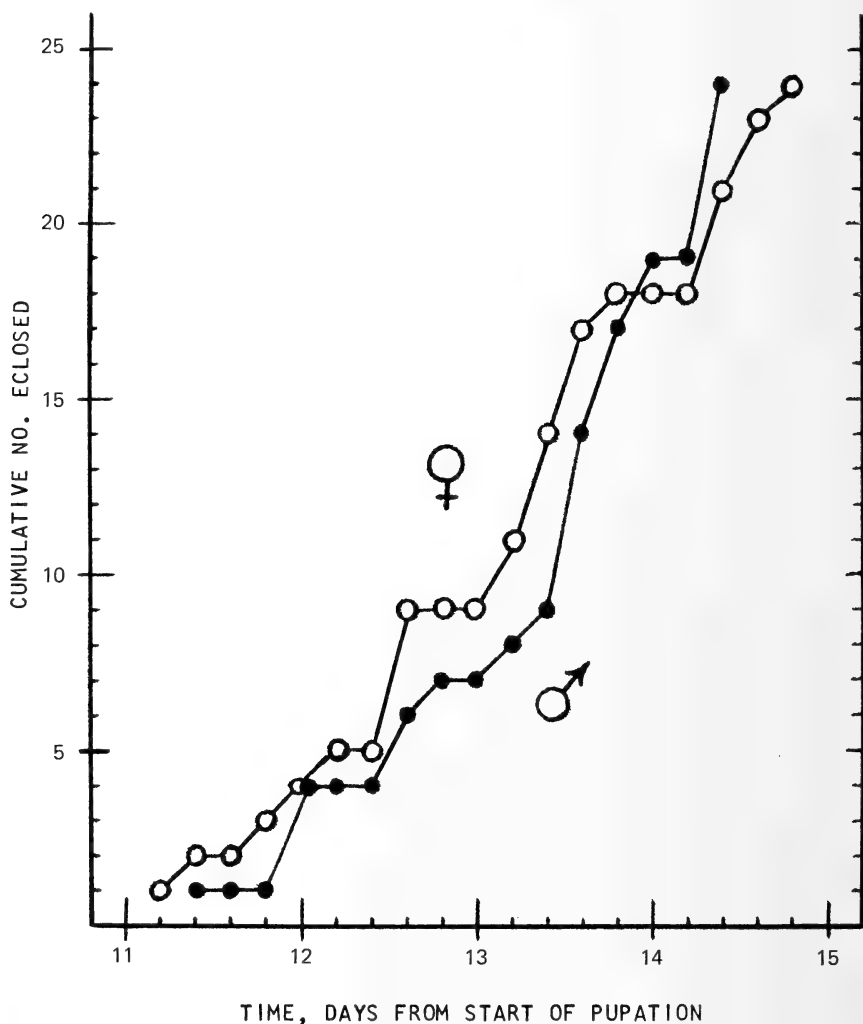
Pupae, detached by clipping the silken girths and pulling free from the silk button at the caudal end, were dropped into the flasks (males in one flask, females in the other) three days before eclosion began, and maintenance of conditions as defined in Table 2 was initiated.



EXPLANATION OF GRAPH 2

Cumulative number eclosed vs. day from start of pupation for experiment 2.

In the graphs and tables each day is arbitrarily taken to begin at 2:39 AM and is divided into five equal periods (beginning at 2:39 AM, 7:27 AM, 12:15 PM, 5:03 PM, and 9:51 PM). At the start of each period the barometric pressure and the room temperature were noted, and the pressure was cycled in the case of experiments 1-3. The object of cycling was to give the pupae a choice of high or low pressure every five hours.

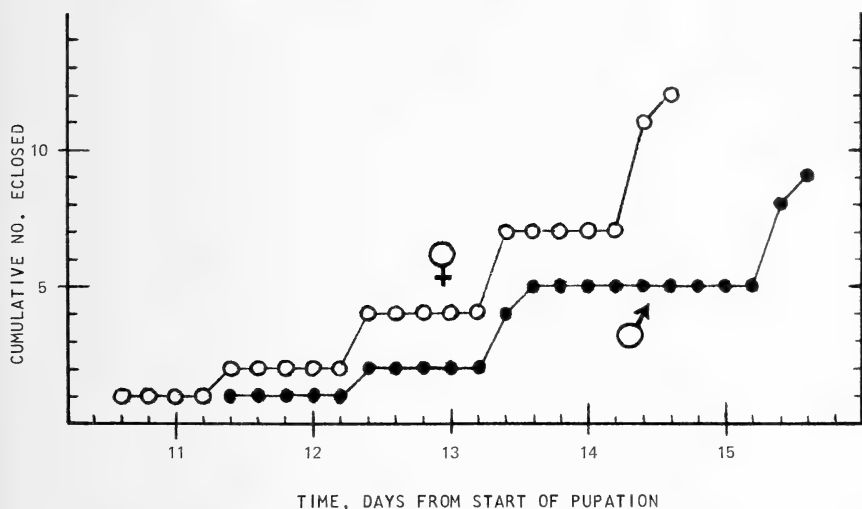


EXPLANATION OF GRAPH 3

Cumulative number eclosed vs. day from start of pupation for experiment 3.

For reference, the first period of the 8th day on Graph 1 was a high cycle, as was the first period of the 11th day for Graphs 2 and 3.

The data are presented in Graphs 1-7. The temperature record for experiment 1 is included in Graph 1, while the temperature record for experiments 2-6 (all done at the same time) and the barometric pressure record applicable to experiments 5 and 6 are shown in Graph 7.



EXPLANATION OF GRAPH 4

Cumulative number eclosed vs. day from start of pupation for experiment 4.

The barometric pressure readings in Graph 7 were used to adjust the pressure in the flasks. For example, if the atmospheric pressure was 760 mm and a pressure of 740 mm was desired in the flask, a differential of 20 mm on the manometer was produced by drawing out air by lung power and closing off the stopcock and the pinch clamp. A rubber bulb was used to pressure the flasks in the high cycles. To correct the pressure readings, which were taken at Convent, New Jersey at an elevation of 290 feet, to 0°C and sea level, approximately 4 mm must be added (Perry, 1950). The flask pressures listed in Table 2 are ranges because some fluctuations necessarily accompanied temperature variations.

In experiments 5 and 6, wide-mouth jars (approximately 3.5 inches inside diameter by 5 inches deep) contained the pupae and humidity-regulating system. The jars were closed tightly enough to maintain regulated humidity but not to hold a pressure differential relative to the atmosphere. The potassium carbonate system was used in experiment 6, while in experiment 5 a saturated sodium carbonate solution in contact with solid hydrated sodium carbonate was included. The sodium carbonate system gave 87% relative humidity at 75°F experimentally; Lange (1946) lists 92% at 65°F.

ECLOSION UNDER CONTROLLED CONDITIONS—RESULTS AND DISCUSSION

The five factors considered were barometric pressure, light, tempera-

TABLE 3. ECLOSION DURING ALTERNATING CYCLES OF HIGH AND LOW PRESSURES

Experiment Number	Pressure	Number Eclosed			Theoretical Random Distribution
		Male	Female	Total	
1	low	7	16	23	25
	high	12	15	27	25
2	low	13	13	26	24
	high	11	11	22	24
3	low	7	13	20	24
	high	17	11	28	24

ture, relative humidity, and sex. The results are discussed in terms of each of these.

Barometric pressure.—The data summarized in Table 3 show no significant trend with respect to barometric pressure. By the chi-square method of testing goodness of fit (Sinnott and Dunn, 1939) it is found that the differences observed in the total numbers eclosed at high vs. low pressure can very possibly be explained by chance alone (Table 4).

In experiment 3 the low pressure was below one of the lowest on record (721 mm) for New York City (Hansen, 1961), and the high pressure was above a record high (788 mm). In experiment 4, in which the pressure was held constant at an abnormally high level, the butterflies had no notable difficulty in eclosing (one unexpanded and one with shriveled forewing vs. two imperfect specimens in experiment 1, three in experiment 2, and one in experiment 5). Also, eclosion in experiment 4 was not delayed and proceeded over about the same time interval as in experiments 2, 3, 5, and 6.

In experiment 1 the larvae were diseased, and only 11 specimens (4 males and 7 females) expanded normally. It is interesting that 7 of these (all but 4 of the females) eclosed during the high pressure cycle, showing the lack of advantage of low pressure even when expansion ability was marginal.

TABLE 4. SIGNIFICANCE OF DATA (TOTAL ECLOSED) OF TABLE 3

Experiment Number	χ^2	Approximate Probability of Observed Deviation by Chance Alone ¹
1	.320	58
2	.333	57
3	1.33	25

¹ For one degree of freedom.

TABLE 5. ECLOSION VS. TIME OF DAY

Period ¹	Experiment 1			Experiment 2			Experiment 3		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
1	0	4	4	1	2	3	1	4	5
2	7	2	9	21	18	39	7	7	14
3	6	14	20	2	2	4	7	9	16
4	5	6	11	0	2	2	4	3	7
5	1	5	6	0	0	0	5	1	6

Period ¹	Experiment 4			Experiment 5			Experiment 6		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
1	0	0	0	0	1	1	2	0	2
2	7	10	17	9	6	15	4	7	11
3	2	2	4	1	4	5	3	2	5
4	0	0	0	0	0	0	1	0	1
5	0	0	0	0	0	0	0	2	2

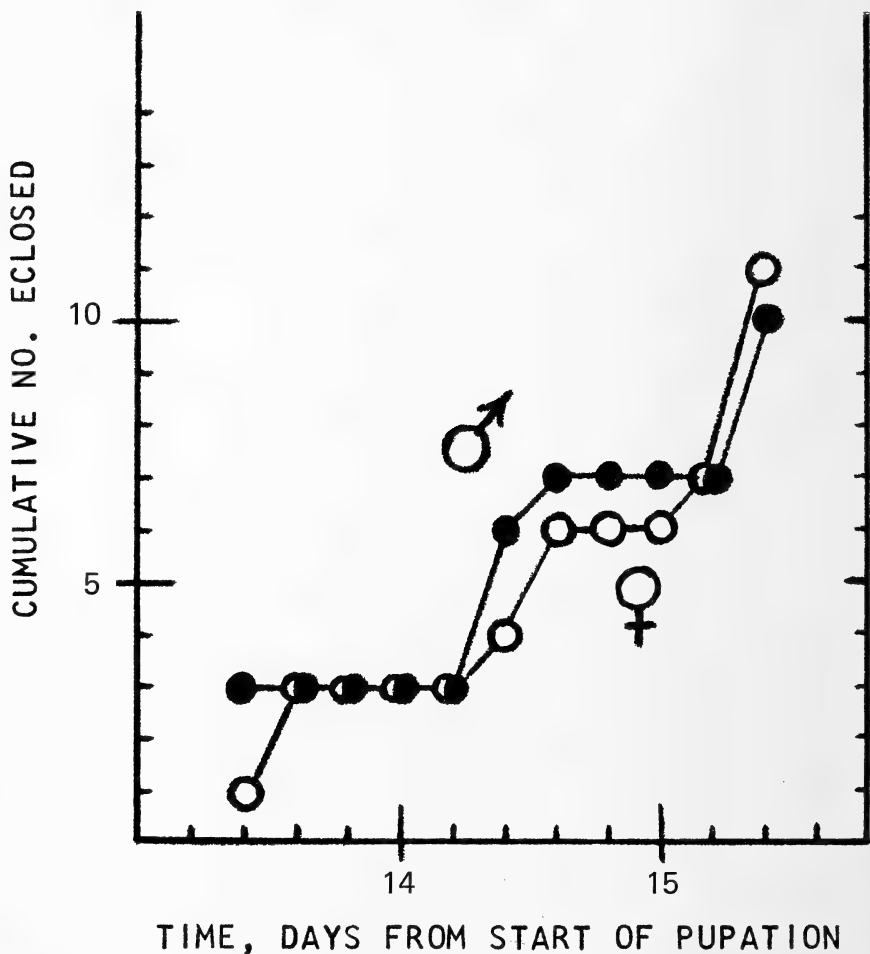
¹ The day was divided into five equal periods beginning at 2:39 AM.

Pupae which are prepared to eclose appear to be able to wait several hours for the stimulus of light and so might have been expected to take advantage of the occurrence of low pressure cycles every four hours and 48 minutes if reduced pressure also is a stimulus.

As expected, there was no real correlation of eclosion with ambient barometric pressure in experiments 5 and 6. For example, eclosion in experiment 5 was concluded at the high point of the pressure record. In view of the data of Table 1 and the results of experiments 1-4, the fortuitous drop in pressure seen in Figure 7 probably had no bearing on eclosion.

Light.—In experiments 1 and 3 the pupae were kept in darkness except for brief intervals of light when the pressure was adjusted between periods. The data (Table 5) indicate a preference for periods 2-4 (7:27 AM-9:51 PM) in experiments 1 and 3, and the chi-square test (four degrees of freedom) shows less than a 5% probability that the results are due to chance alone. It is possible that temperature variation and/or brief admission of diffuse sunlight at the beginning of the favored periods was responsible. However, David and Gardiner (1962) report a rhythm of eclosion for *Pieris brassicae* in darkness.

In experiments 2, 4, 5, and 6, in which diffuse sunlight was available during periods 2 and 3, there resulted a very marked preference for eclosion during the photoperiod. Only 40% of the pupae should have eclosed during the photoperiod by chance, while the result was 90%. The chi-square test shows that in all cases the deviation from chance



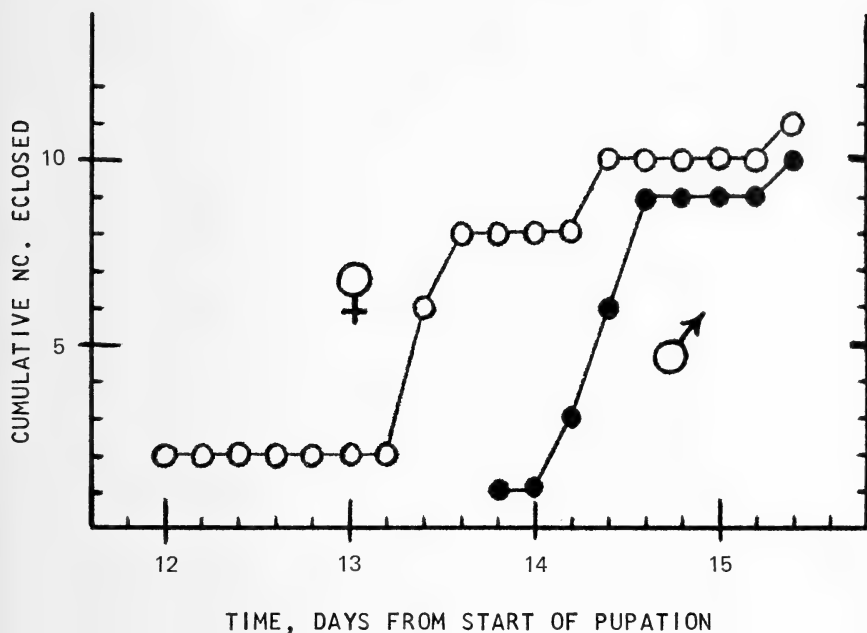
EXPLANATION OF GRAPH 5

Cumulative number eclosed vs. day from start of pupation for experiment 5.

distribution is highly significant. Graphically, the stepwise nature of the curves for experiments 2, 4, 5, and 6 is conspicuous.

The impression is that the mature pupa can wait several hours for the arrival of the photoperiod before eclosing, and it is reported (Mell, 1939) that butterflies generally eclose in the early morning and that the coming of light seems to be the stimulus. In a study including *Pieris rapae*, 85.9% of 1758 pupae eclosed from 8 AM to 6 PM and the remaining 14.1% at night (Pictet, 1933).

Temperature.—In experiments 2–6 the temperature varied over a



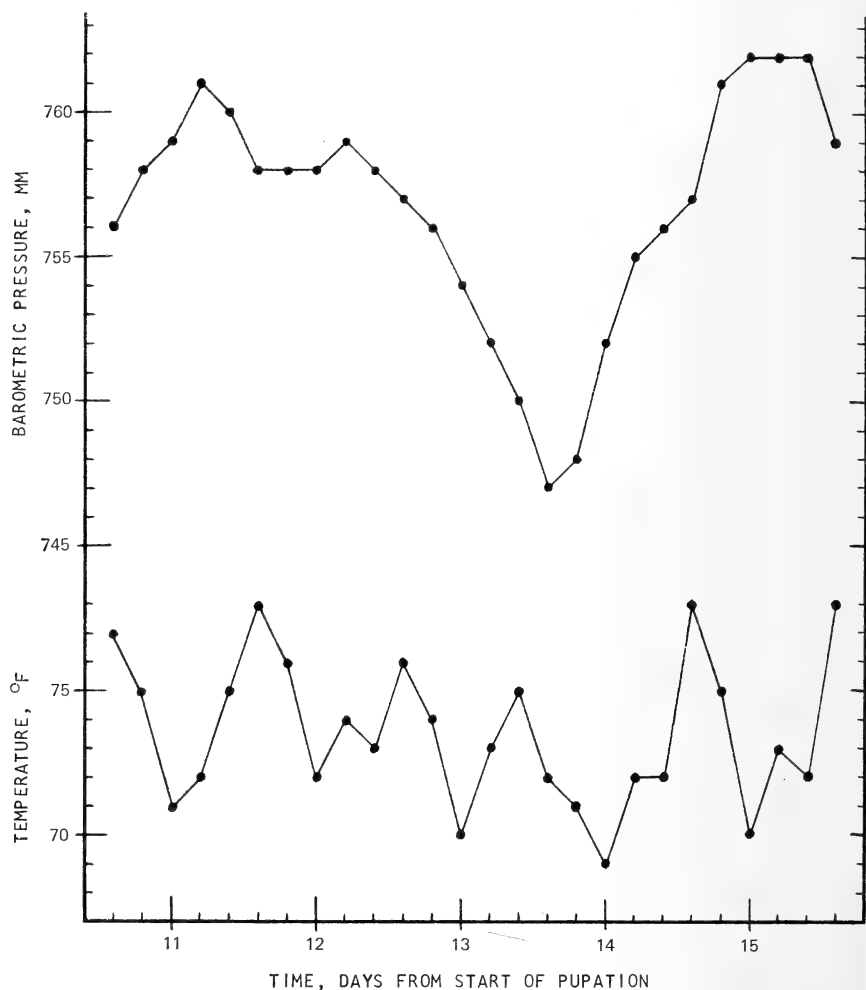
EXPLANATION OF GRAPH 6

Cumulative number eclosed vs. day from start of pupation for experiment 6.

range of 9°F (Graph 7). Low points occurred at the beginning of period 1 (2:39 AM) in all cases, and high points occurred at the beginning of periods 3 or 4. The fluctuations were similar in magnitude, though less regular, in experiment 1 (Graph 1).

It would seem that the effect of light as a factor is predominant in the experiments having a photoperiod (2, 4, 5, and 6), but some temperature fluctuation may be required for photoperiod to promote eclosion; David and Gardiner (1962) report that for *Pieris brassicae* eclosion takes place in the dark period with photoperiod 6 AM–10 PM when the temperature is constant but that eclosion is delayed until morning or afternoon when the temperature fluctuates.

Relative humidity.—Very high humidity may delay eclosion of certain moths (Mell, 1939). However, in experiment 5 eclosion at 87% relative humidity was certainly not hindered, nor was it judged significantly accelerated or delayed vs. eclosion at 43% relative humidity. As in the other experiments, light appeared to be the dominant factor (though possibly through interaction with temperature fluctuation pattern). Eclosion of the males was completed during the highest phase (763–766 mm, corrected to 0°C and sea level) of the ambient pressure record,



EXPLANATION OF GRAPH 7

Record of barometric pressure and temperature during experiments 2-6.

and it is suspected, though it was not experimentally demonstrated, that controlled variations of the pressure would have had no more effect at 87% relative humidity than they were found to have in experiments 1-3 at 43%.

At a lower relative humidity under ambient conditions (23-34% relative humidity, 72-76°F), five males eclosed at 764, 763, 761, 766, and 759 mm (corrected to 0°C and sea level). Again, reduced pressure was not required.

Sex.—In *Pieris napi* (L.) and *P. bryoniae* (Ochs.) the males are said to tend to emerge before the females (Bowden, 1953). However, in experiments 1–3 the sexes eclosed over almost exactly the same time interval and at about the same rate; if anything, the females tended to eclose a little earlier in experiments 2 and 3. In experiments 4 and 6 the females tended to eclose considerably earlier, though the significance of this is dubious because of the limited numbers involved. Certainly, there was no trend for the males to emerge before the females in any of the experiments. This conclusion is, of course, applicable *only* to the specific conditions of the tests.

CONCLUSION

Care must be taken in drawing generalized conclusions from the data because of the possibility of the interaction of factors, the possibility of discontinuities in cause-effect relationships, and the possible effect of rate of change of variables. For example, at some critical values for the three variables the relative humidity, temperature, and barometric pressure might interact so that the pressure *does* influence eclosion. Or the effect of pressure might be nil at slight or major depressions but unexpectedly apparent at medium depressions. Or eclosion might be promoted not simply by low barometric pressure but by the dynamic factor of *falling* pressure.

Therefore, the present work does not prove that barometric pressure cannot influence eclosion of *Pieris rapae* but only that it does not influence eclosion under specific ambient conditions or in certain controlled environments. In fact, even the strain of a species conceivably could have an effect. Still, it seems a reasonable conclusion that light is a principal factor (as appears in the literature) and that barometric pressure is not a significant factor under certain typical summer ambient conditions or when cycled between extreme values, or held at a constant high value, in experiments at constant relative humidity, slightly fluctuating temperature (9°F maximum variation), and controlled photoperiod.

The indication is that the time of eclosion was controlled to the nearest day or so simply by the rate of development of the pupa (in turn controlled by the temperature history; David and Gardiner (1962), for example, list a pupal period for *Pieris brassicae* of 40 days at 54.4°F and only 7.5 days at 86°F). Then, under the particular conditions of the tests, which involved some temperature fluctuation, the mature pupa showed a strong tendency to await the coming of light as stimulus for eclosion. No obvious effect of sex, relative humidity, or barometric pressure upon this process was seen.

SUMMARY

Under typical summer conditions, pupae of *Pieris rapae* (L.) were observed to eclose at up to 770 mm barometric pressure with no apparent preference for atmospheric depression, although reduced pressure has been described in the literature as a requirement for eclosion of certain Lepidoptera.

Under controlled conditions, male and female pupae were studied separately. The relative humidity was held constant, the temperature fluctuated over a maximum of 9°F with minima at night, and a photoperiod (diffuse sunlight) of either 0 or 9.6 hours was provided. The barometric pressure was held at a constant high level (approx. 830 mm) or cycled from approx. 735 to 770 mm or from approx. 690 to 800 mm five times per day to give eclosing pupae a choice of high or low pressure. No significant dependence of eclosion on barometric pressure or sex was found, but light stimulated eclosion under the test conditions. There was no notable difference in eclosion at 87% vs. 43% relative humidity.

The indication is that the time of eclosion was controlled within a day or so simply by the rate of development of the pupa (dependent on temperature history), and that light, if available, then was the immediate stimulus for eclosion in a very significant proportion of cases. It is emphasized that conclusions must be confined to the particular experimental conditions.

ACKNOWLEDGMENT

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FOODPLANTS OF *CALLOPHRYS* (*INCISALIA*) *IROIDES*

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In contrast with other members of the subgenus, which are restricted in host selection, *I. iroides* (Boisduval) is polyphagous. The diverse host plants credited to this West Coast butterfly are summarized by Clench (1961), who indicates some of the early records are doubtful.

Recorded foodplants for *iroides* include "young apples" (*Malus*, Rosaceae) in British Columbia (Bethune, 1904) and both *Ceanothus* (Rhamnaceae) and *Cuscuta* (Polemoniaceae) in southern California (Comstock and Dammers, 1933). Field oviposition was observed and larvae reared on *Cuscuta*, a leafless, parasitic plant which lacks chlorophyll. Clench also lists *Gaultheria* and *Arbutus* (Ericaceae) as hosts but does not cite the original source of these records.

Recent investigations during California Insect Survey activities confirm use of two of these foodplants in central and southern coastal California and have disclosed the use by *I. iroides* of *Chlorogalum pomeridianum*, a monocotyledenous plant in the foothills of the Sierra Nevada.

A nearly mature larva was collected on *Arbutus menziesii* at China Camp, Marin County, June 3, 1964, from which an adult *iroides* was reared, emerging on April 19, 1965. *Ceanothus* probably is commonly used by *iroides* over much of its range. One larva was swept from *C.*

cuneatus near Middletown, Lake County, on May 14, 1966. It fed on the green fruit of this plant in the laboratory prior to pupation in mid-June. Emergence did not occur, but a fully developed adult was dissected from the pupal shell in May, 1967. Additional larvae were taken on an unidentified species of *Ceanothus* at the north end of Casitas Reservoir, Ventura County, on March 15, 1967, by P. A. Opler. One *iroides* emerged April 16, 1967, suggesting, as did Comstock and Dammers' observations, that populations in southern California develop two spring generations.

Six larvae of varying ages were found on *Chlorogalum pomeridianum* (Liliaceae) about two miles south of Grass Valley, Nevada County, California, on July 3, 1967. They were located on lateral branches in the spreading inflorescences, feeding on the flowers and buds. Pupation occurred by late July and adults emerged April 21 and May 15, the following year.

Incisalia iroides was early reported to feed on *Sedum* (Crassulaceae) in California. Comstock (1927) states that the larva and pupa were described by Henry Edwards (1878) from this plant. Possibly this record refers to *I. fotis* (Strecker), which is represented by a recently rediscovered *Sedum*-feeding race near San Francisco, where Edwards did much of his work. Adults of the two butterflies are similar in appearance.

It is curious that *I. augustinus* (Westwood) of the eastern United States is restricted to Ericaceae (Cook & Cook, 1904, 1906; Clench, 1961), yet is considered by Clench to comprise with *iroides* a single widespread, polytypic species. Other workers have treated *augustinus* and *iroides* as closely related species, each with its own subspecific diversity (e.g., dos Passos, 1964). Perhaps further data on host selection by the various races of this complex will help clarify taxonomic relationships.

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BUTTERFLIES FROM COAHUILA, MEXICO

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Dr. C. J. McCoy is Assistant Curator of Amphibians and Reptiles at Carnegie Museum. In June, 1966, accompanied by Mr. Arthur Bianculli, he made a trip¹ to central Coahuila to collect and study these animals. Dr. McCoy also maintains a considerable interest in butterflies and, as his regular work permitted, made a collection of them in the area. Because almost nothing is known about Coahuilan butterflies, a list of his captures should be useful.

The collection was made in three different localities, all in the vicinity of Cuatro Ciénegas de Carranza (about 70 airline km west of Monclova), central Coahuila, Mexico. A sketch map of the area, additional description and some landscape photographs may be found in Taylor (1966). Muller (1947) gives a general description and map of the regional vegetation, also accompanied by photographs.

The three localities are as follows, bracketed portions not being repeated in the species list below:

1. Rio Cañon [ca. 1000 m., 3 mi N Cuatro Ciénegas]

Collecting was done along the river, a spring-fed permanent stream in a deep, narrow canyon with precipitous walls up to 500 feet high. The narrow part is about five miles long and opens at either end onto broad desert basins. Vegetation in the canyon consists of bunch grasses with scattered willows and narrow-leaf cottonwoods along the river, and thickets of mesquite and acacia on higher ground. In side canyons there are hackberry trees and some oaks. Most of the smaller butterflies were taken at the flowers of a low Verbenaceous plant (*Phyla lanceolata*). Lower Sonoran zone: Chihuahuan Desert Scrub (Muller, 1947).

The butterflies here (31 species taken, three others seen) are typical of the Lower Sonoran facies of the Chihuahuan Desert fauna, which extends with little variation over much of the lower elevations on the northern Mexican Plateau and into western Texas, southern New Mexico and southeastern Arizona. With progressive depletion it also occurs in arid and semi-arid Upper Sonoran regions of the southern Plateau and also well into the prairie regions of central United States, and in very dilute form even into eastern United States.

A striking feature of this fauna is the large proportion of known or probable wanderers (species that migrate regularly, whether or not they do so *en masse*): *K. lyside* and *castalia*, *E. nicippe* and *lisa*, *P. protodice*,

¹ Supported by funds from Carnegie Museum and a research grant-in-aid from the Society of the Sigma Xi.

D. gilippus, *A. vanillae*, *E. claudia*, *V. atalanta*, *Libytheana* sp., *H. isola*, *L. marina*, *B. exilis*, *H. phyleus*. These total 14 species, or about 41% of all species taken or seen. In addition to their regular and often long migrations, these wanderers share (a) broad environmental tolerance, both to temperatures and to vegetation type; (b) generally high levels of abundance, some of them inclined to frequent eruptions; (c) broad choice of larval food plant species; and (d) frequent occurrence in disturbed environments. The combination is conspicuously one of opportunistic species, capable of rapidly exploiting a region where conditions are stringent and suitable environments few, widely scattered, and often transient.

It is worth noting that there is no trace of regional endemism in this fauna, such as occurs in some degree in the reptiles, and to a truly remarkable degree in the fresh water fish and especially the fresh water mollusks (Taylor, 1966).

2. Rio Salado [de los Nadadores, 7.3 mi W Sacramento, 650 m.]

The area is extensively farmed, part of a large desert basin. Collecting was done along the man-made channel of the river and along the edges of fallow, weed-grown fields. Hedgerows of fig and pomegranate were present, and scattered cottonwoods along the river. Most of the butterflies were taken from the yellow-and-pink flowers of *Cryptantha*. The locality appears to be in the Subtropical zone: Tamaulipan Thorn Scrub (Muller, 1947).

Twelve species were taken here, and two others seen. Despite more intensive and prolonged collecting, five of these 14 were not found at Rio Cañon: *P. sennae*, *P. tharos*, *B. hyperia*, *M. amymone*, *S. columella*. In this latitude, all of these are regional residents of the Subtropical zone. *P. tharos* ranges far into cooler zones in eastern United States, but not locally. *P. sennae* and *M. amymone* are wanderers, but do not appear to reside anywhere in cooler zones, though they may sometimes occur as transients. *B. hyperia* and *S. columella* are both regionally confined to the Subtropical zone. *S. columella* especially is a good zonal indicator regionally: it is fairly common, multiple brooded, tolerates arid and semi-arid conditions, and is not known to wander at all. On the basis of these species, particularly *columella*, I conclude that this locality lies in the Subtropical zone, but probably near its boundary with the Lower Sonoran.

3. El Capriño [2.4 mi E Sacramento, 550 m.]

A few butterflies were collected at weeds along the roadside, in mesquite grassland. The land is open, rocky, hilly, grazed by goats but not farmed. Probably Subtropical zone.

The Rio Cañon is only about 16 airline miles from the Rio Salado locality. Nonetheless, Muller (1947) shows that they are in different vegetation zones and the butterflies, as described above, indicate different life zones. Dr. McCoy tells me that there is also a striking difference in the herpetofaunas of the two localities. This difference in the localities is explained in part by elevation (Rio Cañon is about 350 meters—1,100 feet—higher than Rio Salado), and in part by the westward decrease in precipitation. The Rio Cañon is itself a well-watered locality, so the latter effect may be less important to the butterflies than the former.

SPECIES LIST

Papilio polyxenes asterius Cramer

Rio Cañon 9–12.VI (3♂ 2♀)

Nathalis iole Boisduval

Rio Cañon 10–19.VI (7♂ 11♀); Rio Salado 30.VI (2♂)

Kricogonia lyside (Godart)

Rio Cañon 9–19.VI (5♀)

This is a known migrant and probably is non-resident.

Kricogonia castalia (Fabricius)

Rio Cañon 9–26.VI (8♂: 2, no apical hind wing black bar;

1, very thin bar; 5, normal bar); Rio Salado 30.VI (1♂, no bar).

I am not convinced of the distinctness of this and the preceding species, but follow Comstock (1944: 515) in discriminating them. Like the preceding, *castalia* is a renowned migrant, probably nonresident at the Rio Cañon at least.

Eurema mexicana (Boisduval)

Rio Cañon 18.VI (1♂)

Eurema nicippe (Cramer)

Rio Cañon 10–22.VI (4♂ 2♀)

Eurema lisa lisa Boisduval & LeConte

Rio Cañon 26.VI (1♂)

Eurema nise (Cramer)

Rio Cañon 18.VI (1♂)

This may be a stray from the Subtropical zone.

Phoebis sennae (Linnaeus)

Rio Salado (seen, not taken)

Pieris protodice (Linnaeus)

Rio Cañon 8–18.VI (3♂ 9♀); Rio Salado 30.VI (2♂ 2♀)

Danaus gilippus strigosus (Bates)

Rio Cañon 9–19.VI (2♂ 2♀)

Agraulis vanillae incarnata (Riley)

Rio Cañon 9.VI (1♂)

Euptoieta claudia (Cramer)

Rio Cañon 9.VI (1♀ ?)

A pair in copula (10:30 A.M., ♂ flying) was also taken in Nuevo Leon: 6 mi S Villa de Garcia (25° 49' N, 100° 35' W), 770 m., 2.VII.

Chlosyne lacinia adjutrix Scudder

Rio Cañon 10–19.VI (1♂ 5♀); Rio Salado 30.VI (1♂ 1♀); El Capriño 23.VI (2♂ 1♀)

To judge by the condition of the specimens, a brood was just coming to

an end in late June, represented almost entirely by badly worn females. At the same time a new brood was beginning to appear, represented chiefly by fresh males.

Phyciodes vesta (Edwards)

Rio Cañon 16-18.VI (2 ♀); Rio Salado 30.VI (3 ♂ 1 ♀)

Phyciodes tharos (Drury)

Rio Salado 30.VI (1 ♀)

Phyciodes phaon (Edwards)

Rio Cañon 9-26.VI (10 ♂ 7 ♀); Rio Salado 30.VI (4 ♂);

El Capriño 23.VI (2 ♂ 1 ♀)

Phyciodes (Tritanassa) texana texana (Edwards)

Rio Cañon 10.VI (1 ♀)

Nymphalis antiopa (Linnaeus)

Rio Cañon (seen, not taken)

Vanessa atalanta (Linnaeus)

Rio Cañon (seen, not taken)

Mestra amymone (Ménétriés)

Rio Salado 30.VI (1 ♀ ?)

Biblis hyperia (Cramer)

Rio Salado (seen, not taken)

Asterocampa leila (Edwards), subspecies

Rio Cañon 9-19.VI (9 ♂ 5 ♀)

Anaea aidea (Guérin-Ménéville)

Rio Cañon 18.VI (1 ♀)

A female was also taken in Nuevo Leon: 6 mi S Villa de Garcia (25° 49' N, 100° 35' W), 770 m., 2.VII.

Libytheana carinenta mexicana Michener

Rio Cañon (a *Libytheana*, probably this, seen but not taken);

Rio Salado 30.VI (1)

I am not certain that this entity is really distinct from *L. bachmanii larvata* (Strecker). It is a well known migrant and perhaps not resident.

Calephelis species

Rio Cañon 15 specimens

These will be determined by Mr. W. S. McAlpine.

Strymon melinus franki Field

Rio Cañon 10-26.VI (2 ♂ 19 ♀); Rio Salado 30.VI (1 ♂ 4 ♀)

Dr. McCoy tells me that when he arrived in the area (Rio Cañon) in early June there were no *melinus* at all, but that they became common towards the end of the month. Curiously, however, the few early specimens are all rather fresh, the late ones much worn. Perhaps these latter are immigrated, rather than newly emerged, specimens.

Strymon columella istapa (Reakirt)

Rio Salado 30.VI (1 ♂ 1 ♀)

Hemiargus (Echinargus) isola alce (Edwards)

Rio Cañon 9-25.VI (12 ♂ 6 ♀)

Leptotes marina (Reakirt)

Rio Cañon 9-18.VI (2 ♂); El Capriño 23.VI (1 ♂)

Brephidium exilis exilis (Boisduval)

Rio Cañon 9-18.VI (6 ♂ 4 ♀)

Systasea evansi (Bell)

Rio Cañon 9-19.VI (2)

Pyrgus oileus philetas Edwards

Rio Cañon 9-10.VI (1 ♂ 2 ♀)

- Pyrgus* sp. (group of *P. communis* (Grote))
Rio Cañon 12-19.VI (4 ♂ 2 ♀); Rio Salado 30.VI (2 ♀)
Pholisora catullus (Fabricius)
Rio Cañon 10.VI (1)
Ancyloxypha arene (Edwards)
Rio Cañon 16-18.VI (1 ♂ 1 ♀)
Copaeodes aurantiaca (Hewitson)
Rio Cañon 18-26.VI (6)
Hylephila phyleus (Drury)
Rio Cañon 10.VI (1 ♂ 1 ♀)
Amblyscirtes nysa Edwards
Rio Cañon 26.VI (1 ♀)

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CONTINUOUS VARIATION IN RELATED SPECIES OF THE GENUS *CATOCALA* (NOCTUIDAE)

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The genus *Catocala* has been extensively studied for more than a century. In fact, at the turn of the century, American journals dealing with the Lepidoptera sometimes devoted the bulk of their coverage to this genus. Even with all this attention many taxonomic problems remain. These problems have defied classical morphological techniques, perhaps because they centered around characters differing in kind rather than amount. This study is, in the main, descriptive of the variation existing in several frequently used diagnostic characters. However, the species used in the examples were selected to suggest the utility of these statistical descriptions in taxonomic studies. They may supplement a knowledge of classical morphology and ecology.

METHODS

An unselected sample of over 1500 *Catocala* of 30 species was taken during the summer of 1961 at a Mercury vapor light operated on the edge of a deciduous wood at the University of Michigan, Edwin S. George

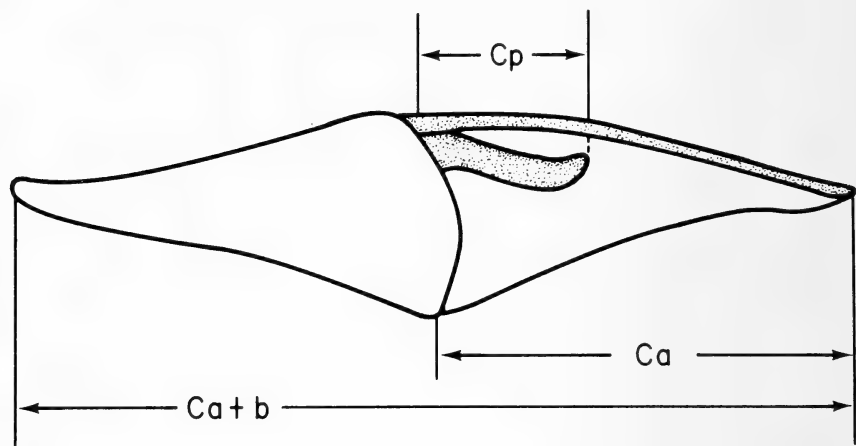


Fig. 1. Schematic diagram of the right clasper of the genus *Catocala*, showing the measurements used.

Reserve, Pinkney, Michigan. From this sample the following series were studied:

- 78 male *C. ilia* Cramer
- 25 male *C. palaeogama* Gueneè
- 25 male *C. resecta* Grote
- 17 male *C. sordida* Grote¹
- 7 male *C. gracilis* Edwards¹

The following measurements were made on each of the 152 specimens: wing span (WS), total right valva (clasper) length ($C a + b$), length of distal clasper segment ($C a$) and length of clasper projection ($C p$) (Fig. 1). The measurement WS was considered a reflection of the overall size of the moth. $C p$ and $C a$, being heavily sclerotized, are more reliable measures than $C a + b$.

RESULTS

Table 1 presents the mean and standard deviation of the four variables for the five species considered.

Table 2 presents the coefficients of correlation of each of the variables on all other variables. The overall size of the moth as measured by WS is not significantly correlated to the size of the genitalia. However, the various genitalia measurements are not independent. $C p$ was chosen for further analysis.

¹ Determined by A. E. Brower, Augusta, Maine, to whom we are grateful for many helpful comments.

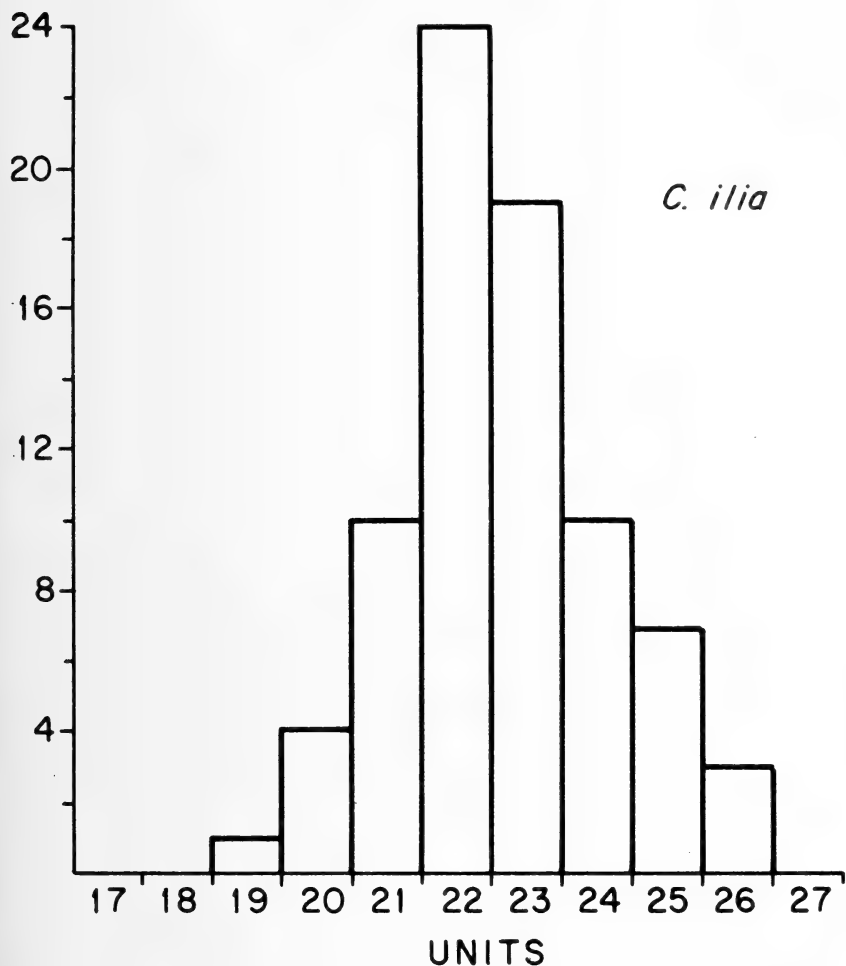


Fig. 2. Frequency distribution of the clasper projection (Cp) in *Catocala ilia*.

Figure 2 presents the frequency distribution of Cp for *Catocala ilia*. It approaches the normal distribution.

Figure 3 presents the frequency distribution of Cp for *C. palaeogama* superimposed on *C. resecta*. These two species are closely related but distinct species. The measurement of Cp definitely indicates two populations with some overlap. The "t" test of difference of the means is significant at a $P < 0.001$.

Figure 4 presents the frequency distribution of Cp for *C. gracilis* superimposed on *C. sordida*. These species are closely related and individual specimens are often impossible to determine with certainty.

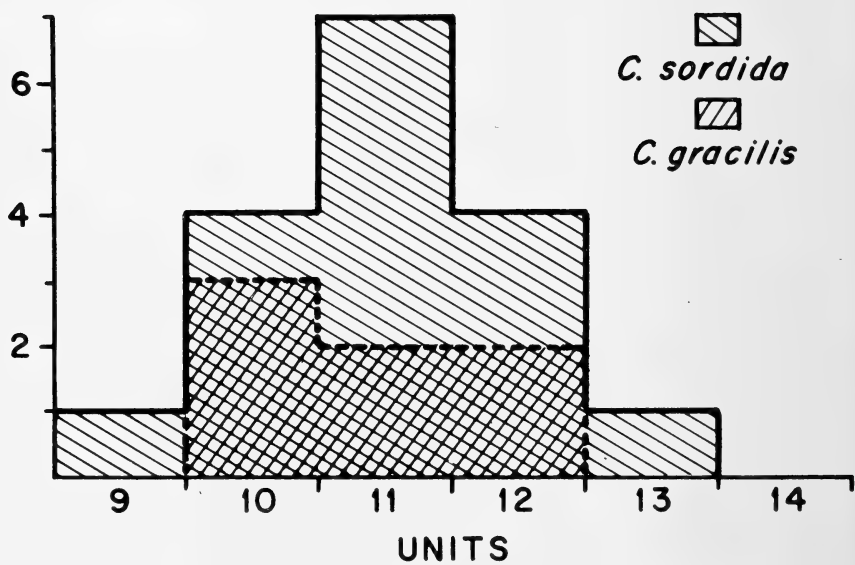
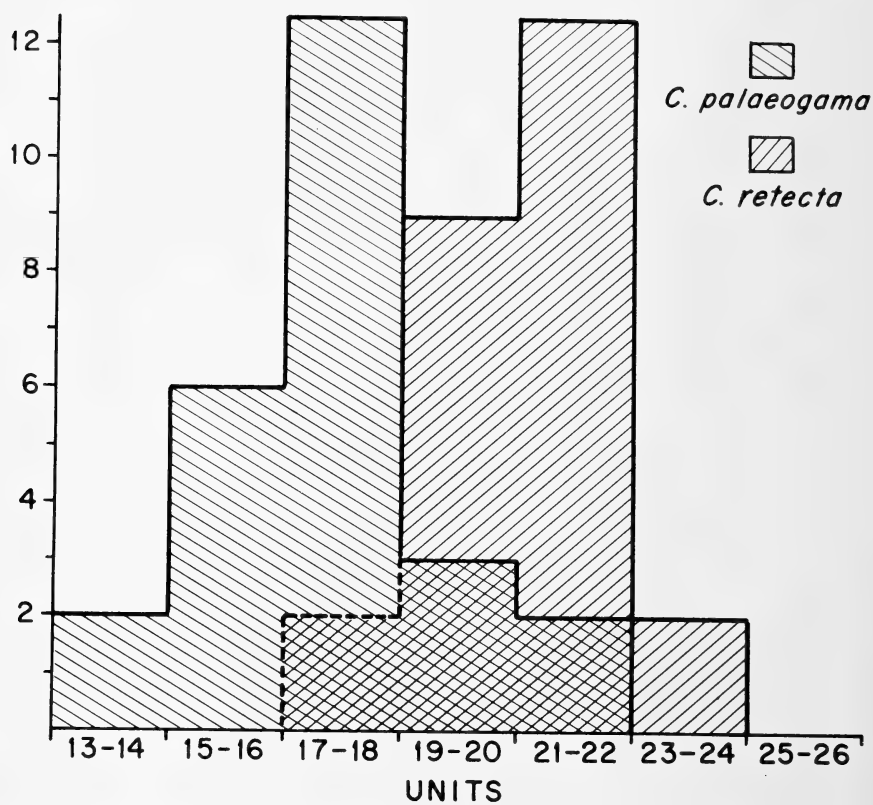


TABLE 1: MEAN AND STANDARD DEVIATION OF FOUR VARIABLES FOR FIVE SPECIES OF *CATOCALA*¹

		Mean	Standard deviation
<i>ilia</i>	WS	77.14103	2.97926
	C a + b	78.20513	4.95003
	C a	40.02564	2.61849
	C p	22.64103	1.51164
<i>palaeogama</i>	WS	67.96000	2.09126
	c a + b	59.20000	4.46281
	C a	32.88000	3.07300
	C p	17.24000	2.14632
<i>retecta</i>	WS	71.48000	2.90287
	C a + b	71.64000	4.51738
	C a	40.68000	3.36304
	C p	20.68000	1.46401
<i>gracilis</i>	WS	41.71429	1.25357
	C a + b	35.42857	2.63674
	C a	20.14286	1.57359
	C p	10.85714	0.89974
<i>sordida</i>	WS	41.70588	1.21268
	C a + b	38.64706	2.64436
	C a	20.23529	1.25147
	C p	11.00000	1.00000

¹ (WS measured in mm.; Ca and Cp measured in units, 50 units = 7 mm.)

Here the measurement of Cp does not indicate two populations and the "t" test is not significant, $P=0.50-0.80$.

DISCUSSION

Variation in the clasper of these five species of the genus *Catocala* is clearly continuous. The frequency distributions are nearly normal, implying that the character is controlled by small additive contributions from many genetic factors, no one of which is individually measurable (*i.e.*, multifactorial inheritance).

It is not surprising that closely related but distinct species (*C. retecta* and *C. palaeogama*) showed some overlapping values. The bulk of their genetic contribution is probably of identical origin. It is even less sur-

←

Fig. 3. Frequency distribution of the clasper projection (Cp) in *Catocala palaeogama* and *C. retecta*.

Fig. 4. Frequency distribution of the clasper projection (Cp) in *Catocala gracilis* and *C. sordida*.

TABLE 2: CORRELATION COEFFICIENTS FOR FOUR VARIABLES IN FIVE SPECIES OF *CATOCALA*¹

		WS	C a + b	C a	C p
<i>ilia</i>	WS	1.0000	0.24635	0.19764	0.16711
	C a + b		1.00000	0.76008	0.31197
	C a			1.00000	0.34030
	C p				1.00000
<i>palaeogama</i>	WS	1.00000	-0.15536	0.44011	0.14147
	C a + b		1.00000	0.26007	0.16008
	C a			1.00000	0.50362
	C p				1.00000
<i>retracta</i>	WS	1.00000	0.37913	0.54990	0.53767
	C a + b		1.00000	0.45561	0.00076
	C a			1.00000	0.57073
	C p				1.00000
<i>gracilis</i>	WS	1.00000	-0.10805	0.70007	0.25332
	C a + b		1.00000	0.38448	0.45163
	C a			1.00000	0.48769
	C p				1.00000
<i>sordida</i>	WS	1.00000	0.55031	0.25436	0.15462
	C a + b		1.00000	0.61213	-0.04727
	C a			1.00000	-0.04994
	C p				1.00000

¹ (WS measured in mm.; Ca and Cp measured in units, 50 units = 7 mm.)

prising that *C. gracilis* and *C. sordida* completely overlap, since they are of similar size, shape and coloration. Their eggs and larvae are nearly identical. They feed on the same food plant (*Vaccinium*). Several possibilities exist to explain this degree of overlap. The sample may be too small to demonstrate a difference. However the frequency distributions give no evidence that these samples are abnormal. There may be hybridization in Michigan. This is very possible if the two species are isolated mainly by weak ecological factors which may be ineffective in this area where *C. gracilis* is on the very edge of its range. Finally it is recognized that parallel varietal forms occur (e.g., some specimens of both species may have a dark shade along the inner third of the forewing). It is possible that these two species are in fact a single breeding population which has been artificially separated on the basis of monomeric traits having diverse gene frequencies in various geographic areas.

The study of continuously varying characters, such as those considered in this report, is unlikely to give definitive results. However it is likely that most adaptive radiation is on the basis of quantitative rather than monomeric traits. Thus such characters are appropriate material for the study of racial and geographic variation.

THE LIFE HISTORY AND HABITS OF *CHLOSYNE FULVIA* (NYMPHALIDAE)

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In the summer of 1961 two larvae were found on paintbrush, *Castilleja integra* A. Gray, west of Pueblo, Pueblo County, Colorado. They were reared and found to represent *Chlosyne fulvia* (Edwards). In order to obtain a more complete description of the life history, the author confined several females with the foodplant on May 16, 1964. Four females laid approximately 100 eggs on May 16 and 17. Descriptions of the egg and larvae from 1964 specimens and a description of the pupae from 1961 specimens follow. In addition, notes on the foodplant and field habits of the species have been included.

FIELD HABITS

C. fulvia flies in juniper woodland in the Upper Sonoran Zone wherever its foodplant abounds, usually on low hills formed from gypsum-rich shale. Adults fly slowly and alight often on the ground, and are thus easy to capture. Males enjoy the few flowers available. Males are not hilltoppers. There are three broods at Pueblo, May 5 to June 10, a second flight occurs in July, and the third from August 23 to September 2. Adults are most abundant in late May and late August.

FOODPLANT

Castilleja integra has crimson bracts and slender leaves one inch in length. It is the only species of paintbrush at the localities near Pueblo where *C. fulvia* flies. Two other undetermined species of *Castilleja* from the Wet Mountains in Pueblo County were offered to the larvae but were refused.

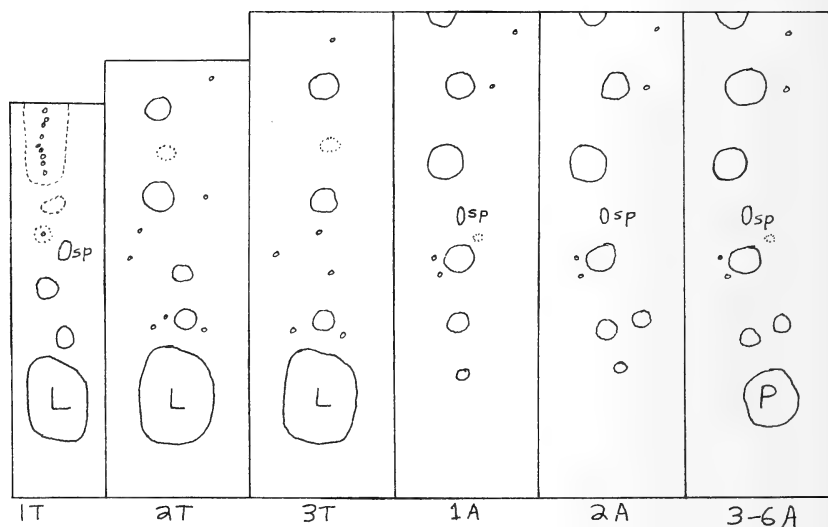
Larvae consume only the fleshy bracts; when the fleshy parts of transplanted plants dried, larvae ate the leaves. One larva devoured part of the ovary and some of the premature seeds.

Eggs are laid in clusters of ten to 30 on stem, leaves, or bracts. Eggs may be laid singly in the field, however. Most of the eggs laid May 16 and 17 hatched May 21.

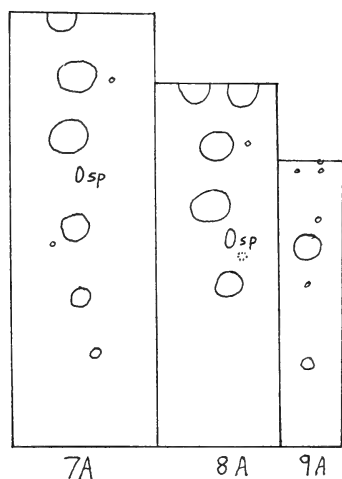
DESCRIPTION OF EARLY STAGES

EGG: Pale yellow. Spherical, with slightly flattened base, diameter 0.5 mm; upper half with approximately 18 vertical ridges, lower half pitted with many small, roughly pentagonal cavities.

FIRST INSTAR: Length 1.5 mm. Cylindrical, pale grayish green, first two thoracic



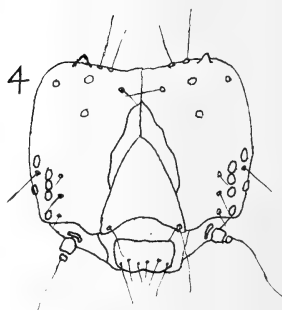
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EXPLANATION OF FIGURES

Figs. 1-4. Mature larva of *Chlosyne fulvia* Edwards. 1, setal map; 2, posterior view of larva; 3, ocelli and ocellar setae; 4, frontal view of head. In figs. 1-2 tiny circles represent unbranched setae, and larger circles represent branching spines; dotted lines delineate borders of sclerotized areas.



EXPLANATION OF FIGURES

Figs. 5-7. Pupa of *Chlosyne fulvia* Edwards. 5, ventral view; 6, lateral view; 7, dorsal view.

segments darker. Head black. Body covered with dark setae, arranged on I-VIII abdominal segments, as follows: one long (1 mm) dorsolateral seta, one short (0.5 mm) lateral seta just below and slightly posterior to dorsolateral seta, one long seta below the short seta, in line with dorsolateral seta; below and slightly behind the spiracle two short setae, one below the other, on thoracic and IX abdominal segments the supraspiracular setae consist of two long setae, forming four equally-spaced setae on the top half of larva in dorsal view. An additional short dorsolateral seta between VIII and IX segments. Larvae molted mostly on May 23.

SECOND INSTAR: Length 2.5 mm. Anterior half pale green, posterior half pale yellow. Pinaculi black, the largest around the longest setae. Prothoracic shield with six long setae and two shorter setae posteriorly. Setae arranged as in first instar. White internal structures appear around each setae in late stages lending a slightly more mottled appearance. Most larvae molted May 26.

THIRD INSTAR: Length 4.5 mm. Similar to mature larva, dull green fading to greenish yellow at end of abdomen, becoming yellow prior to molting. Setae replaced by branched spines (scoli). Base of spines reddish brown, distal portion black. Larvae appear very black and spiny, spines almost as large as those of mature larvae. Each spine with approximately six setae. Dark patches surrounding spines almost touch, forming thin dorsal line along length of larva. Spines arranged as in mature larva. Larvae molted mostly on June 3.

FOURTH INSTAR: Length 8 mm. Ground color ochre yellow, vented surface darker. Spines arranged as in mature larva. Thin, dark dorsal line as in mature larva. Dark patches surrounding spines; in abdominal segments I-VIII and thoracic segments 2-3 both lateral spines above spiracles surrounded by a common dark pinaculum. Most larvae molted June 12.

FIFTH INSTAR: Length 14 mm. Similar to mature larva. Ground color ochre-yellow. Spines arranged as in mature larva. Thin brown line connecting subdorsal as well as dorsal brown pinaculi. Most larvae molted on June 18.

MATURE LARVA: Length about 25 mm. Ground color ochre-yellow; spines black, slightly brownish at base. Body tapering anterior to thoracic segment 3 and posterior to abdominal segment VII. Dark pinaculi surrounding dorsal spines on abdominal

segments I-VIII, and much larger dark brown pinaculi surround both dorsolateral spines on these segments. A narrow dorsal line from thoracic segment 2 to abdominal segment VIII. Thoracic segments 2-3 with dark brown pinaculi around upper dorsolateral spine. A heavy line connecting subdorsal dark pinaculi from thoracic segment 2 to abdominal segment VIII. Ventral surface light brown; boundary between brown and ochre yellow occurring between the upper and lower rows of subspiracular spines. Ventral surface, especially prolegs, covered with small reddish brown setae and hundreds of smaller transparent setae. Arrangement of spines (scoli) as in Figure 1. Setae of the most ventral spine in abdominal segments I, II, and VII unpigmented. Each large spine on dorsal half of body covered with about 20 minute setae, the longest (about 1.3 mm) at base and shortest at distal end of spine. Shorter spines with fewer setae. Leg with black trochanter and tarsal claw, other segments reddish brown. Ventral surface of legs covered with setae. Crochets biordinal, forming a lateral penellipse. Anal plate shown in Figure 2. Anterior lobe of anal plate dark brown, remainder reddish brown. Head reddish brown. Adfrontal sutures darker, separated from rest of head by pale sutures (Fig. 4). Ocelli and ocellar setae shown in Figure 3. Head with many dorsal and lateral setae; only those which have a constant position shown in Figure 4. Larvae began wandering on June 24; most pupated the following day.

PUPA: Length 15 mm. White, mottled with black stripes and spots as in Figures 5-7. Degree of melanism variable; in one individual many black areas were broken into separate spots, presenting a lighter appearance. Light brown showing faintly on dorsal surface: between black spots that are close together; in grooves between segments of abdomen (especially the grooves posterior to wing cases and one groove anterior to these grooves); and outlining wing cases. Light brown not showing on dorsum in a median one mm-wide strip except a few days before eclosure, when the segments posterior to the wing cases turn reddish brown. Ventral surface with light brown in the small spaces between the black in the space between the wing cases. Pupal stage lasts about eight days.

ADDENDUM

In the article "Study of fluorescent pigments in Lepidoptera by means of paper partition chromatography" by George W. Rawson (*J. Lepid. Soc.*, 22 (1): 27-40, 1968), the following additions and corrections should be made.

On page 31, the author of *Melanargia galathea* is Linnaeus, not Seitz.

On page 36, the names of the 14 *Phyciodes* and allies were omitted in the explanation of Plate 2. These are as follows: 1) *Chlosyne janais* (Drury); 2) *C. californica* (Wright); 3) *Phyciodes (Eresia) claudina guatemalena* Bates; 4) *P. (Phyciodes) tharos tharos* (Drury) form "*marcia*" Edw.; 5) *P. (P.) t. tharos* form "*morpheus*" F.; 6) *P. (P.) batesii* (Reakirt); 7) *Chlosyne i. ismeria* (Bdv. & LeC.); 8) *P. (P.) mylitta* (Edwards); 9) *P. (P.) campestris* (Behr); 10) *P. (Tritanassa) ptolyca* (Bates); 11) *P. (Eresia) frisia* (Poey); 12) *P. (Tritanassa) myia* (Hewitson); 13) *P. (Eresia) phillyra* (Hewitson); 14) *P. (Tritanassa) texana* (Edwards).

The color representation of the boxed symbols, A-F, accompanying this plate is as follows: A) Bright violet fluorescence; B) dull blue-violet; C) pale yellow; D) pale blue; E) grayish green; F) pinkish (in the basal portion of nos. 5 and 11).

A TAXONOMIC LIST OF PHILATELIC LEPIDOPTERA

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Many lepidopterists are also philatelists. This includes professional entomologists, some of whom are those actually responsible as instigators or consultants for the many butterfly and moth postage stamps that have of late years appeared around the world.

The first philatelic lepidopteran was issued in 1890 as an ornament in the hair of Hawaiian Queen Liliuokalani. Although one may speculate that it is the beautiful *Vanessa tameamea* Esch., it was not until 1930 when Lebanon honored the silk industry that a definitely determinable species was depicted. Stylized figures had appeared in the interval. In these instances the insects were, of course, incidental. Sarawak in 1950 was the first with nomenclature, *Troides brookiana* Wallace, which was figured unicolorous gray. It remained for the Swiss Pro Juventute issue of 1950 to honor the insect exclusively and in full color. This was largely the work of Dr. Loeliger, a member of our Society until his death and an important force in the Pro Juventute youth movement. The issue was accompanied by a brochure about the insects and was a most noteworthy effort towards stimulation of interest in Lepidoptera in that country.

From this beginning, at first slowly, but with accelerated frequency, over 65 countries have "honored" species of Lepidoptera by 310 butterfly and 115 moth stamps, a total of 425 major varieties by the end of 1966. These embrace 248 species divided 181 and 67 respectively between butterflies and moths. *Papilio machaon* L. with 12 instances leads the list. In most cases the insect is well depicted and the species pertinent to the issuing country. A few are monstrous viz. Lebanon and Togo with *Morphos* and other distant species, San Marino also with inappropriate selections and Albania and Somalia with flying butterflies both upside down and half "inside out." This presents the showier surfaces. Some fine endemics have been chosen (Madagascar, Jamaica *et al.*). All families of butterflies are now represented together with 21 moth families.

Japan 1966 (879) is the only stamp with more than one species. It is a large stamp artistically presenting a girl amidst a veritable swarm of flying butterflies. Ten species can be recognized with reasonable confidence and are included in the list although this stamp does not truly serve as a satisfactory portrayal of the subject species.

It is apparent that the *raison d'être* in many cases is the fiscal benefit to the country of issue. Nevertheless, the popularization of the subject

has worthy aspects. Flagrant abuses are discussed in the philatelic press and need not be pursued here.

Only those species determinable, at least speculatively, are considered in the body of the taxonomic list which follows. Only stamps recognized by the International Postal Union are included.

As to be expected, nomenclature presents a troublesome problem, the same species often appearing under different names. Frequently a racial name has been elevated to specific status.

The issuance of the Cuban 1961 stamp portraying "*Othreis toddi* Zayas (in litt.)" has a particular interest. Inasmuch as the species had not theretofore been described it would appear to represent a most novel medium for publication and be vested with priority standing. Correspondence (January 1964) with Dr. E. L. Todd who is honored in the naming of the striking new species advised that to the best of his knowledge publication had not yet appeared in orthodox channels. He goes on to state, however, that the illustration on the stamp does not constitute one of the requirements for "availability" and quotes the new Code of Zoological Nomenclature requiring that after 1930, in addition to other requirements, there must be a statement of characters differentiating the taxon, or at least reference to such (Article 13a). So the first sortee of philate-lepidopterology into the intricacies of zoological nomenclature is adjudged invalid on a technicality.

There is, of course, difficulty in arranging a list embracing all world faunal zones. Remington (1954) is followed to the family level, modified by Ehrlich (1958) for butterflies to subfamily. For genera and species the sequence follows Munroe (1960) for the Papilionidae, Rothschild & Jordan (1903) for Sphingidae, Peters (1952) for African Rhopalocera, Forster & Wohlfahrt (1955, 1960) for most European Lepidoptera, and various sources including the many volumes of G. F. Hampson's *Catalogue of the Lepidoptera Phalaenae in the British Museum* and of *Macrolepidoptera of the World* (edited by A. Seitz) for other groups and regions. Nomenclature roughly follows these same sources but is modified by work of more recent authors in limited categories and faunas. The checklist is presumed complete through 1966.

Latin names in square brackets appear if nomenclature on the stamp differs from that in the list. In such instances the inscriptions are not necessarily deemed erroneous though such is usually the case. In any event, somewhat arbitrary procedure cannot be avoided to conform to the authorities chosen and to combine examples of the same species under one name. Scott's Standard Postage Stamp Catalogue (1966) numbers and monthly Journal for later assignments are indicated by parentheses. Scott's numbers prefixed by "B" are semi-postal issues;

"C", airmail; "RA", postal tax stamps; "J", postage due. There are no Scott's numbers for North Korea, Red China, Cuba or Mongolia for recent years; numbers are published in foreign catalogues. The United States Treasury Department through its Foreign Assets Control Section, and Pres. Kennedy, by proclamation of Feb. 7, 1962 have forbidden importation of stamps of these countries after that date. Numbers lacking in other instances were not available at the time of preparation of the list.

Grateful acknowledgment is made to Prof. Charles L. Remington of the Department of Biology, Yale University, for his many helpful suggestions, particularly concerning pertinent literature. Thanks are offered also for his counsel in the matter of troublesome determinations. More than once I observed him turning stamps over in his eagerness to detect significant ventral characters.

MOTHS

COSSIDAE	
<i>Cossus Pulchra</i> Rothschild	Spanish Sahara [<i>C. pulcher</i>] 1964 (143)
PSYCHIDAE	
<i>Manatha microcera</i> Bourgogne	Mali 1964 (J14)
GELECHIIDAE	
<i>Pectinophora gossypiella</i> Saunders	Central African Rep. 1965 [<i>Platyedra</i>] (55)
ZYGAENIDAE	
<i>Zygaena carniolica</i> Scop.	Switzerland 1956 (B258) Hungary 1966 (1730)
<i>Arniocera ericata</i> Btlr.	Mozambique 1953 (376)
<i>Erasmia pulchella</i> Hope	China 1958 [<i>E. p. chinensis</i>] 1958 (1186)
<i>Amesia sanguiflua</i> Drury	Lebanon 1965 [<i>Erasmia</i>] (C434)
CASTNIIDAE	
<i>Castnia eudesmia</i> Gray	Chile 1948 (C124) (254) (255)
PYRALIDAE	
<i>Sylepta reginalis</i> Cramer	Cuba 1965
GEOMETRIDAE	
<i>Dysphania militaris</i> L.	Laos 1965 (103)
?	Dubai 1963 (21) (C12)
<i>Abraxas grossulariata</i> L.	Switzerland 1957 (B269)
URANIIDAE	
<i>Chrysidia madagascarensis</i> Less.	Malagasy Rep. [<i>C. madagascariensis</i>] 1960 (C64)
<i>Urania boisduvalii</i> Guer.	Cuba [<i>Uranidia</i>] 1961
DREPANIDAE	
<i>Epicampoptera strandi</i> Bryk	Central African Rep. 1965 (53)
BOMBYCIDAE	
<i>Bombyx mori</i> L.	Lebanon 1930 (108-13) Japan 1947 (383) Trieste Zone B 1950 (30) Zone A 1953 (187)-Overprint Italy (640) Italy 1953 (640) Afghanistan 1963 (640) (641) (C38) (C40)

- Romania 1963 (1582-4)
 Lebanon 1965 (439-445)
 Libya 1964 (249-51)
 Afghanistan 1966 (731)
- BRAHMAEIDAE**
Dactyloceras widenmanni Karsch Central African Rep. 1960 (8)
- SATURNIIDAE**
Saturniinae
Epiphora bauhiniae Guer. Senegal 1963 (224)
Argema mittrei Guer. Malagasy Rep. 1960 (65)
 mimosae Bdv. Mozambique (*Aigenia*) 1953 (371)
Bunaea alcinoe Stoll Togo 1964 (466)
 Rwanda 1966 (118A)
Attacus atlas L. China 1958 (1185)
 Ryukyu Islands 1959 (57)
 Laos 1965 (C46)
Nudaurelia hersilia Westw. Mozambique 1953 [N. h. *dido* M&W] (370)
Athletes ethica Westw. Mozambique 1953 (373)
 gigas Sonth. Rwanda [South] 1965 (119)
Pseudaphelia apollinaris Bdv. Mozambique [*P. pollinaris*] 1953 (377)
Saturnia pyri Schiff. Switzerland 1951 (B211)
 France 1956 (790)
 Romania 1960 (C89)
 Yugoslavia 1964 (728)
 Mali 1964 (J9)
 Mali 1964 (J17)
 Rwanda 1966 (116A)
 Mali 1964 (J18)
- Gynanisa maja* Klug
Gonimbrasia hecate Rougeot
Lobobunea phaedusa Drury
 christyi Sharpe
- LASIOCAMPIDAE**
Lasiocampa quercus L. Switzerland 1952 (B221)
- SPHINGIDAE**
Acherontia atropos L. Hungary 1959 (C207)
 Romania 1960 (C93)
 Poland 1961 (1036)
 Albania 1963 (694)
 Mali 1964 (J7)
 Central African Rep. [*Cenophodes*] 1965 (54)
 Yugoslavia 1964 (726)
 Mali 1964 (J8)
 Israel 1966 (306)
 Spanish Sahara 1964 (142) (144)
- Polyptychus roseus* Druce
Cephonodes hylas L.
Daphnis nerii L.
Celerio lineata Fabr.
- NOCTUIDAE**
Catocalinae
Mormonia dilecta Hbn. Bulgaria [*Catocala*] 1962 (1242)
Catocala fraxini L. Switzerland 1950 (B198)
 Czechoslovakia 1961 (1088)
 Switzerland 1957 (B271)
 Mozambique 1953 (378)
 South Korea 1954 (202A)
 Cuba 1961
 nupta L.
Egobolis vaillantina Stoll
Metopta rectifasciata Men.
 [*Othreis toddi* Zayas]
- ACARISTIDAE**
Xanthospilopteryx mozambica Mab. Mozambique 1953 (380)
Aegocera frevida Wlk. Mozambique 1953 (383)

ARCTIIDAE

Lithosiinae

Chionaema saalmeulleri Btlr.Malagasy Rep. [*C. pauliani*] 1960 (309)

Arctiinae

Carathis gortynoides Grt.

Cuba 1965

Holomelina heros Grt.Cuba [*Eubaphe*] 1965*disparilis* Grt.Cuba [*Eubaphe*] 1965*Rhyarioides metelkana* Led.

Romania 1964 (1618)

Pericallia matronula L.

Lebanon 1965 (C426B)

Arctia caja L.

Switzerland 1954 (B238)

flavia Fuessl.

Yemen 1966

villica L.

Switzerland 1955 (B250)

Ammobiota festiva Hufn.

Czechoslovakia 1966 (1396)

Panaxia dominula L.Hungary [*Arctia hebe*] 1959 (1269)*quadripunctaria* PodaBulgaria [*Arctia hebe*] 1962 (1243)*Amphicallia thewalli* Drc.Hungary [*Callimorpha*] 1966 (1726)*pactolicus* Btlr.

Czechoslovakia 1966 (1395)

NYCTEMERIDAE

Nyctemera leuconoe Hpffr.Albania [*Callimorpha hera*] 1963 (692)

PERICOPIDAE

Phaloe cubana H-S.

Mozambique 1953 (365)

CTENUCHIDAE (SYNTOMIDAE)

Syntomis alicia Btlr.

Rwanda 1965 (116)

Syntomidopsis variegata Wlk.

Mozambique 1953 (381)

Ctenuchidia virgo H-S.

Cuba 1961

Metarctia lateritia H-S.

Ifni 1966 (137) (139) same design

LYMANTRIIDAE

Lymantria monacha L.

Cuba 1965

dispar L.

Mozambique 1953 (379)

Switzerland 1953 (B228)

Romania 1964 (1619)

BUTTERFLIES

HESPERIIDAE

Capila translucida Leech

Red China 1963

PAPILIONIDAE

Parnassiinae

Parnassius phoebus L.

East Germany 1964 (684)

jacquemontii Bdv.

Red China 1963

nomion Hbn.

North Korea 1963

apollo L.

Finland 1954 (B127)

Switzerland 1955 (B251)

Poland 1961 (1038)

Czechoslovakia 1961 (1084)

Bulgaria 1962 (1238)

Germany 1962 (B380)

Czechoslovakia 1963 (1165), 1966 (1394)

Mongolia 1963

Yugoslavia 1964 (727)

Poland 1961 (1035)

Bulgaria [*Thais*] 1962 (1239)

North Korea 1962

South Korea 1966 (501)

Czechoslovakia [*Z. hysipyle* Sch.] 1961 (1083)*mnemosyne* L.*Allancastris cerisyi* Gdt.*Serecinus telamon* Dvn.*Zerynthia hypermnestra* Scop.

<i>Luehdorfia puziloi</i> Ersch.	North Korea 1962
<i>Bhutanitis thaidina</i> Blanch.	Red China 1963
Papilioninae	
<i>Lamproptera meges</i> Zink.	Red China 1963
<i>Teinopalpus aureus</i> Mell	Red China 1963
<i>Eurytides pausianus</i> Hew.	Ecuador [<i>Graphium</i>] 1961 (680), 1964 (711)
<i>molops</i> R&J	Ecuador [<i>Graphium</i>] 1961 (682), 1964 (712)
<i>protesilaus</i> L.	Venezuela [<i>P. p. leucones</i> R&J] 1966 (889)
<i>Iphiclides podalirius</i> L.	Switzerland 1951 (B209)
	Poland [<i>Papilio</i>] 1961 (1037)
	Germany 1962 (B383)
	Albania [<i>Papilio</i>] 1963 (691)
	Hungary 1966 (1729)
	Czechoslovakia 1966 (1391)
<i>Graphium weiskei</i> Ribbe	Indonesia 1963 (B158)
<i>doson</i> Felder	Papua & New Guinea 1966 (212)
<i>antheus</i> Cramer	Red China 1963
<i>policenes</i> Cramer	Mozambique [<i>Papilio a. evombaroides</i> Eim.] 1953 (372)
<i>mandarinus</i> Oberthür	Guinea 1963 (294) (299) (C48)
	Red China 1963
<i>Papilio memnon</i> L.	China 1958 (1188)
	Togo 1965 (486) (489)
	Japan 1966 (879)
<i>elwesi</i> Leech	China 1958 (1184)
<i>euchenor</i> Guer.	Papua & New Guinea 1966 (216)
<i>menestheus</i> Drury	Guinea 1963 (297) (302) (C49)
<i>lormieri</i> Distant	Somalia 1961 (C77)
	Central African Rep. 1963 (31)
<i>ophidicephalus</i> Obert.	Malawi [<i>P. o. mkuwadzi</i>] 1966 (37)
<i>demodocus</i> Esper	Mozambique 1963 (364)
	Guinea 1963 (292, 293) (298) (303)
<i>alexanor</i> Esper	Israel [<i>P. a. maccabeus</i>] 1966 (305)
<i>machaon</i> L.	Switzerland 1954 (B241)
	Czechoslovakia 1955 (714)
	Hungary 1959 (1268)
	Romania 1960 (C92)
	Czechoslovakia 1961 (1085)
	Mongolia 1963
	East Germany 1964 (685)
	Jugoslavia 1964 (729)
	Lebanon 1965 (C431)
	Albania 1966 (927)
	Yemen 1966
	Japan 1966 (879)
<i>bianor</i> Cramer	Japan 1966 (879)
<i>hoppo</i> Mats.	Red China 1963
<i>blumei</i> Bdv.	Indonesia 1963 (B156)
<i>?lorquinianus</i> Fldr.	San Marino 1963 (568)
<i>ulysses</i> L.	Papua & New Guinea [<i>P. u. autolycus</i>] 1966 (209)
<i>zalmoxis</i> Hew.	Central African Rep. 1963 (32)
<i>antimachus</i> Drury	Spanish Guinea 1953 (332) (B28)

- dardanus* Brown
Central African Rep. [*Drurya*] 1960 (11)
Somalia 1961 (C78)
Mozambique [*P. d. tibullus* Kirb.] 1953
(369), (369) as stamp on stamp
(384) (385)
Central African Rep. 1963 (30)
Rwanda 1966 (117A)
Yemen 1966
- phorcas* Cramer
Mozambique [*P. p. ansorgei* Rtsch.] 1953
(375)
Somalia [*P. ansorgei*] 1961 (C80)
Rwanda 1966 (114A)
Rwanda [*P. j. ruandana* Le Cerf] 1965
(117)
Rwanda 1965 (114)
Malawi 1966 (38)
Guinea 1963 (295) (300) (304)
Senegal 1963 (222)
- bromius* Dbl.
magdae Gifford
nireus L.
Dominican Rep. [*P. a. epidaureus*] 1966
(C148) same overprinted 1966
Cuba 1958 (C185)
Ecuador [*P. t. leptalea*] 1961 (681)
Venezuela 1966 (891)
Jamaica 1964 (223), same overprinted
1966, (249)
Cuba [*Papilio*] 1961
Japan 1966 (879)
Red China 1963
Indonesia 1963 (B159)
Sarawak 1950 (180)
Dutch New Guinea [*Papilio*] 1960 (B23)
Papua & New Guinea 1966 (223)
Papua & New Guinea [*O. p. poseidon*]
1966 (215)
Br. Solomon Islands Prot. 1965 (140)
same overprinted 1966, (161)
Ecuador 1961 (683), 1964 (713)
Lebanon [*Papilio c.*] 1965 (C435)
- androgeus* Cramer
caiguanabus Poey
torquatus Cramer
zagreus Dbl.
homerus Fabr.
- Parides gundlachianus* Fldr.
alcinous Klug
Troides aeacus Fldr.
amphrysus Cramer
brookiana Wallace
Ornithoptera paradisea Stgr.
- priamus* L.
victoriae Gray
Battus lycidas Cramer
crassus Cramer

PIERIDAE

Dismorphiinae

Dismorphia cubana H-S

Cuba 1965

Pierinae

Aporia crataegi L.*Delias aruna* Bdv.*Pieris brassicae* L.

Romania 1956 (1103)

Papua & New Guinea 1966 (218)

Switzerland 1956 (B261)

Turkey 1958 (RA227)

Czechoslovakia 1952 (512) (513)

Ascia monuste L.Dominican Rep. [*A. m. eubotea*] 1966
(622) same overprinted 1966*Anthocaris cardamines* L.

Switzerland 1951 (B210)

Czechoslovakia [*Anthocharis*] 1961 (1082)Albania [*Euchloe*] 1963 (695)Lebanon [*Aurore*] 1965 (C432)

Hungary 1966 (1727)

Japan 1966 (879)

- eupheno* L.
Zegris eupheme Esp.
Colotis aurigineus Btlr.
zoe Grand.
danae Fabr.

antevippe Bdv.
euippe L.

eris Klug
Ixias pyrene L.
Coliadinae
Eurema lisa Bdv. & Lec.
proterpia Fabr.

Catopsilia florella Fabr.
Phoebis avellaneda H-S
sennae L.

Gonepteryx rhamni L.

mahaguru Gistel
Colias palaeno L.

berylla Fawcett
croceus Fourcroy

hyale L.
myrmidone Esp.

electo L.

Anteos chlorinde Godt.

Nathalis iole Bdv.

Nymphalidae
Danainae
Danaus chrysippus L.

formosa Godm.
Euploea leucostictos Gmelin
callithoe Bdv.

Ifni [*Anthocharis*] 1963 (111) (113)
Israel [*Z. e. varda* Hemm.] 1965 (307)
Rwanda 1965 (115)
Malagasy Rep. 1960 (306)
Senegal 1963 (223)
Mauritania 1966 (213)
Mali 1964 (J12)
Mozambique [*Teracolus omphale* Godt.]
1953 (368)
Central African Rep. [*C. evippe*] 1963
(29)
Mali 1964 (J11)
Red China 1963

Cuba [*Teria ebriola*] 1958 (C187)
Cuba [*Teria gundlachia* Poey] 1958
(C186)
Dominican Rep. [*E. gundlachia* Poey] 1966
(C146)
Mali 1964 (J20)
Cuba 1961
Dominican Rep. [*P. s. sennae*] 1966 (624)
overprinted 1966
Turkey 1958 (RA225)
Czechoslovakia 1961 (1090)
Albania 1963 (693)
Mongolia 1963
Great Britain 1963 (394)
Japan 1966 (879)
Switzerland 1950 (B200)
Czechoslovakia 1966 (1392)
Red China 1963
Switzerland 1957 (B268)
East Germany 1964 (686)
Hungary 1966 (1734)
Albania 1966 (924)
Bulgaria [*C. balcanica*] 1962 (1244)
Albania 1966 (925)
Rwanda [*C. e. pseudohecate* Berger] 1965
(118)
Dominican Rep. [*A. c. c.*] 1966 (625)
overprinted 1966
Cuba [*N. felicia*] 1958 (C188)

Mozambique [*Danaüs*] 1953 (374)
Spanish Guinea 1958 3 vals., dif. designs
(B50) (B51) (B52)
Senegal 1963 (226)
Mauritania 1966 (215)
Ifni 1966 2 Vals., same design (138) (140)
Somalia [*Danaida morgani*] 1961 (C79)
Red China 1963
Papua & New Guinea [*E. c. duerrsteini*]
1966 (215A)

- Amauris ellioti* Btlr.
niavius L.
- fenestrata* Aur.
lobengula Sharpe
- Lycorea ceres* Cramer
- Clothilda numida* Hbn.
- pantherata* Mart.
- cubana* Salv.
- Ithomiinae
Hymenitis cubana H-S.
- Satyrinae
Hipparchia semele L.
Ragadia crisilda Hew.
Melanargia galathea L.
Brintesia circe Fabr.
- Morphinae
Caligo atreus Koll.
Morpho peleides Koll.
- aega* Hbn.
cyprius Westw.
- Taenaris catops* Westw.
Stichophthalma neumoegei Leech
- Charaxinae
Charaxes varanes Cramer
antamboulou Lucas
azota Hew.
cynthia Btlr.
jasius L.
epijasius Reiche
ansorgei Roths.
ameliae Doumet
- nobilis* Druce
- zingha* Stoll
dehaani Dbl.
- Anaea rufescens* Btlr.
clytemnestra Cramer
- Siderone nemesi* Ill.
- marthesia* Cramer
- Prepona antimache* Hbn.
- Nymphalinae
Heliconius cyrbia Godt.
charitonius L.
- Euxanthe wakefieldi* Ward
- Harma coccinata* Hew.
- Rwanda [*Amaurina ellioti*] 1966 (117B)
- Guinea [Famille Papilionides] 1963 (291)
 (296) (301) (C47)
- Somalia 1961 (C75)
- Malawi [*A. crawshayi*] 1966 (40)
- Cuba 1965
- Cuba [*Anetia numidia briarea* (Latr.)]
 1965
- Dominican Rep. [*C. p. p.*] 1966 (C147)
 same 1966, overprinted
- Cuba [*Anetia*] 1965
- Cuba 1965
- Lebanon [*Satyrus*] 1965 (C430)
- Red China 1963
- Switzerland 1952 (B219)
- Romania [*Kanetisa*] 1964 (1620)
- Venezuela 1966 (C917)
- Br. Honduras 1953 (151), 1961, over-
 printed (165)
- Venezuela 1966 (840)
- Togo 1965 (511)
- Lebanon 1965 (C433)
- Dutch New Guinea 1960 (B26)
- Red China 1963
- Senegal 1963 (221)
- Malagasy Rep. 1960 (C63)
- Mozambique 1953 (382)
- Somalia 1961 (C81)
- Israel 1966 (304)
- Mali 1964 (J13)
- Rwanda [*C. a. ruandana*] 1966 (119A)
- Central African Rep. 1960 (9)
- Lebanon 1965 (436)
- Central African Rep. [*Charaxe mobilis*]
 1961 (5) (6)
- Central Africa Rep. 1960 (10)
- Indonesia 1963 (B157)
- Venezuela [*Hypna*] 1966 (C916)
- Cuba [*A. c. iphigenia* Luc.] 1965
- Cuba 1965
- Dominican Rep. 1966 (626), overprinted
 1966
- Venezuela [*S. m. thebais* Fldr.] 1966
 (C915)
- Cuba [*P. a. crassina* Fruhst.] 1965
- Lebanon 1965 (C427)
- Dominican Rep. [*H. c. churchi*] 1966
 (623) same overprinted 1966
- Mozambique 1953 (366)
- Central African Rep. [*Symothoe sangaris*]
 1961 (4) (7)

Neptis lucilla F.
Hamanumida chalsis Fldr.
Cyrestis camillus F.
Marpesia acilia Godt.

Salamis duprei Vinson
Precis hierta Fldr.

Hypolimnys dexthea Hew.
missippus L.

Doleschallia dascylus God. & Salv.
Kallima inachis Bdv.
 ?*Nessaea obrinus* L.
Parthenos sylvia Cramer

Apatura iris L.

ilia Schiff.

Apaturina erminea Cramer

Sasakia charonda Hew.
Limenitis populi L.

Vanessa cardui L.
atalanta L.

Aglais urticae L.

Kaniska canace L.
Inachis io L.

Nymphalis polychloros L.
antiopa L.

Cameroons [*Cymothoe sangaris*] 1962
 (C42)

Albania 1966 (929)

Somalia [*Euryphura*] 1961 (C76)

Malawi [*C. c. sublineatus*] 1966 (53)

Papua & New Guinea [*M. a. tervisia*] 1966
 (211)

Malagasy Rep. 1960 (308)

Senegal [*Junonia*] 1963 (225)

Laos [*P. cebrene*] 1965 (102)

Malagasy Rep. 1960 (310)

Mali 1964 (J19)

Mauritania 1966 (214)

Japan 1966 (879)

Papua & New Guinea 1966 (222)

Ryukyu Islands 1959 (61), 1960-1 (79)

San Marino 1963 (565)

Red China 1963

Papua & New Guinea [*P. s. pherekides*]
 1966 (217)

Hungary [*A. ilia*] 1959 (1271)

Romania 1960 (C94)

Switzerland 1956 (B259)

Czechoslovakia 1966 (1393)

Papua & New Guinea [*A. e. papuana*
 Ribbe] 1966 (220)

Japan 1956 (622), 1966 (886)

Romania 1960 (C90)

Mongolia 1963

Albania [*Pyrameis*] 1966 (922)

Switzerland 1950 (B197)

Hungary 1959 (C208)

Czechoslovakia 1961 (1089)

Hungary (C208) as stamp on stamp 1962
 (B228)

Romania 1962 (1511)

East Germany 1964 (683)

Lebanon 1965 (C428)

Yemen 1966

Hungary 1961 (1394) 2 vars., silver, gold

Mongolia 1963

Germany 1962 (382)

Japan 1966 (879)

Switzerland 1955 (B248)

Turkey 1958 (RA228)

East Germany 1959 (436)

Czechoslovakia [*Nymphalis*] 1961 (1086)

North Korea 1962

Albania [*Vanessa*] 1963

San Marino 1963 (564) (567)

Mongolia 1963

Jugoslavia [*Vanessa*] 1964 (724)

Japan 1966 (879)

San Marino 1963 (566)

East Germany 1964 (687)

Switzerland 1953 (B229)

- Terinos alurgis* Godm.
Cethosia cydippe L.
biblis Drury
Pandoriana maja Cramer
Chlosyne perezii H-S
 Acraeinae
Acraea hova Bdv.
- LIBYTHEIDAE
Libythea geoffroy Godt.
celtis Feussl.
- LYCAENIDAE
 Lycaeninae
Shirozua jonasi Janson
Chrysozephyrus mushaellus Mats.
Hypokopelates otraeda Hew.
Myrina silenus F.
Epamera handmani Gifford
Axiocerses harpax F.
Lipaphnaeus leonina Sharpe
Heodes virgaureae L.

Lysandra argester Bergstr.
coridon Poda
Agrodiaetus damon Schiff.
Meleageria daphnis Schiff.

?Maculinea arion L.
Lycaena solskyi Ersch.
phoebus Fldr.
Thysonotis danis Cramer
Loxura atymnus Cramer
 Riudininae
Dodona adonira Hew.
- Czechoslovakia 1961 (1087)
 Bulgaria [*Vanessa*] 1962 (1241)
 Germany 1962 (B381)
 Yugoslavia [*Vanessa*] 1964 (725)
 Hungary 1966 (1732)
 Papua & New Guinea 1966 (213)
 Dutch New Guinea 1960 (B25)
 Laos 1965 (101)
 Bulgaria [*Argynnis pandora*] 1962 (1245)
 Cuba 1965

 Malagasy Rep. 1960 (307)

 Red China 1963
 Hungary 1966 (1733)

 Japan 1966 (879)
 Red China 1963
 Mali 1964 (J15)
 Mauritania 1966 (212)
 Malawi 1966 (39)
 Mozambique 1953 (367)
 Mali 1964 (J16)
 Hungary [*Lycaena*] 1959 (C206)
 Romania [*Chrysophanus*] 1960 (C91)
 Hungary [*L. hylas*] 1959 (1270)
 Switzerland 1952 (B220)
 Mongolia 1963
 Bulgaria [*Lycaena meleager*] 1962 (1240)
 Hungary 1966 (1728)
 Turkey 1958 (RA226)
 Red China 1963
 Ifni 1963 (112)
 Dutch New Guinea 1960 (B24)
 Red China 1963

 Red China 1963

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FIRST RECORDS OF TWO BUTTERFLIES IN WISCONSIN (NYMPHALIDAE, PIERIDAE)

I collected in northern Wisconsin in quick hit and run fashion on June 2nd, 3rd, and 4th of 1967. My collecting objective was to document the widespread occurrence of *Erebia discoidalis* (Kirby) in northern Wisconsin, but incidental to my objectives, I uncovered two butterflies previously unreported from the state.

BOLORIA FREIJA (Thunberg)

A single male of this species was taken in an open bog containing sphagnum, labrador tea, cranberry, cottongrass and a sparse growth of black spruce on June 2. After entering the bog, located on highway 17 about five miles north of Rhinelander, Oneida county, I quickly collected three specimens of *Erebia discoidalis* and was about to leave when I noticed and captured the *freiija*. A second *freiija* was sighted but not captured. I had found *freiija* very common in Minnesota bogs the previous week and after capturing this specimen I expected to obtain others as I searched other Wisconsin bogs, but I failed to do so. The abundance of *freiija* in Minnesota had been quite surprising since it was first reported from that state only two years previously. The only other butterfly found in the bog was *Incisalia augustinus* (Westwood) which was common.

PIERIS VIRGINIENSIS Edwards

Later on June 2 I was collecting just south of Presque Isle, Vilas County, Wisconsin, on a small side road leading into a rich maple forest and captured three specimens (2♂♂, 1♀) of *Pieris virginiensis*. Other species taken in the same vicinity include *Euchloe olympia* (Edwards), *Papilio glaucus canadensis* Rothschild & Jordan, *Nymphalis j-album* (Boisduval & LeConte) and *Polygonia satyrus* (Edwards). My three specimens of *virginiensis* are the first documented captures from Wisconsin; however Mr. James R. Neidhoefer of Milwaukee reports (*in litt*) that he collected a specimen (23-V-1961) near Hazelhurst, Oneida County—about 25 miles directly south of my locality. Still later on June 2, 1967, I found *P. virginiensis* very abundant in a maple forest about five miles south of White Pine, Ontonagon County, Michigan and captured about 40 specimens in an hour. These are the westernmost records for *virginiensis* in Michigan, which had previously been reported from Mackinac, Emmet and Benzie counties by Voss and Wagner (1956).¹

I am indebted to Dr. Alexander B. Klots of the American Museum for confirming my determinations. The three specimens of *Pieris virginiensis* and the one of *Boloria freiija* have been donated to the American Museum Collection, New York.—JOHN H. MASTERS, Box 7511, St. Paul, Minnesota.

¹ Voss, E. G. and W. H. Wagner, Jr. 1956. Notes on *Pieris virginiensis* and *Erora laeta*—two butterflies hitherto unreported from Michigan. Lepid. News, 10: 18-24.

TWO VARIANT FEMALES OF *COLIAS* (*ZERENE*) *CESONIA* (PIERIDAE)

The southern dogshead, *Colias* (*Zerene*) *cesonia* (Stoll), is a fairly common visitor in the Lubbock, Texas area. Fellow collectors and myself who have been collecting in this area for years know the species well. I was quite surprised during the months of October and November, 1966, to find two aberrant *C. cesonia*. Both were collected in my back yard at flowers. The striking feature of both specimens was the great reduction of black bordering on the dorsal side of the forewing. Females of this species commonly have less black bordering than males, but the reduction is slight and primarily in the border of the hind wings.



Colias (*Zerene*) *cesonia* (Stoll). Upper lefthand—typical male, upper and underside; upper right—aberrant female, upper and underside; lower right—aberrant female, upper and underside; lower left—location of capture.

The first of the two females (lower right in photograph) was captured on October 24, 1966; the weather was still very mild and that particular day was sunny and warm. During the previous month we had experienced three mild frosts. October 23 I had taken a perfect male specimen (upper left) on the same flowers. The second aberrant specimen (upper right) was taken 14 days later, November 7, 1966, following another frost. The black border on this female's forewings was even more greatly reduced than in the first specimen. The variations could have been caused by genetic mutations but more likely were related to environmental factors such as a rapid change in temperature during pupation.—DWIGHT BENNETT, 2808-1 Street, Lubbock, Texas 79415.

SOUNDS PRODUCED BY *NEPTIS HYLAS* (NYMPHALIDAE)

While in South Viet-Nam between 1955 and 1959, I witnessed two occasions on which specimens of *Neptis hylas* (L.) produced noises which were not incidental to normal movement, as are the clicking sounds made during flight by some of the robust-bodied Nymphalids such as *Charaxes* and *Euthalia*.

On the first of these occasions, in December of 1956, a specimen of *Neptis hylas* alighted in my Saigon garden on a hibiscus leaf four feet from the ground and about six feet away from me. It flattened its wings against the horizontal upper surface of the leaf (a position commonly assumed by this species and others of the genus), extended its reduced foremost pair of legs, and began to snap them together rapidly so that the tarsi met to produce a sharp click which would have been audible even at a distance several times greater than the two yards between myself and the butterfly. In quality, the sound was identical to that made by tapping a fingernail edge against a sheet of paper resting on a resilient surface. The legs were partially extended on a horizontal plane, the angle between femur and tibia being about ninety degrees, and the gesture which brought the tarsi together was similar to that of a child clapping its hands.

The movement was very rapid, the insect giving three successive clicks within less than a second; it paused for about two seconds and then repeated the series of three clicks. After this it flew to a leaf on a level with my head and repeated the performance for a third time before flying away.

The second occasion was three weeks later when another specimen (with fresher coloring) came to almost the same spot on the hibiscus hedge. It settled in the same posture on a leaf five feet up and about eight feet away, turned itself through 180 degrees until it faced me, and produced three rapid clicks. In this instance, the insect's position and its greater distance from me made it difficult to be sure which pair of legs was employed; however, the movement of the legs coincided with the clicks. In an effort to approach more closely I frightened it away.

On neither day was I able to capture the butterfly, or to determine its sex. Both of these incidents occurred between 10:00 and 11:00 A.M., on hot sunny mornings with no wind. I never noticed the presence of a second specimen to which either of the two could have been signaling, although this is inconclusive. Possibly, the behavior was an attempt to dislodge clinging parasites. I subsequently examined every fresh capture of this species for signs of ectoparasitism but found nothing.—

FREDERICK W. SCOTT, P. O. Box 19, Chester, Nova Scotia, Canada.

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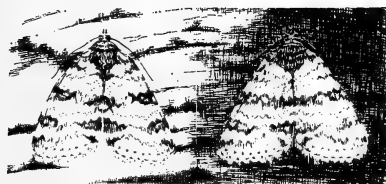
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In This Issue

BEHAVIORAL ADAPTATIONS OF CRYPTIC MOTHS

LIFE HISTORIES OF TWO NOCTUIDS

NEWFOUNDLAND BUTTERFLIES

FREEZE-DRYING CATERpillARS

REVIEW OF PHILOTES

(Complete contents on back cover)

31 March 1969

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

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Number 1

BEHAVIORAL ADAPTATIONS OF CRYPTIC MOTHS. I. PRELIMINARY STUDIES ON BARK-LIKE SPECIES

THEODORE D. SARGENT and RONALD R. KEIPER

Department of Zoology, University of Massachusetts, Amherst

Bark-like cryptic resemblance, as a defensive adaptation of moths, has both static and dynamic components. The colors and patterns of moths are fixed during development, and this static element necessitates dynamic elements, if cryptic resemblance is to succeed as a deceptive stratagem in predator-prey relationships. The dynamic elements are of two types: 1. selection of appropriate backgrounds, in terms of reflectance, hue, and pattern; and 2. adoption of appropriate resting attitudes, which maximize the moth-background resemblances. Figures 1 and 2 illustrate the results of appropriate and inappropriate choices of background and resting attitude in two cryptic species. [For other examples, consult the reviews of Poulton (1890) and Cott (1940).]

Our interests, over the past two summers, have centered on these dynamic, or behavioral, elements involved in the cryptic adaptations of bark-like moths. Both field observations and experimental studies have been carried out, and this paper presents some early results of this work. All of the studies reported here were conducted in Franklin and Hampshire counties in central Massachusetts, during the summers of 1966 and 1967.

FIELD OBSERVATIONS

Two techniques were employed in our studies on the normal resting habits of cryptic moths. The first of these simply involved searching tree trunks for resting moths. When found, a moth was photographed, and extensive notes regarding the moth and its resting place were taken. These notes included references to the species of tree selected, the resting height of the moth, and its resting attitude.

The second technique involved releasing color-marked moths in wooded areas and following them to their resting places. These moths were captured at lights or "sugar," kept overnight in experimental boxes, and released the following morning. A spot of Flo-Paque paint was applied to

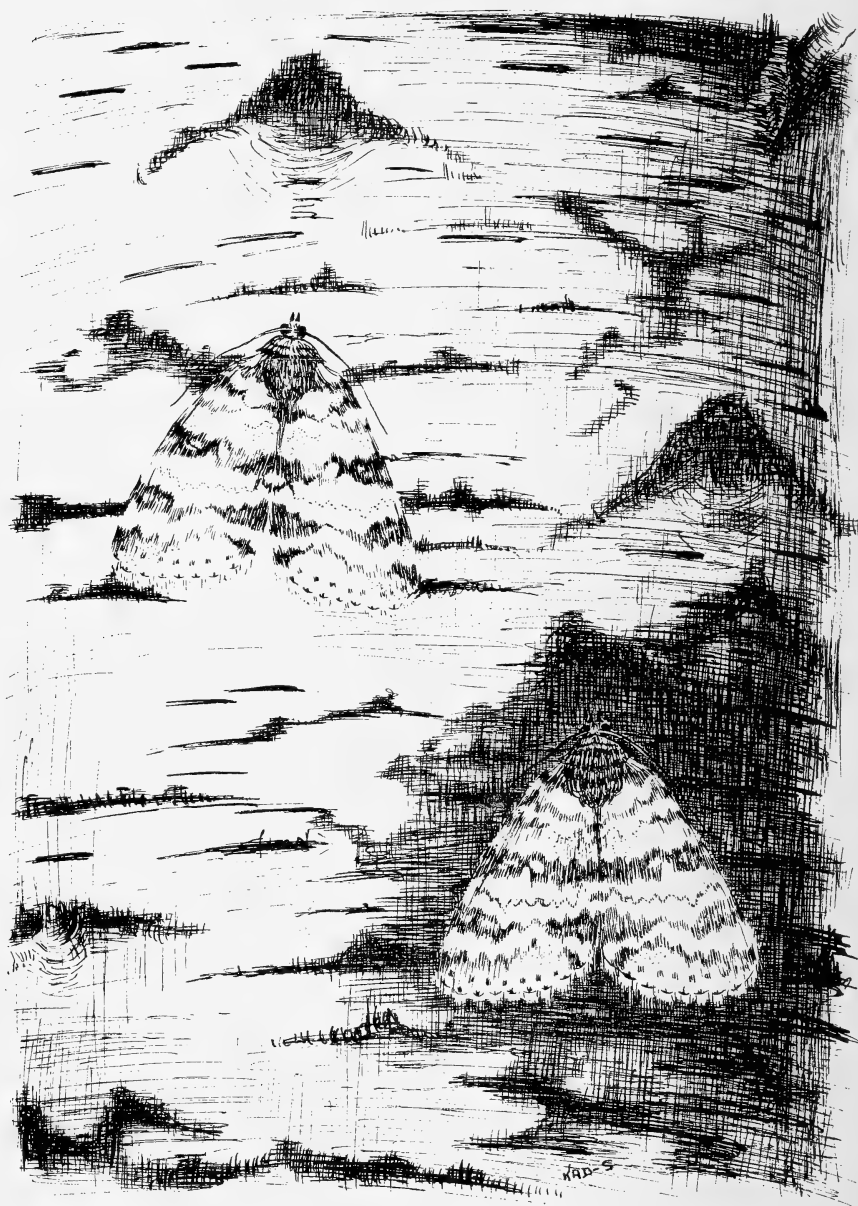


Figure 1. The noctuid, *Catocala relictata* Walker, at rest on an appropriate (upper) and inappropriate (lower) background on paper-birch, *Betula papyrifera* Marsh. Drawing by K. A. Doktor-Sargent.

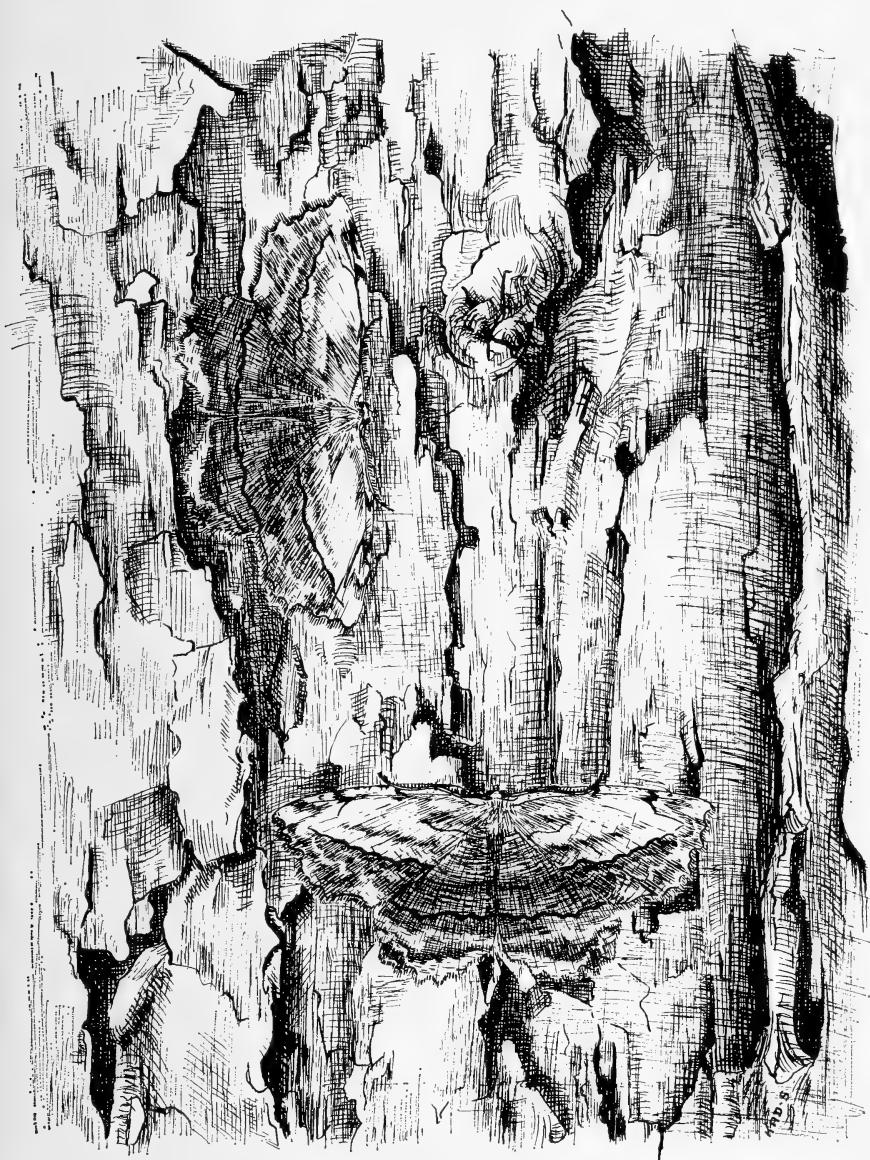


Figure 2. The geometrid, *Lytrosis unitaria* Herrich-Schaeffer, at rest in an appropriate (upper) and inappropriate (lower) resting attitude on red oak, *Quercus rubra* L. Drawing by K. A. Doktor-Sargent.

one forewing of each moth, making later identification in the field possible. Here, as with the undisturbed moths, photographs and notes were taken.

The two techniques yielded very similar results for any given species. The resting attitudes of undisturbed and released individuals were almost invariably identical. The species of trees selected and the resting heights, while more variable, were often remarkably similar in undisturbed and released individuals.

A good example of these similarities is provided by our results with *Catocala relictata* Walker (Noctuidae). We found six undisturbed individuals of this species, and released five others. All of these moths rested with the head up, and eight (four in each group) selected paper-birch (*Betula papyrifera* Marsh) for a resting substrate. The average resting height of the undisturbed moths was 8 feet (range 4–12 feet), and of the released moths was 10 feet (range 7–15 feet).

Table I summarizes our observations on 25 of the most common species encountered on tree trunks. These field observations suggested that some cryptic moths are able to select appropriate backgrounds, and further, instinctively orient themselves on these backgrounds so as to heighten their cryptic resemblance. In order to test these possibilities, a number of experiments were carried out. Three of these experiments will now be described.

TABLE I. FIELD OBSERVATIONS OF COMMON BARK-HAUNTING SPECIES.

Species (Numbers: Undisturbed, Released)	Usual Resting Attitude	Comments
GEOMETRIDAE		
<i>Semiothisa ocellinata</i> Guenée (120+, 0)	sideways	pale trees, e.g., gray birch, red maple; usually within 2 ft. of ground
<i>Melanolophia canadaria</i> Guenée (25, 0)	sideways	often conifers; average height 6 ft.
<i>Lyttosia unitaria</i> Herrich-Schaeffer (3, 3)	sideways	from 3–5 ft.
<i>Cosymbia pendulinaria</i> Guenée (200+, 10)	head up	pale trees, primarily gray and paper birch; average height 5 ft.
<i>Xanthorhoë intermediata</i> Guenée (13, 0)	head down	variety of trees; usually less than 4 ft. from ground
<i>Lobophora nivigerata</i> Walker (6, 0)	head up	gray birch; from 3–8 ft.

TABLE I. CONTINUED

Species (Numbers: Undisturbed, Released)	Usual Resting Attitude	Comments
NOCTUIDAE		
<i>Mamestra adjuncta</i> Boisduval (6, 0)	head up	variety of trees; average height 4 ft.
<i>Apatela innotata</i> Guenée (4, 0)	head up	paper birch; from 5–10 ft.
<i>Catocala antinympa</i> Hübner (3, 8)	head down	often dark trees; average height 5 ft.
<i>Catocala vidua</i> Smith & Abbot (14, 10)	head down	many tree species; average height 5 ft., but often very low
<i>Catocala ilia</i> Cramer (2, 16)	head down	many tree species; average height 17 ft., often very high
<i>Catocala relictia</i> Walker (6, 5)	head up	prefers paper birch; average height 9 ft.
<i>Catocala unijuga</i> Walker (2, 3)	head up	variety of trees; average height 14 ft.
<i>Catocala cara</i> Guenée (1, 6)	head down	often sugar maple; also under eaves; average height 9 ft.
<i>Catocala concumbens</i> Walker (5, 7)	head down	prefers smooth-barked trees; also on fence-posts; average height 4 ft.
<i>Catocala gracilis</i> Edwards (9, 12)	head down	variety of trees; often in furrows; average height 6 ft.
<i>Catocala andromedae</i> Guenée (4, 4)	head down	similar to <i>C. gracilis</i>
<i>Catocala ultronia</i> Hübner (7, 31)	head down	variety of trees; often white pine, near whorl of branches; average height 8 ft.
<i>Catocala crataegi</i> Saunders (0, 20)	head down	often large white pine; average height 9 ft.
<i>Catocala grynea</i> Cramer (1, 4)	head down	average height 6 ft.
<i>Catocala praeclara</i> Grote & Robinson (1, 4)	head down	average height 5 ft.
<i>Catocala micronympha</i> Guenée (2, 7)	head down	often on oaks; average height 6 ft.
<i>Catocala amica</i> Hübner (15, 5)	head down	often on oaks; average height 7 ft.
<i>Epizeuxis aemula</i> Hübner (20+, 0)	head down	many tree species; from 3–6 ft.
<i>Epizeuxis americalis</i> Guenée (50+, 0)	head down	many tree species; from 5–7 ft.

EXPERIMENTAL STUDIES

Our experiments have been designed primarily to assess the importance of background reflectance and hue in the selection of substrates by cryptic moths. One experiment was designed to shed some light on the stimuli which dictate the moths' resting attitudes.

The basic piece of apparatus in these experiments consisted of a plywood box (15 inches square by 19 inches high), into which a cylinder (44 inches in circumference and 19 inches high) was set. This cylinder was made up of blotting paper sections which were painted, or otherwise treated, to provide a selection of backgrounds for the moths. The apparatus was covered with a pane of window glass and a double layer of cheesecloth, and was placed in a wooded area where a thick canopy excluded direct sunlight. Moths were introduced into the cylinder by sliding the glass top to one side.

The moths were collected at lights or "sugar," and immediately released into the experimental boxes. The following morning, between 0600 and 0800 EST, the background selections of the moths were noted.

REFLECTANCE

The field observations suggested that bark-like moths might select trees of appropriate reflectance—light moths preferring light trees such as gray birch, *Betula populifolia* Marsh, or red maple, *Acer rubrum* L.; and dark moths preferring dark trees such as white pine, *Pinus strobus* L., or red oak, *Quercus rubra* L. Accordingly, a number of species were tested for background preferences in an experimental apparatus allowing a choice between black and white backgrounds. (Basically this apparatus consisted of two white and two black 11 × 19 inch pieces of blotting paper, formed into a cylinder of alternating black and white sections.)

Some of the results of this experiment are summarized in Table II, and these illustrate the general finding that bark-like cryptic moths tend to select backgrounds which match the reflectance of their forewings. Similar results have been reported previously (Kettlewell, 1955; Sargent, 1966), and an experiment with painted moths (Sargent, 1968) suggests that these background selections are genetically fixed, and are not based on an ability of the moths to compare themselves with their backgrounds.

HUE

Since most bark-haunting moths are relatively achromatic, an experiment was designed to determine whether such moths would avoid backgrounds of appropriate reflectance, but inappropriate hue. The experimental apparatus was similar to that used previously, but here eight

backgrounds were presented—six achromatic grays, one yellow, and one green.¹

Results obtained with the geometrid, *Cosymbia pendulinaria* Guenée, are presented in Figure 3. Obviously individuals of this species preferred the palest gray backgrounds, and generally avoided the equally pale chromatic backgrounds (there were significantly fewer moths on the yellow and green backgrounds than on the two palest gray backgrounds; chi-square 25, P less than 0.001).

Although this result might be due to a relative insensitivity of the moths to the yellow and green hues presented, existing data on color vision in insects (e.g., Goldsmith, 1961) would not support such an interpretation. It appears that these avoidances of the moths were based on hue characteristics of the yellow and green backgrounds. A stronger conclusion, however, must await further advances in our understanding of insect color vision.

RESTING ATTITUDE

Since field observations indicated that most bark-like moths adopt species-specific resting attitudes on tree trunks, an experiment was devised in an attempt to determine the factors responsible for this behavior. The experimental apparatus was similar to those used previously, but here

¹ Hue and reflectance characteristics of the backgrounds and moths were obtained with a General Electric recording spectrophotometer. Details of the techniques employed may be found in Sargent (1966). The X, Y, Z coordinates for the yellow and green backgrounds were respectively 72.03, 77.00, 29.80; 49.48, 57.15, 62.76.

TABLE II. SELECTION OF BACKGROUNDS BY LIGHT AND DARK SPECIES IN AN EXPERIMENTAL APPARATUS.

Family ¹ Species		Backgrounds		P ²
		Black	White	
LIGHT MOTHS				
G	<i>Semiothisa ocellinata</i> Guenée	2	10	*
G	<i>Eufidonia notataria</i> Walker	5	15	*
G	<i>Cosymbia pendulinaria</i> Guenée	2	19	***
N	<i>Apatela innotata</i> Guenée	1	9	*
DARK MOTHS				
N	<i>Mamestra adjuncta</i> Boisduval	9	1	*
N	<i>Mamestra detracta</i> Walker	12	2	**
N	<i>Chytonix palliatricula</i> Guenée	14	3	**
N	<i>Catocala antinympa</i> Hübner	23	1	***

¹ Families: G = Geometridae; N = Noctuidae.

² Significant deviations from chance selections of the black and white backgrounds (chi-square tests) are indicated by asterisks for probabilities (P) of less than 0.05 (one *), 0.01 (two **), and 0.001 (three ***).

the backgrounds were varied by means of black tape strips applied to pieces of white blotting paper. In this manner, four backgrounds were made up—two with vertical strips, and two with horizontal strips. (These strips were either one-sixteenth or one-eighth inch wide, and were spaced at one-half inch intervals. The difference in tape widths was not significant in the present experiment.)

In addition, a second cylinder of clear acetate was constructed which could be set within the cylinder made up of the taped backgrounds. When in place, this acetate cylinder shielded the moths from any tactile stimuli associated with the tape strips, but allowed visual stimuli to pass.

The results of an experiment using a noctuid which invariably rests with its head down, *Catocala gracilis* Edwards, are shown in Figure 4. All 32 individuals tested in this experiment, with or without the acetate cylinder in place, rested with the head down. However, a significant preference for the vertical strips was shown only when the acetate cylinder was not in place. These results suggest that the basic stimulus dictating a moth's resting attitude is rather general (*e.g.*, gravity), and is not related to the immediate surroundings. On the other hand, it seems apparent that tactile stimuli, which are directly related to the

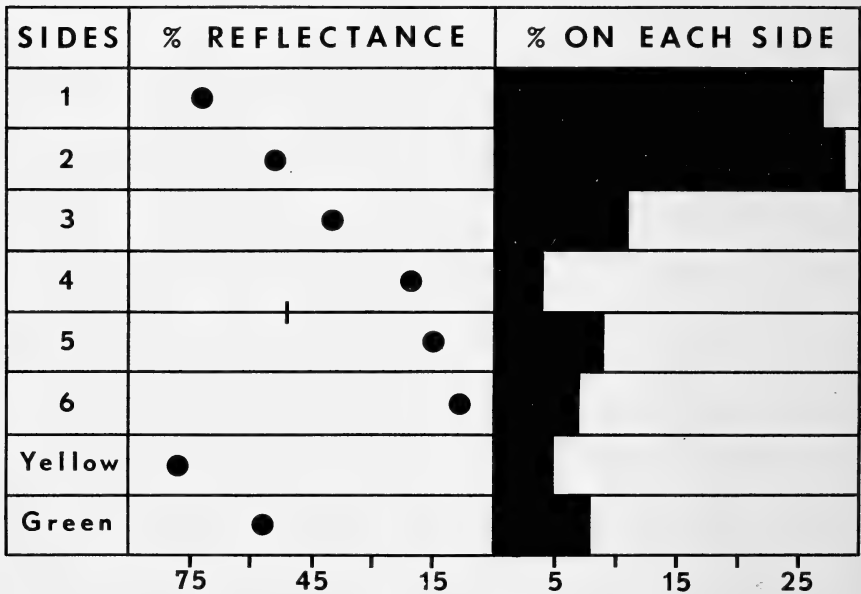


Figure 3. Reflectances of backgrounds in an eight-sided experimental apparatus, and the percent of 92 *Cosymbia pendulinaria* selecting each of these backgrounds. The reflectance of the moths' forewings is indicated by the short vertical line within the figure.

CONDITIONS	BACKGROUNDS & Vertical	NOS. OF MOTHS Horizontal	P
Without Acetate Shield	12	1	★★
With Acetate Shield	7	12	ns

Figure 4. Background selections of *Catocala gracilis* in an experimental apparatus consisting of backgrounds with vertical and horizontal tape strips. Results are shown for two conditions—with and without an acetate shield in front of the taped backgrounds. The significant deviation from a chance distribution on the two backgrounds is indicated by two stars for a probability (P) of less than 0.01; ns = not significant.

immediate substrate, may be important in the selection of a final resting place.

SUMMARY

Behavioral adaptations of bark-like cryptic moths were studied in central Massachusetts during the summers of 1966 and 1967. Both field observations and experiments were carried out.

The release of marked moths in the field seemed to provide reliable information about normal resting habits, as results obtained using this method compared favorably with those obtained from undisturbed moths.

The experiments involved the use of an apparatus, basically consisting of a cylinder made up of blotting paper sections which were painted, or otherwise treated, to provide a selection of backgrounds. Results of these experiments indicated that reflectance, hue, and tactile properties of backgrounds are factors which influence the resting choices of cryptic moths.

ACKNOWLEDGMENTS

Financial support for these studies was provided by a Faculty Research Grant from the University of Massachusetts.

We would like to thank Dr. F. J. Francis of the Department of Food Science and Technology, University of Massachusetts, for his assistance in the determination of moth and background reflectances.

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TWO NEW SPECIES OF LITHOPHANE FROM CALIFORNIA (NOCTUIDAE, CUCULLIINAE)

JOHN G. FRANCLEMONT

Department of Entomology, Cornell University, Ithaca, New York

Lithophane subtilis Franclemont, new species

A species closely related to the eastern *lemmeri* Barnes and Benjamin, but differing by its lighter color and somewhat larger size (Forewing length 20–22 mm: Forewing length 18–19 mm).

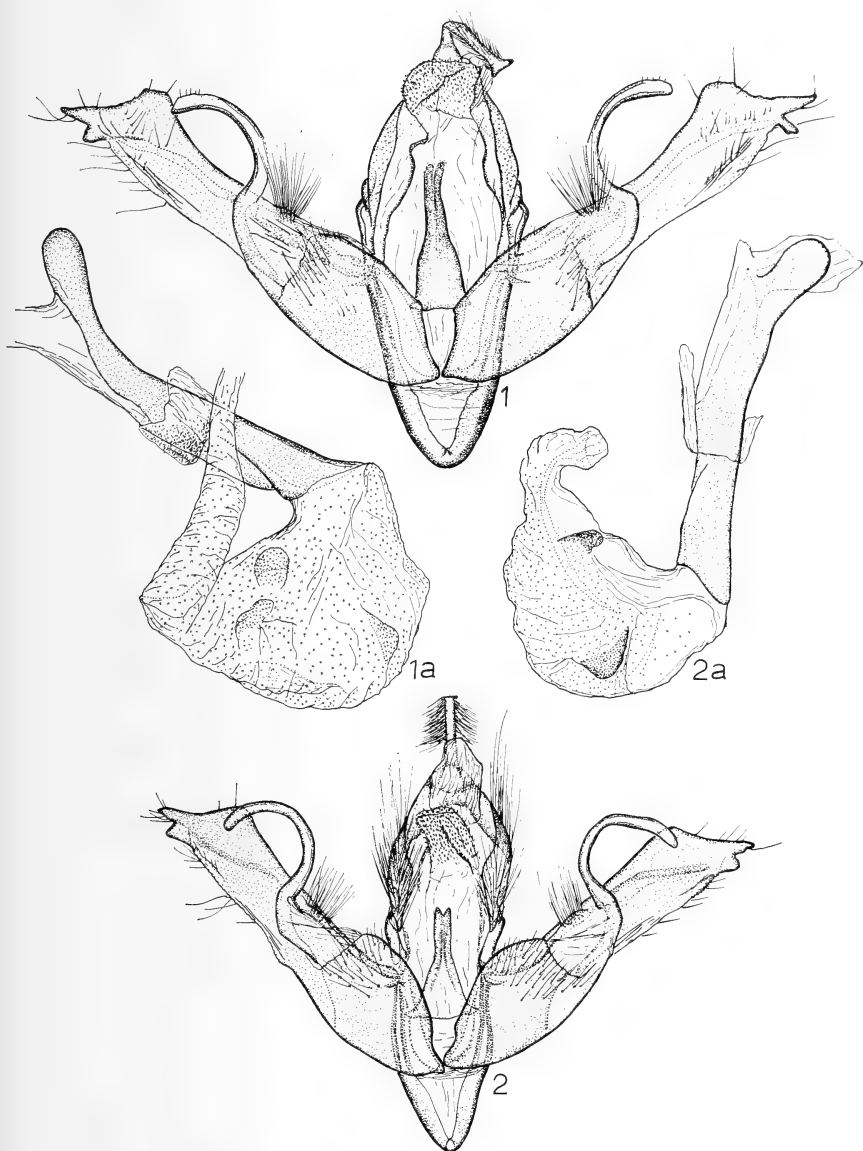
Description: Light gray with considerable admixture of whitish scales; markings vague or obsolescent. Head with frontal tufts well developed; a transverse black line across front, just below level of antennal insertions. Collar (patagia) with a narrow, transverse, black line near upper margin, white above the line, ochreous below; disc of thorax with a pale longitudinal line of whitish scales, bordered on each side by a broader area of blackish scales; anterior thoracic tuft blackish, with the pale longitudinal line running through the center; tegulae margined with black above wing bases, above the black a line of white scales, some spatulate, black scales scattered among the gray and white hair-like scales. Forewing with the transverse lines most evident as longitudinal black and white dashes; t. a. line traceable with a whitish line with accompanying black outer line, sharply angled outwardly as a jagged line to fold (1A), then inwardly to a point below origin on costa, then forming a sharp, acute loop to inner margin; t. p. line traceable as a pale line, sharply angled outwardly from costa to R_4 , then sharply toothed outwardly on the veins and inwardly in fold, then outwardly on 2A, and inwardly to inner margin; a short black dash connecting t. a. and t. p. lines; reniform erect, orbicular oblique, with pale annuli, joined below by a white line with some black scales above, and above the black some ochreous scales; a vague blackish shade angled inwardly from near apex to M_3 and connecting with a narrow black line on Cu below the white line connecting the reniform and orbicular; a vague blackish shade in subterminal area below Cu_2 ; terminal area with short black dashes in the interspaces and extending out onto the fringe. Hindwing fuscous gray with some blackish scales on veins; discal spot dark but faint; fringe pale whitish; terminal area with blackish spots in the interspaces extending onto fringe. Below almost uniform pale whitish gray on both fore and hindwings; the black dashes of terminal area of forewing and the black spots of terminal area of hindwing present. Mid and hind tibiae each with a narrow black longitudinal line on outside.

Male genitalia as figured; differing from *lemmeri* by the longer valvae with proportionately less expanded sacculi, shorter claspers, more expanded costal bulges on each near apex, and more distinct digiti; and by the heavier uncus, almost twice as wide as that of *lemmeri*.

Female genitalia as figured; somewhat larger than those of *lemmeri*.

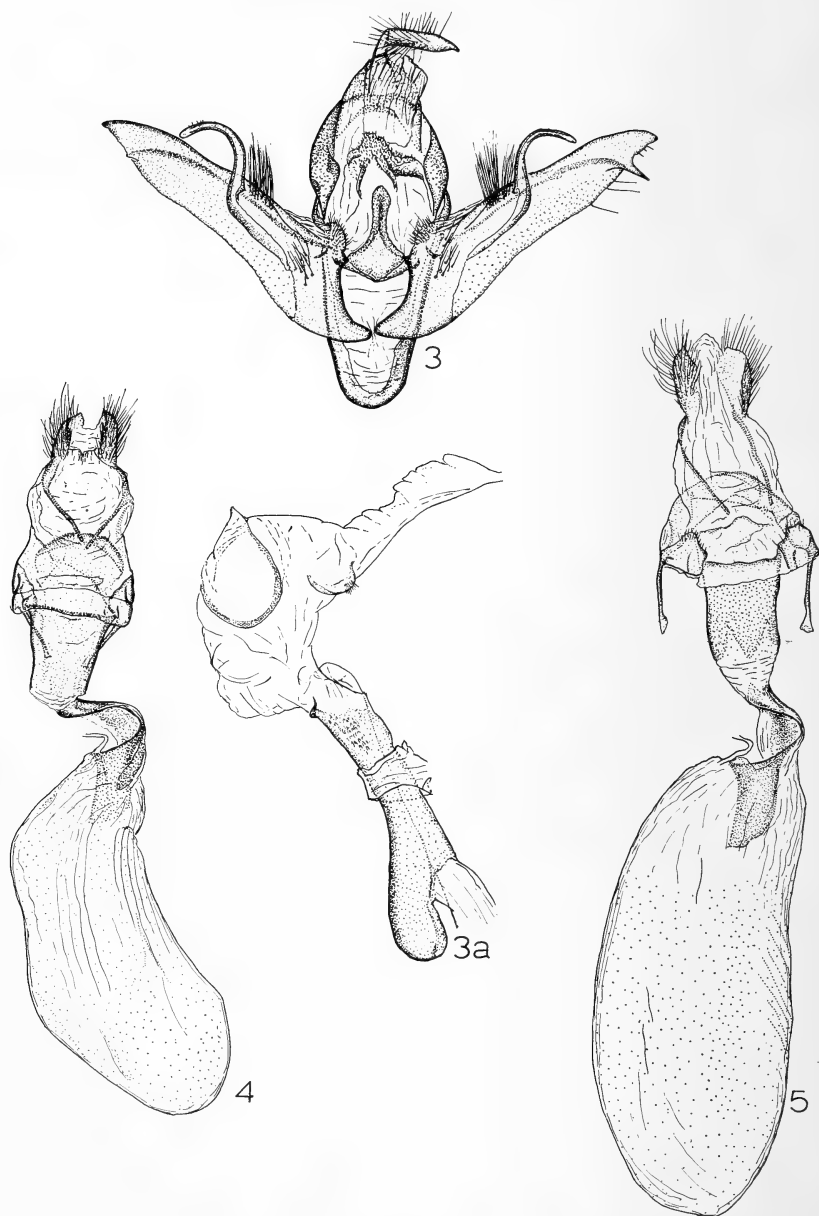
Holotype Male: California, Mint Canyon, Los Angeles County, 16 December 1952 (from Frank P. Sala), in Franclemont Collection to be deposited in U.S. National Museum. Genitalia slide JGF 3571.

Paratypes: 5 ♂♂ and 7 ♀♀, Pinyon Crest, Riverside County, Calif., January, February, and March of 1966 (R. H. Leuschner), in Leuschner Collection. 4 ♂♂ and 3 ♀♀, Mint Canyon, Los Angeles County, Calif., January and February of 1953 and 1954 (Chas. A. Hill) in the Los Angeles



EXPLANATION OF FIGURES

1. *Lithophane subtilis* Franclemont; Type. Male genitalia, aedeagus removed. Slide: JGF 3571. 1a. *L. subtilis* Franclemont; Type. Aedeagus. Slide: JGF 3571.
2. *L. lemmeri* Barnes & Benjamin; Lakehurst, New Jersey. Male genitalia, aedeagus removed. Slide: JGF 4806. 2a. *L. lemmeri*; Lakehurst, New Jersey. Aedeagus. Slide: JGF 4806.



EXPLANATION OF FIGURES

3. *Lithophane tephрина* Franclemont; Type. Male genitalia, aedeagus removed. Slide: JGF 4167. 3a. *L. tephрина*; Type. Aedeagus. Slide: JGF 4167. 4. *L. lemmeri* Barnes & Benjamin; Lakehurst, New Jersey. Female genitalia. Slide: JGF 3574. 5. *L. subtilis* Franclemont; Paratype, Mint Canyon, Los Angeles County, California. Female genitalia. Slide: JGF 3572.



EXPLANATION OF FIGURES

6. *Lithophane subtilis* Franclemont; Paratype, female; Juniper Hills, Mojave Desert, Los Angeles County, California, January 16, 1964, 3500 feet; in Los Angeles County Museum Collection. 7. *L. tephрина* Franclemont; Paratype, female; Cobb Mt., Lake County, California; in W. R. Bauer and J. S. Buckett Collection at Davis, California.

County Museum Collection. 1 ♂ and 5 ♀♀, Mint Canyon, L. A. Co., Calif., December 1952 and January 1953 (from Frank P. Sala), in Franclemont Collection. 1 ♂ and 4 ♀♀, Juniper Hills, Mojave Desert, L. A. Co., California, 3500 ft., January and February of 1964 (C. Henne), 2 in Henne Collection, 3 in the Los Angeles County Museum Collection. 1 ♂, Juniper Hills, Mojave Desert, L. A. Co., Calif., 3500 ft., emerged 25 Oct. 1964 from eggs of a female taken 16 Jan. 1964. Food: *Juniperus californica* Carr.; (C. Henne), in Henne Collection. 3 ♂♂ and 1 ♀, Juniper Hills, 3500 ft., 2 miles S. Pearblossom, Los Angeles Co., Calif., February and March of 1966 (C. Henne), in the Los Angeles County Museum Collection. 2 ♀♀, Big Rock Creek, San Gabriel Mts., L. A. Co., Calif., February 1965 (C. Henne), in Henne Collection. 1 ♀, 2.5 miles SSW of Valyermo, San Gabriel Mts., L. A. Co., Calif. 4800 ft., February 1965 (C. Henne), in Henne Collection.

This species is one of a group the larvae of which feed upon trees and shrubs of the genus *Juniperus* and possibly the genus *Chamaecyparis*. At the Southwestern Research Station of the American Museum of Natural History in Cave Creek Canyon in the Chiricahua Mountains, Arizona, *Lithophane tarda* (Barnes and Benjamin) and *Lithophane longior* (Smith) have been reared on *Juniperus pachyphloea* Torr. from ova laid by confined females. The larvae of *tarda* have been beaten from the same species of juniper at Walnut Canyon near Flagstaff, Coconino County, Arizona. *Lithophane lemmeri* has been reared from a larva found in an area where *Juniperus virginiana* Linn. and *Chamaecyparis thyoides* (Linn.) Britt. *et al.* grow at Lakehurst, New Jersey. The one larva found

was full-fed, and it was assumed that the foodplant had been the *Chamaecyparis*, but it may well have been the *Juniperus*.

There is an undescribed species of this group from El Salto, Durango, Mexico. It was reared by W. C. McGuffin from a larva found on *Juniperus*. Unfortunately, the moth did not expand its wings properly and is in far too poor condition to be used for a description. The genitalia are similar to those of *itata* and *tarda*, but the digiti are of equal size on both valves; there are also other differences.

Lithophane tephрина Franclemont, new species

A small gray species with the general appearance of *itata* Smith and *tarda* Barnes and Benjamin, but differing from both by the very pale hindwings and the slight expansion of the costal area of the forewing.

Description: Light, powdery gray with an admixture of black scales; the markings vague but discernible. Head with frontal tufts moderately developed. Collar (patagia) with a vague line of black scales on upper edge; anterior thoracic tuft conspicuous, blackish; tegulae not set-off. Forewing with basal line fine, black, angled outwardly on base of Cu; t. a. line somewhat diffuse black, crenulate, almost erect, slightly curved outwardly at middle of wing, with a vague, pale shade on inner side; a diffuse, slightly angled, blackish median shade; t. p. line, fine, black, sharply angled outwardly on veins and inwardly in interspaces, angled outwardly from costa to R₅, then incurved to inner margin, a vague, pale shade on outer side; subterminal line fine, very irregular, black; terminal line a series of black spots and short lines at base of fringe; reniform and orbicular not evident, at most a few black scales may represent their annuli. Hindwing grayish white with a pink cast and with a fine dusting of grayish black scales; discal spot blackish and conspicuous. Below pale whitish gray with a pink cast; forewing somewhat darker than hindwing; discal spots dark and conspicuous on both wings.

Male genitalia as figured; similar in general structure to *itata* and *tarda*, most like the former, but differing by the lack of the widely expanded, sclerotized sacculus of the valve; the longer, acute digitus of the right valve; the more reduced, (obsolescent) digitus of the left valve; the much slighter claspers, less than one-half as wide as those of *itata*; and the heavier uncus with the apex acute, not expanded as in *itata* and *tarda*. Vesica with a cluster of short, fine cornuti.

Holotype Male: California, Middletown, Lake County, 18 December 1955 (W. R. Bauer and J. S. Buckett), in Franclemont Collection to be deposited in U.S. National Museum. Genitalia slide JGF 4167.

Paratype: Female; Cobb Mt., Lake Co., Calif.; 19 Feb. 1955 (W. R. Bauer and J. S. Buckett), in Bauer-Buckett Collection.

The drawings are by Miss Linda Yu-ling Chu.

LIFE HISTORY NOTES ON *LITHOPHANE SUBTILIS* (NOCTUIDAE)

JOHN ADAMS COMSTOCK¹

Del Mar, California

and

CHRISTOPHER HENNE

Pearblossom, California

For several years lepidopterists of southern California have been collecting specimens of a *Lithophane* which was suspected as being close to *L. lemmeri*, but seemed sufficiently different superficially to warrant a subspecific name.

Examples were submitted to Dr. John Franclemont, who was revising the genus. Upon a more thorough study of a long series, the result was that he has described the southern California entity as a new species, *Lithophane subtilis*, in the paper which precedes these notes.

Henne was successful in obtaining larvae from *Juniperus californica* Carr., in 1964, and subsequently secured ova from imagoes taken in the Juniper Hills, Los Angeles County, elevation 3,500 feet, which he and Comstock reared to maturity. Joint efforts have resulted in the following:

Egg: (Figures A and B).

Hemispherical, top rounded, base flattened; width, 1.4 mm; height, 1.0 mm; bright yellow with a circlet or belt of red-brown dots running completely around the middle, a few dots of the same color in the micropylar depression.

Approximately 30 ridges running from base toward micropyle, only 6 or so reaching micropylar margin; others gradually pinching out in upper third of egg. The ridges with roughened edges, but not the clearly defined pearl-like knobs of echinoid eggs of many other species. Troughs between these ridges with low, poorly defined cross-striations. Micropyle, small, and deeply depressed, irregularly brown-spotted in and around it. This, and the red-brown 'belt' widely variable.

Eggs laid January 16 hatched February 19 to 22.

FIRST INSTAR LARVA: (Figure C).

Length, 3 mm.

Head: Width, 0.75 mm; dull orange-yellow, smooth and glistening, bearing minute hyaline nodules, topped by translucent setae; ocelli, black or gray; mouth parts slightly darker.

Body: Velvety pale green, cervical shield glistening. First segment slightly wider than head, remaining segments regularly narrower. Each segment with minute black nodules bearing short translucent setae, those of thoracic segments chiefly in transverse lines across the segments. Caudal segments tinged with yellow. Legs, gray-black distally, shading to green proximally; prolegs concolorous with body.

¹ Research Associate in Entomology of the Los Angeles County Museum of Natural History.

Moulting occurred March 3 to 5.

SECOND INSTAR: (Figure D).

Two surviving larvae measured 6 mm. and 8 mm. respectively.

Head: Width, 1 mm; uniform glistening olive-green, including ocelli; tips of ocelli slightly darker; mandibles tinged with brown.

Body: Green, paler than head, except prothoracic shield same shade as head; head slightly wider than body, latter tapering toward cauda but not as noticeably as with first instar; body segments crossed transversely by ridges bearing minute colorless setae along their crests, each arising from a minute black papillus. Segment 11 with a prominent dorsal hump. Legs, black distally, green proximally; prolegs concolorous with body; spiracles inconspicuous, narrowly black rimmed.

THIRD INSTAR:

Length, March 27, approximately 11 mm.

Head: Width, 1.7 mm; glistening green with slightly yellowish tinge; ocelli tipped with brown; mouth parts shaded brown.

Body: Ground color pale green; middorsally a longitudinal line of greenish-white spots, each spot placed anterior to a segmental juncture; laterally, a longitudinal line of larger dark green spots, each on a protruding base; lateral thereto a poorly defined longitudinal greenish-white line, bordered latero-ventrally by another parallel line of dark green raised spots; subspiracularly another poorly defined greenish-white longitudinal line. Legs, black distally, green proximally; prolegs, bright green. Setae so short as to be barely discernible.

FOURTH INSTAR:

Two larvae, length 15 mm. and 20 mm. respectively. April 6.

Head: Width, 3 mm; green, adfrontals paler; ocelli, pale green; front a shade darker green; mandibles tinged with brown.

Body: Ground color, deep green; middorsally a line of large arrow-shaped yellow figures, pointing cephalically and centered on a segmental juncture. Dorsolaterally a zig-zag yellow band extending the length of the body; subspiracularly, another similar band. Spiracles small, black, each margined with a circlet of yellow. Legs, yellow-green with black tips; prolegs, mottled yellow-green; crochets, brownish-yellow. Venter, mottled yellow-green.

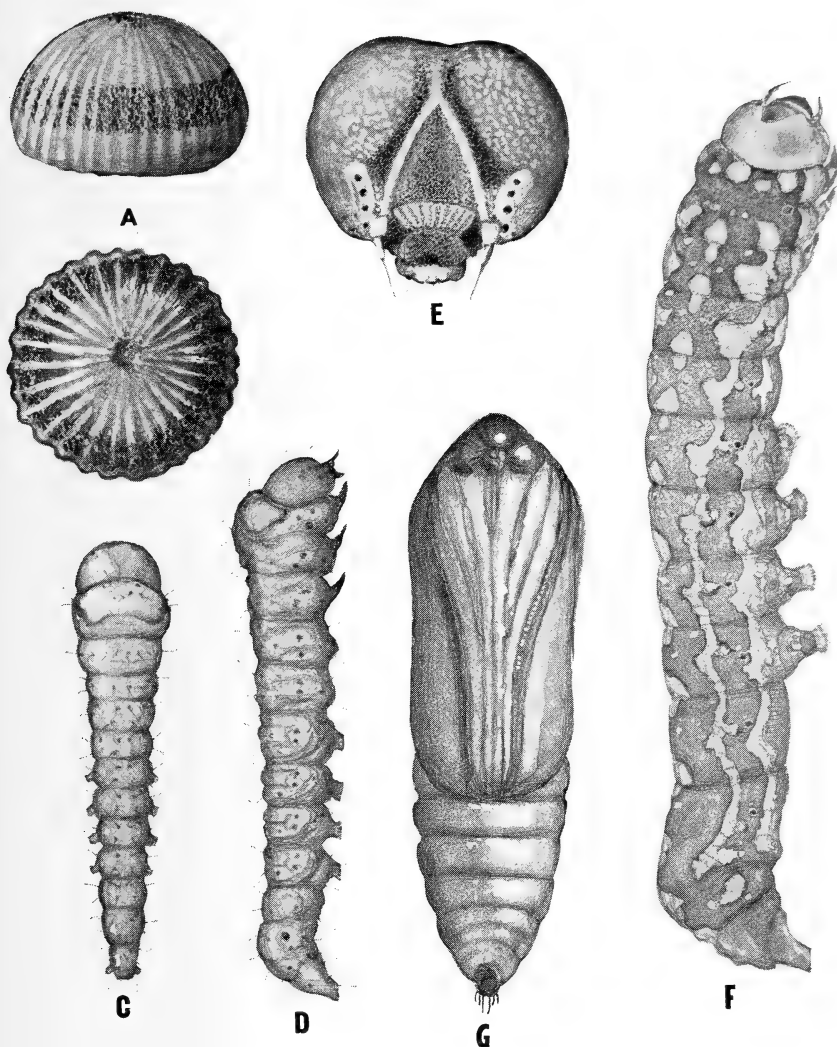
MATURE LARVA: (Figure F).

Length approximately 25 mm.

Head: (Figure E), width 5.5 mm. Adfrontal sutures and antennae white; ocelli dark brown, resting on a pale crescentic field; remainder of head pale green, with round paler green blurred dots.

Body: Supraspiracular and subspiracular longitudinal yellowish-white lines more boldly developed, as shown in the figure. Otherwise, much as in preceding instar.

Pupation occurred May 11, on the floor of the rearing cage, in a compact cocoon, into which fragments of bark, foliage and debris covered an inner lining of white silk.



EXPLANATION OF PLATE

Lithophane subtilis Franclemont. Figs. A and B. Egg, superior and lateral surfaces. C. First instar larva, dorsal aspect. D. Second instar larva, lateral aspect. E. Head of mature larva, frontal aspect. F. Mature larva, lateral aspect. G. Pupa, ventral aspect. All figures enlarged.

Reproduced from water color drawings by J. A. Comstock.

PUPA: (Figure G).

Length, 22 mm.; greatest width, 6.5 mm.

Texture, smooth and glistening. Maxillae reach to wing margins; antennae slightly shorter; segmental junctures well defined; cremaster a small black knob with two black shafts having recurved tips, and two pairs of yellow, short and slender spicules. Body color, yellow-brown, shading to black over head, antennae and cauda.

A six month period passed before an imago emerged, October 29, 1964. Many more adults were reared in our desert laboratory, some of which are included in the type series.

GEOGRAPHICAL DISTRIBUTION

At present, the recorded range of *L. subtilis* is that recorded for the type series, and includes only the areas in Los Angeles and Riverside counties where the host plant, *Juniperus californica* occurs. It probably will be found in semi-desert juniper territory both northward and southward from its present known locus.

In 1943 the authors published a life history of "*Graptolitha longior*" based on larvae taken in Smokey Valley, XYZ Creek, Tulare County, California, at an elevation of 6,200 feet, on *Juniperus occidentalis* Hook. In comparing this record with that of *subtilis*, the suspicion arises that the presumed *longior* was actually the subsequently designated *Lithophane subtilis*.

LITERATURE CITED

- COMSTOCK, JOHN ADAMS and CHRISTOPHER HENNE, 1943. Mature Larva of *Graptolitha longior* Sm. Bull. So. California Acad. Sci., 42 (3): 132.
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AN APPARATUS FOR MEASURING MACULATION PATTERNS

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The application of numerical analytic techniques to external morphological patterns in the Insecta is providing important taxonomic information (Mason, Ehrlich, and Emmel, 1967; Procaccini and Marks, 1966). In certain insect groups with relatively tough anatomical parts (*i.e.*, Coleoptera, etc.) direct morphological measurements are feasible. But in the Lepidoptera direct measurements are usually not possible because

of the fragility of the wings. Therefore many lepidopterists would find helpful a system in which the wing patterns are fully exposed for study, the specimen is easily maneuvered by manipulation of the mounting pin alone, a measurement scale or grid may be superimposed on the wings from a distance, lighting is provided, and the danger of wing injury is minimized. An apparatus was constructed which satisfied all these requirements. The usefulness of the apparatus in quantifying variation in maculation pattern is reported in another place (Procaccini & Marks, 1968).

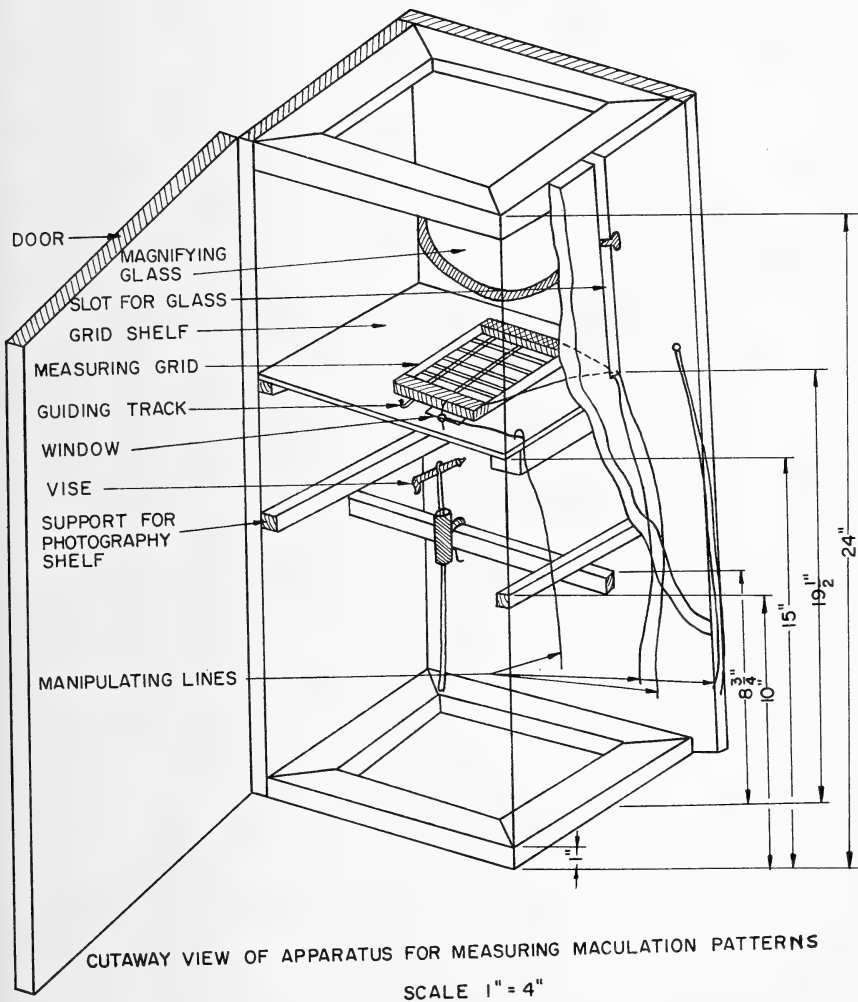


PLATE I

The apparatus (Plate I) which contains all of the measuring equipment is two feet high and measures ten inches square in inside dimensions. One of its sides is a door, giving the investigator easy access to all parts of the interior. This door is attached with two outside hinges, and latches closed with a simple hook and eye. It is kept closed while measurements are being taken, to keep out all external light and to protect the specimen.

Eight and three-quarters ($8\frac{3}{4}$) inches up from the bottom of the apparatus, a cross tie runs parallel to the door, placed midway between the door and the back side of the box. To this cross tie is clamped a fly-tying vise, in which the specimen is held. A fly-tying vise has the advantage of being constructed for delicate work, and yet being strong and rigid. The head of the mounting pin can be firmly clamped in the vise jaws, so the butterfly or moth can be safely held at any angle. Furthermore, the vise jaws are situated at the top of a vertical rod which can slide and pivot within an outer sleeve, to adjust height and angle. Thus, the vise can be adjusted to a convenient position while the specimen is being mounted, and then it can be shifted to another position suitable for taking measurements.

One and one-quarter ($1\frac{1}{4}$) inches above the cross tie, there are supports for an auxiliary photography shelf. This shelf is a simple 10-inch square of $\frac{1}{8}$ -inch masonite with a hole drilled in it, through which the vertical rod of the vise fits. This shelf is normally not used because it restricts the operating room within the box, but it can be quickly installed to provide a uniform background against which a butterfly may be photographed while in the apparatus.

A partial solution to the problem of accurate measurement was found in the use of a grid ruled in millimeters. Such small rulings provide better relative sizes for patterns and grid. The problem of parallax was solved by using two identical grids, one superimposed on the other, glued to the opposite sides of two half-inch spacers. Thus, the two grids remain stationary relative to each other, and when a pattern segment is measured through the parallel grids, the lines of vision are kept parallel as long as the rulings of the upper grid line up perfectly with the corresponding rulings of the lower grid (Plate II).

The parallel grids are supported above the specimen by a shelf which is fifteen inches above the bottom of the box. A 10 by 10-inch square of $\frac{1}{8}$ -inch masonite panel forms the shelf. Two and one-quarter ($2\frac{1}{4}$) inches from the right-hand side of the shelf (viewing through the door), a 2 by 6-inch window is cut in the shelf, running parallel to the right side of the shelf. The measuring grid, which measures $3\frac{1}{2}$ inches by 5 inches, spans this window, and the butterfly is viewed through it. Run-

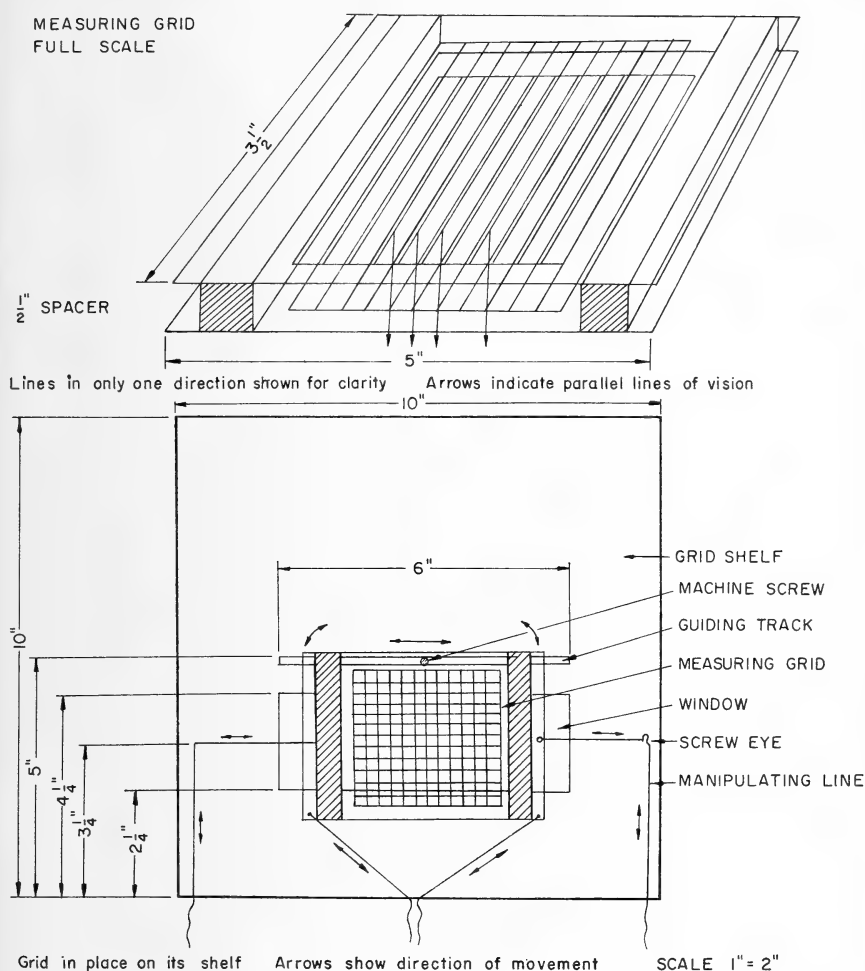


PLATE II

ning parallel to the length of the window, serving as a guiding track, is a 1/8-inch slot in the shelf, 3/4 of an inch from the side of the window. A machine screw, in the middle of one edge of the grid, fastens the grid to the slot, preventing it from slipping down through the opening, and enabling it to be moved along the track and to be swivelled.

Threads lead from the sides of the grid, through guiding screw eyes placed 1 3/4 inches beyond the ends of the window, and then through the right side of the apparatus. Similar threads lead from the corners of the

grid directly through the right side of the box, the side on which the observer stands while measuring. With these threads, one can slide the grid from side to side over the window, and can swivel it, on the screw, through an arc of about 100° . Thus the rulings of the grid can be placed at right angles to various pattern lines on the butterfly without moving the butterfly, and all manipulation is done from outside the box, keeping the butterfly protected.

The most perplexing problem was that of illumination. Lighting must come from below the grid-shelf, because the grids are made of clear plastic, which has rather poor optical qualities. Light coming from above the grids is reflected somewhat, thereby causing eyestrain and reducing the amount of light actually reaching the specimen. Since the butterfly must be held within two inches of the grid-shelf, an external light couldn't illuminate the pattern surface with the angle needed for sufficient clarity and definition. With internal lighting, the problem of heat accumulation within the box was encountered. The answer was found in a four-watt fluorescent light fixture. This fixture was attached to the right side of the box, just under the grid-shelf, forming one of the supports for this shelf. It is only 9 inches long and is $1\frac{1}{4}$ inches square, and it is situated so high that it is about $\frac{1}{2}$ -inch above the butterfly, giving direct, sharp illumination. So little heat is emitted, that the light can be touched, without harm, after extended use.

To further increase accuracy, a magnifying glass was suspended above the grids. This magnifier had to have a depth of focus of at least three inches, so that both the specimen and the grids would be in focus simultaneously. The glass is held in a vertical slot on the right side of the box, in which it has a range of $7\frac{1}{2}$ inches above the measuring grid. It is held in position with a thumb screw, with which it can be set in any position along the slot, depending upon the magnification and clarity of focus desired. The glass itself has a radius of three inches, which, along with the threaded receiver for the thumb screw, centers it over the viewing window.

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1968. Patterns of maculation variation in certain African *Papilios*. *Amer. Zoologist*, 8(4): 807.

A NEW SPECIES OF *EUPRAGIA* FROM FLORIDA
(OECOPHORIDAE)

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In material I collected in south-central Florida in 1964 I have found a new species of oecophorid that represents a genus hitherto unrecorded from the continental United States. At that time two worn males were taken in an almost pure stand of *Taxodium distichum* (L.) Richard. Subsequently, I have received three additional specimens of the species from Mrs. Shirley Hills of Pensacola, Florida. Unfortunately, no females have been taken, so the species cannot be diagnosed for this sex.

The genus *Eupragia* Walsingham will key to couplet 15[a] in Clarke's (1941, Proc. U. S. Natl. Mus., 90: 40) "Artificial key to genera." It may be separated from *Fabiola* Busck (15[a]) by having veins 3 and 4 of the hindwing coincident or stalked (connate in *Fabiola*). In Clarke's "Key to genera based on male genitalia," *Eupragia* will run to couplet 7[a], *Depressaria* Haworth. From this genus it may be separated by having well-developed anellifers; these are lacking in *Depressaria*.



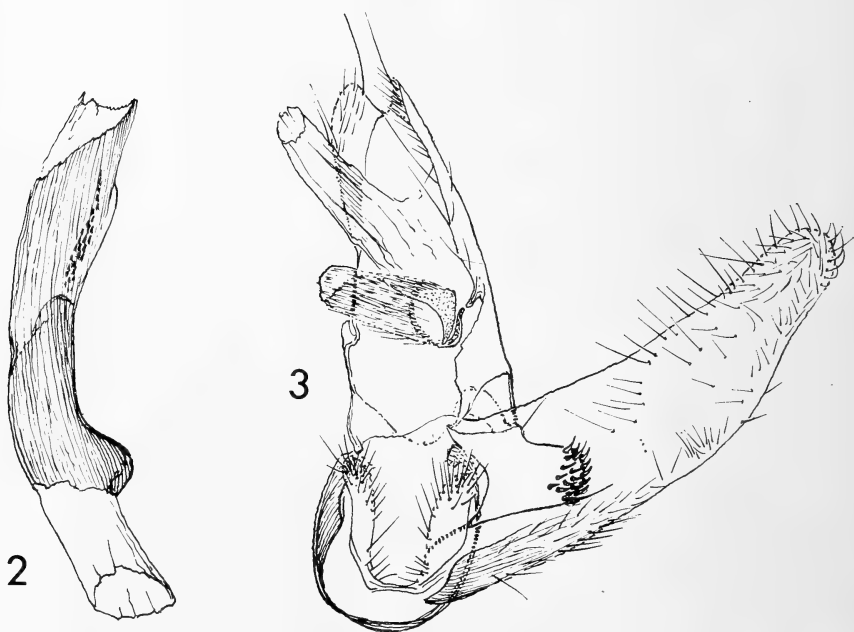
Figure 1. Habitus of *Eupragia hospita* Hodges.

Eupragia (type-species *E. solida* Walsingham, 1911) has three known species: *solida*, which has been taken at Teapa, Tabasco, Mexico and in Nicaragua; *oxinopa* Meyrick, which is known from Gorgona Island, Colombia; and the new species, *hospita*, in Florida.

The drawing of the male genitalia was executed by Mr. A. Cushman of the Entomology Research Division. The habitus photograph was taken by Mr. J. Scott, Staff Photographer, Smithsonian Institution.

Eupragia hospita Hodges, new species

MALE.—Maculation: as in figure 1. *Head*: tongue, maxillary palpus, frons, and vertex white; labial palpus white, dorsal and lateral surfaces of first and second segments grayish brown, dorsal surface of third segment pale grayish brown; lateral and ventral margins of frons grayish brown; occiput white mixed with grayish brown; scape of antenna white, bordered with gray-brown on posterodorsal margin, shaft pale yellow becoming slightly darker distally. *Thorax*: tegula white with light brown scales anterolaterally, disc light brown, apex orange-white to white, some scales lined with off-white, collar pale orange. *Forewing*: white streaked with light brown and brown, spot in cell and one at end of cell dark brown, cilia gray-brown on costa and apex, whitish elsewhere. *Hindwing*: brownish gray, basal row of scales of cilia slightly paler brownish gray, distal row gray-white to white, tuft of scales from base of anal vein gray-white. *Prothoracic leg*: coxa white, overlaid with light brown medially; femur light brown, inner margin off-white to white, a row of setae along



Figures 2-3. Male genitalia of *Eupragia hospita* Hodges; 2, aedeagus; 3, ventral aspect of genitalia (right valva and aedeagus missing).

inner margin; tibia light brown, inner margin of epiphysis off-white; tarsal segments light orange, apices orange-white. *Mesothoracic leg*: much as for prothoracic leg, pale margin of femur broader, femur lacking row of setae; tibia white, apex light orange; tarsus orange-white to pale orange, apices and dorsal surface of first segment white. *Metathoracic leg*: coxa white; femur light brown with a small patch of white scales at apex; tibia white on ventral margin and spines, a broad, medial light orange band, dorsal tuft white with scattered light orange scales; ventral half of tarsal segments pale orange, dorsal half white. *Abdomen*: dorsal surface mottled white and light brown; ventral surface white medially and laterally, a brown band dividing the white areas. Alar expanse: 20–21 mm. *Male genitalia*: as in figures 2 and 3 (RWH slide 3497). Width of anellar lobes one-third length, apex with stout setae; apex of anellifer broadly rounded with stout setae, one or two stout (about one-half width of those at apex) setae costad of midpoint; apex of tegumen deeply excavated; aedeagus cylindrical, produced ventrally at base, vesica with numerous, fine cornuti.

FEMALE.—Unknown.

Holotype male: Florida, Pensacola, May 13, 1962, Shirley Hills, USNM type 69535. *Paratypes*: 2 ♂♂, same data as for type, May 4 and June 21, 1961, collection of Shirley Hills and USNM. 2 ♂♂, Fisheating Creek, Palmdale, Florida, 7–10 May 1964, R. W. Hodges (RWH slide 3497), USNM.

Food plant: unknown.

Discussion: Specimens of *Eupragia hospita* vary greatly in appearance depending upon wear. Fresh specimens have distinct maculation heavily shaded with brown and gray-brown; worn specimens lose much of the brown scaling. The head and thorax of some specimens have become greased, indicating that the larvae possibly are internal feeders.

E. hospita may be separated from *solida* by having the frons and vertex white, those of *solida* are brown medially. It differs from both *solida* and *oxinopa* by having vein 2 of the forewing arising at nearly a right angle, then curving to run parallel with the dorsal margin, and by having veins 2 and 3 of the forewing connate, not separate.

A LARVA OF *CITHERONIA SEPULCHRALIS* (CITHERONIIDAE) FROM NEW JERSEY

On August 6, 1967 I collected a mature larva of *Citheronia sepulchralis* Grote and Robinson, on pitch pine (*Pinus rigida*), near Hammonton, Atlantic County, New Jersey. I attempted to rear the larva but it failed to molt properly, and died.

Many authors mention the rarity of *C. sepulchralis*. In New Jersey the only previous records are those of Muller (1965, J. New York Ent. Soc., 73: 63–77) from Lakehurst, Ocean County, in June. Mr. Muller (personal communication) is not aware of any occurrence elsewhere in the State. Hammonton is 35 airline miles from Lakehurst, and it therefore seems possible that *C. sepulchralis* may be widespread, though rare, in the pine barrens area of New Jersey.

DAVID J. HORN, Dept. of Entomology, Cornell University, Ithaca, N.Y.

THE LIFE HISTORY OF *HELIOLONCHE CAROLUS* (NOCTUIDAE)

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Heliolonche carolus McDunnough¹ presents an anomaly among its relatives. Like the majority of species in the Heliothidinae, *H. carolus* frequents the blossoms of its foodplant. Unlike its relatives, however, which are either inconspicuously marked and colored, or are protectively colored in their resemblance to the blossoms, *H. carolus* with its red and orange wings could not contrast more strongly with the white blossoms of its host, *Rafinesquia neomexicana* Gray. There are several possible explanations of the situation. *Rafinesquia* may not be the sole foodplant of the species, and *H. carolus* may feed primarily on the head of another composite to which it bears a closer resemblance in color. Considering the strong host specificity of other such geographically restricted heliothidine moths, however, and the fact that there is evidently no closely related plant species with blossom coloring similar to that of *H. carolus*, within the known range of the insect, the theory is probably not a tenable one. A second explanation might be that *Rafinesquia neomexicana* was once a dichromatic or even polychromatic species, and that *H. carolus* became adapted to a dark red or orange blossom which the host species no longer has. A third possibility is that *H. carolus* evolved in association with a host plant now extinct, but before the extinction of the latter, managed to transfer to the possibly closely related *Rafinesquia*, to which it is not particularly well adapted, and on which its future existence may well be limited in time. The evident difficulty which the female moth has in ovipositing in the elongate head of *Rafinesquia* may lend some credence to the latter theory.

Heliolonche carolus has been taken only at scattered localities on the Mojave Desert of southern California, but its food plant is listed as extending from Inyo County southward through the Mojave and Colorado deserts to Mexico, and eastward to Utah and Texas. Specimens examined were taken on dates between the middle of March and the first week of May.

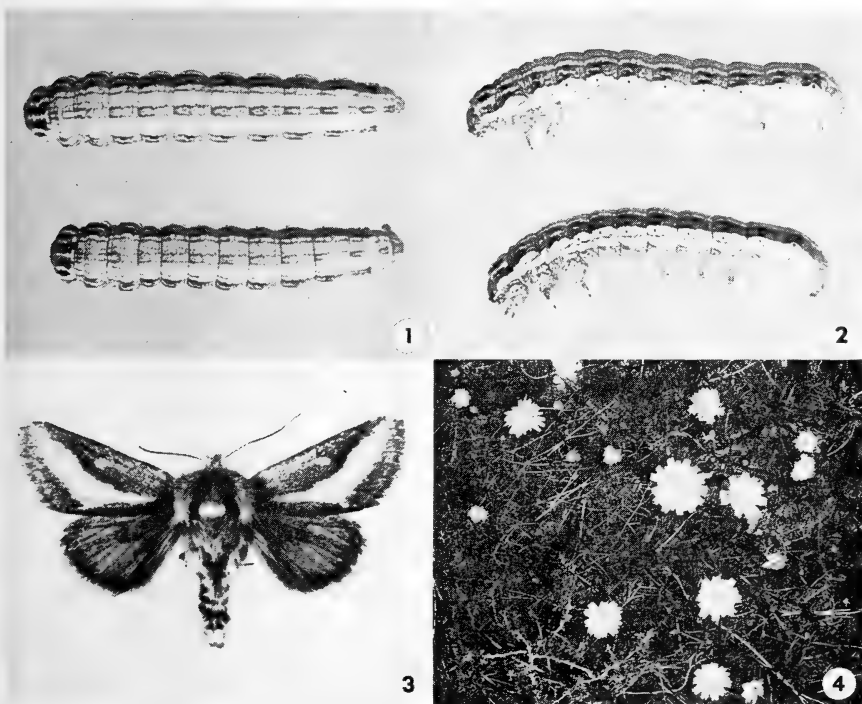
The individuals from which eggs were obtained for life history studies, were captured in the spring of 1955 in the Whitewater Pass area at the southern margin of the Mojave. Although the species was not abundant

¹ *Heliolonche carolus* McDunnough, 1936, Canad. Ent., 68: 45-46.

in this area, copulation and oviposition were observed a sufficient number of times to preclude any misassociation of the moth and its food plant.

BEHAVIOR

Heliolonche carolus is an exclusively diurnal species, and shares with other such day-flying noctuids a greatly reduced condition of the compound eyes. Despite its evident conspicuousness to predators, *H. carolus* rests, feeds and copulates on the head of its food plant. During the process of copulation, the female commonly sits on top of the head while the male assumes a position on the side, below the ray petals. The female has a specialized oviposition pattern; in order to deposit its eggs near the base of the receptacle, the little moth laboriously burrows backward into the elongate head. When it has reached its maximum depth the crumpled wings of the insect are often left projecting above the surface of the blossom. The egg is usually inserted among the developing seeds, less frequently among the florets immediately above the seeds.



Figs. 1-3. *Heliolonche carolus* McDunnough. 1, Fifth stadium larvae, dorsal. 2, Fifth stadium larvae, left lateral. 3, Adult. Fig. 4. *Rafinesquia neomexicana* Gray, food plant of *H. carolus*.

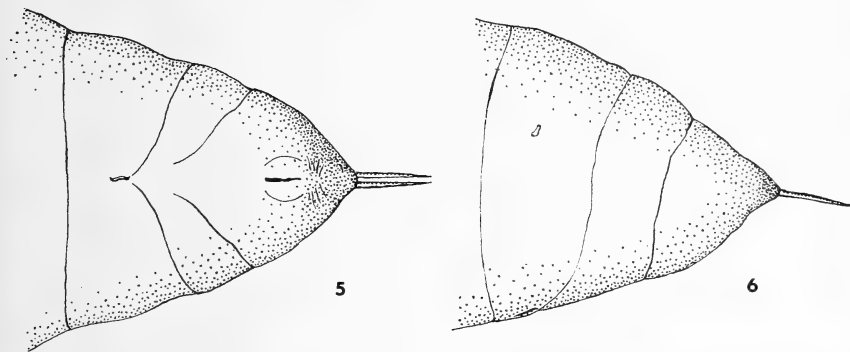
Heliolonche carolus offers an excellent example of those small heliothidine moths that evidently attempt to ensure their future existence by producing an egg of large size, which in turn produces a first-stadium larva of large size and of presumed higher survival potential. In comparison with *Helicoverpa zea*, for example, of which *H. carolus* has less than half the wing expanse and only a fraction of the bulk, *H. carolus* deposits an egg only slightly smaller in diameter and more than one and one-half times as long. A further step in promoting the survival of each individual is the care with which the egg is placed in close proximity to the future larval food. The eggs of *Helicoverpa zea* are frequently scattered rather haphazardly over the flowering heads of its host plants, and the larva often wanders for some period before finding a suitable food substrate. As has been mentioned, the eggs of *H. carolus* are placed deep within the heads of *Rafinesquia* so that the hatching larva is immediately adjacent to the seeds that will form its only food.

Correlated with the deposition of large eggs, however, is a corresponding decrease in fecundity. Whereas *Helicoverpa zea* deposits hundreds or even thousands of eggs, the mean number of eggs deposited by four individually confined wild-caught females of *H. carolus* was only 14, and the maximum deposited by any single female was only 26.

The majority of the eggs observed produced larvae on the fourth day after deposition, a few hatched in three days, a few in five. The newly hatched larva feeds exclusively on the developing seeds and continues to do so for the remainder of its development. By the time the larva reaches the third or fourth stadium, the maturing seeds often constitute a rather dry diet. During the third or fourth stadium the larva generally leaves the first head, which has become fouled, and enters a second. Access to the seed of the second head is gained through the top of the blossom, the larva tunnelling down through the florets. All of the larvae reared matured in five stadia. At the cessation of feeding, the larva burrows into the ground to pupate, and it is in the pupal stage that the insect, like most other endemic desert noctuids, remains quiescent until seasonal rains are again sufficient to trigger their development and the germination of the seeds of the food plants on which they are dependent.

DESCRIPTIONS OF STAGES

ADULT (Fig. 3). Vestiture of body consisting mostly of hair-like scales; buff or pale fawn, often tinged with olive dorsally and with orange ventrally; vestiture rather thin, commonly allowing darkly pigmented body wall to show. Forewing dark purplish-red with a broad, buff or pale yellow, sickle-shaped band extending from base to apex of wing; dark anterior area of wing with a pale patch or streak on or proximal to disc. Fringe concolorous with dark area of wing. Hindwing light to dark orange, with a brown basal area, a usually prominent, brown, inner-marginal band,



Figs. 5, 6. *Heliolonche carolus* McDunnough, apical abdominal segments of pupa. 5, Ventral. 6, Left lateral.

and a variably defined, brown, outer-marginal line or narrow band; a brown discal lunule often evident; fringe orange. Underside of forewing orange with a dark streak extending from base to disc; often a dark submarginal patch near outer angle; fringe orange. Underside of hindwing brighter orange than forewing; a narrow brown streak at immediate base of wing and often along inner margin; fringe orange.

Expanse: 18.1 ± 0.7 mm² (14 specimens).

Egg. Weakly dimpled on micropylar surface; remainder of chorion smooth. Egg pearly white with a pinkish iridescence; showing no color change during incubation until shortly before hatching when ocelli, then mandibles and finally head and prothoracic shield become visible through chorion.

Dimensions: length, 0.81 ± 0.05 mm; width, 0.55 ± 0.04 mm (18 eggs).

FIRST STADIUM LARVA. Head light orange-brown, occasionally suffused with darker brown. Prothoracic shield darker than head, heavily suffused with smoky-brown. Suranal shield usually darker than prothoracic shield. Trunk white or pale cream. Thoracic legs fawn, usually heavily suffused with smoky-grey. Spiracles with dark-brown rims.

Head width: 0.40 ± 0.02 mm (20 larvae).

Duration of stadium: 3.7 ± 1.0 days (20 larvae).

SECOND STADIUM LARVA. Head orange-brown, heavily mottled, especially in dorsal area, with medium smoky-brown. Prothoracic shield fawn-grey, variably suffused with smoky-grey. Suranal shield dark smoky-grey. Maculation of trunk usually well defined. Middorsal band reddish-brown or orange. Subdorsal area consisting of a median band, concolorous with middorsal band, and marginal white bands. Supraspiracular area reddish-brown or orange with a greyish-white median shade. Spiracular band white. Spiracles with dark-brown rims. Ventral region of trunk greyish-white, poorly distinguished from spiracular band. Thoracic legs and proleg shields smoky-grey.

Head width: 0.59 ± 0.05 mm (20 larvae).

Duration of stadium: 2.7 ± 1.0 days (20 larvae).

THIRD STADIUM LARVA. Head bright orange-brown, variably mottled with medium chocolate-brown. Prothoracic shield fawn-grey, marked with dull black. Suranal shield fawn, heavily suffused with dark smoky-brown; occasionally entire shield dark smoky-brown. Middorsal band reddish-brown. Subdorsal area with a reddish-brown median band and white marginal bands. Supraspiracular band reddish-brown

² Standard deviation.

with a creamy-white median line. Spiracular band white. Spiracles with dark-brown rims. Suprapodal area white, occasionally tinged with pink. Midventral area white. Thoracic legs and proleg shields dark smoky-brown.

Head width: 0.83 ± 0.07 mm (20 larvae).

Duration of stadium: 2.5 ± 0.9 days (20 larvae).

FOURTH STADIUM LARVA. Head light orange-brown, mottled with medium chocolate-brown; two dark-brown or black spots on either side of face. Prothoracic shield bright orange-brown, mottled with dark brown or black and with two or three white longitudinal lines. Suranal shield light orange-brown, variably suffused with dark smoky-brown and often with a pair of white longitudinal lines. Middorsal band medium chocolate-brown, often with a purplish suffusion. Subdorsal area consisting of a median reddish-brown or greyish-brown band, and marginal white bands; median band generally paler than middorsal band. Supraspiracular area chocolate-brown, with a discontinuous, irregular, white median line. Spiracular band white or light cream. Spiracles with dark-brown rims. Suprapodal area creamy-grey, often suffused with reddish-brown. Midventral area creamy-grey. Thoracic legs and proleg shields pale fawn variably suffused with smoky-brown.

Head width: 1.28 ± 0.07 mm (25 larvae).

Duration of stadium: 3.2 ± 1.0 days (20 larvae).

FIFTH STADIUM LARVA (Figs. 1, 2). Head fawn, mottled with light orange-brown, usually heavily so in dorsal area; occasionally with chocolate-brown spots on face; a pair of narrow arcs, free of mottling, diverging upward and outward from center of face. Prothoracic shield greyish-fawn, variably marked with black, and with a pair of submarginal white lines; immediate central area of shield usually unmarked with black. Suranal shield fawn, with submarginal, longitudinal white lines. Middorsal band medium chocolate-brown. Subdorsal area white or pale cream; suffused with pale green adjacent to middorsal band; with a pair of irregular, light brown median lines. Supraspiracular area chocolate-brown, usually concolorous with middorsal band; with an irregular and discontinuous median white line. Spiracular band white with a median longitudinal series of small grey spots. Spiracles with dark-brown or black rims. Suprapodal area grey, occasionally suffused with brown. Midventral area grey. Thoracic legs cream proximally, fawn distally.

Head width: 1.66 ± 0.08 mm (20 larvae).

Duration of feeding phase of fifth stadium: 3.7 ± 1.1 days (20 larvae).

PUPA (Figs. 5, 6). Uniform orange-brown. Spiracles on second, third and fourth abdominal segments projecting slightly above general surface of cuticle; remaining spiracles not projecting. Anterior marginal areas of abdominal segments five, six and seven only weakly pitted. Proboscis terminating between apexes of wings. Cremaster consisting of only two elongate bristles borne at apex of a very short prolongation of tenth abdominal segment.

Length to posterior margin of fourth abdominal segment: 6.4 ± 0.3 mm (25 pupae).

ACKNOWLEDGMENT

I appreciate the assistance of Mr. John E. H. Martin, Entomology Research Institute, Ottawa, in photographing larvae in the field.

NOTES ON LARVAL HOST ACCEPTANCE IN A CALIFORNIA
POPULATION OF *PLEBEJUS ACMON* (LYCAENIDAE)

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Plebejus acmon (Westwood and Hewitson) is a well-known blue that ranges from the Pacific Coast to the Great Plains, the various populations within this range varying considerably. The species level status of this species and related entities is still unclear. Downey (1961) points out that *P. lupini* (Bdv.), *P. monticola* (Clemence) and *P. chlorina* (Skinner) have all, at one time or another, been regarded as conspecific with typical *P. acmon*.

Edwards (1889) states that the larval hostplant for this species is *Hosackia*, whereas Comstock (1927) and Downey (1961) assert that larvae of the *P. acmon* group, including *P. a. cottlei* (Grinnell), feed on *Eriogonum*, *Hosackia*, *Astragalus*, and *Lotus*. Klots (1951) mentions a fifth genus, *Acmispon*, but Munz & Keck (1959) place members of the legume genera *Hosackia* and *Acmispon* in the genus *Lotus*.

On May 7, 1967, eight second instar larvae of the common, widespread phenotype of *P. acmon* were found in the San Bruno Mountains near Colma, San Mateo County, California, skeletonizing the leaves of *Eriogonum latifolium latifolium* Sm. The larvae varied from grass green to pale pink in contrast to the "dingy yellowish" color reported by Klots (1951). These larvae were observed on the tops and the undersides of the leaves during warm weather and moved towards the stems near the base of the plant when cold temperatures, which are frequent in the San Bruno Mountains, prevailed. In the laboratory the larvae were reared in vials, one larva/vial. The plants listed in Table 1 were used as hosts.

The larvae fed on all of the listed plants except leaves of *Melilotus indicus*, although two of four died after feeding on *Eriogonum latifolium latifolium*. The flowers of *Eriogonum* species were accepted as readily as the leaves and are known to be used in the field later in the season (Opler, 1968). Five of the eight larvae pupated between May 18 and 26 and the adults emerged between May 27 and June 1. Later field observations confirmed that the females visited the leaves of *E. l. latifolium*, where the eggs were presumably deposited. Although most of the plants were not yet (as of May 7) in bloom, the larvae devoured the flowers of this plant taken from other areas of the San Bruno Mountains.

It is probable that *Plebejus acmon* has several broods in the San Bruno Mountains, larvae of the spring brood feeding on the leaves and larvae of

TABLE 1. HOST PLANT ACCEPTANCE BY SECOND INSTAR LARVAE OF
Plebejus acmon

PLANT	NO. OF LARVAE	REMARKS
Leguminosae:		
1. <i>Lotus scoparius</i> Ottley (leaves)	2	Both accepted plant readily—one placed on <i>Eriogonum fasciculatum foliolosum</i> for final three days; other fed until pupation (V-18)
2. <i>Trifolium obtusiflorum</i> Hook. (flowers)	1	Fed until pupation (V-26)
3. <i>Melilotus indicus</i> (L.) (leaves)	1	No feeding occurred—died after three days
Polygonaceae:		
4. <i>Eriogonum latifolium latifolium</i> Sm. (leaves and flowers)	4	All accepted it readily—two died and two fed until pupation (V-22 and V-25)
5. <i>Eriogonum fasciculatum</i> var. <i>foliolosum</i> (Nutt.) S. Stokes (leaves and flowers)	1	Last instar transferred from <i>Lotus scoparius</i> , fed for three days until maturity (pupated V-18)

succeeding broods feeding on the flowers after the leaves have curled and hardened. Further evidence for the lack of host specificity by *P. acmon* was suggested by the ability of the larvae to feed on *Trifolium* (clover) in the laboratory, although this was not observed in the field. The large number of buckwheats and legumes available to females of *P. acmon* might explain its wide distribution. Further work on hostplant selection and morphology, behavior and host specificity of the larvae as well may help clarify the nomenclature within the *P. acmon* complex.

My sincere thanks go to Wayne Gagné and J. A. Powell, of the University of California, Berkeley, for advice and assistance and critical review in preparation of the manuscript.

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NOTES ON NEWFOUNDLAND BUTTERFLIES

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INTRODUCTION

The island of Newfoundland is roughly triangular, having an east-west extent of about 300 miles and a north-south extent of about 270 miles (Fig. 1). It is located in the mouth of the Gulf of St. Lawrence, and is separated by about fifteen miles from the Labrador coast to the northeast. To the southeast is Cape Breton Island of Nova Scotia at a distance of eighty miles. Excluding Greenland, Newfoundland is the easternmost part of North America. All Newfoundland localities mentioned in this article may be found on the map of Fig. 1.

The first records of Newfoundland Lepidoptera are due to Gosse (1883), who collected 13 species on Carbonear Is., about thirty miles west of St. John's, between 1832 and 1835. His data, however, remained unpublished until 1883, when it came into the possession of W. H. Edwards (1883). It was not until 1934 that extensively publicized collecting again took place on Newfoundland. At that time McIsaac found 21 species near Doyles Station in the extreme southwestern part of the island. This was reported by dos Passos (1935), who also described four new subspecies from the McIsaac material. By far the most ambitious research to date on Newfoundland Lepidoptera was carried out in 1949 by Krogerus, taking part in a Finnish-Swedish expedition. Krogerus travelled the island extensively, and recorded a total of 29 species of Rhopalocera and several hundred species of Heterocera (Krogerus, 1954).

ENVIRONMENTAL OBSERVATIONS

For about two weeks at the end of July, 1965, I collected along the west coast of Newfoundland. The entire northeastern U. S. was then three years into a severe drought; this drought was manifested in Newfoundland only by clear skies a phenomenally high fraction of the time (50%). Biting insects were so severe that highway construction had been stopped—this in spite of the fact that weather conditions only permit road building about three months out of the year. Otherwise 1965 was an apparently normal summer.

Western Newfoundland consists of a low coastal plain up to twenty miles wide, which rises abruptly about 1500' into the plateau-like Long Range.

Figure 2, taken on Table Mt., showing the coastal plain on the left and the plateau on the right, is quite characteristic of the abrupt transi-

tion between the two. The Long Range plateau is remarkably level, and extends many miles inland; it is cut by U-shaped glacial valleys such as the one shown in Fig. 3, at least in the South. In the North the plateau apparently has not been glaciated (Brown, 1955). Figure 3 was taken just south of Table Mt. on Aug. 1 looking east into a glacial valley. The snow patches are about 1000' above sea level, and are on the *southern exposure only*. (Perhaps in winter the north wind disburdens itself as it begins to dip into the valley just as it does after dipping on the leeward side of a snowfence, and piles snow there to an enormous depth.)

In most cases the coastal plain is forested with black spruce, although certain exposed areas very close to the sea, such as Port aux Basques, have only tundra-like vegetation including Arctic grasses, pitcher plant, Labrador tea, and dwarf birch. The Long Range plateau is apparently

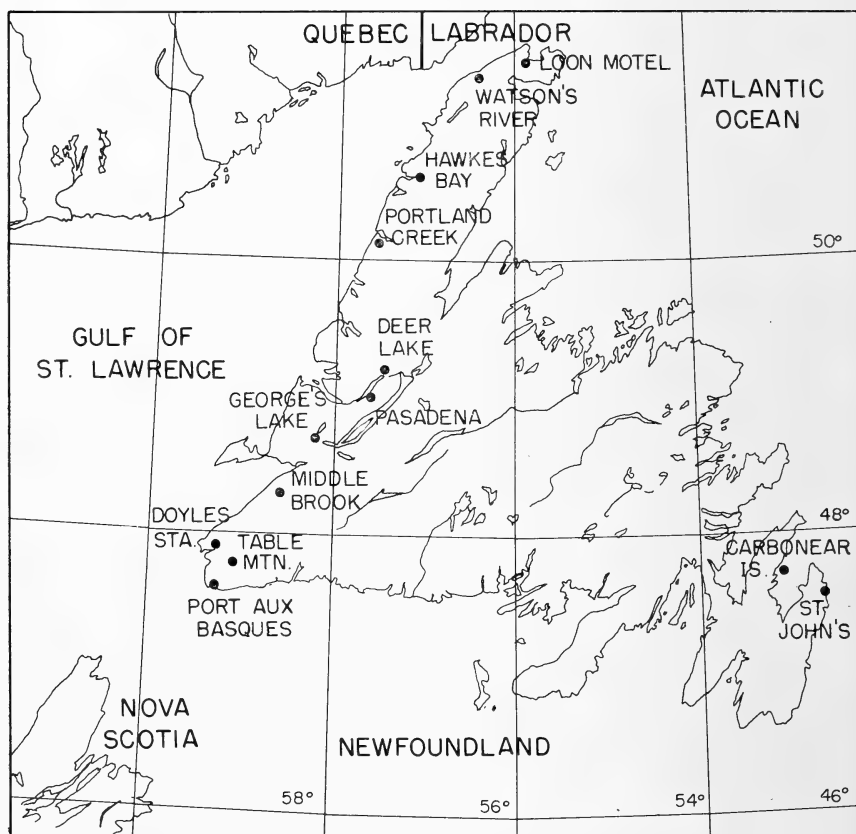


Fig. 1. Newfoundland and adjacent land masses. All localities mentioned in the text are indicated here.



Fig. 2 (upper). The edge of the Long Range plateau. On the far left is the Gulf of St. Lawrence, next is the coastal plain, and finally the abrupt 1500' transition to the plateau. The very edge of the plateau is a typical habitat for *Papilio brevicauda* Saunders and *Agriades aquilo* (Bdv.). Fig. 3 (lower). Looking east into a U-shaped glacial valley carved from the plateau. Note the snow patches on the *southern* exposure.

completely tundra and barrens; it is exceedingly inaccessible in most places. Bogs, some miles in extent, occur both on the coastal plain and on the plateau. These bogs, in addition to the plants representative of more southern bogs, are characterized by a small edible berry (probably *Rubus chamaemorus* L.), superficially resembling a strawberry.

An all-weather road, which is paved south of Deer Lake, follows the west coast. Just north of Deer Lake it rises to a height of 1500'; otherwise it follows the coastal plain. All of the records reported here are from walking distance of this road. No previously unreported *Rhopalocera* were taken, although some of my captures have been found only once before, and others represent significant range extensions.

ANNOTATED LIST OF SPECIES¹

SATYRIDAE

1. *Coenonympha inornata macisaaci* dos Passos (Figured by Brown (1955)). Port aux Basques (STL), 22-VII-65; Table Mt. (ATL), 23-VII-65; Middle Brook (F), 24-VII-65; George's Lake (B), 24-VII-65; Hawkes Bay (F), 29-VII-65; Watson's River (STL), 26-VII-65; Loon Motel (F), 26-VII-65. This species is found in all environments, including above and seaward of tree line. Brown (1955) knew of no records of it from near or beyond tree line. For this and other reasons, he concluded that *macisaaci* could not have survived the last ice age on Newfoundland.² While I would not attempt to pass final judgment on this conclusion, it does appear that *macisaaci* can tolerate a colder environment than has sometimes been assumed.

NYMPHALIDAE

2. *Speyeria atlantis canadensis* (dos Passos). Hawkes Bay (F), 29-VII-65. This species was common at one locality (25♂♂, no♀♀), and not seen elsewhere. It is compared in Fig. 4 with the mainland race, typical *atlantis* (Edw.). The VHW light submarginal band may be seen to be considerably reduced in *canadensis*. Grey (1966) has indicated that these Hawkes Bay specimens are smaller and more red than the type series of *canadensis* from Doyles Station, Newfoundland.
3. *Boloria selene terraenovae* (Holland) (Figured by Holland (1931), Plate LV, Fig. 13). Hawkes Bay (B & F), 29-VII-65; Loon Motel

¹ B = bog; F = forest (generally black spruce); ATL = above tree line; STL = seaward of tree line.

² In a private communication, L. P. Grey of Lincoln, Maine, has made the imaginative suggestion that *macisaaci* may have passed the most recent ice age on the Grand Bank.

(F), 26-VII-65. This race may be nearly always distinguished from the mainland race, *atrocostalis* (Huard), by the obsolescence of the first DHW submarginal dot (cell RS).

4. *Vanessa atalanta* (L.). Hawkes Bay (F), 26-VII-65.

5. *Vanessa cardui* (L.). Hawkes Bay (F), 26-VII-65.

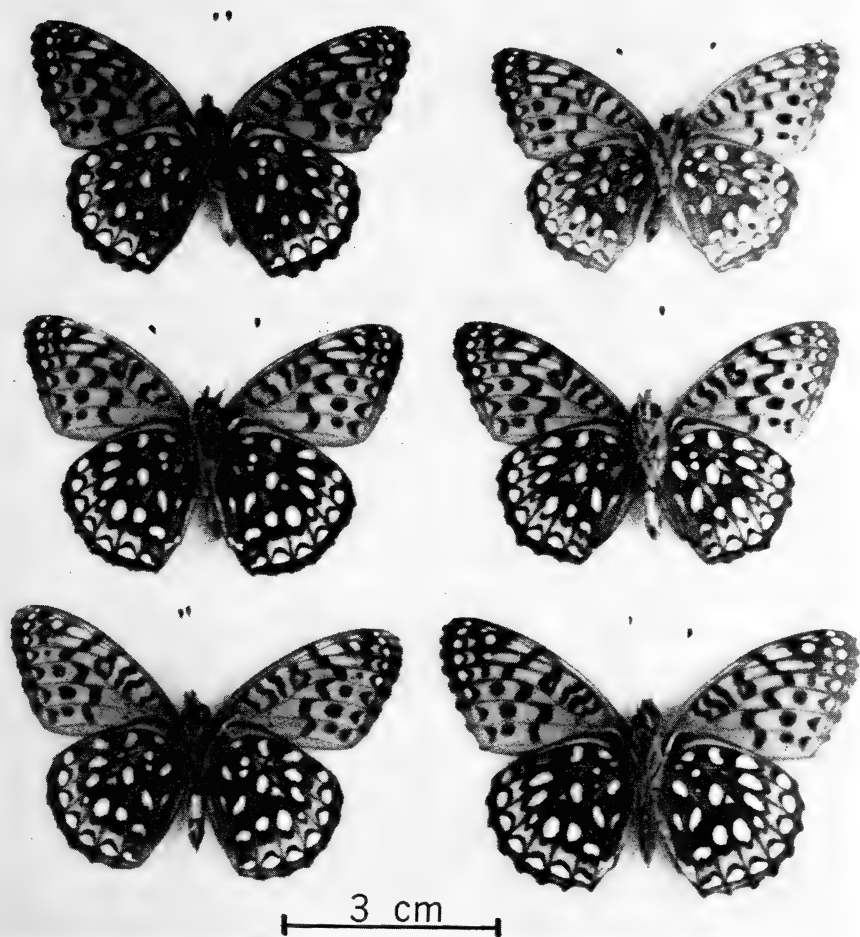


Fig. 4. *Speyeria atlantis*. Left side shows *S. a. canadensis* (dos Passos) from Hawkes Bay, Nfld. Right side shows typical *atlantis* (Edw.) from San Quentin, N.B. Note the reduced submarginal light band on the hind wing of *canadensis*. (All specimens are males.)

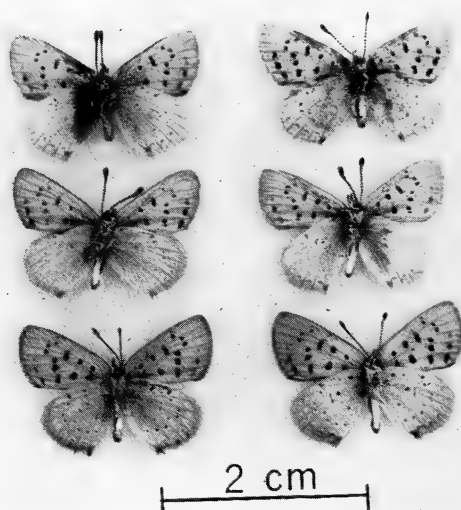


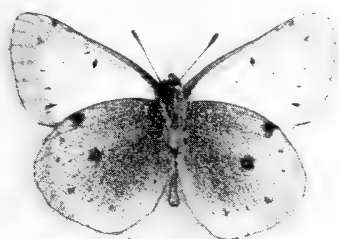
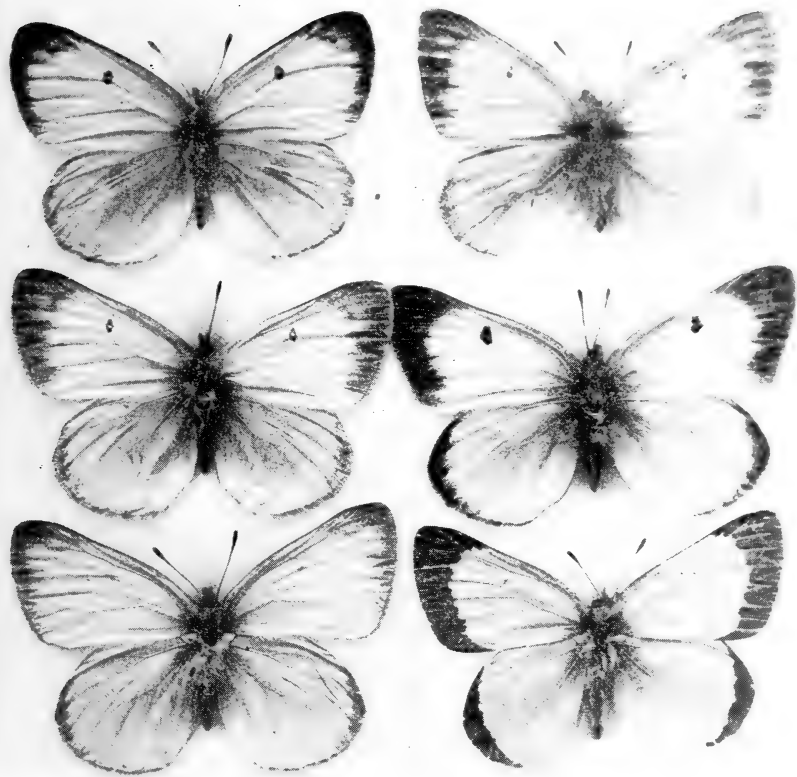
Fig. 5. *Lycaena epixanthe*. Top pair are *L. e. phaedrus* (Hall) from Hawkes Bay, Nfld.; middle pair are *phaedrus* from Cape Breton Highlands, N.S.; bottom pair are typical *epixanthe* (Bdv. & LeC.) from Lincoln, Me. All specimens are males. Note that there is little difference between the Nova Scotia and Newfoundland specimens, but that the Maine specimens are definitely more heavily marked.

LYCAENIDAE

6. *Agriades aquilo* (Boisduval). Port aux Basques (STL), 22-VII-65; Table Mt. (ATL), 23-VII-65. This little butterfly fairly swarmed at the tops of small rises. It is apparently associated with much harsher environments than its Rocky Mountain and Sierra Nevada relatives, *rustica* (Edw.) and *podarce* (Felder & Felder).
7. *Plebejus argyrognomon aster* (Edw.) (Figured by Klots (1951), Plate 19, Fig. 7). George's Lake (B), 24-VII-65; Hawkes Bay (B), 29-VII-65. This insect was seen by the hundreds at Hawkes Bay.
8. *Lycaena epixanthe phaedrus* (Hall). Hawkes Bay (B), 29-VII-65. The Newfoundland form of this subspecies is illustrated in Fig. 5, and is compared with *phaedrus* from nearby Cape Breton Is., N.S.,

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Fig. 6. *Colias* from Table Mt., Nfld. Top left, yellow female *interior laurentina* (Scudder); top right, yellow female *pelidne labradorensis* Scudder; second row and third row left, white *pelidne* females; third row right, *pelidne* male. (Even though the *pelidne* females are quite variable, none have the rounded forewing characteristic of *interior*.); lower: *Colias pelidne* male with submarginal spots normally diagnostic of *philodice*.



and with typical *epixanthe* (Boisduval & Le Conte) from Maine. My specimens bear no resemblance to the subspecies *amicetus* (Scudder),³ supposedly described from Newfoundland (figured by Holland (1931), Plate LXIV, Figs. 41 & 42), in that my specimens have the VHW grey (not white) and not immaculate.

PIERIDAE

9. *Pieris rapae* (L.). Hawkes Bay (F), 29-VII-65; Loon Motel (F), 26-VII-65. These records apparently represent northward extensions of the known eastern distribution of this pest.
10. *Colias interior laurentina* (Scudder). Table Mt. (ATL), 1-VIII-65. My single Newfoundland specimen is shown in Fig. 6, and is distinguished from Maine material by a more orange discal spot on the DHW and more green suffusion on the VHW.
11. *Colias pelidne labradorensis* Scudder. Table Mt. (ATL), 23-VII-65 and 1-VIII-65; Port aux Basques (STL), 22-VII-65. My specimens are very distinct from the *labradorensis* example illustrated by Holland (1931). Table Mountain where *pelidne* Boisduval & Le Conte was rather common, is the only place I know of at which it is sympatric with *interior* Scudder. Hovanitz (1950a) has suggested that there is a "continuous morphological intergradation" between *pelidne* and *interior*, so that the two are conspecific. My Table Mountain *pelidne* specimens, some of which are shown in Fig. 6, were quite variable, but do not seem to intergrade with the illustrated Table Mountain *interior* specimen, either in wing shape or color or pattern. White females outnumbered yellow 11:1 among my *pelidne* specimens. This figure is almost exactly the reverse of that cited by Hovanitz (1950b) (3:32) for Newfoundland in what he calls the "*interior-pelidne* complex." The flight period of *interior* is apparently later than that of *pelidne* on Table Mountain. On Aug. 1 when the *interior* was taken in fresh condition, *pelidne* was only about one fifth as common as it had been on July 22. The *pelidne* which were seen on Aug. 1 were usually, but not always, worn. A single *pelidne* male, taken on Table Mountain, 23-July-65, possesses the VHW submarginal spots normally distinctive of *philodice* Godart. This specimen, which is illustrated at the bottom of Figure 6, has been examined by Dr. A. B. Klots of the American Museum of Natural History. Dr. Klots, long a student of this genus, expressed his judgment that it "could be a hybrid with *philodice*, or merely an expression of some ancestral gene."

³ In a private communication, F. M. Brown of Colorado Springs, Colorado, has indicated that the name *amicetus* Scudder is a synonym of *epixanthe*. The status of this name is apparently quite complex.

PAPILIONIDAE

12. *Papilio brevicauda* Saunders. Table Mt. (ATL), 23-VII-65.

HESPERIIDAE

13. *Hesperia comma borealis* Lindsey. Loon Motel (F), 26-VII-65; 10 mi. W. of Loon Motel (F), 26-VII-65. This species has previously been recorded from Newfoundland only by Krogerus (1954), also from the extreme northwest tip of the island. As Fig. 7 shows, my specimens bear a remarkable resemblance to material from Mt. Albert on the Gaspé Peninsula.

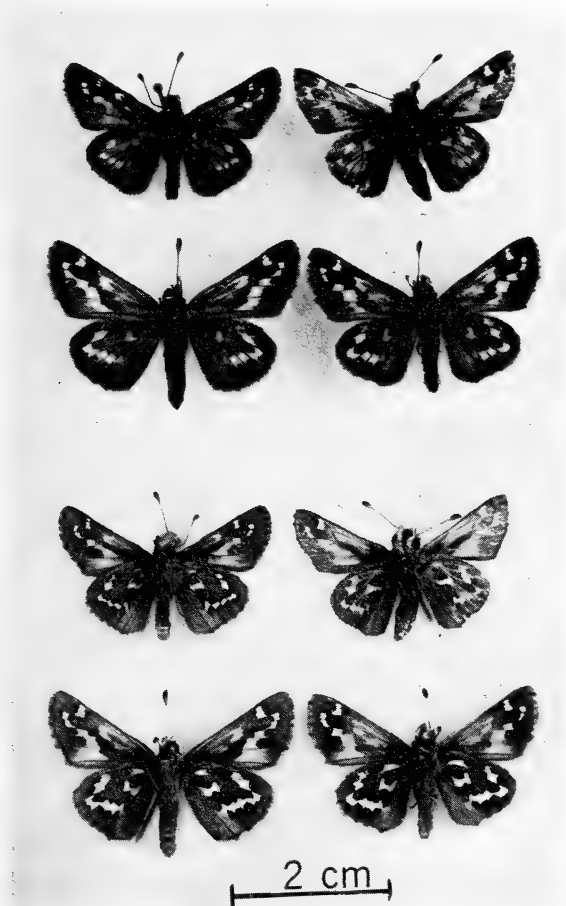


Fig. 7. *Hesperia comma borealis* Lindsey. Top, uppersides; bottom, undersides. Both frames have males above and females below; Mt. Albert, Que., to the left and Loon Motel, Nfld., to the right. Note the extreme similarity of the females.

The following province records for moths were taken at light around habitations:

NOCTUIDAE

14. *Ceramica picta* (Harris). Loon Motel (F), 27-VII-65.

LIPARIDAE

15. *Olene vagans* Barnes & McDunnough. Portland Creek (F), 30-VII-65.

ACKNOWLEDGMENTS

I would like to thank F. M. Brown for critically reading the manuscript and L. P. Grey for numerous interesting discussions and comments. The *Colias* identifications have been verified by Dr. A. B. Klots, and the moths have been identified by Dr. A. E. Brower.

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A SIMPLIFIED METHOD OF FREEZE-DRYING CATERPILLARS

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In recent years freeze-drying of museum specimens has been studied and has provided means of obtaining specimens up to the size of a hamster in their natural form without too much difficulty (Meryman 1960, 1961). Application of this method to insects, particularly to caterpillars, has yielded satisfactory results (Blum and Woodring, 1963; Woodring and Blum, 1963). However, the vacuum or pump systems (Meryman, 1959) employed in the methods, while not overly troublesome for a laboratory, are generally more than an average collector can afford. For caterpillars and other small specimens a vacuum or a pump, while desirable for speeding the process, is not a necessary requirement for the same result, as is shown in the present paper.

Freeze-drying is based on the fact that ice evaporates just as water does, although at a much slower rate. In more scientific terms, the "partial pressure of water vapor" over ice is quite low. That means that if ice is brought into a dry atmosphere in a closed system at low temperature, only a small amount of ice needs to evaporate in order to saturate the atmosphere with water vapor. Once this state of equilibrium is reached no more ice evaporates. If the water vapor is removed, the equilibrium is disturbed and is restored by further evaporation of ice. The removal of the water vapor can be achieved, for example, by passing a stream of dry, that is, water-free air over the ice; or, as in the method to be presented, by binding the vapor on an appropriate agent, called a desiccant. Of course, the whole process must be done at a low temperature in order to prevent melting of the ice. Operation under low pressure, that is, in an evacuated system, has the advantage that the water molecules can readily move away from the surface of the ice and when using a desiccant rapidly reach its surface where they are bound. However, the principal process of water evaporating from the ice and moving to the desiccant takes place under normal pressure too, although more slowly. With respect to time it would seem best to operate at as high a temperature as possible but of course without exceeding that of the melting point. The transfer of the water vapor from the surface of the specimen to the desiccant is not the only process to be considered. Water vapor from within the specimen has also to penetrate the integument in order to reach the surface. This process too is accelerated by increasing the temperature. In addition, however, higher temperature also speeds the decay of the specimen. In order to

avoid the latter, a temperature below the optimum for speedy drying must be maintained. Such considerations are of mere theoretical interest since the temperature in the ice cube compartment is preset and in the freezer variations are possible only within a limited range for the collector working at home.

With this admittedly sketchy discussion of the underlying principle it will be easily understood how freeze-drying of a caterpillar is effected. The animal is brought into a container together with some desiccant. The container is then closed air-tight, stored in a deep freezer or in the ice cube compartment of a refrigerator and left there until essentially all the water from the frozen specimen has moved to the desiccant. The time required for this process predominantly depends on the size of the specimen and the temperature (see above). There is no formula established to allow an exact calculation or even a rough estimation of this time, and each experimenter will have to gain his own experience. But some idea may be obtained from the series of experiments described below.

The containers present no problem. Any tightly closing screw cap glass or plastic container is suitable provided its size fits the dimensions of the specimen.

Desiccants suitable for the purpose exist in large numbers. We consider Silicagel as the most practical one. It is readily obtained at a low price from a supply house for chemicals. Silicagel is sold as granules of 1-2 mm diameter and in dry state is of deep blue color. This color is due to an impregnation with a salt that changes its color to pink when wet. Thus the color of the material readily indicates exhaustion. The pink Silicagel no longer has water-absorbing properties and consequently the charge in the container must be renewed. Silicagel has another enormous advantage, namely, it can readily be regenerated by mere warming. A collector who has no access to special drying ovens can perform this task by simply placing the pink Silicagel into a pot or frying pan and keeping it at moderate heat, while occasionally stirring it with a piece of wood or a spoon. The heating may be effected on the burner of a range or, preferably, because it is milder and more uniform, in an oven. No harmful components are released. When the mass has completely regained the blue color, it is placed back into the storage bottle, kept there tightly closed and is ready for reuse. Extreme heat should be avoided during the drying procedure because it may cause cracking of the particles and render them less effective in their drying power. As a rule of thumb the lowest temperature that achieves blueing should be used.

During experimentation over more than two seasons some experience has been acquired, and a few points of interest may be discussed, but

anyone applying the method may find ways of improvement in one respect or another. A caterpillar that is sluggish and does not move around, *e.g.*, a saddle-back caterpillar, can be brought with the leaf on which it sits directly into the desiccant-containing jar, which after closing is placed directly into the freezer. The animal dies from undercooling with hardly any movement and the drying process starts to take place.

Species that move about can also be treated in this way but in many cases will curl or contract before they die and will then not show their natural position or form. In such an event it is often helpful to put the caterpillar in a container without desiccant and to place it in a refrigerator (not freezer!). At the reduced temperature the animal commonly ceases moving and while still alive comes to rest in a natural position. Once this state is reached the container is transferred to the deep frost compartment or freezer where the caterpillar solidifies in the desired position. When thoroughly frozen (say, overnight) the specimen is transferred to the desiccant-containing jar. It is advisable to make this transfer as rapidly as possible in order to prevent large amounts of moisture from condensing on the specimen. This condensed water, of course, must also be removed and more drying time is required and more desiccant is used up. In this modification of the method it is also advisable to have the desiccant-containing jar cooled before introducing the specimen. The reason for this is that the outside portion of the specimen in contact with the desiccants may thaw sufficiently to become flat or get dells impressed from the granules of the Silicagel. Of course such distortions once the specimen is dried cannot be repaired.

The final method is to kill the caterpillar before subjecting it to freeze-drying by dropping it into boiling water. After removal from the water it is essential to place the specimen on a blotting paper and to allow evaporation of the adherent water. Hairy specimens after such treatment show the hairs completely entangled. But natural position of the hairs can readily be restored by brushing with a soft brush after complete outside dryness has been reached. In order to avoid dells the specimen should not be brought directly into the Silicagel but rather be placed on a piece of paper or thin cardboard. After arranging the specimen in the desired position, the jar is closed and carefully placed into the freezer.

It is advisable to inspect the jars in the freezer from time to time and observe the progressive expansion of the pink layer in the Silicagel. If its major portion is pink the desiccant should be renewed. In order to avoid thawing of the specimen, the following procedure is recommended. A jar with new desiccant is placed into the freezer and allowed to cool. Then this jar and the one containing the specimen and the exhausted

desiccant are removed from the freezer, both rapidly opened, and the specimen is quickly (to avoid condensation of water) transferred to the new jar; the jar is closed at once and returned to the freezer.

Renewal of desiccant is rarely necessary. The occasion usually only occurs when an extremely large specimen was placed in an unappropriately small container, or too many specimens were put into one jar, or too little desiccant was added. Some experiences will soon establish the minimum amount of desiccant necessary to completely avoid renewal of the charge. During the study most cases where renewal became necessary arose due to a cap that did not fit tight enough and thus permitted entrance of humidity from without.

A frost-free freezer is not a necessity but offers a great advantage. It allows inspection of the contents of jars without hindrance by ice accumulation on the outer walls.

In all cases studied by the authors the form of the specimen was retained perfectly. This held for specimens in sizes from that of a small skipper larva to the caterpillar of *Citheronia regalis* (Fabricius) and included hairy specimens like *Syntomeida epilais jucundissima* Dyar. Unfortunately, the situation with respect to the retention of color is not as favorable. Some colors are kept, others are not. The discoloration usually does not take place during the drying itself but is a slow process that occurs during the later storage of the dried specimen. It seems that the color green especially tends to fade. However, this cannot be ascribed to the freeze-drying method as such but is rather due to the particular chemical behavior of chlorophyll, the pigment usually responsible for this green color. Thus, description of the color on a label accompanying the specimen or a color photograph is recommended for permanent records. Some caterpillars show a shine in natural conditions and this may be lost during the freeze-drying. With non-hairy specimens the shine can be restored by spraying with a transparent lacquer. In order to avoid attacks by various museum pests it is advisable to spray the finally dried specimen with one of the commercial household or garden insecticides (Hess bomb, Raid, etc.).

The following data will give a rough idea about the quantitative aspects of the process. The experiments were carried out in the following manner. Caterpillars of *Malacosoma americana* (Fabricius) were weighed and put into small screw-cap plastic vials containing an adequate charge of Silicagel. The containers were then placed into the ice cube compartment of a refrigerator. Jars were taken after a specified number of days and allowed to warm to room temperature. The specimens were then removed from the jars and weighed again. These weights as well as the original

weights and weight losses in grams and also in per cent are tabulated in Table I. Specimen No. 3, after being removed from the jar and weighed, was placed into an oven and dried at 110°C to constant weight (overnight). The total weight loss, that is, referred to the original weight amounted to 82.5%. A fresh specimen of 0.631 grams was killed and immediately dried in an oven at the same temperature and it showed a total weight loss of 82.7%. These data were used to obtain the figures in the last column expressing the weight loss with respect to moisture. It must, of course, be realized that this figure represents not only loss of water but includes that of some other volatilizable material.

Inspection of the data in Table I shows that freeze-drying beyond a certain time does no longer produce a significant removal of moisture. After 550 days only 94% water is removed. This might be taken as an indication of incomplete drying. However, caution must be exercised in such a judgment. It is highly probable that complete dryness (that is, removal of moisture) has been attained and that the remaining 6% are partly nonaqueous volatile materials and chemically bound water. It is enough to reduce the water content of the specimen to a degree sufficient to prevent decay and this seems to be achieved with a water content of only about 10%. Specimen No. 3 after having been freeze-dried to a loss of about 50% and then for final, rapid drying, was placed into an oven. No decay or other adverse phenomena were observed. From this experiment the conclusion may be drawn to a possible short-cut of the methods. It seems to be sufficient to freeze-dry the specimens to a loss of about 40–50% of their moisture and then to dry them to completion at an elevated temperature. It may also be possible to speed the process by removing the jars after about 40% drying from the freezer and then allow to stand at room temperature where faster final drying can be achieved. However, this will require further investigation and at the present time

TABLE I. DATA ON FREEZE-DRYING LARVAE OF *Malacosoma americana* (FABRICIUS).

Specimen Number	Days	Original weight in grams	Weight in grams after specified days	Weight loss in grams	%	% Loss expressed as moisture
1	1	0.386	0.381	0.005	1.3	1.6
2	10	0.459	0.438	0.021	4.7	5.7
3	40	0.699	0.405	0.294	42	51
4	100	0.481	0.137	0.344	72	87
5	111	0.417	0.103	0.314	75	91
6	550	0.669	0.151	0.518	77.5	94

the simplest and safest way is to place the specimen into the desiccant-containing jar and allow to stand in the freezer for about 3-6 months depending on the size of the caterpillar. The well-known tent caterpillar *Malacosoma americana* should readily serve as a guide. The specimens used in the experiments were in their last instar and about one inch in length.

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A NEW FOODPLANT FOR *EUPHYDRYAS PHAETON* (NYMPHALIDAE)

On July 17, 1967, a wet meadow near Newton, New Jersey, was visited where *Melitaea harrisii* Scudder and *Euphydryas phaeton* (Drury) were plentiful. Whenever I find *E. phaeton* flying, I look them over first for variations, then try to locate the foodplant, turtlehead (*Chelone glabra* Linnaeus), to find the larva of *Papaipema nepheleptena* Dyar (Noctuidae) boring in the root of this plant. This meadow and several others in the neighborhood were investigated thoroughly, but no turtlehead could be found. Later, a larva of *E. phaeton* was found on a plant with white flowers, and further investigation enabled collection of a dozen larvae of all sizes in the space of 15 minutes. The caterpillars were sitting on the top of either leaves or flowers where they could be easily detected. This plant, which was growing in this meadow by the hundreds, was identified as eastern pentstemon (*Pentstemon hirsutus* Linnaeus), or hairy beard-tongue. It grows from one to three feet high, with the flowers one inch wide. The range of this plant is said to be the eastern half of the U.S.A. and adjacent Canada. Like turtlehead, it belongs to the snapdragon family, Scrophulariaceae.

Turtlehead being extremely rare in the New Jersey area, larvae of *E. phaeton* should therefore be expected on pentstemon.

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PHILOTES OF NORTH AMERICA: SYNONYMIC LIST AND DISTRIBUTION (LYCAENIDAE)

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INTRODUCTION

The genus *Philotes* Scudder has received more than the ordinary amount of attention in the last two decades, particularly from lepidopterists in the western United States. During this period several papers dealing with *Philotes* have been published, and I have amassed considerable information by examination of museum specimens, correspondence, and exchange with numerous collectors. In the present list, this material is brought together for the genus as a whole, including the known distributions—both by regions and by counties within each state where sufficient records are available to warrant their inclusion. As an addendum to the synonymic list, additional notes are given on intermediate forms, questionable records, allopatry, sympatry, and type localities for each name listed.

Four new subspecies of *Philotes* have been described since the dos Passos list (1964). According to my concepts, these newer subspecies, along with those described earlier, fall into "phylogenetic-geographic" sequences, which are parallel in two of the species.

In the arrangement given below species are indicated by numbers, and follow the arrangement as listed by dos Passos (1964), with the known distributions added.

Synonyms and aberrant forms are also listed as they appear in dos Passos, with only the localities published in the original descriptions added. No new names have been described for the more recent aberrations.

Subspecies are indicated by letters. The subspecies of *Philotes battoides* and *P. enoptes* are arranged in a geographical "ring" by allopatric populations in the following order:

- a* The nominal subspecies in the Sierra Nevada of California;
- b* Adjacent or contiguous subspecies on the west and east slopes of the Sierra Nevada; thence
- c* East and north through the Great Basin; thence
- d* North through the Rocky Mountains; thence
- e* West into the Pacific Northwest; thence
- f* South along the Pacific Coast; thence
- g* East and southeast into the Mojave and Colorado Deserts.

The subspecies of *Philotes rita* are arranged in the order given by Mattoni (1966), which also indicates a geographical "ring" and a similarity of wing-pattern sequence:

- a* The nominal subspecies in Arizona and southwestern New Mexico; thence
- b* Northeast into the prairie grassland of eastern Colorado; thence
- c* Northwest across the Rocky Mountains into the Great Basin of Utah; thence
- d* West into the mountains of Nevada; thence
- e* Southwest into the east slope areas and Mojave Desert of California.

SYNONYMIC LIST AND GEOGRAPHICAL DISTRIBUTION

PHILOTES Scudder, 1876

Type: *Lycaena regia* Boisduval, 1869 (= *Lycaena sonorensis* Felder & Felder, 1865)

471 *battoides* (Behr), 1867

a. b. battoides (Behr), 1867

CALIFORNIA: Sierra Nevada; Arctic Alpine.

County records: Alpine, eastern Fresno, northwestern Inyo, Mariposa, Mono, eastern Tulare, Tuolumne.

b. b. intermedia Barnes & McDunnough, 1917

CALIFORNIA: Northern ranges; Cascades; Sierra Nevada, west slopes.

Counties: Calaveras, Del Norte, El Dorado, Nevada, Placer, western Shasta, Sierra, Siskiyou, Tehama, Trinity.

ab. *malcolmi* Gunder, 1927

CALIFORNIA: American River, Placer Co. (Type).

c. b. glaucon (Edwards), 1871

CALIFORNIA: Cascades, east slopes; Great Basin; Sierra Nevada, east slopes.

Counties: Inyo, Lassen, Modoc, Mono, eastern Shasta.

IDAHO: Western; Great Basin.

Counties: Adams, Elmore, Owyhee.

NEVADA: Western & northwestern; Sierra Nevada region.

Counties: Douglas, Elko, Humboldt, Lander, Lyon, Ormsby, Storey, Washoe.

OREGON: South-central & southeastern; East of Cascade divide.

Counties: Grant, Harney, Klamath, Lake.

d. b. centralis Barnes & McDunnough, 1917

Rocky Mountain areas of ARIZONA, COLORADO, NEW MEXICO, UTAH and WYOMING.

e. b. oregonensis Barnes & McDunnough, 1916

OREGON: North-central & northeastern; Central & southern Cascades. (Limited to higher elevations in Cascades and other mountains in the southern and southeastern regions.)

Counties: Baker, Crook, Deschutes, Gilliam, Jackson, Jefferson, Klamath, Lake, Linn, Morrow, Wasco.

WASHINGTON: Cascades, central & east slopes; Blue Mtns.; Northeastern.
 Counties: Chelan, Columbia, Kittitas, Okanogan, Stevens, Yakima.
 BRITISH COLUMBIA: Southern interior; Kootenays.

f. *b. bernardino* Barnes & McDunnough, 1916

CALIFORNIA: Coast ranges, central Calif. to Mexican Border; Southern Sierra Nevada; Tehachapi Mtns.; Western Mojave and Colorado Deserts to Pacific Coast.

Counties: Fresno, Kern, Inyo, Los Angeles, Monterey, Orange, Riverside, San Benito, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, Tulare, Ventura.

BAJA CALIFORNIA NORTE: U. S. Border south to Cedros Island; Sierra San Pedro Martir.

ab. *baldyensis* Gunder, 1925

CALIFORNIA: Camp Baldy, San Bernardino County (Type).

g. *b. martini* Mattoni, 1955

ARIZONA: Deserts, west to central; Desert mountains (Ajo, Hualapai Mtns., Prescott Nat. For.).

Counties: Maricopa, Mohave, Pima, Yavapai.

CALIFORNIA: Mojave Desert, eastern & northern; Desert mountains (Ivanpah, Old Woman, Panamint, Providence, Sheephole Mtns.).

Counties: Inyo, Kern, eastern San Bernardino.

472 *enoptes* (Boisduval), 1852

a. *e. enoptes* (Boisduval), 1852

CALIFORNIA: Northern ranges; Cascades; Sierra Nevada, east & west slopes.

Counties: Alpine, Amador, Calaveras, Eldorado, Fresno, northeast Humboldt, Inyo, Kern, Lassen, Modoc, Mono, Nevada, Placer, Plumas, Shasta, Sierra, Siskiyou, Tuolumne, Trinity, Tulare, Yuba.

NEVADA: Western; Sierra Nevada region.

Counties: Douglas, Ormsby, Washoe.

b. *e. ancilla* Barnes & McDunnough, 1918

COLORADO: Rocky Mountains.

IDAHO: Southern, southeastern.

MONTANA: Southern; Bitterroot Range, Crazy Mtns.

NEVADA: Eastern, northeastern.

NEW MEXICO: Northern.

UTAH: Northern, northeastern.

Counties: Davis, Duchesne, Juab, Salt Lake, Summit, Tooele.

WYOMING: Rocky Mountains; Grand Tetons.

c. *e. columbiae* Mattoni, 1955

OREGON: Eastern; Cascades, north-central & east slopes.

Counties: Baker, Clackamas, Harney, Morrow, Umatilla, Wasco.

WASHINGTON: Columbia River Basin; Cascades, central & east slopes.

Counties: Chelan, Kittitas, Klickitat, Okanogan, Yakima.

d. *e. bayensis* Langston, 1964

CALIFORNIA: North Coastal; San Francisco Bay, North Coast Range.

Counties: Contra Costa, Humboldt, Marin, Mendocino, Solano, Sonoma.

e. *e. smithi* Mattoni, 1955

CALIFORNIA: Central Coastal; Seashore dunes, Santa Lucia Range.

County: coastal Monterey.

- f. *e. tildeni* Langston, 1964
CALIFORNIA: Central Inner Coastal; Mt. Hamilton & Diablo Ranges.
Counties: western Kern, eastern Monterey, San Benito, eastern San Luis Obispo, eastern Santa Clara, western Stanislaus.
- g. *e. dammersi* J. A. Comstock & Henne, 1933
ARIZONA: Deserts, west to central; Mountains, central (Prescott Nat. For., Tonto Basin).
Counties: Coconino, Gila, Yavapai.
CALIFORNIA: Colorado & Mojave Deserts; Central & desert slopes of Laguna, San Bernardino, San Gabriel & San Jacinto Mtns.
Counties: Los Angeles, Riverside, San Bernardino, San Diego.
- 473 *mojave* Watson & W. P. Comstock, 1920
mohave Auctorum
CALIFORNIA: Colorado & Mojave Deserts; Desert slopes of San Bernardino, San Gabriel, San Jacinto & southern Sierra Nevada Mtns.
Counties: Inyo, Kern, Los Angeles, Riverside, San Bernardino.
- 474 *rita* (Barnes & McDunnough), 1916
- a. *r. rita* (Barnes & McDunnough), 1916
ARIZONA: Mountains, central & southeastern.
Counties: Coconino, Cochise, Pima, Santa Cruz, Yavapai.
NEW MEXICO: Southwestern.
County: Grant.
- b. *r. coloradensis* Mattoni, 1966
COLORADO: East of Front Range, prairie grassland.
Counties: Chaffee, Cheyenne, Custer, El Paso, Fremont, Lincoln, Prowers, Saguache.
- c. *r. pallescens* Tilden & Downey, 1955
UTAH: Northwestern, Stansbury Mtns.
County: Tooele.
- d. "*Philotes rita* subspecies," Clench, 1967
NEVADA: Northeastern, Montello Wells.
County: Elko.
- e. *r. elvirae* Mattoni, 1966
CALIFORNIA: Western Mojave Desert; Desert slopes of San Gabriel Mtns. & Sierra Nevada.
Counties: Inyo, Kern, Los Angeles, Mono.
- 475 *spaldingi* Barnes & McDunnough, 1917
ARIZONA: Northern; Kaibab Plateau, North Rim.
COLORADO: Rocky Mtns.; San Juan Mtns.; Mesa Verde.
NEW MEXICO: Northern; Northwestern; Zuni Mtns.
UTAH: Central & eastern Rocky Mtns.
- 476 *speciosa* (Henry Edwards), 1876
CALIFORNIA: Western Colorado & Mojave Deserts; Southern San Joaquin Valley; West slope of Sierra Nevada.
Counties: Imperial, Inyo, Kern, Los Angeles, Mariposa, San Bernardino, San Diego, Ventura.

477 *sonorensis* (Felder & Felder), 1865

CALIFORNIA: Coast Ranges, central Calif. to Mexican Border; West slopes of Sierra Nevada; Slopes adjoining western Colorado and Mojave Deserts.

Counties: El Dorado, Imperial, Los Angeles, Mariposa, Monterey, Orange, Placer, Riverside, San Benito, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, Santa Clara, Stanislaus, Tuolumne, Ventura.

BAJA CALIFORNIA NORTE: U. S. Border south to vicinity of Punta Prieta; Ensenada; Sierra Juarez.

Syn. *regia* (Boisduval), 1869

CALIFORNIA: Los Angeles (Type).

Genetic form *comstocki* Gunder, 1925

CALIFORNIA: Los Angeles County—several localities, San Gabriel River, Duarte (Type).

ab. *sonoralba* Watson & W. P. Comstock, 1920

CALIFORNIA: Los Angeles County; San Diego (Type).

DISTRIBUTION, INTERMEDIATE FORMS, HOSTS, AND TYPE LOCALITIES

Distribution.—The known distribution of the genus *Philotes* confirms that given in previous lists (Martin & Truxal, 1955; Mattoni, 1955). In addition, more recent data increases the known ranges of most of the species and subspecies. This is partly due to more interest in Lycaenidae in the last two decades, and many more Lepidopterists collecting at unlikely localities and at unusual times of year, even in some well-known areas.

Intermediate Forms.—Within the species that have been broken up into subspecies, by definition it may be assumed that the subspecies are allopatric to each other. However, this is not completely true. In general, each subspecies appears "typical" and different from the others when sampled well within its range or center of distribution. However, in some instances the subspecies become "atypical" on the peripheries of their ranges. Where one meets another this gives rise to intermediate forms and the geographical area can be considered a "blend zone."

Sympatry.—In the context of the following notes, the sympatric species are in association either on an ecological or a purely geographical basis.

Ecologically sympatric refers to instances where flight periods of two or more species coincide and the opportunity for interspecific matings occurs. This is a broad definition, and even though the two or more species may be in the same general vicinity, usually one or more ecological barriers exist. For example: a) All of the *Philotes* are relatively weak fliers, and tend to stay close to their specific food-plant; b) The foodplants are almost always different species for the sympatric *Philotes* (foodplants for those proven in recent literature are *all* different species); c) The adult flight periods may overlap only slightly; and d) The adult flight periods may not coincide at all in some seasons.

Geographically sympatric refers to situations where the adult flight periods of two or more species occur at different times of the year. In many instances the flight periods are separated by several months. Feb.-Mar. & June-July, or May-June & Sept.-Oct. are common patterns in many of the sympatric areas. The greatest spacing in season in sympatric species appears to be Feb.-Mar. for *Philotes sonorensis* as opposed to Aug.-Sept.-Oct. for three subspecies of *P. enoptes*. In many areas, the *enoptes* adults can be collected in October at the exact spot where *sonorensis* was taken the previous February. The adult flight periods for most *Philotes* are correlated with the blooming season of the foodplants—some species and groups of *Eriogonum* flowering in the spring, others in mid-summer, and still others in late summer and autumn.

Foodplants.—Most *Philotes* species and subspecies have a narrow host plant preference. If the life history and/or the exact host has been recorded, it is also listed in the following notes, giving the literature source. In some of the older literature there may be general foodplants recorded, such as "buckwheat," "*Eriogonum* sp.," "stonecrop," or "Sedum." In most instances, these are not repeated, and the literature is not cited.

Type Localities.—The type localities of all of the species and subspecies are given. For the earlier described entities the reader is referred to Comstock & Huntington (1958-1964) where each name is listed alphabetically giving the type locality, location of type in museums, original description, additional references and synonyms. For these I have listed the locality essentially verbatim as given by Comstock & Huntington, adding only the county where appropriate.

PHILOTES BATTOIDES (Behr)

Philotes battoides battoides is the high elevation subspecies in the Sierra Nevada of California. Some specimens from mid-elevations on the east slopes show integration into *glaucon*, whereas no tendencies toward *intermedia* on the west slopes have been observed. In much of its range, *battoides* is ecologically sympatric with *P. enoptes enoptes*. Type: Mineral King, Tulare Co., Calif., elev. 11,000 ft.

P. b. intermedia is primarily in the northern California mountains and the west slopes of the Sierra Nevada. However, there are a few specimens labeled with localities in Kern and Los Angeles counties that are on deposit in some museums. These are old specimens (30 to 60 years old) and although they are *intermedia* more recent specimens from the same areas have been *bernardino* which is very common in southern California (Tehachapis, Mt. Baldy, etc.). Throughout most of its range, *intermedia* is ecologically sympatric with the much commoner *P. enoptes enoptes*. Type: "Shasta County, Calif."

P. b. glaucon is the subspecies represented in the Great Basin, with a wide range in several states. Some specimens show integration into *oregonensis* at higher elevations, particularly in southeast Oregon and along the east slopes of the Cascades. In various parts of its range, *glaucon* is ecologically sympatric with *P. enoptes enoptes* and *columbiae*, and is usually geographically sympatric with *P. rita elvira*.

Foodplant: *Eriogonum umbellatum* (sens. lat.)—Calif., O. Shields; Ore., C. Crowe; Idaho, R. Langston. Type: "Nevada."

P. b. centralis is the subspecies represented in the Rocky Mountains, and appears to show a clinal variation from north to south. Although recorded from the "Rocky Mountain States," the actual localities of specimens examined were so scattered that county listings would be superfluous. If additional specimens along with more distributional data had been available, the variation in *centralis* might seem more logical. In parts of its range, *centralis* is ecologically sympatric with *P. enoptes ancilla* and *P. spaldingi*.

Foodplant: *Eriogonum umbellatum* (Scott *et al.*, 1968). Type: Salida, Chaffee Co., Colo.

P. b. oregonensis is the high elevation subspecies in southern Oregon, but the elevation at which it occurs decreases with increased latitude as it ranges north through Washington into British Columbia. Some specimens show integration into *glaucon* at lower elevations, particularly in southeast Oregon and along the east slopes of the Cascades. In a considerable portion of its range, *oregonensis* is ecologically sympatric with *P. enoptes columbiae*. At some of the localities for *oregonensis* cited by Leighton (1946), *columbiae* has been taken commonly. Since *columbiae* was described later (Mattoni, 1955), there is a probable mixture of the two in older collections. Type: Crater Lake, Klamath Co., Ore.

P. b. bernardino is the common spring and early summer subspecies in cismontane southern California, but ranges both north and south of this locus as noted in the synonymic list. With little variation, it occurs from the immediate coast to the tops of the higher mountains in certain counties (e.g., Los Angeles, San Diego). Although their flight periods are usually earlier, *P. mojave*, *P. speciosa*, and *P. sonorensis* are sympatric with *bernardino* in portions of its range. It is also geographically sympatric with the late-season flying *P. enoptes tildeni* & *dammersi*, and *P. rita elvira*.

Foodplants: *Eriogonum fasciculatum fasciculatum* in coastal southern California; *E. f. foliolosum* throughout most of its range; and *E. f. polifolium* & *flavoviride* in the deserts and east slope areas (Langston, 1965).

Type: Camp Baldy, San Bernardino Mts., Calif.

P. b. martini is a desert subspecies. Although the typical insect is quite distinct, intermediates to *bernardino* have been taken in the western parts of its range. In the western part of its range, *martini* is ecologically sympatric with *P. mojave*, and it is geographically sympatric with the later-flying *P. enoptes dammersi* in California and Arizona, and with *P. rita rita* in Arizona.

Foodplant: *Eriogonum fasciculatum polifolium*; and the earlier known distribution are given by Mattoni (1955). Description and Type: Oatman, Mohave Co., Arizona (Mattoni, 1955).

PHILOTES ENOPTES (Boisduval)

Philotes enoptes enoptes occurs in California and Nevada in the Cascades and Sierra Nevada, from Siskiyou to Kern County. However, there are a few specimens labeled with localities from Los Angeles and Riverside counties that are on deposit in the museums. These are old specimens (undated, or more than 40 years old—Dodge, Friday collrs.). The late-season specimens are *dammersi* (before its description), and early season (May–June) specimens of *enoptes* have not been collected in southern California in recent years. *P. enoptes enoptes* is quite distinct from all of its subspecies throughout most of its range, although integration into *bayensis* has been noted in northeastern Humboldt County.

Foodplant: Adults have been associated with *E. latifolium nudum* & *saxicola*—Calif., Nev. (R. Langston). Type: "California. May in dry sections."

P. e. ancilla is the subspecies represented in the Rocky Mountains. Except for Utah, the actual localities of specimens examined from the other states were so scattered that county listings would be superfluous. Further collecting may show a blend into *columbiae* along the western periphery of its range. In portions of its range, *ancilla* is ecologically sympatric with *P. battoides centralis* and *P. spaldingi*. In northwestern Utah it is geographically sympatric with the later flying *P. rita pallescens*. Type: Eureka, Juab Co., Utah.

P. e. columbiae is the subspecies represented in the Pacific Northwest. Although there may be a blend into *ancilla* along the eastern parts of its range, at present it appears to be distinctly allopatric to *enoptes enoptes* to the south. In many parts of its range, *columbiae* is ecologically sympatric with *P. battoides glaucon* & *oregonensis*. The description and earlier known distribution are given by Mattoni (1955). Type: Columbia River near Brewster, Okanogan Co., Wash. (Mattoni, 1955).

P. e. bayensis is the subspecies represented around San Francisco Bay and the North Coast Range of California. It is allopatric to all other *Philotes* species and subspecies, except for a possible blend into *enoptes enoptes* in the northeastern corner of Humboldt County.

Foodplants: *Eriogonum latifolium auriculatum* & *nudum*; detailed distribution given by Langston (1964, 1965), and life history (Langston & Comstock, 1966). Type: China Camp, Marin Co., Calif. (Langston, 1964).

P. e. smithi is known only from the immediate coast of Monterey County, California, and is allopatric to all other subspecies of *enoptes*. It is geographically sympatric with the spring-flying *P. sonorensis*.

Foodplant: *Eriogonum parvifolium*; detailed distribution given by Langston (1964, 1965). Type: Burns Creek, State Highway 1, Monterey Co., Calif. (Mattoni, 1955).

P. e. tildeni is found along the Inner Coast Range of central California, and is allopatric to all other subspecies of *enoptes*. Normally a late-season flier, it is geographically sympatric with the earlier *P. battoides bernardino* and *P. sonorensis*.

Foodplants: *Eriogonum latifolium indictum* & *saxicola*; detailed distribution given by Langston (1964, 1965). Type: Del Puerto Canyon, 22 miles W of Patterson, Stanislaus Co., Calif. (Langston, 1964).

P. e. dammersi is the subspecies represented in the desert and adjacent mountain areas of southern California and Arizona. At present it appears to be completely allopatric to all other subspecies of *enoptes*. As a fall flier it may be ecologically sympatric with *P. rita rita* in Arizona. In various parts of its range it is geographically sympatric with the earlier flying *P. battoides bernardino* & *martini*, *P. mojave*, *P. speciosa*, and *P. sonorensis*.

Foodplants: *Eriogonum elongatum*, *E. wrightii trachygonum*; life history given by Comstock & Henne (1965). Type: Snow Creek, Riverside Co., Calif. (Comstock & Henne, 1933).

PHILOTES MOJAVE Wats. & Comst.

Philotes mojave is found in the Colorado and Mojave Deserts of California, and the bordering mountain slopes to the west. As a spring flier, it is ecologically sympatric in various parts of its range with *P. battoides bernardino* & *martini*, *P. speciosa*, and *P. sonorensis*. It is also found in the same geographical areas as its closest ally (on the basis of similarity of genitalia) *P. enoptes dammersi*, and with *P. rita elvirae*, but these are both late-season fliers.

Foodplant: *Eriogonum pusillum*; detailed distribution and life history are given by Comstock (1966). Type: "Mojave Desert, California."

PHILOTES RITA (B. & McD.)

Philotes rita rita is found in Arizona and southwestern New Mexico. It is allopatric to all of its other subspecies. Mattoni (1966), speculates that its range may extend into Mexico, the lack of records being an artifact of poor collecting. As a fall flier it may be ecologically sympatric with *P. enoptes dammersi*, and it is geographically sympatric to the spring-flying *P. battoides martini* in the eastern portions of the latter's range.

Foodplant: "Close to *Eriogonum wrightii*"; and some of the classic localities are given by Mattoni (1966). Type: "So. Arizona."

P. r. coloradensis is found in eastern Colorado, and is allopatric to all other *rita* subspecies. The types and other specimens were taken in gently rolling prairie grassland, further east than any other known *Philotes* in North America. Mattoni (1966) speculates that this new subspecies probably ranges "east into Kansas, north into Nebraska, and south into New Mexico."

Foodplant: *Eriogonum effusum*; detailed distribution given by Mattoni (1966). Type: 7 miles south of Kendrick, Lincoln Co., Colo. (Mattoni, 1966).

P. r. pallescens is found in northwestern Utah, and is allopatric to all other *rita* subspecies. Although atypical populations have been found in Duchesne Co., Utah, and other areas (i.e., Nevada) the typical insect is known only from the general vicinity of the type series. It is geographically sympatric with the earlier-flying *P. enoptes ancilla*.

Foodplant: *Eriogonum* sp.; detailed distribution given by Tilden & Downey (1955). Type: Little Granite Mtn., Dugway Proving Grounds, Tooele Co., Utah (Tilden & Downey, 1955).

"*Philotes rita* subspecies" is based on a single male specimen from Elko County, Nevada. Clench (1967) states that "In the sum of its characters it is closest to *pallescens*, . . ." It is further stated that one "character suggests a relationship to *elvirae*." Although I have not seen the specimen, it is no doubt an intermediate between the two. Further late summer collecting in Nevada, will probably reveal *rita* populations across the state, connecting with the California colonies of *elvirae* in Inyo and Mono counties.

P. r. elvirae is found in the east slope and Mojave Desert areas of California, and is allopatric to all other named *rita* subspecies. In the northern

part of its range it has occasionally been taken with *P. battoides glaucon* if flying late due to higher elevation or a retarded season. In the southern areas it comes almost into the range of *P. enoptes dammersi*, which is also a late-season flier. In various portions of its range, *elvirae* is geographically sympatric with the earlier-flying *P. enoptes enoptes*, *P. battoides bernardino*, *P. speciosa*, and *P. sonorensis*. The life history is recorded by Comstock & Henne (1967).

Foodplants: *Eriogonum plumatella* and detailed distribution are given by Mattoni (1966). Type: 3.5 mi. SW. of Pearblossom, Los Angeles Co., Calif. (Mattoni, 1966).

PHILOTES SPALDINGI B. & McD.

Philotes spaldingi is generally distributed in the central and southern Rocky Mountain States. Localities of specimens examined were so scattered that county listings would be superfluous. Morphologically, *spaldingi* is distinct from all other species of *Philotes*, but superficially resembles *Plebejus melissa*, especially on the underside. In portions of its range, *spaldingi* is ecologically sympatric with *P. battoides centralis* and *P. enoptes ancilla*.

Foodplant: *Eriogonum racemosum* (Scott *et al.*, 1968). Type: Provo, Utah Co., Utah.

PHILOTES SPECIOSA (Hy. Edw.)

Philotes speciosa is found most commonly in the western Colorado and Mojave Deserts of California. Morphologically, *speciosa* is distinct from all other species of Lycaenidae. As a spring flier, it is ecologically sympatric in portions of its range with *P. mojave*, *P. sonorensis* and *P. battoides bernardino*, although the latter is usually on the wing later in the season. It is geographically sympatric with the late-season fliers *P. enoptes dammersi* and *P. rita elvirae*. The life history is recorded by Comstock & Dammers (1932).

Foodplants: *Oxytheca perfoliata*, *O. trilobata* & *Eriogonum reniforme*; and detailed distribution are given by Thorne (1961). Mature larvae have also been found on flowers of *Eriogonum ?pusillum* (Thorne, 1967). Type: Havilah, Kern Co., Calif.

PHILOTES SONORENSIS (F. & F.)

Philotes sonorensis is found most commonly in cismontane southern California, but ranges both north and south. Except for different numbers of spots and their locations, plus other variability (*comstocki*, *sonoralba*, etc.), that seems to occur in varying percentages within the populations, there appears to be no other clinal or consistent variation in

this species throughout its extensive range. Morphologically, *sonorensis* is very distinct from all other species of Lycaenidae.

In most seasons its major adult flight is in February and March (both in the north and south), but may extend into May or June at higher elevations, or if the season is retarded by long periods of rain or snow. Its flight period is essentially over before the appearance of the other *Philotes*. Although it may overlap in time of adult flight with *P. mojave* and *P. speciosa*, *sonorensis* can be considered only geographically sympatric with *P. battoides intermedia* & *bernardino*, *P. enoptes*, *smithi*, *tildenii* & *dammersi*, and *P. rita elvirae*. The life history is recorded by Comstock and Coolidge (1930).

Foodplants: The larvae are known to feed on various types of stonecrop (Family Crassulaceae). In older literature it was recorded generally from *Sedum* (e.g., Comstock, 1927; Comstock & Coolidge, 1930). In the northerly parts of its range it has been associated with *Dudleya cymosa cymosa*, *setchellii*, and *minor* (Langston, 1965), and in southern California with *Dudleya lanceolata*, and probably other sedums and stonecrops.

Type: "Sonora, Mexico." There are no records of *P. sonorensis* from the state of Sonora, Mexico as known by its present boundaries. According to Brown (1967), butterflies named by the Felders all are found within the present limits of California and their true type localities must lie somewhere from Los Angeles southward into extreme northern Baja California.

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R. Albright (Ore.)
R. P. Allen (Calif.)
P. H. Arnaud, Jr. (Nev., N. Mex.)
D. L. Bauer (Ariz., Calif., Nev., Ore.,
Wash.)
K. S. Brown, Jr. (Calif.)
R. M. Brown (Calif.)

C. R. Crowe (Ore.)
T. W. Davies (Calif., Nev.)
E. J. Dornfield (Ore.)
J. C. Downey (Calif., Nev., Utah, Wyo.)
J. F. Emmel (Ariz., Calif., Colo.)
T. C. Emmel (Calif.)
C. Henne (Calif.)

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|---|--|
| P. J. Herlan (Nev.) | J. A. Powell (Baja Calif., Calif., Ore.) |
| K. C. Hughes (Ariz., Calif.) | J. J. Renk (Calif., Colo., Wyo.) |
| R. J. Jae (Colo.) | D. C. Rentz (Calif.) |
| S. G. Jewett (Ida., Ore., Wash., Wyo.) | O. E. Sette (Ariz., Calif., Nev.) |
| N. L. La Due (Calif.) | O. A. Shields (Ariz., Calif.) |
| J. Lane (Calif., Ida., Nev., Wyo.) | A. J. Slater (Calif.) |
| R. L. Langston (Calif., Ida., Nev., N. Mex., Wash.) | R. E. Stanford (Calif.) |
| M. Lundgren (Calif.) | W. J. Steele (Calif.) |
| C. D. MacNeill (Calif., Nev.) | O. R. Taylor, Jr. (Colo.) |
| J. W. MacSwain (Calif.) | F. T. Thorne (Ariz., Calif.) |
| L. M. Martin (Ariz., Calif.) | J. W. Tilden (Ariz., Calif.) |
| R. H. T. Mattoni (Ariz., Calif., Colo.) | S. Van Campen (Calif.) |
| E. J. Newcomer (Brit. Col., Ore., Wash.) | D. Veirs (Calif.) |
| P. A. Opler (Calif., Nev., Ore.) | T. P. Webster, III (Calif.) |
| | R. S. Wielgus (Calif.) |

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A SEARCH FOR THE TYPE LOCALITY OF *SPEYERIA* *NOKOMIS APACHEANA*¹

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The first specimens of *Speyeria nokomis apacheana* (Skinner) were brought back by the Wheeler Expedition of 1871, and were collected by Ferdinand Bischoff, a naturalist attached to the Expedition as a hospital orderly. The section of the Survey containing Bischoff spent much of the field season of 1871 in Nevada and east-central California. A careful analysis of Bischoff's itinerary (Brown, 1957) during this period shows that the collector's residence at Fort Independence in the Owens Valley of California from the 18th of July to the 10th of August corresponds to the flight period of *apacheana* in present-day Inyo County. Since Bischoff probably was limited in his explorations by a combination of the summer heat and the limited transportation at his disposal—walking or horseback, and the fact that Bischoff did not encounter the Round Valley colonies of *apacheana* further north, it has been assumed by Brown (1957)

¹ This is a by-product of a field trip supported through special permission by funds from N. S. F. grant GB-2741 to F. Martin Brown for the study of Edwards's type specimens.

that the type locality for *apacheana* lies in the mountains and valleys west of Camp Independence.

During the flight period of *apacheana* in the summer of 1966, Sam Johnson and I made a thorough survey of the area within a 40-mile radius of old Fort Independence in search of existing colonies of *apacheana* or indications of old spots where the butterfly may have once occurred, in an attempt to determine the original type locality. The purpose of this paper is to present the details of this search, and analyze its result.

In my experience with *nokomis* in Colorado, Utah, and in the Round Valley area of California, I have discovered that the conditions for the maintenance of a *nokomis* colony are remarkably similar in a number of localities. The primary factor necessary is an abundant and constant source of water, below 7000 feet in altitude, such as that provided by a large spring that can withstand a prolonged drought. With this surface water, a marshy meadow is formed containing a growth of sedge grass, scrub willows, cottonwoods, reeds, *Phragmites communis* (Trin.), purple thistles or burdock, and violets. The meadow can be quite small, but must support a substantial population of food-plant violets. It was for this specialized environment that we searched in the area of Fort Independence.

In the rain shadow of the Sierra Nevada range, the Owens Valley receives very little moisture in the form of precipitation. The little water reaching the floor of the Valley is contained by the few streams that run out from the higher peaks, and a series of springs that break out at the foot of the mountains. The alluvium on the floor of the Valley is so uniform in its deposition that little water emerges along spring lines, and practically none wells to the surface to form meadows. An exception is Round Valley north of Bishop, the metropolis of *apacheana*, where a tremendous quantity of water comes to the surface to make a marshy area several miles square. The Owens River, originating on the Mono Plateau north of Bishop, flows south through the Valley to nearly dead Owens Lake south of Lone Pine. Providing an important water source for the City of Los Angeles, the Owens has been enclosed in an aqueduct and diverted away from its original bed. The Inyo Mountains bounding the east side of the Valley are extremely dry, and there appears to be only one permanent stream in the whole range. The soil of the Valley is sandy, and vegetation sparse in dry areas. Because of this general scarcity of water a search for a suitable locality for *apacheana* can immediately be narrowed to the few moist spots in the Valley.

An investigation of wet meadow areas began within a ten-mile radius of old Camp Independence. This restricted area would be about the possible range that Ferdinand Bischoff could cover in a day's outing.

There are only four permanent streams that apply to this radius that emerge from the nearby Sierra Nevada. These are Symmes Creek, Independence Creek, Oak Creek, and Thibaut Creek. All these water sources are precipitous, juvenile streams that drop so rapidly that there is no side cutting or deposition of alluvial material until an alluvial fan is reached on the valley floor. The streams are constantly shifting their beds across their alluvial fans, and stream banks are covered with boulders. As a result, no stream marshes or meadows are formed on the upper reaches of these water courses. As the streams terminate on the valley floor, they are channeled directly to the aqueduct or are impounded as trout rearing ponds. With the lack of success along the streams, attention was turned to the springs in the area.

In the vicinity of Independence there are two types of springs. One group emerges along a line between 6000' and 6400' at the base of the Sierra Nevada. The other group wells to the surface on the floor of the Valley on a line at 3840'. Many of the springs at higher elevations are fed by only enough water to support a small area of sparse grass, a clump of reeds, and one or more live oaks. Others, such as Grays Meadow on the Onion Valley road about five miles west of Independence; Tub Springs, about 5½ miles directly west of Independence; and Scotty Springs, about five miles southwest of Aberdeen, put out sufficient water to support a small lush area of sedge grass, willows, and a small grove of oaks *Quercus kelloggii* (Newb.). At Lower Grays Meadow Campground there is a small sedge marsh about fifty feet wide by a hundred feet long on the north side of Independence Creek that is fed by a small spring line. There are extensive willow patches, and an area of extremely wet sedge grass. Because of the abundance of water, and the long-standing existence of the marsh, this locality appeared to me to be a perfect environment for *nokomis*. However a careful search in grass clumps and under willow thickets revealed no foodplant violets, and thus there appears to be no possibility for the occurrence of *apacheana* or any other *Speyeria* in this locality. Of particular interest was Tub Springs, which forms a long narrow marsh with an extensive growth of willows, sedge grass, oaks, and most important, numerous clumps of violets. The violet species found in Tub Springs did not appear to be of the type found in the Round Valley locality, being a smaller plant with a much smaller leaf size. *S. apacheana* was not found during repeated investigations of the springs. The only *Speyeria* seen in the area was *Speyeria zerene malcolmi* (Comstock), which ranges from 6400' at Tub Springs up to about 8400' in adjacent Oak Creek. The only other spring at a comparable elevation with a large volume of water is Scotty Springs. However, the original configuration of this area has been altered by the

diversion of these springs for electric power. The springs on the floor of the Valley have all nearly dried up, or have been utilized for human purposes. According to an old map circa 1900, Black Rock Springs, about seven miles north of Old Camp Independence, formed numerous marshes and small ponds. Presently, this water source has been made into trout rearing ponds, and other smaller springs are channeled into the Los Angeles aqueduct or have been made into stock ponds. Hines Spring near Aberdeen no longer reaches the surface, and only a line of old cottonwoods marks the bed where it once flowed. There are numerous dry lakes over the floor of the Valley that appear to contain water only in wet seasons. The only active spring found on the floor of the Valley, about 4 miles directly east of Fort Independence, contained a large stand of *Phragmites communis* and other grasses, but no violets.

In 1913 the Owens River was diverted into the Los Angeles Aqueduct just east of Aberdeen. Therefore, none of the original river flows into a ten-mile radius of Fort Independence. The river above its point of diversion meanders in entrenched banks, with very few backwaters. The country through which the river flows between Bishop and Independence is quite alkaline, with *Atriplex* (Chenopodiaceae), *Chrysothamnus* (Compositae), salt grass, and other arid growth occurring on the river banks. Because of this harsh environment for violets, the possibilities for colonies of *Speyeria nokomis* along the Owens River in the central part of the Owens Valley seem quite remote.

The vicinity of Fort Independence itself is quite green in terms of the surrounding country, but this lushness seems to be primarily due to irrigation water from Oak Creek, which provides sustenance for the fields of the Fort Independence Indian Reservation. The Reservation has been under continual irrigation since the time of Bischoff's visit to Fort Independence, and it is difficult to determine the original configuration of its water supply during this early period. Some of the willow trees in the windrows separating hayfields are very old, but whether they were growing in wet areas before the advent of irrigation, I would not venture to say. Any present concentration of water appears to be channeled irrigation water. No violets of any sort were discovered, even in the dampest and most undisturbed areas of the Reservation.

With the failure to discover *apacheana* in the Independence area, we decided to determine the southern limits of its distribution in the Owens Valley. The first large stream north of a ten-mile radius of Independence is Big Pine Creek that flows through the town of Big Pine. A fault scarp formed by an earthquake in 1872 forms a long spring line in the west part of town. This wet area and stream marshes on Big Pine Creek were investigated thoroughly, but neither specimens of *apacheana* nor violets

were seen. Keough Hot Springs between Big Pine and Bishop have been diverted for human use. The last major water source before reaching Round Valley is Bishop Creek. This stream is highly disseminated by irrigation as it reaches the town of Bishop. Although water is abundant, natural undisturbed marshes are difficult to find. The southernmost colony of *nokomis* discovered in the Owens Valley was in an extensive undisturbed sedge meadow two miles west of the Bishop city limits near the Izaak Walton fish ponds. A fresh male of *apacheana* was observed, and violets were found down in the grass in a wet spot in the meadow.

The results of this investigation indicate that there are at present no colonies of *apacheana* south of the city limits of Bishop, 40 miles north of the proposed type locality. However there are localities within the range of Bischoff's wanderings that may have once held populations of *apacheana*. The following are hypotheses that may explain the disappearance of this insect from the Independence area in the last hundred years.

The best explanation for the absence of violets of the proper species, and the elimination of *apacheana* from the Independence area is a general warming and drying of the Owens Valley. Mean annual temperatures from climatological data issued by the U.S. Weather Bureau indicate that from the second to the sixth decade of the current century the valley appears to have warmed about 2° F. Thus the Fort Independence area may be as much as 4° warmer than it was when Bischoff was there. Precipitation data are more complete for Camp Independence than are temperature data. The three decades that have been arbitrarily selected and the mean annual precipitation for each are: 1866–1875, 6.75 inches; 1906–1915, 5.93 inches; 1951–1960, 4.52 inches. This desiccation may have been a factor in the elimination of *apacheana* from the vicinity of Camp Independence if Bischoff collected it there. Local conditions seem to bear out these statistics. The Palisade Glacier above Big Pine has been retreating in recent years. A decrease in size of a spring line directly east of Independence near the Owens River appears to be taking place. This is indicated by extensive dark spring soil deposits at some distance away from the present boundary of the marshy area. The general scarcity of large cottonwoods and willows away from irrigated areas near Independence indicates that the central part of the Owens Valley has not been wet for some time. The Bishop vicinity, presently containing colonies of *apacheana*, appears to be appreciably cooler and wetter than Independence further south. Maximum temperatures are identical at 109°. Minimum temperatures are -15° F. for Bishop and -5° F. for Independence. Average January temperature for Bishop is 37.6° and for Independence 39.0°. Average July temperature for Bishop is 73.1° and for Independence 78.3°. The growing season is 152 days at Bishop and

200 days at Independence. The average annual precipitation for Bishop is 7.49 inches and 4.49 inches for Independence. These figures indicate that conditions may no longer be proper for the existence of a colony of *apacheana* on the floor of the Owens Valley as far south as the town of Independence.

Crustal movement may have played a significant part in the exposure of the water table in the Owens Valley. The earthquake in 1872 formed a fault scarp just west of Big Pine. This fracturing is apparently responsible for an extensive spring line that presently exists on this scarp. Other upheavals during this period may have altered the level of the water table sufficiently to destroy existing springs and create new ones.

Because of his peculiar dealings with water in the Owens Valley, man may have played a significant part in determining the fate of colonies of *apacheana* in the proposed type locality. In the early 1900's, the city of Los Angeles bought the water rights to nearly every water source in the Owens Valley. This water was brought away from irrigated farms and diverted directly into the aqueduct that was constructed. This channeling of streams and springs may have destroyed natural wet areas they once supported. Water sources not owned by Los Angeles are under intense human use. Many springs have been enclosed as stock ponds, and marshy areas are cut up by grazing cattle. If the types of *apacheana* were taken in the immediate vicinity of the old Fort, subsequent diversion of surface water and tilling of the soil may have obliterated any natural marshes. Extensive well operations where the water table approaches the surface may have destroyed springs that previously emerged on the surface in the middle of the Valley.

CONCLUSIONS

No colonies of *Speyeria nokomis apacheana* presently exist in the vicinity of old Camp Independence in the central part of the Owens Valley of Inyo County, California. Therefore, the type locality proposed by Brown (1957) can probably never be absolutely confirmed unless records for *apacheana* are discovered for the Independence area for the period between 1871 and the present. Localities appearing perfect in every respect to me for the occurrence of the species except for violet populations can be found in the immediate area of Fort Independence. This indicates that *apacheana* may have once occurred in this part of the Owens Valley, but was eliminated in the past one hundred years by a multiplicity of factors which cannot be surely defined. The extent of man's influence on the previous existence of *apacheana* cannot be determined by the very vagueness of the exact type locality, but I suspect that climatic conditions have played a much greater part in its extermination

than the efforts of man to concentrate the water of the entire Owens Valley into one canal. In Round Valley, *apacheana* has survived man's water diversion, spraying of herbicides, and intensive grazing of livestock. It is the tremendous vitality provided by a continuing supply of water that has maintained the proper environment for the foodplant violets for generations of this beautiful butterfly despite these external pressures. Because of the failure to achieve its objective, the results of this search cannot be termed a success. However, the problems encountered in the reconstruction of a past environment, and the changes in this environment over a period of time might be of some interest to the student of historical research on Lepidoptera.

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ENVIRONMENTAL EFFECTS ON PIERIS
COLLAPSIBLE BAIT TRAP
TECHNIQUE FOR HAND-PAIRING
SYNONYMIC LIST OF NEARCTIC MELITAEINAE

(Complete contents on back cover)

29 May, 1969

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NOTES ON THE BIOLOGY AND HOSTPLANT ASSOCIATIONS OF *ORNITHOPTERA PRIAMUS URVILLEANUS* AND *O. VICTORIAE* (PAPILIONIDAE)

R. STRAATMAN

Bishop Museum Field Station, Wau, New Guinea

In 1964 the biologies of *Ornithoptera priamus urvilleanus* Guérin & Ménéville and *O. victoriae* Gray were studied on various islands of the Solomon Islands Archipelago. On the islands of Guadalcanal and Nggela, the early stages of the two species live together on *Aristolochia tagala* Chan, but on other islands they were found on separate hosts, which they did not seem to share. Reports from Forestry Department, Honiara, tell of the almost complete disappearance of both species from the Honiara region due to extensive cutting of the undergrowth and also because of reckless collecting of adults and their early stages.

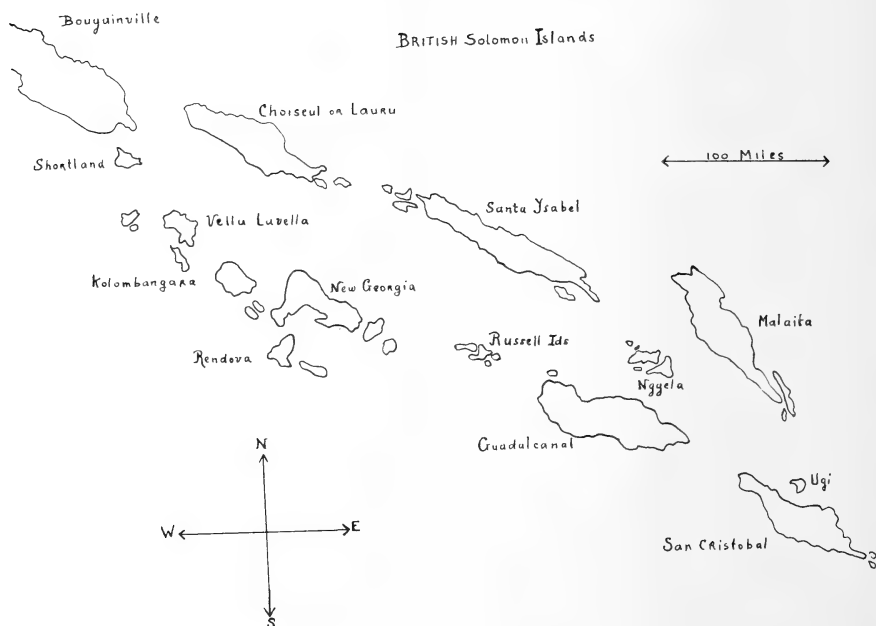
ORNITHOPTERA PRIAMUS URVILLEANUS Guérin-Ménéville

First Instar: Upon hatching, larva wine red, turning dark brown or almost black in a few hours. All segments with long tubercles consisting of two parts: lower part fleshy from base to approximately one-fifth of its length, remaining four-fifths stiff, hard, shiny black, carrying numerous black spines. Fleshy part of dorsal tubercles of fourth abdominal segment red, on other segments dark brown.

Second Instar: Tubercles rather long, pointed, fleshy, without spines. Dorsal tubercles of fourth abdominal segment light red, all remaining tubercles same colour as body.

Third Instar: A faint, short, lateral, light pink to whitish saddle-mark on fourth abdominal segment.

Fourth & Fifth Instars: Ground colour varying from dark ashy grey to almost black. Saddle-mark distinct, white, extending from base of white dorsal tubercles of fourth abdominal segment to base of lateral tubercles of same segment. Sometimes part of a second white mark on fifth abdominal segment. (In the Trobriand Islands many larvae have two or even three distinct saddle-marks.) Larva of *O. priamus urvilleanus* almost identical to that of *O. priamus poseidon* Doubleday, differing in fourth and fifth instars. Dorsal tubercles in the fourth and fifth instars of *urvilleanus* bright red for approximately three-quarters their length as compared to one-fifth or less in *poseidon*. Tips of tubercles black in both forms. Osmaterium dark red. Measurements of one mature larva: total length 94 mm, greatest width 22 mm, longest tubercle 12 mm; headcapsule: length 8.1 mm, width 7.7 mm.



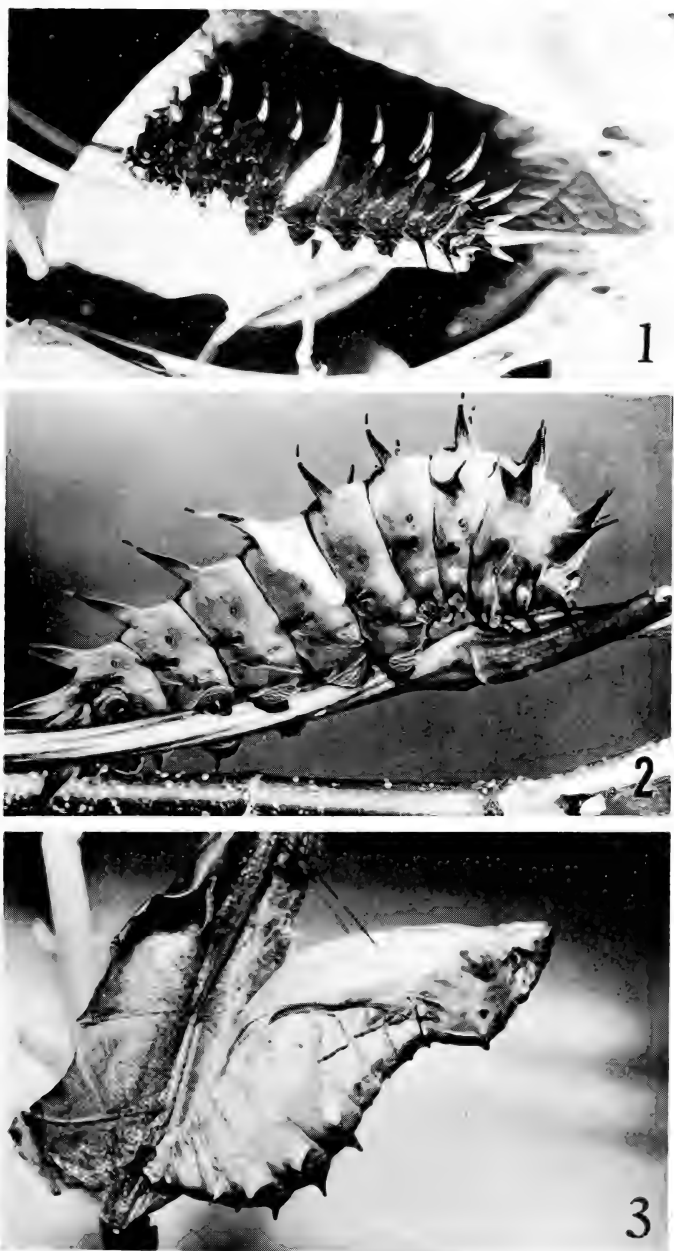
Pupa: Ground colour of *O. urvilleanus* more yellow and markings less distinct than pupa of *O. poseidon*. Abdominal segments with eight sharp, short dorsal processes.

Pupation occurs under a leaf of a tree or shrub growing some distance from the hostplant, seldom on the hostplant itself. The pupal stage ranges from 30 to 33 days.

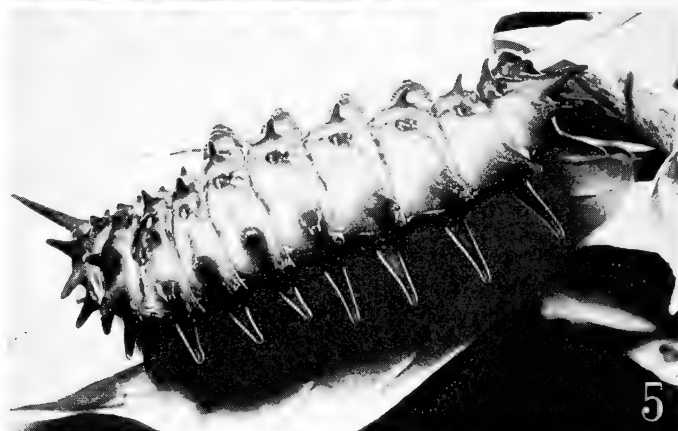
The average sex ratio with specimens emerged was nearly 45% males with minor variations on different islands. On Banika, one of the Russell Islands in the Central Solomons, *O. urvilleanus* was found localized along some stretches of the beach where *Aristolochia tagala* grows mixed with undergrowth of coconut plantations. Average size of the butterflies here is slightly smaller than those of Guadalcanal.

On Malaita *O. urvilleanus* was found rather localized along a sandy beach where *Aristolochia tagala* grows abundantly. Male imagos are slightly smaller and of a darker coloration as compared to those of Guadalcanal and other islands.

On Santa Ysabel, males are larger and of a brighter, paler blue. The host, *A. tagala*, is localized along stretches of sandy beach. On San Cristobal *O. urvilleanus* was not observed.



Figs. 1-3. Early stages of *Ornithoptera*. 1, *O. priamus urvilleanus* Guérin-Ménéville, larva; 2, *O. priamus poseidon* Doubleday, larva; 3, *O. priamus urvilleanus*, pupa.



Figs. 4-6. Early stages of *Ornithoptera victoriae* Gray. 4, penultimate instar larvae; 5, mature larvae; 6, pupa.

Butterflies emerging from pupae brought to San Cristobal from other islands were shown to missionaries and local inhabitants, who were all of the opinion that this species does not occur on this island. Again, *A. tagala* is abundant along the beach, but leaves and stems did not show any trace of damage caused by larvae.

In December, the island of Rendova (opposite New Georgia) was visited and numerous larvae and pupae of *O. urvilleanus* were seen on or near *A. tagala* along the eastern sandy shores. Male adults resemble closely those described from Santa Ysabel, being large and of a bright blue colour. Females are large and clearly marked.

Oviposition and Behaviour.—It was frequently observed that females of *O. priamus* seldom oviposit on the hostplant itself. Eggs were generally laid on twigs and stems of trees and shrubs growing in the vicinity of the hostplant, sometimes on dead sticks or even on stones on the ground. Only on rare occasions were females observed ovipositing on *Aristolochia* plants.

After locating its host which appears to be done by scent, the female butterfly encircles it and frequently touches leaves and stems with her outstretched legs. Inspection completed, she may then lay from one to several eggs. The number of eggs laid depends on the size of the inspected foodplant. This oviposition behaviour often results in the loss of many newly hatched larvae. Assuming the pungent scent of the *Aristolochia* is carried towards the larva, it may eventually reach its future host. Sometimes it happens that the branch on which the egg is attached is not directly connected to the *Aristolochia*, necessitating the larva to walk down to the ground as happens to those hatched from eggs laid on stones. In doing so, it faces possible drowning in heavy rain or dew, or attack by spiders, ants, wasps, tree frogs, or small lizards.

There is little danger that the young larva would perish from starvation, because after devouring its eggshell no food is needed for at least twenty-four hours. Neither its spiny appearance in the first instar, nor its osmaterium seem to offer much protection, if any at all, from its numerous predators. Contrary to the rarer species of *Ornithoptera*, which generally lay but few eggs, the female of *O. priamus* may lay as many as fifty eggs, which appears more than sufficient to ensure species survival.

In later instars many larvae are killed by the green tree-ant, *Oecophylla smaragdina* Fabricius, or by a small formicid species constructing its nest against branches of trees. Prepupae and soft, fresh pupae are often destroyed by these ants. *Vespa* species, probably *V. tropica* Sulzer and *V. affinis* Fabricius, were seen attacking large larvae, stinging them and then chewing pieces out of the paralyzed bodies which were then carried

to their nests. Some birds attack large larvae, which apparently are not as distasteful as is generally believed. It was observed several times that a mature larva in wanderings to find a suitable spot for pupation, was swallowed by large toads. This happens when the larva walks low enough to the ground to be reached by the toad with a short jump. No parasites were recorded as attacking *O. urvilleanus*.

ORNITHOPTERA VICTORIAE Gray

First Instar: Ground colour dark fleshy red, tubercles of the same colour, carrying numerous black spines.

Second Instar: Tubercles comparatively longer, fleshy, without spines. Dorsal tubercles of fourth, seventh, and eighth abdominal segments light red.

Third & Fourth Instars: Ground colour darker red; in the penultimate instar, tubercles very long with a broad base.

Fifth Instar: Ground colour and tubercles dark wine red. Tubercles comparatively shorter and narrower than in penultimate instar. Neither saddle-mark nor other markings present. The two tubercles of first thoracic segment longest (up to 17 mm); the following two segments with eight, first abdominal six, the remaining segments four tubercles each. Osmaterium orange-yellow; head, prothoracic shield and legs glossy black, prolegs light fleshy. Measurements of a large larva: length 97 mm, greatest width 22 mm, average length of dorsal tubercles 11 mm; headcapsule: 8.3 mm, width 7.8 mm.

Pupa: Ground-colour dark yellow, slightly mottled with brown, wing cases light yellow, dorsal saddle-mark orange-yellow. Abdominal segments with six short blunt processes dorsally.

In the Malaita form of *O. victoriae reginae* Salvin, the pupa has a dark brown streak extending over lower part of wingcases along the abdominal segments. Pupation occurs under a leaf of a plant other than the host-plant, sometimes a great distance from it. The pupal stage is long, 38 to 42 days. In the specimens observed, the sex ratio in the emerging adults was nearly 40% males on Nggela, but not more than 26% to 28% males on other islands.

The hostplant association differs from that of *O. urvilleanus*. On Guadalcanal larvae of both *Ornithoptera* species were found feeding on the same hostplant, *Aristolochia tagala* Chan. This may be the only *Aristolochia* species found on this island. On Nggela two different *Aristolochia* species were found growing in the same environment. The first species is *A. tagala*. The second has small, yellowish, thick, triangular leaves and its mature stems are covered with thick layers of corky bark. Although larvae of *O. victoriae* were found on both *Aristolochia* species, there was a distinct preference for the plants with the corky stems.

On Malaita the host preference was more pronounced. The plant with corky stems grows in numbers, although localized, and generally in areas along the beach or a little inland on poor, rocky soil with light undergrowth. In this environment the early stages of *O. victoriae reginae* were

present but those of *O. urvilleanus* were absent. The following experiments were carried out:

1. Larvae of *O. v. reginae* in various instars, were taken from their hostplant, the *Aristolochia* with corky stems, and transferred to *A. tagala*. After some hesitation and wandering, the larvae began to feed. After about a week it became apparent however, that they were not growing. A week later they were dead. Only those which were in the fifth instar when transferred, survived. These larvae reached maturity and pupated into small pupae from which no butterfly emerged.

2. From Guadalcanal larvae of *O. victoriae* were brought to Malaita and released on the *Aristolochia* with corky stems. It took these larvae longer before they accepted their new host and began feeding, as compared to those in the first experiment. The younger larvae died within ten days, but some fifth instar larvae continued feeding for several weeks, growing smaller and weaker, and died without reaching maturity.

3. Larvae of *O. urvilleanus* collected from *A. tagala* were transferred to the hostplant of *O. victoriae reginae*. They accepted it more readily than did *O. victoriae* larvae from Guadalcanal, but in spite of continuous feeding they gradually grew smaller and after a period of two to three weeks all were dead.

On the Russell Islands (Central Solomons), no *O. victoriae* were seen and according to the local inhabitants this species appears to be absent here. Although Seitz (1927) mentioned that *O. victoriae* was not known to occur on San Cristobal, adults and larvae of *O. victoriae* were found on this island at some distance from the Government station, Kira-Kira, where they appear to be localized. The larvae were found on *A. tagala* growing in sandy areas not far from the beach. The hostplant with corky stems was not found, and it is likely that it is absent on this island. The female butterfly of the San Cristobal race has the markings on its wings larger and more yellow than in any other form of *O. victoriae*; the male has the bright green and yellow markings on the forewings joined. Both sexes are slightly smaller as compared to those on other islands. On Santa Ysabel females and an occasional male were seen on the wing. A few small plants of the *Aristolochia* with corky stems were found, but no larvae were present. However, it is likely that this plant when growing in a suitable environment, would be the host of *O. victoriae inabellae* Rothschild, as the numerous *A. tagala* plants growing in sandy areas along the beach failed to produce any instars of *O. victoriae*, while those of *O. urvilleanus* were present.

On Rendova Island (opposite New Georgia) the plant with corky stems was located along the rocky western shore and a few larvae of *O. vic-*

toriae rubianus Rothschild were seen. On *A. tagala* plants growing abundantly along the sandy eastern shore, where at the time the early instars of *O. urvilleanus* were numerous, no specimens of *O. victoriae* were found.

Predators.—It was noticed that on those islands where early instars of *O. victoriae* were found together with those of *O. urvilleanus* on *A. tagala*, the number of predators appeared to be higher than was the case in areas where *O. victoriae* is associated with the hostplant having corky stems, generally growing in a more open and drier environment. Parasites have not been observed to attack this species.

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OCCURRENCE OF *THYMELICUS LINEOLA* (HESPERIIDAE) IN VIRGINIA

In recent years there has been a great amount of attention drawn to the rather rapid expansion of the range of the European skipper, *Thymelicus lineola* (Ochsenheimer) in the United States and Canada.

On June 21, 1968 I collected two fresh males of this skipper in Giles County, in the mountains of southwestern Virginia. They were taken in an open grassy meadow just north of Buckeye Mountain, about three miles west of the small town of Eggleston, Virginia. It was about 6:00 P.M. when they were first seen flying slowly near the ground among the tall grass. They were easily caught as they rested on the grass. No more were seen that day or the following day. A rainy period for the remainder of the time that I was in the area, hindered further collecting.

The foodplant, *Phleum pratense* L. was very common in the meadow and surrounding areas.—GERALD B. STRALEY, Eggleston, Virginia.

EFFECTS OF ENVIRONMENTAL FACTORS ON THE MARKINGS OF *PIERIS RAPAE* (PIERIDAE)

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INTRODUCTION

The spring brood of *Pieris rapae* (Linnaeus) has the dark markings "somewhat reduced, sometimes entirely absent" in the United States (Klots, 1951) and "much less distinct" in England (Pugh, 1934). According to Comstock and Comstock (1943), the "typical form is dimorphic; the spring brood, which comes from the wintering chrysalids, is composed of smaller butterflies, which are of a duller white than the summer butterflies and with smaller black markings on the middle and tip of the wings." The spotless form of the spring brood male (*Pieris rapae* "immaculata") is illustrated by the latter authors. Incidentally, the reduction in size of the spring brood noted by Comstock and Comstock (1943) was not found in a sampling of New Jersey specimens, in which forewing lengths (base to apex) averaged 22 mm for both males and females vs. 22 or 23 mm for summer brood specimens (Kolyer, 1966). Scudder (1899) notes the "more grimy under surface" of the spring brood.

In New Jersey, spring brood males are very often (over 50% of one sampling) of the "immaculata" form, though the more heavily-marked specimens begin to resemble the summer brood, while spring brood females tend to lack the apical marking and have the basal area of the forewing dusky. The underside of both sexes shows more or less increased melanization. Examples are shown in Plate III, No. 26 (cf. Plate II, No. 17, for typical summer brood forewings).

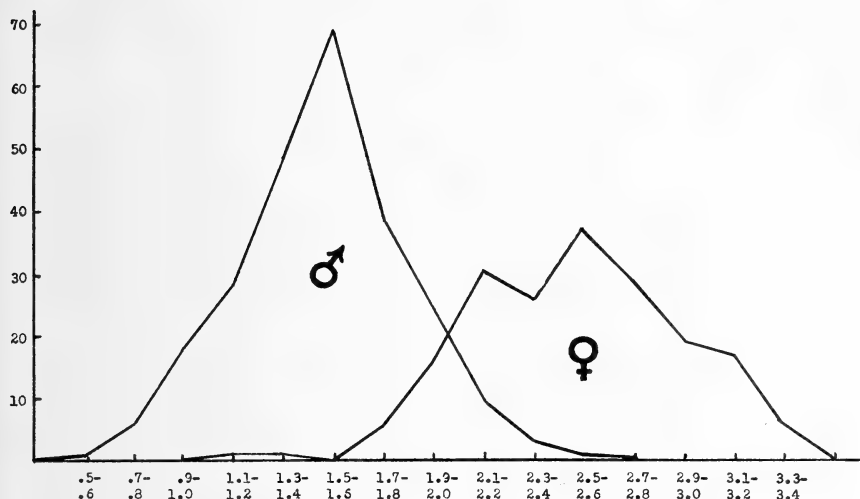
The object of the present work was to study some of the factors, notably reduced temperature, which may be involved in the pronounced seasonal dimorphism of *Pieris rapae*. This paper is an extension of a previous publication (Kolyer, 1966) which was concerned principally with the effect on the markings of feeding larvae various chemicals affecting melanogenesis.

EXPERIMENTAL PROCEDURE

The rearing procedure was the same as used in the earlier work (Kolyer, 1966); larvae were reared in cardboard boxes with gauze windows in the lids and were fed cabbage leaves from refrigerated heads. Data on the conditions of rearing are given in Tables 2-4. Before refrigeration, pupae were packed carefully along with facial tissue in fiber mailing cans, which were covered with polyethylene bags to exclude moisture.

TABLE 1. SUMMARY OF EXPERIMENTAL CONDITIONS AND EFFECT ON MARKINGS

Group No.	Special Conditions	Notable Adult Markings, with reference to specimen no. in Plates I-IV
1	Pupae at 40-45°F. for 3-7 weeks.	Generally typical summer brood. Nos. 1 and 2 show extreme range of variation. (Note unusual asymmetric ♂, no. 3).
2	Pupae at 32-38°F. for 39 days.	Normal summer brood; some basal melanization of ♀ forewings.
3	Larvae reared in darkness at reduced temperature; pupae at 33-68°F. for 8-26 days.	Four of 17 specimens rather lightly marked; these are illustrated previously (Kolyer, 1966).
4	Larvae reared at reduced temperature (10 hr. photoperiod) to extend larval stage to 45-50 days.	Essentially summer brood markings; nos. 4 and 5.
5	Reared at room temperature with 10 hr. photoperiod (control for Group 4).	Typical summer brood markings; no. 6.
6	Pupae at 37-41°F. for 11-29 days, then 10-16°F. for 49 days.	One "immaculata" ♂, one summer brood ♀; nos. 7 and 8.
7a, b	Pupae (pupated at room temp. or 57-60°F.) at 34-39°F. for 25-32 days, then 12-16°F. for 40 days.	One "immaculata" ♂, 3 lightly-marked ♂♂; 1 summer brood ♀, 3 lightly-marked ♀♀ (esp. no. 12); nos. 9-14.
8a, b	Pupae (pupated at room temp. or 57-60°F.) allowed to develop at 53-57°F. (13-29 day pupal stage).	Summer brood markings with slight tendency to lightness, e.g. weak apical markings in a few ♀♀; nos. 15 and 16.
9	No special conditions (control for Groups 7-18).	Summer brood markings, even for 4 dwarfed specimens; nos. 17 and 18.
10a, b	Pupae (pupated at room temp. or 57-60°F.) at 34-39°F. for 61-67 days.	♂♂ with tendency toward basal melanization, 2 "immaculata"; one ♀ with unusual melanization (no. 23); nos. 19-23.
11	Pupae (pupated at 57-60°F.) at 53-57°F. for 24 days, then 34-39°F. for 37 days.	Summer brood markings (2 ♂♂); no. 25.
12a, b	Pupae (pupated at room temp. or 57-60°F.) at 34-39°F. for 151-157 days.	Of 21 ♂♂, 4 with weak spots, 5 "immaculata," tendency to basal melanization in others; of 16 ♀♀, 4 very lightly marked, 1 with unusual melanization; nos. 32-35.
13	New pupae exposed to 14°F. for 30 min.	♀ with weak markings and undersized forewings; no. 27.
14	New pupae exposed to 14°F. for 2 hr.	Essentially summer brood markings; no. 28. (Note scales missing in spot 1 of ♀.)
15	New pupae exposed to 18°F. for 1 hr., then 41°F. for 15 min.	Asymmetric ♀ with discal spot reduced on right forewing; no. 29.
16	Pupae at 34-39°F. for 24-28 days, then left wingcase contacted with Dry Ice for 1 sec.	♂ with light markings, ♀ with apical markings almost absent, asymmetric ♂ with discal spot weak on left forewing; no. 30.
17	Like Group 16 but contacted with Dry Ice for 3 sec.	♂ with light markings, asymmetric ♀ with discal spot missing on left forewing; no. 31
18	Pupae in oxygen atmosphere for 62 hrs.	Summer brood markings, like Group 9.



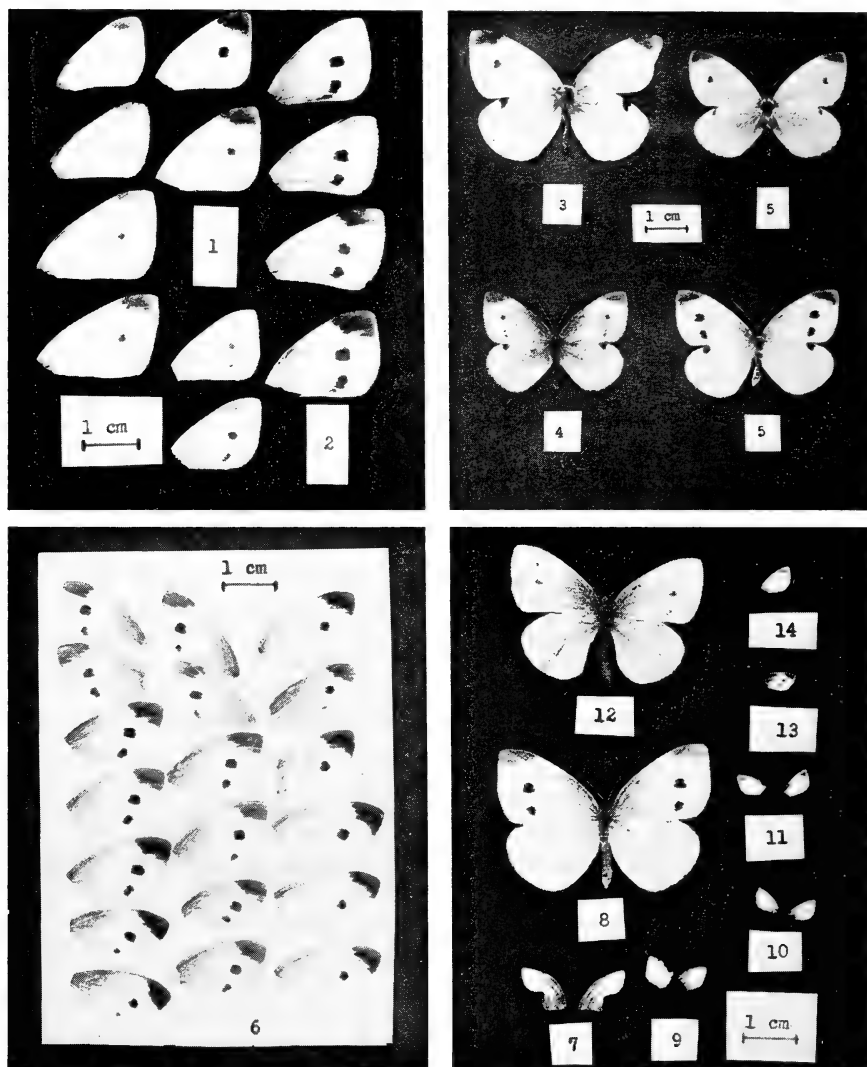
EXPLANATION OF GRAPH 1

Frequency curves for forewing spot widths (spot 1 or upper spot for ♀♀) for Group 1. Vertical axis = number of specimens; horizontal axis = spot width in mm.

In those cases in which larvae were exposed to reduced temperature under light (*e.g.* Group 4), a refrigerated compartment with a plastic window was used. Three layers (each 0.005 inch thick) of Aclar fluorocarbon film (Allied Chemical Corp.), which is highly transparent to light to a wavelength of 230 millimicrons, comprised the window separating the insects from the external light source. Pupae were similarly exposed in some cases (*e.g.* Group 8). Relative humidity and temperature in the tables are for the atmosphere external to the rearing boxes and do not describe the microenvironment at the surface of the cabbage leaf. Yields of adults generally are given as a fraction, *e.g.* 3/7 means that seven pupae yielded three adults. In Table 5, specimens were expanded normally unless otherwise noted. Incidentally, the photographs in Plates I–IV were taken by a published procedure (Kolyer, 1965) with specimens on either red (which appears as dark gray) or black velvet in Riker mounts.

RESULTS AND DISCUSSION

Variability of markings. Discussion of the results must be preceded by emphasizing the great variability in the markings between individuals. This was pointed out in the earlier work (Kolyer, 1966), and another illustration is seen in Plate I, Nos. 1–3, and in Graph 1, which shows approximately normal distribution curves for the widths of the male spot



EXPLANATION OF PLATE I

Specimens of *Pieris rapae* (L.). 1-3, Group 1; 1, forewings of 6 ♂♂ showing range of variation of markings, especially the discal spot; the forewing just above the number 1 is a yellow form; 2, forewings of 6 ♀♀ showing range of variation of markings; 3, unusual asymmetrically-marked ♂. 4-5, Group 4; 4, ♀, eclosed on day = 63; 5, ♂, eclosed on day = 117 and ♀, eclosed on day = 81. 6, Group 5 (control for group 4), forewings of 6 ♂♂ (right hand column) and 13 ♀♀. 7-8, Group 6; 7, unexpanded forewings of ♂; 8, ♀. 9-11, Group 7a; 9, unexpanded forewings of ♂ (left) and ♀ (right); 10, unexpanded forewings of ♀; 11, unexpanded forewings of ♂. 12-14, Group 7b; 12, ♀; 13, unexpanded forewing of ♀; 14, unexpanded forewing of ♂.

TABLE 2. ORIGIN OF EGGS AND CHRONOLOGY FOR GROUPS 1-6

Group No.	Origin of Eggs	Chronology (days from arbitrary starting point)			
		Oviposition	Hatching	Pupation	Ecdysis
1	U.S.D.A. ¹	—	0	9-17	approx. 36-72
2	Third generation of culture ²	0-2	4-6	24-28	71-75
3	Same	Same	Same	32-50	62-87
4	Adults collected at Morristown and Berkshire Valley, New Jersey, August 6 and 7, 1966	0-2	3-5	48-55	63-117
5	Same	Same	Same	20-26	27-31
6	U.S.D.A. ³	—	0-2	16-34	103

¹ Eggs from field-collected adults were reared at U.S. Department of Agriculture, Ag. Res. Service, Entomology Res. Div. lab at Charleston, S.C., under the direction of W. J. Reid, Jr. Larvae were fed collards or cabbage.

² The culture (at Convent, N.J.) was started July 2, 1964 with eggs from adults taken at Morristown and Flemington, N.J.

³ Eggs were from N. R. Spencer, U.S. Department of Agriculture, Entomology Res. Div., Columbia, Missouri.

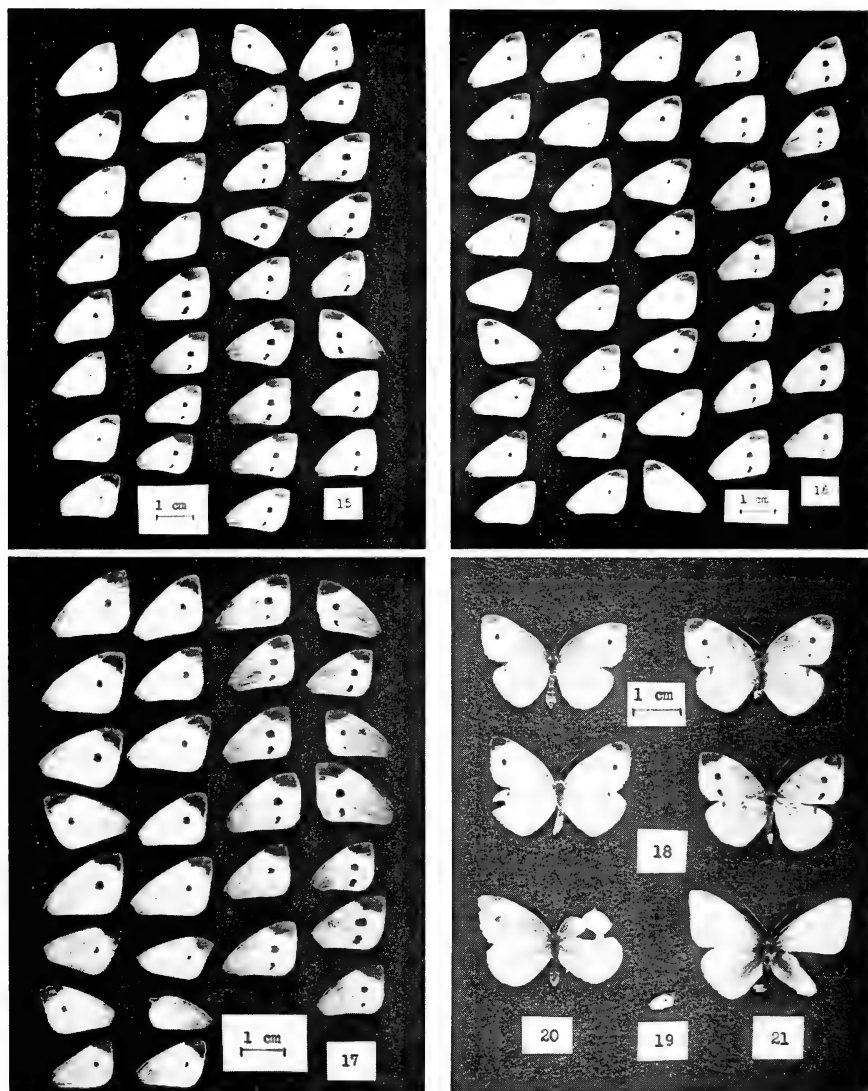
and female spot 1 (the upper discal spot). The intensity of the markings also varies greatly. This variability noted for the summer brood also occurs in the spring brood. For example, among the eight forewings in Plate III, no. 26, will be noted a male and a female wing that might pass for somewhat lightly-marked summer brood specimens. The result is that conclusions must be drawn with caution, especially where only a few specimens are involved.

Possible factors determining spring brood markings. In New Jersey, conditions for the spring brood differ from summer brood conditions in (1) reduced temperature during the larval period (in September and October), (2) shortened photoperiod (causing the diapause necessary for overwintering), (3) reduced temperature at the time of pupation, (4) reduced temperatures, often well below freezing, during the winter, and (5) reduced temperature during completion of pupal development (typically in April) when diapause has ended. Number 4 may seem to be the most notable difference, but the others must be considered.

Another way to look at the problem is to consider the point in development at which spring brood markings are determined, *i.e.* the larval stage, the early part of the pupal stage (pupation and shortly thereafter), the dormant part of the pupal stage (when the pupa has hardened but has not begun final development), or the final portion of the pupal stage when the imago develops and wing pigments are deposited.

The experiments were intended to give some idea of the relative importance of the above factors and of their time of operation.

Results discussed in terms of possible factors. The experimental conditions and results, given in detail in Tables 2-5, are summarized for



EXPLANATION OF PLATE II

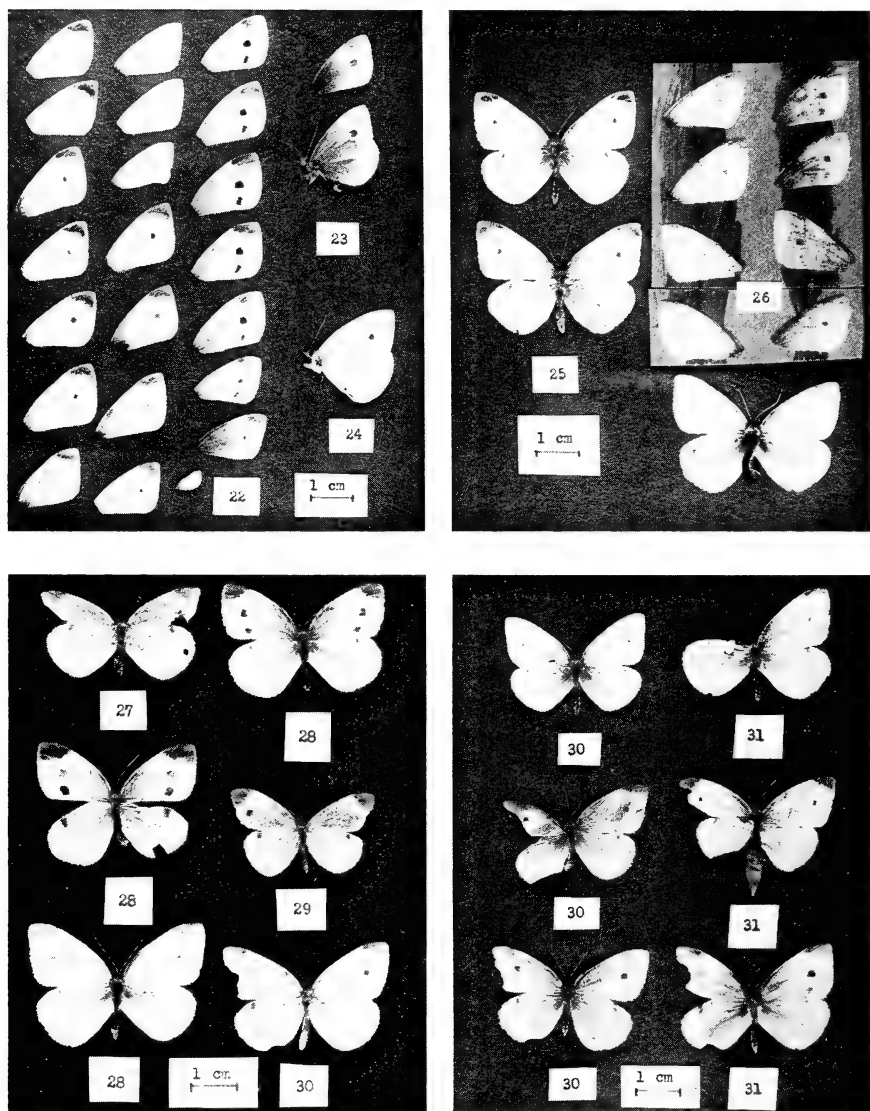
Specimens of *Pieris rapae* (L.). 15, Group 8a, forewings of 12 ♂♂ (first column and top four in second column) and 21 ♀♀; the four ♂♂ in the second column eclosed after day = 46, as did the five ♀♀ at the bottom of the last column. 16, Group 8b, forewings of 25 ♂♂ (first three columns) and 13 ♀♀; the two ♂♂ at the bottom of the third column eclosed after day = 46, as did the ♀ at the bottom of the last column. 17-18, Group 9 (control for Groups 7-18); 17, forewings of 16 ♂♂ (first two columns) and 13 ♀♀; 18, ♂ (lower left) and 3 ♀♀, undersized specimens (forewing length 16 mm vs. 17-21 mm for remainder of Group 9). 19-21, Group 10a; 19, unexpanded forewing of ♀; 20, ♀; 21, ♂.

convenience in Table 1. The following discussion covers, by number, the five factors enumerated above.

(1) In certain *Colias species*, the effect of a slowed development rate is said to resemble that of reduced temperature (Hovanitz, 1945). In *Polygonia c-album*, the length of the larval period is supposed to control production of light and dark forms (Klots, 1951). In Group 4, the larval period was extended by reduced temperature from the normal summer length of about three weeks to 45-50 days. Only three individuals were obtained, none of which had spring brood markings. This demonstrates that larvae reared at reduced temperatures *can* give summer brood markings but, considering variability, does not show that such larvae *cannot* give spring brood markings. In Group 3, in which the larval stage lasted about 28-44 days due to reduced temperature, there was some reduction in markings in four of 17 individuals, but this might be attributed to exposure of the pupae to reduced temperatures for up to 26 days. In conclusion, reduced temperature during the larval stage had no dramatic result such as a high incidence of reduced markings or production of "immaculata" males.

(2) Photoperiod may determine spring and summer forms in some butterflies. For example, variation of the photoperiod can produce the seasonal forms of *Ascia monuste* (L.) (Pease, 1962). In *Pieris rapae*, the photoperiod is known to be responsible for diapause when the temperature is sufficiently low. For example, almost all pupae diapause when larvae are reared at 17-20° C. with a 10 hr./day photoperiod (Barker, Cohen, and Mayer, 1964), while at 20° C., but not at 24° C., pupae diapaused when larvae were given photoperiods of under 11 hrs./day (Barker, Mayer, and Cohen, 1963). At summer temperatures in New Jersey, normal summer brood markings resulted when larvae were reared in darkness or with 18 hrs. light/day (Kolyer, 1966). Normal summer brood markings also were given by 10 hrs. light/day at summer temperatures (Group 5; Plate I, No. 6) or at reduced temperatures (Group 4). However, spring brood markings were given with photoperiod provided by diffuse summer sunlight during rearing when the pupae were held for over two months at reduced temperatures, as will be seen. In summary, all that can be said is that photoperiod gave no striking results in the experiments, which does not mean that it might not have considerable effect with high-intensity fluorescent light or direct sunlight, for example. As will be seen, a reduced photoperiod (or diapause) is not *necessary* for experimental production of spring brood markings, although it may have an influence in nature.

(3) Aberrations in butterflies may be caused by chilling recently-



EXPLANATION OF PLATE III

Specimens of *Pieris rapae* (L.). 22-23, Group 10b; 22, forewings of 14 ♂♂ (first two columns) and 8 ♀♀ (one unexpanded); 23, forewing (above) and underside of normal summer brood ♀ for comparison. 25, Group 11, 2 ♂♂. 26, forewings of 4 ♂♂ (left column) and 4 ♀♀, typical spring brood (taken at Flemington, N.J., May 1, 1965), and spring brood ("immaculata") ♂ (below) taken at Southold, Long Island, N.Y., circa 1947. 27, Group 13, ♀. 28, Group 14, ♂ (bottom) and 2 ♀♀. 29, Group 15, ♀. 30, Group 16, 2 ♂♂ and 2 ♀♀. 31, Group 17, 2 ♂♂ (above) and ♀.

TABLE 3. LARVAL AND PUPAL CONDITIONS FOR GROUPS 1-6

Group No.	Light	Larvae		Pupae			Yield Adults from Pupae
		Temp., °F.	Relative Humidity, %	Light	Temp., °F.	Relative Humidity, %	
1	12-14 hrs./day artificial light	71-77	40-50	None ¹	40-45 ¹	-	Approx. 80%
2	Approx. 18 hrs./day diffuse sunlight or incandescent light	69-81	39-55	None ²	32-38 ²	-	15/30
3	Dark ³	37-68 ³	38-78 ³	None ⁴	33-68 ⁴	44-80 ⁴	17/27
4	Generally 10 hrs./day ⁵	Generally 52-60 ⁵	Approx. 40-50	Continuous ⁶	66-78	30-45	3/7
5	10 hrs./day ⁷	75-89	46-70	None	76-85	43	50/62 (19 expanded normally)
6	Diffuse sunlight ⁸	68-79	27-34	None ⁹	37-41, then 10-16 ⁹	-	2/20

¹ Starting about 24 hrs. (occasionally 3-4 days) after pupation, pupae were refrigerated for approx. 21-49 days. The pupae received perhaps 1 hour light/week during sorting.

² Starting about 0.5-4 days after pupation, on day-28, pupae were refrigerated for 39 days. Then the pupae were left at room temp. with 18 hrs. light/day.

³ Starting on day-12 (Oct. 19, 1964), the larvae (3-8 mm) were removed from room temp. conditions and reared in the dark at reduced, fluctuating temperature (unheated building, Convent, N.J.). The average of 38 random temperature readings was 53°F.

⁴ For day-32-58 (unheated building). The average of 48 random temperature readings was 51°F. Pupae were in darkness in the unheated building for 8-26 days. On day-58 (Dec. 4, 1964) they were transferred to the rear room (67-77°F., 36-52% rel. humidity, 18 hrs. light/day). All pupae were brown.

⁵ Starting on day-6, the larvae (3-6 mm) were removed from room temperature conditions and reared at 10 hrs. incandescent light/day and 52-58°F. until day-25. Then the larvae were refrigerated (darkness, 34-37°F.) until day-29. From day-29-39, the larvae were returned to 52-58°F. for 10 hrs. incandescent light/day while being refrigerated (darkness, 34-37°F.) for the remaining 14 hrs./day (object was to slow growth). From day-39-55, the larvae were again exposed to 10 hrs. incandescent light/day at 52-58°F. Light was provided by a 25 watt bulb 30 inches from the larvae.

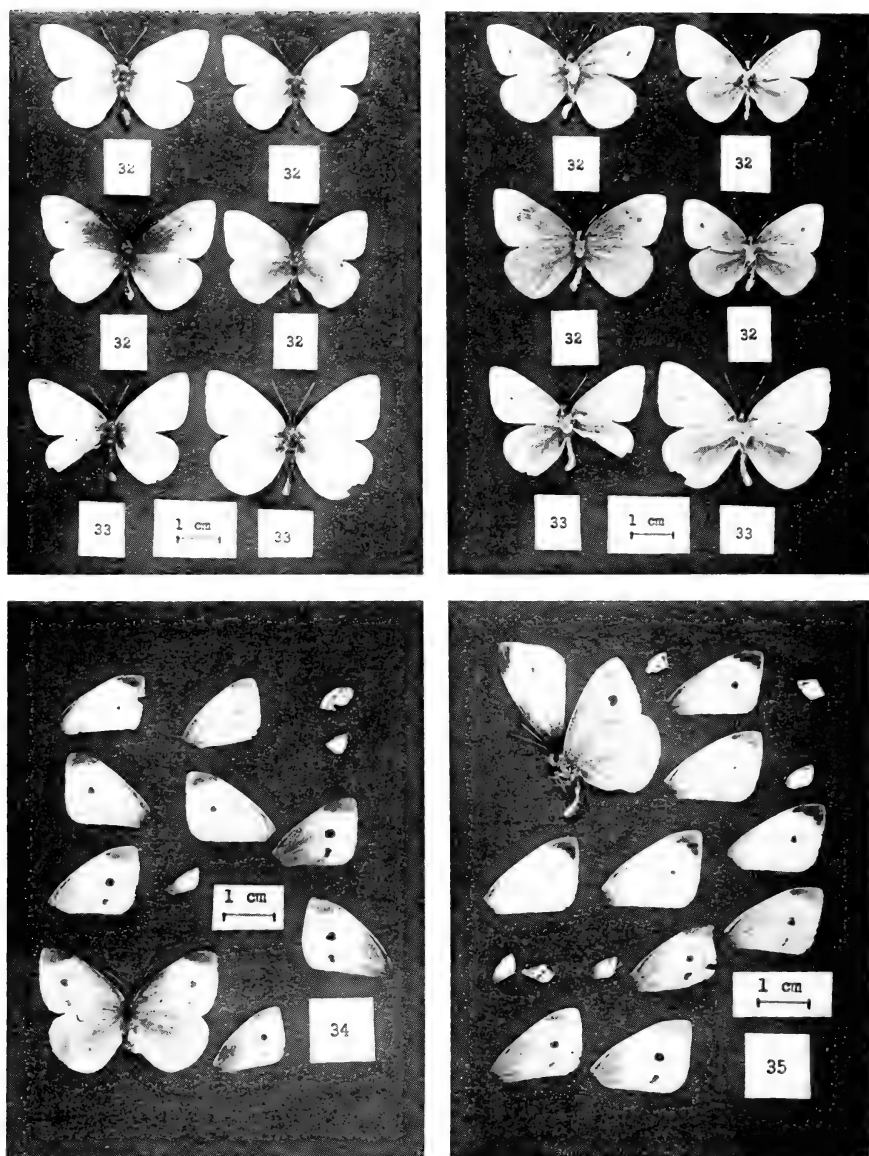
⁶ Light was provided by a 25 watt bulb 25 inches from the pupae. Of new pupae, four were brown and three more or less green.

⁷ Light was provided by a 25 watt bulb 30 inches from the larvae.

⁸ April 8-May 13, 1967 at Convent, N.J.

⁹ The pupae were refrigerated (37-41°F.) about 12 hrs. after pupation. On day-45, the pupae were transferred to a freezer (10-16°F.), left for 49 days, and then transferred to a refrigerator (37-41°F.) for 1 day before removing (on day-95) to rear room conditions (76-84°F., 52-57% rel. humidity, diffuse sunlight).

formed pupae. For example, the wing pattern of *Nymphalis anitopa* (L.) and other species is particularly susceptible to change by chilling at 12-48 hours after pupation (Kühn, 1927). Newly-formed pupae of *Zerythnia hypermnestra* Sc. were chilled at -10° C. to give adults with an extensive black pattern (Rácz, 1967). The frequency of melanic and albinic butterflies in certain parts of Pomerania has been attributed to very severe temperature changes (Mecke, 1926). When recently formed *Pieris rapae* pupae



EXPLANATION OF PLATE IV

Specimens of *Pieris rapae* (L.). 32, Group 12a, 2 ♂♂ (above) and 2 ♀♀; the undersides are shown in the right-hand photograph. 33, Group 12b, 2 ♂♂; the undersides are shown in the right-hand photograph. 34, Group 12a, ♀ and forewings of 6 ♂♂ (above; two unexpanded) and 5 ♀♀ (one unexpanded). 35, Group 12b, ♂ underside with upper surface of forewing to the left, and forewings of 8 ♂♂ (above; three unexpanded) and 7 ♀♀ (three unexpanded).

were chilled (Groups 13–15), some variations in markings were noted, but there was no indication that the spring form might be produced in this way. Some reduction of markings was noted when one wing case was contacted briefly with solid carbon dioxide (dry ice) (Groups 16 and 17), but the symmetrical effects are suspected to be due to the refrigeration preceding dry ice treatment. In one female (Plate III, No. 31) the discal spots were obliterated on the chilled wing, but the overall results suggest that extreme chilling of new pupae be discounted as the predominant cause of spring brood markings. In any event, it is hard to imagine sudden, extreme temperature changes as the prime natural causative factor. Pupation at 57–60° F., a rather mild variation, had no noticeable effect on markings vs. pupation at room temperature in Groups 7, 8, 10, 11, and 12. The only notable effect was on pupal color, which generally was darkened. The green pupae (estimated at 40–50% of the total) formed at 57–60° F. were heavily speckled with black vs. solid light green for green pupae formed at room temperature. Of course, differences in light composition and intensity, and in photoperiod, were involved as well as reduced temperature.

(4) Pugh (1934) stored *Pieris rapae* pupae, presumably in diapause, at 20° C. and in a "cool cellar." After two months the pupae at 20° C. began to emerge to give eight specimens all "intermediate between typical spring and summer broods" in markings. The pupae in the cool cellar were removed to room temperature after six months to give eight specimens with "typical spring markings." In the present work, nondiapause pupae were refrigerated at 40–45° F. for 3–7 weeks (Group 1) to give summer brood markings, at 32–38° F. for 39 days (Group 2) to give no effect except some basal melanization of female forewings, at 34–39° F. for 61–67 days (Group 10) to give two or three "immaculata" out of 16 males (Plate II, No. 21; Plate III, No. 22) and a tendency to basal and under-side melanization and loss of apical markings in females (especially Plate III, No. 23), and at 34–39° F. for 151–157 days (Group 12) to give five "immaculata" out of 21 males and four of 16 females with extremely light markings (Plate IV, Nos. 32 and 33, shows specimens with spring brood markings). When pupae were exposed to 34–41° F. for 11–32 days and then to 10–16° F. for 40–49 days (Groups 6 and 7) there was a pronounced reduction in markings; of 5 males, 2 were "immaculata" (one shown in Plate I, No. 7), and of five females, three were more or less lightly marked (most notably No. 12, in Plate I). The significance of the above reduction in markings by storage at reduced temperature can be seen by comparing with the control forewings (Group 9) in Plate II, No. 17).

TABLE 4. LARVAL AND PUPAL CONDITIONS FOR GROUPS 7-18

Laboratory site—Rearing was done at Convent, N.J.

Origin of Eggs—Adults collected at Morristown, N.J., June 18, 1967.

Oviposition—0-3 day (June 20-23, 1967).

Hatching—3-6 day (June 23-26, 1967).

Temperature and Relative Humidity During Larval Stage—73-87°F. and 41-55%, except that on day-17 (July 7) the larvae (final instar) of Groups 7b, 8b, 10b, 11, and 12b were transferred to 57-60°F. and 47-55% rel. hum. The pupae were refrigerated when less than 24 hours old.

Light During Larval Stage—Diffuse sunlight (approx. June 23-July 14, 1967) for Groups 7a, 8a, 9, 10a, 12a, and 13-18. For the other Groups, diffuse sunlight (approx. June 23-July 7), then (after day-17) 10 hrs. light/day (50 watt daylight fluorescent bulb 24 inches from larvae).

Group No.	Chronology (days from June 20, 1967)		Pupal Conditions			Yield Adults from Pupae
	Pupation	Eclosion	Light	Temp., °F.	Rel. Hum., %	
7a	17-22	81-87	None	34-39, then 12-16 ¹	—	4/30
7b	20-24	80-83	None	34-39, then 12-16 ¹	—	4/30
8a	17-22	39-51	Continuous ²	34-39, then 53-57 ²	approx. 30	33/40
8b	20-24	38-54	Continuous ²	34-39, then 53-57 ²	approx. 30	38/40
9	22-24	27-34	Diffuse sunlight	76-86	52-57	approx. 80%
10a	18-22	92-94	None	34-39, then R.T. ³	—	3/11
10b	20-24	92-97	None	34-39, then R.T. ³	—	24/40
11	20-24	93-95	Mostly none ⁴	53-57, 34-39, then R.T. ⁴	—	2/2
12a	18-22	185-188	None	34-39, then R.T. ⁵	—	17/32
12b	20-24	184-189	None	34-39, then R.T. ⁵	—	20/28
13	20	26	Diffuse sunlight	14 for 30 min., then 77-87 ⁶	approx. 57	3/3
14	20	27-29	Diffuse sunlight	14 for 2 hrs., then 77-87 ⁷	52-57	6/11
15	24	32	Diffuse sunlight	18 for 1 hr., 41 for 15 min., then 76-82 ⁸	52-57	1/7
16	18-22	51-53	Diffuse sunlight	34-39, then R.T. ⁹	—	8/10
17	18-22	51-52	Diffuse sunlight	34-39, then R.T. ¹⁰	—	7/10
18	21	28-29	Diffuse sunlight	77-84	Note 11	9/10

The conclusion is that storage at reduced (but not necessarily subfreezing) temperatures, without diapause, causes a significant incidence of spring brood markings, *e.g.* five "immaculata" males of total of 21 after 5 months at 34–39° F. In New Jersey, the pupae are exposed for 6–7 months to generally low temperatures, often far below freezing (daily lows of 10–20° F. are not uncommon in midwinter, and a record low of –34° F. was recorded in New Jersey in 1904). Intuitively, one might expect these subfreezing temperatures to influence the markings. However, delayed pupal development itself, without reduced temperatures, seems to cause reduced markings since Pugh (1934) reported specimens "intermediate between typical spring and summer broods" by storage of diapause pupae at 68° F. Certainly, the present work demonstrates that subfreezing temperatures are not necessary to obtain the spring form. Thus, in the production of spring brood markings in nature, it is not obvious what contribution is made by reduction of temperature below that level of cold needed to arrest pupal development.

(5) In Group 8, nondiapause pupae were allowed to develop at 53–57° F. About 13–29 days were required for development, presumably more or less simulating natural conditions in New Jersey in April. (Typical time for development in the summer is 5–10 days, *e.g.* Group 9). The result (Plate III, Nos. 15 and 16) was a slight tendency toward reduction of markings, but there was no pronounced effect such as formation of

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¹ Within 24 hours after pupation, the pupae were refrigerated (34–39°F.) and left to day-50. Then the pupae were left in a freezer at 12–16°F. for 40 days. To reduce possible temperature shock, the pupae were kept at 28°F. for 12 hours and then 34°F. for 1 day before removing (on day-71) to 68–82°F. and 48–56% R.H. (diffuse sunlight).

² On day-25, the pupae were removed from refrigeration (34–39°F.) and exposed to continuous light (50 watt daylight fluorescent bulb 24 inches from larvae) at 53–57°F. and approx. 30% R.H.

³ Within 24 hours after pupation, the pupae were refrigerated (34–39°F.). On day-86 the pupae were removed to rear room conditions (68–83°F., 45–55% R.H., diffuse sunlight) and allowed to develop. Group 10a was under refrigeration for 63–67 days, Group 10b for 61–65 days.

⁴ Having shown no sign of development at 53–57°F., the two pupae were again refrigerated (34–39°F.) on day-49. On day-86 they were removed to rear room conditions (68–83°F., 45–55% R.H., diffuse sunlight). Thus, the pupae spent about 24 days at 53–57°F. and 37 days at 34–39°F.

⁵ Within 24 hours after pupation, the pupae were refrigerated (34–39°F.). On day-176, they were removed to rear room conditions (67–74°F., 30–42% R.H., diffuse sunlight). Group 12a had been refrigerated for 153–157 days, Group 12b for 151–155 days.

⁶ Still-soft pupae (less than 8 hours old) were placed in a freezer at 14°F. for 30 minutes and then returned to the rear room.

⁷ As in footnote 6, but at 14°F. for 2 hours.

⁸ Pupae (less than 9 hours old) were placed in a freezer at 18°F. for 1 hour, then transferred to a refrigerator at 41°F. for 15 minutes, and then returned to the rear room.

⁹ On day-46, the pupae, which had been refrigerated within 24 hours after pupation, were removed from the refrigerator. A rounded piece of dry ice was pressed against the left wingcase for 1 second, and the pupa then was left at ambient conditions (74–89°F., 45–63% R.H., diffuse sunlight).

¹⁰ As in footnote 9, except that dry ice exposure was 3 seconds.

¹¹ A one-liter flask containing the pupae (less than 24 hours old) was well-flushed with oxygen (Linde Co.) and stoppered tightly. For humidification, solid potassium carbonate hydrate in contact with the saturated solution was included; this gives 43% R.H. in air at 72°F. (humidity level imparted to oxygen unknown). After 62 hours the pupae were removed (day-24) to the rear room.

TABLE 5. DATA ON ADULTS

(See Table 1 for illustration numbers in Plates I-IV)

Group No.	Males		Females	
	Number	Markings	Number	Markings
1	251	Mostly typical SB	189	Mostly typical S
2	5	SB	10	SB, but with some BM
3	7	S and AM weak ¹	10	AM almost absent in two ¹
4	1 (enclosed on day-117)	More LM than control (Group 5) but still SB	2	(1) Eclosed on day-63—nor- AM, smallish S (spot 1 = 1.6 mm, spot 2 = 1.0 mm); (2) eclosed on day-81—SB
5	6 (E)	SB	13 (E)	SB
6	1 (UE _x)	I	1	SB
7a	2 (UEcl)	(1) No S, weak AM; (2) rather LM	2 (UEcl)	Smallish S, rather weak AM
7b	2 (UEcl)	(1) I; (2) rather LM	2	(1) very LM; (2) UEcl, SB
8a	12	Essentially SB; S appeared as "window" (no scales) in 4 cases	21	Essentially SB; S lacked scales in 1 case; sl. weak AM in 3 cases
8b	25	Essentially SB	13	Essentially SB, but AM weak in about 3 cases
9	17	SB ²	16	SB ² ; scales partly missing in S in one case
10a	1	Very LM with BM, UM; borderline I	2	(1) UEcl, SB; (2) LM
10b	15	Some with BM; one I (UE _x); another I shown in Plate III	9	AM light in some cases; AM missing on one FW (UE _x); one with heavy BM and UM
11	2	SB	0	—
12a	9	3—SB; 3 (2 UE _x)—weak S; 3—I (one UE _x)	8	6—SB but BM in some cases (one UE _x); 1—very LM; 1—very LM, heavy BM
12b	12	9—SB, but some BM and UM (3 UE _x); 1—weak S (UE _x); 2—I	8	BM and weak AM in some cases; 2 (UE _x) with very LM
13	2	SB	1	LM; FM deformed (undersized)

¹ Unlike any of 57 ♂♂ or 49 ♀♀ in a control brood reared at 68–81°F. and 35–61% R.H.² Including dwarfed specimens (1 ♂, 3 ♀♀).

SB = summer brood markings, like No. 17 in Plate II

AM = apical marking

S = spot(s)

LM = lightly-marked

BM = basal melanization of forewing

UE_x = unexpanded

UM = underside melanization

FW = forewing

I = "immaculata"

E = expanded normally

UEcl = unable to eclose

TABLE 5. CONTINUED

Group No.	Males		Females	
	Number	Markings	Number	Markings
14	3	2—SB; 1—rather light AM	3	(1) SB; (2) scales missing from S; (3) upper S almost split into 2 spots
15	0	—	1	Asymmetric; S greatly reduced on right FW
16	3	(1) SB; (2) S smaller on left FW; (3) LM	5	Left FW more or less deformed; one with AM almost absent; one with S sl. enlarged on deformed left FW
17	2	(1) LM, left FW UEx; (2) dwarfed left wings	5	2—SB; 2—light AM; 1—S missing on left FW
18	2	SB	7	SB

"immaculata" males. Two of the pupae which had formed at 57–60° F. (10 hrs. light/day) failed to show signs of development (whitening of the wingcases) after 24 days at 53–57° F. and were suspected to be diapause pupae (Group 11). After 37 days refrigeration, these were allowed to develop at room temperature (7–9 days required) and gave two males with summer brood markings (Plate III, No. 25). The conclusion is that any slight effect on markings by moderately reduced temperature during completion of development of the adult wings would be overshadowed in nature by the effect of reduced-temperature storage, which in Groups 10 and 12 gave a significant portion of spring brood markings even though the pupae completed development at 67–83° F.

The above results suggest that the point in development during which the principal factor (extended reduced temperature) is effective is the dormant part of the pupal stage. A purely speculative explanation for the results is that the chromogen which is finally oxidized to give the markings (Onslow, 1916) is distributed only in the final stage of development after diapause has broken (or the pupae have been removed from refrigeration). Then, the normal movement of chromogen to the upper surface and out from the base toward the apex may be restricted by unknown changes which have occurred in the wing during prolonged dormancy. This would explain the loss of apical and discal markings and the concentration of melanin at the base of the forewing and on the undersides of the wings.

Other factors investigated. Hot, moist air is reported to produce in-

creased black pigmentation in *Junonia coenia* (Hbn.) (Schrader, 1926). In the present work, *Pieris* pupae were allowed to develop at 69–78° F. and a constant 87% relative humidity (measured at 75° F.); the adults had normal summer brood markings. Development of pupae at an unnaturally-high barometric pressure (825–830 mm), 43% rel. humidity, and 69–78° F. also gave summer brood markings. Four dwarfs were produced by some of the last larvae to pupate in Group 9 (see Plate II, No. 18). These had forewings 16 mm in length (measured from base to apex) vs. generally 21 mm for the remainder of Group 9, but the markings were essentially normal. In *Pieris brassicae*, the small form “minor” can be produced by starvation (Gardiner, 1963), but the above dwarfs were produced in the presence of an ample food supply. At the time the dwarfed pupae were formed mortality among both larvae and pupae was very high, presumably due to an unidentified disease; this factor may have been related to the observed dwarfism.

When *Gonepteryx rhamni* pupae had been exposed to pure oxygen, the adult butterflies were much paler than normal (Becker, 1937). On the other hand, atmospheric oxygen is responsible for the dark markings of *Pieris brassicae* by oxidation of localized chromogen on the wings of the maturing pupa (Onslow, 1916). Though this condition is not found in nature, *Pieris rapae* pupae were exposed to oxygen for various lengths of time in the present work. When nine pupae (less than 24 hours old) were left in pure oxygen (humidified as described in Table 4, Note 11) at 73–87° F. for one week, the adults (eclosed on the last day) failed to expand in all cases. The markings in the unexpanded wings seemed not unusual. The same result was given with five pupae (four eclosed) similarly exposed to oxygen for 6 days. When the time of exposure (10 pupae) was reduced to 62 hours (Group 18), nine adults eclosed, eight of which expanded normally. The markings were neither more nor less intense than those of the control (Group 9).

SUMMARY

Experiments were conducted to evaluate the relative importance of some environmental factors in determining the spring brood markings of *Pieris rapae* (L.), including reduced intensity of the apical and discal markings and increased melanization of the base of the forewing and the undersides of the wings.

Normal summer brood markings were produced by rearing the larvae at reduced temperatures to extend the larval period from the normal three weeks to 45–50 days.

Chilling of newly-formed pupae gave some aberrations in markings but was not indicated as a factor in seasonal dimorphism.

Only a hint of spring brood markings was obtained by allowing pupae to develop at 53–57° F. or by refrigeration (32–38° F.) of pupae for 39 days.

A significant proportion of specimens with spring brood markings, including the male form "immaculata" and females with no apical markings and heavy melanization of the basal area of the forewing, was produced by refrigeration of pupae at 34–39° F. for about 65 days (two or three of 16 males were "immaculata") or about 155 days (five of 21 males were "immaculata"). Spring brood markings were also produced by refrigeration pupae at 34–41° F. for 11–32 days and then at 10–16° F. for 40–49 days (two of five males were "immaculata"). None of the pupae in the above experiments were in diapause.

High relative humidity or high barometric pressure had no effect on markings when pupae developed at summer temperatures. In an incidental experiment, pupae exposed to pure oxygen for 6–7 days gave adults unable to expand their wings. Briefer exposure (62 hrs.) allowed normal expansion, but markings were typical of the summer brood.

The conclusion is that subfreezing temperatures, diapause, shortened photoperiod, and reduced temperature during the larval stage, time of pupation, or completion of development preceding eclosion, were unnecessary in producing significant proportions of spring brood specimens experimentally. However, the possibility cannot be excluded that the above factors may play a role in nature.

The present work and the literature suggest that the dominant factor causing reduction of markings might be expressed as extended dormancy of the pupa, necessarily accompanied by temperatures sufficiently reduced to prevent completion of development. The role of degree of temperature depression, beyond that needed to arrest pupal development, is not clear from the available data.

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A NEW SUBSPECIES OF *Callophrys fotis* FROM THE SAN FRANCISCO BAY AREA (LYCAENIDAE)

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With the subspeciation *Callophrys (Incisalia) fotis* (Strecker) demonstrates, it is not surprising that a population differing from the previously described subspecies has been discovered in the San Francisco Bay area. With more extensive collecting in the Coast Ranges other subspecies may be expected.

The subspecies was first collected by David Rentz and reported by C. Don MacNeill in 1962 from the San Bruno Mountains, San Mateo County, (MacNeill, 1963).

***Callophrys fotis bayensis* Brown, new subspecies**

Holotype male: Wings, dorsal primaries uniform slate gray; androconial scales approximately one-half size of surrounding wing scales, pad paler than wing ground color; fringe from apex to vein 2V white, from 2V along inner margin slate-gray, becoming hair-like nearer body. Secondaries much the same as primaries, except anterior third of discal area paler. Vannal area much lighter, almost iridescent white.

Ventral primaries brown with red highlights. Beginning at coastal margin in post-medial area, a white spot with black line extending to M_3 , a distal offset approximately one-fourth its entire length, then continuing to Cu_2 . Little or no white scaling on distal edge of this line. Submarginal area with one black spot in each of cells, Cu_1 , M_3 , M_2 , and M_1 . Submarginal and marginal areas of secondaries reddish-brown with scattering of gray scales. Post-medial area below vein M_3 with long white hair-like scales over base of dark gray. Anterior of M_3 much the same as marginal area. Traversing the wing a dark median line bends out sharply in area of discal cell, distal edge of median line with scattered white scales. Submedial and basal areas with heavy, dark brown scaling, area with thick long hair-like reddish-brown scales. White spot on inner curve anal lobe more prominent than dorsal surface. Dark spots in cells R_1 , Rs , M_1 and M_2 , on distal edge of post-medial area.

Head, crown, and front with reddish-brown scaling; eyes hairy bordered with white scales; labial palpi have mixture of black and white scales. Thorax and abdomen hairy and concolorous with dorsal wing surface.

Allotype female: Wings, dorsal primaries and secondaries tan in distal and limbal area; perimeters gray.

Ventral primaries and secondaries marked as male.

Holotype male: California, San Mateo Co., San Bruno Mts., April 4, 1962 (C. D. MacNeill); allotype female, same locality, March 19, 1963 (C. D. MacNeill). Types are deposited in the California Academy of Sciences, San Francisco; Entomology Type #9547.

Paratypes, 16 males and 20 females; all are from the same locality as holotype; the dates and collectors are as follows: 1 ♂, 3 ♀ III-23-1962 to III-30-1962, 1 ♂, 1 ♀ IV-4-1962, 2 ♂, 1 ♀ IV-5-1962, 1 ♂ IV-11-1962, 1 ♂, 1 ♀ III-13-1963, 4 ♂, 2 ♀ III-19-1963, 2 ♂, 2 ♀ III-20-1963 (C. D.

MacNeill); 1 ♂ IV-11-1962 (U. Kinet); 1 ♂, 3 ♀ IV-5-1962 (R. M. Brown); 1 ♀ III-23-1962 (D. C. Rentz); 1 ♀ IV-6-1962, 2 ♂, 2 ♀ IV-7-1962, 1 ♀ IV-10-1962 (J. Powell); 1 ♀ III-17-1966 (A. J. Slater); 1 ♀ III-19-1966 (P. A. Opler).

One male and one female are in the collections of the U. S. National Museum, Washington, D. C., The Carnegie Museum, Pittsburgh, and the Canadian National Collection, Ottawa. The remainder of paratypes will be at the California Academy of Sciences; the California Insect Survey, University of California, Berkeley; the collection of Paul A. Opler of the University of California, Berkeley; and the author's collection.

Callophrys fotis bayensis Brown, approaches *Callophrys fotis mossi* (Hy. Edwards), closely in general appearance but averages 2.2 mm smaller measured from right primary base to apex. The irregular line on the underside of secondaries has less white on the distal edge than *C. f. mossi*. The gray area between this line and the postmedian row of spots is restricted below m_3 , whereas in *C. f. mossi* the gray tends to cover the entire area.

The markings on *Callophrys fotis doudoroffi* dos Passos, are quite similar to *C. f. bayensis*, except that *C. f. doudoroffi* is lighter in color with less contrast between the basal and distal areas. *C. f. doudoroffi* averages 1.4 mm larger than *C. f. bayensis*, as measured from base of right primary to its apex.

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A LIGHTWEIGHT COLLAPSIBLE BAIT TRAP FOR LEPIDOPTERA

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The use of bait traps for collecting African butterflies has been reported by Rydon (1964). However, only a limited number of collectors so far have utilized traps in North America, in part because most traps are bulky and therefore difficult to transport in large quantities. Another drawback in many existing designs is the difficulty of removing specimens from the traps once they have been captured. The purpose of this article is to report the design and use of an inexpensive collapsible trap which overcomes these deficiencies. Each trap weighs only 17 oz. and can be collapsed to a total thickness of $1\frac{1}{4}$ ".

This trap is similar in design to the East African hanging trap illustrated by Rydon (1964) except that an inverted cone of nylon netting is suspended by two threads from the upper rim of the trap, and is sewed to the lower rim (Figure 1). A $\frac{1}{4}$ " plywood platform ($12'' \times 12''$) holding the bait cup is hung $1''$ – $2''$ below the lower rim, using four screw eyes and $\frac{1}{2}$ " bent chain links.

Twenty-five of these bait traps were made for a cost of less than \$1.50 each, as follows: two coat hangers were bent into hoops $11''$ in diameter; the ends were straightened and then doubled over to form convenient handles for the rims. Green fine-mesh nylon netting then was glued with contact cement to the top rim, and the outside cylinder ($36''$ around \times $30''$ high) was cut from the same material and was sewed to the upper rim using heavy thread with a back-stitch every $\frac{1}{2}$ inch.

The green nylon cone first was cut using a quarter-circle pattern having a radius of $23''$. The central opening at the apex of the cone had a radius of $7\frac{1}{2}''$ on the pattern, giving the upper opening of the cone a diameter of about $4''$, permitting a killing jar, hand, and arm to pass through it readily. The central hole was strengthened with a light springy wire hoop, so that it would hold its shape. The wire hoop was inserted into a sleeve machine-sewed in the upper end of the nylon cone. The lower coat hanger rim was sewed to both the bottom of the cone and cylinder at the same time, in the same way that the upper rim was attached. The side seams of both the cone and cylinder were machine stitched with a zig-zag pattern to prevent the nylon from running.

Small brass safety pins were used to attach the four ends of the cord bridle to the upper rim, and also to attach the threads both to the upper rim and to the wire hoop in the cone. Tying slip knots in these

threads allowed the height of the cone to be easily adjusted. The safety pins keep the nylon from tearing and also permit the threads to be detached, if necessary.

The bait used in the traps consisted of a mixture of stale beer, brown sugar, unsulfured blackstrap molasses, and fermenting fruit (apples, peaches, and bananas). The bait was placed in a white styrofoam cup, and a small piece of cellulose sponge was set in the bait cup to provide a landing site for the insects. A small stone placed in the cup provided enough weight to hold the cup in position on the platform. Stones also proved useful as counter-balances for leveling the platforms, and in strong winds, heavy stones placed on the platforms kept the traps from swaying.

During the summer of 1967 between 9 and 19 traps were tested in 4 woodland localities in Vermont, Massachusetts, Connecticut and Virginia, respectively (Table 1). Among the butterfly species collected were eight nymphalids and four satyrids. The Papilionidae, Pieridae, Lycaenidae, and HesperIIDae were absent from the traps, although they were present in all of the areas where the traps were placed. Also collected were four species of *Catocala* and four species of the Sphingidae (Table 1), as well as a variety of common small moths.

Occasional trap interference was caused by chipmunks (*Tamias striatus*) and flying squirrels (*Glaucomys* spp.) in the Vermont and Massachusetts localities. These animals not only ate some specimens (*Euphychia*, *Limenitis*) but also chewed holes in the nylon netting. Even when the tears were extreme the traps could be easily repaired using contact cement and nylon patches. Once small mammal interference occurs, the trap has to be moved to a new location in order to remain effective. Another instance of trap interference probably was caused by a deer in Virginia.

In addition to Lepidoptera, species of Diptera, Hymenoptera, and small Coleoptera often were taken in the traps. Unwanted dead Lepidoptera or other insects can be removed from each trap by detaching the platform, turning the trap over so that the dead insects fall to the top, grasping the nylon cylinder and closing it at the hoop of the cone, and then putting the upper and lower rims together, turning the cone inside out beneath the rims, and shaking the rims by the rim handles. Unwanted living specimens can be released simply by detaching the platform, turning the trap upside down, and everting the cone upwards, thereby permitting the insects to fly out.

Collecting with bait traps has a number of advantages not inherent in collecting with a hand net:

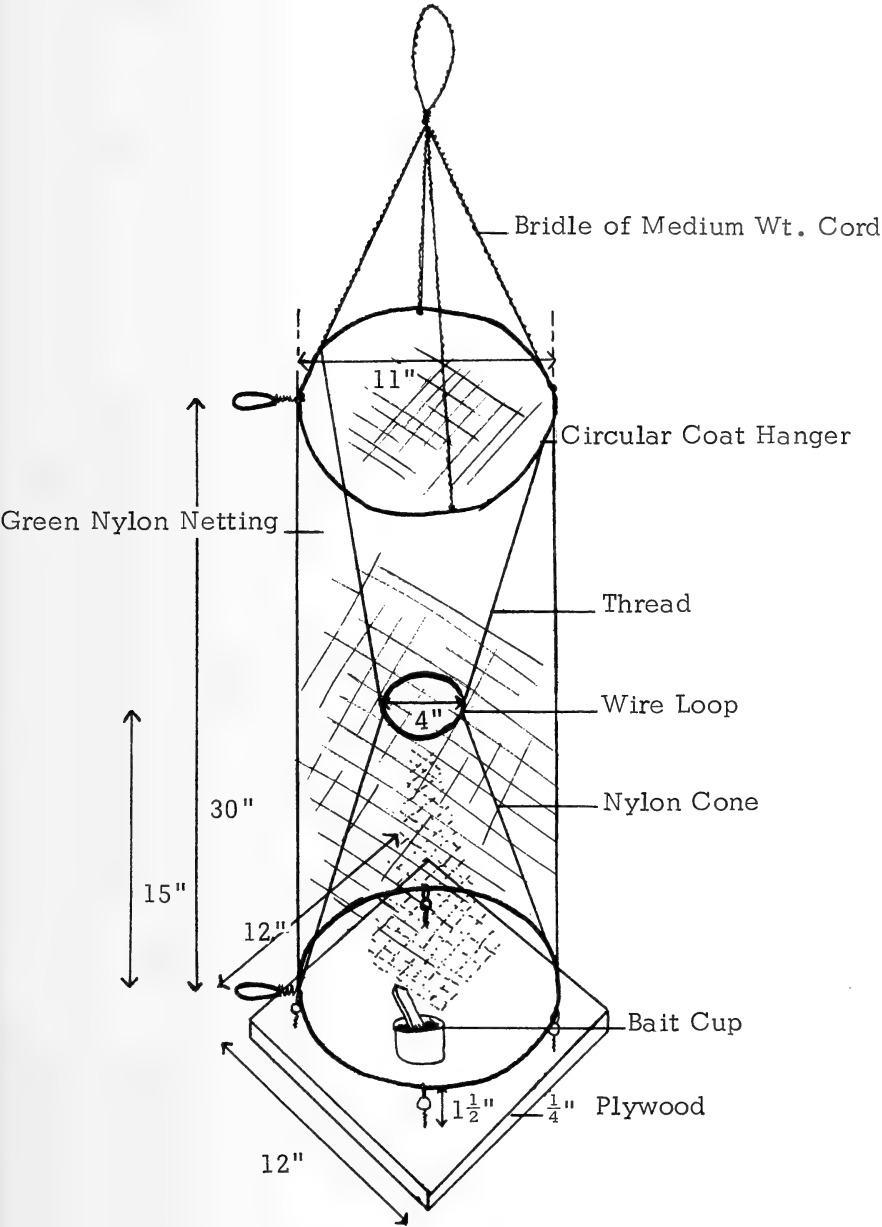


Fig. 1. Diagram of collapsible hanging bait trap.

TABLE 1. SPECIES OF LEPIDOPTERA COLLECTED IN BAIT TRAPS

	Localities ¹	Abundance in traps ²
RHOPALOCERA:		
NYMPHALIDAE		
<i>Limenitis archippus</i> (Cramer)	II	U
<i>Limenitis arthemis</i> (Drury) ³	I, II	C
<i>Limenitis astyanax</i> (Fabricius)	II, III	C
<i>Nymphalis antiopa</i> (Linnaeus)	I-IV	C
<i>Nymphalis v. j-album</i> (Boisduval & LeConte)	I, III	U
<i>Polygonia interrogationis</i> (Linnaeus)	I-IV	C
<i>Polygonia comma</i> (Linnaeus)	I-IV	C
<i>Vanessa atalanta</i> (Linnaeus)	I-IV	C
SATYRIDAE		
<i>Cercyonis pegala</i> (Fabricius)	I-III	A
<i>Euptychia cymela</i> (Cramer)	I-IV	A
<i>Lethe eurydice</i> (Johansson)	I-III	C
<i>Lethe portlandia</i> (Fabricius)	I-III	A
HETEROCERA (large species only):		
NOCTUIDAE		
<i>Catocala epione</i> Drury	III	C
<i>Catocala grynea</i> Cramer	III	U
<i>Catocala ilia</i> Cramer	III	A
<i>Catocala ultronis</i> Hubner	III	C
SPHINGIDAE		
<i>Amphion nesus</i> Cramer	II, IV	U
<i>Darapsa pholus</i> Cramer	I, II, IV	C
<i>Sphecodina abbotti</i> Swainson	I, III, IV	C
<i>Sphinx kalmiae</i> Abbot & Smith	II	U

¹ I—Addison Co., Starksboro, Vt., VII 6-VII 19, 1967, 16 traps;

II—Franklin Co., Shutesbury, Mass., VI 24-VII 1, 1967, 19 traps;

III—Middlesex Co., Middletown, Conn., VII 24-VIII 2, 1967, 9 traps;

IV—Giles Co., Mountain Lake, Va., VI 13-VI 16, 1967, 18 traps.

² A—Abundant; C—Common; U—Uncommon.³ Including form "proserpina" Edwards, common at site II.

1) Traps provide a means of collecting large numbers of specimens of common species from a given locality with a minimum expenditure of time.

2) All species taken in the traps were collected in approximately equal sex ratios; the trap samples are not biased in favor of males, as netted samples often are (Brower, 1963).

3) The traps may also double as efficient breeding cages. Two species (*Euptychia cymela* and *Cercyonis pegala*) were occasionally found in copula in the traps when large numbers of individuals were present. The former species also was observed ovipositing near the top of one trap.

4) Traps of this type should prove to be quite useful in mark-release and recapture experiments and quantitative population studies of certain species of Lepidoptera.

In conclusion, these traps provide an efficient means of collecting all species of Lepidoptera known to be attracted to baits. Samples taken with traps are highly selective, being biased in favor of certain nymphalids (i.e. the Angle Wings) and the satyrs. However, by altering the type of bait, the distance of the opening between the platform and the lower rim of the trap, and by placing these traps in other than woodland habitats, additional species can probably be collected with them.

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BOOK REVIEW

UNTERSUCHUNGEN ÜBER DIE SYSTEMATIK DER TRIBUS THYATIRINI, MACROTHYATIRINI, HABROSYNINI UND TETHEINI (LEPIDOPTERA: THYATIRIDAE), by Karl Werny. 463 pp., 436 figs. and maps. 1966. Inaugural-Dissertation, Universität des Saarlandes, Saarbrücken, Germany.

An important worldwide revision of parts of the moth family Thyatiridae has remained little noticed, on this continent. The work encompasses the 102 species of the tribes Thyatirini, Macrothyatirini, Habrosynini and Tetheini. The revision was published as the author's Ph.D. thesis by the faculty of Mathematics and Natural Sciences of the University of Saarbrücken, under the auspices of the late Professor Dr. G. de Lattin who expressed the hope that the research on the remaining tribes of the subfamily Thyatirinae (28 species) and the small subfamily Polyplocinae (50 species) would follow soon.

In the North American fauna we do not have many species of the family Thya-

tiridae. However, the status of some of these was unclarified. Therefore, we are duly thankful to the author for having presented us with an answer to our old questions.

The revisionary work itself is thorough and anyone who has done something along this line will appreciate the enormous work the author did. Not only have every species and subspecies, genus and tribe been profusely discussed, but also the male and female genitalia and some venation drawings are shown, as well as black and white photographs of the moths. Maps show the worldwide distribution of almost all genera involved. An impressive bibliography and indices to tribes, genera and species with subspecies and forms complete the very satisfactory and industrious work.

For us on this continent, what the author has to say about our well known species of the following genera is of special interest.

Euthyatira Smith, 1891: *pudens* (Guenée, 1852); Werny shows with the help of the male and female genitalia that there is a specific difference between *pudens* and what was up to now thought to be only an individual form of it, *pennsylvanica*. The valvae are different enough to warrant alone the decision of the author. There follows the interesting nomenclatorial fact that *pennsylvanica* will have as author Werny, as Smith had previously described it only as a "variety" of *pudens*. *E. lorata* (Grote, 1881) and *semicircularis* (Grote, 1881); Werny says that they are distributed all over the northern United States, and adds, in the case of the latter, southern Canada. This, however, is erroneous. Both species are clearly, at least as is known from specimens in our American collections, only western, as is also convincingly shown by the localities of the specimens used by the author, who succumbed to a common error of European authors dealing with North American species, not having a vivid enough idea about the influence of the Rockies on distributional facts.

Habrosyne Hübner, 1816: Only two of the many species of this genus are familiar with us; *scripta* (Gosse, 1840) and *gloriosa* Guenée, 1852, the latter being quite rare but probably more widely distributed than supposed previously. As subspecies to *scripta* are *chatfeldti* Grote, 1895, and *abrasoides* Barnes & Benjamin, 1929, to *gloriosa*, *arizonensis* Barnes & McDunnough, 1912. In dealing with *abrasoides* and *arizonensis* author did not understand the meaning of Barnes & Benjamin in their description of *abrasoides*, that it is "a parallel to *gloriosa* (*rectangulata*) race *arizonensis* B. & McD." Of course, the subspecies as such are not parallel. What the author misinterprets as "identical," refers to the development of similar characters in two nearly related species, i.e. parallel development under the same local conditions.

Pseudothyatira Grote, 1865: Here, too, we are shown that what we considered to be individual forms of one species, are in reality two species: *cymatophoroides* (Guenée, 1852) and *expultrix* (Grote, 1863). The male and the female genitalia show constant differences in 178 specimens investigated by the author. The reviewer checked the genitalia of a series of both species in our collection from different North American localities and found that Werny's findings were confirmed. Both species fly at the same time of the year and in many localities they both occur, *cymatophoroides* being the more uncommon. Werny says that there is no knowledge about the immature stages of both species. Research in this direction should prove to be rewarding.

Following the old (and perhaps a little outmoded) way Werny had first made slides of the genitalia and then the drawings. The result is artificially distorted genitalia, and the aedoeagi are not all shown in the same position, which makes comparison difficult. Drawings can be made from the genitalia while these are put in alcohol and glycerin (80% alcohol and glycerin at equal parts) in small glass dishes. They may then be kept indefinitely in vials with the same mixture or, if absolutely not avoidable, slides can be made then. This would be very recommendable for the future work.

Notwithstanding the above few little remarks, we have all reason to congratulate the author on his tremendous work and we can only hope that he will bring it to a good finale, soon.—J. C. E. RIOTTE, *Research Associate, Department of Entomology, Royal Ontario Museum, Toronto, Ontario, Canada.*

FIELD NOTES AND SUBSPECIFIC STATUS OF *OENEIS*
MELISSA (SATYRIDAE) IN NORTHERN QUEBEC

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During July, 1967, Fred Fauver, of Nasson College, Springvale, Maine, and I collected in the Schefferville area of northern Quebec. Due to personal help of Henry Hensel of Edmundston, New Brunswick, who collected in Schefferville during July, 1964, Hensel's paper concerning his trip there, and through a paper by Dr. Eugene Munroe, who collected there as part of the Canadian Northern Insect Survey of 1948, we had reasonable knowledge of the butterfly fauna of the area before we arrived. I was especially interested in collecting the *Oeneis* known from the region. Munroe reported one species, *O. melissa assimilis* Butler, and Hensel had found two additional species, *O. taygete taygete* Geyer, and *O. jutta ridingiana* Chermock & Chermock. We were especially advised to look for the scarce *O. melissa* which had been reported by both investigators to frequent only the tops of the highest hills. Since Hensel took only one individual, and Munroe was able to catch very few, we were doubly eager to find the species and collect a good series.

Although we carefully searched the highest points (2,200+ ft. elev.) in the immediate vicinity of Schefferville, we were unable to find *O. melissa*. The other two *Oeneis* were common, *O. jutta* being found in moist tundra forest at about 1,700 feet, while *O. taygete* was confined to moist grassy beds of dried up lakes from 2,000 to approximately 2,500 feet. Then on July 16 we investigated Irony Mountain (approx. 2,880 ft.) 25 miles northwest of Schefferville. On the summit we found *O. melissa* fairly numerous. Most of the individuals we saw and caught were first seen flying against a strong northwest wind in attempts to reach higher ground. When they were within 20 feet or so of the summit marker, they would generally settle on the black quartzite rocks which covered the ground. The species was wary and difficult to catch in the wind. When alarmed, an individual would invariably fly up, be caught in the wind and be blown down the southeast slope of the mountain. Although we were not able to follow a wind-blown individual, we presume that one blown down the mountain returned to the summit after a short time. This presumption is based on the fact that we once managed to frighten away every detectable individual, and within a very few minutes, they reappeared *en masse*.

The first *Oeneis* that we caught attracted our attention as not fitting

the descriptions of *melissa assimilis*. The two females we caught were in fresh condition and tended from brown to yellow brown on the dorsal sides of the wings. Males were of a uniform gray-brown dorsally. Ventrally, both sexes showed appreciable contrast between the light distal area of the hindwing and the dark postmedian band. Both sexes seemed to be unusually small for *assimilis*. In contrast to individuals of the Irony Mountain population, typical *assimilis* is very dark gray or black dorsally with little or no brown in either sex, and shows less contrast between light and dark areas on the ventral hindwings.

When I returned home from Schefferville, I took the series of *melissa* to Dr. C. F. dos Passos for help in making a determination. We agreed that the Schefferville specimens resembled *O. melissa semplei* Holland more than *O. m. assimilis*. In addition, Schefferville is nearer the type locality of *semplei* (Little Cape Jones River, east coast of Hudson Bay) than that of *assimilis*, which has a more northern distribution. From the evidence we believe that *Oeneis melissa* from the Schefferville area should be referred to as *O. melissa semplei*.

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HELICONIUS HECALE AND XANTHOCLES IN VENEZUELA (NYMPHALIDAE)

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Heliconius hecale Fabricius is an easily recognizable species that has only been known from a limited area in Guiana. Hall (1939) noted that *H. hecale* was found at Parika (where it was locally common), Demerara and Mabaruma, British Guiana. While Emsley (1965) records *H. hecale* from El Chorro, Venezuela, I have been unable to verify its presence in Venezuela until recently. During December of 1966, Albert and Mary Lou Gadou, of Caracas, collected in the Guiana Highlands close to the British Guiana border at El Carmen (25 Km northeast of El Dorado), Bolivar, Venezuela. I recently examined their El Carmen "catch" and was happily surprised at finding a short series of *H. hecale*. Emsley (1965) noted that the pair of specimens from El Chorro were unique because the white forewing bands were shifted toward the apex and did

not intersect the cell. I consider the El Carmen specimens, which have slightly wider bands than British Guiana specimens, but in the normal position, to be nominate *H. hecale*. *Heliconius ethillus* Godart was collected sympatric with *H. hecale* at El Carmen. This is significant because while *ethillus* and *hecale* are readily separated by pattern they are morphologically indistinguishable. Emsley (1965) states: "It is not known to what degree if any *H. hecale* is geographically or ecologically isolated from ostensibly sympatric forms of *H. ethillus*. . ."

During February, 1966, I collected three specimens of *Heliconius xanthocles* Bates, not previously known from Venezuela, 85 kilometers south of El Dorado on the El Dorado/Santa Elena road, Bolivar, Venezuela. Dr. Michael G. Emsley of the Philadelphia Academy of Science confirmed my determinations. An examination of the Gadou collection revealed several additional examples of *H. xanthocles* that had been captured at Santa Elena de Uairena, Bolivar, Venezuela during August, 1964. All of the Venezuelan *xanthocles* lack rays on the hindwings and are best referred to as nominate *H. x. xanthocles*. *Heliconius xanthocles* was found sympatric with two similarly marked species: *Heliconius burneyi catharinae* Staudinger and *Heliconius elevatus tumatumari* Kaye at Kilometer 85 and *H. b. catharinae* and *H. elevatus roraima* at Santa Elena. The Gadous collected about ten examples of *H. e. roraima* at Santa Elena, the only known specimens outside of the type series from Mt. Roraima.

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NOCTURNAL COPULATION OF RHOPALOCERA

The article on mating behavior of butterflies by Miller and Clench (1968, *J. Lepid. Soc.*, 22: 125-132) prompts me to report several instances of mating pairs of butterflies collected on a moth sheet using a 15 watt "BL" florescent light. Six pairs have been taken but only two species are involved, *Libytheana bachmanii* (Kirtland) and *Strymon melinus* Hubner. Four pairs of *L. bachmanii* were collected in 1966 in Lake Corpus Christi State Park near Mathis, Texas. Three pairs on the 15th and one pair on the 16th of June. Collection times were 10:35 P.M. (2 pair), 11:15 P.M. and 11:45 P.M. Central Standard Time. It should be pointed out that *L. bachmanii* was literally swarming all through the park at this time and 27 other individuals were taken from the light sheet during three evenings of collecting. The specimens were probably disturbed from the trees overhead by our activity or by other large insects which were swarming around the light. All four pairs were mated when found and may either have been resting in coition in the trees above or joined after their arrival on the sheet.

In the same park, 17 June, 1968 we collected another mating pair of *L. bachmanii* and one pair of *S. melinus*. The *L. bachmanii* were paired when found at 11:05 P.M.

(Central Daylight Time). At the same time two *S. melinus* were noticed sitting near the top of the sheet about four inches apart and about 18 inches from the light. One had a damaged hindwing which proved to be a valuable observation since this damaged specimen (a female) was later found paired with a fresh male, probably the one previously observed. Copulation occurred sometime between 11:10 and 11:45 P.M. when the pair was found and collected. *L. bachmanii* was a scarce species this visit while *S. melinus* was only reasonably common. I would like to acknowledge my thanks to the Texas Parks and Wildlife Dept. for making available the necessary park collecting permits.—J. RICHARD HEITZMAN, 3112 Harris Ave., Independence, Missouri.^{1, 2}

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BOOK REVIEW

MICROLEPIDOPTERA OF THE PHILIPPINE ISLANDS, by A. Diakonoff. U. S. National Museum, Bulletin 257, 484 pp., 1967. \$2.00 paper cover.

Diakonoff estimates that less than 20% of the existing Microlepidoptera fauna is enumerated in this survey, which is based largely on the C. F. Baker collection at the U. S. National Museum. A total of 291 species is recorded, distributed among 138 genera, of which 19 genera and 146 species are new, and 18 genera and 203 species (70%) are endemic to the islands. The available material, albeit scanty, is said by Diakonoff to have a pronounced Malayan character.

The treatment includes the lower Ditrysia, beginning with the Tortricoidea in the order of most arrangements, that is, it does not encompass the pyraloids and zygaenoids. There are no Monotrysia. The species treated are about equally divided between the tortricoids, the gelechioids, and the yponomeutoid-tineoid families, with the Tortricidae having the highest total, 74 species. The Glyphipterygidae shows a surprising development, with 30 species, or more than 10% of the known fauna.

A table appended to the text gives a list of the species with indications of the individual islands from which they are known. The preliminary state of knowledge is probably best illustrated here, as only about 35 species are recorded from more than one island, only seven species from more than two.

The text is accompanied by some 490 excellent line drawings, done by several artists, and by about 390 photographs of the moths, which are on the whole good for all except the aegeriids. Genitalia of virtually all species, including previously described ones, are figured. Lectotypes are selected for 20 species, including a dozen which were described from areas other than the Philippines. Lectotypes are enumerated in the appendices and are figured and include five Formosan species, two of which do not occur in the Philippines. Keys are based on a mixture of superficial and genital characters and at least in some cases (*e.g.*, Copromorphidae) include all the species of the Asiatic fauna, with indications of their geographical occurrence, although these species are not treated further in the text.

The present work is not intended to be a classification, yet Diakonoff's linear arrangement of families includes some interesting placements. For example, the Orneodidae, a group long under controversy as to its affinities, is placed among the gelechioid families; while the Ethmiidae, a group with undoubted relationships to some of the Gelechioidea, especially the Oecophoridae and Stenomidae, is placed with the yponomeutids and plutellids, a retrogression to the practice of a half century ago.

This is a highly valuable contribution to anyone interested in biogeography of Lepidoptera, and it will form the starting point for the development of faunistic studies of the as yet poorly known Microlepidoptera of the Philippine Islands.—J. A. POWELL, University of California, Berkeley.

DETAILED DESCRIPTION OF LARVA OF *POLYDORUS ARISTOLOCHIAE*

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Polydorus aristolochiae (Fabricius) is the commonest large-tailed, black butterfly of the Indo-Pakistan subcontinent. At Tandojam ($25^{\circ}26'N$; $68^{\circ}32'E$), West Pakistan, larvae were found feeding on *Aristolochia bracteata*. The present work was undertaken during the year 1962-63.

Ghosh (1914), Talbot (1939) and Wynter Blyth (1957) have briefly described the larva of *P. aristolochiae*. The descriptions below should make the knowledge of this species larva more complete.

The body of the larva is covered with a series of pointed, fleshy outgrowths. Their position and number present important diagnostic characters. These outgrowths are present in all instars with slight modifications, including suppression of some in certain instars.

The position and structure of outgrowth is given below:

Sub-median Tubercles: Present dorsally on either side of median line.

Dorso-lateral Tubercles: Present on either side of sub-median tubercles in dorso-lateral position.

Lateral Tubercles: Present on lateral position below dorso-lateral tubercles on either side.

Sub-lateral Tubercles: Situated on either side below series of lateral tubercles.

Ventro-lateral Tubercles: Present on either side below line of sub-lateral tubercles at the base of legs.

Ventral Tubercles: Situated on ventral side, present only on second abdominal segment in contrast to preceding ones have rounded apices.

Following is the occurrence and appearance of these tubercles, as described separately for each instar.

FIRST INSTAR.

Sub-median Tubercles: Present on the mesothoracic, metathoracic, and 1st to 9th abdominal segments, covered with six to seven black hairs. Tubercles of mesothoracic, metathoracic, and 7th and 8th abdominal segments yellowish brown; those of 3rd abdominal segment cream colored, remainder chocolate brown, those of 4th abdominal segment tinged slight yellowish.

Dorso-lateral Tubercles: Present only on mesothoracic and metathoracic segments. Each tubercle covered with five to six black hairs. Tubercles of the mesothoracic segment of chocolate color, those of metathoracic yellowish brown.

Lateral Tubercles: Present only on prothoracic segment, chocolate brown, covered over with seven to eight black hairs larger than hairs on dorso-lateral tubercles of metathoracic segments.

Sub-lateral Tubercles: Present on mesothoracic and metathoracic and 1st to 8th abdominal segments, covered with six to seven black hairs, smaller than those present on dorso-lateral tubercles. Tubercles of thoracic segments yellowish brown, those of 4th to 8th abdominal segments brown.

Ventro-lateral Tubercles: Present on three thoracic and 1st to 7th abdominal segments, covered with 4 to 5 black hairs. Tubercles as well as hairs smaller than

preceding series. Color of tubercles yellowish brown except prothoracic and last three abdominal segments, yellowish.

Shield present on prothorax, dark brown, laterally on either side with a whorl of hairs, in line with sub-median tubercles.

Ventral side of first three and 8th abdominal segments with a number of short, paired hairs; 1st abdominal segment with one to two hairs on each side, 2nd abdominal segment with five to six hairs on either side, 8th abdominal segment with only one pair of tiny black hairs.

Towards end of 1st instar pairs of whitish spots appear in front and behind prothoracic shield; yellowish white spots appear near bases of sub-median and lateral tubercles and at the tip of sub-lateral tubercles.

SECOND INSTAR LARVA.

Resemblance to full-grown larva becomes practically complete except yellowish band which becomes gradually broader in successive stages. Location and number of tubercles same as in 1st instar larva; yellowish white spots present, representing beginning of a band on 3rd abdominal segment; pair of prominent yellowish dots dorsally in 4th abdominal segment. Tubercles change from yellowish to scarlet with slight orange tinge; tips of tubercles specially sub-median series have a yellowish tinge.

THIRD INSTAR LARVA.

No morphological or color difference between 2nd and 3rd instar except larger size and disappearance of all hairs from tubercles. Larva thus looks smooth. Yellowish dots behind band, prominent in second instar, become pinkish and elongated in size, giving appearance of tubercles.

FOURTH INSTAR LARVA.

No morphological or color difference between 3rd and 4th instar except larger in size, appearance of ventral tubercles, and tubercles present on band attain pale yellowish to scarlet color with pale orange tinge. Ventral tubercles appear on 2nd abdominal segment in line with prolegs, smaller than all other tubercles; color varies from light orange to scarlet with orange tinge; ventral tubercles possess rounded ends and are covered with minute black hairs.

FIFTH INSTAR LARVA.

Color same as in preceding; larger, measuring 39 to 42 mm in length, 9 to 10 mm in breadth. Position and appearance of tubercles as in 4th instar; two pairs of sub-median tubercles appear on prothorax and 10th abdominal segment. Band, prominent, creamy colored, extends to ventro-lateral region on either side. A pair of white dots on 4th abdominal segment touching sub-median tubercles.

ACKNOWLEDGMENT

To J. A. Powell, University of California, Berkeley, I wish to express my sincere appreciation for critically editing, correcting and improving this paper.

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A SIMPLE TECHNIQUE FOR HAND-PAIRING *LIMENITIS* BUTTERFLIES (NYMPHALIDAE)

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The development of various methods for hand-pairing butterflies has been reviewed by Clarke and Sheppard (1956). Such methods have been very useful in genetic and hybridization studies, particularly among the Papilionidae and the Pieridae. However, the Nymphalidae and other families having relatively small copulatory structures are known to be quite difficult to hand-pair. Clarke and Sheppard state that Lorkovic had successfully hand-paired three genera of Nymphalids, *Limenitis*, *Neptis*, and *Melitaea*. In addition, Remington (1958) has produced interspecific hybrids between *Limenitis wiedemeyeri* Edwards and *L. astyanax* (Fabricius) by hand-pairing. The present paper will report a simple hand-pairing technique developed during the past two summers which has proved useful for breeding *Limenitis* in the laboratory.

The method involves stunning the male and female to be paired in a large sodium cyanide insect killing bottle from one to five minutes at room temperature, and then everting the male claspers (often partially accomplished by the cyanide treatment) by applying slight pressure to the lateral and ventral portions of the male's abdomen with the thumb and forefinger. Meanwhile, the stunned female is held in the other hand, and her abdomen is curved downward, so that it is exposed beneath the wings. The butterflies are positioned so that the male can clasp the ventral portion of the female's abdomen one segment in front of the ovipositor. During this procedure the male is moved constantly in a small circle to stimulate eversion of the genitalia and clasping. While still unconscious the pair is laid on its side with the male's abdomen positioned at an angle of about 135 degrees in relation to the female's. The male involuntarily opens and closes his valvae, thereby inserting the aedeagus and initiating the rhythmic contractions of copulation.

Once the male has clasped the abdomen of the female and the butterflies begin to recover from the cyanide (usually within four to seven minutes after stunning), the pair is placed on a rectangular piece of moist cellulose sponge set on a paper towel, and the male's hindwings are positioned inside the female's, using a pointed probe. The pair is then covered with a transparent plastic shoe box above which are placed incandescent and fluorescent lamps, and the butterflies are left undisturbed while recovery and mating proceed.

Occasionally during recovery from the cyanide one or both butterflies may begin to flap their wings violently, and the pair may break apart; however, if the pair is clasping properly, only slow rhythmic wing movements occur as the butterflies bask in the warmth of the lights.

Since developing this technique in August, 1965, I have been able to carry out 35 matings involving the species and forms of *Limenitis* occurring in New England. Table 1 lists the numbers and types of intra-specific and interspecific crosses which have been completed to date. The brood data obtained from those crosses made during 1966 have been reported elsewhere (Platt & Brower, 1968).

As the table indicates, mated females could not always be induced to oviposit. Bred females were confined in silk organza bags outdoors on boughs of trees for egg laying. Females of *L. arthemis* (Drury), including its form "*proserpina*" Edwards, and *L. astyanax* (Fabricius) were placed on wild cherry, *Prunus serotina* Ehrl. and females of *L. archippus* (Cramer) were put on black willow, *Salix nigra* Marsh. Extended periods of cold, windy, and rainy weather, as well as predation by stink bugs, (Hemiptera, Pentatomidae) which occasionally pierce the abdomens of females through the bags, accounted for the deaths of nine females before they had laid eggs.

In eight other instances eggs which were laid were found to be infertile. Therefore, after death all hand-paired females were dissected (using the method employed by Burns, 1966) to determine whether or not a spermatophore had been formed within the bursa copulatrix of each female. The presence of a spermatophore within the female was considered evidence that the pairing itself had been successful.

Successful matings were found to last from 45 minutes to over two hours; in no case has a spermatophore been found in females which have been in copula for only 25 minutes or less. So far there have been only five cases in which no spermatophore was found in females which had been in copula for longer than one hour. In all successful pairings to date only a single spermatophore has been formed.

Refinement of this hand-pairing method during the past summer has permitted me to pair practically any two individuals, provided that the male is at least five days old, and that its abdomen has hardened; also, the female, which is usually larger than the male, must be stunned in the killing bottle before the male is put into it, and must remain in the bottle while the male is being stunned.

Further, I have found that if the first pairing attempt is unsuccessful, the butterflies can be stunned several more times without danger of killing them. However, the individuals apparently develop a higher tol-

TABLE 1. HAND-PAIRED *Limenitis* CROSSES CARRIED OUT AT WAKEFIELD, R. I. AND MIDDLETOWN, CONN. (1966-67). Dissection of the 35 females involved in these crosses revealed that each contained a single spermatophore.

P ₁ Cross		No. of broods	Eggs fertile	Eggs infertile	Eggs not obtained
Male	Female				
Intraspecific ¹ :					
<i>arthemis</i> × <i>arthemis</i>		2	1	1	0
<i>astyanax</i> × <i>astyanax</i>		8	3	3 ²	2
<i>archippus</i> × <i>archippus</i>		5	4	0	1
" <i>proserpina</i> " × " <i>proserpina</i> "		3	3	0	0
" <i>proserpina</i> " × <i>arthemis</i>		1	0	1 ³	0
" <i>proserpina</i> " × <i>astyanax</i>		2	1	0	1
<i>arthemis</i> × <i>astyanax</i>		4	1	1	2
<i>astyanax</i> × <i>arthemis</i>		3	2	1	0
	Totals	28	15	7	6
Inter-species:					
<i>archippus</i> × <i>arthemis</i>		1	0	0	1
<i>archippus</i> × <i>astyanax</i>		3	2	0	1
<i>arthemis</i> × <i>archippus</i>		2	1	0	1
<i>astyanax</i> × <i>archippus</i>		1	0	1	0
	Totals	7	3	1	3

¹ All breeding and collecting evidence accumulated to date supports the contention that *L. arthemis*, *proserpina*, and *astyanax* represent intergrading forms within a single species complex.

² These three crosses involved a single male which was bred to three different females; the male and two of the females were F₁ siblings of a wild-caught female from Stanton, N. J., which laid 47 eggs, only 8 of which hatched; the third female was an F₁ from a wild female captured near Springdale, N. J.; the author believes this infertility has resulted from the use of an inviable *astyanax* strain.

³ A very old male, which died in copula, was used in making this cross.

erance to the cyanide each time that they are stunned, so that with each successive attempt they must remain in the bottle for a longer period of time.

This method has enabled me to breed several males three or four separate times, using different females each time. In such cases the males breed best on alternate, rather than consecutive days. Between pairings the males are kept in labeled, transparent envelopes in total darkness at room temperature. Virgin butterflies to be paired are kept the same way, and are fed a solution of dilute honey and water once daily, except on the day that they are to be bred.

Apparently females will breed most readily a day or two after emergence from the chrysalids; however, successful first matings have been accomplished with some females more than two weeks after they have hatched.

The viability of both parents and progeny seems to be unaffected by

the cyanide treatment, for sex ratios and total numbers in the hand-paired broods compare favorably with those in broods obtained from wild females, and from females bred in outdoor cages. Only in the interspecific crosses in which *L. archippus* has been paired to either *L. arthemis* or *L. astyanax* is there evidence of inviability in the heterogametic (female) sex: all F_1 progeny in these crosses so far have been males.

This simple method of hand-pairing has proved extremely useful in crossing *Limenitis* butterflies, and has provided a means of using male individuals in a series of crosses with females having different phenotypes. With modifications this technique may prove useful for breeding other species of Lepidoptera, and for effecting hybrid crosses between closely related forms.

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BOLORIA POLARIS (NYMPHALIDAE) IN NORTHERN BRITISH COLUMBIA

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During two northern vacations, my family and I have passed the vicinity of Summit Lake, Mile 392 on the Alaska Highway in northern British Columbia, on four separate occasions. However, only on July 12, 1966, as we were returning home after spending a few weeks collecting in Alaska and the Yukon Territory, did we find the weather suitable for collecting. Because Summit Lake is the point of highest elevation, 4,250 feet, along the Alaska Highway, it was felt that an hour or two collecting might yield some interesting specimens. The hillside selected for collecting was steep and with little vegetation, but some of the rocky outcrops appeared to be logical spots to find a basking *Oeneis* or *Boloria*. Although the subsequent weather was not entirely cooperative, in approximately one hour spent on the hillside, *O. polixenes* (F.), *B. titania* (Esper), *B. freija* (Thunb.), *Pieris napi* (L.), and *Plebejus saepiolus* (Bdv.) were taken. The real prizes, however, were three *Boloria polaris* (Boisduval), all females but unfortunately all slightly worn. Others were seen, but once frightened were impossible to follow, much less capture.

This is not the first record of *B. polaris* in British Columbia. Both Blackmore (1927) and Llewellyn-Jones (1951) list *polaris* as having been taken at Atlin, although the latter record is presumably a repeat of Blackmore's. As the crow flies, Atlin is about 300 miles west and somewhat north of Summit Lake.

One of the Summit Lake specimens is compared in figure 1 to a female taken at Coppermine, N. W. T. on July 1, 1966 by Henry Hensel. It is readily apparent that the B. C. specimen is appreciably larger than its arctic counterpart. The average forewing length of the British Columbia specimens is 21.5 mm, whereas that of four Coppermine females is 19 mm.

Several differences can be noted on the ventral surface of the hindwings. On the British Columbia specimens, the area surrounding the submedian-median row and the basal spots is very dark brown thus making these areas, which contain predominantly white scales, stand out clearly. The postmedian spots are prominent and are separated only by the darker veins. Little if any of the dark brown coloration invades this area and the submarginal spots are also prominent, large and white. They are separated by dark brown scales.

In contrast, the Coppermine specimens exhibit an orangish-brown to brown general tone on the ventral surface of the hindwings. This ground

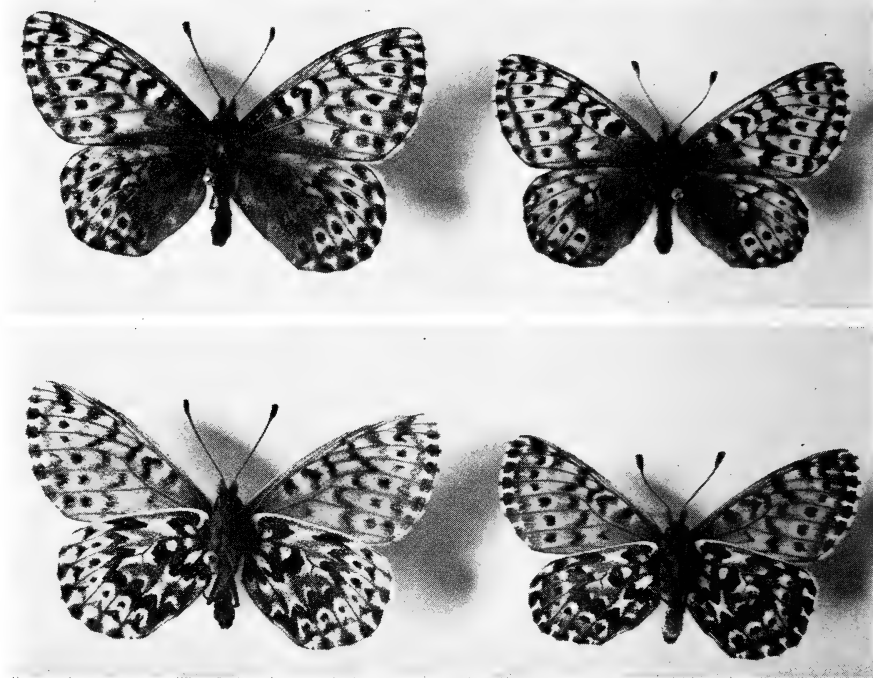


Fig. 1. *Boloria polaris* (Bdv.). Top: Dorsal View. Left: Near Summit Lake, Mile 393, Alaska Highway, British Columbia, July 12, 1966. Right: Coppermine, Northwest Territories, July 1, 1966. Bottom: Ventral view of the same specimens.

color covers an extended area including much of the area between the basal spots and the postmedian spots as well as the area adjacent to and including the submarginal spots. The postmedian spots are reasonably distinct as are the submarginal spots. The submedian-median row is white-edged but is much invaded by darker scales, thereby greatly decreasing its contrast with the ground color of the wing.

Typical *B. polaris* was described by Boisduval from Cap Nord, Norway. Klots (1951) has stated that he can see no consistent difference between the typical insect and *B. p. groenlandica* (Skinner) (TL west coast of Greenland), *B. p. americana* (Strand) (TL Ellesmere Island, Jones Sound), or any of the Nearctic populations. Presumably the Coppermine specimens should resemble typical *B. polaris*. Obviously, important differences exist between the two populations compared in the present paper. However, determination of the exact status of the Summit Lake *B. polaris* population must await the accumulation of a longer series, and its comparison with the typical Norwegian insect as well as other North

American populations. Nevertheless, the present author believes that *B. polaris* from northern British Columbia deserves careful consideration for subspecific status.

ACKNOWLEDGMENT

I wish to thank Mr. Cyril F. dos Passos, who confirmed my identification of this insect and kindly provided me with the Atlin record.

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A NOTABLE INTERGENERIC MATING (LYCAENIDAE)

The following intergeneric mating was observed by the author at Bear Creek Canyon, Yakima County, Washington, on June 9, 1968, at 1:30 P.M., P.D.T. A pair of copulating lycaenids was flushed from the road and soon resettled a few paces away. To my surprise the male participant was *Plebejus icariodes montis* Blackmore, and the female, *Everes amyntula* (Boisduval). The specimens were again flushed and netted airborne. The *amyntula* was the flying partner, in this instance.

Plebejus icariodes was quite common in the area, but the female *amyntula* was the only example of the species noted.

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A REVISED SYNONYMIC LIST OF THE NEARCTIC MELITAEINAE WITH TAXONOMIC NOTES (NYMPHALIDAE)

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INTRODUCTION

Within about one year two authors working independently revised a substantial number of Nearctic Melitaeinae genera. The first, H. L. Higgins (1960), published a revision of *Chlosyne* and allied species [genera], and the second, D. L. Bauer (1961), published on the Tribe Melitaeini. These two works, while not covering exactly the same ground, between them rendered the arrangement of the Melitaeinae genera and species in the Synonymic List (dos Passos, 1964) somewhat obsolete. That list had

been completed as of December 31, 1958 but was long in course of publication. During that period it proved impossible to incorporate therein results of the foregoing publications.

The Nearctic Melitaeine genera dealt with by Higgins are *Melitaea*, *Chlosyne*, *Thessalia*, *Texola*, *Dymasia*, and *Microtia*. Those of the Tribe Melitaeini treated by Bauer are *Chlosyne*, *Microtia*, *Melitaea*, *Poladryas*, *Phyciodes* with three subgenera (*Phyciodes*, *Eresia*, and *Tritanassa*), and *Euphydryas*. Thus it will be seen that both authors dealt with *Melitaea*, *Chlosyne*, and *Microtia*. This paper will attempt to reconcile their respective views concerning those three genera, and where that is impossible, allocate the genera and species as thought best. A few changes will be suggested in genera covered by one author only.

Higgins' paper is long and detailed. It purports to give full synonymies and figures of the genitalia of the species. On the other hand, Bauer's paper is short but contains keys and figures of the adult insects. However, it includes no synonymies and does not treat subspecies or other infra-subspecific forms. For these reasons it has been necessary to rely more heavily on Higgins than Bauer, although the latter's revision is the later. Both papers are great improvements on the arrangement of the Synonymic List which was not a revision of the Melitaeinae.

Higgins often uses "form" to denote a subspecies. This is of course not in conformity with the Rules of Zoological Nomenclature. Also and more important, Higgins has misdetermined the type of one genus proposed by him (*Dymasia*) and unfortunately does not give the dates of capture or the localities for source material of his figures. Bauer likewise has misdetermined the type species of *Poladryas*.

In preparing the following synonymic list, an effort has been made to solve all current problems because students are entitled to have this portion of the list brought up to date.

Fortunately, while this paper was in preparation, my colleague Mr. F. Martin Brown worked together with me on many of the problems involved in this subfamily. It is a pleasure to express my thanks to Mr. Brown for many valuable suggestions that he made. He has also had the kindness to read a draft of this manuscript. While we do not agree on all questions, especially the status of *Melitaea ismeria* Boisduval and LeConte, 1833, and the type and type locality of *Melitaea callina* Boisduval, 1869, our understanding of these problems has been clarified by frank discussions.

An effort has been made to fit the following names into the Synonymic List, hence the numbers start with 548 where the Melitaeinae commence on that list. A similar arrangement of the genera has been followed insofar as possible.

Subfamily **MELITÆINAE****CHLOSYNE** Butler, 1870Type: *Papilio janais* Drury, 1782*Melitaea Auctorum*‡*Synchloë* Doubleday (*nec* Hübner, 1818), 1844*Coatlantona* Kirby, 1871*Charidryas* Scudder, 1872548 **nycteis** (Doubleday), "1846-52" [1847]*nyctis* (Boisduval), 1869 (*lapsus calami*)a **n. nycteis** (Doubleday), "1846-52" [1847]*oenone* (Scudder), 1863‡*harrisii* (Edwards *nec* Scudder, 1862), 1870ab. *millburni* (Rummel), 1926ab. *lacteus* (Gunder), 1928ab. *greyi* (Field), 1934b **n. drusius** (Edwards), 1884ab. *hewitsoni* (Field), 1936c **n. reversa** (Chermock & Chermock), 1940549 **gorgone** (Hübner), "1806" [1810] (*partim*, ♂)*ismeria* (Boisduval & Le Conte), [1833]a **g. gorgone** (Hübner), "1806" [1810] (*partim*, ♂)b **g. carlota** (Reakirt), "1866-7" (1866)*nycteis* Edwards (*nec* Doubleday), 1861ab. *nigra* (Cary), 1901ab. *nox* (Gunder), 1928550 **harrisii** (Scudder), "1862" [1863]a **h. harrisii** (Scudder), "1862" [1863]b **h. hanhami** (Fletcher), "1903" [1904]c **h. albimontana** (Avinoff), 1930d **h. liggetti** (Avinoff), 1930551 **gabbii** (Behr), 1863*pola* (Boisduval), 1869a **g. gabbii** (Behr), 1863*sonorae* (Boisduval), 1869ab. *pasadenae* (Gunder), 1924ab. *newcombi* (J. A. Comstock), 1926ab. *gunderi* (J. A. Comstock), 1926b **g. sabina** (Wright), 1905552 **acastus** (Edwards), "1874-6" (1874)ab. *pearlae* (Gunder), 1926form *flavula* (Barnes & McDunnough), 1918

- 553 **neumoegeni** (Skinner), 1895
 ab. *fridayi* (Gunder), 1932
 ab. *boharti* (Gunder), 1933
- 554 **damoetas** (Skinner), 1902
 ab. *damoetella* (McDunnough), 1927
- 555 **malcolmi** (J. A. Comstock), 1926
- 556 **palla** (Boisduval), 1852
 a **p. palla** (Boisduval), 1852
 form ♀ *eremita* (Wright), 1905
 form *sterope* (Edwards), "1870-1" (1870)
 hewesi (Leussler), 1931
 ab. *wardi* (Oberthür), 1914
 ab. *blackmorei* (Gunder), 1926
 ab. *stygiana* (J. A. Comstock), 1926
 ab. *hemifusa* (Gunder), 1930
 ab. *hopfingeri* (Gunder), 1934
 b **p. whitneyi** (Behr), 1863
 whitnegi (Behr), 1868 (*lapsus calami*)
 ab. *vanduzeei* (Gunder), 1928
 c **p. vallismortis** (Johnson), 1938 (*emendatio*)
 d **p. calydon** (Holland), 1931
- 557 **hoffmanni** (Behr), 1863
 a **h. hoffmanni** (Behr), 1863
 helcita (Boisduval), 1869
 ab. *abnorma* (Wright), 1905
 ab. *hollandae* (Gunder), 1928
 b **h. segregata** (Barnes & McDunnough), 1918
 bridgei (J. A. Comstock), 1924
 c **h. manchada** Bauer, "1959" [1960]
- 558 **definita** (Aaron), "1884" [1885]
 schausi (Godman), (1901)
 ab. *albiplaga* (Aaron), "1884" [1885]
- 559 **endeis** (Godman & Salvin), 1894
- 560 **janais** (Drury), 1782
- *561 **lacinia** (Geyer), 1837
 a **l. adjutrix** Scudder, 1875
 nigra (Cockerell), 1893 (*partim*)
 bicolor (Cockerell), 1893 (*partim*)
 rufa (Cockerell), 1893 (*partim*)
 ab. *inghami* Gunder, 1928

- b **l. crocale** (Edwards), "1874-6" (1874)
nigra (Cockerell), 1893 (*partim*)
bicolor (Cockerell), 1893 (*partim*)
rufa (Cockerell), 1893 (*partim*)
 form *nigrescens* (Cockerell), 1893
 form *rufescens* (Cockerell), 1894
 form *flavida* Higgins, 1960

- 562 **californica** (Wright), 1905
 ab. *chinois* Gunder, 1924

PHYCIODES (ANTHANASSA) Scudder, 1875

Type: *Eresia cincta* Scudder (*nec* Edwards, 1864) 1875
 (= *Melitaea texana* Edwards, 1863)
Tritanassa Forbes, "1944" [1945] (*partim*)

- 563 **texana** (Edwards), 1863
 - a **t. texana** (Edwards), 1863
smerdis (Hewitson), 1864
 - b **t. seminole** (Skinner), 1911
- 564 **ptolyca** (Bates), 1864

PHYCIODES (ERESIA) Boisduval, [1836]

Type: *Nereis eunice* Hübner, "1806" [1807] (= *Eresia eunice* Boisduval, [1836]) (*lapsus calami*)

- 565 **frisla** (Poey), 1832
 - a **f. frisla** (Poey), 1832
gyges Hewitson, 1864
 - b **f. tulcis** (Bates), 1864
genigueli Reakirt, "1865" [1866]
archesilea R. Felder, 1869
punctata Edwards, "1870-1" (1870)

PHYCIODES (PHYCIODES) Hübner, "1816" [1819]

Type: *Papilio coccyta* Cramer, "1779" [1777] (= *Papilio tharos* Drury "1770" [1773])

- Tritanassa* Forbes, "1944" [1945] (*partim*)
- 566 **tharos** (Drury), "1770" [1773]
 - a **t. tharos** (Drury), "1770" [1773] (*gen. aest.*)
 \neq *morpheus* (Fabricius, 1775 *nec* Pallas, 1771)
morphius (Fabricius), 1781 (*lapsus calami*)
coccyta (Cramer), "1779" [1777]
euclea (Bergstrasser), 1780
morphea (Godart), 1819
tharossa (Godart), 1819

- selenis* (Kirby), 1837
- ab. *packardii* (Saunders), 1869
- ab. *reaghi* Reiff, 1913
- ab. *dyari* Gunder, 1928
- gen. vern. marcia* (Edwards), "1868-9" (1868)
- b **t. artica** dos Passos, 1935
- c **t. pulchella** (Boisduval), 1852
 - pascoensis* Wright, 1905
 - form ♀ *herse* Hall, 1924
 - ab. *nigrescens* Hall, 1924
- 567 **batesii** (Reakirt), 1865
 - ab. *harperi* Gunder, 1932
- 568 **phaon** (Edwards), 1864
 - gorgone* (Hübner), "1806" [1810] (*partim*, ♀)
 - gorgonia* (Clark & Clark), 1941 (*lapsus calami*)
 - gen. aest. aestiva* Edwards, 1878
 - form *hiemalis* Edwards, 1878
 - ab. *thornei* Gunder, 1934
- 569 **campestris** (Behr), 1863
 - a **c. campestris** (Behr), 1863
 - ♂ *pratensis* (Behr), 1863
 - ab. *macdunnoughi* Gunder, 1928 (*emendatio*)
 - b **c. camillus** Edwards, "1870-1" (1871)
 - ab. *mata* (Reakirt) "1866-7" (1866)
 - ab. *emissa* Edwards, "1870-1" (1871)
 - ab. *rohweri* Cockerell, 1913
 - ab. *tristis* Cockerell, 1913
 - c **c. montana** (Behr), 1863
 - orsa* (Boisduval), 1869
- 570 **picta** Edwards, 1865
 - a **p. picta** Edwards, 1865
 - b **p. canace** Edwards, "1870-1" (1871)
 - ab. *jemezensis* Brehme, 1913
- 571 **vesta** (Edwards), "1868-9" (1869) (*gen. hiem.*)
 - hiemalis* Edwards, 1878
 - gen. aest. aestiva* Edwards, 1878
 - boucardi* Godman & Salvin, 1878
- 572 **mylitta** (Edwards), "1861-3" (1861)
 - a **m. mylitta** (Edwards), "1861-3" (1861)
 - collina* (Behr *nec* Lederer, 1861) 1863
 - collinsia* Edwards, 1872 (*lapsus calami*)

- mylittae* Wright, 1883 (*lapsus calami*)
epula (Boisduval), 1869
- b **m. barnesi** Skinner, 1897
 ab. *collinsi* Gunder, 1930
 ab. *macyi* Fender, 1930
- c **m. pallida** (Edwards), 1864
- d **m. thebais** Godman & Salvin, 1878
 arida (Skinner), 1917
- 573 **orseis** Edwards, "1870-1" (1871)
 ab. *edwardsi* Gunder, 1927

THESSALIA Scudder, 1875

Type: *Melitaea leanira* Felder & Felder, 1860

- 574 **leanira** (Felder & Felder), 1860
- a **l. leanira** (Felder & Felder) 1860
 form *obsoleta* (H. Edwards), 1877
 obliterata (Strecker), 1878 (*lapsus calami*)
 form *wrightii* (Edwards), 1886
 form *leona* (Wright), 1905
 ab. *carolynae* (Gunder), 1926
 form *pelona* (Gunder), 1930
- b **l. cerrita** (Wright), 1905
- c **l. daviesi** (Wind), 1947
- 575 **cyneas** (Godman & Salvin), (1878)
 ab. *infrequens* (Gunder), 1928
- 576 **alma** (Strecker), "1877" [1878]
 fulvia (Edwards), 1879
 ab. *sinefascia* (Williams), 1914
 ab. *koebelei* (Gunder), 1927

- *577 **theona** (Ménétriés), 1855
- a **t. thekla** (Edwards), "1870-1" (1870)
 ab. *benjamini* (Gunder), 1928
- b **t. bollii** (Edwards), "1877" [1878]
- 577½ **chinatiensis** (Tinkham), 1944

DYMASIA Higgins, 1960

Type: *Melitaea dymas* Higgins (*nec* Edwards, 1864) (= *Melitaea chara* Edwards, "1883" [1884])

- 578 **dymas** (Edwards), 1864
 larunda (Strecker), "1877" [1878]
 ♂ *senrabii* (Barnes), 1900
- 579 **chara** (Edwards), "1883" [1884]
 dymas Higgins (*nec* Edwards, 1864), 1960

- a **c. chara** (Edwards), "1883" [1884]
- b **c. imperialis** (Bauer) "1958" [1959]
 - ab. *jacintoi* (Gunder), 1924
 - ab. *nitela* (J. A. Comstock), 1926

TEXOLA Higgins, "1958" [1959]

Type: *Eresia elada* Hewitson, 1868

580 **elada** (Hewitson), 1868

- a **e. elada** (Hewitson), 1868
- b **e. callina** (Boisduval), 1869
- c **e. ulrica** (Edwards), 1877
 - ubrica* (Skinner), 1898 (*lapsus calami*)
 - imitata* (Strecker), "1877" [1878]
- d **e. perse** (Edwards), 1882

POLADRYAS Bauer, [1961]

Type: *Melitaea pola* Oberthür, 1911, *nec* Boisduval, 1869
 (= *Melitaea arachne* Edwards, "1868-9" [1869])

581 **minuta** (Edwards), 1861

- a **m. minuta** (Edwards), 1861
 - approximata* (Strecker), 1900
- b **m. nympa** (Edwards), 1884

582 **arachne** (Edwards), "1868-9" (1869)

- pola* Oberthür (*nec* Boisduval, 1869), 1911
- ab. *polingi* (Gunder), 1926
- ab. *gunderiae* (Holland), 1931
- a **a. monache** (J. A. Comstock), 1918
- b **a. gilensis** (Holland), 1931

MICROTIA Bates, 1864

Type: *Microtia elva* Bates, 1864

583 **elva** Bates, 1864

EUPHYDRYAS Scudder, 1872

Type: *Papilio phaeton* Drury, "1770" [1773]

‡*Lemonias* Hübner, [1806] (Opinion 278, name 79)
Melitaea Auctorum (*nec* Fabricius, 1807)

592 **phaeton** (Drury) "1770" [1773]

ab. *streckeri* (Ellsworth), 1902

593 **chalcedona** (Doubleday), "1846-52" [1847]

ab. *lorquini* (Oberthür), 1914

- b **c. dwinellei** (H. Edwards), 1881

- f **c. perdiccas** (Edwards), "1880-1" [1880] (*emendatio*)
perdiceas (Edwards), "1880-1" [1880] (*lapsus calami*)

- 593½ **colon** (Edwards), "1880-1" [1881]
 594 **anicia** (Doubleday), "1846-52" [1847]
 k ab. *melanodisca* (J. A. Comstock), 1918
 l ab. *rubrolimbata* (J. A. Comstock), 1918
 595 **editha** (Boisduval), 1852
 g **e. nubigena** (Behr), 1863
 nubigea (Carpenter), 1877 (*lapsus calami*)
 l **e. edithana** (Strand), 1915

The following explanations will help answer questions concerning placement of names, especially where the above list deviates from the treatment of either Higgins or Bauer, or both, or where more recent information has been incorporated. The present arrangement includes eight fewer species level taxa, owing primarily to the relegation to subspecies of entities formerly considered to be species.

CHLOSYPNE

For reasons that will be explained in a subsequent paper, *Chlosyne ismeria* (Boisduval and LeConte) has been placed in the synonymy of *C. gorgone* (Hübner) ♂ and *C. gorgone* (Hübner) ♀ in the synonymy of *Phyciodes* (*Phyciodes*) *phaon*.

There is no definite record of the occurrence of *Chlosyne erodyle* (Bates), 1864, in the Nearctic region. Consequently, it has been omitted from the list.

Also three heretofore considered subspecies of *Chlosyne lacinia* (Geyer), 1837, have been omitted because they are not believed to occur in the Nearctic region. These are *Synchloë quehtala* Reakirt, 1866, described from Vera Cruz, Mexico; *S. ardema* Reakirt, 1866, described from Mexico, and *S. pretona* Boisduval, 1870, described from Guatemala.

ANTHANASSA

Brown (1965: 192) has applied to the International Commission on Zoological Nomenclature to designate a type-species under the plenary powers for *Anthanassa* Scudder. If that application is granted, *Melitaea texana* Edwards, 1863, will become the type-species of *Anthanassa* (Z.N. (S.) 1697).

ERESIA

Eresia leucodesma (Felder & Felder), 1861, has been omitted on the advice of Brown (1966: 424).

The author is advised by Bauer (*in litt.*) that three specimens of *Phyciodes ptolyca* (Bates) have been taken in Texas and that he has one of the three in his collection, hence that name has been added to the list as no. 564.

THESSALIA

Bauer ([1961]: 139) places *leanira* in *Chlosyne*. Higgins (1960: 442) places *leanira* in *Thessalia*. Higgins is followed.

DYMASIA

Higgins (1960: 455) proposed the name *Dymasia* with *Melitaea dymas* Edwards as the type species. Unfortunately, as Brown (1966: 381) has pointed out, Higgins misdetermined *dymas*. The specimen before him was *Melitaea chara* Edwards which Higgins (1960: 456) incorrectly placed in the synonymy of *dymas*. They are actually two different species although closely related, the females being quite different. Consequently, *dymas* Higgins equals *chara* Edwards, and *chara* is therefore the type of *Dymasia*. Higgins (1960: 456) claims that *imperialis* is the spring generation of *dymas* at Palm Springs, but it seems to the author to be entitled to subspecific rank.

TEXOLA

Brown (1967: 273) has cast doubt upon the occurrence of *Texola elada callina* in southern California, although one type was named from Sonora, southern California. That situation will be examined in a later paper.

POLADRYAS

Melitaea pola, Bauer's type of *Poladryas*, is the *pola* of Oberthür and not of Boisduval and is actually *M. arachne* Edwards, hence the type of *Poladryas* is *M. arachne* Edwards "1868-9" (1869).

Higgins under *Melitaea* lists *minuta*, *approximata*, *pola*, *arachne*, *monache*, *gilensis*, *nympha*, *polingi*, and *gunderiae*. It is a question whether to follow Higgins and list these names as *Melitaea*, or Bauer and list them as *Poladryas*. In either event, the species will remain substantially as in the Synonymic List. Higgins places *gilensis* in the synonymy of *Melitaea pola*, but the author has given it subspecific standing.

Bauer does not mention *nympha* Edwards, *approximata* Strecker, *gilensis* Holland or *monache* apparently because he considers them to be subspecies.

MICROTIA

Higgins (1960: 460) states that *elva* is not Nearctic, but Bauer ([1961]: 132) claims that *elva* occurs in southern Arizona to southern Texas, hence it is listed. In substantiation of that statement, he has furnished the author with a recent record from Madera Canyon, Santa Rita Mts., Pima Co., Arizona. This specimen, collected by Lloyd Martin, is in the Los Angeles County Museum.

Melitaea dymas is the other species Bauer places in *Microtia* while

Higgins places it in *Dymasias* as the type. That situation is explained under *Dymasias*.

EUPHYDRYAS

Bauer ([1961]: 127-130) lists the same five species of *Euphydryas* as dos Passos (1964) but in different order and adds *Euphydryas colon* as a sixth species. Since Bauer gives no reason for changing the order of listing the names, there is no point in following him and in repeating the listings except to include *colon* as a species and list those instances where an additional name or a typographical correction should be added or made in the list.

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INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE A.(N.S.)82

Required six-month's notice is given on the possible use of plenary powers by the International Commission on Zoological Nomenclature in connection with the following names listed by case number: (see, *Bull. zool. Nomencl.* 25, pt. 2/3, 27 September 1968):

1843. Validation of *Aphis gossypii* Glover, 1877 (Insecta, Hemiptera)
1845. Type-species for *Anoplius* Dufour, 1834; Neotypes for *Sphex niger* Fabricius, 1775, and *Sphex nigerrimus* Scopoli, 1763 (Insecta, Hymenoptera) (see, *Bull. zool. Nomencl.* 25, pt. 4/5, 17 January 1969)
1852. Suppression of *Siphocoryne angelicae* del Guercio, 1911 (Insecta, Hemiptera)
1853. Validation of emendation to *Hyposmocoma* of *Hyposmochoma* Butler, 1881 (Insecta, Lepidoptera)

BOOK REVIEW

THE NORTH AMERICAN AEGERIIDAE (LEPIDOPTERA): A REVISION BASED ON LATE INSTAR LARVAE; by Margaret Rae MacKay. Entomological Society of Canada, Memoir 58: 1-112, including 49 figs. 1968.

Miss MacKay's revision is the most important work concerning the North American Aegeriidae since the work of Engelhardt in 1946. It is unusual for a taxonomic revision to be based entirely upon larval features. The close agreement between MacKay's conclusions about the higher classification of the Tortricidae based on her study of their larvae and the conclusions reached by Obratzov affirm the reliability of her methods and conclusions.

The major source of material for this study was the extensive G. P. Engelhardt collection of aegeriid larvae, at the U. S. National Museum. Other material came from only five other sources. Late instar larvae of 60 of the 114 species (53%) of North American Aegeriidae were studied and thoroughly described. The author's conclusions were somewhat hampered by the fact that larvae of six genera (*sensu* Engelhardt) were not available for study. It is unfortunate that two of these genera are the sole representatives of two of Engelhardt's nine suprageneric groupings, *i.e.*, Signaphora Group and Calasesia Group.

The phylogenetic relationships of the higher categories as interpreted by MacKay differ strikingly from the arrangements of Engelhardt (1946, U. S. Natl. Mus., Bull. 190) and Niculescu (1964, Linneana Belgica (III) 3). The 60 species studied are treated as representing 20 genera in five tribes and two subfamilies. MacKay's study indicates that three new genera should be recognized. Since two of the new genera indicated are established from single larvae, and since genera are more normally established on the basis of adults, the genera are referred to nominally as Genus I, Genus II, and Genus III. If all authors past and present displayed such concern for nomenclatural stability, much needless work could be (have been) eliminated for future systematists. When adults of the new genera are studied in comparison with those of closely related genera or when more larval material becomes available, names can be given to these genera if justified.

In the text there are keys to all tribes, to genera within each tribe, and to species for the larger genera. The treatment of each species includes a listing of material examined, a larval description, citation of recorded hosts, and a brief statement of distribution. Ten subspecies are included by MacKay, eight of these were treated as races and two as forms by Engelhardt. MacKay does not list the latter as new combinations nor does she give any substantiation for their elevation to subspecific status.

The figures illustrate 54 of the species under consideration. These figures, which display MacKay's concern for features of taxonomic importance include setal maps, frontal view of head, arrangement of ocelli and surrounding setae, and crotchets.

There are separate indices to scientific names of the hosts and the moths at the end of the treatment.

Despite the excellence of this treatment, there remains much work to be done with the North American Aegeriidae. Engelhardt's species concept and his sometimes ambiguous usage of "race," "form," and "variety" as well as his frequent omission of type localities make it difficult for one to identify many specimens with any degree of certainty. Distribution for most non-economic species are poorly known, and several species complexes in the west urgently need study.

MacKay has now provided an excellent framework within which any new information at the species level may be easily interpolated. This work should be included in the personal library of any serious student of North American Lepidoptera.—PAUL A. OPLER, *University of California, Berkeley*.

A NEW SUBSPECIES OF *PYRRHOPYGE CREON*
(*HESPERIIDAE*) FROM PANAMA

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The genus *Pyrrhopyge* is represented in the Republic of Panama by approximately six species and/or subspecies, depending upon the terms of reference and the sources of material. None are common and most are rather local. One of the most beautiful and distinctive of these is *Pyrrhopyge creon* Druce. The shining dark blue brilliance of the upper surface of the forewings and single sub-tornal dark red spot of the hindwings makes recognition of this species relatively easy.

In 1963, Gordon Small took several specimens of a large *Pyrrhopyge* that did not agree with existing illustrations or written descriptions. Continued collecting by Mr. Small during the ensuing years has produced an excellent series of specimens. Concurrent search of the literature, perusal of available museum collections and genitalic study has been made by the senior author. We have reached the conclusion that we have an undescribed subspecies of *Pyrrhopyge creon*.

***Pyrrhopyge creon lilliana* Nicolay and Small, new subspecies**

Male: Length of forewing, 30 mm \pm 1 mm; holotype 29 mm.

Upside: Forewings very dark, shining purple-blue with a vague darker bordering area. Hindwings with discal area of the same dark shining blue; the single dark red tornal spot of *P. c. creon* increased to from three to five dark orange-red spots following the curve of the outer margin from interspace 1b to interspace 4, the largest and always most prominent in interspace 1, triangular to strigiform in 1b, becoming progressively smaller and less definitive from interspace 2 through 4 (Fig. 1).

Underside: Dark blue coloring same as upperside, but less shining and brilliant; orange-red spots of hindwings repeated, more quadrate and slightly larger and more definitive than on upper surface. Fringes, head, palpi and pectus, black; collar, tegulae, pronotum, and abdomen, dark blue-black.

Female: Length of forewing, 35 mm \pm 1 mm; allotype 34 mm.

Upper and undersides: All coloring and maculation same as in male, orange-red spots proportionately enlarged (Fig. 2).

Holotype male: Republic of Panama, Cerro Campana, Panama Province, 2,500 feet, 24 December 1964. Allotype female, same locality, 20 August 1963. Eighty-nine male paratypes and sixteen female paratypes all from the same locality with dates of July thru September and November–December being most prevalent. One male bears the date 15 February and another, 28 June. Holotype male and allotype female deposited

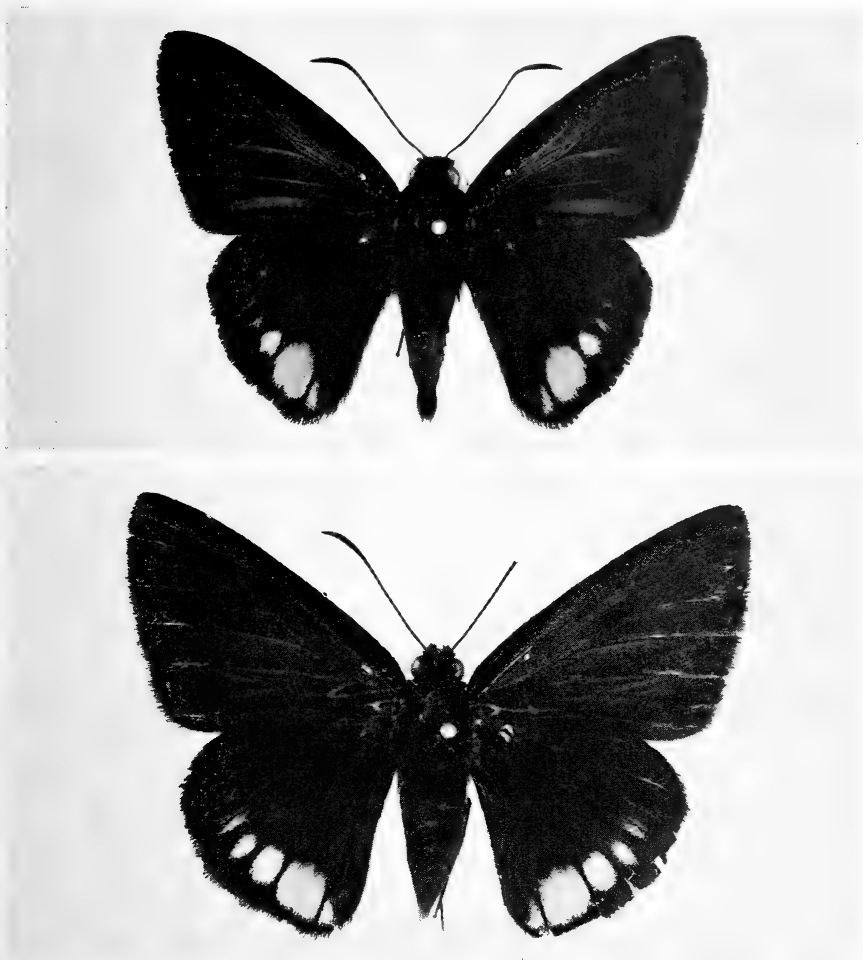
in the U. S. National Museum. Paratypes deposited in the following institutions: American Museum, New York, New York; Carnegie Museum, Pittsburgh, Pennsylvania; California Academy of Sciences, San Francisco; the remainder in the authors' collections.

Within the type series, the number of red spots on the secondaries varies from three to five. Of 90 male specimens, 12 have three spots, 25 have four spots and 53 have five spots. One female has four spots, the remainder, five.

The conspecific character of *lilliana* with *creon* is clearly indicated by the male genitalia (Fig. 3). Evans' (1951) figure, although rather rough and with only the inside view of the left valva shown, is recognizable. The valve of *P. creon* are asymmetrical, this feature clearly shown in Bell's (1931) treatment of the genus and in the earlier treatment by Godman and Salvin (1879-1901). A close comparison of the male genitalia of *P. c. lilliana* was made with those from specimens of *P. c. creon* collected in Costa Rica. Small variations between individuals occur but are considered within the limits of specific variation to be expected within a species complex.

Thus far, *lilliana* has been taken only in the type locality—the cloud forest clothing the upper slopes of Cerro Campana and the neighboring ridges at elevations of 2,000-3,000 feet. This mountain is located about 40 miles southwest of the Canal Zone. Northeast of this point (toward South America as one travels by land), the mountains forming the Continental Divide rapidly diminish in altitude, and similar environments are not to be found for at least 60 miles. The intervening area of low altitudes, of which the Canal Zone is a part, very likely acts as an effective barrier, preventing the species from spreading toward South America. In the opposite direction, one would suspect that *creon* has a clinal distribution along the slopes of the ridges forming the Continental Divide. True *creon* has been found from Calobre, Veraguas Province, Panama, westward through Chiriqui Province, Panama, and into Costa Rica. Unfortunately, due to the lack of collections made in the area between Calobre and Cerro Campana and also in the area east of the Canal Zone, it is impossible to make a definite statement about the distribution of *creon* and its subspecies at this time.

The subspecies *lilliana* has two chief flight periods, one in July, August and into September and again in November-December. Both flights occur in the wet season, but at those times in which the average precipitation is least. It is not uncommon during its flight periods, and one can usually expect to see three or four specimens in a given day. Unfortunately, mists and clouds frequently envelope the mountains, and like



Figs. 1-2. *Pyrrhopyge creon lilliana* Nicolay & Small. Fig. 1 (upper), holotype male. Fig. 2 (lower), allotype female.

most lepidopterous species *lilliana* is active during those intervals in which the sun is shining. These intervals tend to be frustratingly few and far between. Furthermore, *lilliana* only flies from about 9:30 A.M. to 12:30 P.M. so that the actual time available to collect individuals of this species in any given day is rather small.

Although *lilliana* is undoubtedly capable of extremely swift flight, it flies with only moderate speed in a skipping and, at times, buzzing manner. The male is prone to rest with outstretched wings on the tips of



Fig. 3. *Pyrrhopyge creon lilliana* Nicolay & Small; male genitalia; lateral aspect.

leaves 8–16 feet above the ground. Certain particular trees and shrubs are definitely preferred, and an individual will often post itself on a leaf, from which it makes short forays after other species of Lepidoptera, only to return to the same, or a neighboring spot a few moments later. One individual was observed to “attack” a perched hummingbird. The female is much more directional in her flight, apparently in search for the foodplant. Both sexes are unwary, and thus easy to capture. Nothing is known of the early stages.

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THOMAS HERBERT ELLIOT JACKSON (1903-1968)

T. H. E. Jackson, known to his many friends as "Pinkie," was murdered by a criminal gang at his home near Kitale, Kenya, on the night of May 22, 1968.

Pinkie Jackson was born in Dorset, England, on January 12, 1903. His father, Brigadier General H. K. Jackson, hoped that his son eventually would enter professional military service and enrolled him at Wellington College. Young Jackson, however, showed little inclination for the army and after Wellington went to Harper Adams Agricultural College in Shropshire.

In 1923, after a brief visit to Kenya, he went to India to work on an indigo plantation. Kenya, however, had made an impression, and the following year he returned there to stay. After a time spent learning to grow coffee with Mr. Maxwell Trench near Nyeri, he settled on a farm of his own on the slopes of Mt. Elgon, where he was soon joined by his father and family. Coffee had not been grown in that area before but was eventually established by Jackson and his father, and after many vicissitudes the farm "Kapretwa" blossomed forth, to become one of the finest and most successful coffee estates in the district.

At the outbreak of World War II Jackson joined the Officer Cadet Training Unit and was later drafted to the 4th King's African Rifles. After some service with this regiment he was sent by the Kenya government to raise and train a company of Turkana Irregulars for duty on the troubled Abyssinian frontier. Later he was charged with the military administration of a large area in northern Somalia. By the end of the war he had reached the rank of Lieutenant Colonel.

The war over, Jackson returned to Kapretwa and continued to improve and develop it in subsequent years. Among other things he pioneered the growing of tea and built the first processing plant in the Kitale district. At the start of the Mau Mau emergency in 1953 he volunteered and served in a senior capacity in the Embu district. From then on he devoted his time to his farm, to his superb garden and to his entomological activities.

Jackson had been an enthusiastic naturalist from his early youth. He became an excellent field ornithologist and botanist, and over the years built up one of the most beautiful gardens in Kenya as well as an outstanding collection of local and exotic orchids. His most absorbing interest, however, was entomology, which he pursued throughout his life. In 1935 he took part in the British Museum Ruwenzori expedition, with the dipterist T. W. Edwards and the botanist George Taylor (now Sir George Taylor, Director of Kew Gardens), and collected vast numbers of

insects, particularly butterflies, moths and beetles, most of which are now in the British Museum.

Not long after that Jackson began to form his own collection of butterflies. From the beginning he devoted particular attention to their early stages, and his first papers were concerned with life histories he discovered. His collection, which he built with the same diligence and enthusiasm that marked his every undertaking, grew rapidly, particularly in his favorite groups, the Nymphalidae and the Lycaenidae and their allies.

He collected widely in Africa himself, in Kenya, Uganda, Somalia, southern Ethiopia. He was one of the first to explore entomologically the Kigezi district of southern Uganda, a mountainous region where, in the Kayonza Forest, he found many new species.

Jackson also trained several African collectors whom he sent not only to areas in Kenya, Uganda and Tanzania, but also to Middle Congo, Cameroun, Nigeria and Ivory Coast. At the time of his death he was negotiating with the government of Gabon to send one of them to that country. These men were not ordinary collectors, but highly trained specialists. One was particularly adept at finding the eggs and larvae of the genus *Iolais*, large, handsome blue and white hairstreaks whose larvae feed on the parasitic plant *Loranthus*, high in the forest canopy. Through the efforts of this man Jackson thus obtained long, perfect series of a host of species of this genus and its relatives, many of them new or previously little known. Another of his collectors specialized in finding nests of the ant genus *Crematogaster* and in building platforms high up in infested trees to collect liptenids associated with these ants.

Whenever he had the chance Jackson would go to the British Museum to study the rich African collections and to compare the increasing number of new or little known species that he or his collectors had found. Through that institution he was put in contact, in 1938 or 1939, with M. Henri Stempffer of Paris, the world's foremost authority on African Lycaenidae. This was to be a most fortunate association, a happy combination of collector and specialist, both of rare ability and great productivity.

Jackson published relatively little himself. He began rather late (he was 34 years old when his first paper appeared), and his early articles came out at considerable intervals. From the late 1950's, however, he began to publish more, and the last decade of his life saw more from his pen than all the preceding years. His most important papers, perhaps, are the one written in collaboration with V. G. L. van Someren (1960) on mimicry in African butterflies, and the series of taxonomic articles on the very difficult liptenid genus *Epitola* and its allies (1962a, 1964, 1964a, 1967).

Jackson's collection had grown to be one of the largest assemblages of African butterflies anywhere, and certainly the largest on that continent. And this despite the fact that he gave away duplicate specimens by the thousands, to anyone or to any institution he thought would put them to good use: to Stempffer, to the Museum National d'Histoire Naturelle (Paris), to the Musée Royale de l'Afrique Centrale (Tervuren), to Carnegie Museum, to the National Museum of Kenya, to the British Museum. The latter institution further received over the years the types of nearly all the many forms named by Jackson, or by Stempffer from Jackson's material.

In 1961 Jackson began to feel that his collection itself should be more readily available to scientists and in June of that year gave half of it, some 65,000 specimens, to the British Museum. The other half, along with his fine entomological library, he willed to the National Museum of Kenya, where it now is.

Mere words can scarcely do justice to Pinkie Jackson's many personal qualities. His great charm and warmth of personality won him close friends wherever he went. He was an ideal companion in the field, and a delightful correspondent, full of enthusiasm, extremely knowledgeable and always articulate.

The brutal murder of this unfailingly kind, generous and wise man was a great shock to all who knew him and a grievous loss to his many friends and relatives and to African entomology.

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The above biographical account was adapted in part from an Appreciation published by one of us (RHC) in the *East African Standard* (Nairobi), June 14, 1968, and also in *J. E. Afr. Nat. Hist. Soc.* 26, 3(115): 149, June 30, 1968. Sir George Taylor, Director of The Royal Botanic Gardens (Kew), has also published an obituary notice (*London Times*, June 11, 1968), a copy of which he was so good as to send us and on which we have drawn. M. Henri Stempffer (Paris) and Mr. Norman D. Riley (British Museum) have contributed additional information and have helped with the bibliography. We thank all these gentlemen for their assistance.

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 HARRY K. CLENCH, *Carnegie Museum, Pittsburgh, Pennsylvania*

ERNEST E. PLATT, A SOUTH AFRICAN LEPIDOPTERIST

(July 3, 1874–August 28, 1966)



In 1897 a young man, 23 years of age, arrived in Durban intending to make a living as a printer. I never knew why he had selected Port Natal (as Durban was best known overseas in those days), but neither did I get the impression that he had come with the intention of studying nature.

On arrival at Durban he was engaged by the printing firm of T. L. Cullingworth as a compositor, but three years later he started on his own with a fellow worker, H. A. Wilson. Together they formed a small company called the Electric Press as it was the first printing works in Durban that used electricity for running the presses.

This was where I met Mr. Platt for the first time in 1912 when I was introduced to him by a collector of butterflies, Mr. Edgar Clark.

Durban had at that time at least six insect collectors, most of them were especially interested in butterflies. No big town anywhere in South Africa at that time, and for many years afterwards, had so many insect collectors. Durban in those days had many streets with patches of original vegetation, and at times butterflies swarmed in the main streets. Most of the bluff opposite the bay was an area of virgin soil covered with subtropical bush, swarming with insect life. No wonder that my friend Platt soon joined the enthusiastic band of butterfly collectors. But he was not a mere collector for long. Soon he became fascinated by the intriguing life-histories of the Lepidoptera. In addition he started collecting and cultivating orchids in the hothouse where caterpillars and their food plants had been the only occupants.

During the past 20 years he went to no end of trouble to get the food plants required and I have known him to go on a Sunday as far as Eshowe when finally the natural bush nearby had to make way for the cultivation of sugar cane. Also in those days several rivers had to be crossed by drifts, as bridges were few and far between while the roads were often mere muddy tracks in the summer.

Almost from the beginning he made notes of his caterpillar breeding; photographs were taken of the caterpillars while on the food plants which he had identified at the Natal Herbarium; and at least one caterpillar of each species was preserved. The Lepidoptera, thus bred, often from the egg stage onwards, he generously presented, with the cabinets, to the Grahamstown Museum as unfortunately its entomological collection had been destroyed by fire. The notebooks, negatives of the photos and the preserved caterpillars and pupae he presented to the Transvaal Museum.

The list of the Lepidoptera foodplants which he compiled, as published in volume III of the South African Journal of Natural History in 1921, is thus a reliable document of what was known up to that date, and no other worker had contributed so much to the study of the life-histories of the South African Lepidoptera as had been compiled by the late Ernest Platt.

A. J. T. JANSE, *Pretoria, South Africa*

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24 September 1969

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A REVIEW OF THE GENUS *ACANTHOPTEROCTETES* WITH DESCRIPTION OF A NEW SPECIES (ERIOCRANIIDAE)

DONALD R. DAVIS

Smithsonian Institution, Washington, D. C.

In the course of my revisionary studies on the American Incurvariidae, I recently received from Mr. James H. Baker of Baker, Oregon, two specimens of an unknown moth which superficially resembled an incurvariid. Upon dissection the true affinities of this undescribed species were recognized, and the genus *Acanthopteroctetes* was suspected as the proper placement. Through the courtesy of Dr. Annette F. Braun, I was able to examine the unique holotype of *A. tripunctata* and to confirm the generic placement of the new species collected by Baker. Because our knowledge of this genus is so meager, I thought it desirable to redescribe the taxon, which at present contains only three species, one of which remains unnamed. It is further hoped that the information contained herein will assist efforts currently being pursued by others to revise this family on a global basis.

The genus *Acanthopteroctetes* was proposed by Braun (1921) in the subfamily Eriocraniae [sic], which at that time was generally considered a subdivision of the Micropterygidae even though Busck and Böving (1914) had earlier pointed out the distinctness of the two groups. Braun accurately diagnosed the genus as not being closely related to any described taxon but stated that it was nearest *Eriocrania*. McDunnough (1939) recognized the separation of the Eriocraniidae and Micropterygidae but probably failing to note Braun's discussion of the relationships of *Acanthopteroctetes* erroneously placed the genus in the Micropterygidae. I concur with Braun's remarks, particularly in light of the structure of the female genitalia which is described herein for the first time.

I wish to express my appreciation to Mr. James H. Baker for the gift of the two specimens which initiated this study, and to Dr. Annette F. Braun for the loan of the material under her care. I am indebted to Mr. Andre Pizzini, staff artist of the Department of Entomology, Smithsonian

Institution, for the drawings and to Mr. Victor Kranz, staff photographer of the Smithsonian Institution, for the photographs.

ACANTHOPTEROCTETES Braun

Acanthopteroctetes Braun, 1921, Proc. Acad. Nat. Sci. Philadelphia, 73(1): 22; Fletcher, 1929, Mem. Dept. Agric. India, Ent. series, 11: 2; McDunnough, 1939, Mem. So. California Acad. Sci., 2(1): 110.

TYPE OF GENUS.—*Acanthopteroctetes tripunctata* Braun. Monobasic.

ADULT.—Small, slender-bodied moths; wing expanse approximately 11–16 mm.

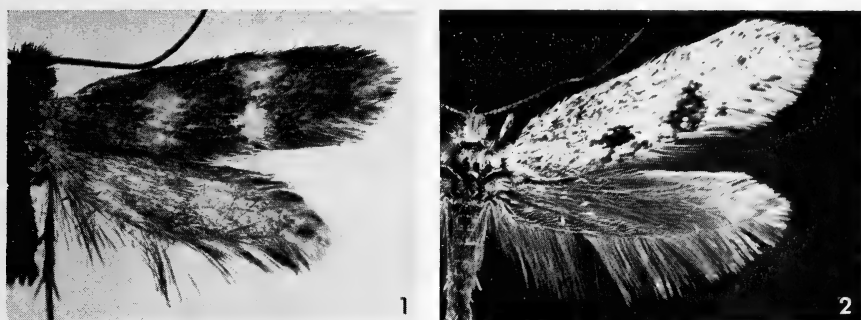
Head (figs. 3–5).—Rough, densely covered by erect, hairlike scales. Occipital region above foramen magnum raised to form a low, rounded, transverse ridge extending width of head. Lower margin of frons with a bilateral pair of shallow but prominent, cuplike excavations, each approximately one-half diameter of eye. Labrum narrow, elongate; apical margin rounded. Epipharynx small, triangular, membranous. Pilifers absent. Eyes evenly rounded, smooth. Ocelli absent. Antennae slender, simple, approximately three-fourths the length of forewing; each segment clothed with a single row of relatively narrow, flatly-appressed scales above and with scattered pubescence below; scape moderately enlarged, cylindrical, without pecten. Mandibles absent. Maxillary palpi greatly lengthened, normally folded in repose, five-segmented with fourth (penultimate) segment the longest, doubling fifth in length. Tongue naked, reduced, approximately one-half the length of maxillary palpi. Labial palpi reduced, approximately equal to first segment of maxillary palpi in length, two-segmented with apical segment about twice the length of basal one. Labial sclerite narrow, nearly twice as long as broad, roughly rectangular, lateral margins slightly concave.

Thorax: Mostly clothed with relatively broad, appressed scales except for a lateral patch of erect, hairlike scales arising from each tegula and two similar patches arising on either side of mid-dorsal line near posterior margin of mesonotum. Wings (fig. 16) slender, lanceolate. Forewings 12-veined with vein 7 stalked to 8 and terminating on costa near apex; 6 stalked to 7+8 and arising below their separation; 10 and 11 stalked, arising from cell slightly beyond middle; base of media undivided within cell; accessory cell absent; jugum present. Hindwing 11-veined, with vein 10 (R_2) completely fused to R_1 ; frenulum absent; base of subcostal vein with a short costal spur; stalking of veins 6, 7 and 8 as in forewing; base of media undivided; lower half of discal cell open due to atrophy of medial-cubital crossvein between 3 and 4; fringe along hind margin elongate, equalling width of wing. Prothoracic tibiae (fig. 15) without epiphysis but with 2–3 short spines at middle and a similar number at apex; mesothoracic tibiae with a single apical spur and with spines distributed as in forelegs; metathoracic tibiae with a pair of apical spurs and a second pair of spurs situated near distal one-third, all spurs approximately equal in length, also with a single spine at middle, a scattered series of 6–8 short spines between two sets of spurs and a whorl of 2–4 apical spines.

Abdomen: Cylindrical; sclerites simple, unmodified; eighth segment of female with a single row of long, stout bristles encircling abdomen.

Male genitalia: Uncus bifid, revolute; lower margins serrulate near apex. Tegumen and vinculum broad, united to form a short cylinder; anterior margin of vinculum concave. Transtilla well developed, with a prominent, elongate, revolute, median process extending caudad; apex of process with an acute, median ridge arising dorsally; ventral margins of median process serrulate at apex; basal region of transtilla abruptly expanded and loosely articulated to bases of valvae. Juxta well developed, of various form. Valvae relatively simple, without secondary appendages except for a relatively broad, membranous fringe extending along lower (ventral) margin. Aedeagus rather complex, stout, with a prominent array of cornuti.

Female genitalia: A single genital opening (monotrysian). Ovipositor of the piercing type; apex acute, spear-shaped, dorsal edge smooth, ventral edge minutely serrulate;



Figs. 1-2. Adults: 1, *Acanthopteroctetes tripunctata* Braun, male holotype, Glacier National Park, Montana, wing expanse 11 mm; 2, *Acanthopteroctetes bimaculata* Davis, female holotype, Baker, Oregon, wing expanse 15 mm.

apophyses slender, greatly elongated; posterior apophyses extending to tip of ovipositor and forming the greater part of the shaft; anterior pair considerably shorter, terminating on eighth abdominal segment. Ductus bursae greatly dilated. Corpus bursae completely membranous and relatively small. Signum apparently absent.

DISCUSSION.—Several features serve to distinguish this interesting genus from the other members of Eriocraniidae. Among the more noteworthy are the absence of ocelli and mandibles, the two segmented labial palpi, and the distinctly different venation. The Eriocraniidae have been partly characterized as possessing ocelli (Meyrick, 1912) and mandibles (Busck and Böving, 1914; Imms, *et al.*, 1957). Furthermore, I am unaware of any member of this group of Lepidoptera whose labial palpal segmentation is less than three. The New Zealand genus *Mnesarchaea* (Mnesarchaeidae) is interesting in that it too lacks mandibles and possesses rather slender wings. That genus, however, apparently differs from *Acanthopteroctetes* in too many other respects for the two taxa to be regarded as closely allied.

Certain structural modifications in the male genitalia present some difficulties for interpretation, the principal among these being the proper terminology for the two sclerites situated in the diaphragma. For convenience, I have adopted the term *juxta* for the rather broad sclerite ventrad to the aedeagus. Dorsad to the aedeagus lies another heavily sclerotized structure whose lateral-basal arms articulate with the bases of the valvae. I have referred to this element as the *transtilla*, even though its derivation and composition may be much more complex.

Probably because of the rarity of the species involved, very little is known of the biology of this genus. The adults are apparently diurnal as observed by Braun (1921). Nothing is known concerning larval behavior, although considering the structure and probable function of the ovipositor, it is very likely that the larvae are leafminers, a habit well established throughout the small family.

KEY TO THE SPECIES OF ACANTHOPTEROCTETES

- 1a. Ground color of forewings fuscous, spotted with pale yellow (fig. 1)
----- *A. tripunctata* Braun
- 1b. Ground color of forewings paler, whitish to pale brown, not spotted as above.
2a. Vesture of head with whitish and fuscous scales equally intermixed; forewings with 2 fuscous spots (fig. 2) -----
----- *A. bimaculata* Davis, new species
- 2b. Vesture of head unicolorous, pale stramineous; (pattern of forewings obscure, apparently unicolorous) ----- *A. species.*

ACANTHOPTEROCTETES TRIPUNCTATA Braun

(Figures 1, 6-9; Map 1)

Acanthopteroctetes tripunctata Braun, 1921, Proc. Acad. Nat. Sci. Philadelphia, 73(1): 22; Fletcher, 1929, Mem. Dept. Agric. India, Ent. Series, 11: 2; McDunnough, 1939, Mem. So. California Acad. Sci., 2(1): 110 (no. 9857).

ADULT (fig. 1).—Wing expanse: ♂, 11 mm.

Head: Hairlike scales pale reddish brown, unicolorous. Antennae pale fuscous; scape more whitish. Palpi pale brown.

Thorax: Scales of dorsum fuscous; bristlelike tufts on tegulae pale fuscous; venter pale brown with slight suffusion of white. Legs fuscous. Forewings fuscous with a slight coppery luster; three large, pale yellowish spots, one at basal third of wing, two at apical third; outer pair nearly anastomosing to form an irregular and incomplete band across wing. Hindwings slightly paler, scales narrower, approximately one-half the width of those in forewings.

Abdomen: Fuscous.

Male genitalia (figs. 6-9): Uncus not deeply bilobed, ventral margin (as viewed laterally) with approximately 4 pairs of minute serrations. Tegumen relatively short, about same length as uncus. Caudal margin of vinculum with a deep V-shaped, median cleft. Median process of transtilla with 3-4 pairs of ventral serrations. Juxta elongate, exceeding length of entire transtilla, acuminate at caudal end. Valvae with ventral membranous fringe reduced; sacculus more expanded than in *A. bimaculata*. Aedeagus with two stout cornuti at apex and a series of three aligned down one side.

TYPE.—Holotype, male; in the collection of Annette F. Braun.

TYPE LOCALITY.—Glacier National Park, Montana, Canyon Creek, 5,500 feet.

HOST PLANT.—Unknown.

DISTRIBUTION (Map 1).—Presently reported only from Glacier National Park, Montana, in the Rocky Mountains.

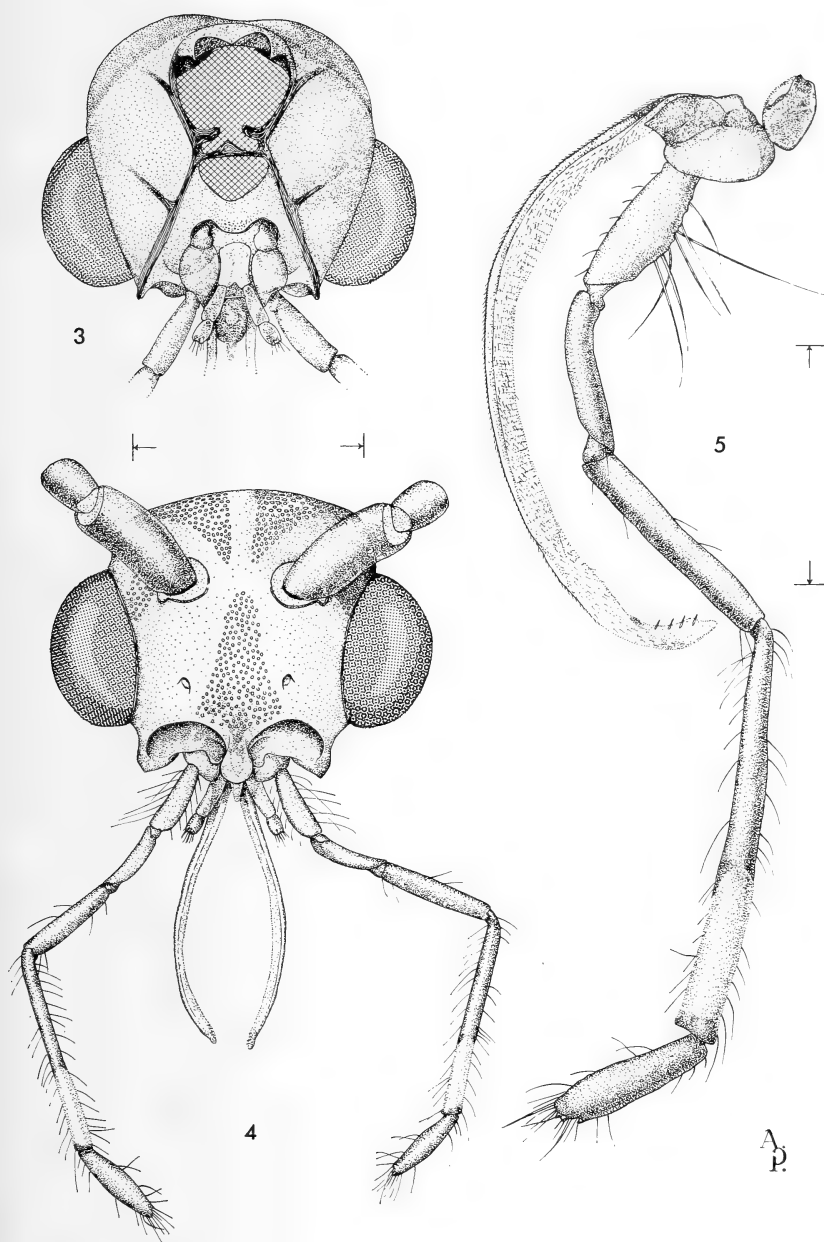
DISCUSSION.—This species is represented only by the unique holotype which was collected July 23, 1920, while flying in sunshine through an open area in the forest, by A. F. Braun.

***Acanthopteroctetes bimaculata* Davis, new species**

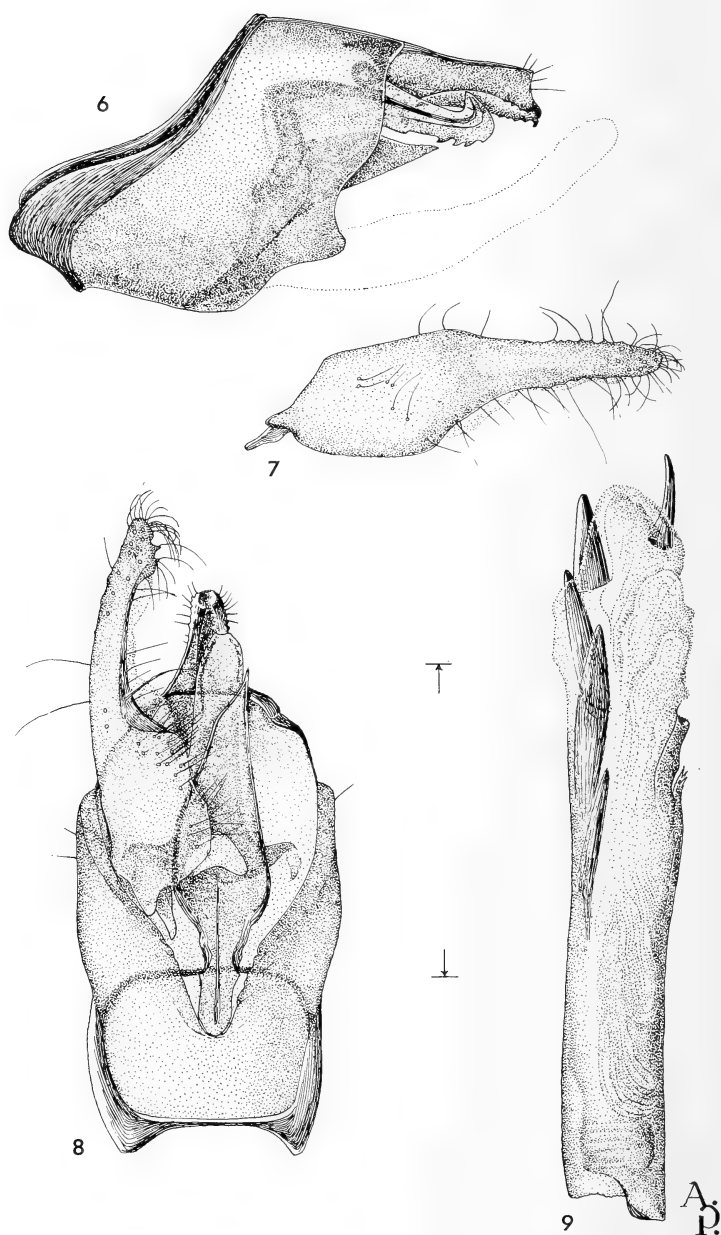
(Figures 2, 3-5, 10-16; Map 1)

ADULT (fig. 2).—Wing expanse: ♂, 16 mm; ♀, 15 mm.

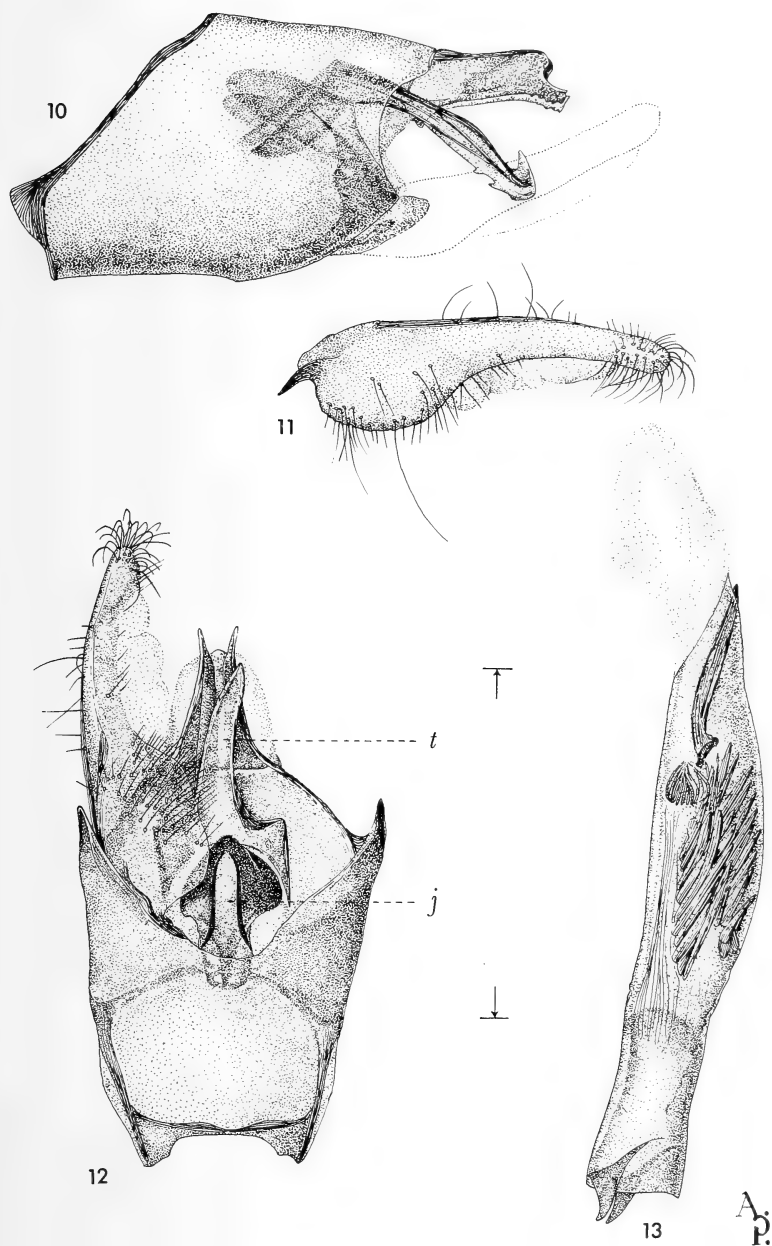
Head (figs. 3-5): Clothed with a scattered mixture of white and fuscous, hairlike scales. Antennae banded along proximal half of flagellum, with scales of each segment brownish fuscous at base, white at apex; distal half of flagellum mostly fuscous;



Figs. 3-5. Head structure of *Acanthopteroctetes bimaculata* Davis: 3, ventral view of head; 4, frontal view of head; 5, maxilla. (Scale of figs. 3-4 = 0.5 mm; of fig. 5 = 0.25 mm).



Figs. 6-9. Male genitalia of *Acanthopteroctetes tripunctella* Braun: 6, lateral view (valvae removed); 7, right valva, meso-lateral view; 8, ventral view, right valva removed; 9, aedeagus. (Scale = 0.5 mm).



Figs. 10-13. Male genitalia of *Acanthopteroctetes bimaculata* Davis: 10, lateral view (valvae removed); 11, right valva, meso-lateral view; 12, ventral view, right valva removed, *t* = transtilla, *j* = juxta; 13, aedeagus. (Scale = 0.5 mm).

scape mostly whitish with pale suffusion of brown. Palpi sparsely covered with pale brown and whitish scales.

Thorax: Dorsum clothed with a scattered mixture of white and pale brownish scales; bristlelike scale tufts on tegulae and rear portion of mesonotum fuscous; venter mostly whitish. Legs (fig. 15) fuscous. Forewings mostly white, with a somewhat irregular suffusion of pale brown to fuscous; two irregularly shaped but very distinct spots of fuscous located along hind margin near proximal third and distal third of wing; fringe whitish along outer margin, becoming pale brown along hind margin. Hindwings thinly scaled; scales very slender, hairlike, less than one-fourth the width of those in primaries, pale brownish; fringe unicolorous, brownish.

Abdomen: Pale fuscous.

Male genitalia (figs. 10-13): Uncus rather deeply bilobed; lower margins with approximately 5 pairs of minute serrations. Tegumen relatively long, exceeding length of uncus. Caudal margin of vinculum less deeply excavated than in *A. tripunctata*. Median process of transtilla with 3-4 pairs of ventral serrations. Juxta short, broad, length less than that of transtilla; caudal end broad and bluntly pointed. Valvae with ventral membranous fringe prominent; sacculus less expanded than in *A. tripunctata*. Armature of aedeagus complex, with a single, large, apical spine and two rows of approximately 10-12 stout cornuti at middle.

Female genitalia (fig. 14): Apex of ovipositor with approximately 10 minute serrations along ventral margin. Caudal margin of eighth segment with a series of about 9 pairs of stout, elongate, sensory setae encircling abdomen; the longest setae originating dorsally, with series gradually decreasing in length toward venter and arising from rather large, well defined pits. Ductus bursae swollen toward caudal end; a dark, funnel-shaped sclerotization present in inflated portion. Corpus bursae relatively small, ovoid.

HOLOTYPE FEMALE: Oregon, Spring Creek, Baker, [Baker County], May 17, 1962, coll. by J. H. Baker; in the United States National Museum, no. 69929.

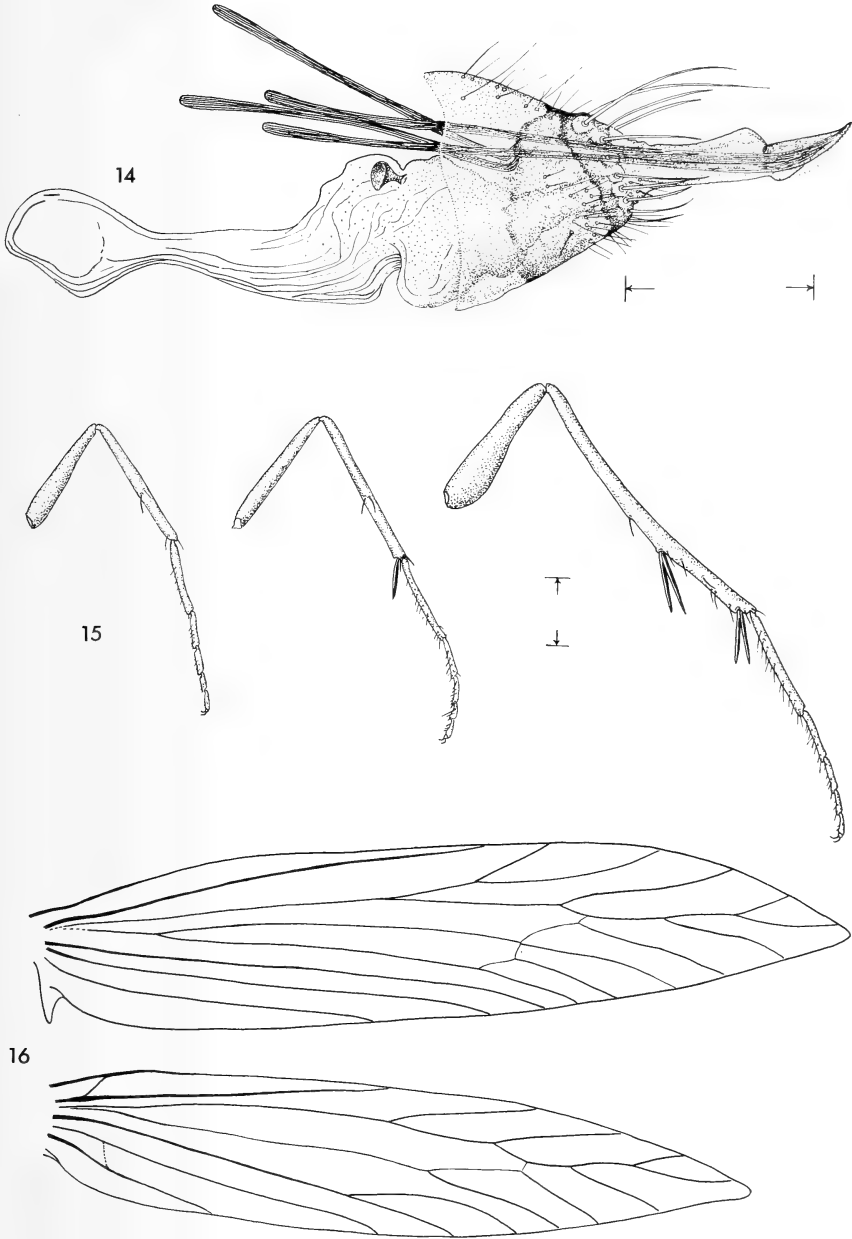
PARATYPES: *California:* Tulare Co.: Monache (misspelled on label as Monachee) Meadows, 8,000 ft., 1 ♀, July 8-14, (USNM). *Oregon:* Baker Co.: Baker, Spring Creek, 1 ♂, May 7, 1962, coll. by J. H. Baker, (USNM).

HOST.—Unknown.

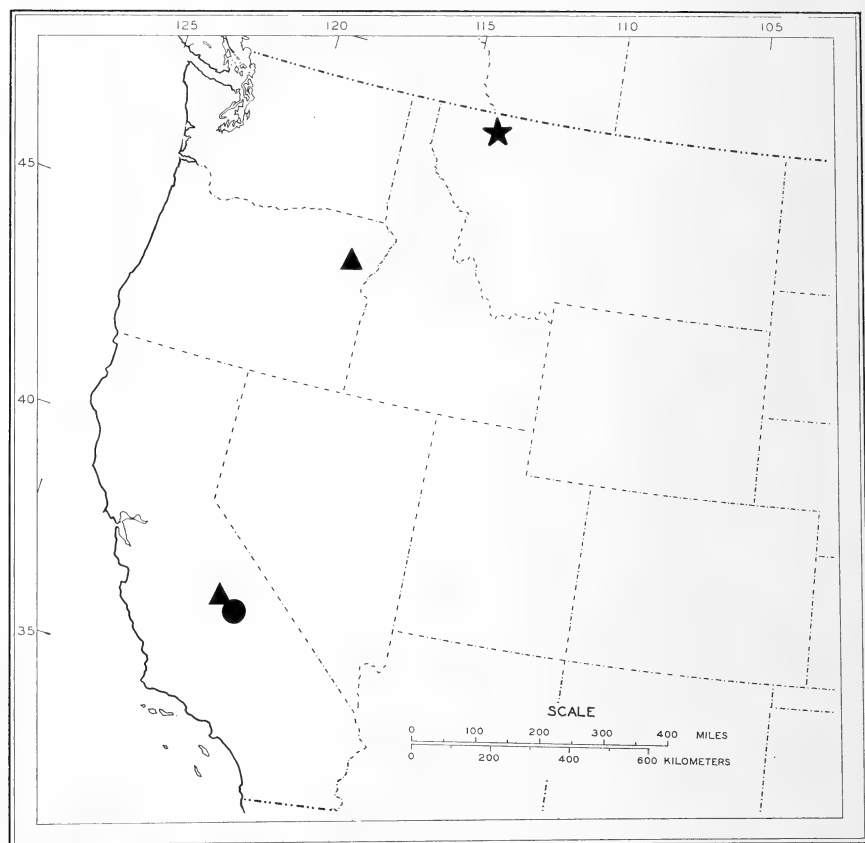
DISTRIBUTION (map 1).—Known from the Blue Mountains-Wallowa Mountains section of the Columbia Plateau in northeastern Oregon south to the southern Sierra Nevada of east-central California.

DISCUSSION.—This species may be easily distinguished from the only other described member of the genus, *A. tripunctata*, by its distinctly different maculation and by certain features of the male genitalia, the aedeagus in particular. With regard to maculation, these two species are nearly exact opposites with the ground color of *A. bimaculata* whitish to light gray and that of *A. tripunctata* fuscous. In addition, the aedeagus of the former with its double row of cornuti is much more heavily armed than that of *A. tripunctata*.

In the inflated portion of the female reproductive tract, which I have interpreted as the ductus bursae since it seems to be anterior to the junction of the common oviduct, is a peculiar, funnel-shaped sclerotization whose homology remains uncertain. Possibly this tract actually repre-



Figs. 14–16. *Acanthopteroctetes bimaculata*: 14, female genitalia, lateral view; 15, legs; 16, wings. (Scales = 0.5 mm).



Map 1. Distribution of *Acanthopteroctetes*. Star: *A. tripunctata* Braum; triangles: *A. bimaculata* Davis; closed circle: *A.* species.

sents a portion of the corpus brusae and the sclerotization is a signum. It should be possible to resolve this uncertainty as soon as additional females are collected and studied.

A single specimen of this species has been collected at Monache Meadows, Tulare County, California. Its origin strongly suggests that it and the following species may be conspecific; however, the former specimen, although in rather poor condition, clearly exhibits the wing pattern of typical *A. bimaculata*. Furthermore, the funnel-shaped structure in the bursa of this specimen is identical to that of the type from Baker, Oregon and differs markedly from that of the second specimen from California, which may be briefly treated as follows.

ACANTHOPTEROCTETES species

Map 1

A third member of this genus occurs in the southern Sierra Nevada of California. Braun (1921) refrained from naming this insect because it is represented by a single female in poor condition, and I likewise will characterize it briefly.

The specimen measures approximately 13 mm across the wings, and, although its present condition makes this difficult to ascertain, it seems to have been a relatively pale, uniformly colored moth. The vesture of the head is largely intact, however, and differs from that of either of the two known species in being a uniform, pale stramineous. The female genitalia closely resembles that of *A. bimaculata*, except for the distinctly different signa-like structure in the bursa. In this species the structure is more elongate and cylindrical and less sclerotized.

The specimen was collected at Monache Meadows, Tulare County, California, at an elevation of 8,000 feet, July 10, 1917. It is deposited in the collection of A. F. Braun.

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BOOK REVIEW

ON THE TYPES OF SOUTH AFRICAN MICROLEPIDOPTERA DESCRIBED BY THE LATE EDWARD MEYRICK AND PRESERVED IN THE TRANSVAAL MUSEUM, PRETORIA, AND THE SOUTH AFRICAN MUSEUM, CAPE TOWN; VOLUME 1, TINEIDAE; by A. J. T. Janse. Transvaal Mus., Pretoria, Memoir No. 16, 127 pp. + 118 plates in black and white. 1968. 8.50 Rand (\$11.90), paper covers.

The enormous chore of illustrating the types of the 15,000-plus species described by E. Meyrick, begun by J. F. G. Clarke on specimens in the British Museum, is being continued by Janse. Although the majority of Meyrick's types were placed in

the British Museum with his collection, a considerable number were returned by Meyrick to various museums throughout the world. In his introductory volume, Clarke catalogued 14,199 species of Microlepidoptera exclusive of the Pyraloidea, and indicated type depositions for the 50% or so where known. Probably three-fourths of those known are located at the British Museum; of the remainder possibly the largest portion, perhaps 1200 species, is housed in the two South African institutions.

The present volume treats some 216 species and includes not only photographs of the moths and genitalia, but drawings of wing venation and the head and of genitalia in some instances, as well. In all, some 432 photographs and 550 drawings are involved. Photographs of the moths, which depict dorsal views of one pair of wings and sometimes head and thorax, are fair to good, those of the genitalia mediocre to good. In males one valva has been removed and the genitalia shown in essentially lateral aspect or at a slight oblique, as was done by Janse in *The Moths of South Africa* for related groups. Thus for certain features, the illustrations are difficult to compare with figures published by other tineid specialists. Janse considers this position to be more desirable owing to an alleged greater distortion when mounted dorso-ventrally.

This work exceeds in depth that of Clarke, in that descriptive notes are given, often rather detailed for the genitalia. Janse's treatment, however, includes neither the original citations (which were all published in Volume 1 of Clarke), nor information from the labels, even type localities in most cases. Meyrick often published meagre locality information relative to that which had been available; Clarke reported some examples of this but none were South African.

In justifying the deposition of primary types, Janse mentions in his introduction that Meyrick rarely marked specimens he described as types, a practice recorded by Clarke as an "almost fanatical opposition to the labelling of types." Later, however, Janse in several instances discusses red, square "type" labels, which are variously stated to indicate one specimen from a series as the type (e.g., p. 25), or to be present on both a type and a specimen from a locality not mentioned in the original description (e.g., p. 55). In most cases involving series, as well as for uniques, "Holotypes" are cited, and a few lectotypes are formally identified as such, even though many are in effect designated.

In general species synonymy is not dealt with, but in one case (p. 43) an apparent manuscript name of Meyrick, *Ellochotis seclusa*, is given as a synonym, yet the moth and its genitalia are figured and appear to differ from the supposed senior counterpart, *E. infausta*, suggesting two species may be involved. If so, *seclusa* is sufficiently characterized and should be credited to Janse.

All names are retained in the combinations as originally proposed, irrespective of subsequent taxonomic maneuvering, even where genera were later considered as synonymous by Meyrick (e.g., *Amydria* Clemens). In this manner genera and species are arranged alphabetically, and some 74 generic names are involved. Included are 55 Meyrick names, of which the genotypic species for 42 are treated herein, which gives some index of the importance of this work. One genus is synonymized, where two isogenotypic genera are recognized.

Another valuable feature of the present book is the reproduction on pp. 9-22 of a key to some 325 world genera of Tineidae and Incurvariidae, as developed and used by Meyrick throughout his life. Meyrick's keys, which were of course written without the use of genital characters, were distributed to a few contemporary workers, but were never published. Janse states an intent to include keys corresponding to each family in subsequent issues of the series dealing with South African species.—JERRY A. POWELL, *University of California, Berkeley.*

A REVIEW OF *GLAUCOPSYCHE*, THE SILVERY BLUES, IN CALIFORNIA (LYCAENIDAE)

ROBERT L. LANGSTON

31 Windsor Ave., Kensington, Calif.

The genus *Glaucopsyche* Scudder, 1872, is represented in California by two species: *lygdamus* (Doubleday) and *xerces* (Boisduval). The former is widespread throughout the length of California and consists of three named subspecies of which there are intermediates and blend zones, plus variant local populations. The latter has been recorded only from the San Francisco Peninsula and is now presumably extinct.

The primary purpose of this paper is to bring together most of the older published reports on *Glaucopsyche*, giving insofar as possible, the known information on distribution, food plants, type localities, and how the subspecies differ from each other.

A secondary purpose is to confirm the occurrence of *Glaucopsyche lygdamus columbia* in California. More than 40 years ago it was stated by Comstock (1927) that "Another race of *behrii* has been separated by Dr. Skinner, under the name *columbia*, which occurs in the mountains of northern California, Oregon and Washington." More recently it has been indicated (Storer and Usinger, 1963) that the subspecies in the Sierra Nevada is *Glaucopsyche lygdamus behrii*. Museum and private collections may have interior (Sierra Nevada, Cascades) specimens determined either way.

Glaucopsyche lygdamus shows clinal tendencies with each subspecies blending into one or more subspecies at various points in their respective ranges. This appears to be the case in California with typical *behrii* in the Coast Range, and the Sierra Nevada/Cascades populations being the atypical southern extension of *columbia* from Washington and Oregon.

The species and subspecies of *Glaucopsyche* are given below in the categories and sequence as listed by dos Passos (1964).

Genus *GLAUCOPSYCHE* Scudder, 1872

Scudder, S. H., 1872. A systematic revision of some of the American Butterflies; with brief notes on those known to occur in Essex County, Mass., p. 33, (Salem, Mass.).

Generotype: *Polyommatus lygdamus* Doubleday, 1842.

In the Nearctic area this genus is represented by only two species. One of these, however, is composed of a rather extensive array of named subspecies (and synonyms), with much blending and intermediate forms.

The adult *Glaucopsyche* are recognized by a transverse median—post-median row of rounded black spots sharply ringed with white on the underside. Distal to these spots there are no other markings, which is

distinctive, because additional maculation is prevalent in other Plebejinae. The upperside of the males characteristically is a bright, silverish blue. Depending upon subspecies, the females are either brown, or have varying amounts of blue overscaling on the upperside of the wings.

Glaucopsyche lygdamus (Doubleday)

Polyommatus lygdamus Doubleday, 1842, Entomologist, no. 14, p. 209, London.

The silvery blue is the common name applied to the nominotypic subspecies *l. lygdamus*. This subspecies occurs in the eastern United States.

Type data: Pine forests of Georgia, in the British Museum (Natural History)—Comstock & Huntington (1961); Screven Co., Georgia—Klots (1951).

However, the species as a whole has an extensive range. It occurs in the northern United States from coast to coast; across all of Canada northward into the boreal regions of Alaska, the Yukon and the Northwest Territories; south in the Appalachians to Georgia, Alabama and Arkansas; south in the western Great Plains and the Rocky Mountains to New Mexico and Arizona; Great Basin and the Pacific Coast south into Baja California, Mexico.

The altitudinal range is from sea level to above timberline.

Early stages: Oviposition occurs after the adult mating in the spring. The larvae feed in spring and/or summer, with diapause occurring in the pupal stage. The mature larvae are, depending on subspecies and individuals, variably colored, from pale green or pale coffee color to purplish, with a darker dorsal stripe, often reddish brown with a purplish tinge. In the middle of the tenth segment there is a gland providing a secretion for which ants tend the larvae, a long known phenomena widespread in the Lycaenidae, and confirmed in *Glaucopsyche* (Downey & Lange, 1956). The body is "frosted" with numerous white hairs. The brownish pupae are formed amid debris and are suspended to a fixed object by means of the cremaster and a silken girdle.

Foodplants: Many Leguminosae, including *Astragalus* (rattle-weeds, loco-weeds); *Lathyrus* (everlasting peas), *L. couperi* (beach pea), *L. ochroleucus*, *L. caroliniana*; *Lotus* (trefoils), *L. glaber*, *L. scoparius* (deerweed); *Lupinus* (lupines), *L. micranthus*; *Vicia* (vetches), *V. cracca*, *V. gigantea* (giant vetch). Other hosts according to Downey (in Ehrlich, 1961) include the legume *Hedysarum boreale* (northern loment) and *Adenostoma fasciculatum* (chamise, greasewood) (Rosaceae).

Adults: The adults appear early in the season, fly briefly, and are single brooded, March (at sea level and south), to early June (at timberline and far north).

Glaucopsyche l. australis Grinnell

Glaucopsyche behrii australis Grinnell, 1917, Canad. Ent., 49 (10): 350.

The southern blue is the subspecies represented in cismontane southern

California and Baja California, Mexico; ranging northward in the Coast Ranges of central California, it integrades into *behrii*.

Typical southern examples may be distinguished from their northern relatives by the greater amount of blue on the upperside of the female, and by the smaller black spots on the underside of the hindwings. Specimens in which these spots have become obsolete may be referred to the aberrant form "*sinepunctata*" J. A. Comstock, 1926.

The blend zone appears to be an irregular line from Monterey and San Luis Obispo Counties eastward into Kern County. Populations on the coast south of Big Sur, Monterey County, have mostly dark females as in *behrii*, but smaller underside hindwing spots as in *australis*. Examples from Nacimiento Lake, San Luis Obispo County, show similar intermediate tendencies, whereas some specimens from Walker Pass, Kern County, have extensive blue on the females as in *australis*, but larger underside spots on both pairs of wings.

Type data: of *australis*, Pasadena, Los Angeles Co., Calif., May 20, 1907, in the F. Grinnell Collection; of *sinepunctata*, Mint Canyon, Los Angeles Co., Calif., May 1, 1921, in the Los Angeles County Museum.

Glaucopsyche l. behrii (Edwards)

Lycaena behrii Edwards, 1862, Proc. Acad. Nat. Sci., Phila., 2: 224.

Behr's silvery blue is the subspecies represented in the Coast Ranges of central and northern California. Common in the greater San Francisco Bay region, specimens from Monterey-San Benito to Napa-Sonoma Counties are close to "typical." Since it was described before the holotype concept, it has been speculated that W. H. Edwards' "California" locality refers to specimens from Marin County, north of San Francisco Bay. This was mentioned by Comstock (1927), with a female figured (pl. 56, fig. 24); the male underside (pl. 56, fig. 25) is of *columbia* from Plumas County (southern Cascades).

Averaging larger in size than *australis*, the underside has a row of large black spots (larger than other California subspecies) on a darkish gray ground color. The upperside of the male is a lustrous blue, with narrow dark margins. The female is dark brown, with rarely a few blue scales in the basal portions of the wings.

To the south, *behrii* blends into *australis*, as noted above. The intermediate forms do not necessarily blend uniformly in the same characters. Some specimens blend into *australis* by having smaller spots on the underside hindwings, whereas others show an increased amount of blue on the females. There may be various combinations of several characters in these intermediate populations.

To the east and north, *behrii* probably blends into *columbia*. Truly intermediate examples from large populations are not known to me. This is due to little personal collecting in the probable areas (mentioned below), and lack of available museum specimens.

Early stages: As recorded by Williams (1908), the mature larva is "pale coffee color, lighter below the spiracles. A reddish-brown line occurs in the median line, which has a purplish tinge. Oblique dashes whitish. Sub-horizontal and horizontal bands obscure. Lateral line white, becoming purplish ventrally. Body covered with roughened long pale hairs. Shield, grayish-green." The pupa is brown, with paler metathorax and wing covers.

Foodplants: Eggs and larvae were taken in Marin County on the small annual *Lupinus micranthus* (Williams, 1908). He also recorded it from *Lotus glaber* (= *scoparius*), *Astragalus*, and a large yellow lupine (probably *Lupinus arboreus*).

Type data: of *behrii*, "California"; of the ab. *sternitzkyi* Gunder, 1929, Fairfax, Marin Co., Calif., in the American Museum of Natural History.

Glaucopsyche l. *columbia* (Skinner)

Lycaena lygdamus columbia Skinner, 1917, Ent. News, 28: 213.

The Columbia silvery blue is the subspecies represented in Washington and Oregon. It ranges south in the Cascades and Sierra Nevada of California. It also occurs eastward in the Great Basin, where it blends into *oro* Scudder, 1876. Intermediates may be found in Idaho, Utah, western Montana and Wyoming, although Leighton (1946), records *oro* also from Washington.

Typical *columbia* is even larger than *behrii*, and on the underside is lighter gray with the spots averaging proportionally smaller. The upper-side of the female has a greater amount of blue overscaling than *behrii*, but is still predominately brown as opposed to the extensive blue on *australis* females.

The Cascade and Sierra Nevada populations in California represent an atypical southern extension of *columbia*. Examples from California show convergence toward *behrii*, with a tendency for the underside spots to become larger, and a reduction of the blue overscaling on the females.

Geographically, *columbia* is separated from *behrii* by the Sacramento and San Joaquin Valleys. Future collecting should reveal blending where the Coast Range converges with the Cascades (Mendocino, Trinity, or Shasta National Forests).

Specimens approaching *oro* have also been taken in eastern California (Inyo, Mono counties). However, until more specimens are available, and a more continuous distribution is known through Nevada and Oregon,

these will be considered as smaller, more prominently spotted examples of *columbia*.

Type: Port Columbia,¹ [Okanogan Co.], Washington, April 25, 1916, in the Academy of Natural Sciences, Philadelphia.

Glaucopsyche xerces (Boisduval)

Lycaena xerces Boisduval 1852, Ann. Soc. Ent. France, Series 2, 10: 296.

The *xerces* blue and its named forms were narrowly distributed on the San Francisco Peninsula from near Twin Peaks to North Beach, and the Presidio southward to Lake Merced. Lone Mountain, formerly an isolated, sandy hillock, was the classical resort of *xerces*. There are no known captures of any of these blues since World War II (Tilden, 1956). Tilden also states that it is "conceivable that the species may reappear, but such a possibility seems remote. Downey & Lange (1956) are more precise, stating that the last known specimens were collected at the Presidio during May, 1941.

Expansion of the city of San Francisco has destroyed much of the natural habitat formerly available to this blue. However, it appears that sufficient ecological niches remain that elimination of the habitat could not be the single cause of extinction. As in the case of *Cercyonis sthenele* (Boisduval), 1852 (Satyridae), which disappeared much earlier, *xerces* and its forms did not adapt to conditions further south or inland. Cold summer fogs drift over the peninsula, resulting in the climate being warmer in the winter and much cooler in the summer than on land masses in nearly every direction. Downey & Lange (1956) conclude that the "effect of a sudden shift in amplitude of these rather narrow annual climatic oscillations might have been greater on *xerces* than on comparable numbers of another species in another area where the 'normal' yearly fluctuations are more extreme."

In comparison with *lygdamus*, the males of *xerces* are more of a lilac blue rather than silverish. The females tend to be more of a grayish-brown, although this may be an artifact of old faded specimens. The typical form of *xerces* is the variety in which the black spots of the underside have disappeared, leaving large white spots on a field of steel-gray. The other forms have an increased amount of black spotting, as illustrated by Downey & Lange (1956) and most in color by Comstock (1927). Information from the literature, plus additional evidence presented by Downey & Lange (1956), show that there is a polymorphic group under the taxon *Glaucopsyche xerces*.

¹ J. C. Hopfinger sent the type specimens to Henry Skinner in 1916, and, as Brewster, Okanogan Co., then had a small local post office called Port Columbia, Skinner named the butterfly *columbia*.

Early stages: Recorded in detail by Williams (1908) and repeated with colored illustrations by Comstock (1927). The general color pattern of the larvae and pupae are very similar to that of *G. lygdamus behrii*. The larval color seems to be variable in both species. The hatching of eggs to pupation has been recorded from 31 to 48 days. The pupal stage averages between 10 and 11 months.

Foodplants: The preferred host was reported to have been *Lotus glaber* (= *scoparius*), which is still found in restricted parts of San Francisco and environs. Oviposition has been observed, and eggs and larvae have also been found on *Lupinus arboreus*. Williams (1908), noted that in captivity the caterpillars readily devoured the leaves and seed pods of *Lupinus micranthus* and *Astragalus menziesii*.

Adults: Museum specimens and published records indicate one brood of adults in the spring. Most specimens are March and April, but it has been recorded from late February to early June.

Type data: (as given by Comstock & Huntington (1958–1964)), of *xerces* (Boisduval), 1852, California, in the U. S. National Museum (?); of form *antiacis* (Boisduval), 1852, San Francisco, Calif., in the U. S. National Museum (?); of *intermedia* Chermock, 1929, Lone Mountain, San Francisco, Calif., in the F. H. Chermock Collection (?); of form *meritla* (Edwards), 1866, California; of form *polyphemus* (Boisduval), 1869, California, in the U. S. National Museum (?); of *Ab. huguenini* Gunder, 1925, San Francisco, Calif., April 24, 1917; of *Ab. barnesi* Gunder, 1927, San Francisco, Calif., April, 1923, in the Barnes Collection, U. S. National Museum.

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FIELD OBSERVATIONS ON FOREST *OENEIS* (SATYRIDAE)

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Based on their ecological preferences,¹ the *Oeneis* of the Nearctic Region can be placed in three groups: forest species, including *Oeneis macounii* (Edwards), *Oeneis nevadensis* (Felder & Felder), and *Oeneis jutta* (Hübner); prairie and steppe species including *Oeneis uhleri* (Reakirt), *Oeneis chryxus* (Doubleday), *Oeneis alberta* Elwes, and the closely related *Neominois ridingsii* (Edwards); and the arctic taiga-tundra/alpine summit species including *Oeneis taygete* Geyer, *Oeneis bore* (Schneider), *Oeneis melissa* (Fabricius) and *Oeneis polixenes* (Fabricius). Excepting *O. chryxus*, which frequently ventures into both forest and mountain top environments, these butterflies occupy restricted biotopes. The *Oeneis* have remarkably complex adult behavior patterns which, in the forest species, are very similar and apparently based on three primary instincts: (1) sexual reconnaissance and rendezvous including territory occupation, (2) thermoregulation, and (3) feeding.

OENEIS MACOUNII (Edwards)

Like some of the other species in the genus, *O. macounii* has a two year life cycle and flies only in alternate years. From Riding Mountain, Manitoba and westward it flies in odd numbered years while to the east it flies in even numbered years. It is local and restricted in habitat to open jack pine forests (Masters, Sorensen & Conway, 1967). The life cycle and local nature of colonies contribute to a paucity of records, but *macounii* has a wide range from the east slope of the Rockies in Alberta (Elwes, 1893) east to Algonquin Park, Ontario (Durden, *in litt.*) and south to Pine County, Minnesota (Rysgaard, 1939).

We have made detailed observations on *O. macounii* in Minnesota and Manitoba (Masters *et al.*, 1967; Masters & Sorensen, 1968a). Both sexes could be distinguished readily on the wing due to differences in flight behavior. Females fly slowly and aimlessly through the pine forest. Males are more active, repeatedly perching on favorite leaves that serve

¹ Generalizations on ecological preferences are based on our personal observations, together with information from about 30 references in the literature to habitats of North American *Oeneis*.

as observation points over small clearings. From such a vantage points they drive away other males that come into view and wait for a female. When a male is captured, he will often be replaced by a new male in an hour or two, occupying the same glade, frequently using the same perch.

Territoriality in *O. macounii* appears to be a mechanism developed for the purpose of acquiring a mate (Masters *et al.*, 1967). A territory usually consists of a small glade which a male can observe and patrol from a strategic perch. Usually the perch will be among the green leaves on a tree branch or at the top of a low bush, but frequently it will be on a bare twig. The nature of the chosen perch does not seem to be as important as its location. If an observer remains stationary nearby, the male butterfly becomes unaware and can be observed at close range. Observing (JHM) that a particular butterfly would return again and again to the same perch, it had seemed a simple matter to move a camera and tripod into the glade, focus on the perch and wait; but the presence of observer and camera seemed to alter the topography of the clearing from the butterfly's point of view and another perch was selected, usually closer to the camera. One such butterfly under observation was captured and allowed to be replaced by another male; the habits of the replacement and his selection of perches were almost identical to those of his predecessor.

Behavioral thermoregulation of *O. macounii* is best demonstrated by our observations at Riding Mountain, Manitoba during 1967. On June 23, a cold cloudy day with the temperature never exceeding 55° F., no *macounii* were observed flying and the only individuals located were hanging on the undersides of leaves near the ground. On June 24th the sky was clear and the temperature reached 68° F., *macounii* were active and always landed with their wings open into the sun. June 25th was a hot day for Riding Mountain at 80° F. The butterflies were still active, but after alighting they quickly folded their wings and sometimes leaned slightly away from the sun. These behavioral differences are related to thermoregulation and involve control of the amount of wing surface exposed to the sun. Clench (1966) cites the importance of thermoregulation to butterfly behavior and concludes that the opening and closing of the wings is one of several devices that permit control of the amount of solar heat received, the wings being the butterflies' primary area for heat exchange. With a slight modification to lower thresholds, our observations correlate rather well with the six heat zones that Clench cites for butterfly activity. For other *Oeneis*, such as *O. alberta* (Brown, 1952), these thresholds are significantly lower.

Feeding seemingly played a minor role in *macounii*'s daily behavior.

Regularly used glades usually contained a few flowers which were visited for brief periods throughout the day, and the butterfly returned to his overlooking perch.

OENEIS NEVADENSIS (Felder & Felder)

Oeneis nevadensis occurs in the Cascade and Sierra Nevada ranges from southwest British Columbia to Sonoma County, California. Comstock (1927) adequately and briefly described the habitat of *O. nevadensis*: "It is a forest dweller, delighting in little open glades where spots of sunlight filter through the leafy canopy, in which it sports with a nervous jerky flight." Guppy (1962) observed *Oeneis nevadensis gigas* Butler on Vancouver Island and indicated that males are usually collected in clearings along the tops of ridges and that these clearings probably serve as a rendezvous for mating. A male would establish his territory on a hilltop and would drive off other males coming into view. Females were presumed to fly to the hilltops to mate and then to disperse to other areas for egg laying. Guppy's "hilltopping" theory explains the territorial habits of the males and accounts for the relative scarcity of females.

Oeneis nevadensis appears to be as similar to *O. macounii* in habits as it is morphologically. Indeed, the two occupy a very similar biotope and functional niche on opposite sides of the Rockies and are probably subspecies of each other. In the past they have been rather arbitrarily separated into two species because of misconceptions about the *macounii* habitat and the lack of male androconial patches or male *macounii*. In his revision of the genus, Elwes (1893) was unable to separate female *macounii* from *nevadensis*. Brown (1964) affirms that male *macounii* do have androconia, though they are more inconspicuously restricted to the area of the veins. We have discovered that the androconia are more in evidence on *macounii* from westward populations.

OENEIS JUTTA (Hübner)

Oeneis jutta is one of the most widespread species in the genus and is found in the Palearctic as well as Nearctic. In the Nearctic it is found across the arctic from Alaska to Newfoundland, south to Maine and Minnesota and, in the Rockies, to Colorado and Utah. Masters and Sorensen (1968b) review subspeciation in *O. jutta*.

Oeneis jutta occurs in black spruce/sphagnum bogs which at first glance appear to be quite different from the habitat of either *O. macounii* or *O. nevadensis*. However the best "*jutta* bogs" are those where black spruce and tamarack are of medium density and the sunlight filtering through them creates small glades similar to those in the jack pine forests inhabited by *O. macounii*. Labrador tea and other ground cover in

the bog present an uneven floor with many perches suitable for males.

Oeneis jutta ascerta Masters & Sorensen, flying in Minnesota bogs, has habits similar to those we observed for *O. macounii*. Males establish territories consisting of small sunlit clearings and fly out at all intruders. They return again and again to a favorite perch which might consist of a tuft of cottongrass, as observed by Nielsen (1964), the top of a clump of labrador tea or laurel, a tree trunk or dead limb of a fallen spruce, or a low growing tamarack or spruce. Females differ in flight and habits from the males and wander without apparent direction through the bog; sometimes flying to the top of a tamarack tree, a habit never observed in males. Females are more frequently encountered along the edges of bogs and this accounts for their preponderance in some collections. Apparently territory occupation serves to acquire a mate for *jutta* just as it does for *macounii* and *nevadensis*. In one instance we (JHM) observed two males hovering about the end of a spruce branch: on closer investigation, it was discovered that a freshly emerged female with her wings still wet was under the branch. This indicates that a female scent as well as vision serves to attract males to females.

O. jutta generally perch with wings closed during most types of weather, and they quickly disappear if cloud cover obscures the sun. In the evening, several hours before sunset, the males come out into larger clearings to cavort in the last rays of sunlight; at these times they fly in closer contact with each other and with less belligerent appearing behavior. Possibly they obtain enough solar energy from the sun to extend the length of their day, but perhaps it is only an exhibition of phototropism. We (JTS) observed a group of about 15 *jutta* engaging in this type of activity near noon on a cloudy day in Koochiching County, Minnesota.

Oeneis jutta ridingiana Chermock & Chermock appears to be the subspecies endemic to Riding Mountain and the nearby uplifts of western Manitoba; it is a small and relatively brightly adorned *jutta*. Acid spruce/sphagnum bogs are edaphic climax forest situations (maintained by wet acid soil conditions rather than climate). The gradual seral succession of bogs is obvious to one who visits them in Minnesota and then on Riding Mountain, for Riding Mountain bogs are old with dense growths of black spruce and relatively dry turf. The density of these forests seems to be a detriment to *jutta* because the open sunlit patches are not found in them. *O. jutta* seemed to be scarce or rare here and preferred the edges of the bogs where the most sunlight penetrated. Cottongrass (*Eriophorum spissum* Fern.), the *jutta* foodplant, was also scarce in these bogs and restricted to their more open edges.

Interestingly, the habitats of other *Oeneis* species seem to be related to

edaphic situations. The jack pine forest habitat of *O. macounii* is an edaphic condition which in this case is maintained by well drained sandy soil. Virgin prairie (the habitat of *O. uhleri varuna*) is usually thought of as a climax community, but Sauer (1950) regards it as a nearly stable subclimax community maintained by fire—somewhat the same level as an edaphic climax community. Steppe, or short grass prairie, is possibly similarly maintained by fire. If one distinguishes between tundra and taiga (Polunin 1959, regards taiga as the sparsely timbered country near the northern limit of arborescent growth), most of our arctic *Oeneis* are found on taiga rather than tundra. Mackay (1966) considers taiga as an edaphic climax community that is maintained by discontinuous permafrost that inhibits subsurface drainage and gives the soil a grainy character. The taiga will not yield entirely to trees in a warming trend but much of it might actually yield to tundra “through the establishment of a sphagnum-moss ground cover, a resulting shallowing of the active layer, and an eventual favoring of the tundra succession.”

Oeneis jutta reducta McDunnough is found in an atypic situation in Colorado. There are no spruce or tamarac bogs in Colorado, but there are many beaver-dam/willow bogs. Wherever lodgepole pine forests border these bogs, one is apt to find *O. jutta*. *Oeneis jutta reducta* has apparently found an unique biotope to meet its needs which include the bog for breeding and larval food, and the pine forest for adult social patterns which are probably not unlike those of eastern *jutta ascerta*. Willow/beaver bogs certainly don't constitute a climax situation, but in the tension zone between them and the climax lodgepole pine forest is a long enduring subclimax community if the beaver populations are not disturbed. Don Eff (in Brown, 1954) very adequately describes the Colorado habitat: “It is found in the dry areas among the lodgepole pines, especially where the growth is not too thick and the trees are large in size, and where the green ground is dappled with sunshine and shadows. . . They love the rotten logs and the sides of trees and in spite of the multitude of flowers nearby never visited any.”

OENEIS CHRYXUS (Doubleday)

Oeneis chryxus is primarily a prairie and steppe species, but in some areas it has a tendency to move into other habitats. We observed at Stagecoach Meadows, Gunnison County, Colorado that *O. chryxus chryxus* was found in the open “meadow,” but more commonly at the edge of the woods surrounding it. In this tension zone between forest and steppe, there were many fallen trees and open areas. *O. chryxus* in this area seemed to favor perches on fallen trees and the attitudes of males for each

other was reminiscent of what we had observed for *Oeneis macounii* and *jutta*. We were unable to observe a consistent behavior for *chryxus* on the Colorado steppe.

OENEIS UHLERI (Reakirt)

Our observations on *Oeneis uhleri uhleri* at Hall Valley, Park County, Colorado, indicate that the prairie and steppe species may also have complicated social patterns. The habitat here was a rather dry slope with grasses the predominate growth. The slope rose from a roadbed at a 30° incline for about 50 feet and then to a 20° incline before extending another 30 feet to the edges of a pine forest. The favored spot for *O. uhleri* was at the "break" on this incline. Males alighted in the short grass along this crest and seemed to space out five to eight yards apart, but periodically flew straight up to flutter in fixed positions several feet off above the ground for 30 to 60 seconds. The butterflies, while in hovering flight, were difficult to approach from below. They spotted the investigator about five yards away and then allowed the wind to carry them rapidly up hill and out of sight. On the other hand, a butterfly in hovering flight could be easily approached and netted from above. We believe that these butterflies were surveying the downhill terrain while in hovering flight and that this is a primary method of sexual reconnaissance. Aerial encounters between males along the crest were also much in evidence. Quite likely they are able to maintain "territories" even on the uniform terrain of the steppe.

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A NEW SUBSPECIES IN THE *CERCYONIS MEADI* GROUP (SATYRIDAE)

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Cercyonis meadi (Edwards) is a rare species in collections, due partly to the scattered and isolated geographic distribution of its populations in the Rocky Mountain states and the inter-mountain West. The senior author has accumulated extensive series of this species from all areas, and a full report of the species' biology, variation, and distribution will be published shortly in a comprehensive treatment of the genus *Cercyonis*.

A unique new subspecies of this red-patched *Cercyonis* was discovered by the authors in the San Luis Valley of southern Colorado, in late summer of 1964. This ecologically strange basin is situated at above 7,500 feet elevation, yet is extremely arid and unforested, with saltbush (*Atriplex*) the dominant vegetation. This habitat is quite different from the usual coniferous forest associations of typical *Cercyonis meadi meadi* (Edwards) and *C. meadi mexicana* (Chermock), and the San Luis Valley butterfly is equally distinct. In order to make the name available for inclusion in a forthcoming popular book, this subspecies is described here.

Cercyonis meadi alamosa Emmel & Emmel, new subspecies

Holotype, male. Expanse, 39.3 mm. Forewing length, 21.2 mm. *Forewings, superior surface:* Dull brown, with a russet red patch around the two forewing ocelli. Both ocelli pupilled with white scales. *Hindwings, superior surface:* Dull brown, with well-marked, pupilled black ocellus at anal margin. *Forewings, inferior surface:*

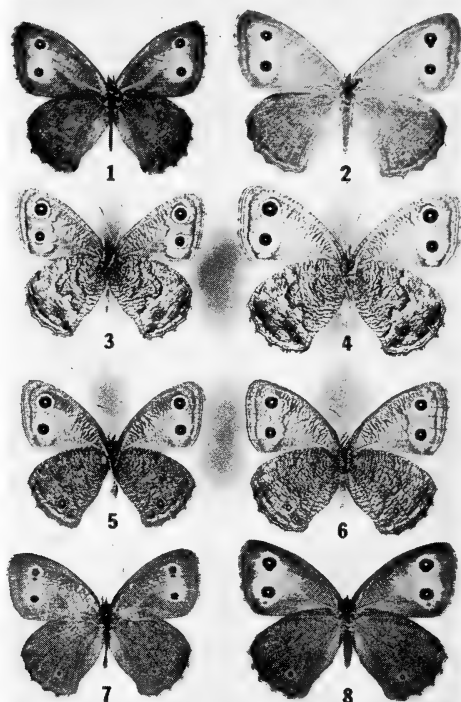


Fig. 1-4. *Cercyonis meadi alamosa* Emmel & Emmel. Dorsal surface of holotype male (1) and allotype female (2); ventral surface of paratype male (3) and paratype female (4), from the type locality, San Luis Valley, Colorado.

Fig. 5-8. *Cercyonis meadi meadi* (Edwards). Ventral surface of male (5) and female (6); dorsal surface of male (7) and female (8). Males from Deckers, Douglas Co., Colorado, Aug. 9, 1959; Ray J. Jae, collector. Females from Big Spring Ranch, nr. Florissant, Teller Co., Colorado, 8600' elev., Aug. 8, 1962; T. C. Emmel, collector.

Brown areas of typical *meadi* covered with white scaling. The russet red patch extending from ocelli almost to thorax. *Hindwings, inferior surface*: Entire wing, except two heavy brown lines creating the medial band, heavily suffused with white scaling. Only one or two marginal ocelli present; thus resembling typical *meadi* ocellation, differing from the heavy ocellation in *mexicana* populations. Head, thorax, and abdomen as in typical *meadi* and *mexicana*. *Genitalia* (Fig. 9): Lacking dorsal spine on shoulder of valva, which is found in the other subspecies of *meadi*.

Allotype, female. Expanse, 45.4 mm. Forewing length, 24.9 mm. As in male, generally lighter brown in dorsal ground color (fresh specimens).

Holotype male: Colorado, San Luis Valley, 7.0 miles north of junction of Highway 17 & Highway 112, on Highway 17, Saguache County, 7539'

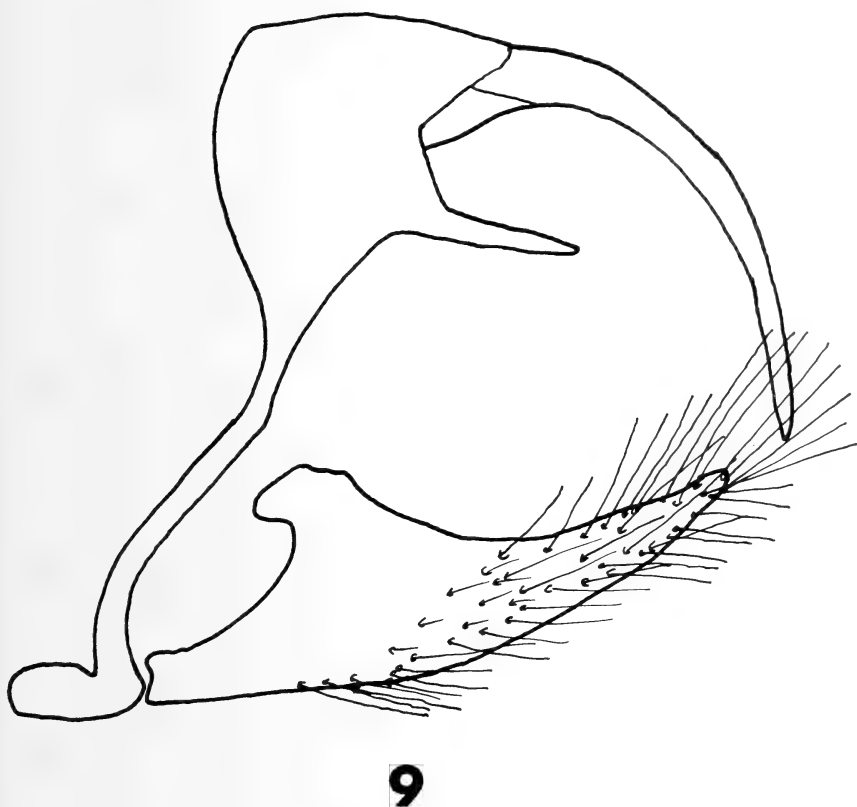


Fig. 9. Male genitalia of *Cercyonis meadi alamosa* Emmel & Emmel (paratype), lateral view.

elevation, August 17, 1964, T. C. & J. F. Emmel, collectors. Allotype female: Same locality, August 20, 1965, T. C. Emmel, collector. Paratypes: 55 ♂, 8 ♀, same locality, August 17, 1964, T. C. & J. F. Emmel, collectors; 9 ♂, 10 ♀, same locality, August 20, 1965, T. C. Emmel and Michael K. Fosdick, collectors; 1 ♀, at entrance to Great Sand Dunes National Monument, about 8000' elev., Alamosa County, Colorado, August 18, 1964, T. C. Emmel, collector; 1 ♀, Mosca Pass Trail, 8300' elev., Great Sand Dunes Nat. Mon., Alamosa Co., Colorado, August 18, 1964, T. C. Emmel, collector.

The holotype and allotype are deposited in the type collection, Los Angeles County Museum of Natural History. Paratypes will be deposited in the following institutions and collections: California Academy of Sciences, American Museum of Natural History, United States National Museum, and Stephen F. & Edwin M. Perkins collection, Portland, Ore-

TAXONOMY, DISTRIBUTION AND BIOLOGY OF THE GENUS *CERCYONIS* (SATYRIDAE). I. CHARACTERISTICS OF THE GENUS

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Evolution of butterflies in the satyrid genus *Cercyonis* has produced a complex of species groups and variable populations in North America that has not been reviewed thoroughly since the last century. The purpose of this paper and others to follow in the series is to provide a critical, modern synthesis of taxonomic, distributional and biological information on all species and subspecies within the genus, based on extensive studies by the author from 1960 to the present.

In future papers, each species group will be treated intensively, with plates of both sexes of adults of all subspecies, larvae, pupae, figures of eggs, genitalia, androconia, antennae and other important morphological characters, and chromosomes. Genetic data and hybridization crosses will also be summarized in the present series from material to be published in full elsewhere.

TAXONOMY

The Nearctic genus *Cercyonis* has had over thirty specific, subspecific, or varietal names applied to it, and no taxonomic revision has been attempted since the 1880s (Edwards, 1880). On the basis of extensive field work, examination of over 5,000 adult *Cercyonis* specimens, rearing of many of the named forms, and studies of external and internal morphology of all these forms, the following new taxonomic treatment is proposed.¹

- I. *Cercyonis sthenele* (Boisduval, 1852)
 - a. *sthenele sthenele* (Boisduval, 1852)
 - b. *sthenele silvestris* (Edwards, 1861)
 - c. *sthenele paulus* (Edwards, 1879)
 - behrii* (Grinnell, 1905)
 - d. *sthenele masoni* (Cross, 1937)
- II. *Cercyonis oetus* (Boisduval, 1869)
 - a. *oetus oetus* (Boisduval, 1869)
 - b. *oetus charon* (Edwards, 1872)
 - c. *oetus phocus* (Edwards, 1874)
- III. *Cercyonis meadi* (Edwards, 1872)
 - a. *meadi meadi* (Edwards, 1872)

¹ Subspecies names are used as a convenient reference to well-differentiated sets of populations. The term *form* in the taxonomic section refers to a phenotypic form of a subspecies which appears sympatrically with one or more other phenotypic forms in at least one part of the geographic range of the subspecies. In the *Cercyonis pegala* complex especially, there is a tendency for several of the named phenotypes to appear in polymorphic populations.

- melania* (Wind, 1946)
- b. *meadi mexicana* (R. L. Chermock, 1948)
- c. *meadi alamosa* Emmel and Emmel, 1969
- IV. *Cercyonis pegala* (Fabricius, 1775)
 - a. *pegala pegala* (Fabricius, 1775)
 - b. *pegala alope* (Fabricius, 1793)
 - form *nephele* (Kirby, 1837)
 - form *maritima* (Edwards, 1880)
 - form *ochracea* (Chermock and Chermock, 1942)
 - form *carolina* (Chermock and Chermock, 1942)
 - c. *pegala texana* (Edwards, 1880)
 - d. *pegala ino* (Hall, 1924)
 - e. *pegala boopis* (Behr, 1864)
 - olympus* (Edwards, 1880)
 - borealis* (F. H. Chermock, 1929)
 - form *baroni* (Edwards, 1880)
 - form *incana* (Edwards, 1880)
 - f. *pegala ariane* (Boisduval, 1852)
 - form *wheeleri* (Edwards, 1873)
 - hoffmani* (Strecker, 1873)
 - form *gabbii* (Edwards, 1870)
 - form *stephensi* [♀] (Wright, 1905)
 - g. *pegala damei* (Barnes and Benjamin, 1926)

The morphological and general biological differences between the species groups are summarized in Table 1. More specific discussion of biological and regional differentiation within the genus will appear in four future papers in this series.

DISCUSSION

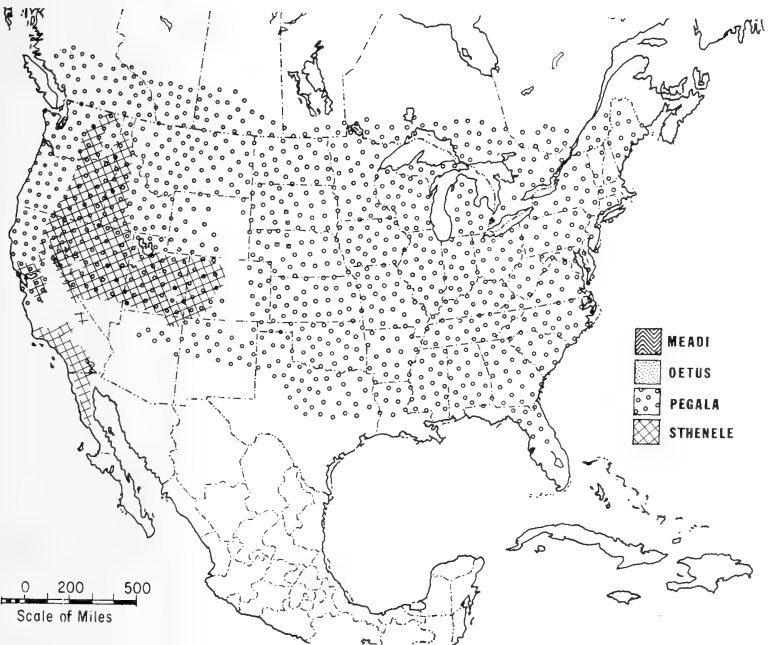
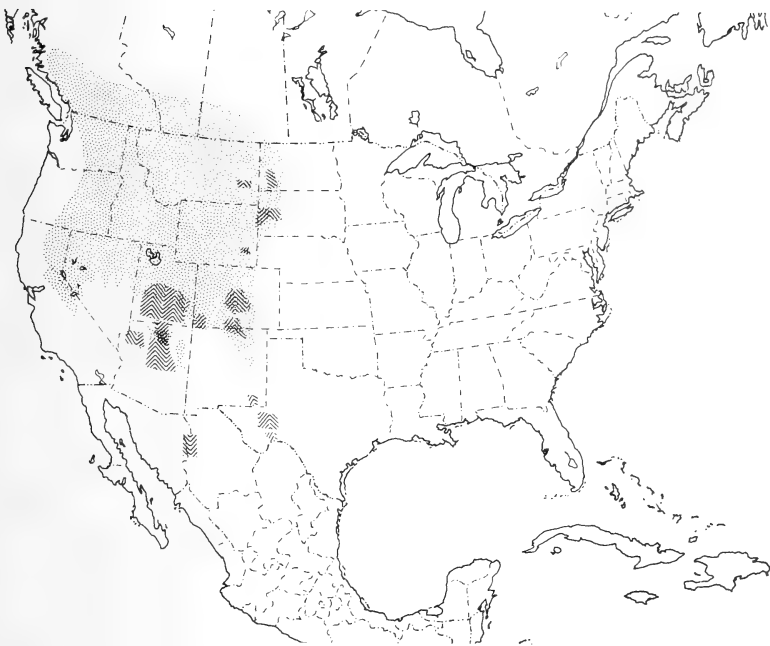
I. *Cercyonis sthenele*:

These small-to-medium-sized *Cercyonis* occur throughout most of the arid Upper Sonoran areas of the western United States. *Cercyonis s. sthenele* is known only from the area now occupied by the city of San Francisco, California, and has been extinct since approximately 1880. *C. s. silvestris* is distributed intermittently from Baja California in Mexico north through California (west of the Sierra Nevada) and Oregon to Washington. Jones (1951) reports it as occurring in the southern interior of British Columbia. *C. s. paulus* is found in eastern California, at scattered localities in eastern Oregon, and throughout Nevada above the desert areas. *C. s. masoni* is known from western Colorado, northeastern Arizona, Utah, and Wyoming; with further collecting, it may be found in northern New Mexico.

→

EXPLANATION OF MAPS

The distribution of the four species of *Cercyonis* in North America. Upper map: *C. meadi* and *C. oetus*; lower map: *C. pegala* and *C. sthenele*.



No representatives from the *sthenele* group have been found east of the Continental Divide, north of the Canadian border (with the possible exception of British Columbia), or on the Mexican mainland.

II. *Cercyonis oetus*:

These small-sized *Cercyonis* occur throughout most of the mountain ranges of the western United States and north into western Canada. *Cercyonis oetus oetus* ranges from the central Sierra Nevada and Owens Valley (Inyo County) in California north through almost all of Oregon to Yakima and Okanogan counties in Washington. It is also found in southern Idaho and in the mountain ranges of Nevada. *C. o. charon* is found in the Rocky Mountains from northern New Mexico through Colorado and Wyoming to Alberta in Canada. It also occurs in the higher mountains of northern and eastern Arizona, Utah, Montana, eastern Idaho and the Black Hills of South Dakota. *C. o. phocus* is known from British Columbia and from scattered populations in Washington, Montana, and Idaho. Occasional specimens from the mountains of New Mexico show the dark *phocus* phenotype.

No *Cercyonis oetus* populations have been found south of central Arizona or central New Mexico, nor east of the eastern edge of the Rocky Mountains and the Black Hills. Thus, while the range of *C. oetus* is slightly more extensive (to the north) than that of *C. sthenele*, both species are completely restricted to the Nearctic portion of the western half of the Northern American continent.

III. *Cercyonis meadi*:

These medium-sized *Cercyonis* with a reddish forewing flush occur in scattered populations in northern Mexico and the central Southwest, from Upper Sonoran into Transition zone areas. *Cercyonis meadi meadi*, a highland subspecies with blackish underside, is found in Colorado in the moderate elevations (7500–9500 feet) of the Rocky Mountains. *C. m. mexicana*, a lowland subspecies with brownish underside, occurs in northwestern Chihuahua, Mexico, in northern to northwestern Arizona, southern to central Utah, northern New Mexico, the Davis Mountains of Texas, eastern Montana, North Dakota (McKenzie and Slope counties), the Black Hills (near Nemo) of South Dakota, as well as the eastern lowland slopes of the Front Range in Colorado. *C. m. alamosa*, with a silvery-gray underside, is a race endemic to the San Luis Valley (8000 feet) of southern Colorado.

No *C. meadi* occur in Nevada, in the Pacific Coast states, or in the northern states, and the present known distribution is curiously disjunct. The population density varies considerably from year to year in a given area.

IV. *Cercyonis pegala*:

These large-sized *Cercyonis* are the only *Cercyonis* group to be distributed east, as well as west, of the Rocky Mountains. They are found from sea level up to elevations of about 7000 feet. *Cercyonis pegala pegala* is distributed from the Mississippi Valley east to the Atlantic Coast and from the Gulf States north to North Carolina and New Jersey. *C. p. alope* ranges from Virginia and New Jersey north to eastern Quebec and Maine, and into New York; northward and westward, the yellow-patched *alope* intergrades with the completely dark *nephele* and the somewhat lighter *ochracea* (in Ohio). To the south, *alope* blends with *carolina* in the Carolinas. At eastern points in Massachusetts, *alope* intergrades with the darker-yellow form *maritima*. Populations containing two forms of *alope* are frequent in the areas indicated; thus it seems best to treat *nephele*, *maritima*, *ochracea*, and *carolina* as simple phenotypic forms of *alope* that have their particular centers of abundance which interdigitate frequently along their respective margins; it is clear even in the 1870s (Edwards, 1880) that the proportion of these forms varied in observed populations from year to year, and present data show that no stability of gene frequencies has been reached as yet.

Cercyonis p. texana ranges from central Texas north to Kansas and Missouri. *C. p. ino* occurs in Alberta and Manitoba, Canada, and in North Dakota and Montana. *C. p. boopis* ranges from central New Mexico and Arizona north through Colorado to South Dakota and west to the Pacific Coast, from central California north to British Columbia on the coastal side of the Cascades and Sierra Nevada. Several local color or dwarfed forms (*incana* and *baroni*) have been named from northern California, and many other odd-colored forms appear in scattered populations to the north. I have even seen specimens with a greenish underside from near Portland, Oregon. But none are worthy of nomenclatural designation.

Cercyonis p. ariane has a strongly-striated pattern on the ventral surface, with a yellow forewing flush; it occurs in the lowland areas of Utah (form *gabbii*), Nevada (form *wheeleri*, now believed extinct), eastern California, eastern Oregon, and eastern Washington (typical *ariane*). The heavily yellow-washed female form, *stephensi*, occurs mainly in northeastern California populations, but this phenotype also appears among females in Nevada and Oregon.

Cercyonis p. damei occurs only within the Grand Canyon of Arizona; it may represent the result of introgression of reddish-forewing-flush characters from *meadi* populations on the surrounding Kaibab Plateau into a *C. pegala boopis* population formerly residing as a "pure" form in the canyon bottom.

TABLE 1. MAJOR DIFFERENTIATING CHARACTERS FOR THE FOUR SPECIES OF *CERCYONIS*

CHARACTER	<i>pegala</i>	<i>sthenele</i>	<i>oetus</i>	<i>meadi</i>
Antennal coloration	Brown with proximal half of each segment white.	Brown with proximal fifth or less of each segment white.	Like <i>sthenele</i> on dorsum, all white on venter.	As in <i>sthenele</i> .
Size of ventral forewing ocelli	Equal, or posterior one larger (some ♀♀).	Posterior equal or smaller than anterior in ♂; equal in ♀.	Posterior smaller than anterior in ♂; equal in ♀.	Posterior usually smaller than anterior in ♂; equal in ♀.
Position of ventral forewing ocelli	Equally distant from wing margin.	Equally distant from wing margin.	Posterior ocellus closer to wing margin than anterior one.	About equally distant from wing margin.
Normal length of forewing	♂, 25-27 mm, ♀, 28-31 mm. Larger in many eastern populations.	♂, 21-23 mm, ♀, 22-26 mm	19-22 mm	♂, 20-24 mm, ♀, 23-25 mm
Coloration of central forewing (dorsal and ventral)	Dark brown in western populations; yellow in most eastern populations; russet or reddish in Grand Canyon populations.	Dark brown; occasionally slightly yellow or tan around ocelli (♀) but not over whole FW.	As in <i>sthenele</i> .	Chocolate brown, with reddish or rusty area in limbal zone, varying towards base of wing, always present on underside if not also dorsally.
Sex patch on FW of males	Three medium- to large-sized, below Cu ₁ , Cu ₂ , and 2V.	Four medium- to large-sized, below M ₃ , Cu ₁ , Cu ₂ , and 2V. Patch Cu ₂ with smoothly convex basal edge.	Four large, below M ₃ , Cu ₁ , Cu ₂ , and 2V. Patch Cu ₂ with sharp notch in basal edge.	Variable in northern Arizona and Utah: 2 to 4 (Cu ₁ and Cu ₂ always present). Elsewhere, only Cu ₁ and Cu ₂ patches present, the Cu ₂ patch divided horizontally.

TABLE 1—Continued

CHARACTER	<i>pegala</i>	<i>sthenele</i>	<i>oetus</i>	<i>meadi</i>
Ventral hindwing ocellus pupil	Oblong or a linear dash; thin layer of white scales makes the pupil a dull white. Often a mixture of black and white scales near pupil margins produces blue.	In <i>masoni</i> usually large and rounded; with heavy layer of white scales, bright white. Similar in <i>paulus</i> . In <i>silvestris</i> , a tiny white dot. In <i>s. sthenele</i> , a small white dot. NEVER BLUE.	Usually round and bright white (heavy scaling).	Round and bright white (heavy scaling).
Ventral hindwing ocellus outer ring	A prominent light tan ring surrounds the black spot; a dark brown ring outside the tan ring.	Tan ring barely indicated around black spot; most ocelli surrounded by large brown rings which touch each other between the ocelli.	No tan ring; usually not even a trace of an outer dark brown ring.	As in <i>oetus</i> .
General ventral hindwing color	Light mottled tan in southeast U.S. to Texas (<i>p. pegala</i> and <i>p. texana</i>), Utah (<i>p. galbii</i>), and north-east California, southeast Oregon, and Nevada (<i>stephensi</i> form). Dark mottled brown elsewhere (various shading combinations, random geographically).	Dark mottled brown with whitish scaling over most of the species' range; pale brown in southern and central California.	Dark brown; also zigzag pattern in the far west, mottling in Rocky Mountains, and uniform slate black-brown in British Columbia and adjacent areas.	Dark, finely-mottled brown in higher Rocky Mountains; light and dark mottled brown elsewhere, except in <i>alamosa</i> , heavy, white mottling.
Larval instars	Six	Five	Five	Five

BIOLOGY

All four species of *Cercyonis* are univoltine. *Cercyonis sthenele* flies in June and July, *C. oetus* in July and August, *C. meadi* from late July to early September, and *C. pegala* from June to August, depending on the area (earlier in eastern and western coastal populations, later in inland populations as in Colorado).

Cercyonis pegala subspecies have six larval instars while the other three species have five instars. The larval food is grass, and most do not seem to be narrowly restricted in host choice; the only species that seems on circumstantial evidence to be restricted to very few grass species is *C. meadi*. Mating can occur almost immediately after the female's emergence from the pupa, but the male is several days old before he makes any mating attempts. Eggs are deposited singly on dried or living grass stems; five to thirty per day may be laid for up to thirty days (in the lab) by a female. Normal egg production is 100–150 eggs in *C. oetus*, *C. sthenele*, and *C. meadi*, and 200–300 eggs in *C. pegala*. The adults can live up to 45 days in the laboratory, but the normal life span in natural populations is only 5–10 days (capture-recapture data; Emmel, unpublished).

At 25° C the eggs hatch 10 days after oviposition, and the first-instar larvae go into diapause immediately. The site for diapause in nature is likely in the base of grass clumps. During the fall and winter, the diapausing larvae shrink to one-half their former length. In late spring, probably April in most localities, larvae come out of diapause and begin feeding. In the wild they are probably strictly nocturnal feeders; in the laboratory, daytime feeding occurs also.

At 25° C, the larvae can reach a mature state in three to four weeks, but in nature this requires two months for *C. oetus*, and two and one-half to three months for *C. meadi*, *C. sthenele*, and *C. pegala*. The natural site for pupation is near the base of a grass clump, where the pupa is hung from bent-over grass blades. The pupa hatches in ten to twelve days at 25° C, and probably in about twenty days in most wild populations.

SYMPATRIC DISTRIBUTION

In a number of localities, two or three species of *Cercyonis* are found flying together, often alighting on the same flowers, or are at least in close enough proximity that the adults may have visual contact with each other. In all such sympatric populations, there is a partial separation of flight periods of adults, and there are usually different habitat preferences by the respective species. For instance, near Florissant, Colorado, *Cercyonis oetus* adults reach their peak of activity the last week of July and the first week of August, while *Cercyonis meadi*, flying in the same

meadows, does not reach its peak of abundance until the latter half of August. Where *Cercyonis pegala boopis* and *Cercyonis sthenele masoni* occur together (e.g., at Glenwood Springs, Colorado), *C. p. boopis* flies mainly in oak thickets while *C. s. masoni* flies in grassy sagebrush areas adjoining the oak forest.

The species that are sympatric in the western states may be listed as follows: *Cercyonis pegala boopis* or *C. p. ariane* frequently with *Cercyonis sthenele masoni* or *C. s. paulus* through the intermountain west; in Colorado, *C. p. boopis* occasionally also with *Cercyonis oetus*. *Cercyonis sthenele* occasionally is sympatric with *Cercyonis oetus* in eastern California and the Northwest, and again in Colorado. *Cercyonis meadi* is sympatric with *C. oetus* at scattered points in central Colorado and with *C. pegala boopis* near Colorado Springs.

No natural *Cercyonis* hybrids are known to the author except in one area on Fruitland Mesa, Delta County, Colorado. Here, *Cercyonis pegala boopis* and *C. sthenele masoni* both occur in the same habitat and adults fly at the same time; judging from wing and genitalic characters, hybridization seems to be fairly frequent. Also, judging from present distributions and phenotypic characters, it is possible that the populations of *C. pegala damei* in the Grand Canyon are the result of past hybridization between *Cercyonis meadi mexicana* on the North Rim and *C. pegala boopis* populations along the bottom of the gorge. A future paper in this series will discuss these situations further.

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A CASE OF AUTHORSHIP, *MELITAEA RUBICUNDA* (NYMPHALIDAE)

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A series of synopses of the butterflies of North America appeared in the first series of the Bulletin of the Brooklyn Entomological Society. They were published between 1878 and 1885. Most of these articles carry no author's name, yet some of them are nomenclatorially important. The authorship for the majority is indicated in a letter from George D. Hulst, of the Brooklyn Society, to Herman H. Strecker. This was written September 28, 1880, and in part reads "By the way, Graef & Tepper run the Synopsis of the Butterflies in the Bulletin and that of *Argynnis* has been made out by Mr. W. H. Edwards entirely" (Hulst, 1880).

Thus the article on *Argynnis* in volume 2: 41, 89-92, and volume 3:23-24, 27-28, 67-68, 1880 should be credited to W. H. Edwards, according to Hulst. However, on page 89 there appears a footnote: "We hereby acknowledge our thanks to Mr. W. H. Edwards of Coalburgh, West Virginia, to whom we are deeply indebted for his kindness in furnishing us with descriptions of species not represented in our cabinet." This cast some question upon which descriptions of species noted in the article should be credited to Edwards and which to Graef and Tepper.

Beyond the material on *Speyeria* and *Boloria*, both of which Edwards included in *Argynnis*, there is evidence that Edwards wrote the section on *Melitaea*. In a letter to Henry Edwards dated September 26, 1880, he said, "I have been engaged in writing desc's for Tepper for Brooklyn Bulletin of the Melitaeas & take much trouble in order to have their Synopsis right, as near as may be" (Edwards, 1880).

The article on "*Melitaea* Fabr." appeared in volume 3: 69-70, 1880; 3: 80-81, 97-98, volume 4: 11-12, 1881; and volume 5: 61-62, 1882. In this article there are four new descriptions: *colon* Edw. (p. 80), *perdiceas* (sic) Edw. (p. 80) and *baroni* Hy. Edw. mss. (p. 80) published in the January 1881 number, and *rubicunda* Hy. Edw. mss. (p. 97) published in the April 1881 number. I discussed the situation for *colon* and *perdiccas* (Brown, 1967: 320-321). Earlier I discussed the peculiar situation that credits *baroni* to W. H. Edwards with the publication date July 2, 1879 (Brown, 1966: 373). In neither of these places did I comment upon the authorship of *rubicunda*. Both W. H. Edwards and Henry Edwards published the name accompanied by adequate descriptions of the same insect in April, 1881. We do not know precisely when the April, 1881 number of the Bulletin of the Brooklyn Entomological Society was issued. We do know that the April, 1881 issue of "Papilio" is dated "April 26, 1881." If we use the same philosophy for month dates of publication as is used for year dates, then until proven otherwise the Bulletin is assumed to have been published on the last day of April in 1881 and Henry Edwards has four days priority in use of the name *rubicunda*. This conforms with current usages of the name.

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HULST, G. E., 1880. mss. Letters to Herman H. Strecker in the Dept. of Entomology, Field Museum, Chicago, Ill.

ON THE ECOLOGY OF NATURAL DISPERSAL: *DIONE MONETA*
POEYII IN TEXAS (NYMPHALIDAE)

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On December 31, 1964, the neotropical butterfly *Dione moneta poeyii* (Butler) was taken by my companion as we collected in the brush country of south Texas near Catarina (Dimmit County). That area was experiencing most unusual weather, complete with warm temperatures, abundant flowers, and thousands of butterflies. Had my companion not continued to collect randomly, we would not have seen *Dione moneta*, for after taking a large series of the similar *Agraulis vanillae* (L.) (see fig. 1), I had shifted my attention to other species. Doubtless I would have ignored the *Dione* as just another *A. vanillae* had it entered my field of vision.

No similar species to *A. vanillae* are listed in U. S. field guides or checklists. An attempt to identify the specimen soon expanded into an inquiry concerning its possible origin and the reasons for its occurrence in Texas. This investigation stimulated some thoughts about the nature and general importance of "stragglers" and about the criteria for deciding whether a given record represents natural dispersal.

The possibility that this Texas record of *D. moneta* represents natural dispersal from Mexico was examined, and the results reported below. In addition, the ecological facts gathered in this study lend some evidence towards possible clarification of the term "subtropical" as applied to the south Texas region, an area well known for its records of "stray" tropical butterflies. Thus, the purpose of this paper exceeds simply recording another tropical butterfly for Texas.

IMPORT VS. STRAGGLER

The term "straggler" is familiar to most American lepidopterists. It refers to an individual butterfly which undergoes long range geographical displacement by natural means (*i.e.* by its own powers of flight, with or without the help of such factors as wind). That we term such an individual butterfly "straggler" indicates a lack of certain information about that individual. A straggler may be only one of a vast migrating group, or it may be a lone stray.

I will avoid trying to distinguish migration from other forms of natural movement, since it seems more important to distinguish the naturally dis-

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persed individuals from the imported ones. Biological information gained from an unusual record depends largely upon which of these two categories is applicable to that record. On the other hand, the biological significance of both categories depends upon how successfully the new region is invaded. In either case, if populations of a species establish themselves in a new region, at best they provide unique opportunities for microevolutionary studies (Burns, 1966), and at worst, they seriously threaten the future of the native fauna, flora and agriculture (Elton, 1958).

Is it worthwhile to attempt to distinguish naturally dispersed individuals from imported individuals of species which, because they rarely or never established permanent populations in a new region, seem to be of little biological consequence? The answer is yes, if we consider that a single fertilized female reaching a new region is theoretically capable of starting a new butterfly population. For most species, the chance of such successful invasion (by natural means) occurring during a human life is near zero. Considered in the context of geological time however, the occasional long distance dispersal by a species becomes more significant. Certainly the earth's islands were not all populated by man's importation of new species, or by large scale migrations. The "stragglers" have played their part.

THE INVESTIGATION OF NATURAL DISPERSAL

Because of the extreme difficulty in tracking even large migrations of insects over long distances, the investigation of a single stray (if there are such things) seems impossible except in retrospect. In one instance, a widely observed climatic event, wind, has been correlated with observed dispersal in the Lepidoptera. In this case, when two species of African moths appeared in Britain, their probable flight path was compared with synoptic weather conditions. It was concluded that this event did represent natural dispersal, and that wind was an important factor in promoting the long flight (French, 1967).

Such an approach seems to be the only reasonable way to study most records of geographically displaced insects. Even if the original collector takes no data other than locality and date, later workers might possibly make conclusions about the origin of a specimen by carefully studying past climatic and other ecological records for the region in question.

Most of the important points to consider when attempting to give a record natural dispersal status fall into two categories. First, one should consider available evidence concerning the butterfly's flight characteristics (migratory or not, etc.), and habitat preference (altitudinal limits, etc.) within the species distribution (Ford, 1945). Second, the region in which the displacement occurred should be checked with respect to



Fig. 1. A, *Dione moneta poeyii* (Butler) ♀, dorsal view. B, The same specimen, ventral view. (Note: For further details refer to Emsley (1963), and for a color plate see Seitz (1924) pl. 84e (labelled *Dione butleri*). C, *Agraulis vanillae* (L.) ♂, ventral view.

overall weather patterns and other ecological factors such as condition of vegetation over the projected path, topography, and other butterflies on the wing at the same point in time.

DIONE MONETA: FLIGHT CHARACTERISTICS; DISTRIBUTION

Like *A. vanillae*, *D. moneta* is a strong, fast flier. Though *A. vanillae* is a known migrant, no records could be found of migrations of *Dione moneta*. Emsley (1963) provides the most recent indication that *D.*

moneta had previously been taken in Texas: "... on occasions it has been recorded in Texas. . . ." However, no record of these Texas specimens could be found by Emsley upon a review of the museum notes taken for his 1963 paper. Any authors, including Emsley (1963) and Michener (1942), who extend the genus *Dione* Hübner to the U. S. must refer (at least indirectly) to the distribution of *Dione moneta poeyii* (Butler) quoted by Stichel (1907): "Honduras, Mexico, Texas." Strangely enough, Stichel provides no supporting data for such a claim, nor does he refer to literature which does. Even so it would still seem strange that *Dione moneta* is not mentioned—even as a "vague" or "doubtful" record—by Klots (1951), Ehrlich (1961), or dos Passos (1964). According to Hoffmann (1940) *D. moneta poeyii* ranges through most of Mexico. Emsley (1963) records that *Dione moneta* seems to be confined to montane habitats above 1000 meters throughout its range. However, Emmel (1961) provides interesting evidence that at least in the more northerly, marginal part of its range, *D. moneta* (= *D. butleri* Stich.) flies at lower elevations during the winter dry season. He reports taking this butterfly near Gomez Farias during January at an elevation of about 900 feet. My own field work in that region during July–August 1965, turned up no *Dione moneta* below 1100 meters.

Generally speaking, the Sierra Madre Oriental is poorly known biologically in northern Mexico (Martin, 1958), and this generality extends to our knowledge of butterfly distribution in the temperate and tropical forests of Mexico (Monroe, 1963; Hovanitz, 1958). Therefore, it is possible that the normal range of this species extends much further north than is now known.

DIONE MONETA: ECOLOGY OF OCCURRENCE IN TEXAS

Since this butterfly occurs at elevations up to 7000 feet in northern Mexico, there would appear to be no montane barriers to it between its normal range and Catarina, Texas, some 350 miles due north (see fig. 2). Many plants in *D. moneta*'s montane chaparral habitat near Carabanchel are found in the low country of northern Mexico and southern Texas (Personal observation). A northward emigrating or straying individual of this species should not be stopped by the vegetational changes if the weather remains favorable.

The climatic conditions in November and December 1964 were unusual for south Texas. The temperatures were warm throughout the period, with readings above 90° F several days in the last weeks of December. According to the U. S. Weather Bureau's National Summary of Climatological Data (1964), every state southeast of a line from West Texas to Maine experienced their monthly maximum temperatures for

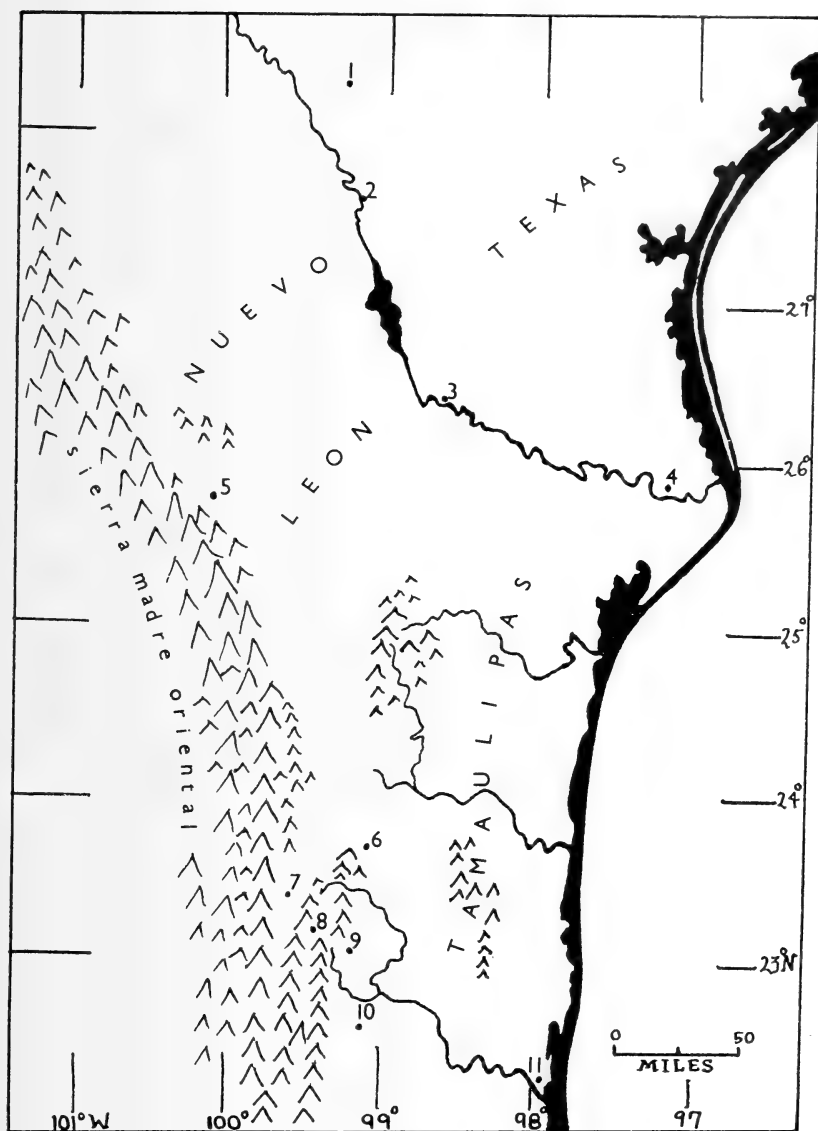


Fig. 2. Map of southern Texas and northern Mexico. The numbered localities are as follows: 1. Catarina, Tex. 2. Laredo, Tex. 3. Rio Grande City, Tex. 4. Brownsville, Tex. 5. Monterrey, N.L. 6. Victoria, Tamps. 7. Jaumave, Tamps. 8. Carabanchel, Tamps. 9. Encino, Tamps. 10. Cd. Mante, Tamps. 11. Tampico, Tamps.

December between the 22nd and 27th of that month. These temperatures ranged from 56° (Michigan) to 92° (Texas) and were generally above 70°. This is evidence of the widespread nature of the late December conditions. Unusually heavy rainfall was recorded in the late summer of 1964 in southern Texas, and no freeze had occurred before December (see fig. 3), with the result that most plants were still green and many were in flower (*e.g. Lantana*). Steady south winds, estimated at 10–15 m.p.h., prevailed during the whole of the last two weeks of December, which indicates, at least roughly, conditions existing in Mexico.

The butterfly species found together with a displaced butterfly might provide important evidence concerning its possible origin. Listed below are some of the species on the wing with *Dione moneta* in Catarina, Texas, December 31, 1964.

Agraulis vanillae, *Anaea andria*, *Asterocampa leilia*, *Brephidium exilis*, *Colias eurytheme*, *Colias cesonia*, *Danaus gilippus*, *Danaus plexippus*, *Euptoietia claudia*, *Eurema daira*, *Eurema lisa*, *Eurema mexicana*, *Eurema nicippe*, *Hemiargus isola*, *Kricogonia castalia*, *Libythea* sp., *Mestra amymone*, *Papilio polyxenes*, *Phoebis sennae*, *Pieris protodice*, *Precis lavinia*, *Strymon melinus*, *Vanessa atalanta*, *Vanessa virginiensis*.

Of these species, 30% are known migrants, 17% have been previously recorded together in mixed migratory flights (this includes *A. vanillae*) and 17% have been known to migrate northward in the spring (Williams, 1930, 1958).

THE SUBTROPICS OF SOUTHERN TEXAS AND NORTHERN MEXICO

A substantial part of the transition from the wet-dry seasonality of the northeastern Mexican tropics to the hot-cold seasonality of the southeastern U. S. occurs between southern Tamaulipas and central Texas. Localities near the center of the region (*i.e.*, in southern Texas) may vary greatly in early winter environment from one year to the next. The direction and extent of this variation depends upon at least three factors: 1.) The amount and distribution of late summer-early fall precipitation. 2.) The time of occurrence and intensity of Canadian cold air masses moving south. 3.) The time of occurrence and intensity of warm tropical air masses moving north.

Many plants on the semi-arid fringes of the tropical zones possess the ability of shedding their leaves in response to the drought of the tropical dry season. It follows then, that in the semi-arid region of Texas and Mexico being discussed, summer drought results in a leafless and bleak winter much sooner than usual. Likewise, early killing frosts may leave the countryside gray and bare before mid-November (irrespective of summer rainfall).

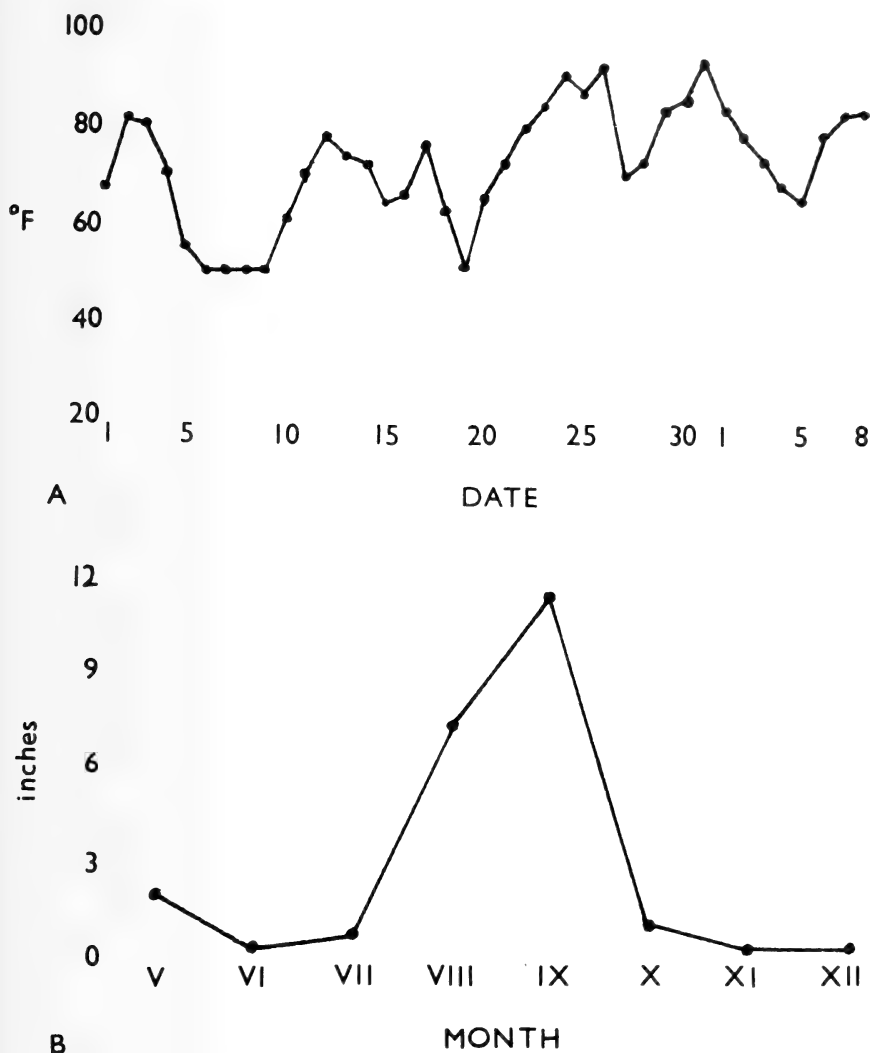


Fig. 3. Climatic Data. A, Graph of daily maximum temperatures recorded at Catarina weather station December 1, 1964 to January 8, 1965. B, Monthly rainfall totals, Catarina, Texas, May 1964 to December 1965.

(Note: the rainfall total for August equals or exceeds the yearly total for that area in drouth years, and is roughly one-half of the normal yearly average.)

On rare occasions, such as the winter of 1951, extremely cold air masses reach southern Tamaulipas (Martin, 1958). On the other hand, northward bound tropical warm air masses often bring southern Texas relief

from winter cold. Such mild weather, however, will not bring back leaves and flowers previously lost by summer-fall drought, by early frost, or by a combination of these factors.

Because of the various climatic factors which must interact in proper sequence and in proper intensity, the "tropical" winter of 1964 was indeed unusual for the Catarina area of South Texas. Essentially this phenomenon can be looked upon as a temporary northward shifting of the tropical temperature and rainfall regimes. On the other hand, the winter of 1951 represents the reverse situation. It is thus clear that the nebulous concept, "subtropical," as applied to southern Texas and northern Mexico, would be better understood if the unpredictable nature of the climate in this region could somehow be conveyed by the prefix of the term.

CONCLUSION AND SUMMARY

The occurrence of *Dione moneta* in Texas was but one in a series of unusual ecological events during the tropical winter weather of 1964-65. Numerous facts indicate that this record represents natural dispersal on the part of this butterfly species. It will now be useful to summarize the more significant of them:

1. *Dione moneta* is a strong flier, and is closely related to a known migrant, *Agraulis vanillae*.
2. *Dione moneta* is on the wing during December and January only 350 miles south of Catarina, Texas.
3. Though normally restricted to montane habitats above 1000 meters, *D. moneta* has been known to shift to lower elevations in northern Mexico during the winter dry season.
4. Many suitable adult food plants of this species remained green and in flower over a wide area of northern Mexico and southern Texas during the winter of 1964-1965.
5. Widespread, striking climatic conditions, including steady south winds and warm temperatures were correlated with the occurrence of *D. moneta* in Texas.
6. Among twenty-four other butterfly species in company with this specimen of *Dione moneta*, 30% were known migratory species, several being northward spring migrants.

To conclude, I hope that collectors will keep on the watch for *Dione moneta*, especially during exceptionally warm winter weather in "subtropical" Texas and Mexico. In addition, similar investigations of other tropical butterfly records for Texas would be of great interest since many questions about the distribution and dispersal of tropical insects are yet to be answered.

ACKNOWLEDGMENTS

I greatly appreciate the help of the following persons: Thomas Gilbert, Mrs. Ira T. Burns, David Lees, Professor E. B. Ford, F.R.S., and Dr. J. A. Powell.

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UNCOMMON BUTTERFLIES OF NORTHEASTERN INDIANA

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AND

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Indiana has a rich butterfly fauna. If the old records are correct, the State may have as many as one hundred twenty-five species. This paper, however, will not list all of the one hundred or more species collected over a thirty-five year period by the authors, but will include a listing and brief reference to the uncommon species found in northeastern Indiana.

HESPERIIDAE

Euphyes dion (Edwards)

Specimens: July 14, 1952; July 7, 1953; and July 2, 1954, in Lagrange County bogs. June 30, 1968 collected several in Wabash and Kosciusko Counties.

Euphyes dukesi (Lindsey)

A single male was collected on July 24, 1962, in Steuben County. This may constitute a new State record.

Euphyes conspicua (Edwards)

Specimens have been taken in July in Lagrange, Steuben and Wabash Counties.

Euphyes bimacula (Grote & Robinson)

In Lagrange County a single specimen was taken on July 7, 1955 in a bog near Cedar Lake. From late June to early September it is found in boggy or marshy meadows in Kosciusko and Wabash Counties (1966-1968).

Poanes massasoit (Scudder)

Ten specimens were taken on July 11, 1950 in the Plato bog, Lagrange County. One male was captured on July 30th. Apparently rare or absent in the other counties of northeastern Indiana.

Poanes viator (Edwards)

Three worn specimens at a boggy place along a road in Richland Township, Steuben County, July 24, 1962. Sparingly in Wabash County, July 1967.

Hesperia leonardus Harris

One specimen Sept. 4, 1954, Steuben County on blossoms of teasel plant. Collected from July to September (1967 & 1968) in Wabash and Kosciusko Counties on blossoms of the purple boneset plant.

Hylephila phyleus Drury

Specimens from August 18 to September 21 (1967 & 1968) on zinnia flowers. Never common.

Thymelicus lineola (Ochsenheimer)

Specimens: June 22 and July 1, 1967, grassy field, North Manchester, Wabash County. Identification was confirmed by Dr. Fredrick H. Rindge, Curator of Lepidoptera of the American Museum of Natural History, New York. During June and July (1968) this species was more common in Wabash and Kosciusko Counties.

Staphylus mazans hayhurstii (Edwards)

June 19, 1945 a single specimen was taken in a peat bog, Waynesdale, Allen

County. In June and July (1967) collected in wooded areas and along roads of North Manchester, Wabash County.

Achalarus lyciades (Geyer)

Specimens: June 11, 1942, at a bushy tract, Fox Lake, Steuben County. June 16 and July 4, 1968 in brier clump in woods, Kosciusko County.

PIERIDAE

Pieris protodice Boisduval & LeConte

June 1942 collected in Lagrange County. Scarce in Wabash and Kosciusko Counties from June to October (1966-1968).

Colias cesonia (Stoll)

A single specimen near Eel River, North Manchester, Wabash County, September 1934.

Eurema nicippe (Cramer)

One male, August 14, 1968, North Webster, Kosciusko County, near *Cassia* plants.

RIODINIDAE

Calephelis muticum (McAlpine)

One battered specimen was collected August 8, 1949 and another on July 21, 1956, Plato bog east of Lagrange. Two were taken on July 24, 1954 at the Cedar Lake bogs.

LYCAENIDAE

Strymon melinus Hübner

July 24, 1954 one specimen along a road and bog at Cedar Lake. Specimens from June 29 to October 3 (1966-1968) in Wabash and Kosciusko Counties.

Strymon titus (Fabricius)

Specimens: July 7, 1953, along a road and bog at Cedar Lake. Collected in late June and July (1967 & 1968) on dogbane, goldenrod and white sweet clover, North Manchester, Wabash County.

Strymon acadica (Edwards)

Several specimens were collected every July from 1953 to 1956 near Cedar Lake. In Wabash County specimens were taken on July 9 and 12, 1967; June 30, 1968 on dogbane; and July 7, 1968 on common milkweed flowers, North Manchester, Indiana.

Strymon caryaevorus McDunnough

Pair collected June 22, 1968 on hickory tree leaf, Kosciusko County. Dr. Fredrick H. Rindge prepared a slide of the male genitalia. Several more were collected in early July. This constitutes a new State record.

Strymon edwardsii (Grote & Robinson)

Specimens: June 30, 1968 North Manchester, Wabash County and July 4, 1968 Kosciusko Co. Found in wooded areas.

Strymon liparops strigosa (Harris)

One specimen July 7, 1953, along a road at the Cedar Lake bogs, on butterfly weed blossoms. July 12, 1966; June 24 and July 6, 1968 specimens were taken at North Manchester, Wabash County.

Lycaena helloides (Boisduval)

Specimens: August 20, 1967 North Manchester, Wabash County. August 24, 1968 Camp Mack, Milford, Kosciusko County.

Lycaena epixanthe (Boisduval & LeConte)

A specimen collected in July 1966, North Manchester, Wabash County.

NYMPHALIDAE

Nymphalis vaughani (Denis & Schiffermüller)

Two specimens collected in August 1934 in an old apple orchard near Eel River, North Manchester, Wabash County. Not found in recent years.

Euphydryas phaeton (Drury)

Specimens: July 7, 1955 and July 6, 1956 in the Cedar Lake bogs, usually on the higher ground.

Speyeria idalia (Drury)

Specimens: Two females, June 24, 1942, along the north shore of the Big Turkey Lake, Lagrange County. August 11, 1968, North Manchester, Wabash County.

Euptoietia claudia (Cramer)

Two specimens July 6, 1956 on a quaking bog on the east side of Cedar Lake in Lagrange County. Uncommon in July and August (1966 and 1968) in Wabash County.

SATYRIDAE

Lethe eurydice applachia R. L. Chermock

July 17, 1942 two specimens collected along the border of a bog at Hogback Lade, Steuben County. The identification was made by Frank Chermock.

Lethe eurydice (subspecies undetermined) was collected July–August 1967 in North Manchester, Wabash County.

Euthychia mitchellii (French)

Specimens: July 11, 1950, on a quaking bog on the east side of Cedar Lake in Lagrange County. Many others were collected in July each year from 1952 to 1956.

Specimens were donated to the Ohio State Museum, the Ohio State University Museum and the U. S. National Museum.

EUREMA SALOME IN TEXAS (PIERIDAE)

Within the United States *Eurema salome limoneus* (Felder and Felder) is definitely known to occur only in Arizona (Klots, 1951, "Field Guide to the Butterflies"). The data on old specimens supposedly collected in Texas is vague and uncertain. In fact, in a list of the butterflies and skippers of Texas reproduced by Xerox in 1963 by R. O. Kendall and H. A. Freeman *Eurema salome* is not mentioned. Therefore, it was of some interest to find a female of *Eurema salome* in poor condition among a collection of Texas butterflies donated to the California Insect Survey by J. O. Hunt, of San Diego, California. The specimen was collected by Hunt at Harlingen, Cameron County, Texas on August 18, 1957.—PAUL A. OPLER, *University of California, Berkeley, California*.

BOOK NOTICE

INDEX LITTERATURAE ENTOMOLOGICAE, Serie II, vol. III (M–R). By W. Derksen and U. Scheiding-Göllner. 528 pp. Published by the German Academy of Agricultural Sciences. Berlin, 1968.

The "Index" contains all entomological papers published in the period 1864 to 1900. The third volume includes the authors' names in alphabetical sequence from Maag to Rzehak. For most authors the important biographical dates are given. The "Index" is very important for all students in entomology. For reviews of the first two volumes, see *Journal Lepid. Society*, 19: 62 (1965) and 21: 144 (1967).—JOSEF MOUCHA, *National Museum, Prague, Czechoslovakia*.

AN EXTREME PHENOTYPE OF *PIERIS PROTODICE* (PIERIDAE)

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Vernal phenotypes in Pieridae are described by Klots (1951) as "paler, with reduced dark borders or spots" relative to the summer phenotypes. This characterization applies only to the upper surface of the wings; beneath, the hindwing is generally more or less melanized in the vernal phenotype. This redistribution of black pigment may fulfill a thermo-regulatory function (Clench, 1966).

The "cold weather" phenotype of *Pieris protodice* Boisduval & LeConte (f. vern. *vernalis* Edwards) occurs in late autumn and early spring throughout the range of the species (Rawson, 1945; Bean, 1877). Lutz (1948) characterized it as possessing "so much greenish gray on the hind wings that the white is reduced to narrow triangular spots; spots on the upper side are much reduced, or even absent." Shapiro (1968) has demonstrated

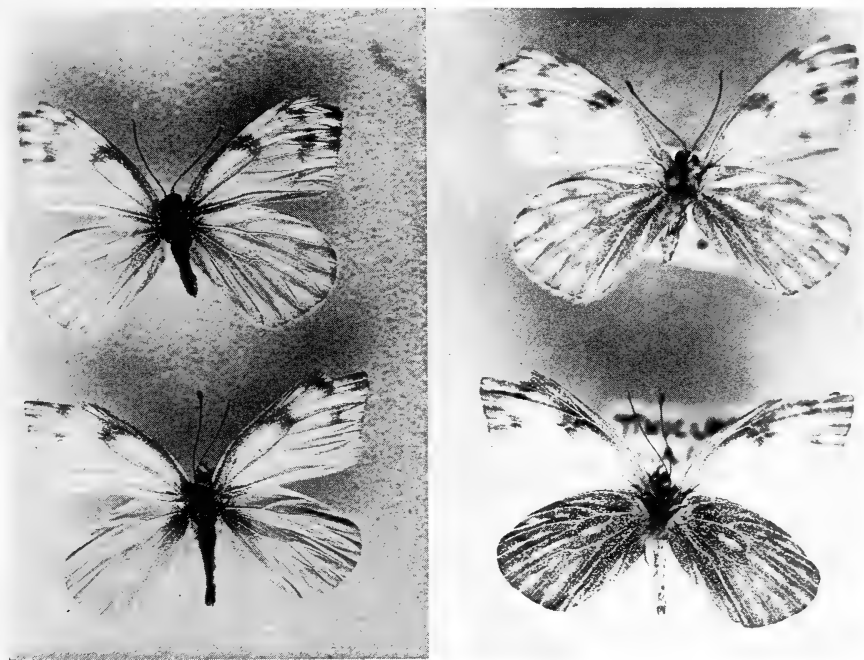


Fig. 1. *Pieris protodice* f. vern. *vernalis*, females. Upper surface at left, lower at right. Above: normal, Camden, N. J., March 29, 1968. Below: extreme, Tinicum Wildlife Preserve, Phila. Co., Pa., March 30, 1968.

that the *vernalis* phenotype may be induced by exposure of the larvae to long nights, regardless of temperature. Specimens obtained by photoperiodic manipulation in the laboratory are similar to wild Philadelphia, Pennsylvania butterflies exposed to equivalent photoperiods in late larval life.

An extreme specimen of *vernalis* taken at the Tinicum Wildlife Preserve, Philadelphia County, Pennsylvania, March 30, 1968, is illustrated in figure 1, along with a normal *vernalis*. The Tinicum specimen, a female, is darker on the lower surface than the darkest female grade figured by Abbott, Dillon, and Shrode (1960). The dark vein-lines are even broader and more confluent than is usual in the spring phenotype (*calyce* Edwards) of the western, montane sibling species, *Pieris occidentalis* Reakirt. The specimen differs from *calyce* also in the intensity of the melanization, which obscures the underlying yellow pigment almost completely and presents a black, rather than a brownish green effect.

No photoperiod or photoperiod-temperature combination yet tested will induce such extreme melanization in the lower surface. In the Cornell culture of *P. protodice*, which has been maintained through seventeen generations for genetic studies, heritable variations in expression of the *vernalis* phenotype under standardized conditions have been observed. However, a brood of 39 reared from the Tinicum female (already mated to an unknown male) in an inducing photoperiod of fourteen hours darkness produced only normal *vernalis*.

ACKNOWLEDGMENTS

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LEPIDOPTERA ASSOCIATED WITH PIG CARRION

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Putrid fish, decomposing snakes, lizards, and mammals, and the urine, excrement, and odors of carnivorous animals attract certain species of butterflies and moths (Holland, 1931; Field, 1938; Klots, 1951). These products, which are often considered offensive, have been used as baits by experienced collectors for attracting butterflies. Clark (1932) recommended suspending dead snakes from trees to attract woodland butterflies, especially those which ordinarily remain high in the trees. According to Klots (1958) there is some evidence that some butterflies (*e.g.*, *Apatura*) and moths are perhaps exclusively carrion feeders.

During the summers of 1962, 1963, and 1966 a comparative study of pig carcasses both exposed to and isolated from arthropods was undertaken to determine the actual processes and rates of decomposition (Payne, 1965). A faunistic survey was conducted in conjunction with this study (Payne and Crossley, 1966). Special attention was focused on the food habits, relative abundance, order of succession, and microseral distribution of individual members of the carrion microcommunity. The present paper deals with the lepidopteran species which were associated with the various stages of pig decay.

RESULTS AND DISCUSSION

Twenty-one species of Lepidoptera were collected from pig carrion. Table 1 gives a systematic list of all 21 species and their relative abundance during the different stages of pig decomposition. A brief synopsis of these species and their food habits follows.

PAPILIONIDAE.—Two species, *Battus philenor* and *Papilio glaucus* were frequently observed feeding at carrion. These large butterflies even attempted to enter the protective cages containing pig carcasses. They were attracted to the pig carrion when odors and decay were most pronounced (advanced decay stage). According to Chermock (1952) *B. philenor* is also attracted to deer dung and manure piles, and Reinthal (1966) collected over 50 *P. glaucus* from fresh cow dung and from decaying bodies of butterflies (*glaucus*). Reed (1958) collected both of the above papilionids from dog carcasses in Tennessee.

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TABLE 1. SYSTEMATIC LIST OF LEPIDOPTERA COLLECTED FROM DEAD PIGS DURING SUMMER MONTHS 1962, 1963, AND 1966, CLEMSON, SOUTH CAROLINA.³

Species	Stages of Decomposition				
	Fresh	Bloated	Active decay	Advanced decay	Dry
PAPILIONIDAE					
<i>Battus philenor</i> (Linnaeus)				—	—
<i>Papilio glaucus</i> Linnaeus				—	—
SATYRIDAE					
<i>Minois alope</i> (Fabricius)				—	—
NYMPHALIDAE					
<i>Chlosyne nycteis</i> (Doubleday & Hewitson)				—	—
<i>Phyciodes tharos</i> (Drury)				—	—
<i>Polygonia faunus</i> Edwards				—	—
<i>Asterocampa clyton</i> (Boisduval & LeConte)				—	—
<i>Asterocampa celtis</i> (Boisduval & LeConte)				—	—
HESPERIIDAE					
<i>Epargyreus clarus</i> (Cramer)			—	—	—
<i>Atrytone ruricola metacomet</i> (Harris)				—	—
<i>Wallengrenia otho</i> (J. E. Smith)				—	—
SPHINGIDAE					
<i>Amphion nessus</i> (Cramer)				—	—
NOCTUIDAE					
<i>Palthis asopialis</i> (Guenee) ⁴					
GEOMETRIDAE					
<i>Mellilla xanthometata</i> (Walker)				—	—
<i>Anavitrinella pampinaria</i> (Guenée)				—	—
<i>Epimecis virginaria</i> (Cramer)				—	—
PYRALIDAE: PYRAUSTINAE					
<i>Desmia funeralis</i> (Hubner)				—	—

³ The relative abundance of each species during the different stages of decomposition is indicated by a solid line (abundant) or a broken line (scarce).

⁴ For record only. No evidence of attraction to the carrion community. Insufficient evidence to determine seral distribution.

TABLE 1—(Continued)

Species	Stages of Decomposition				
	Fresh	Bloated	Active decay	Advanced decay	Dry
<i>Anageshna primordialis</i> (Dyar)				— — — — —	
TINEIDAE					
<i>Tinea</i> sp.				— — — — —	
<i>Acedes fuscipunctella</i> (Haworth)				— — — — —	
<i>Acedes pallescentella</i> (Stainton)				— — — — —	

SATYRIDAE.—Only one species, *Cercyonis pegala alope* a wood nymph, was attracted to carrion. It too, preferred the moist carrion and was observed sucking fluids from the actively decomposing pigs. These butterflies were among the most numerous at the carrion site; however, they were not the most common butterflies to actually feed on the carrion. They would often alight on the cages containing the pigs without entering to feed. Pig carcasses suspended at four feet from trees were preferred to carcasses on the ground or in the water. Another satyrid, *Euptychia cymela* (Cramer), was observed regularly at the carrion site but was not observed feeding.

NYPHALIDAE.—Five species, *Chlosyne nycteis*, *Phyciodes tharos*, *Polygonia faunus*, *Asterocampa clyton*, and *Asterocampa celtis*, were observed feeding on carrion fluids. *A. celtis* and *A. clyton* were collected from pigs placed in water and those which were suspended from trees 25 feet above the ground. These two *Asterocampas* seem strongly attracted to carrion, and have been collected from dead dogs (Reed, 1958) and dead snakes (Clark, 1932). According to Clark, they often feed on carrion to the point of stupefaction.

Melitaea nycteis and *P. tharos* often entered the ½ inch galvanized hardware cloth covered cages to feed upon carrion fluids. *Polygonia comma* (Harris) and *P. interrogationis* were collected from dog carcasses in Tennessee (Reed, 1958); however, only *P. faunus* was positively identified from pig carrion in South Carolina. The other *Polygonias* may have been present and eluded capture.

Nymphalis vau-album j-album (Boisduval and LeConte), congregates at decaying animal matter and has been reported feeding in numbers on long-dead porcupines (Macy and Shepard, 1941). *Limenitis arthemis* (Drury), is reported (Saunders, 1932 and Klots, 1951) to be fond of

excreta of foxes and raccoons, and the dead and decomposing bodies of various animals. *L. a. astyanax* (F.), is also addicted to carrion, manure, and excrement (Klots, 1951). Neither *Nymphalis* nor *Limenitis* was observed at pig carrion in this study.

HESPERIIDAE.—Three species, *Eparigyreus clarus*, *Atrytone ruricola metacomet*, and *Wallengrenia otho*, were collected from carrion. *A. r. metacomet* ranked as one of the more common carrion visitors, and was often observed probing the carcass with proboscis before carrion fluids were present (evident), as if trying to locate a suitable place to feed. *E. clarus* was attracted to a bait of chicken feathers and entrails at Clemson, S. C. and was the only skipper collected from dog carcasses in Tennessee by Reed (1958).

The hesperiids often visited the carcasses without feeding or alighting on the pigs but merely alighting on cages or ground. *E. clarus* and *A. metacomet* were collected from carrion in water and from pigs suspended from trees at 4–10 feet.

SPHINGIDAE.—One species, *Amphion nessus*, was a common visitor to the decaying carcasses. *A. nessus* arrived at the soupy carrion in the late afternoon before sunset, while the other moths were night visitors only. This sphingid was attracted to carrion in water and those pigs suspended from trees at four feet. As many as three moths have been observed feeding simultaneously on one pig carcass. *A. nessus* and *Sphecodina abbotti* (Swainson) were taken from dog carcasses in Tennessee (Reed, 1958).

NOCTUIDAE.—Only one noctuid, *Palthis asopialis*, was collected from pig carrion. Three specimens were collected; two were observed at night on the dried carcass and one was found beneath the carcass during the daylight hours. They were not observed feeding. Underwing moths, *Catocala fraxini* L., have been reported feeding on dead fish in Russia (Remington, 1947). No underwings were observed by us on dead pigs although they were present at the carcass site.

GEOMETRIDAE.—Three species, *Mellilla xanthometata*, *Anavitrinella pampinaria*, and *Epimecis virginaria*, were observed feeding on carrion on the ground, in the water, and suspended from trees. *A. pampinaria* was the dominant geometrid attracted to carrion at night. These geometrids were often observed feeding on the carrion fluids which had drained to the soil. The only geometrid taken from carcasses by Reed (1958) was *Melanolophia canadaria* Guenée.

PYRALIDAE: PYRAUSTINAE.—Two species, *Desmia funeralis* and *Anageshna primordialis*, were taken from pig carrion. *D. funeralis* was collected from carcasses in the water and those suspended from trees at four feet, and was even collected from a chicken feathers and entrails bait.

TINEIDAE.—Three species, *Tinea* sp., *Acedes fuscipunctella*, and *Acedes pallescentella*, were associated with the carcasses exposed on the ground and those suspended from trees 4–52 feet, during the late stages of decomposition. They even completed a life cycle on the carcasses. Their larvae fed upon the remaining dried carrion tissues, skin, and hair; they also constructed larval cases from bits of pig hair and skin. Adults were not observed feeding on carrion but were taken from the water containing dead pigs.

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DISTRIBUTION OF FOODPLANT CHEMORECEPTORS ON THE
FEMALE FLORIDA QUEEN BUTTERFLY, *DANAUS*
GILIPPUS BERENICE (NYMPHALIDAE)

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Fox (1966) considers the structure of the prothoracic legs of butterflies and relates this to their possible chemosensory function. He points out that in the nymphalid butterflies the forelegs are greatly reduced. The forelegs of the males of these butterflies lack the post-tarsus and have fusion of the tarsal subsegments while the females have forelegs reduced in size without loss of any parts. Further study by Fox revealed that the foretarsi of females in all families of the Nymphaloidea have clusters of trichoid sensilla associated with spines on the tarsi which were not found on the foretarsi of males or on the mid- or hindtarsi of either sex. Fox relates this finding to the work of Ilse (1937) who reported that *Pieris brassicae* females, placed on a green surface would drum the surface with their forelegs. In his own experiments Fox observed three species of nymphalids to scrape with their forelegs the surface on which they were rested, and he suggests that the drumming of the forelegs on plants releases chemicals which stimulate the trichoid sensilla on the foretarsi. In this way the specific larval food plants might be identified.

In an attempt to localize the chemoreceptors which play a role in food plant identification by female queen butterflies, *Danaus gilippus berenice* (Cramer), ablation of likely sites of the receptors, the antennae and the tarsi, was carried out. The egg laying ability of treated females was tested by releasing groups of females in cages in which the larval foodplant, *Asclepias*, was provided. Two types of cages were used. One of these was a large outdoor screened cage (approximately 8 feet by 8 feet by 7 feet high) and the foodplant stalks were placed in vials which were attached to the sides of the cage. The other type of cage was much smaller and was constructed of cheese cloth which was stretched around two aluminum wire rings about 1.5 feet in diameter and 2 feet apart, so as to form a tube. The tops and bottoms of the cages were fastened with draw strings. The cages were placed over a bouquet of *Asclepias*. These cages could be readily moved and for the tests were always placed out-of-doors.

All tests were performed at the Archbold Biological Station in Lake Placid Florida. Two species of *Asclepias* were used for the egg laying experiments, namely, *Asclepias tuberosa rolfsii* and *A. humistrata*. Tarsi of the middle and hindlegs of the female butterflies were cut off at the junction of the basal segment of the tarsi with scissors. The complete fore-

TABLE 1. EGG LAYING OF FEMALE QUEEN BUTTERFLIES WITH VARIOUS SITES OF CHEMORECEPTORS REMOVED OR BLOCKED

Sites of Chemoreceptors Removed	No. of Females	Cage Type	<i>Asclepias</i> Species	Eggs
Forelegs	5	Cloth	<i>A. t. rolfsii</i> & <i>A. humistrata</i>	yes
Mid- & hindtarsi & antennae	18	Screen & Cloth	<i>A. t. rolfsii</i> & <i>A. humistrata</i>	yes
All tarsi and antennae	15 ¹	Screen	<i>A. t. rolfsii</i>	no
All tarsi	12	Cloth	<i>A. t. rolfsii</i>	no
Mid- & hindtarsi	5	Cloth	<i>A. t. rolfsii</i>	yes

¹ 12 of these retested with the same result.

legs, which are quite reduced in queen butterflies and not used for walking, were removed. Chemoreceptors on the antennae were blocked by painting the complete antennae with Testor's Pla paint (Testor Corporation, Rockford, Ill.). The categories of treated females are shown on Table 1. Butterflies used in the tests were collected from the Devil's Garden area in Hendry County Florida.

These tests were most general in nature. However, because the food-plant choice is so specific in the queen butterfly and the recognition of this foodplant is necessary for the elicitation of egg laying, egg laying by only a few females serves as a valid indication that the chemoreceptors which are stimulated by the foodplant are still present. The opposite situation is more difficult, that is to conclusively say that after the removal of structures possibly bearing chemoreceptors, the females will never lay eggs. The mid- and hindtarsi and complete prolegs of 27 queen females were removed and none laid eggs. Twelve of these were retested on a second day with the same result. On the other hand, blocking the chemoreceptors on the antennae, removing mid- and hindtarsi with the forelegs intact and removal of only the forelegs did not inhibit egg laying in queen butterfly females (Table 1). From this it might be concluded that tarsal chemoreceptors are necessary for food plant recognition, and those on the reduced forelegs are sufficient for egg laying but are not necessary when mid- and hindtarsi are present. Since the forelegs are not used in walking or grasping, the failure of females with mid- and hindtarsi plus the forelegs removed cannot be explained simply as a physical inhibition.

The foretarsi of the queen butterfly do have what appear to be trichoid sensilla associated with the spines. These are not quite like those de-

scribed by Fox (1966) (for other nymphalid butterflies) which are in groups at the bases of the spines. But rather, in the female queen butterfly the sensilla partially wrap around the spines and the tips are next to the tips of the spines. The mid- and hindtarsi have several types of sensilla so that it is impossible to even suggest which might be those which are stimulated by the foodplant.

That the prothoracic legs seem to have chemoreceptors involved in foodplant recognition possibly explains why they are maintained when they do not serve a function in ambulation. Another hypothesis is that the foretarsi of the females are protected because of the reduced size of the forelegs. It would seem that the tarsi of the other two pairs of legs would be exposed to considerable wear and danger of damage. However, the forelegs are held next to the thorax and are not subject to these situations. Therefore, the reduction of the forelegs of the nymphalid butterflies may be a mechanism for protecting this site of chemoreceptors and permitting egg laying by the females over a longer period of time. An analogous situation in butterflies might be that of the sucrose receptors on the antennae which cause a behavioral response, proboscis extension, only when the tarsi are removed (Frings and Frings, 1959). This would be an example of a "backup system" for mid- and hindtarsal chemoreceptors. Evidence relating to the hypothesis that foreleg reduction is a mechanism for protecting this site of chemoreceptors might be gained by surveying a wild population of butterflies to determine if damage to the tarsi of the mid- and hindlegs is common. This would give some indication of the selective pressure which might be acting.

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A NOTE ON *HELICONIUS ANTIOCHUS SALVINII*
(NYMPHALIDAE)

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Seitz (1924) observed: "I doubt if any species of *Heliconius* is really scarce. Often I have observed in certain localities of South America certain *Heliconiinae* to be rather scarce but I invariably found later on, that the species considered so rare would at some more distant place, at some other time or in a certain limited locality, suddenly appear in great numbers, proving thereby that it is only at the limits of its range of distribution or outside of their normal time of appearance that they become really scarce." These words were prophetic in the case of *Heliconius antiochus salvinii* Dewitz (1877), heretofore known only from a small number of specimens and only from a restricted locality on the border between Venezuela and British Guiana (Emsley, 1965).

On a collecting expedition to El Pao, Bolivar, Venezuela, during March 1965, I was surprised not only at encountering *H. a. salvinii*, but at finding it the dominant forest *Heliconius*. El Pao has an elevation of 560 meters and is located in a Guiana Highland area of rather heavy selva, or lowland tropical forest. This butterfly was seen gliding ten to fifteen feet above the ground across open spots on wooded trails near El Pao. Señor Albert Gadou, who lived for several years at El Pao, informed me that *H. a. salvinii* flew the year around and was always the commonest *Heliconius* there. Gadou has found *salvinii* at several other localities near El Pao and Señor Yury Budaracy found it abundantly at El Dorado, Bolivar, Venezuela. Apparently *salvinii* does not occur between El Pao and El Dorado, nor in the Gran Sabaña region south of El Pao. No other form of *Heliconius antiochus* has been found sympatric with *salvinii*. This supports the present placement of *salvinii* as a subspecies of *antiochus* rather than assigning it to a species status or dismissing it as a polychromatic form.

Heliconius a. salvinii (figure 1), which has not previously been figured, is very distinct and is readily distinguished by the broad yellow bar on the hindwings.

My search of the major institutional collections has uncovered but seven specimens of *salvinii* in the United States and a few in England—they are as follows:

VENEZUELA: Rio Suapure, Bolivar, Venezuela. 4 ♂'s 1 ♀, Carnegie Museum, Pittsburgh; several specimens, British Museum of Natural History, Tring. All part of a

¹ Research Associate, section of insects and spiders, Carnegie Museum, Pittsburgh.

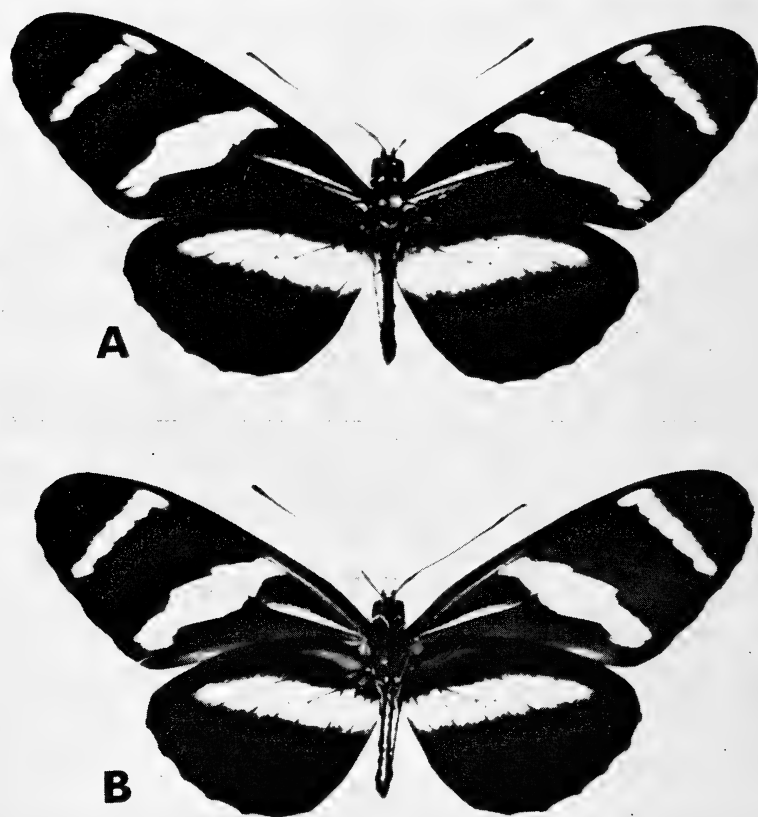


Fig. 1. *Heliconius antiochus salvinii* Dewitz, El Pao, Bolivar, Venezuela, March, 1965, J. H. Masters collector. A upperside; B. underside.

series collected by S. Klages in 1899 and 1900. "Venezuela—10 miles from border with Guyana." Specimen in the British Museum of Natural History, South Kensington.

GUYANA: Kartabo, Guyana. 2 ♂'s, Carnegie Museum, Pittsburgh. One collected by S. Williams in 1927, the second one probably from the same source. Matope, Cuyuni River, Guyana. Specimen in the British Museum of Natural History, South Kensington.

Examples of *H. antiochus salvinii* from El Pao have been placed in the collections at Carnegie Museum, Pittsburgh; American Museum of Natural History, New York; Philadelphia Academy of Science; and the United States National Museum, Washington.

I am indebted to Dr. John R. G. Turner of the University of York, Heslington, England for providing me with information on Venezuelan

Heliconius in British collections; and to the late Dr. Richard M. Fox of Carnegie Museum and Dr. Michael G. Emsley of the Philadelphia Academy of Science for reading and commenting on my manuscript.

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AN ANOMALOUS FORELEG IN A MALE OF DODONIDIA HELMSII (SATYRIDAE)

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Individuals with one structure or another abnormally developed are well known in many organisms. A few of these aberrations are genetic, such as the "aristopedia" mutant of *Drosophila melanogaster* (Meigen) in which the antenna is modified into an imperfect leg-like structure through the action of a single gene. Other abnormalities are not genetic, or at least the trait is not transmitted to the offspring, if any; these aberrations are "birth defects" resulting in teratological specimens.

Teratology frequently has been noted in the Lepidoptera, with most examples involving extra wings, deformed wings, or aberrant venation. Most frequently the latter involves the atypical placement of one or more veins, the anastomosis of ordinarily separate veins, or the bifurcation of usually undivided veins as shown by Warren (1936). I encountered several such minor aberrant wing venations in the examination of hundreds of Satyridae for a higher classification study, so such anomalies are not rare. Aberrant genitalic structures, such as those reported for a female of *Pellicia dimidiata* Herrich-Schäffer by Monroe and Miller (1967), are less frequently encountered, probably because relatively few specimens are dissected.

The reduced forelegs of both sexes of the Nymphaloidea are of great importance in the classification of these butterflies, and occasionally one will encounter some bizarre configurations of these structures. One very unusual foreleg was noted in the only male I had of the New Zealand satyrid *Dodonidia helmsii* Butler, a butterfly which closely resembles no other species but which logically should be allied to the New Zealand

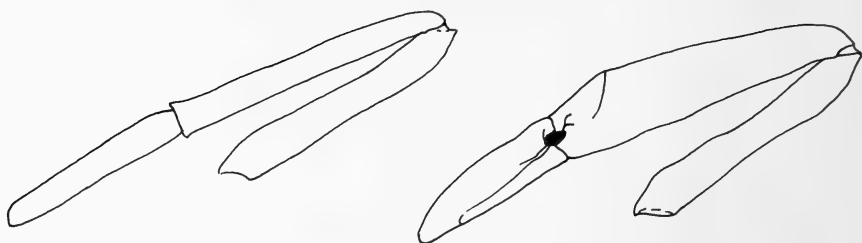


Fig. 1. Normal (left) and aberrant (right) forelegs of ♂ *Dodonidia helmsii* Butler; New Zealand; Carnegie Museum collection. Note particularly the hole completely through the leg at the junction of the tibia and tarsus.

and Australian *Xenica*-series of the Hypocystini (Miller, 1968). Nevertheless, if any satyrid should be aberrant, *helmsii* is the prime candidate. The femur is normally developed in this leg, as is the proximal part of the tibia. The distal half of the tibia and the entire tarsus are both greatly distended and apparently joined by an immovable "suture," rather than a freely movable articulation as is normal in insects. At the junction between the tibia and the tarsus there is a hole passing entirely through the leg from side to side. Aberrant as the butterfly is, the configuration of this leg was too anomalous to be accepted without verification by the examination of other legs, and the opposite leg on the same specimen was normally developed and typical of the condition seen in most hypocystines. Perhaps if the foreleg had been somewhat aberrant, but not so extensively so, I would have accepted its validity. The two forelegs of *helmsii* are figured in Fig. 1.

I cannot guess what caused the aberrant leg in this specimen. Perhaps it was a tumorous growth, perhaps it was the result of an injury or perhaps it was caused by something entirely different. The moral of this case is undoubtedly that one should not take a single specimen which is highly aberrant and totally unexpected too seriously. Systematists generally have learned this lesson with wing structure and pattern anomalies, and to a lesser degree with genitalic aberrations, but the legs, palpi, etc., have been considered "conservative" characters, and as such immune from variation. This conclusion is at least suspicious and probably completely misleading.

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BOOK REVIEW

A REVISION OF THE MOTHS OF THE SUBFAMILY PRODOXINAE (LEPIDOPTERA: INCURVARIIDAE), by Donald R. Davis. U. S. National Museum, Bulletin 255, 170 pp., Washington, D. C., 1967. Paper cover, \$1.00.

Possibly no group of so-called Microlepidoptera has attracted greater attention among biologists than the yucca moths. Therefore, a broad audience will be interested to learn that despite the title indicating a traditional taxonomic treatment, Davis has compiled a much more comprehensive treatise. Not only is an up-to-date classification presented, but the history of the yucca-yucca moth story is reviewed, phylogenetic relationships among the prodoxines and their relatives are proposed, and original biological observations are reported for several of the species. Perhaps the single most interesting new fact is the description of *Parategeticula pollinifera*, a moth which transports pollen of *Yucca schottii* but deposits its eggs into sterile tissue of the inflorescence rather than into the ovules.

The taxonomic treatment encompasses 17 species in five genera. In addition to *Parategeticula*, new genera are proposed for the *Agave* feeders (*Agavanema*) and for a new species (*Meseptiola*) which may be an associate of *Nolina*. Descriptions are accompanied by excellent drawings of morphological features of the adults, such as mouthparts and genitalia. Good photographs, executed by Mr. Jack Scott, illustrate adults of each species and female abdominal structures, including the ovipositor "saws." This is an innovation to Lepidoptera taxonomy which is very effective and may prove valuable in other moth groups. The early stages are not described in detail.

It is unfortunate that our study of biological relationships of the prodoxids associated with *Yucca whipplei* (Powell and Mackie, 1966, U. Calif. Publ. Ent., 42) could not have been included in Davis' otherwise comprehensive work. *Yucca whipplei* harbors the most complex community of prodoxine moths, so far as known, and on its basis many generalizations for the genera or the subfamily, based primarily on Riley's work, need to be modified; but they will be perpetuated by the present revision.

In discussion of relationships of the prodoxines, Davis presents a plausible theory of evolutionary development, based on both morphological and biological features, which implicates the subfamily as a New World derivative of an Incurvariid prototype. In this context, he theorizes on the evolution of primitive Lepidoptera. Davis supposes that early Lepidoptera were external feeders and that this habit has continued into the higher moths and butterflies, and that such groups as the hepalioids, ericranioids, and incurvarioids, all internal feeders, represent specialized offshoots which were not involved in a direct line to the higher Lepidoptera. This may well have been the case, but Davis' present argument is not valid because it treats the Micropterygidae as equivalent to generalized Lepidoptera, ignoring Hinton's rather convincing arguments for a more primitive position for the Micropterygidae. In order to follow Davis' line of reasoning, it would be necessary to refute or justify Hinton's conclusions about Zeugloptera-Trichoptera-Lepidoptera relationships. That the most primitive known ericraniid, *Agathiphaga* Dumbleton, 1952, is a borer in seeds of a Gymnosperm casts further doubt on a theoretical line of development directly through external feeding types.

Specialists may question some of the taxonomic decisions. The name *synthetica* Riley, 1892, after some 70 years in synonymy, has been exhumed to accommodate the Joshua tree moth, in favor of *paradoxa* Riley, 1889, on the grounds that the latter is a *nomen nudum*. However, Riley's original proposal of *paradoxa* included mention of the host and that *paradoxa* is its pollinator. That this comprises a diagnosis "of the work of an animal" [I.C.Z.N., 24 b], evidently has been the interpretation of 20th century Lepidopterists. It would appear that the plenary powers of the Commission need be invoked in order to preserve *synthetica* and suppress *paradoxa*.

Lectotypes are designated which revise type localities or seem to be Neotypes in several instances:

1) for *yuccasella*; a lectotype is designated, "*Pronuba yuccasella* Riley, ♂, June, 'C. Mo.'" However, the lectotype specimen at the U. S. National Museum bears the data "May 31/73," and "♀ moth," and this would have to be a Neotype, since the name is credited to Riley as of the Anonymous, 1872, report in *Nature*, in order for it to have priority over *alba* Zeller, 1873.

2) for *synthetica*, "Mojave, Kern Co., Calif." (A type locality was not specified by Riley, but his discussion suggests Antelope Valley, Los Angeles County. The lectotype specimen bears the additional data "2-4-91," presumably in reference to a collection date subsequent to the 1887 and 1888 collections made by Riley and Koebele, which are the only ones mentioned in the original description of *synthetica*.)

3) for *aterrima*, "Arrowhead, Calif." (This is the data on the specimen; Davis then quotes Trelease for the type locality, "From the foothills immediately north of San Bernardino.") Arrowhead refers to Arrowhead Springs, at 2,000 feet, not the more well known Lake Arrowhead at 5,000 feet.

4) for *pulverulentus*, "San Diego Co." (Evidently a Neotype, since the type locality was given as Santiago, Calif. The only Santiago within the distribution of *pulverulentus* is the Canyon and Peak in Orange County. Apparent syntypical specimens with the data "Santiago, May 20" are cited in Davis' material examined, and one is cited "lectotype"; but the lectotype specimen bears the data "San Diego Co., Calif. 20/5 86," as given in the formal "lectotype" designation.)

A few errors of minor nature bear notice here. The map for *T. synthetica* lacks a spot for Walker Pass, Kern County, the northern record given in the data. The map for *T. maculata* has been rendered somewhat confusing by inclusion of a dot in northern California representing "Plumas Co." specimens, which are certainly mislabeled, and by a symbol representing the subspecies *extranea* near Beverly Hills, evidently for a cotype labeled "Los Angeles," but there is no evidence that the black *extranea* phenotype occurs anywhere west of San Bernardino now.

Specimen labels from my material have been misread as "Samalayucca, 12 miles S. of Chihuahua," instead of 12 miles south of Samalayuca, in the northern part of the State of Chihuahua, resulting in dots on the *T. yuccasella* and *P. quinquepunctellus* maps, some 200 miles south of the Samalayuca dunes, and this is the southern record for the latter species. However, both are undoubtedly more widespread in western Mexico than Davis' data shows.

No mention is made of the unique caudal spurs on the larva of *Prodoxus cinereus*, although these were described by Riley. A photograph given by Davis (fig. 22) is not a clear one, but the larva appears to lack the hooks, indicating that the species shown is actually *P. aenescens*. *Prodoxus marginatus* and *P. pulverulentus*, are treated as species, and are referred to as "these two biological entities." However, in our work we found no behavioral difference between these two allopatric counterparts. The distribution of *marginatus* given by Davis includes a record for Fallbrook, in northern San Diego County, based on three males which were taken along with specimens which he cites under *pulverulentus*. This certainly is too weak a basis for indicating sympatry, particularly since females show a more appreciable difference. We reared large numbers of pod inhabiting *Prodoxus* from sites near Fallbrook and found populations there to represent *pulverulentus*.

Biologists and ecologists will find this book to be an important reference to the classic example of insect-plant symbiotic relationships. Lepidopterists will find it a well done and easily used addition to the increasingly more complete mosaic representing our knowledge of the North American Microlepidoptera fauna.—JERRY A. POWELL, *University of California, Berkeley*.

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(Complete contents on back cover)

15 December 1969

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BEHAVIORAL ADAPTATIONS OF CRYPTIC MOTHS. IV. PRELIMINARY STUDIES ON SPECIES RESEMBLING DEAD LEAVES

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A number of experimental studies have demonstrated that cryptic coloration conveys a selective advantage to animals by enabling them to avoid detection by predators (Young, 1916; Carrick, 1936; Turner, 1961). In addition to morphological adaptations, behavior of cryptic animals is also important. An animal, even if it is cryptically patterned, must be able to choose an appropriate background and to orient itself so that the cryptic pattern attains maximum effectiveness.

Several studies have shown that certain species of cryptic moths, which normally rest on tree trunks, are capable of selecting backgrounds which tend to match the reflectance of their forewings (Kettlewell, 1955; Sargent, 1966), and that these moths will adopt appropriate attitudes upon these backgrounds (Sargent, 1969). There are other moth species which rest in or on other substrates and which seem to be colored or patterned to match these substrates. This paper presents some early results from studies designed to examine the behavior of moths which resemble and rest in dead leaves.

FIELD STUDIES

Two techniques were used in studying the natural resting habits of these moths. The first of these simply involved searching an area of forest floor covered with dead leaves. When a resting moth was located, a photograph was taken, along with notes concerning the resting attitude. Occasionally moths were flushed before being photographed. These were then followed to subsequent resting places and appropriate notes were taken.

The second technique involved releasing moths in wooded areas, and following them to their resting places. These moths had been captured

TABLE 1. FIELD OBSERVATIONS OF SOME MOTHS WHICH REST IN DEAD LEAVES

Species ¹	Remarks
Geometridae:	
<i>Euchlaena</i> spp. Hübner (0, 6)	On top of dead leaves, often with one or both wings raised and resting against some object (e.g., tree trunk, rock)
<i>Metarrhanthia duaria</i> Guenée (0, 3)	Flat on top of leaves with wings spread
<i>Hyperitis alienaria</i> Herrich-Schaeffer (4, 2)	Flat on top of leaves with wings spread
<i>Sabulodes transversata</i> Drury (6, 0)	Flat on top of leaves with wings spread
<i>Abbotana clemataria</i> Smith and Abbot (0, 8)	Flat on top of leaves with wings spread
<i>Nematocampa filamentaria</i> Guenée (7, 0)	Flat on top of leaves with wings spread
Noctuidae:	
<i>Parallelia bistriaris</i> Hübner (28, 6)	Often "head down" in leaves, wings closed
<i>Panopoda rufimago</i> Hübner (0, 4)	Tends to crawl at least partly under leaves, wings closed
<i>Zanclognatha cruralis</i> Guenée (50, 7)	In or on top of leaves, wings closed
<i>Chytolita morbidalis</i> Guenée (110, 10)	Flat on top of leaves, wings closed
<i>Renia discoloralis</i> Guenée (10, 2)	In or on top of leaves, wings closed

¹ Numbers in parentheses: (previously undisturbed individuals, released individuals)

at lights or "sugar," kept overnight in experimental boxes, and released the following morning. Here, as with the undisturbed moths, photographs and notes were taken.

The two techniques produced similar results for a number of species and these observations are presented in Table 1. These results suggest that a number of brownish, leaf-like moths are able to select appropriate backgrounds and further, to orient with respect to these backgrounds so as to increase their crypsis.

EXPERIMENTAL STUDIES

Several species were released into an experimental box in an attempt to determine if the moths would exhibit preferences for certain test substrates. The experimental box (24 inches square by 19 inches high) was constructed of plywood. The floor of the box was equally divided into four quadrats (each 12 × 12 inches), and during these experiments,

TABLE 2. SELECTION OF SUBSTRATES BY MOTHS IN AN
EXPERIMENTAL APPARATUS

Species	Number of individuals selecting substrates:				
	pine needles	dead grass	dead leaves	twigs	P
<i>Parallelia bistriaris</i> Hübner	3	6	11	3	ns
<i>Epizeuxis lubricalis</i> Geyer	0	2	15	3	*
<i>Zanclognatha cruralis</i> Guenée	3	3	10	5	ns
<i>Amphipyra pyramidoides</i> Guenée	2	3	19	2	*

* Denotes significant deviations from chance selections. Analysis by chi square tests, Probability less than 0.01

ns Denotes no significant deviation from chance selection. Probability greater than 0.05

each quadrat contained a different substrate. In these experiments, the substrates used were: dead needles of white pine, dead grass stems, dead oak and maple leaves, and small twigs. Fresh substrate material was added nightly, and the box was rotated to eliminate any "position" effect. The box was covered with a pane of window glass and placed in a wooded area where a thick canopy excluded direct sunlight. Moths were introduced into the box by sliding the glass top to one side.

The moths were collected at lights or "sugar" bait and immediately introduced into the experimental box, generally 5–10 moths of the same species per night. The following morning, between 0600–0800 E.S.T., the box was checked and the substrate selection by moths noted.

The results of this experiment, which are summarized in Table 2, suggest that at least some of the species examined are capable of selecting appropriate substrates. However, the moths appear to fall into three groups with respect to their behavior in the box.

Moths in the first group never selected a substrate but instead were always found sitting either on the glass or on the sides of the box (*e.g.*, the geometrids *Abbotana clemataria* Smith and Abbot and *Nematocampa filamentaria* Guenée).

The noctuids *Parallelia bistriaris* Hübner and *Zanclognatha cruralis* Guenée are examples of moths which show the second type of behavior observed in the experimental box. Moths of this group select dead leaves, but also are frequently found resting on top of other substrates. From observation of both released and undisturbed moths, it appears that both species behave the same way in the wild, resting on top of leaves or other substrates if forced into areas where no dead leaves are present. Apparently these species choose any substrate which offers a relatively flat surface. *P. bistriaris* further enhances its crypsis by resting

TABLE 3. SELECTION OF DIFFERENTLY COLORED SUBSTRATES (3×3 IN. CARDBOARD SQUARES) IN AN EXPERIMENTAL BOX

Species	Number of individuals selecting substrates:				
	Black	Brown	Green	Yellow	P
<i>Parallelia bistriaris</i> Hübner	4	1	2	1	—
<i>Epizeuxis lubricalis</i> Geyer	2	3	1	2	—
<i>Amphipyra pyramidoides</i> Guenée	12	5	5	4	—

with the head burrowed into the substrate so that the moth is resting almost perpendicular to it. This posture allows the lighter-colored edge of the wing to stick up from the substrate and thus serves to break up the pattern of the moth.

On the other hand, the noctuids *Epizeuxis lubricalis* Geyer and *Amphipyra pyramidoides* Guenée did not rest on top of any substrate, but instead were found resting on the plywood floor of the box beneath the layer of dead leaves. This third type of behavior may not represent selection of dead leaves as such, but may only result from the moths choosing this substrate because it can be easily burrowed into and then effectively shields the moths from the light.

In an attempt to learn more about the mechanisms governing these choices, several additional experiments were devised. The same box was used, but cardboard squares (3×3 inches) were presented instead of the previous natural substrates in an attempt to keep the texture of the substrates constant.

In the first experiment, an attempt was made to determine the importance of the color of the substrate. Accordingly, squares of four different colors were used: black, chocolate brown, dark green, and bright yellow. The results of this experiment are shown in Table 3. For *A. pyramidoides*, there were sufficient numbers for a chi square test, but no significant selection tendency was noted. The sample sizes for the other species were too small to analyze separately, but the results were tested across species. In both cases however, the results suggested that the color of the substrate was not important to the moths in choosing a substrate.

In an attempt to determine the influence of the shapes of the substrate components on the choice of the moths, squares of white cardboard were used, but they were presented in four different shapes: flat squares ("flat"), squares folded in the middle and set on end ("tent"), squares folded in the middle and set on a side ("right angle"), and squares laid flat but set on top of a nail ("leaf") and thus raised off the floor of the

TABLE 4. SELECTION OF SUBSTRATE COMPONENTS (3×3 IN. CARDBOARD SQUARES) OF DIFFERENT SHAPES IN AN EXPERIMENTAL BOX

Species	Number of individuals selecting substrates:				P
	"Tent"	"Right Angle"	"Flat"	"Leaf"	
<i>Parallela bistriaris</i> Hübner	5	6	4	5	ns
<i>Epizeuxis lubricalis</i> Geyer	19	1	0	0	*
<i>Amphipyra pyramidoides</i> Guenée	26	0	0	0	*

* Denotes significant deviations from chance selections. Analysis by chi square tests, probability less than 0.01

ns Denotes no significant deviation from chance selection. Probability greater than 0.05

box. Sufficient numbers were obtained for only three species, but fortunately these represent two of the previously discussed types. The results from this experiment are shown in Table 4. *P. bistriaris* was found about evenly distributed on all substrates, but was oriented somewhat differently on each. For example, on the "right angle" squares, this moth generally perched "head down" on the inside of the extended arm. However, when resting on the flat substrates, the moth lay flat on top of the cardboard. In the wild, this species shows a similar behavior, resting "head down" in substrates which permit burrowing (e.g., dead leaves, grass) but laying flat on substrates such as pine needles.

The other species, *E. lubricalis* and *A. pyramidoides*, were found to prefer the "tent" substrate (analysis by chi square, $P < 0.01$). Once again these data agree with the data obtained in the wild, for the former species rests beneath layers of dead leaves, while the latter species avoids light by resting in crevices.

SUMMARY

The behavior of cryptic moths which resemble dead leaves was studied in central Massachusetts during the summers of 1967 and 1968. Both field observations and experiments were carried out.

Data obtained from undisturbed and released moths of the same species closely agree, suggesting that information gained from observing released moths is reliable.

The experiments involved the use of an experimental box in which the behavior of captured moths could be analyzed with respect to both natural and unnatural substrates. The results suggest that some cryptic moths, which resemble dead leaves, are capable of selecting this substrate when presented with a choice of substrates. Furthermore, it appears that the color of the substrate is not important to the moths when making selections, but that the shape or arrangement of substrate components may be the important factor. In general, two types of behavior

were shown. Some moths which rest flat on top of substrates or burrow slightly into them in nature, choose those substrates which allow this resting attitude to be assumed. Other moths, which are apparently negatively phototactic, select those substrates which allow burrowing, and thus serve to shield the moths from light.

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I would like to thank Dr. T. D. Sargent of the Department of Zoology, University of Massachusetts, for his assistance in planning and conducting this study.

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THE NAME ANTHOCHARIS (PIERIDAE)

The generic name *Anthocharis* Boisduval, Rambur & Graslín, 1833¹ was published twice in quick succession, in consecutive livraisons of the same work; on 2 February on plate Papillonides 5, figs. 6, 7, and on 29 June on pages [35, 36]; in livraisons 12 and 13 respectively. On each occasion only one species was included, *Anthocharis cardamines*, i.e. *Papilio cardamines* Linnaeus, 1758, which is the type species by monotypy. The gender of the genus is feminine.

On the first occasion when it appeared, no authorship was indicated for the name. The heading of page [35] reads "*Anthocharis cardamines* Boisd.," suggesting that Boisduval claimed it as his own new combination. However, both technically and for clarity, it would seem best to credit the triple authorship.

These facts are published because it is noticed that some references are appearing to "*Anthocaris*," and once such an incorrect spelling gains currency it becomes increasingly difficult to eradicate. There is no doubt that *Anthocharis* is correct. Inevitably, misspellings followed, and in fact within two years "*Anthocaris*," "*Anthocarix*," and "*Anthacaris*" had all appeared. However, Boisduval himself, and all the nineteenth century authors were usually correct.—CHARLES F. COWAN, *Little Gaddesden House, Berkhamsted, Herts., England*.

¹ BOISDUVAL, [J.B.A.de], RAMBUR, P., & GRASLIN, A. [de], 1832 [-1837]. Collection iconographique et historique des Chenilles, ou Description et Figures des Chenilles d'Europe, avec l'Histoire de leurs Métamorphoses, et des Applications a l'Agriculture. pp. [1-5], 6, [7], 8-14, [15-496], pls. [126]. Paris.

A SYNOPSIS OF NEARCTIC ADELID MOTHS, WITH DESCRIPTIONS OF NEW SPECIES (INCURVARIIDAE)

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Adelids are small, brightly colored, dayflying moths with exceptionally long antennae. They comprise a group of about 250 species of worldwide distribution, which usually has been assigned family status. However, these insects are closely allied to the Incurvariidae according to structures of the adults and probably will be considered a subfamily of the Incurvariidae by future writers in general. Forbes (1923) accorded the adelids subfamily rank along with the Prodoxinae (yucca moths) and the typical incurvariids, and Davis (1968) has used the same classification. The three groups share similarities in mouthpart structure, wing venation, and male genitalia, and are unique among primitive Lepidoptera in the possession of a well developed piercing ovipositor with which the eggs are inserted into plant tissue. From related moths, the adelids are most easily distinguished by the greatly elongated antennae, which are often two to three times the length of the forewing in the males. A few species, including one described here, have relatively short antennae, slightly longer than the forewing in the male, and slightly shorter than the forewing in the female.

TAXONOMY

Present classifications propose six or seven genera to accomodate the world fauna. These include three large genera: *Ceromitia*, which is primarily South African in distribution; *Nemophora* (including *Nemotois*), which is widespread over the Palearctic, Indo-Malayan, and Australian Regions; and *Adela*, which is mainly Holarctic, being well represented in both the Old and New Worlds.

The present synopsis treats 13 species, one in *Nemophora*, the remainder in *Adela*, three of which are previously undescribed.

For the most part Nearctic adelids have been described on the basis of external features, particularly color, which serves to distinguish species in most cases. In addition to color pattern differences, species of North American *Adela* also exhibit remarkable interspecific variation in eye size wing venation, and antennal structure (*e.g.*, Table 1). In most species the antennae of the male are about twice the length of the female's, while in other species the difference is less.

¹ Research in part supported by National Science Foundation grants GB-4014 and GB-6813x.

TABLE 1. MORPHOLOGICAL VARIATION AMONG NORTH AMERICAN ADELA

	HW M ₁ + M ₂	♂ Antenna w/spe- cialized scaling	♂ Eye	♂ Antenna: FW	♀ Antenna: ♂ ¹
<i>bella</i>	stalked	yes	small	3 +	.5
<i>aeruginosella</i>	?	?	small	3 +	.5
<i>ridingsella</i>	stalked	yes	large	3 +	.5
<i>purpurea</i>	stalked	yes	large	3 +	.5
<i>trigrapha</i>	separate	no	large	3 +	.5
<i>eldorada</i>	separate	no	large	3 +	.5
<i>flammeusella</i>	separate	no	large	3 +	.5
<i>thorpella</i>	separate	no	large	2.5	.6
<i>oplerella</i>	separate	no	small	1.2	.75
<i>septentrionella</i>	separate	no	intermed.	3	.67
<i>singulella</i>	separate	no	small	4.5	.75
<i>punctiferella</i>	separate	no	small	3 +	.75

¹ Approximate length of female antenna compared to male, corrected to eliminate size dimorphism in forewing.

On the other hand, structures of the genitalia, long the standard of species differentiation for most microlepidopterists, are exceedingly uniform both in males and in females, at least in the North American species. Although there are apparently consistent minor differences between species in the males, these are difficult to define and compare relative to the easily observed and measured distinguishing features of external morphology. In females I have found no differences in internal structures. The ovipositor "saws" may exhibit small differences, but so slight that very high magnification, phase contrast microscopy is required (*i.e.*, nothing comparable to the diversity found in Prodoxinae (Davis, 1968)). By contrast, the shape of the seventh sternite of the female varies conspicuously between some of the species. For these reasons I have relied almost exclusively on external characters for the present diagnosis. In fact, color features alone will readily separate nearly all the Nearctic species.

MATERIAL AND METHODS

Adelids are often encountered in large numbers visiting flowers on warm spring days and can easily be collected. Nonetheless until quite recently they had remained poorly known in most parts of North America. Although I have been able to examine some 4000 specimens during this study, probably 75% of these have been collected in California during the past decade by persons collecting in my interest. A request (Powell,

1961) for collecting received considerable response from hymenopterists and professionals of other interests, but the legion of western amateur lepidopterists have steadfastly refused to touch anything in this size range. In the eastern half of North America both the geographical distributions and biologies of these moths remain poorly known.

Difficulties inherent in study of dry adult specimens, owing to their small size, fragile condition, and dense vestiture were in part overcome during this investigation by preparation of whole mounts of representative specimens on slides. After removal of the wings, specimens were cleared and dehydrated by routine methods used in genitalic preparations. A saggital section was then made of the exoskeleton, employing surgical scissors, and mounted in Canada Balsam, a modification of the technique suggested by Hogue (1964). However, with the exception of the head appendages and abdominal sclerites of the female, no useful exoskeletal characters were discovered. Subsequently it has sufficed to clear only the head in order to make accurate measurements of the antennae and mouthparts.

For practical purposes identification of species can be done from dry material, but the antennal lengths have to be estimated since the antennae curl upon drying.

Forewing length is measured along a line from mid-base to apex, and unless otherwise indicated (as in length:width ratios) includes the fringe. Eye diameter is measured along the greatest distance across the eye as viewed from an external plane; the distance between the eyes, along the shortest distance, *i.e.*, across the crown in large eye males, across the front below the antennae in small eye individuals. Measurements of mouthpart lengths are exclusive of vestiture.

My study of adelids began in 1961 when I selected what I thought would be an "easy" group as a project in the Bulletin of the California Insect Survey. I knew the species and assumed that a couple of seasons' survey work to fill in the poorly known distributions would be sufficient to complete an adequate treatment. Although the five previously recognized California *Adela* were described between 1875 and 1890, three previously undescribed (and virtually uncollected) species turned up, two quite distinct from the known fauna and the third a sibling of the widespread *Adela trigrapha*. In addition, two color forms of *A. singulella* were discovered which posed an interesting problem.

The survey was essentially finished by 1965, but I delayed its completion, hoping that some information on the biologies of California *Adela* could be discovered. Through assistance provided by National Science Foundation grants GB-4014 and GB-6813x this has been partially success-

ful. The main purpose of the present paper is to make the new taxa available for use in the survey bulletin and in more comprehensive revisionary work by D. R. Davis at the U. S. National Museum.

Primary types of the newly described species are deposited at the California Academy of Sciences, on indefinite loan from the California Insect Survey.

BIOLOGY

All the North American adelid moths are believed to undergo a single annual generation, flying in spring or early summer. In Europe, *Nemophora swammerdamella* (L.) is said to live two years in the larval stage (Ford, 1949), and this longevity may obtain with *N. bellula*, a Boreal Nearctic species which ranges to 65° N. latitude. Members of both *Adela* and *Nemophora* feed as larger larvae within cases on lower leaves or fallen leaves during summer. Overwintering is accomplished by prepupal larvae or pupae in the larval cases. In a number of Palearctic species in both genera, females are known to deposit the eggs into young seed of particular plants, and this has proven to be the case with several California *Adela*. The larvae consume the contents of the developing seed capsules and then descend to the ground where they construct flat, usually pear- or figure eight-shaped cases, in which they feed on lower parts or fallen leaves of the same or other plants. A number of species for which no oviposition site is known have been reared from the case-bearing larvae in Europe (e.g., Stainton, *et al.*, 1873). None of the Nearctic species has been reared, and I have had success neither with rearing the larvae from first instars nor in finding cases in the field, despite the fact that adults of every species are sometimes abundant.

In Europe the oviposition hosts of *Adela* include *Cardamine* and *Sisymbrium* (Cruciferae), *Hypericum* (Hypericaceae), and *Veronica* (Scrophulariaceae), and suspects include *Salix* (Salicaceae) and *Quercus* (Fagaceae); in California oviposition occurs in *Linanthus* and *Gilia* (Polemoniaceae), *Platystemon* and *Meconella* (Papaveraceae), and *Holodiscus* (Rosaceae); for *Nemophora* in Europe, *Scabiosa* (Dipsaceae) (several species), *Anemone* (Ranunculaceae), and *Ballota* (Labiatae) have been recorded as foodplants. All species are specific to one or two closely related plant genera. (Stainton, 1873; Schutze, 1931; Ford, 1949; Jacobs, 1949).

Weiss and West (1925) reported an adelid as a petiole gall maker on Virginia creeper in New Jersey, but the moths were not reared. The identification was based on larvae and is suspect, in view of biological characteristics of other *Adela*.

KEY TO SPECIES OF NEARCTIC ADELINAE

1. Males: Frenulum well developed; abdomen with 7 visible segments, the terminal one not laterally flattened or attenuate, fully scaled 2
 Females: Frenulum lacking; abdomen with 6 visible segments, the terminal one often partially unscaled, laterally flattened, sharply attenuate, for piercing 14
2. Antenna thickened, width of flagellum near base more than .2 eye diameter, basal 5 segments each with one short peg-like seta; forewing broad, length less than 3× width, orange with a broad pale, transverse band at outer $\frac{1}{3}$ *Nemophora bellela* (Walker)
 Antenna filamentous, width of flagellum near base less than .2 eye diameter; no stout setae on basal segments; forewing narrower, length more than 3× width *Adela* 3
3. Eyes enlarged, extending on to crown behind antennae, eye diameter nearly 2× or greater than 2× the distance between eyes 4
 Eyes small, not extended back of antennae; eye diameter only slightly greater or smaller than distance between eyes 9
4. Eyes greatly enlarged, nearly holoptic; diameter 3× or more the distance between eyes; antennae without specialized scaling 5
 Eyes moderately enlarged; diameter about 2× the distance between eyes; antennal flagellum with enlarged, specialized scaling between segments 8–13 8
5. Antennae greatly elongate, more than 3× forewing length; more than 150 segments; forewing if bronzy, with fringe dark 6
 Antennae moderately elongate, about 2.5× forewing length; about 120 segments; forewing brassy bronze with whitish fringe *thorpella* Powell
6. Eye diameter usually about 4× the distance between eyes; forewing black usually with complete transverse whitish stripes 7
 Eye diameter usually about 3× the distance between eyes; forewing bronzy or coppery with at most isolated whitish spots *flammeusella* Chambers
7. Vestiture of crown mostly or entirely orange; inner two forewing bands pale yellow, usually broad, width of median one .22–.50 the distance between them in cell (about .42–.70 eye diameter); labial palpus elongate, segments II + III usually 1.06–1.15 eye diameter *eldorada* Powell
 Vestiture of crown mostly or entirely black; inner two forewing bands usually white, narrower, width of median one .10–.20 the distance between them (.25–.42 eye diameter); labial palpus usually shorter, segments II + III .90–1.06 eye diameter *trigrapha* Zeller
8. Antennal flagellum with specialized scaling on segments 8–10, segments relatively large, less than 100; forewing orange-brown with metallic lead colored spots above tornus *ridingsella* Clemens
 Antennal flagellum with specialized scaling on segments 11–13, segments small, more than 160; forewing purplish or bluish with a broad whitish transverse stripe at outer $\frac{1}{3}$ *purpurea* Walker
9. Antennae short, about 1.2× forewing length; forewing deep bronzy with at most a few whitish spots *oplerella* Powell
 Antennae long, more than 2× forewing length 10
10. Eye diameter about .25 greater than distance between eyes; forewing black usually with white transverse bands *septentrionella* Walsingham
 Eye diameter about .5 to .75 the distance between eyes; forewing not black 11
11. Antennae greatly elongate, more than 4× the forewing length; forewing bronzy with white transverse band or costa white at outer $\frac{1}{3}$
 *singulella* Walsingham

- Antenna less elongate, about $3\times$ forewing length; forewing, if bronzy, costa without white 12
12. Antennal flagellum with specialized scaling on segments 9–11; forewing purplish with indistinct metallic reddish striae in outer $\frac{1}{3}$ *bella* Chambers
Antenna with or without specialized scaling; forewing bronzy or greenish with no transverse striae in outer $\frac{1}{3}$ 13
13. Forewing metallic green basally, purplish apically, with ill-defined streaks
..... *aeruginosella* Walsingham
Forewing bronzy with or without a white dot or transverse line at end of cell *punctiferella* Walsingham
14. Forewing broad, length about $3\times$ width, orange with a broad, transverse pale band at outer $\frac{1}{3}$; hindwing with veins R_s and M_1 usually stalked
..... *Nemophora bellela* (Walker)
Forewing usually narrower, if orange, without transverse band; hindwing R_s and M_1 separate *Adela* 15
15. Antenna thickened on basal half by elongate, dense, purplish scaling, filamentous, white distally 16
Antenna not thickened on basal half, filamentous, evenly diminishing in diameter 17
16. Forewing bluish or purplish with concolorous, metallic, transverse striae on outer $\frac{1}{3}$ *bella* Chambers
Forewing metallic green basally, purplish apically, with ill-defined streaks but no transverse striae on outer $\frac{1}{3}$ *aeruginosella* Walsingham
17. Antenna shorter than forewing; forewing dark bronzy with or without indistinct pale spotting *oplerella* Powell
Antenna longer than forewing 18
18. Antenna greatly elongate, more than $2.5\times$ forewing length 19
Antenna moderately elongate, about $1.2\text{--}2.1\times$ forewing length 20
19. Antenna more than $3\times$ forewing length; forewing narrow, length about $3.4\times$ width, bronzy with complete white transverse band or white along costa at outer $\frac{1}{3}$ *singulella* Walsingham
Antenna less than $3\times$ forewing length; forewing broader, length about $3.1\times$ width, bronzy with or without a dot on thin incomplete transverse line at outer $\frac{1}{3}$ *punctiferella* Walsingham
20. Antenna elongate, more than $2\times$ forewing length; forewing black usually with thin, white transverse bands *septentrionella* Walsingham
Antenna less elongate, about $1.2\text{--}1.6\times$ forewing length 21
21. Antenna short, 1.3 or less times forewing length 22
Antenna longer, 1.5 or more times forewing length 23
22. Abdomen with VII sternite strongly produced and attenuate, more than $3.2\times$ VI sternite (pl. 6, fig. 1); forewing olivaceous bronze, reflecting brass metallic, fringe whitish *thorpella* Powell
Abdomen with VII sternite less attenuate; length less than $3.1\times$ VI (pl. 5, fig. 2); forewing orange brown, with lead colored metallic scaling on black spots above tornus; fringe brownish *ridingsella* Clemens
23. Forewing black, green or bluish with or without one or more white transverse bands 24
Forewing bronze colored reflecting metallic purplish to coppery with or without whitish spots, no transverse bands *flammeusella* Chambers
24. Head bright orange; forewing greenish with 2 or 3 transverse white bands
..... *trigrapha* Zeller and *eldorada* Powell
Head orchreous; forewing bluish with one broad transverse white band at outer $\frac{1}{3}$ *purpurea* Walker

NEMOPHORA Hoffmannsegg

Nemophora Hoffmannsegg, 1798, Illiger Verz. Käfer Preussens, :499; Hübner, 1826, Verz. bek. Schmett., :417; Meyrick, 1912, Gen. Insectorum, 133:2 (synonymy); Fletcher, 1929, Mem. Dept. Agric. India, Ent. Ser., 11: 146 (synonymy).

Nemotois Hübner, 1826, Verz. bek. Schmett., :416.

Nematopogon Zeller, 1839, Isis, :185.

Nemotois (error) Chambers, 1876, Canad. Ent., 8:103.

Type.—*Tinea degeerella* Linnaeus, 1758 (Europe)

The above synonymy follows Fletcher (1929), although Meyrick and others have credited the name *Nemophora* to Hübner, 1826 (type: *swammerdammella* L., 1758). Janse (1945), Jacobs (1949), and Diakonoff (1951) recognized Hoffmannsegg as the valid author and considered *Nemotois* a synonym of *Nemophora*, but retained *Nematopogon* Zeller (type: *schwarziella* Z., 1839) as a separate genus.

NEMOPHORA BELLELA (Walker), **new combination**

(Pl. 1, fig. 1; pl. 5, fig. 1)

Adela bellela Walker, 1863, Cat. Lep. Het. Brit. Mus., 28:501; Walsingham, 1880, Proc. Zool. Soc. Lond., :79.

Nemotois bellela; Barnes & McDunnough, 1917, Checklist Lepid. Bor. Amer., :196.

Adela bellela (error), Walsingham, 1890, Insect Life, 2:284.

Nemotois bellela (error), Meyrick, 1912, Lepid. Cat., 6:10; Forbes, 1923, Cornell Univ., Agr. Exp. Sta., Mem. 68:78 (distr.).

Nemotois bellela (error), Anderson, 1915, Proc. Ent. Soc. B. C., 6:129 (distr.).

Type data.—St. Martin's Falls, Albany River, Hudson's Bay, type female in British Museum.

Taxonomic discussion.—Walsingham (1890) suggested that this species may be synonymous with the widespread Palearctic *N. degeerella* (L.), a possibility enhanced by its presently known distribution. Specimens from Japan were said to be indistinguishable from North American examples.

Geographical distribution.—A boreal species ranging from Quebec across Canada north of the plains to the mountains of British Columbia; northward, widespread in the Northwest Territories, Yukon, and Alaska; at least to 65° N. Lat. at Great Bear Lake. Forbes (1923) reported it from Colorado.

Flight period.—Late June and July.

Oviposition site.—Unknown; *N. degeerella* is said to feed on leaves of *Anemone nemorosa* (Ranunculaceae) (Schutze, 1931).

ADELA Latrielle

Adela Latrielle, 1796, Gen. Crust Ins., 4:224; 1796, Prec. caract. Ins., :147; 1802, Hist. Nat. Crust. Ins., 3: 417.

Type.—*Tinea reamurella* L. (= *viridella* Scopoli, 1763) (Europe).

ADELA BELLA Chambers

(Pl. 1, fig. 2)

Adela bella Chambers, 1873, *Canad. Ent.*, 5:73; Chambers, 1878, *Bull. U. S. Geol. Survey*, 4:110 (biol.); Walsingham, 1880, *Proc. Zool. Soc. Lond.*, :79; Walsingham, 1890, *Insect Life*, 2:285 (synonymy); Engel, 1908, *Ann. Carnegie Mus.*, 5:135 (distr.); Meyrick, 1912, *Lepid. Cat.*, 6:12; Forbes, 1923, *Cornell Univ. Agr. Exp. Sta.*, 68:78 (distr.); Kimball, 1965, *Lepid. Fla.*, :303 (distr.).
Adela chalybeis Zeller, 1873, *Verh. Zool.-bot. Ges. Wien*, 23:226; Chambers, 1878, *Bull. U. S. Geol. Survey*, 4:127; Walsingham, 1880, *Proc. Zool. Soc. Lond.*, :79.
Adela iochroa Zeller, 1877, *Horae Ent. Soc. Rossicae*, 13:218; Walsingham, 1880, *Proc. Zool. Soc. Lond.*, :79.

Type data.—Kentucky, location of type unknown (*bella*); Texas, location of type unknown (*chalybeis*); Dallas, Texas, April 27, type in Staudinger collection (Walsingham, 1890) (*iochroa*).

Geographical distribution.—Widespread in eastern North America, from southern Quebec (Kazubazua) through the eastern coastal states to northwestern Florida and Alabama; Ohio, Kentucky, Tennessee and central Texas. Records are lacking for the Mississippi Valley.

Flight period.—March in Florida, April and May northward, August in Quebec.

Oviposition site.—Unknown; Chambers (1878) stated that the adults occur on flowers of *Celastrus scandens* (Celastraceae).

ADELA AERUGINOSELLA Walsingham

Adela aeruginosella Walsingham, 1890, *Insect Life*, 2:285.

Type data.—Louisiana (Morrison), type in British Museum.

Taxonomic discussion.—According to the description, this species should be very similar to *A. bella*, differing primarily by the greenish color, although Walsingham did not mention the eye size. It apparently has not been recollected subsequent to the type series. In response to inquiries I have been able to locate only one specimen of *Adela* from the Gulf states; that a male from Baldwin County, Alabama, in the Mather collection, which is indistinguishable from more northern *A. bella*.

Distribution.—Louisiana.

Flight period.—Unknown.

Oviposition site.—Unknown.

ADELA RIDINGSELLA Clemens

(Pl. 1, figs. 3, 4; pl. 5, fig. 2)

Adela ridingsella Clemens, 1864, *Proc. Ent. Soc. Phila.*, 2:426; *Tineina N. A.*, :250; Chambers, 1878, *Bull. U. S. Geol. Survey*, 4:127; Walsingham, 1880, *Proc. Zool. Soc. Lond.*, :78, 79 (synonymy); Walsingham, 1890, *Insect Life*, 2:285; Meyrick, 1912, *Lepid. Cat.*, 6:10; Forbes, 1923, *Cornell Univ. Agr. Sta., Mem.* 68:77 (distr.).

Adela ?ridingsella; Weiss and West, 1925, Ent. News, 36:116 (biol.); Felt, 1940, Plant Galls and Gall Makers, :287 (biol.).

Adela schlaegeri Zeller, 1873, Verh. Zool.-bot. Ges. Wien, 23:227.

Dicte corruscifasciella Chambers, 1873, Canad. Ent., 5:74.

Adela corruscifasciella; Chambers, 1878, Bull. U. S. Geol. Survey, 4:127 (synonymy).

Adela coruscifasciella (error), Walsingham, 1880, Proc. Zool. Soc. Lond., :79.

Type data.—"Virginia. Taken by Jas. Ridings of Philadelphia," type in Academy of Natural Sciences, Philadelphia (Busck, 1903) (*ridingsella*); Ohio, location of type unknown (*schlaegeri*); Kentucky, location of type unknown (*corruscifasciella*).

Geographical distribution.—Widespread in eastern North America, from Nova Scotia, Ontario, and Quebec, Maine to Pennsylvania and the mountains of North Carolina.

Flight period.—June and July.

Oviposition site.—Unknown; Weiss and West (1925) in New Jersey found larvae in petiole galls of *Parthenocissus quinquefolia* (Vitaceae). The larvae later formed external cases and were identified as adelid, possibly *Adela ridingsella* by Carl Heinrich. If correctly classified as *Adela*, the species involved might be *bella*, judging from the more southerly distribution of the plant and moth.

ADELA PURPUREA Walker

(Pl. 1, figs. 5, 6; pl. 5, fig. 3)

Adela purpurea Walker, 1863, Cat. Lepid. Het. Brit. Mus., 28:501; Walsingham, 1880, Proc. Zool. Soc. Lond., :78, 79 (synonymy); Walsingham, 1890, Insect Life, 2:285; Meyrick, 1912, Lepid. Cat., 6:10; Forbes, 1923, Cornell Univ. Agr. Exp. Sta., Mem. 68:78 (distr.).

Adela biviella Zeller, 1873, Verh. Zool.-bot. Ges. Wien, 23:226; Chambers, 1878, U. S. Geol. Survey, 4:127.

Type data.—St. Martin's Falls, Albany River, Hudson's Bay, type in British Museum (*purpurea*); Massachusetts, location of type unknown (*biviella*).

Taxonomic discussion.—Meyrick (1912a, b) listed *A. caeruleella* Walker, supposedly described from Australia, in North America. This species was described on the page following *purpurea*, and Forbes (1923) has suggested that the two may be the same. However, no mention of a white, transverse band is made by Walker for *caeruleella*.

Geographical distribution.—Widespread in Boreal North America, from the Yukon Territory at 62° N. Lat., through the southern provinces of Canada to Quebec and southward to northern New Jersey.

Flight period.—May and June in northern Canada; April in New England.

Oviposition site.—Unknown. Forbes (1923) and labels on specimens from several areas indicate that the adults visit *Salix* blossoms.

ADELA TRIGRAPHA Zeller

(Pl. 2, figs. 1, 2; pl. 5, fig. 4)

Adela trigrapha Zeller, 1875, Verh. Zool.-Bot. Ges. Wien, 25:342; Chambers, 1878, Bull. U. S. Geol. Survey, 4:128 (synonymy); Walsingham, 1880, Proc. Zool. Soc. Lond., :79 (synonymy); Meyrick, 1912, Lepid. Cat., 6:10; Powell, 1967, Pan-Pac. Ent., 43:83 (biol.).

Adela (*Nematais*?) *trifasciella* Chambers, 1876, Canad. Ent., 8:103; Meyrick, 1912, Lepid. Cat., 6:10. (new synonymy)

Adela fasciella Chambers, 1876, Canad. Ent., 8:103.

Adela flammeusella (not Chambers, 1876); Linsley and Usinger, 1936, Pan-Pac. Ent., 12:50 (biol.).

Adela flammsusella (error) (not *flammeusella* Chambers); Linsley and Usinger, 1936, Pan-Pac. Ent., 12:53.

Type data.—California, location of type unknown (*trigrapha*); "from Mr. James Behrens, San Francisco," type apparently lost, neotype male, by present designation: California, 2 miles west of Fairfax, Marin County, April 17, 1961 (J. Powell), in U. S. National Museum (*trifasciella*); from "Mr. Behrens, San Francisco," type apparently lost, neotype female, by present designation: California, 2 miles west of Fairfax, Marin County, April 17, 1961 (J. Powell), in U. S. National Museum (*fasciella*).

Taxonomic discussion.—The synonymy of the two names *trifasciella* and *fasciella* as representing the sexes of one species was suggested by Chambers at the time of their proposal, but later (1878) he considered *fasciella* synonymous with *trigrapha*. I can see no difference between the descriptions of *trifasciella* and Zeller's male of *trigrapha* and concur with Walsingham (1880) that all three names refer to the one species. A search of the U. S. National Museum and Museum of Comparative Zoology collections, the most likely locations for Chambers' types, proved negative for any of Chambers' *Adela*. I have therefore made the above neotype designations from a locality in the San Francisco Bay area. I know of no colony of *A. trigrapha* in San Francisco now, although specimens were taken there in 1908. The neotype of *trifasciella* is of the variety mentioned by Zeller with the outer transverse band broken. About 40% of my sample from this locality have the band broken.

Colonies typical of the neotype locality occur throughout the San Francisco Bay area counties, mostly in the hills away from the immediate coast, up to at least 2300 feet on Mt. Hamilton (Pl. 2, figs. 1, 2). These populations are characterized by moderately large individuals (forewing length of males average 8.5–9 mm), having narrow, white forewing bands (median band width .12–.18 the distance between inner bands in cell, .3–.4 eye diameter), and a few to several orange scales at the back of the crown. The species shows considerable interpopulational variation, but geographical trends are difficult to define. Colonies of the inner

coast range (Yolo County, western Stanislaus County, eastern Alameda County, interior San Luis Obispo County), on Santa Cruz Island, and in the foothills of the Sierra Nevada (*e.g.*, nr. Soulsbyville, Tuolumne County; near Posey, Tulare County; near Woody, Kern County) consist of smaller individuals (forewing length of males average 7.5–8 mm) which tend to have reduced whitish markings, with the transverse bands of the forewing sometimes almost obsolete, but more variable than shown in typical colonies (width of median band .10–.20 the distance between the inner bands, .25–.42 eye diameter), and with even less pale scaling of the crown, usually only a few scales, which are sometimes whitish instead of orange. As discussed below, these colonies are at times sympatric with the newly described species *A. eldorada*, which is more similar to typical *trigrapha*, presuming that Zeller's material originated from the San Francisco area.

Northward in the coast ranges the moths average slightly larger than in the San Francisco Bay area, with somewhat larger, slightly yellowish forewing bands and generally more orange on the crown, mostly one-third to one-half of the scales comprising the occipital tufts, thus approaching *A. eldorada* in these regards. Further study of colonies from higher elevations (3–4000 feet) in Lake County northward will be needed to clarify relationships between the two species in this region.

Geographical distribution.—Southern British Columbia to southern California (records are lacking for most of Washington and all but southernmost Oregon). The species occurs over much of cismontane California, in the coast ranges up to about 4000 feet and the foothills of the Sierra Nevada to 2000 feet; and in parts of the central valley.

Flight period.—Late March to mid-May in the foothills, mid-April to mid-June in Lake County northward.

Oviposition substrate.—Buds of *Linanthus androsaceus* and *L. bicolor* (Polemoniaceae).

***Adela eldorada* Powell, new species**

(Pl. 2, figs. 3, 4; pl. 5, fig. 5)

Adela trigrapha (not Zeller, 1875); Usinger and Storer, 1963, *Sierra Nevada Nat. Hist.*, :191, pl. 14, fig. 45.

A large species of the Sierra Nevada which resembles *A. trigrapha* but has relatively broader bands on the forewing and predominantly orange head vestiture in the male.

Male.—Length of forewing 5.3 to 6.8 mm. *Head:* Eye large diameter 3.1 to 4.4× the distance between eyes on crown. Antenna elongate, about 3× forewing length, 166 to 172 segments; scape scaled, black above, whitish ventrally with elongate black and white bristles ventrally, flagellum scaled, basal 30 segments

banded black and white, remainder white. Maxillary palpus minute, 3 segments (distal 2 sometimes fused), length about .15 eye diameter; labial palpus elongate, 3 segments, length usually about 4:6:4.5, II + III 1.06 to 1.14 eye diameter, scaled, black, with a dense brush of elongate black bristles on ventral half. Scaling of tongue and front sparse, elongate, pale and dark, of crown elongate, dense, usually mostly to almost entirely orange, the remainder black. *Thorax*: Dorsal scaling black except immediately behind head, orange, appressed with intermixed elongate, erect hairs. Underside similar, dark gray; tarsi white ventrally; hind tibiae and tarsi with elongate, dense black scale brushes. *Forewing*: Length 3.2 to 3.3 times width (exclusive of fringe); costa flattened or slightly concave towards middle. Ground color black; three transverse yellow-white bands, the inner one from costa at $\frac{1}{4}$, angled slightly inward, median one from about mid-costa, angled outward slightly bowed, to dorsum before tornus, width of median one .22 to .28 (rarely to .5) the distance between the two bands along a line in cell; third band from outer $\frac{1}{4}$ of costa, ending above tornus before terminal margin, narrower than inner two bands, usually broken (in about 70% of the sample), the lower part small, sometimes obsolete. Fringe black. Underside black, the pale bands of upperside showing through, the outer one reproduced by pale scaling. *Hindwing*: About as broad as forewing. Ground color brownish black, reflecting metallic purplish; usually two yellow-white spots near hind margin, inner one often reduced, sometimes lacking, just beyond anal angle, outer one at termination of 1st A fold. Fringe brownish black. Underside brownish black. *Abdomen*: Dorsal scaling black, faintly reflecting metallic purplish; underside somewhat paler, distal two segments and genital scaling often with some intermixed whitish. Genitalia essentially indistinguishable from *A. trigrapha* except larger (about 3:2 at the type locality); uncus strongly protruding; valvae round apically; reflexed part of aedeagus relatively short, about $\frac{1}{3}$ the total length, its sclerotized portion arrowhead-shaped (2 preparations examined).

Female.—Length of forewing 5.6 to 6.9 mm. *Head*: Eye small, not extended onto crown; diameter .67 to .70 the distance between eyes. Antenna about .5 as long as in male, about 1.5 forewing length; 70 to 76 segments; scaled, banded dark gray and white or mostly gray on basal $\frac{2}{3}$, white beyond. Labial palpus shorter than in male (about 4:5), segment II usually slightly longer than III; scaled, black, and with elongate black bristles ventrally. Maxillary palpus small, but not smaller than in male, 3 or 4 segmented, the basal 2 segments larger. Tongue and lower front scaling black; upper part of front and crown densely clothed with elongate, bright orange scaling, no intermixed black. *Thorax*: Dorsal scaling metallic green anteriorly, becoming blackish posteriorly. Underside dark metallic gray, tibiae metallic greenish exteriorly. *Forewing*: Broad, length about 2.7 times width; costa gently convex. Ground color dark metallic green; three pale yellow bands, arranged as in male but narrower (width of median band .18 to .25 the distance between inner two), outer one not reaching costa, often broken (in 45% of the sample). Fringe blackish. Underside dark brown; pale bands of upperside showing through, not reproduced. *Hindwing*: Broader than forewing; frenulum lacking. Ground color dark brown, reflecting metallic purplish; the two marginal pale spots of male usually absent, when present, rarely also a third spot in cubital interspace. Underside dark gray-brown, without pale spots. *Abdomen*: Scaling entirely metallic blackish. VII sternite moderately elongate, length about 3.0 VI (Pl. 5, fig. 5).

Holotype male and allotype female: California, One mile east of Woody, Kern County, May 3, 1964 (J. Powell). Paratypes (125), all California: Fresno Co.: Trimmer, Kings Riv. Cyn., 1♂ IV-10-32 (E. L. Donohoe). Kern Co.: 1 mi. E Woody, 1♂, 1♀ IV-25-64 (C. A. Toschi), 10♂, 2♀ V-3-64 (J. Powell & P. A. Rude). Madera Co.: Bass Lake, 1♂ V-30-42 (C. Kennett). Mariposa Co.: Mariposa, 9♂, 1♀ V-20-61 (S. M.

Fullerton); 3 mi. N Bagby, 2♂ III-25-65 (R. L. Langston & J. Powell). Placer Co.: East end Bear Vy., nr. Emigrant Gap, 14♂, 4♀ VI-1-64 (P. H. Arnaud, Jr.). Tulare Co.: California Hot Springs, 3♂ V-14-63 (C. A. Toschi & J. Powell); 5 mi. NE Springville, 3♂, 1♀ V-14-63 (S. W. Earnshaw & Powell). Tuolumne Co.: N fork Tuol. Riv., 3 mi. NE Tuolumne, 16♂, 1♀ V-1-61 (C. D. MacNeill & Powell), 8♂, 4♀ V-13-61 (MacNeill); Tuol. Riv., 2 mi. NE Tuolumne, 4♂, 2♀ V-13-61 (MacNeill); Crocker Sta., 6 mi. S Mather, 7♂, 1♀ VI-12-61 (MacNeill & Powell); 4 mi. S Mather, 1♂ VI-12-61 (Powell); Twain Harte, 13♂, 7♀ VI-17-63 (M. R. Lundgren), 1♂ V-24-64, 7♂ V-30-64 (M. R. & S. H. Lundgren). Paratypes deposited in collections of California Academy of Sciences, California Insect Survey, and U. S. National Museum.

The following additional specimens have been examined, which probably represent *eldorada* but are not designated as paratypes owing to insufficient information on the populations involved. California: Butte Co.: S of Cohasset, 2♂, 1♀ IV-5-63 (L. D. Thurman). El Dorado Co.: Cool, 2♂ IV-5-63 (L. D. Thurman). Fresno Co.: 4 mi. W Tollhouse, 1♂ V-13-61 (D. J. Burdick). Kern Co.: Haviilah, 3000', 1♂ IV-28-64 (J. Powell). Big Cr., nr. Huntington Lake, 2♂ VI-9-63 (C. P. Alexander). Madera Co.: 21 mi. NE Madera, 2♂ IV-14-61 (D. J. Burdick). Mariposa Co.: Mariposa, 4♂ V-7-39 (M. L. Walton); Mt. Bullion, 1♂ V-7-54 (Martin & Truxal). Tulare Co.: 4 mi. N Kaweah, 2♂ V-13-63 (S. W. Earnshaw).

This species is similar in superficial appearance and structure to *Adela trigrapha*, from which it differs by being larger and more brightly colored, in the male with relatively wider transverse bands which are yellowish rather than white and with orange vestiture on the head. The new species further differs by having in both sexes slightly larger labial and maxillary palpi, particularly the second segment of the labial palpi.

Adela eldorada essentially replaces *trigrapha* on the west slope of the Sierra, ranging from about 1500 to 6000 feet. In these areas it flies in canyon situations, in semi-shaded spots in the forest, or more or less open chaparral, and has not been observed visiting flowers. This habitat preference, which is similar to that of *A. septentrionella*, at once impressed us as distinct from that of *trigrapha* when we first encountered the species in 1961. *Adela trigrapha*, by contrast, almost invariably flies in more or less open meadow or grassy hillside situations where *Linanthus* grows and commonly visits flowers, especially Compositae. Owing to the nearly allopatric distribution, I would have been inclined to regard *eldorada* as a biological race or subspecific counterpart, except the two were found together near Woody, Kern County, in 1964. Here *eldorada* flew in small

openings in deep chaparral and scrub oak on a north facing slope, while *trigrapha* was common around *Baeria minor* (Compositae) on grassy flats subtending the slope, a few meters away.

As discussed above, populations of *A. trigrapha* from interior portions of the Coast Range and from foothills of the Sierra Nevada are characterized by individuals which are smaller and darker with less tendency for orange on the male head than typical *trigrapha* from the central coastal counties. Thus a character displacement type of situation obtains in which *trigrapha* and *eldorada* are much more distinct where their populations are sympatric or adjacent (along the Sierra Nevada foothills) than where samples from remote areas (coastal *trigrapha* and Sierran *eldorada*) are compared.

Each of the differences mentioned to distinguish *eldorada* from *trigrapha* breaks down in a few specimens from one locality or another. For example, specimens from 6000 feet in Tuolumne County, near Mather, show the extreme in orange head vestiture, characteristic of *eldorada*, but some have narrower forewing bands than at any other Sierran locality, well within the range shown by typical *trigrapha*. Specimens from east of Millville, Shasta County, are referred to *trigrapha* on the basis of wing markings, head color, and habitat, but they have a larger labial palpus than any other *trigrapha* measured, as in *eldorada*.

As mentioned in connection with *trigrapha*, its representatives from Lake County northward tend to have increased orange head scaling, yellowish bands, and more hindwing spots, and relationships between the two species should be investigated in mountains around the northern end of the Sacramento Valley and northward.

The only southern California mainland population sample I have studied, from Railroad Canyon near Elsinore, Riverside County (17♂, 1♀ IV-13/17-65, C. A. Toschi and J. Powell) is composed of small individuals as in interior northern sites. However, the Riverside specimens have relatively broad forewing bands (median band .21 to .28 the distance between inner bands, .45 eye diameter) and the head shows a moderate amount of pale, usually whitish, scaling.

ADELA FLAMMEUSELLA Chambers

(Pl. 3, figs. 3-5; pl. 5, fig. 6)

Adela flammeusella Chambers, 1876, Canad. Ent., 8:104.

Adela flammensella (error) Chambers, 1878, Bull. U. S. Geol. Survey, 4:127; Walsingham, 1890, Insect Life, 2:284 (synonymy).

Adela flamensella (error) Walsingham, 1880, Proc. Zool. Soc. Lond., :78, 79.

Adela lactimaculella Walsingham, 1880, Proc. Zool. Soc. Lond., :80, pl. 11.

Adela flammeella Meyrick, 1912, Lepid. Cat., 6:10.

Type data.—"from Mr. Behrens" [San Francisco], type apparently lost, neotype female, by present designation: California, 6 miles southeast of Yorkville, Mendocino Co., V-18-66 (J. Powell), in U. S. National Museum (*flammeusella*); "Mendocino County, California, June 10, 1871,"¹ type in British Museum (*lactimaculella*).

Taxonomic discussion.—This species was described on the basis of a single female specimen lacking antennae, which evidently has subsequently been destroyed. The description conceivably could apply either to *flammeusella* as it has been interpreted or to one of the two species described below, *A. thorpella* or *A. oplerella*. However, Chambers' use of "saffron" for the head color (the same term he used for *fasciella* = *trigrapha*) suggests that the species has been correctly interpreted by subsequent writers. Thus I have designated a neotype from a colony geographically and phenotypically near the type of *lactimaculella*, which was described on the basis of better material but later recognized by Walsingham (1890) to be a synonym of *flammeusella*. My concept of Walsingham's name is based on the good original description and figures and on my specimens from Lake and Mendocino Counties compared with the type at the British Museum by R. W. Hodges.

Walsingham supposed that the white markings were worn off Chambers' type, but unmarked individuals are normal in females, although rare in the north coastal counties. In this regard the species shows geographical variation but no well-defined trend. Males from Mendocino and Lake Counties tend to be strongly spotted, with at least the three spots described by Walsingham well-developed and white, strongly contrasting. Often a fourth spot appears above the tornus, and rarely there are two more at basal one-fourth, one each just above and just below the cell (Pl. 3, fig. 3). The females usually have three or four rather ill-defined spots. The neotype has none.

Southward, in populations of the San Francisco Bay area counties, specimens are generally less well marked, with most males having only the three spots illustrated by Walsingham, and these are not as large and contrastingly white, appearing yellowish or tan. Unmarked females are common, about 50% having at most a trace of the outer costal spot (Pl. 4, fig. 4). On Santa Cruz Island and in Placer County at 1300 feet in the Sierra Nevada foothills, about 50% of males have no markings on the forewing, the remainder having reduced spots, and females are immaculate. At Cool, El Dorado County, only seven airline miles from a Placer County sample site, all individuals in two samples (16♂, 13♀)

¹ Essig's (1941) account of the Walsingham itinerary places this date's collecting in the vicinity of Little Lake, near Willits.

have unicolorous forewings (Pl. 4, fig. 5). Southward in the Sierra Nevada the phenotype is more like the Placer County composition.

Geographical distribution.—Southern Washington (Columbia River), southward (although records are lacking for Oregon) through foothills and interior valleys of most of cismontane California, mostly below 2000 feet.

Flight period.—Late March (rare), April and May, to early June at higher elevations.

Oviposition site.—Unknown; probably various species of *Orthocarpus* (Scrophulariaceae) are involved.

***Adela thorpella* Powell, new species**

(Pl. 2, figs. 5, 6; pl. 6, fig. 1)

A densely hairy moth with large eyes in the male and olivaceous-bronzy colored forewings with brassy metallic reflections and a whitish fringe.

Male.—Length of forewing 5.9 to 7.0 mm. *Head*: Eyes enlarged, extending onto crown behind antennal sockets; eye diameter 3.3–3.7 times the distance between eyes; maxillary palpus small, length about .2 eye diameter, 3 segments of equal lengths; labial palpus elongate, about 1.5 eye diameter, segment lengths about 1:2:2. Antenna about 2.5 times forewing length, flagellum about 120 segments, scape with scale tuft dorsally and enlarged hair tuft ventrally. Mouthparts and crown above and below antennal sockets densely clothed with long hairs, whitish below front, with intermixed blackish bristles, slightly ochreous behind eyes in fresh specimens. *Thorax*: Scaled, black, and sparsely hairy, pale ochreous dorsally; densely hairy, gray to blackish ventrally; femora and hind tibiae with elongate brushes. *Forewing*: Length 3.7–4.0 times width (exclusive of fringes). Ground color olivaceous-bronze, reflecting metallic brass, at times overlaid with pale yellowish scales; without markings or more usually at least a trace of a white spot pattern which when well developed is composed of a faint spot in middle near base, a distinct, small spot angling in from costa beyond end of cell, and an opposing, distinct, larger spot angling upward from dorsum before tornus. Fringe distinctly white from apex nearly to tornus, becoming brown at tornus. Underside dark brown, costa and terminal fringe white. *Hindwing*: About as broad as forewing; M_1 and M_2 separate. Ground color brown, faintly reflecting purplish; fringe whitish around outer margin, becoming brownish at inner margin. Underside similar. *Abdomen*: Scaling black dorsally and ventrally; genital scaling whitish. *Genitalia*: Uncus bilobed, rather strongly protruding; valvae round apically; folded portion of aedeagus comparatively short (only about one-half the unfolded portion), its sclerotization spear- rather than arrowhead-shaped (4 preparations examined).

Female.—Length of forewing 5.7 to 6.1 mm. Generally similar to male, differing as follows. *Head*: Eye small, lateral to and almost entirely below antennal socket; eye diameter slightly over .5 the distance between eyes. Labial palpus shorter, about .67 as long as in male. Antenna shorter, 1.3 to 1.4 times forewing length; about 67 segments. Frenulum lacking. Abdomen fully scaled, brownish, mixed with paler ventrally and apically. Sternite VII elongate-attenuate (Pl. 6, fig. 1), about 3.25 times the length of VI.

Holotype male and allotype female: California, Russelmann Park, north slope of Mt. Diablo, 1100 feet elev., Contra Costa County, April 9,

1958 (J. Powell). Paratypes (184), all California: Colusa Co.: 4 mi. NW Lodoga, 13♂, 18♀ IV-12-62 (J. A. Chemsak and J. Powell). Contra Costa Co.: Mt. Diablo, 1♂ IV-4-36 (E. S. Ross); same data as holotype, 17♂, 3♀. El Dorado Co.: Tallac, Lake Tahoe, 1♂ no date (B. P. Clark donor). Lake Co.: 1 mi. SW Lakeport, 11♂, 9♀ IV-24-63 (R. W. Thorp). Madera Co.: 3.7 mi. W Oakhurst, 8♀ V-15-63, on *Platystemon* (R. W. Thorp). Mariposa Co.: 3 mi. N Bagby, 6♂, 3♀ III-25-65 *Platystemon californicus* (R. L. Langston and J. Powell). Monterey Co.: Hastings Reservation near Jamesburg, 12♂, 4♀ IV-27-63, on *Platystemon* and *Meconella* (R. W. Thorp); 6 mi. N Jolon, 1♂ IV-15-64 on *Layia* (R. W. Thorp). San Benito Co.: Limekiln Cyn., SW of Paicines, 4♂ III-30-63 (K. A. Hale and D. C. Rentz), 1♂, 1♀ IV-29-65 on *Platystemon* (P. A. Opler), 4♂ IV-24-65 (D. C. and K. A. Rentz), 3♀ IV-24-68 (J. T. Doyen and J. Powell). Santa Clara Co.: 1 mi. N New Almaden, 18♂, 12♀ III-29-65, "mainly on *Platystemon*" (P. A. Opler); 3.5 mi. NE New Almaden, 8♂, 2♀ IV-3-65 on *Plagiobothrys* (P. A. Opler); 0.5 mi. N New Almaden, 4♂, 16♀ IV-4-65 "mainly on *Platystemon*" (P. A. Opler). Sonoma Co.: 1 mi. S El Verano, 2♂ III-25-64, *Platystemon californicus* (R. W. Thorp), 2♂ IV-9-64, *Platystemon californicus* (J. Powell). Paratypes deposited in British Museum, California Academy of Sciences, California Insect Survey, and U. S. National Museum.

A nearly equal number of additional specimens, from the following localities in the southern half of the State, have been examined but not designated as paratypes. Kern Co.: Miracle Springs, IV-29-64 (J. Powell). Riverside Co.: Railroad Cyn., 4 mi. E Elsinore, IV-14/17-65, *Platystemon californicus* (J. Powell). San Luis Obispo Co.: 3 mi. N Nacimiento Dam, IV-14-67, *Platystemon* (J. A. Chemsak and J. Powell); 4 mi. S Creston, IV-13-67, *Meconella linearis* (Chemsak, Powell and Rude). San Diego Co.: San Diego, III-23-21 (W. S. Wright). Santa Barbara Co.: Prisoner's Harbor, Santa Cruz Island, IV-29-66 (J. Powell).

Southern California specimens tend to be slightly smaller and darker, with increased white spotting.

The few specimens of *Adela thorpella* which had been collected prior to 1958 evidently had been mixed in collections with *A. flammeusella*. The two are easily distinguished, however, by the brassy, rather than bronzy or coppery color, and the white fringe of the forewing of *A. thorpella*, its reduction of purplish on the hindwing, its heavier vestiture on body and legs, and appreciably shorter antennae. The present species is more similar in superficial appearance to *A. oplerella*, described below. From the latter, *A. thorpella* differs by its larger size, relatively longer antennae in both sexes and larger eyes in the male.

The species is named for Robbin W. Thorp, who, in connection with his bee studies, made most of the collections of this moth during the early years of my *Adela* survey.

***Adela oplerella* Powell, new species**

(Pl. 3, figs. 1, 2; pl. 6, fig. 2)

A small, dark bronzy colored moth with short antennae only slightly longer than the forewing in the male, and shorter than the forewing in the female.

Male.—Length of forewing 4.4 to 5.5 mm. *Head*: Eye lateral, almost entirely below antennal socket, diameter about .3 the distance between eyes. Labial palpus elongate, porrect, segments variable in length, II + III about 1.9 times eye diameter; scaled brown dorsally and whitish ventrally, ventral half with many spreading, elongate (to 2× eye diameter), black bristles. Maxillary palpus small, length about .3 eye diameter, three segments, the basal two subequal, larger than third. Antenna 1.0 to 1.2 forewing length; flagellum of 48 to 50 segments; scaled dark brown. Head clothed with elongate, irregularly spreading black and pale ochreous hairs. *Thorax*: Dorsal scaling blackish brown, reflecting bronzy, interspersed with long semi-erect black and ochreous hairs. Underside similar, coxae and femora densely hairy. Hind tibia and tarsi with pale elongate hairs and scale brushes. *Forewing*: Length 3.4 to 3.6 times width (exclusive of fringes). Ground color dark olivaceous bronzy, strongly metallic when fresh; without markings or with two faint whitish spots, one on costa beyond cell and one at lower corner of cell. Fringe dull whitish above tornus. Underside dark brown with scattered pale scales, costa and terminal fringe pale ochreous. *Hindwing*: Slightly narrower than forewing; M_1 and M_2 separate. Ground color dark brown, reflecting metallic bronzy and purplish. Fringe dull whitish below apex. Underside similar, with scattered pale scales in outer half. *Abdomen*: Dorsal scaling black, reflecting metallic bronze. Underside slightly paler. Genitalia with uncus reduced, lateral lobes scarcely protruding; valva strongly tapered apically; sclerotized part of reflexed portion of aedeagus spear-shaped, about .8 as long as basal portion (two preparations examined).

Female.—Length of forewing 5.0 to 6.1 mm. Essentially as described for male, differing as follows: Labial palpus slightly shorter, segments II + III about 1.8 eye diameter; antenna shorter, about .8 to .9 forewing length, 40 to 46 segments; elongate hairs of head and thorax mostly ochreous to pale ochreous. Wing fringes generally paler; frenulum lacking. Abdomen with VII sternite elongate, 3.35 to 3.5 times VI (Pl. 6, fig. 2); VIII moderately heavily sclerotized; internal genitalia without sclerotization.

Holotype male and allotype female: California, 5 miles southeast of Nicasio, Marin County, April 30, 1967, on *Platystemon californicus* (P. A. Opler and W. J. Turner). Paratypes (108), all California; Marin Co.: 21♂, 18♀ same data as holotype, 1♂ IV-13-68 (P. A. Opler); 5.5 mi. E Nicasio, 2♂, 6♀ IV-30-67 (G. A. Gorelick); 1 mi. SE Corte Madera, 8♂, 5♀ IV-13-68, on *Platystemon californicus* (P. A. Opler). San Francisco Co.: Lake Merced, 1♂, 1♀ III-21-08, 1♀ IV-19-08, 1♀ IV-11-09 (F. X. Williams). Santa Clara Co.: Silver Creek hills, 2♂ IV-12-62 (W. E. Ferguson); 6♀ IV-20-62 on *Platystemon californicus* (J. A. Chemsak and J. Powell); 1 mi. N New Almaden, 9♂, 5♀ III-29-65 on *Platystemon*

(P. A. Opler); 3.5 mi. NE New Almaden, 6♂, 10♀ IV-3-65 on *Platystemon* (P. A. Opler); 0.5 mi. N New Almaden, 5♀ IV-4-65 (P. A. Opler). Paratypes deposited in collections of British Museum, California Academy of Sciences, California Insect Survey, G. A. Gorelick, and U. S. National Museum.

As mentioned above, this species is most similar to *A. thorpella* among described species, and the two occur together on *Platystemon californicus* in central coastal California. *Adela oplerella* is smaller, darker and has small eyes in the male; the short antennae will distinguish the present species from all other described Nearctic *Adela*.

The species is named for Paul A. Opler, who has collected nearly all the specimens of this moth in addition to many other *Adela* during the course of this study.

ADELA SEPTENTRIONELLA Walsingham

(Pl. 3, fig. 6; pl. 4, figs. 1, 2; pl. 6, fig. 3)

Adela septentrionella Walsingham, 1880, Proc. Zool. Soc. Lond., :79, pl. 11; Walsingham, 1890, Insect Life, 2:285; Meyrick, 1912, Lepid. Cat., 6:10; Powell, 1967, Pan-Pac. Ent., 43:84 (biol.).

Type data.—Mendocino County, California, May and June, 1871, types in British Museum.

Taxonomic discussion.—Collections from northern Washington and British Columbia show a high proportion of specimens with reduced white markings, often the forewings are essentially immaculate black. Occasional examples in typical California populations exhibit a broadening of the white bands, as in Pl. 4, fig. 6.

Geographical distribution.—Widespread in the Pacific Coast states, from southern British Columbia and northwestern Idaho to the Transverse Range in southern California. The species is more Boreal than other West Coast *Adela*, following *Holodiscus* from canyon transition zone situations near the coast to near timberline above 6000 feet in the Trinity Alps and the mid Sierra Nevada, and 8000 feet in the southern Sierra Nevada.

Flight period.—Mid-April (rare), May and June, to mid-July at high elevations.

Oviposition site.—Buds of *Holodiscus discolor* (Rosaceae).

ADELA SINGULELLA Walsingham

(Pl. 4, figs. 3–5; pl. 6, figs. 4, 5)

Adela singulella Walsingham, 1880, Proc. Zool. Soc. Lond., :80, pl. 11; 1890, Insect Life, 2:285; Powell, 1961, Pan-Pac. Ent., 37:63.

Type data.—Mendocino County, California, May 25, 1871,¹ types in British Museum.

Taxonomic discussion.—Although typical populations of this species were not rediscovered for nearly 90 years after Walsingham found it, we now have adequate samples from four localities in the counties north of San Francisco Bay. Almost no variation in size or color is shown (Pl. 4, figs. 3, 4). Southward in the central Coast Range and along the west slope of the Sierra Nevada, are populations which are morphologically indistinguishable and occur in close association with the same plant. However, all these samples (some 150 specimens from a dozen localities) consist of specimens which average slightly smaller and lack all trace of the white forewing band, having only the white scaling along the costa which in the typical form gives rise to the transverse line (Pl. 4, fig. 5). In addition, the unbanded moths exhibit a duller appearance, lacking the purplish metallic reflections of the forewing, and thus superficially resemble *A. punctiferella*, with which some of the more austral colonies are nearly sympatric. I would consider the unbanded populations as a subspecies except for two small collections from the Transverse Range in southern California, which contain both phenotypes: 1) 9♂, 3♀ "Mt. Baldy, San Bernardino Mts.," and "San Bernardino, Calif., Sept." (USNM) which includes one male with the white band, the rest without it; at least the date on the latter is in error and probably the locality (Possibly the specimens came from Camp Baldy in the San Gabriel Mountains, west of San Bernardino.); 2) 3♂, 1♀ Tanbark Flat [2800' above Glendora], Los Angeles County, VI-18/19-56 (G. I. Stage and A. Menke, CIS, LACM), in which the males are banded, the female unbanded. The latter is worn and possibly also bore white scaling when fresh.

Thus some kind of polytopic interpretation may obtain when more colonies are discovered, particularly around the southern end of the Central Valley, and it seems best to withhold nomenclatural designation of the unbanded race for the present.

Geographical distribution.—California, southern Mendocino, Napa and northern Marin Counties (typical form); west slope of the Sierra Nevada (600–6000') from El Dorado to Kern County, in the Coast Ranges of Santa Clara County southward, to San Luis Obispo County (unbanded form), thence into the San Gabriel Mountains.

Flight period.—Mid-May to mid-June north of San Francisco Bay, the

¹ The Essig (1941) account of Walsingham's itinerary places this date's collection in the vicinity of Yorkville in the southern part of the county.

central Sierra Nevada and the San Gabriel Mountains; April in south Coast Range and southern Sierra Nevada.

Oviposition site.—Buds of *Gilia capitata* and *G. achillaefolia* (Polemoniaceae).

ADELA PUNCTIFERELLA Walsingham

(Pl. 4, fig. 6; pl. 6, fig. 6)

Adela punctiferella Walsingham, 1890, *Insect Life*, 2:284.

Type data.—Los Angeles, California, type female in British Museum.

Taxonomic discussion.—The tiny white spot at the end of the cell of the forewing, which gave the species its name, is present on less than 30% of the individuals in all populations sampled (some 400 specimens from about 20 sites). Rarely a thin, transverse line is developed instead, usually not completely crossing wing. The moth is very similar to the unbanded form of *A. singulella*, differing by the shorter antennae, slightly broader, more rounded appearing forewing, and by lack of white on the costa.

Geographical distribution.—Semi-arid parts of California and southern Nevada; east side of the Coast Ranges from Colusa County southward, southern end of the Sierra Nevada, the desert ranges east of the Sierra Nevada into Nye County, both cis- and transmontane sides of the Transverse and northern Peninsular Ranges to Riverside County.

Flight period.—Beginning of March to April at lower elevations to mid-May in the interior mountains.

Oviposition site.—Unknown; the moths have been observed in close association with *Gilia tricolor* and *G. scopulorum* (Polemoniaceae) at several widely scattered stations.

INCURVARIINAE

CHALCEOPLA Braun

Chalceopla Braun, 1921, *Proc. Acad. Nat. Sci., Phila.*, 73:20.

Cyanauges Braun, 1919, *Ohio J. Sci.*, 20:24 (Preocc.).

Type.—*Incurvaria cyanella* Busck, 1915 (eastern U. S.).

CHALCEOPLA SIMPLICIELLA (Walsingham), **new combination**

Adela simplicella Walsingham, 1880, *Proc. Zool. Soc. Lond.*, :81, pl. 11; Walsingham, 1890, *Insect Life*, 2:284; Meyrick, 1912, *Lepid. Cat.*, 6:12.

Type data.—Southern Oregon, May, 1872, types in British Museum.

Taxonomic discussion.—My recognition of this species is based on one specimen in the U. S. National Museum, from Rouge River, Oregon, collected by Walsingham and identified by him as *simplicella*. It was compared, along with specimens of *Adela oplerella*, with the type at the

British Museum for me by R. W. Hodges, in 1963. I had considered the possibility that the latter species might be *simpliciella*, owing to the similar antennal lengths, but *simpliciella* is quite distinct, not *Adela*, and is congeneric with *Chalceopola cyanella*, according to D. R. Davis. I have recently collected *C. simpliciella* in Del Norte County, California, and it is similar to two other Californian species, but distinct, based on characters of the male genitalia. By contrast with *Adela*, members of *Chalceopola* possess elaborate interspecific genitalic features.

Geographical distribution.—Southern Oregon and extreme northern California.

Flight period.—May (Oregon); July at 4500 feet elevation in northern California.

Oviposition site.—Unknown; two related, apparently undescribed, species in California oviposit in young pods of *Arabis glabra* (Cruciferae) and *Erysimum capitatum* (Cruciferae), and each is host specific, according to observations at several localities.

CHECKLIST OF NEARCTIC ADELINAE

NEMOPHORA Hoffmannsegg, 1798

bellela (Walker, 1863)

bellella Walsingham, 1890

belleta Anderson, 1915

ADELA Latrielle, 1796

bella Chambers, 1873

chalybeis Zeller, 1873

iochroa Zeller, 1877

aeruginosella Walsingham, 1890

ridingsella Clemens, 1864

corruscifasciella (Chambers, 1873)

schlaegeri Zeller, 1873

purpurea Walker, 1863

biviella Zeller, 1873

trigrapha Zeller, 1875

trifasciella Chambers, 1876

fasciella Chambers, 1876

eldorada Powell, 1969

flammeusella Chambers, 1876

flammansella Chambers, 1878

flamensella Walsingham, 1880

lactimaculella Walsingham, 1880

flammeella Meyrick, 1912

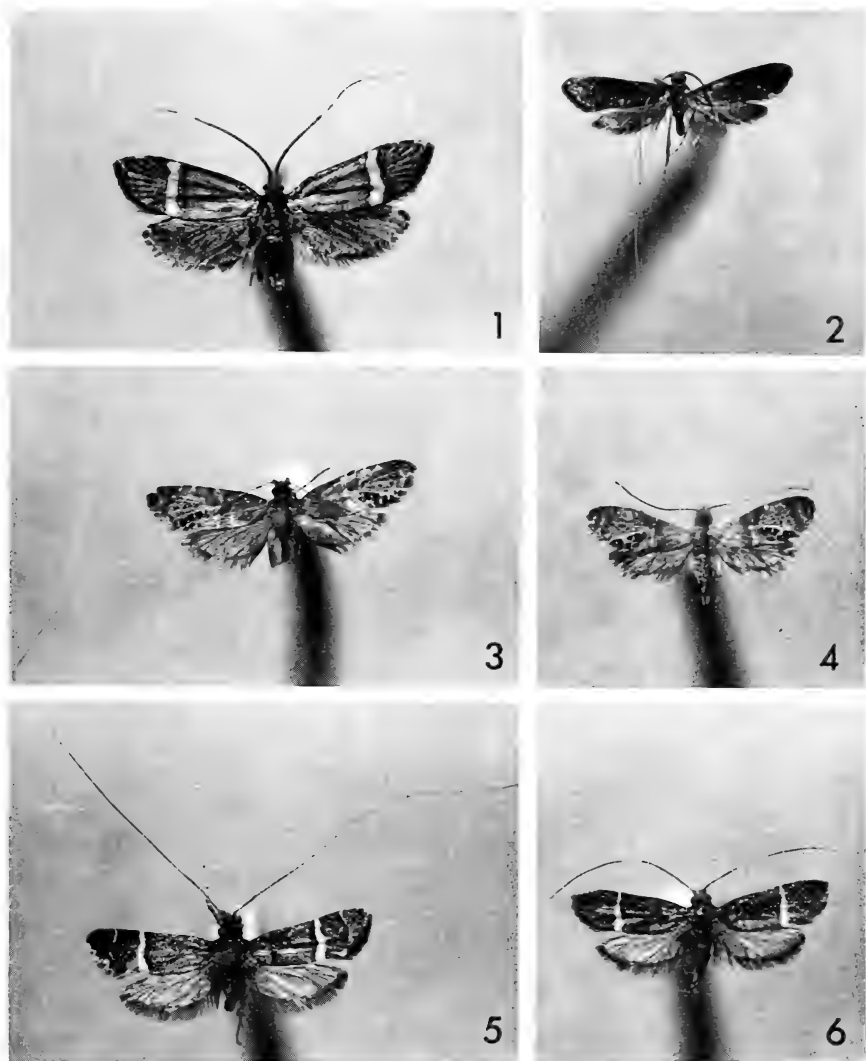
thorpella Powell, 1969

oplerella Powell, 1969

septentrionella Walsingham, 1880

singulella Walsingham, 1880

punctiferella Walsingham, 1890

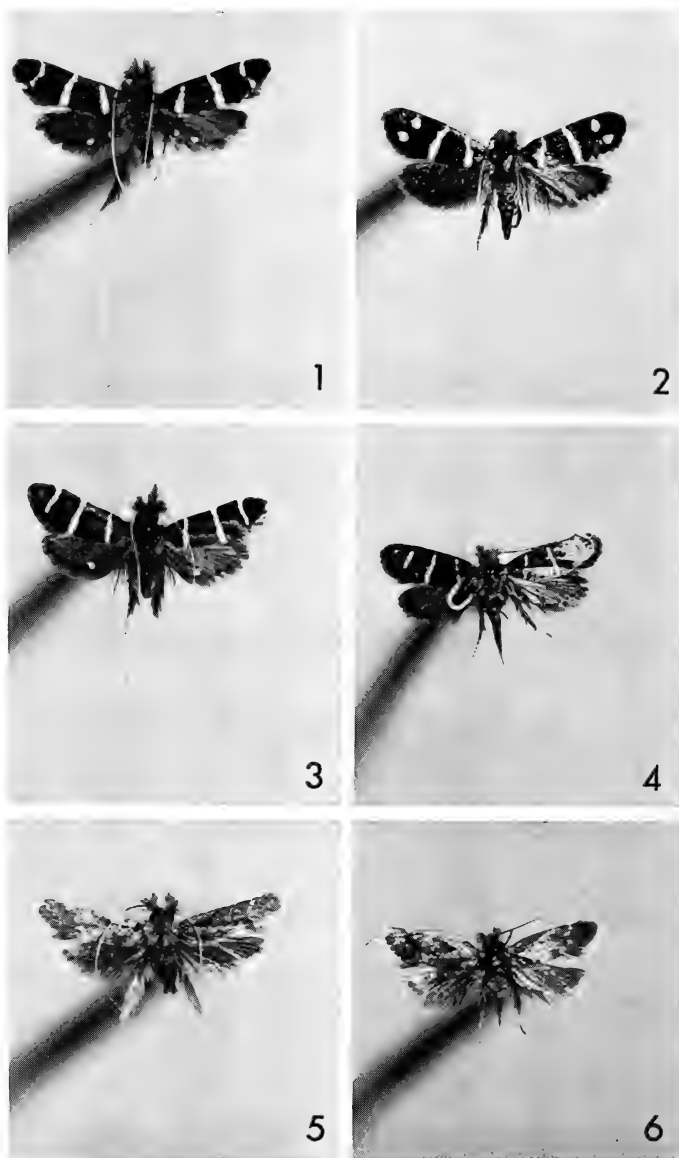


EXPLANATION OF PLATE 1

Figs. 1-6, adults of adelid moths.¹

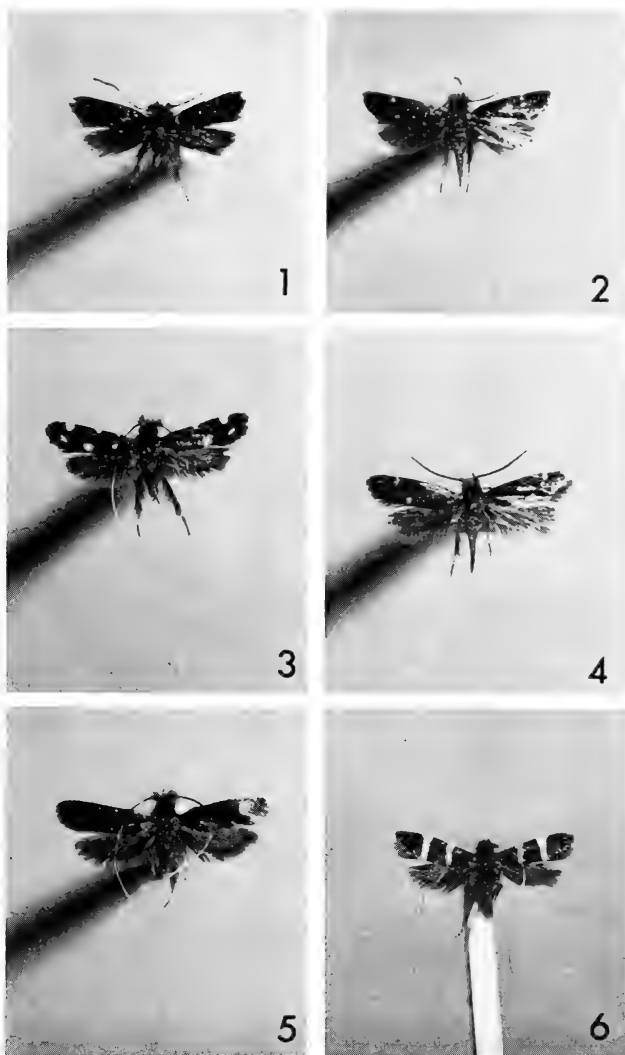
- 1, *Nemophora bellela* (Walker), ♂, Dawson, Yukon, VI-30-49 (W. W. Judd).
- 2, *Adela bella* Chambers, ♂, Anglesea, N. J., V-30 (W. D. Kearfott).
- 3, *A. ridingsella* Clemens, ♂, Lac Mondor, Ste. Flor, Que., VI-22-51 (E. Munroe).
- 4, *A. ridingsella*, ♀, Merivale, Ont., VI-21-43 (G. S. Walley).
- 5, *A. purpurea* Walker, ♂, Constance Bay, Ont., IV-30-33 (G. S. Walley).
- 6, *A. purpurea*, ♀, Merivale, Ont., V-3-38 (T. N. Freeman).

¹ Photographs of the moths are reproduced at approximately $2.3 \times$ natural size.



EXPLANATION OF PLATE 2

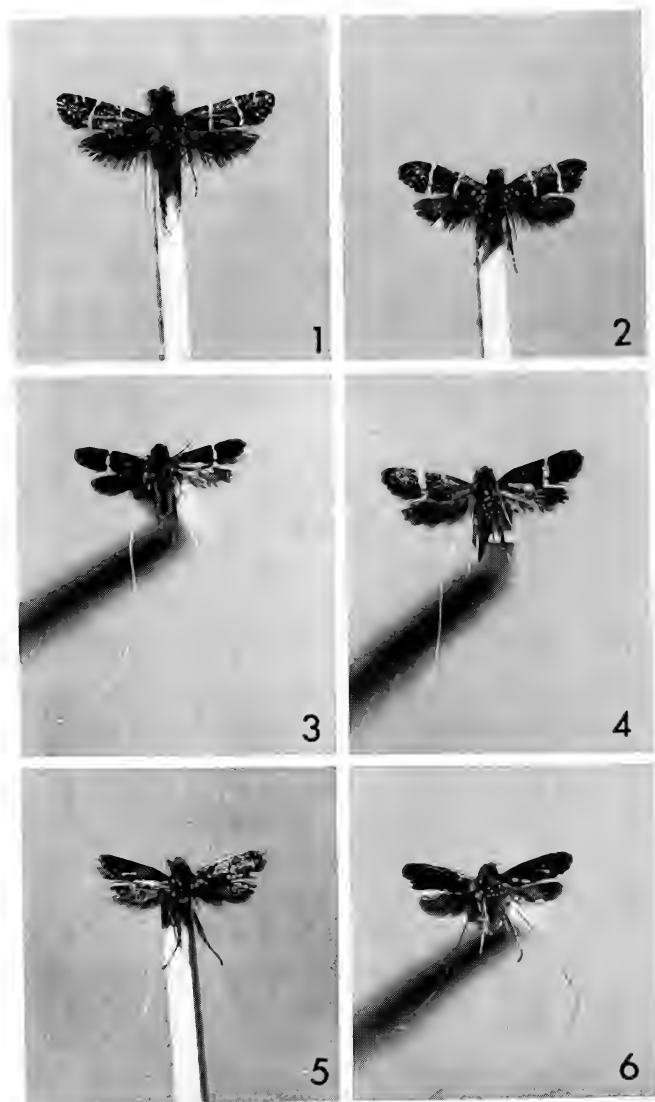
- 1, *A. eldorada* Powell, ♂ holotype, 1 mi. E Woody, Kern Co., Calif., V-3-64.
- 2, *A. eldorada*, ♀ allotype, same data.
- 3, *Adela trigrapha* Zeller, ♂, 9 mi. N Upper Lake, Lake Co., Calif., IV-4-62.
- 4, *A. trigrapha*, ♀, Russelman Park, Contra Costa Co., Calif., V-5-57 (J. Powell).
- 5, *A. thorpella* Powell, ♂, 1 mi. S El Verano, Sonoma Co., Calif., III-25-64 (Thorp).
- 6, *A. thorpella*, ♀, Russelmann Park, Contra Costa Co., Calif., IV-9-58 (J. Powell).



EXPLANATION OF PLATE 3

Figs. 1-6, adults of adelid moths.

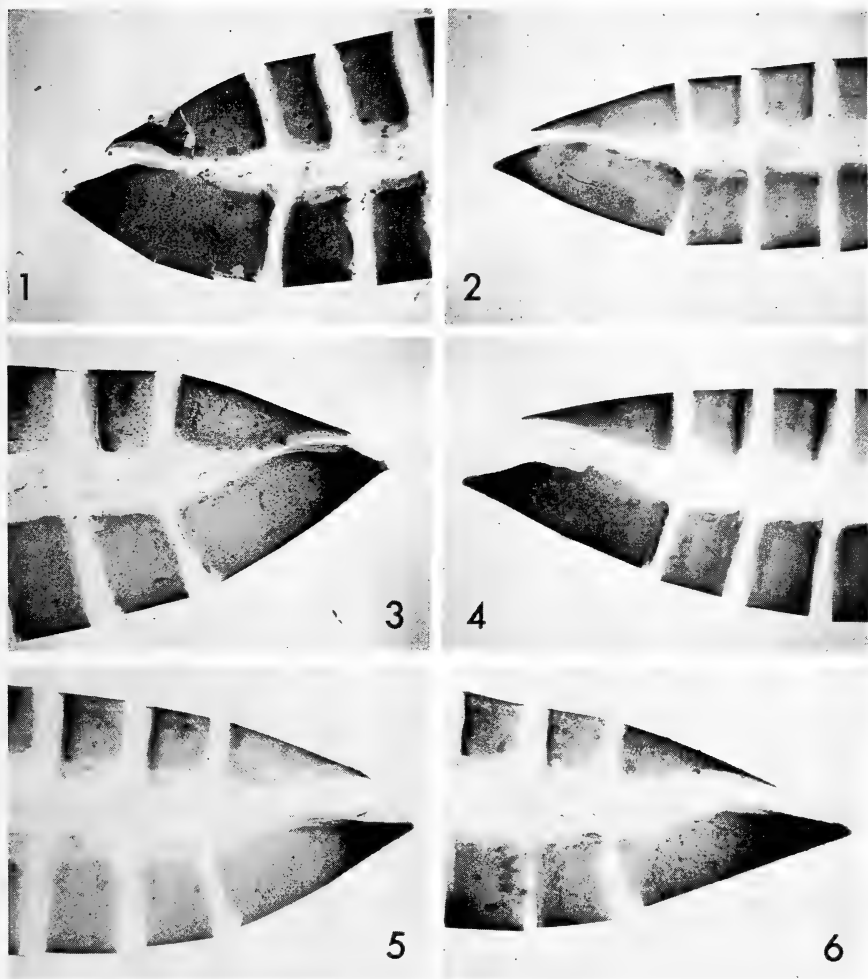
- 1, *Adela oplerella* Powell, ♂, 1 mi. N New Almaden, Santa Clara Co., Calif., IV-4-65 (P. A. Opler).
- 2, *A. oplerella*, ♀, same data, III-29-65.
- 3, *A. flammeusella* Chambers, ♂, 2 mi. SE Upper Lake, Lake Co., Calif., V-11-61.
- 4, *A. flammeusella*, ♀, Silver Cr. hills, Santa Clara Co., Calif., IV-20-62 (J. Powell).
- 5, *A. flammeusella*, ♂, Cool, El Dorado Co., Calif., IV-24-61 (J. Powell).
- 6, *A. septentrionella* Walsingham, ♂ aberrant, 2 mi. W. Fairfax, Marin Co., Calif., IV-17-61 (J. Powell).



EXPLANATION OF PLATE 4

Figs. 1-6, adults of adelid moths.

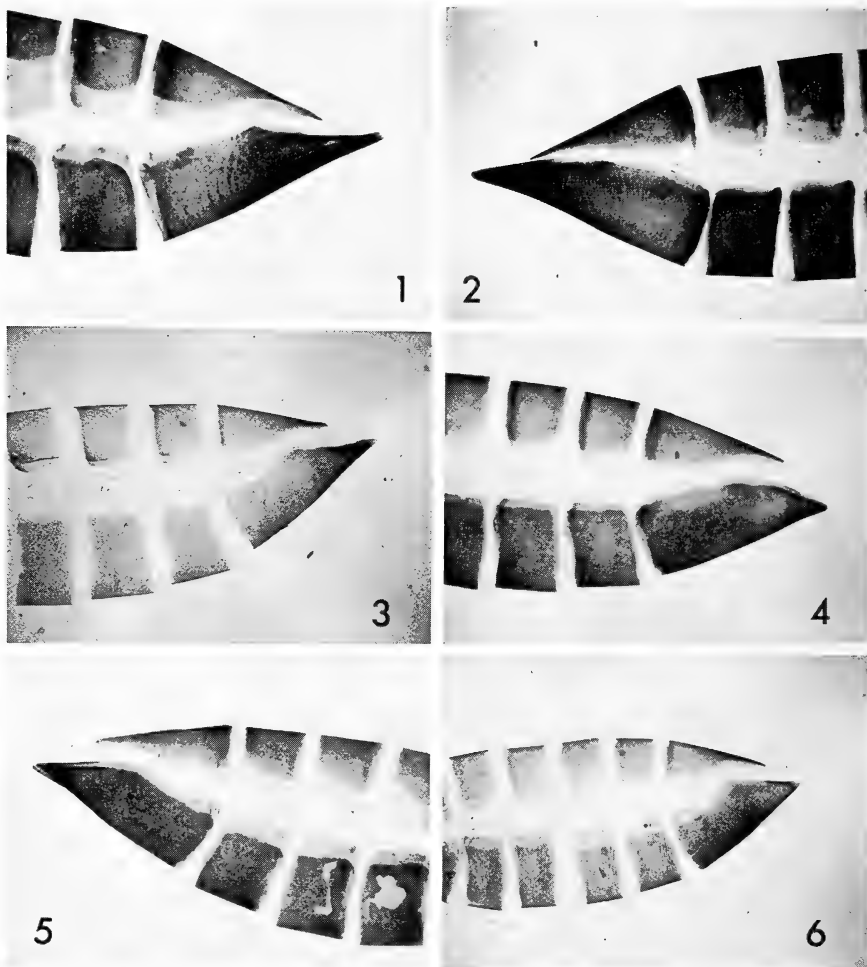
- 1, *Adela septentrionella* Walsingham, ♂, 2 mi W Fairfax, Marin Co., Calif., IV-17-61.
- 2, *A. septentrionella*, ♀, same data.
- 3, *A. singulella* Walsingham, ♂, 5 mi. SW Ukiah, Mendocino Co., Calif., V-22-60 (S. F. Cook, Jr.).
- 4, *A. singulella*, ♀, 7 mi. E Conn Dam, Napa Co., Calif., VI-5-64 (J. Powell).
- 5, *A. singulella*, ♂, La Panza Campgr., S. L. O. Co., Calif., IV-29-62 (R. W. Thorp).
- 6, *A. punctiferella* Walsingham, ♂, 5 mi. S Sage, Riverside Co., Calif., IV-16-65.



EXPLANATION OF PLATE 5

Figs. 1-6, terminal abdominal segments of female adelid moths.

- 1, *Nemophora bellela* (Walker), Swim Lakes, Yukon, 3200', VI-13-60 (E. W. Rockburne) (JAP prep. 2641).
- 2, *Adela ridingsella* Clemens, Merivale, Ont., VI-21-43 (Walley) (JAP prep. 2642).
- 3, *A. purpurea* Walker, Lac Mondor, Ste. Flore, Que., V-11-51 (E. Munroe) (JAP prep. 2638).
- 4, *A. trigrapha* Zeller, Alpine Lake, Marin Co., Calif., IV-25-58 (J. Powell) (JAP prep. 1806).
- 5, *A. eldorada* Powell, 1 mi. E Woody, Kern Co., Calif., V-3-64 (J. Powell) (JAP prep. 1795).
- 6, *A. flammeusella* Chambers, 3 mi. NW Middletown, Lake Co., Calif. IV-15-64 (L. D. Thurman) (JAP prep. 1791).



EXPLANATION OF PLATE 6

Figs. 1-6, terminal abdominal segments of female adelid moths.

- 1, *Adela thorpella* Powell, 1 mi. SW Lakeport, Lake Co., Calif., IV-24-63 (R. W. Thorp) (JAP prep. 1802).
- 2, *A. oplerella* Powell, 5 mi. SE Nicasio, Marin Co., Calif., IV-30-67 (P. A. Opler & W. J. Turner) (JAP prep. 2634).
- 3, *A. septentrionella* Walsingham, 2 mi. W Fairfax, Marin Co., Calif., V-13-66 (J. Powell) (JAP prep. 2632).
- 4, *A. singulella* Walsingham (typical), 7 mi. E Conn Dam, Napa Co., Calif. VI-12-64 (J. A. Chemsak) (JAP prep. 1816).
- 5, *A. singulella* (unbanded), 1 mi. S Mather, Tuolumne Co., Calif., VI-12-61 (G. I. Stage) (JAP prep. 1818).
- 6, *A. punctiferella* Walsingham, 4 mi. NW Lodoga, Colusa Co., Calif., IV-12-62 (J. Powell) (JAP prep. 2643).

ACKNOWLEDGMENTS

Several persons have helped considerably with the development of this study. J. A. Chemsak of this department made a search for Chambers types at Harvard and for *Adela* at other institutions which I was not later able to visit. R. W. Hodges, of the U. S. National Museum, compared some of my specimens with Walsingham types at the British Museum (Natural History) during his visit there in 1963. D. R. Davis provided helpful comments on relationships among incurvariid genera, as well as an opportunity to study U. S. National Museum material. Microphotographs of female abdominal pelts were executed by H. V. Daly of this department.

Acknowledgment is also made to the following whose cooperation enabled use of institutional collections in their care: A. B. Klots and F. H. Rindge, American Museum of Natural History; P. H. Arnaud, Jr., and C. D. MacNeill, California Academy of Sciences, and to the latter for considerable effort in the field; H. K. Clench, Carnegie Museum, Pittsburgh; T. N. Freeman, Canadian National Collection, Ottawa; L. M. Martin and C. L. Hogue, Los Angeles County Museum; and P. J. Darlington, Museum of Comparative Zoology, Harvard.

Much of the distributional and seasonal information is attributable to a number of persons who made special efforts in collecting *Adela* for this project, mostly as tangents to interests in disciplines other than Lepidoptera, while students at the University of California. Among these I would particularly like to thank: D. J. Burdick, Fresno State College; J. A. Chemsak; W. E. Ferguson, San Jose State College; R. L. Langston, Berkeley; P. A. Opler and D. C. Rentz, University of California, Berkeley; G. I. Stage, U. S. National Museum; C. A. Toschi (Mrs. M. J. Tauber), Ithaca, New York; R. W. Thorp, University of California, Davis; and L. D. Thurman, then of the Department of Botany, University of California, Berkeley.

A. J. Slater helped with biological observations, while he was an assistant on National Science Foundation grant GB-4014, which also provided support for some of my field work. A portion of the publication cost has been supplied by N.S.F. grant GB-6813X.

Finally, a special note of appreciation is due Helen K. Sharsmith, University of California, Berkeley, Herbarium, who has willingly provided identifications for hundreds of plant collections during the past several years, a good portion of which were made in connection with this study during the time I was trying to narrow down flower visitation records to the few involved in oviposition. Dr. Thurman also assisted by rendering identifications of various *Orthocarpus*.

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BOOK REVIEW

THE MOTH BOOK, a Guide to the Moths of North America, by W. J. Holland. xxiv+479 pp., & 48 plates in color. Reprint ed., 1968, Dover Press, 180 Varick St., New York. \$5.00, paperback.

Although lepidopterists have long condemned *The Moth Book* as incomplete and obsolete, no replacement manual has been forthcoming, and both amateurs and professionals still find Holland's work a useful reference. Inasmuch as it has been out of print for many years and has demanded increasingly inappropriate prices by book dealers, the reprint edition should find instant popularity.

In this edition Holland's text is reprinted unabridged and unaltered except for correction of a few typographical errors. It has been supplemented by a series of footnotes by A. E. Brower, of Augusta, Maine, which clarify some nomenclatural discrepancies and taxonomic errors according to present usage. As indicated by Brower in a forward, a thorough revision of the text would have required an enormous amount of work by a number of specialists. However, it is a shame that at least up-to-date generic assignments could not have been given, for example simply as duplicate explanations of plates. This would have required relatively little work by a few specialists. It would have been a simple matter to list combinations as given in McDunnough's Checklist or in more recent revisions, such as Michener's 1953 classification of the Saturniidae and Engelhardt's 1946 treatment of the aegeriids (MacKay's 1968 revision having not yet been published).

The situation is compounded somewhat in the micros, since Brower's footnotes in groups like the Noctuidae presumably are more comprehensive. For example, *Croesia semipurpurana* (Kearfott), misidentified as *albicomana* Clemens by Holland, has been emended to the correct species by Brower, but has been left in *Tortrix*, although *Tortrix* was restricted and *Croesia* resurrected by Obraztsov in 1955. Similarly, in other tortricids (Plate 48), the moth called *Platynota flavedana* Clemens (fig. 24) looks more like an olethreutine, such as *Hedia* or *Apotomis*; the female shown in fig. 32 probably is *Archips purpuranus* (Clemens), not *Choristoneura rosaceana* (Harris); *macrocarpana* Walsingham (fig. 26) should be referred to *Henricus*, *alisellana* Robinson (fig. 39) to *Argyrotaenia*, the species in fig. 40 is a member of the *inconditana* complex, not *tunicana* Walsingham, and it should be referred to *Sparganothis*.

Mechanically the Dover edition is excellent. The color on the whole is good, not as good as the original edition, but better for many plates than some of the subsequent editions I have seen. The text, reproduced on a $6\frac{1}{2} \times 4$ inch bed (about $7\frac{1}{4} \times 5\frac{1}{2}$ inch for the plates), is clear throughout. The paper is opaque with minimal show-through and is advertised to not discolor or become brittle with age. The pages are sewn in signatures, not glued individually as in many paperbacks; thus the book will open flat for easy reference and is readily available for permanent binding.

The Dover Press is to be congratulated on having issued this edition at a reasonable price, making Holland's popular work again available to students and the general public.—JERRY A. POWELL, *University of California, Berkeley*.

CACTUS-FEEDING INSECTS AND MITES, by John Mann. U. S. National Museum, Bulletin 256; x + 158 pp. & 8 halftone plates. Smithsonian Inst., Washington, D. C., 1969; \$1.25, paper cover.

This publication deals with the species believed to be restricted to the family Cactaceae. Included are about 50 pyralids, mostly Phycitinae, half a dozen miscellaneous micros, and one butterfly, "*Thecla*" *melanis* Drury. Scavenger moths, flower

visitors, and incidental associates have been omitted. The text places on record information from the extensive investigations by and bibliography of the Commonwealth Prickly Pear Board and the Queensland Department of Lands, whose domestic and overseas fieldwork was conducted during 1921-1939 and 1958-1959.—ED.

A REVISION OF THE MOTHS OF THE SUBFAMILY GEOMETRINAE OF AMERICA NORTH OF MEXICO (Insecta, Lepidoptera), by Douglas C. Ferguson. Peabody Museum of Natural History, Yale University, Bulletin 29; iii + 251 pp. & 41 line drawings & 8 halftone plates. Yale U., New Haven, 1969; paper cover.

A classification based largely on male and female genitalia and on larval characters, of some 75 species distributed in 15 genera and 5 tribes. Of these, four tribal names, two genera, and 10 species are proposed as new. Some larval information is available on 32 species in 11 genera, and this information is used to support the tribal classification. Material from most of the major collections of North America except some of the western ones was employed. It is indeed a pity that our economic values force the moths of this group to be figured in black and white.—ED.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

A.(n.s.)84

ANNOUNCEMENT

Required six-month's notice is given on possible use of plenary powers by the International Commission on Zoological Nomenclature in connection with the following names listed by case number. (see, *Bull. zool. Nomencl.* 26, pt. 1, 12th May 1969):

- 1848. Suppression of *Papilio sebrus* Huebner, 1824/26 (Insecta, Lepidoptera).
- 1869. Type-species for *Physothrips* Karny, 1912 (Insecta, Thysanoptera).
- 1870. Suppression of two works by J. Muller, 1826 & 1828.
- 1871. Type-species for *Xyletinus* Latreille, 1809 (Insecta, Coleoptera).

Comments should be sent in duplicate, citing case number, to the Secretary, International Commission on Zoological Nomenclature, c/o British Museum (Natural History), Cromwell Road, London, S.W.7, England. Those received early enough will be published in the Bulletin of Zoological Nomenclature.—W. E. CHINA, Assistant Secretary, May 1969.

LARVAL BEHAVIOR OF *AGATHYMUS*, INCLUDING A
DIVERGENT GROUP IN BAJA AND SOUTHERN
CALIFORNIA (MEGATHYMIDAE)

DON B. STALLINGS¹ AND VIOLA N. STALLINGS

Caldwell, Kansas

This is the first of a series of papers based on our studies of the immature stages of the Megathymidae. Particular consideration is given to the first and last larval instars, as we find significant characters and behavior patterns in many instances in these instars at both the species level and at higher levels.

By 1965 we had made studies in the field of the larvae of all of the described species of *Agathymus* except *indecisa* (Butler & Druce), *escalantei* Stallings, Turner & Stallings, *stephensi* (Skinner), *comstocki* (Harbison), and *dawsoni* Harbison.

Our studies covered all of the species observed in the final instars and about half of the species in the first instar. Some of our observations have been recorded for individual species in our previous papers. From these observations we reached the following conclusions in regard to larval behavior of *Agathymus*.

1. Newly emerged larvae proceed to the upper portion of the leaf and bore in to commence feeding activities. We noted that the fiber portion of the leaf was regurgitated by the larvae. After a few days the larvae leave this feeding cavity and proceed towards the leaf base where they either again enter the leaf to feed, or transfer to another plant. In many instances after making the second entry they may come out and reenter the plant for a third time or transfer to another plant. If the plant produces too much fluid in the larval cavity the larvae may be overwhelmed and die, and if too little fluid is produced the larvae will suffer from lack of food. The larvae feed on the fluid of the plant; this is evident from the small size of the cavity. The pulp removed seems to be insufficient to have produced the larvae.

2. When the larvae have made their final entry they form a tube-like cavity parallel with the length of the leaf (see plate I, figures 1-4). In some species the cavity is in a single leaf; in other species the cavity may involve more than one leaf; and in some instances the cavity may extend into the caudex of the plant. All species form a tube-like cavity, but each species usually has its own particular variation of the cavity. While cavities are usually at the base of the leaf, some species place them lower than

¹ The research for this paper was made possible to a large degree by Research Grant #GB 1190 from the National Science Foundation, made available to the first named author.

others, and some place the cavity towards the edge of the leaf while others place it near the center. The cavity is enlarged as the larvae grow. A tiny hole is made to the outside from the upper part of the cavity, through which frass is expelled. Some species place this hole on the upper side of the leaf, others on the underside, and some may place it on either side. During this period the interior of the cavity is bright red. Shortly before pupation the larvae produce a white, waxy powder and cover the interior of the larval cavity so that it appears to be white. At the same time the excrement hole is enlarged to provide an exit for the adults when they emerge. The exits are covered with silk "trap-doors." Most species have their own particular color, shape and texture for the trap-doors.

As a result of variation of the above mentioned characters from species to species, nearly every species of *Agathymus* can be identified in the field during its larval period, and in many instances can be identified from the larval cavity after it has been abandoned. Nearly all species of *Agathymus* use only one species of *Agave* as a food plant. (Note that *Aegiale* does not powder the cavity, see plate II, figure 4).

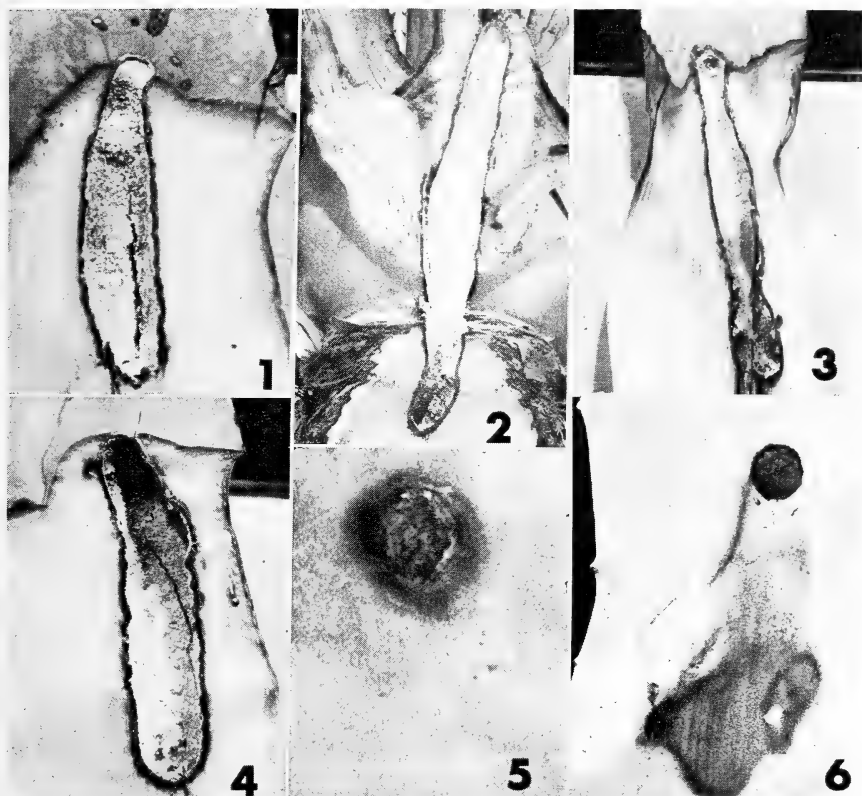
3. Normally the activities of the larvae in the final larval cavity do not damage the plant to the extent that there is visible evidence from the outside. The only evidence of the infestation is the tiny excrement hole, or later the trap-door (see plate I, figure 5). In contrast, the activities of the larvae of the related genus *Aegiale* cause so much injury around the excrement holes that the leaves turn brown in those areas (see plate II, figure 5).

4. When an *Aegiale* enlarges the excrement hole and builds its trap-door it makes a substantial silk "collar" around the exit hole before building the trap-door. *Agathymus* does not build this collar.

5. Unlike other genera of the Megathymidae, the *Agathymus* do not glue their ova to the leaves of the food plant, instead they drop their ova among the leaves of the food plant where they lodge or fall out onto the ground.

In June of 1965 we had the opportunity to make field studies of *A. stephensi* (Skinner) in San Diego County, California near Jacumba, and at the type locality on the old Stephen Ranch. We had been in the field at Jacumba only a few minutes when we both paused to exclaim "Looks like *Aegiale*." For most of the infested plants were showing distinct discoloration around the excrement holes, unlike any *Agathymus* that we had previously examined (see plate I, figure 6).

When we exposed a larval cavity we found a second major difference from other *Agathymus*. At the upper end of the cavity there was a distinct lateral bulge (see plate II, figure 1). For more figures of the larval cavity



EXPLANATION OF PLATE I

1-4, Larval cavities of *Agathymus*. 1, *A. aryxna* (Dyar), Chiricahua Mts., Arizona. 2, *A. micheneri* Stall., Turn., & Stall., Saltillo, Coahuila, Mexico. 3, *A. judithae* (Stall. & Turn.), Hueco Mts., Texas. 4, *A. aryxna*, Peloncillo Mts., New Mexico. 5-6, Trapped doors of *Agathymus*. 5, *A. carlsbadensis* (Stall. & Turn.), Guadalupe Mts., New Mexico. 6, *A. stephensi* (Skinner), Stephens Ranch, La Puerta Valley, California.

of *stephensi* see (Comstock and Dammers, 1934). In the area of this bulge the cavity extended to just below the surface of the leaf, much closer to the surface than the remainder of the cavity.

Our first thought as to the reason for this bulge was that the larvae of this species were not as agile as other members of the genus and needed a turn-around area in order to reverse their position in the cavity. However a careful study of a large number of larval cavities disclosed that in more than half of them the bulge area was not large enough to be used for this purpose, at least not in the last instars.

We noted that while *stephensi* cut excrement holes on either side of

the leaves, about 80% were on the upper side. There was a strong tendency for the cavity bulge to be to the right of the excrement hole when on the upper side of the leaf and to the left when on the under side of the leaf (*i.e.*, to the right or left of the observer facing the side of the leaf with the excrement hole). In a few instances we found little evidence of the bulge.

A third difference that we noted was that the amount of waxy powder covering the cavity interior was reduced so that the red of the cavity showed through so as to appear slightly pinkish.

We visited Charles F. Harbison at San Diego, California, who had taken us to visit the *stephensi* type locality. He let us examine a number of leaves of *Agave* that had been infested by *A. comstocki* (Harbison), which he had described from Baja California, Mexico. Again, we found major differences in the larval cavity:

1. The larvae had formed discoid cavities, with the circular dimension being parallel with the leaf (see plate II, figures 2 & 3). In the other *Agathymus* the circular dimension of the larval cavity is perpendicular to the length of the leaf.

2. There was only a minute amount of white waxy powder, and this was concentrated around the exit hole and adjacent area.

3. The exit hole had a silk collar similar to that of *Aegiale* but not as prominently developed.

4. The leaves exhibited discoloration around the exit hole similar to that of *Aegiale* and *stephensi*.

Mr. Harbison indicated to us that a second Baja California species, *A. dawsoni* Harbison, has the same general characters as those described above for *comstocki*.

From the foregoing it is evident that the *Agathymus* occurring in southern California and southward into Baja California has distinctive differences in larval habits from other *Agathymus*. In these and in morphological characters they appear to represent a distinctive group within *Agathymus*. While this group of species of *Agathymus* is distinct from *Aegiale* they do show more characters in common with *Aegiale* than do other members of the genus *Agathymus*.

Since the discovery of this situation we have speculated as to the adaptive significance for these differences and have discussed this with other biologists. Dr. C. D. Michener suggested that since the area occupied by *comstocki* and *dawsoni* is more arid than the locales of other *Agathymus*, there may be some moisture-conserving advantages in the discoid larval cavity. Dr. C. L. Remington pointed out that a sphere is the strongest "anti-collapse shape" which could become important in ex-



EXPLANATION OF PLATE II

1-4, Larval cavities of *Agathymus*. 1, *A. stephensi* (Skinner), Stephens Ranch, La Puerta Valley, California. 2-3, *A. comstocki* (Harbison), 2 mi. NE San Simon, Baja California, Mexico. 4, *Aegiale hesperiaris* (Walker), Casa Blanca, Nueva Leon, Mexico. 5, Trap-door, *A. hesperiaris* (Walker), Casa Blanca, Nueva Leon, Mexico.

tremely arid habitats. In this respect it will be noted that in *comstocki* and *dawsoni* the circular dimension is the major dimension, while in the other *Agathymus* it is the minor dimension. We have wondered if the leaves of the food plants of *comstocki* and *dawsoni* are structured

so that there is only a small, localized area that is suitable for the feeding, and therefore the cavity is disc-shaped in order to encompass more of the suitable feeding area.

Another reason for this difference in larval cavity construction could be that in each case the shape of the larval cavity represents the easiest way to construct a cavity that will produce sufficient food. In most *Agave* the leaves have tough fibers running the length of the leaves. In constructing the tube-like cavity, less of the fibers would be intersected, hence this cavity would be easier to construct, as less of the fibers would have to be cut. However, in the more arid locales, such as Baja California, this tube-like cavity could be unsatisfactory, since it would at the same time intersect less of the plant fluids that flow through the length of the leaf. The discoid cavity would intersect more of the plants fluids, which could be necessary in order for the Baja California populations to survive. If the foregoing is true it would not be unexpected to learn that the mouth-parts of the Baja California larvae are differently developed than the mouthparts of the populations that construct the tube-like cavities.

Harbison was familiar with the fact that first instar *Agathymus* go to the tip of the leaf to do their initial feeding. He advises us that he has made repeated examinations of plants infested with *comstocki* and *dawsoni* for evidence of this larval entry site, but has not found any such indications. Perhaps the larvae of *comstocki* and *dawsoni* enter the plant but once and form the discoid cavity. If this is true then we can speculate as to what *stephensi* is doing.

If *stephensi* represents a northern extension of the group which form discoid larval cavities but has moved into an environment in which the tubular cavity is more adaptive, the first instar larva of *stephensi* may enter the leaf like its Baja California relatives and form a small discoid cavity. At this stage *stephensi* would diverge from its relatives and thereafter resemble the rest of the *Agathymus* species, as it moves to the right or left, as the case may be, of the initial small discoid cavity and proceeds to build a tubular cavity. Thus, it would produce the bulge in a tubular cavity that we in fact observed in *stephensi*.

While the foregoing is speculation, we feel that it has ecological and evolutionary interest. We hope that lepidopterists in southern California will make some field studies which would either prove or disprove this idea. Such studies would be rather simple to conduct and could be completed in one or two seasons.

The larval biologies of *A. escalantei* Stallings, Turner & Stallings and *A. indecisa* (Butler & Druce) are still unknown.

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COLLECTING AND OBSERVING *THYMELICUS LINEOLA* FORM
"PALLIDA" (HESPERIIDAE) IN NEW JERSEY

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Since the discovery of *Thymelicus lineola* Ochsenheimer in Ontario in 1910, this butterfly has become distributed over most of the north-eastern United States. In many localities it has become abundant; however, no recent paper mentions the capture of the form "pallida." The first individual of "pallida" collected at Lakehurst, New Jersey was on July 1, 1967 by B. Ziegler and myself. Strangely, this site is about the last one in the area where *lineola* has established itself.

Dr. and Mrs. dos Passos and I went to this locality June 21, 1968 to search for this pale skipper. The collecting site is about 15 acres of grassland bordered on three sides by highways and on the other by woods. Several small patches of milkweed (*Asclepias*), dogbane (*Apocynum*), and daisies (*Compositae*) are found there. At this time only about a tenth of all the flowers were in bloom. Individuals of *I. lineola* were swarming over the whole area. Wherever there was a milkweed in bloom as many as a dozen individuals could be found feeding. Not a single "pallida" was found among them; I did not catch a single individual on milkweed. The first "pallida" were caught on dogbane and among grasses. Mrs. dos Passos then noted that the "pallida" were easily distinguishable when visiting the composite flowers, since most were feeding with expanded wings. Taking her advice we collected thirty specimens in two hours. When their wings are folded it is more difficult to identify "pallida" since the underside of normal *lineola* is also pale. The difference is also evident with individuals in flight.

It is characteristic of *pallida* not to mingle with normal *lineola*. They have never been seen flying or feeding together but were caught singly and always at some distance from typical *lineola*. A similar observation was reported by Clench (Lepid. News, 1948, 2: 105), who stated "pallida was never observed in the areas where *lineola* was most common, but rather seemed to appear only in areas of lesser abundance."

I retained eight females alive for oviposition. These, with several males, were kept in a large screen cage with a flower pot of witch or quack grass, *Agropyron repens* L., and a jar with daisies and clover for nectar. Kneeling in front of the cage with a large magnifying glass I searched for eggs for two days without finding any. Repeating this unsuccessfully on the third day I decided to kill the females, which appeared to be in excellent condition. Later I noticed that their abdomens appeared thinner than when put in the cage, and therefore I reexamined the pot of grass carefully. To my surprise I found one egg on a dead oak leaf on the bottom of the pot and then a dozen more in the folds of dead grass leaves lying on the bottom. Only one egg was oviposited on a green blade of grass. Working my way up to the top of the thick, hollow grass stems I found the tips had cracks where I had cut them with a dull knife because they were too long for the cage. Only by pressing on these tips could the two-inch long cracks be noticed. In two of these cracks most of the eggs were deposited in long rows. In one I found 30 eggs and in another 25. About seventy eggs were found where none could be seen at first. Probably more eggs would have been oviposited if the females had been kept alive longer. How they were able to lay their eggs inside the grass stems through the almost invisible cracks is a puzzle to me.

We were so preoccupied with collecting adults "*pallida*" that we did not look for eggs in the field. Pengelly (1965, Proc. Entomol. Soc. Ont. 95 (1964): 102) reports that among various species of grasses collected in the field, most eggs of *T. lineola* were found on redtop (*Agrostis alba* L.), and timothy (*Phleum pratense* L.) and were deposited under the blades of grass where they enclose the stem between the three lowest nodes. According to my observations in New Jersey, "*pallida*" has slightly different ovipositing habits than typical *T. lineola*. Most "*pallida*" eggs were found in the uppermost parts of the stem; none were found below between the nodes of the grass.

Thymelicus lineola "*pallida*" eggs are white, smooth and elongate. For several weeks and almost full-grown larva with large head could be seen through the egg's hole, giving the impression of an early emergence, but like typical *lineola*, they hibernate in the egg stage.

SEASONAL VARIATION OF *COLIAS CESONIA THERAPIS* IN VENEZUELA (PIERIDAE)

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Colias cesonia (Stoll), with its various subspecies, is found throughout Tropical America from northern Argentina to the United States. The subgenus *Zerene* Hubner, to which *cesonia* belongs, seems to be tropical in origin and is found throughout the Neotropics at low elevations. The subgenus *Colias* Fabricius, on the other hand, is worldwide in distribution but is confined to high elevations in the Andes in the equatorial regions of South America. *Colias cesonia therapis* (Felder & Felder), like many of the other *C. cesonia* subspecies, is strikingly different in appearance from the nominate race (figure 1). *C. c. therapis* inhabits the coastal mountain range of Venezuela.

My first experience in collecting *C. c. therapis* was during the dry season (March 1965) at the Henry Pittier National Park, Aragua, Venezuela. The butterflies were swarming at flowering *Lantana* on dry slopes at an elevation of about 1,000 feet. All of the *C. c. therapis* captured had a strong roseate suffusion on the ventral surface of both wings, a character similar to that found in the form "rosa" M'Neill of Nearctic *Colias cesonia cesonia* populations.

Since that time I have received series of the butterfly from the same location taken throughout the year by Señor Francisco Romero of Maracay, Venezuela. Study of these additional specimens showed that at certain times of the year the roseate suffusion predominates while at

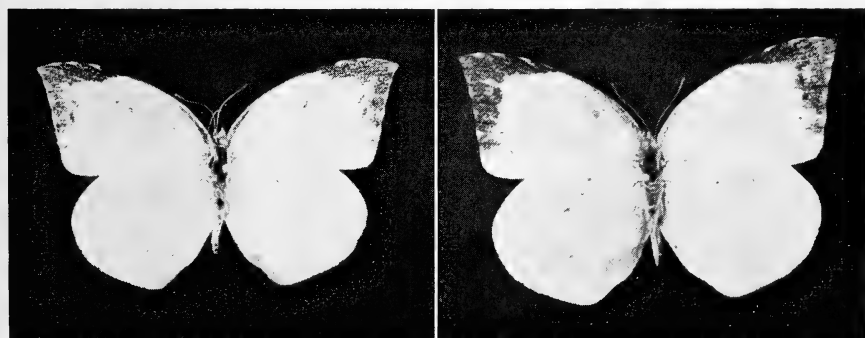


Fig. 1. *Colias cesonia therapis* (F. & F.), left male, right female, Aragua, Venezuela, March 1965. Actual size.

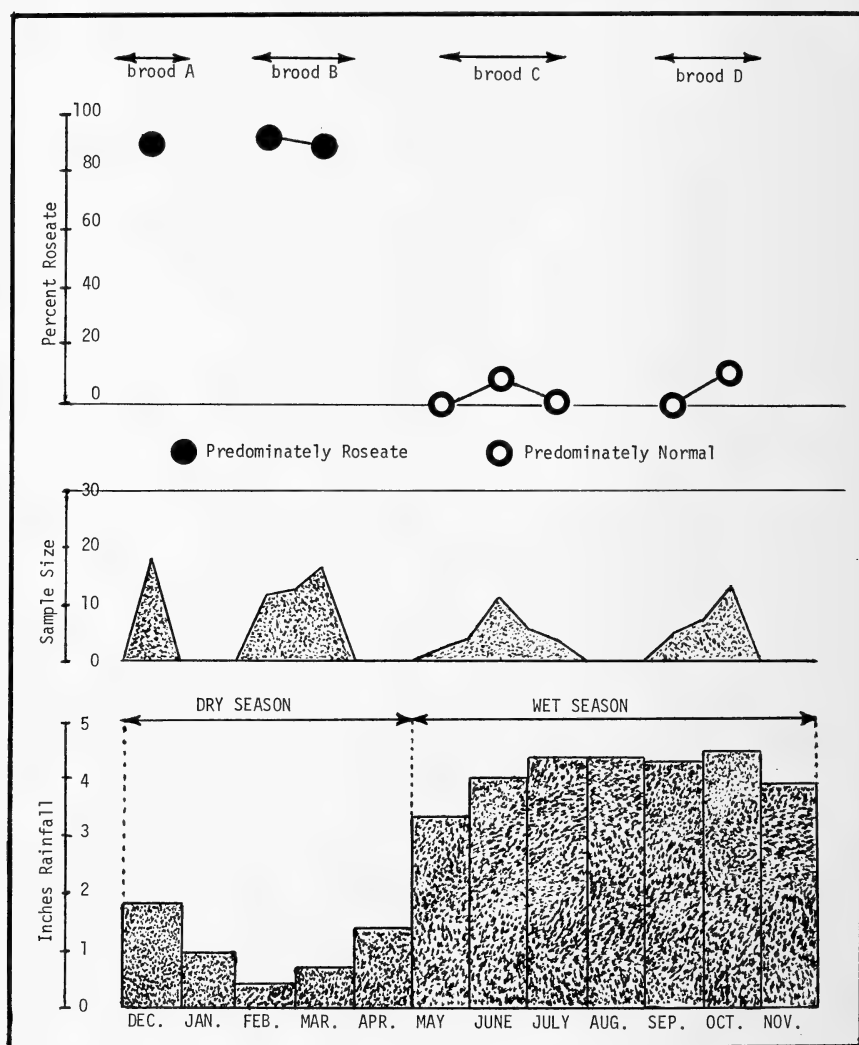


Fig. 2. Correlation of "roseate" form of *Colias cesonia therapis* (F. & F.) to rainfall and annual broods.

other times it is absent. Apparently there are four broods of *therapis* annually at Aragua: two are roseate and two are normal (figure 2). The occurrence of the roseate form correlates with the dry season (months of less than two inches of rain), while the ordinary form predominates in the wet season (more than three inches of rain per month). In a series, the extent of roseate suffusion varies widely and I have classified as

"roseate" all specimens showing the tendency to any degree. The examination of 52 ♂♂ and 23 ♀♀ from Aragua indicates an overall 89.3% correlation of the roseate form to the dry season, and nine ♂♂ from Caracas have 100% correlation. The material from Aragua and the correlation of coloring with rainfall and broods is shown in graphic form in figure 2.

Trivial names have not been given to either the wet or dry season form of *therapis* and since seasonal forms are not formally nameable under the International Code of Zoological Nomenclature I see no reason why "rosa" cannot be used as a *nomen collectivum* for the roseate dry season form of *therapis*. *Colias cesonia cerbera* (Felder & Felder) is more than likely the dry season form of *Colias cesonia* as it occurs in western Venezuela. Both white and yellow females occur in *therapis*, with white predominating four to one in Aragua, but the female background color has no seasonal correlation.

The form "rosa" is certainly a dry season form which originated in the tropics; quite likely it has spread to the northern regions as a mainly winter form. In the United States the form "rosa" certainly occurs in late fall, especially in the western (drier) part of its range. Wet and dry seasonal forms are not often encountered in the Neotropics, though in Africa where 80 to 95% of the annual precipitation occurs during the wet season, they are quite pronounced in genera such as *Colotis* and *Precis*. Brown (1929) suggests that *Phoebis cypris* (Fabricius) and *Phoebis neocypris* (Huebner) are probably wet and dry phases of the same population. The problem, of course, is the lack of exact collecting dates on much of the material from the Neotropics, a lack that has possibly kept wet and dry seasonal forms of many species from being recognized. This same lack of exact data prevented me from using specimens in both private and institutional collections to supplement my tabulation.

ACKNOWLEDGMENTS

I gratefully acknowledge the assistance of Señor Francisco Romero, Señor Albert Gadou and Señor Harold Skinner, respectively of Maracay, Caracas and Los Dos Caminos, Venezuela for supplying specimens for study; the late Dr. Richard M. Fox of the Carnegie Museum who read my manuscript and made helpful suggestions in the presentation; and Dr. Alexander B. Klots of the American Museum and Harry K. Clench of the Carnegie Museum who were kind enough to comment on my data.

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MONARCH OBSERVATIONS IN MID-TOWN AND LOWER MANHATTAN, NEW YORK CITY

Late summer and early fall observations in several areas of the northeastern United States indicated 1968 to be a year of unusually high density of the monarch (*Danaus plexippus* (L)). It seemed of interest, therefore, to plan a day of observation of migration through an area so unnatural and yet so extensive as New York City. Battery Park at the extreme southern tip of Manhattan suggested itself as one vantage point of importance. Wide avenues run approximately north-south through the island and produce a funnel-like effect as the island narrows southward. The northern edge of the Park is a sudden termination to the long trails through the world's greatest concentration of tall buildings.

October 2 was chosen more for convenience than in order to hit the peak of activity. Casual observations at my home in rural Washington, Connecticut, suggests that this date was ten days or more after a decline began. Observations started in mid-town Manhattan with the first sighting of a monarch at 43rd St. and Fifth Ave., 12:58 (E.D.T.). It was drifting southward about eight feet above ground. One block north and one minute later the second was seen. The third followed in three minutes, between 47th and 48th Sts., this individual flying about 40 to 50 feet high. At 1:48 P.M. in the heart of the financial district on lower Broadway, I observed the fourth individual. Strangely enough, there were no more in the last two blocks of Broadway or as the Park was traversed to the waterfront, reached at 2:04 P.M.

In the next hour there were 47 and an additional 30 were tallied in the following 57 minutes. Count was kept minute by minute, interrupted at 4:01 after none had been sighted for eight minutes. A brisk wind had arisen, at times blowing at an estimated 15 mph, and thin cloudiness had formed which reduced the sunlight noticeably from time to time. When observations were resumed a half hour later, ten minutes produced but a single sighting.

The precise point of almost all observation was close to the south end of the paved strip about 50 feet wide and 450 feet long adjacent to the sea wall lining the edge of the park. It is doubtful if any observed individual was more than 75 feet away, so a 150 foot front seems a fair estimate of visual coverage. Thus 77 migrating monarchs were seen to pass the 150 foot front in 117 minutes. The later single individual at the waterfront and the additional four others on the city streets brought the day's total to 82.

All monarchs observed at Battery Park took off over the water in a narrow sector slightly west of south, bounded by the Statue of Liberty and Governors Island. This would bring them to the eastern edge of Staten Island and thence to the New Jersey coast. At times there was obvious difficulty with the wind, but I saw none driven back to shore. The spacings of the sightings was remarkably even until near the rather abrupt ending. On one occasion four were seen at once and on another, four in the same minute. However, there was only one logbook entry of three, and most were singles. In only one instance did I see the migrants take note of each other, an aerial engagement of not more than a few seconds. None were seen at rest or even lingering. The monarchs flew 4-8 feet over the water; buffeting by wind being a disturbing factor to their flight.

As opportunity avails itself observations, attempting to determine the vertical extent of the migration, will be made from vantage points in the tall buildings.—SIDNEY A. HESSEL, Peabody Museum of Natural History, Yale University, New Haven, Conn.

A NEW *PAPILIO* FROM COLOMBIA AND A NEW SPHINGID FROM NEW GUINEA

ERNEST RÜTIMEYER

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In 1924 my brother-in-law, while involved in a mission to reorganize the Columbian army, participated in a collecting trip in the Putumayo Valley, which netted some 5000 butterflies. Later I was able to acquire a share of this lot, and found among its contents a new species. I checked in Seitz Volume V, but was unable to find anything like it.

I sent the butterfly to Dr. Jordan of the Tring Museum, but his tremendously rich collection did not reveal anything similar. At this point Dr. Jordan forwarded the specimen to Dr. Tams of the British Museum of Natural History. He too, could not discover anything resembling this *Papilio*, but wrote me that it seems to belong to an unknown species worth describing.

Papilio dospassosi Rütimeyer, new species

This species has a systematic arrangement close to *Papilio isidorus* Doubleday. According to Dr. Tams, British Museum, it bears resemblance to *Papilio trapeza* R. & J. and *P. xynias* Hewitson, but belongs to group *machaon* Linne.

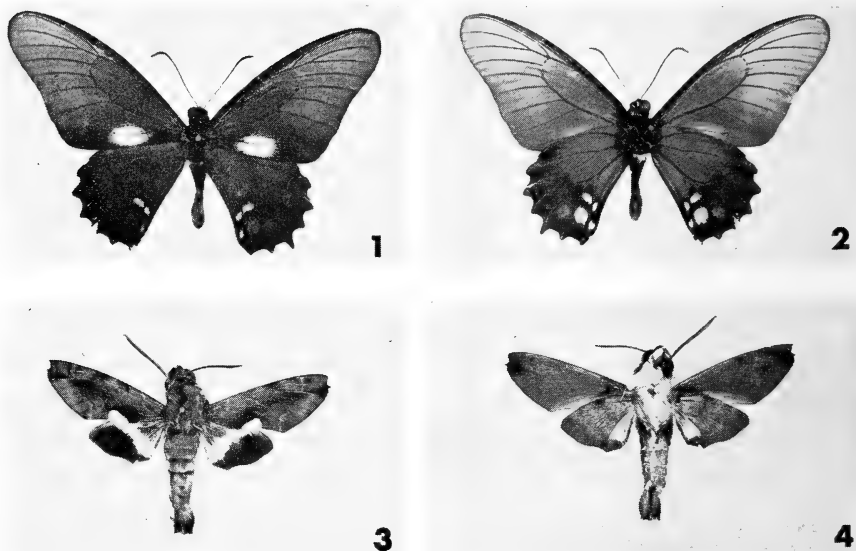
Ground color dark on both primaries and secondaries. Expanse 67 mm from apex to apex. Head and palpi dark, eyes without hairs. Collar with two little white spots. Three big red marks on each side of thorax. Abdomen dark without distinct markings. Forewing, upperside, in cell 1a and 1b (method of Aurivillius, Seitz Vo. XIII) white mark similar to *Papilio xynias* Hewitson, but smaller, pure white, length 6 mm, not reaching second vein. Hindwing, upperside, with two red patches, smaller though similar to *Papilio trapeza* R. & J. A third red mark near anal angle. Fringes of forewing between veins 1-5, and hindwing between all veins, white.

Undersurface of forewing dark without detectable markings; hindwing, with 3 white round spots, middle largest, under the 2 red spots of upperside. These 3 white round spots represent the principle distinguishing characteristic from other *Papilio*.

Holotype male: S. E. Colombia, in the valley of the Rio Putumayo, a tributary of the Middle Amazon, August, 1925, collected by Henry Pillichody, deposited in the American Museum of Natural History, New York.

I am naming this new species as a very modest sign of my gratitude to Dr. Cyril F. dos Passos, for his most generous gifts of butterflies, especially *Oeneis* Hübner, some years ago.

The second species is easily recognized as a typical *Macroglossum*. Its main character lies in the peculiar fact that the yellow band of the upper surface of the secondaries extends further into the primaries.



EXPLANATION OF FIGURES

Figs. 1-2, *Papilio dospassosi* Rüttimeyer; 1, upperside; 2, underside. Figs. 3-4, *Macroglossum moecki* Rüttimeyer; 3, upperside; 4, underside.

However in this instance as a white continuous band until the second vein. This does not occur in any other *Macroglossum* species.

I sent this hawk moth to Dr. Jordan who forwarded it to Mr. Riley of the British Museum of Natural History. Both sent it back to me with the identical observation: "never seen, absolutely unknown."

Macroglossum moecki Rüttimeyer, new species

Expanse from apex to apex 51 mm. Head brown without markings. Thorax brown above, white below. Abdomen bright brown, first two segments hidden by thick layer of reddish brown hairs. Third and fourth segments show yellow spot on side of abdomen. All segments with four wedge-shaped strips. Underside of abdomen with a narrow white band.

Forewing with dark disc plus dark colored surface surrounding short white area on dorsal margin before tornus. Dark area tapering towards under apex, where dark patch located—somewhat similar to *rectifascia* Fldr. and *imperator* Btlr. (both from Ceylon). White pretornal area represents a distinguishing characteristic, yet somewhat like white band of *errans* Wlkr., cut short, with clear-cut boundary. Hindwing dark with exception of 2-4 mm wide yellow band, resembling *nubilum* R. & J. Fringes slightly brighter.

Undersurface brown. Forewing 3 dark bands costa to back edge. Outer edges deeper brown. Hindwing with yellow band along anal edge.

Holotype male: Schouten Islands, off N. W. New Guinea. It was obtained from Mrs. Walsh, well known in worldwide entomological circles

as a collector at Sukabumi, south of Djakarta, Java, Indonesia. This specimen is being deposited with the American Museum of Natural History, New York.

I name this species as an expression of my deepest gratitude to Arthur Moeck, of Milwaukee, Wisconsin, U.S.A., for all the co-operation and encouragement received from him over a period of years.

ACKNOWLEDGMENTS

I am indebted in describing either or both of these specimens to: Captain Henry Pillichody, my brother-in-law, now residing in Switzerland; Dr. Karl Jordan, chief of Tring Museum; Dr. Tams, director of the Entomological Section of the British Museum of Natural History; Mr. Riley, first assistant of the lepidopterological collections of the British Museum of Natural History.

THE EFFECT OF X-IRRADIATION ON THE LARVAE OF *COLIAS PHILODICE* (PIERIDAE)

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Extensive studies on the effects of X-irradiation on Lepidoptera have not been reported. I believe that lack of interest is due to statements in the literature that members of the Lepidoptera are very resistant to radiation. In a series of experiments, I have found that larvae of Lepidoptera are quite sensitive and responsive to moderate dosages of X-rays. In a previous paper, we reported observations on the marked sensitivity of the larvae of *Papilio polyxenes asterius* Stoll to radiation (Arnold & Arnold, 1968). In the present paper I show that larvae of *Colias philodice* Godart are somewhat more tolerant to moderate dosages of X-rays. The resulting adults showed a variety of deformities, which are being studied histologically.

MATERIALS AND EXPERIMENTAL METHODS

Females were collected August 16, 1966, near Palos Park, in Cook County, Illinois. They were immediately caged with their foodplant red clover, *Trifolium pratense* L. A total of 390 ova were deposited by the same evening. On August 22, 265 larvae emerged. The remaining ova hatched on August 23 and 24. The 260 larvae used for the experiment

were reared under identical conditions for two days. Clear plastic boxes, measuring $5'' \times 5'' \times 1\frac{1}{2}''$, housed the larvae. Air holes were made to supply sufficient air for the 40 larvae in each box. The foodplant used was *Trifolium pratense* L.

The larvae were allowed to mature at their normal rate until August 24. The two-day-old larvae were then divided into five groups: four groups of 40 to be irradiated and one group of 100 for a control. All were first instar larvae. On this day, the four groups were irradiated at dosages of 1500r, 3000r, 4500r, and 6000r. Irradiation factors were 250 Kv, 15 MA, no filter, dosage rate = 233r/10 second, target distance = 17 cm. Irradiation was carried out with a Phillips machine and at a temperature of 72°F. Precautions were taken to avoid "backscatter." The four groups of larvae were irradiated in the open, clear plastic boxes and afterwards transferred to new boxes and fresh foodplant.

RESULTS

Thirty-four of the 160 irradiated larvae pupated. This was quite surprising in that none of the irradiated larvae of *Papilio polyxenes asterius*, living under the same conditions, survived to pupate (Arnold & Arnold, 1968). From these 34 *Colias* pupae, 24 adults emerged. The greatest loss of larvae in the four irradiated groups occurred within two days following irradiation. The larvae in the irradiated groups continued to expire gradually. Death usually occurred during the process of moulting, and this trend was also noted with irradiated larvae of *Papilio polyxenes asterius* (Arnold & Arnold, 1968). A large number of the remaining larvae died while preparing for pupation. The larvae were periodically observed with a dissecting microscope at 23× and 30× for external effects of the X-irradiation. There were no signs of radiation burns or any major differences in color, patterns, etc., noted on the larvae. The lengths of the larvae were measured periodically, and variations in length appeared to fall into the normal range of variation. A few larvae of each of the four irradiated groups survived to pupate. More than half the 24 adults were deformed. These deformities were primarily in the wings, but other deformities were observed and are being studied.

By comparison, 77% of the control larvae pupated. Four of the control pupae died. Perfect adults emerged from the remaining 95% of these pupae.

DISCUSSION

The effects of X-irradiation on Lepidoptera have not been adequately studied. There is a general feeling in the literature that the Lepidoptera

are quite resistant to irradiation. There have been a few studies of the sterilization effects of gamma radiation (same as X-rays) on Lepidoptera, which are agricultural pests. The dosages used were in the range of 30,000–40,000 rads. Pupae and adults were exposed to such dosages without lethality. Yet in the present experiment and the previous one (Arnold & Arnold, 1968), a dosage of 1500r was sufficient to kill larvae. This may not be the best comparison inasmuch as different stages of development of different species of Lepidoptera were exposed to the dosages of radiation. I have found only one reference to effects of X-irradiation on larvae of Lepidoptera (Whiting, 1950). He showed that a dose of 40,000r of X-rays prevented pupation of the flour moth, *Anagasta kühniella* (Zeller), many specimens of which continued to live as larvae up to 40 days, i.e. 37 days after the controls pupated.

In a previous report (Arnold & Arnold, 1968), eight day old larvae of *Papilio polyxenes asterius* were exposed in groups to dosages of 1500r, 3000r, 4500r, and 6000r and all the exposed larvae succumbed by the 17th day following radiation. In the present study, two day old larvae of *Colias philodice* were exposed to the same dosages of X-irradiation with the surprising result that 21% of the irradiated larvae survived to pupate. It seemed that irradiation of younger larvae of *Colias philodice* would be more lethal since younger developing tissues are usually more susceptible to X-irradiation damage. In the case of *asterius*, the lethal dose would seem to be below 1500r, possibly in the vicinity of 750–1000r. The lethal dose for *philodice* would appear to be above 6000r. Thus *philodice* could possibly tolerate up to 10 times as much radiation as *asterius*.

Both *asterius* and *philodice* larvae suffered their greatest losses within a short time after their exposure to X-irradiation. Deaths also occurred at times of moulting. The *asterius* died while in their second and third moults, *philodice* expired while in their first, second, third, and fourth moults and while preparing for pupation. Ten of the 34 *philodice* pupae died as pupae. Thus the radiation responses observed for the two species seem to be of two types, an early and a latent. The early responses appear almost immediately, within a day or two after irradiation, and the latent responses develop when moulting or pupation stages began. The explanation for the latent damage possibly may rest upon the findings of Baldwin and Salthouse (1959a, b; 1961). They found latent effects of radiation sometimes occur during a brief period of intense mitotic activity which takes place when the insects pass from one instar to another by moulting. If the insect is irradiated prior to moulting,

visible damage and death may not show up until moulting occurs. The larvae of *philodice* and *asterius* were irradiated in their first and second instars respectively. None of the larvae had visibly begun the moulting process, though it is likely many had begun the period of intense mitotic activity which precedes moulting. Thus it is quite possible that many of the larvae of the two groups which exhibited an early response may have been exposed to the X-irradiation when in the process of the intense mitotic activity preceding their moult. The latent response, as Baldwin and Salthouse predicted, appeared when moulting occurred.

The question also arises as to why did some of the *philodice* survive to pupate. Perhaps the answer to this question may be dependent upon which stage of mitosis the *philodice* was irradiated or whether some of the larvae had probably not advanced to the period of intense mitotic activity. The metaphase is known to be the stage of mitosis to suffer the greatest effects of radiation damage. Thus a *philodice* larvae irradiated while in telophase could likely have survived to pupate.

This difference in the survival response between *philodice* and *asterius* to radiation is being investigated further. Perhaps the different species of Lepidoptera vary in sensitivity to radiation. A comparative analysis utilizing larvae of similar ages of these two species is under study for a more appropriate comparison of sensitivity and the actual changes seen post irradiation.

SUMMARY

The present study reports the reaction of the larvae of *Colias philodice* to moderate doses of X-rays. When exposed to the same doses of X-rays, the *philodice* proved to be much more resistant than the larvae of *Papilio polyxenes asterius*. Twenty-one percent of the *philodice* following radiation survived to pupate, whereas none of the *asterius* survived. Approximately one-half of the *philodice* adults which emerged were deformed. Studies will be made to obtain further comparisons of the effects of X-rays on the other members of the Lepidoptera.

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A SUGGESTION REGARDING HINDWING DIVERSITY AMONG MOTHS OF THE GENUS *CATOCALA* (NOCTUIDAE)

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Throughout much of North America, moths of the genus *Catocala* occur in a bewildering array of species and varieties (e.g., Barnes & McDunnough, 1918). In New England alone, there are at least 52 *Catocala* species, and 43 additional distinctive varieties (Forbes, 1954). For the past five years (1964-68), I have been studying *Catocala* in central Massachusetts (Hampshire and Franklin counties), and during that time have collected or observed well over 1000 individuals of 27 species.

The numbers and variety of sympatric *Catocala* species, together with their relatively narrow ecological niche (phytophagous larvae, cryptic adults which rest on tree trunks), raise a number of interesting evolutionary questions. One question that has intrigued me for some time concerns the various patterns and colors of the hindwings of these moths. It is generally assumed that these hindwings serve to startle predators, being flashed when crypsis fails to deter attack. A startled predator is then momentarily confused, during which time the moth may escape. But why are these hindwings typically banded in many species, and uniformly black (on the upper surface) in others? And why, among the species having banded hindwings, do the ground colors vary through yellows, oranges, pinks, and reds? In short, what factors have been operating to promote specific hindwing diversity in this genus?

One suggestion for this diversity might be based on phylogenetic affinities within the genus, closely related species having similar hindwing patterns and colors. However, a glance at taxonomic arrangements of the *Catocala* (e.g., Barnes & McDunnough, 1918; Forbes, 1954) is sufficient to show that closely related species may exhibit a variety of hindwing types.

A second suggestion might ascribe a role to the hindwings in courtship and mating behaviors, the different patterns and colors serving as releasers, and so functioning to isolate various species. Virtually nothing is known of courtship and mating in the *Catocala*, so this suggestion must remain quite tentative. If, however, these behaviors occur at night, then a releaser role for the hindwings (especially with respect to color) seems somewhat questionable.

Another suggestion for hindwing diversity recently occurred to me

while examining my records of *Catocala gracilis* Edwards, *C. sordida* Grote, and *C. andromedae* Guenée. These three species are widely sympatric, are of approximately the same size (wingspread 45 mm), and have very similar gray forewings (Forbes, 1954). However, the hindwings are banded with yellow-orange and black in *gracilis* and *sordida*, and are an unbanded black in *andromedae*. [Specific distinctions between *gracilis* and *sordida* were not attempted in the field, and the two species are considered together throughout this note. It is possible that there is only one species here (see Adams & Bertoni, 1968).] My records indicated that these species often occur together in central Massachusetts, coming to bait on the same nights, and resting by day on trees in the same woodlots. The inclusive dates of occurrence for 67 *gracilis* and *sordida* taken over the past five summers are 16 July and 31 August; these dates for 25 *andromedae* are 26 July and 28 August. Furthermore, the resting habits of these moths are apparently identical. I have found 21 *gracilis* and *sordida*, and 10 *andromedae*, resting on tree trunks. All of these moths were resting in a head-down attitude, and ranged between 5 and 12 feet above the ground (average height of 6 feet for *gracilis* and *sordida*, and 7 feet for *andromedae*).

The similarities in dates of occurrence, forewing patterns, and resting habits between *Catocala gracilis* and *C. sordida* on the one hand, and *C. andromedae* on the other, suggested the possibility that selectionpressures have been operating in these two cases to promote convergence with respect to cryptic adaptations, and divergence with respect to startle adaptations. This kind of situation, in which two or more species resemble one another in cryptic characteristics, but differ markedly in startle characteristics, might be termed *schizomimicry*.

Although schizomimicry is purely conjectural at the present time, it would seem to provide a selective advantage to at least one of the species involved. Coppinger (1969a, 1969b) has experimentally demonstrated that birds may not attack (and may actively avoid) novel insects in their diets, novelty here being defined in terms of stimulus change with respect to the previous experience of the birds. Thus, in the proposed schizomimicry situation, novelty might enhance the effectiveness of the startle patterns. Using the example discussed here, a predator might habituate to the startle pattern of *C. gracilis* after a number of encounters, but be effectively startled again upon encountering *C. andromedae*. In this way, at least the rarer species in a schizomimicry complex might derive some protection from predators. Actually, all of the species could benefit from their association, if the predator's startle response was in part a function of its most recent experience.

The process proposed here for producing hindwing diversity among the *Catocala* is similar to that described as "apostatic selection" by Clarke (1962), in that both processes would promote diversity among sympatric species having common predators. However, Clarke related his concept to the "specific searching image" hypothesis of Tinbergen (1960), *i.e.*, that predators develop tendencies to take one type of prey at a time, overlooking others which appear different; while the present proposal views novelty, or a novel stimulus effect, as the factor which deters predation on prey which differ in appearance. In addition, of course, the process proposed here would result in mimicry, as well as apostasy, between species.

This explanation of some of the hindwing diversity among the *Catocala* does pose one seemingly perplexing question: if this diversity among otherwise similar moths is advantageous, why has not disruptive (Mather, 1955), or apostatic (Clarke, 1962), selection resulted in considerable infraspecific hindwing diversity? A partial answer might be that many *Catocala* species simply lack the genetic potential for effective hindwing diversity (*i.e.*, for startling patterns which are sufficiently novel to deter predation). It might also be suggested that some of the observed hindwing diversity is indeed the product of disruptive selection. In this view, some of the variants would be morphs, rather than species; or, if species, would have arisen sympatrically from morphs. Sympatric speciation might be envisioned in these circumstances, if crosses involving unlike hindwings (heterogamy) produced intermediate moths which were at a selective disadvantage, in terms of startle characteristics, to moths produced in crosses involving like hindwings (homogamy).

The situation of *C. gracilis* and *C. sordida* versus *C. andromedae* would seem the most likely possible example of schizomimicry among the *Catocala* of my experience. However, certain other pairs and groups of *Catocala* species might also exhibit such a relationship. For example, in central Massachusetts, *C. habilis* Grote and *C. concumbens* Walker have overlapping dates of occurrence, roughly similar pale gray forewings, identical head-down resting attitudes, and similar tendencies to rest low on light trees; but *habilis* has orange and black banded hindwings, and *concumbens* has pink and black banded hindwings. (*C. robinsonii* Grote, a black hindwinged species, might also be included in this latter association.) Another possible example involves *C. palaeogama* Guenée (yellow and black banded hindwings) and *C. lacrymosa* Guenée (black hindwings): these species exhibit similar forewings, with parallel variations; extensive sympatry; and the same seasonal occurrence (Forbes,

1954). Other examples might be cited, but perhaps these will suffice to suggest the possible extent of schizomimicry in the *Catocala*.

The ideas advanced here are admittedly quite speculative. However, the proposed advantage of hindwing diversity is certainly experimentally testable, and one of my graduate students, Charles G. Kellogg, is currently devising such experiments. We would be interested in receiving comments and suggestions from others on any matters relating to this note.

I would like to express my appreciation to Dr. Raymond P. Coppinger of Amherst College for allowing me to read pre-publication copies of his important papers; and to Dr. Ronald R. Keiper of Pennsylvania State University for providing me with records of his observations of *Catocala* in the field.

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SWARM OF *EUREMA LISA* UNDER MERCURY VAPOR LAMP

Migration swarms of *Eurema lisa* Boisduval & LeConte, have been often reported in the past, and specimens of *Rhopalocera* are occasionally taken at lights, but the two combined are an unusual occurrence, at least for this collector. On the night of September 27, 1968, at 11:50 P.M., I found a swarm of several hundred *E. lisa* resting on pavement beneath a mercury-vapor lamp rated at 20,500 lumens (400 watts). The temperature at the time, obtained later from the nearest ESSA station, was 61° F. The lamp is located in the parking area of a business establishment near my home in Henderson, western Kentucky. The specimens appeared dazed, and were not resting vertically, but with folded wings tilted to about 75 degrees. Only eleven samples were collected, and the sexes were about evenly represented, six males and five females.—J. B. Wood, 140 Pines Drive, Henderson, Kentucky.

NEW DISTRIBUTIONAL DATA ON THREE NORTHEASTERN
UNITED STATES BUTTERFLIES

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Newly discovered but presumably relict localities are reported in New York and Pennsylvania for *Lycaeides melissa samuelis* Nabokov (Lycaenidae), *Colias interior* Scudder (Pieridae), and *Poanes massasoit* (Scudder) (Hesperiidae). Each connects parts of the range previously considered disjunct. The distributions of the three species are discussed.

LYCAEIDES MELISSA SAMUELIS Nabokov

The "Karner blue" is reputed to be the most local butterfly in the northeastern United States. Virtually all museum specimens come from either the famous colony in Albany County, New York, or the south end of Lake Michigan. Its distribution in the intervening area is poorly known: the only New York record west of the Adirondacks and Catskills is Clayton, Jefferson Co., on the banks of the St. Lawrence (Forbes, 1928).

On July 16, 1968 the author, L. L. Pechuman, and John Burton collected a series of *L. m. samuelis* in a small area on the Tonawanda Indian Reservation in Genesee County, western New York. Great numbers of fresh individuals were flying among roadside lupines (*Lupinus perennis*), the foodplant, and in adjacent brush land overgrown with small oaks and sumac. The species was still abundant on August 1, and a single female, still in good condition, was taken by Dr. Pechuman on August 23.

Genesee County *L. melissa* are slightly smaller than most from Albany County. The tendency for the postmedian black spot in cell Cu₁ of the forewing underside to be produced basad, which is present to some degree in other populations, is well developed in our series in both sexes.

Lucien Harris, Jr. informs me *in litt.* that southern Appalachian records of this species cannot be substantiated. Clark (1938) recorded it from Blantyre, Transylvania County, North Carolina on the basis of mislabeled material. Harris (1950) recorded it from Fulton County, Georgia based on a manuscript list dating from 1905; no supporting specimens are known. At present *L. melissa* is not known in the eastern U.S. south of Pennsylvania.

The distribution of *L. m. samuelis* has also been confused by records probably belonging to subspecies of *L. argyrognomon* (Bergsträsser).

These include Scudder's (1889) records from Anticosti, Cape Breton, and the north shore of the Gulf of St. Lawrence. All of the definite localities known to me from which *L. m. samuelis* has been recorded are listed below (in part from Nabokov, 1943):

NEW HAMPSHIRE: Nashua, Hillsboro Co. (W. P. Comstock, AMNH)¹

MASSACHUSETTS: (no data) Angus, Edwards colls. (AMNH)

NEW YORK: Tonawanda Indian Reservation, Genesee Co.; Clayton, Jefferson Co. (Forbes, 1928); "Adirondacks," no date (Bruce, CU); Albany, Karner, Colonie, all Albany Co. (USNM, AMNH, NYSM, MCZ, ANSP, CU); Brooklyn, Kings Co. (Scudder, 1889)

PENNSYLVANIA: Wayne Co. (USNM); "Pa." (MCZ)

OHIO: Sylvania, Lucas Co. (D. B. Stallings coll.)

MICHIGAN: Detroit, Wayne Co. (MCZ); Ness Lake (T. N. Freeman coll.); Spring Lake, Ottawa Co. (B. Smith, CU)

INDIANA: "dune region" (Porter Co.?) (Nielsen, 1962)

ILLINOIS: "northern Illinois" (Scudder, 1889)

ONTARIO: London (Scudder, 1889; MCZ); Toronto (Scudder, 1889; D. B. Stallings, T. N. Freeman colls.); Norfolk Co. (Dunlop, 1965); Simcoe, Norfolk Co. (Holmes, 1964).

The western limits of the range of *L. m. samuelis* are not well known. *Lycaeides m. melissa* (Edwards) occurs eastward throughout North Dakota (Puckering and Post, 1960), on the western plains of Minnesota and southeast to Olmsted County (Macy and Shepard, 1941), and in Burnett County, northwestern Wisconsin (Royer, 1962). The subspecies of *melissa* thus appear to be separated by an area where neither occurs, but the distance between them is comparable to that separating isolated populations of *L. m. samuelis* from one another. *Lycaeides argyrognomon scudderii* (Edwards) occurs widely in Minnesota and has been reported from Lake County, Michigan (Nielsen, 1951). Otherwise it seems to occur north of the range of *L. m. samuelis*, from Manitoba to eastern Quebec. In the Maritime Provinces and Labrador other subspecies, *L. a. aster* (Edwards) and *L. a. empetri* (Freeman), occur north of the range of *L. m. samuelis*. Although largely allopatric in the east, the two *Lycaeides* do overlap in the western half of the continent.

Lycaeides melissa samuelis and its host plant, *Lupinus perennis*, are usually associated with sandy soils. In New York the plant is widespread on such soils (House, 1924; Beauchamp, 1923; Bray, 1915) and more colonies of the butterfly certainly await discovery. Bruce's record from the Adirondacks remains ambiguous; lupine occurs widely on the west slope and also in the Lake Champlain region.

¹ Abbreviations: AMNH = American Museum of Natural History, New York; ANSP = Academy of Natural Sciences, Philadelphia; CU = Cornell University, Ithaca, New York; MCZ = Museum of Comparative Zoology, Harvard, Cambridge, Mass.; NYSM = New York State Museum, Albany; USNM = United States National Museum, Washington, D.C.

COLIAS INTERIOR Scudder

This species occurs in the Adirondack region (Forbes, 1928) and Tug Hill (R. T. Cardé, personal communication) in northern New York and has been reported from high elevations in Virginia (Clark and Clark, 1951). It has not been found in south-central New York. Its occurrence has long been suspected in Pennsylvania, but could not be substantiated by Tietz (1952).

A fresh male of this species was collected on a beaver meadow in the Tioga State Forest north of Cedar Run, Tioga County, Pennsylvania, on July 11, 1968 by the author. The locality is open with a heavy growth of blueberry, bracken, sweet fern, and grasses on dry ground among the tree stumps, and sedges and cutgrass (*Leersia oryzoides*) around the pond. The elevation is about 1800 feet, and the area is a deeply dissected plateau and lies in the Canadian Zone.

POANES MASSASOIT (Scudder)

This species is common on the coastal plain in marshes and marsh-meadows from southern New England to southern New Jersey. On the piedmont it extends to Lancaster County, Pennsylvania (G. Ehle, personal communication) and near Washington, D.C., (Clark, 1932; Andersen, 1963). There are no authenticated reports farther south. In New York it is reported from the southeastern counties (coastal plain, Hudson Valley) (Forbes, 1928). Scudder (1889) gives a record from Wyoming, Pennsylvania (presumably Luzerne County). Otherwise in Pennsylvania, the species is limited to the southeastern corner (Philadelphia, Bucks, Delaware, Montgomery, Chester and Lancaster Counties) (Shapiro, 1966). However, it occurs locally from southern Ontario to Wisconsin, South Dakota, Nebraska, and Iowa, around the Great Lakes (Nielsen, 1963; Price, 1948). This disjunct distribution, breaking across the Appalachians and the Allegheny plateau, is repeated in other marsh Hesperiidæ.

On July 18, 1968 this species was discovered on a beaver meadow southwest of Gracie, Cortland County, New York. It was subsequently found half a mile away, at Sphaerium Brook and Mud Pond on the Lloyd-Cornell Reservation near McLean, Tompkins County, within the same drainage basin. It remained on the wing until July 30. Careful searching failed to reveal its presence in similar habitats in central New York outside the Beaver Creek basin.

The fifteen specimens collected by the author and R. T. Cardé were compared with material from Spring Valley, Rockland County, and Monroe, Orange County, N.Y. and from Downingtown, Chester County,

Pennsylvania and Mt. Holly, Burlington County, New Jersey. The Gracie-McLean butterflies differ in having a well developed upperside pattern in the males (orange spots always present on hindwing, usually on forewing) and a complete, "viator-like" pattern in the females. The males resemble one female figured by Clark (1932, pl. 53, fig. 9) and the females resemble another (pl. 53, fig. 5). The blotch on the underside of the hindwing is always clear yellow.

The unique coloration and spatial isolation of the Gracie-McLean population (130 miles from the nearest known colony to the southeast, 150 miles from any to the west, and 95 miles from the unverified Wyoming, Pennsylvania locality) suggest that this is a relict population rather than a recent colonization.

The Gracie beaver meadow is not permanently wet, and it has been forested in modern times. It could not have supported a relict population of *P. massasoit* continuously. Elsewhere within the morainic Beaver Creek basin are bogs and marshes in various stages of development. The Mud Pond vegetation is a fairly typical sedge and *Sphagnum* mat building out into open water. The area of the pond has shrunk drastically from its postglacial maximum, but habitat suitable for *P. massasoit* may have been present continuously there. Although *P. massasoit* was commoner on the beaver meadow than at Mud Pond in 1968, the former was presumably colonized fairly recently—perhaps from the latter. The diversity of wet habitats in the basin could have permitted the survival of the species over thousands of years by colonizations over distances of only a mile or two.

Poanes massasoit was not collected during the biological survey of the Lloyd-Cornell Reservation (Forbes, 1926) but the butterfly collecting was not thorough, and the species is easily overlooked.

A movement similar to that hypothesized for *P. massasoit* seems to have occurred in the McLean population of *Chlosyne harrisii* (Scudder) (Nymphalidae). In the 43 years since the survey this relatively conspicuous species has moved half a mile in two steps, from Mud Pond to the extreme northeast corner of the basin. It is now completely absent from its former haunts. Its foodplant, *Aster umbellatus*, is still present, but shaded by shrub growth which has developed since then; the plant is in my experience more shade-tolerant than the butterfly. Dethier (1959) and Dethier and MacArthur (1964) observed that density-dependent emigration regulated populations of this butterfly before the available food was exhausted. This mechanism may have insured the perpetuation of the McLean colony by encouraging colonization well before the deterioration of its original habitat. The nearest known colony

beyond the Beaver Creek basin is in southern Cortland County, 12 miles distant.

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BOOK REVIEW

MOTHS AND HOW TO REAR THEM, by Paul Villiard; 242 pp. + xiii, 356 black and white photographs; 1969. Funk & Wagnalls, 380 Madison Avenue, New York, New York. Cloth, \$10.

With the publication of Mr. Villiard's book, *Moths And How to Rear Them*, the breeders of large moths in the United States, have a book to turn to for answers to many of the perplexing problems which arise concerning the breeding requirements of many common and also some scarce species of domestic and foreign moths. Mr. Villiard spent nearly nine years in the preparation of this book. Though far from complete, this is the first rearing manual to incorporate representatives of several different families of moths, the Saturniidae, Ceratocampidae, Sphingidae, Arctiidae, Noctuidae, Lasiocampidae, Notodontidae and others. Much of the life history of the various species is represented by outstanding photographs, however, a few are too dark to really do justice to their subjects. It is unfortunate that they could not have been reproduced in color as the author had taken them; since color is so important to the identification of many species. Along with the photographs there is a text description of each stage, rearing requirements, lists of preferred and alternate foodplants, geographic range, and popular name, if any, of each species. The author gives the availability through professional dealers of live material for each species, that is, where the stages may be obtained and, in a few instances, gives the names of specific breeders who sell living material.

Also included is an appendix of photographs for the easy identification of food-plant twigs in winter. This is occasionally necessary when one is in need of forceable twigs to feed young larvae in late winter.

For the beginner, who knows little about rearing, detailed instructions are given for the construction of simple but effective rearing receptacles, general rearing procedures, the handling of ova and larvae, and the proper storage of pupae and cocoons. Also for the beginner, is a detailed word and picture review of the process used to pin and spread large moths.

Two errors which bear correction are: the photograph called *Malacosoma americana* (Fabricius) (p. 206) is definitely not that species but closely resembles a female of *Porthetria dispar* (Linnaeus) and the photo given as *Hemerocampa leucostigma* (Abbot & Smith) (p. 216) is also in error since the female of *leucostigma* is wingless. Although I am not certain of the species, it is certainly a noctuid and not a liparid. In spite of a few other minor errors the book is well written and easily understandable by a beginner.

Professional, amateur, and beginning moth breeders will find this book an interesting and useful addition to their libraries and one they will refer to over and over again. Mr. Villiard is to be congratulated on his most welcome addition to the literature on the rearing of lepidoptera and it is hoped that he will keep his promise, set forth in the preface, to compile a more comprehensive rearing manual in the future.—ROBERT S. BRYANT, 522 Old Orchard Rd., Baltimore, Maryland.

EDITOR'S FOOTNOTE—Mr. Bryant has been very kind. Aside from the misleading title, there is no excuse for the publishers to have processed a book of this nature without having availed themselves of a review by a professional or competent amateur lepidopterist, of which there are many in the New York area, any one of whom would have at once recognized the gross errors mentioned above, as well as various other errors and omissions. Perhaps the most outstanding of these is the almost total lack of reference to the literature and the sources of the information given. Other aspects, such as obsolete taxonomic assignments, lack of author's names, emphasis on availability from dealers rather than in the field, erroneous and incomplete hostplant data, many improbable and superfluous photographs, and incredible statements (e.g., in a well filled mount, sphinx moths "look like bomber planes"; repellents recommended "to keep spiders and other insects" out of cases) further exhibit the prevailing disregard for professional level treatment which most Lepidoptera works have shown during the past few decades. Moreover, many of the book's recommendations display a blatant disregard for U. S. D. A. quarantine regulations regarding importation of living insects, and reference is even made to an "unwritten law of a breeder which is not to liberate any species that is not indigenous"!

SOME ADDITIONAL NOTES ON MATING BEHAVIOR IN BUTTERFLIES

CLIFFORD D. FERRIS

University of Wyoming, Laramie, Wyoming

A recent paper (Miller and Clench, 1968) discusses mating behavior in butterflies. The present note provides some additional information concerning three species.

PIERIDAE

Pieris protodice (Boisduval and LeConte). On the morning of August 24, 1968, this species was observed to be swarming along state road 338 south of Animas in Hidalgo County, New Mexico. The density of adults was estimated at from 6 to 12 per square yard. Males predominated in about a 10-1 ratio to females. The area of maximum density extended for nearly a mile along the roadside. This writer's attention was attracted to a cluster of adults flying about a single wild mustard plant. Upon closer observation, a newly emerged female, wings not yet fully developed, was seen hanging from a stem, coupled with a rather battered male. Mating must have taken place just following emergence. The pair was observed for about fifteen minutes. During this period, a steady stream of males attempted to couple with the female. The already coupled male remained completely passive in a head down position during this time. Time did not permit observation of the cessation of mating. During the period of observation, no flight or motion of the pair ensued other than the extension of the wings of the female to full size. The pair was first observed at approximately 9:00 A.M. (MDT). Other coupled pairs were observed in flight. The males seemed definitely to initiate mating while the females remained passive, resting in plants. Chrysalids were observed attached to white mustard plants (*Draba* species), while sweet clover (*Melilotus alba*) was abundant nearby.

NYMPHALIDAE

Speyeria nokomis nitocris (Edwards). During the past three summers (1966-68), the writer has had occasion to observe and collect this species in Arizona (Gila Co. and Apache Co.) and New Mexico (Catron Co.). Only a few matings have been noted as in the areas cited, the males seem to predominate over the females by a high ratio. In the cases observed, the males initiated the coupling. The usual pattern in these areas seems to be the following: In the forenoon, the males "patrol" close to the ground without feeding, apparently searching for females. Males have

been observed as the dew dries, usually about 8:30 A.M. (MST). Just after flight begins, some feeding upon red thistles has been recorded, but this is of short duration. Females first appear about one-and-one-half to two hours later. They have a way of "insinuating" themselves. They suddenly appear on the ground where seconds before there was nothing. Apparently they come from two locations. In all of the locations mentioned, *nokomis* habitat is a mountain meadow centered about a small stream with relatively steep surrounding hillsides. The hillside cover is predominately ponderosa pine, blue and Englemann spruce. In some cases, the females flutter out from the tree cover to rest in the grass or clover near the stream, where they are found by the males on patrol. In other cases, the females appear from the center of the low shrubbery (mainly willow) which borders the stream and alight in the nearby grass to be discovered by the males. In the courtship flight the partners circle about one another, rising to the treetops, usually with additional males attempting to interfere. The instant of coupling has not been observed. Coupled pairs have been detected resting in the grass. In all cases, copulatory flights and coupled pairs have been observed between 11:00 A.M. to 1:00 P.M. (MST).

PAPILIONIDAE

Papilio bairdi bairdi (Edwards). This species has been observed on several occasions in Cochise County, Arizona, and was found to be quite common near Portal on August 21, 1968. During the morning hours, males and females were seen flying and feeding but no attempt at mating was noted. This species appears to be very wary in the morning hours and is rather difficult to capture at that time. By late afternoon (3:00 to 6:00 P.M.), feeding and flight was quite leisurely. Several courtship flights were observed with the male chasing the female in level flight. One coupled pair was seen and captured at approximately 4:30 P.M. (MST). The female was flying rather rapidly while the male remained completely passive. The pair had been resting in the brush until disturbed by the writer. It was found that both males and females were easily taken feeding on desert sunflower (*Helianthus* species) in the late afternoon.

LITERATURE CITED

- MILLER, L. D. & H. K. CLENCH, 1968. Some Aspects of Mating Behavior in Butterflies. *J. Lepid. Soc.*, 22: 125-132.

GREGARIOUS HABIT OF CHRYSALIDS OF *NYMPHALIS* *ANTIOPA* (NYMPHALIDAE)

RUSSELL A. RAHN
Wausau, Wisconsin

The gregarious habit of the larvae of *Nymphalis antiopa* (L.) has been known for a long time. It is this habit which enabled the writer to collect over eighty larvae at one time which had virtually defoliated a small willow in our Wisconsin back yard. These were collected in what apparently was the second to the last instar, and reared through one molt. The larvae were fed sandbar willow (*Salix interior*) and yellow willow (*S. lutea*), and formation of the chrysalids began on August 8, 1968. The larvae were reared in a cage of wood frame construction, covered with cloth netting. The dimensions of the cage were 12 × 22 inches and 28 inches in height.



EXPLANATION OF FIGURE

Cluster of 66 chrysalids of *Nymphalis antiopa*, showing a gregarious habit in captivity (photo by R. Radunz).

By August 12, all larvae had formed chrysalids, with a gregarious habit persisting through this stage. The accompanying illustration shows over sixty chrysalids occupying a space no larger than six by six inches in the rearing cage. It may be significant that this corner was the one that received the largest amount of sunlight. Struble (1952) has reported a similar situation occurring under natural circumstances with *Nymphalis californica* (Bdv.), with an aggregation of chrysalids found under a hollow piece of driftwood. However, the two situations may not be completely comparable. Larvae of *N. californica* are known to periodically build up in large numbers, so that "aggregations" of pupae of this species might normally be expected, and 1952 was a year of such an outbreak. The present observation on the behavior of *N. antiopa* did not come about as a result of any unusually large population outbreak.

The close spacing of the chrysalids apparently had no ill effect on emergence, for by August 23, all but one had emerged, and all were in perfect condition.

LITERATURE CITED

- STRUBLE, G. R., 1952. Unusual Pupation Site for *Nymphalis Californica*. Lepid. News, 6(6-8): 107.

A GYNANDROMORPHIC PHAEOURA MEXICANARIA (GEOMETRIDAE)

On July 16, 1968 at Estes Park, Colorado, I caught, in a light trap, a gynandromorphic specimen of *Phaeoura mexicanaria* (Grote), (fig. 1). The gynandromorphism of the body appears to be perfectly bilateral, but the genitalia (fig. 2), would be perfectly male if it were not for two exceptions: instead of a single uncus there is one half of an uncus and one ovipositor lobe, also the tegumen is asymmetrical.

The length of the forewing is 31 mm on the right side and only 26 mm on the left. The exoskeleton of the abdomen was prepared and the weaker middorsal sclerotization separates plainly the terga in two halves. Here again the dissymmetry is quite obvious: the left half terga of the second, third, fourth and fifth segments measure about 4 mm. The corresponding figure for the right side is only about 3 mm.

Finally, the tergum of the eighth abdominal segment is even more asymmetrical, being small and heavily sclerotized on the female side, larger and very weakly sclerotized on the male side.—ANDRÉ BLANCHARD, P.O. Box 20304, Houston, Texas.



Fig. 1 (upper): Gynandromorphic *Phaeoura mexicanaria* (Grote). Estes Park, Colorado.

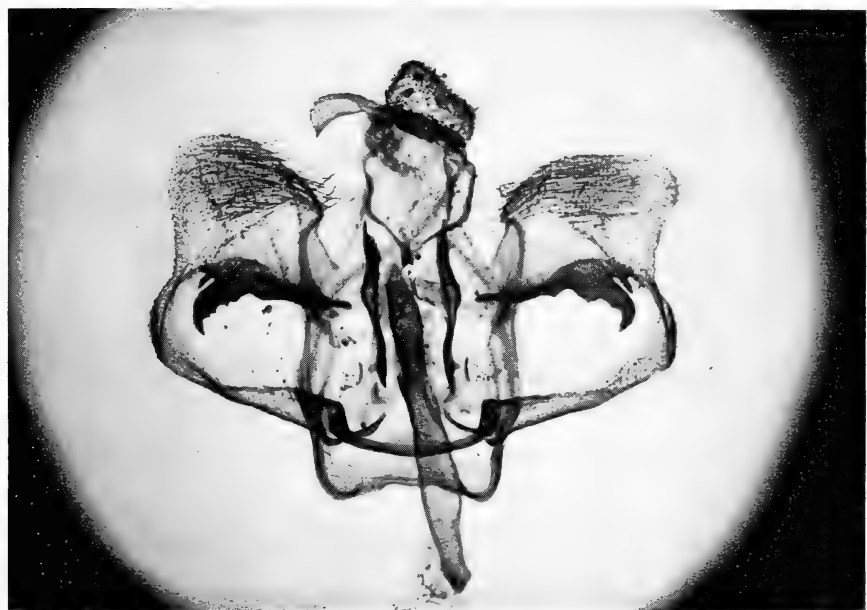


Fig. 2 (lower): Genitalia of the same specimen.

BOOK REVIEW

THE HIGHER CLASSIFICATION, PHYLOGENY AND ZOOGEOGRAPHY OF THE SATYRIDAE (LEPIDOPTERA), by Lee D. Miller. Memoirs of the American Entomological Society. Number 24, iii + 174 pp., 327 figures, 7 tables. 1968. Soft cover. Price \$7.00. Available from American Entomological Society, 1900 Race Street, Philadelphia, Pa. 19103.

This is one of the few revisionary treatments of butterflies on a world-wide basis and is probably the best of such efforts to date. It might be further categorized as one of the more important revisions of any large insect group from a theoretical as well as a practical standpoint.

The treatment is composed of six sections: Introduction, Comparative Morphology, Systematic Treatment, Evolution and Zoogeography, Bibliography, and Index. The revision owes its excellence in part to the uniform, concise writing, the imaginative construction, and the nearly faultless logic of the theoretical aspects.

Miller's work is not holistic as only external features of the adults are considered. The immature stages and internal features of the adults are ignored. Thirty-two characters of the antennae, head, labial palpi, thorax, legs, and wings were measured for all of the nearly four hundred nomenclatorially valid satyrid genera of the world. In such a large undertaking Miller's use of the "exemplar method" as explained by Sokal and Sneath (Principles of Numerical Taxonomy, 1963: 161-162) was both expedient and scientifically valid. Miller considered the type-species of a genus to be typical of it, since it is this entity which bears nomenclatorial "responsibility" for the generic name. Thus, Miller states "systematic decisions at one taxonomic level should be reached by examination of most (preferably all) of the entities at the next lower major taxonomic level.", and thereby justifies his study of genera rather than species in his construction of a higher classification for the Satyridae.

One drawback of Miller's study is that it is not stated in the text by what method his measurements (approximately 12,000) were evaluated. If a computer was not utilized to calculate the numerous possible relationships involved, it is difficult to imagine how Dr. Miller was able to reach any objective conclusions free from bias. Instead the reader can only assume that the author employed subjective weighting of a few selected characters to devise his categorizations.

The assembly of the data has been executed in a manner enabling future application of other techniques such as the phylogenetic methods of Hennig or those of numerical taxonomy as practiced by the "pheneticists."

A statement of the objective of the study, "the analysis, both in space, and, where possible, in time, of the evolution, phylogeny and zoogeography of the higher taxa of the Satyridae.", is comprehensive and is followed by an historical sketch which considers the previous attempts toward the construction of classifications of higher categories of the Satyridae. In table 1, Miller compares the higher classifications of previous authors with his own.

The introductory section is terminated with a discussion of material studied and methods employed. The collections of the Carnegie Museum and British Museum of Natural History were the sources most heavily utilized for study material.

The section on comparative morphology is a recitation of the 32 characters utilized in the study and their variation and usefulness. Miller states that much needless emphasis has been placed on androconial patches, venation, and external genitalia by past workers in their attempts to cope with the suprageneric relationships of the satyrids.

The largest section of the work deals with the systematics of the Satyridae. All nomenclatorially valid genera are placed in a hierarchy of subfamilies, tribes, and "generic-series" and treated in keys. All subfamilies and tribes, nine of which are proposed by Miller, are characterized by 23 of the 32 measured features. For each higher category an objective synonymy is presented along with the original citation. For each tribe all included genera are listed, including primary objective synonymy.

Line drawings of both wings and leg features of selected genera are presented for each of the higher categories. For each tribe bar graphs are presented which contrast relative lengths of femur + tibia + tarsus of the fore- and hindlegs with the midlegs (unity). Measurements for most genera are presented and the sexes are treated separately. Brief remarks on occurrence, economic importance, and folklore add to the information content of the work, but some of this seems out-of-place.

Tables are presented which list diagnostic characters for the tribes within a subfamily. These allow a reader to quickly perceive the major differences between the subordinate categories within the group.

Miller begins his section on the evolution and zoogeography of the satyrids by concisely stating the principles followed in his reconstruction. He points out that the fossil record for butterflies is almost nonexistent, and states the reasonable thesis that butterflies can disperse much more rapidly than continents can drift or land bridges can wax and wane. He gives the origin of the Papilionoidea as Jurassic. In his hypothetical reconstruction inferences derived from the recent distribution of satyrids and the principles of animal evolution as based on vertebrate fossil evidence and interpretation are heavily relied upon.

A discussion of the probable time sequence of the evolution and intercontinental dispersals within Satyridae is then presented. The text is supplemented by 11 sequentially arranged diagrams of the world upon which the migrations and radiations as proposed in the text are schematically represented.

The Neotropical Faunal Region is chosen as the site of origin of the satyrids. Subsequent trans-beringian migrations of New World stock to the Old World and succeeding radiations and dispersals are proposed in no more detail than is justified by the tenuous evidence available. The author presents a proposed phylogeny of the Satyridae which is a dichotomous construction plotted against the geologic time scale. None of the tribes are supposed by Miller to have arisen any later than mid-Tertiary. The "generic-series" are not included in the phylogenetic scheme described above, but are included in the time sequence discussion ("later history of the Satyridae").

In summary, this reviewer found Miller's work to be characterized by conciseness, lucidity, and smoothness of conception, technique, writing, and expression. His painstaking work does not include recent techniques in the field, *e.g.*, computer methods, cytogenetics, or chromatography. Realistically, such involvement might have delayed the appearance or even prevented the completion of this one man vs. 400 genera undertaking. It is unfortunate that there have been so few families of insects subjected to such fine, critical treatments on a world-wide basis. This should stand as an example for lepidopterists to contrast with failings of less fortunately endowed works on butterflies.—PAUL A. OPLER, *University of California, Berkeley, California*.

BOOK NOTICE

Stehr, Frederick W., & Edwin F. Cook, "A revision of the genus *Malacosoma* Hübner in North America (Lepidoptera: Lasiocampidae): systematics, biology, immatures, and parasites." *United States National Museum Bulletin* 276: 321 pp., 399 figs. 1968.

Six species are recognized: *disstria*, *constrictum* (2 subspecies), *tigris*, *americanum*, *californicum* (6 subspecies) and *incurvum* (3 subspecies); *M. californicum* is particularly variable and sometimes difficult to distinguish from *M. incurvum*, but the other species appear to be clearly separated. A comprehensive and valuable monograph of a difficult genus.—PETER F. BELLINGER, *San Fernando Valley State College, Northridge, California*.

MINUTES OF THE FIFTEENTH ANNUAL MEETING OF THE PACIFIC SLOPE SECTION OF THE LEPIDOPTERISTS' SOCIETY

September 6-8, 1968, Berkeley, California

Friday, Sept. 6

Open house was held in Wellman (Agriculture) Hall on the Berkeley Campus. The collections of the California Insect Survey of the Dept. of Entomology, University of California, Berkeley and the extensive library facilities were available for study.

A field trip for collectors to the San Joaquin Delta area, about 70 miles northeast of the Berkeley Campus, met first at the Antioch Dunes, Contra Costa County. The purpose was to secure *Apodemia mormo langei*, several of which were taken by each of the collectors. In addition, *Ochlodes yuma*, *O. sylvanoides*, *Lerodea eufala*, *Erynnis tristis*, and many other species were taken. Rod Davis met us at the dunes, and the group caravanned to his home in Antioch for a much welcomed lunch and refreshments. During the afternoon the group went to Brannan Island, Sacramento County, and collected an area where the *Phragmites* grass is plentiful. Species taken that are not usually found in the immediate Bay Area included: *Ochlodes yuma*, *L. eufala*, *Pholisora catullus*, *Lycaena helloides* and *Pseudohazis eglanterina*.

Saturday, Sept. 7

Members and guests gathered at the museum for registration and inspection of the collection. Then the group went to the Earth Sciences Building for the morning session with Dr. J. A. Powell presiding.

The Saturday morning session included the following presentations:

Welcome Message—W. W. MIDDLEKAUFF, *Associate Dean of The College of Agriculture, University of California, Berkeley.*

The Lepidopteran Heart: A clue to the evolution of the Order—JOHN H. HESSEL, *Stanford University, Stanford, Calif.*

Life history studies in North American Sterrhinae (Geometridae)—CHARLES V. COVELL, *University of Louisville, Louisville, Kentucky.*

Investigations of the ecology of *Laspeyresia cupressana* (Tortricidae)—GORDON W. FRANKIE, *University of California, Berkeley.*

The poison oak leaf-roller, *Gracilaria diversilobiella* (Gracilariidae)—HAROLD SWEET, *College of San Mateo, San Mateo, Calif.*

Notes and exhibits:

Papilio bairdii: Color slides of larvae and adults—hybrids, color phases.—FRED THORNE, *El Cajon, Calif.*

Heterochroa bredowii californica: Color slides of larvae, pupae and their habits.—L. E. GILBERT, *Stanford, Calif.*

Collecting localities in Kentucky: Color slides of scenery, plants, *Speyeria diana*, etc.—C. V. COVELL, *Louisville, Kentucky.*

After lunch the meeting was called to order, with C. D. MACNEILL, Oakland Natural Sciences Museum, Oakland, Calif., presiding.

The Saturday afternoon session consisted of a symposium on population dynamics of butterflies, with the following presented:

Territoriality in butterflies—LAWRENCE E. GILBERT, *Stanford University, Stanford, Calif.*

The relationship of adult movements to population structure in *Euphydryas editha*—PETER F. BRUSSARD, *Stanford University, Stanford, Calif.*

Some aspects of larval biology of *Euphydryas editha*—MICHAEL C. SINGER, *Stanford University, Stanford, Calif.*

The Monarch butterfly: Population dynamics of overwintering migrants—ROBERT G. BROWNLEE, *Stanford Research Institute, Menlo Park, Calif.*

Notes on some populations of *Papilio indra* and *P. zelicaon* in Washington—DAVID V. MCCORKLE, *Oregon College of Education, Monmouth, Oregon.*

After some discussion of the papers presented, the business meeting was called to order by Dr. J. A. Powell. As editor, he discussed the problems of the *Journal*. There is a considerable backlog of papers, and the printing costs are getting higher. It is proposed to have "Supplements" to the *Journal* for articles too long for regular publication, but shorter than monograph size. Publication costs will be offset by changing the dues categories—\$5 Student, \$8 Regular, and \$10 for institutions.

An official emblem for the Society was discussed. The emblem was proposed at the 1967 meeting in Corvallis, Oregon.

It was announced that the 1969 National Meeting will be in East Lansing, Michigan, and there is a possibility for the West Coast in 1970.

It was moved and passed that the 1969 Pacific Slope Meeting be held in Los Angeles, Calif. Lloyd M. Martin volunteered the facilities of the Los Angeles County Museum of Natural History.

Fred Thorne made a motion that the Secretary *Pro Tem* send letters of thanks to Dr. J. A. Powell for the excellent program, and to P. A. Opler for the local arrangements plus the Friday field trip. The motion was seconded and passed unanimously.

Dr. Powell announced that it is time for the members to consider the possibility of electing new editors for both the JOURNAL and the NEWS, as he and E. J. Newcomer have served five years of their six year terms.

The annual banquet was held at Spenger's Fish Grotto in West Berkeley. Cocktails and the dinner were followed by numerous slides accompanying the evening address—"Butterfly research today: Tropics and temperate regions."—THOMAS C. EMMEL, *University of Florida, Gainesville, Florida.*

Sunday, Sept. 8

Members and guests met at the Earth Sciences Building around 9:30 a.m. for the Sunday morning session. The meeting was called to order with J. H. Shepard, University of California, Berkeley, presiding. The program included the following presentations:

Colias from Afghanistan and Kashmir—WILLIAM HOVANITZ, *Arcadia, Calif.*

Report on 1968 Annual Meeting in Washington, D. C.—PAUL A. OPLER, *University of California, Berkeley, Calif.*

The genus *Cercyonis* in North America—THOMAS C. EMMEL, *University of Florida, Gainesville, Florida.*

Collecting Lepidoptera in southern Florida—CHARLES V. COVELL, *University of Louisville, Louisville, Kentucky.*

At 12:30 p.m. the meeting was adjourned for the taking of group pictures and lunch.

The meeting was called to order at 1:45 p.m., with P. A. Opler presiding. Notes and exhibits:

Colias eurytheme—Color slides of ♂ collected in Minnesota with complete absence

of black. *Incisalia iroides*—Slides showing mating behavior—J. A. POWELL, University of California, Berkeley.

Papilio zelicaon: Pictures of mostly black mature larva among many normal larvae in Sacramento—N. L. LA DUE, Sacramento, Calif.

On display, were various contributors' boxes of Lepidoptera and color-plate paintings of butterflies by W. H. HOWE, Kansas City, Missouri.

The Sunday afternoon session concluded with the following two papers:

Some classical collecting localities in the southwestern United States—J. W. TILDEN, San Jose State College, San Jose, Calif.

Biosystematics of *Callophrys dumetorum* and *C. viridis* in California—GLENN A. GORELICK, University of California, Berkeley, Calif.

At 4:10 p.m. the meeting was adjourned.

A total of 60 members and guests attended one or more sessions, including members from nine states outside of California. Registered members included: P. H. Arnaud, Jr., George Connor, C. V. Covell, T. W. Davies, Rod Davis, B. A. Drummond, T. C. Emmel, Ken Goeden, G. A. Gorelick, Bill Hammer, C. F. Harbison, Chris Henne, Pete Herlan, J. H. Hessel, Richard Holland, William Hovanitz, W. H. Howe, Bob Koyama, Noel LaDue, John Lane, R. L. Langston, Alvin Ludtke, David McCorkle, C. D. MacNeill, L. M. Martin, S. O. Mattoon, Dennis Murphy, E. J. Newcomer, P. A. Opler, J. A. Powell, Joe Roberds, Jim Scott, E. O. Sette, J. H. Shepard, W. L. Swisher, F. T. Thorne, J. W. Tilden, Richard Williams.

Respectively submitted, ROBERT L. LANGSTON, *Secretary, pro tem.*

CORRECTION

The article, "A collecting trip to northern Queensland," by Douglas Marsden (J. Lepid. Soc., 22:121-2, 1968) contains errors to which I draw attention for the sake of accuracy of future records. *Eurema hacabe phoebus* should be *E. hecabe phoebus*, the widely distributed eastern species. *Delias mysis aestiva* is the name of the subspecies from the Port Darwin area, a thousand miles to the west. I think Marsden has mistaken the normal male of *mysis mysis* for the northwestern Australian race. The Fabrician type of *m. mysis* came from the Endeavour River, less than 100 miles north of Cairns and the areas in which Marsden collected. *Eurema candida virgo* needs very careful checking. No writer has recorded this species south of the Claudie River district, and I have checked with several of my Queensland colleagues, who, like myself, have never taken it even as far south as Cooktown. True *virgo* is distinctive among all Australian *Eurema* in that the male is the normal yellow with a wide, deep black border, but the female is white. I think it probable that a dark specimen of *E. brigitta australis* has been mistaken for the rare *virgo*, which is known only from the extreme northern part of Cape York Peninsula.—L. E. COUCHMAN, West Hobart, Tasmania, Australia.

BOOK NOTICE

A REVISION OF THE PEORIINAE AND ANERASTIINAE (AUCTORUM) OF AMERICA NORTH OF MEXICO (Lepidoptera: Pyralidae), by Jay C. Shaffer. U. S. National Museum, Bulletin 280; vi + 124 pp. incl. 26 halftone plates. Smithsonian Inst., Washington, D. C., 1968; 20 cents, paper cover.

A thorough revision of adults of the species formerly assigned to the Anerastiinae. Shaffer transfers *Anerastia* and seven related genera to the Phycitinae, necessitating proposal of Peoriinae to accommodate *Peoria* and the remaining genera in the separate subfamily. In all, some 15 genera and 39 species are treated, of which four genera and seven species are described as new.—ED.

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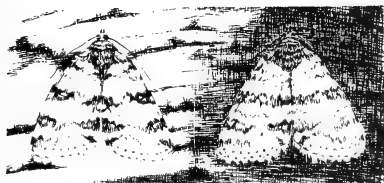
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SUPPLEMENT 1

SYSTEMATIC REVIEW OF THE MEGATHYMIDAE

by H. A. Freeman

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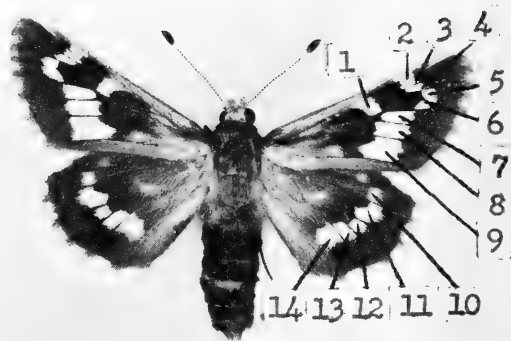
Volume 23

Supplement 1

SYSTEMATIC REVIEW OF THE MEGATHYMIDAE

H. A. Freeman

1605 Lewis Drive, Garland, Texas



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INTRODUCTION

In 1938, when this study began, the family Megathymidae was perhaps the most poorly known family of Rhopalocera. At that time there were 14 names regarded as species (one of which was later to be treated as a synonym and another as a subspecies) and four names regarded as subspecies, three of which are now recognized as full species. Today we recognize 49 species and 15 subspecies in this group of butterflies. The life histories of all species and subspecies have been worked out, with the exception of three which are known only in part. Chromosome counts have been made for many of the species by Dr. Charles Remington and his staff at Yale, and I have studied the chromosomes of additional species. Besides the work that I have done with this family, contributions to our knowledge of this interesting family have been made by Don B. Stallings, Viola Stallings, Dr. J. R. Turner, Ernest R. Tinkham, Charles F. Harbison, Dr. Charles Remington, and Dr. John A. Comstock.

In preparing keys for the identification of species and subspecies, reference is made to the spots of the wings and to the wing shape, and these characters are illustrated on plate 1. The spot numbers are given as 1 to 14, beginning with the cell spot (fig. 1). The wing shape is determined by a ratio of three measurements: 1) base-to-apex of forewing, or primary; 2) apex-to-outer angle (tornus) of primary; and 3) base-to-termination of Cu_1 of hindwing, or secondary. The wing shape is considered broad, if this ratio is 3:1.85:1.85, or greater (fig. 2); medium, if the ratio is about 3:1.6-1.8:1.6-1.8 (fig. 3); and narrow, if the ratio is less than 3:1.6:1.6 (fig. 4). As may be expected, infraspecific variation occurs in this ratio, but when based on average specimens, this character is useful as a means of identification.

A number of terms used in the keys are here defined: 1) sericin - a gelatinous protein that cements silken fibers found in the construction of the trap-door over the feeding tunnel in *Agathymus*; 2) apiculus - the erect, short point at the end of the club in some skippers; 3) pulvillus - a soft, padlike structure between the tarsal claws; 4) paronychium - a small, sleeve-like structure over the base of the tarsal claw; 5) tent - a silken tube constructed by the larvae of certain Megathymidae over the feeding tunnel; 6) phantom spot - an indistinct spot, usually spot 14; 7) genitalia simple - valvae and vaginal

plate thin without any spines or processes; 8) genitalia fairly simple - valvae and vaginal plate thin with a few spines and other processes; 9) genitalia complex - valvae and vaginal plate thick with many spines and other processes; 10) flat black - in relation to the ground color, in which it is grayish-black with no purple gloss; 11) dull colored - not shiny; 12) deep black - very dark black with a slight purple gloss; 13) warm colored - refers to ground color, usually black with some intermixed brown or orange scales; 14) heavy - in relation to scaling, very dense; and 15) proharpe - a spiny process extending diagonally upward from near the terminal end of the sacculus or ventral part of the harpe or valva of the male genitalia.

ACKNOWLEDGMENTS

I would like to express my appreciation to the National Science Foundation for Research Grants G-9900 and GB-398 which made this study possible. The photographs used in this article were made by Mr. Don B. Stallings, Caldwell, Kansas.

Family MEGATHYMIDAE Comstock

Comstock, J. H. and A. B., 1895, Manual Study Insects: p. 365.

This family is made up of five genera containing 49 species and 15 subspecies. It is restricted to the Nearctic and northern Neotropical Regions. The adults are robust insects, usually measuring over 50 mm in wing expanse. They have a small head which is usually one half the width of the thorax. They have clubbed antennae, which show generic variation. The larvae feed in the caudex of *Yucca*, *Agave*, or *Manfreda* plants and the pupae have the ability to move up and down in the larval tunnel.

Key to the subfamilies of Megathymidae

- 1a. Larvae construct a silken tent over feeding tunnel, pulp feeders; pupae with cremaster broadly rounded at terminal end, densely clothed with stiff, long bristles; vaginal plate of female simple and thin; adults usually fly in spring and summer, one species double brooded.....Megathyminae (p.3)
- 1b. Larvae construct a sericin-cemented trap door over feeding tunnel prior to pupation, primarily sap feeders; pupal cremaster may be bare or provided with hooks; vaginal plate of female complex and thick; adults fly in late summer and fall.....Aegialinae (p.26)

Subfamily MEGATHYMINAE Holland

Holland, W. J., 1899, Butterfly Book: 368.

Key to the genera of Megathyminae

- 1a. Antennal club with an apiculus; antennae extending to inner edge of cell spot; paronychium bilobed, short and broad; genitalia simple; pupal cremaster barely spatulate, not depressed in center; tent constructed in last stages of larval feeding; *Manfreda* feeders..
.....*Stallingsia* Freeman
- 1b. Antennal club without apiculus; antennae not reaching cell spot; paronychium usually bilobed and fairly broad; genitalia fairly simple; pupal cremaster spatulate, with depressed center; tent constructed as larvae feed; *Yucca* feeders, except two species which feed on *Agave*.....*Megathymus* Scudder

STALLINGSIA Freeman

Stallingsia Freeman, 1959, Lepid. News, 12: 87 ["1958"]

Key to the species of *Stallingsia*

- 1a. Expanse usually more than 50 mm; spot 9 well defined.
.....2
- 1b. Expanse usually less than 50 mm, (average of males 42 mm, females 45 mm); spots 7 and 8 elongated; spot 9 obsolete; southeastern Texas, northeastern Mexico..
.....*maculosus* (Freeman)
- 2a. Average expanse of males 64 mm, females 65 mm; ground color brown; secondaries with or without discal spots; spots 7 and 8 elongated; southwestern Mexico.....
.....*smithi* (Druce)
- 2b. Average expanse of males 57 mm, females 59 mm; ground color chocolate brown in females, brownish-black in males; spots 7 and 8 round; extreme southern Mexico..
.....*jacki* S., T. & S.

1. *Stallingsia smithi* (Druce)

Megathymus smithi Druce, 1896, Biol. Centr. - Amer., Lepid. Heter., 2: 320, pl. 69, fig. 6.

Stallingsia smithi; Freeman, 1959, Lepid. News, 12: 87 ["1958"].

Type locality. - Amula, Guerrero, Mexico.

Distribution. - Mexico: Several specimens were taken near Guadalajara, Jalisco Mexico in apparently *Manfreda maculata* (Martius) Rose, which differ somewhat from specimens collected by Wilson near the type locality. This is still a very rare species in collections.

Chromosome number. - unknown.

2. *Stallingsia maculosus* (Freeman)

Megathymus maculosus Freeman, 1955, Amer. Mus. Novitates, 1711: 10.

Stallingsia maculosus; Freeman, 1959, Lepid. News, 12: 87 ["1958"]

Type locality. - Kingsville, Texas.

Distribution. - Southern Texas and northern Mexico. This species was first discovered at Parita Creek, Bexar Co., Texas. Later specimens were collected at Kingsville, Sinton, Falls City, Floresville, Sullivan City, and Mission. The only Mexican location where this species has been found was 35 miles southwest of China, Nuevo Leon.

Life history. - This is the only Megathymid that is known to be double brooded. I have collected pupae in April that emerged in May, while most of our specimens were collected as larvae and pupae during August and emerged during September and October. The larvae feed in the caudex of *Manfreda maculosa* Hooker. pH of soil, -7-7.3 in areas where larvae were collected.

Chromosome number. - 50.

3. *Stallingsia jacki* Stallings, Turner, & Stallings

Stallingsia jacki Stallings, Turner, and Stallings, 1963. Jour. Lepid. Soc., 17:117, pl. 2.

Type locality. - near Tuxtla Gutierrez, Chiapas, Mexico.

Distribution. - Known only from the type locality.

Life history. - This species is apparently single brooded. Larvae I collected during August, 1964, emerged during May and June of the following year. The food plant is a species of *Manfreda* which has unusually long, solid green, leaves and grows in tall grass, making the location of infested plants difficult. pH of soil, -7 - 7.2.

Chromosome number. - unknown.

MEGATHYMUS Scudder

Megathymus Scudder, 1872, Rept. Peabody Acad. Sci., 1871:83(62).

Key to the males of *Megathymus*

- 1a. Antennal club half white, half black; veins on lower surface of secondaries not contrasting with ground color.....2
- 1b. Antennal club all white; veins on lower surface of secondaries black, contrasting with ground color..8
- 2a. Wing shape narrow; no discal spots on lower surface of secondaries; no dense hair-like scales on wings.3
- 2b. Wing shape narrow; dark discal areas and distinct white spot near anal angle on lower surface of secondaries; no dense hair-like scales on wings.....4
- 2c. Wing shape broad; discal spots present on lower surface of secondaries; dense hair-like scales on upper surface of secondaries and lower surface of primaries.....5
- 3a. Ground color deep reddish-black; usually one subcostal spot on lower surface of secondaries; spots and marginal border of secondaries orange yellow; east of Mississippi River.....*yuccae* (Bdv. & LeC.)
- 3b. Ground color variable from brownish black to flat black; usually two subcostal spots on lower surface of secondaries; spots and marginal border of secondaries white to lemon yellow; west of the Mississippi River.....*coloradensis* Riley
- 4a. Ground color dull black; spots 7, 8, and 9 well developed, with a yellowish cast; spot 7 usually reaches to or slightly beneath spot 6; overscaling near base of wings brownish-yellow; Hidalgo, Mexico.. *beulahae* S. & T.
- 4b. Ground color purplish-black; spots 7, 8, and 9 small, white; spot 7 usually well separated from spot 6; overscaling near base of wings light yellowish-gray; vicinity of Coahuila, Mexico.....*gayleae* S., T. & S.
- 5a. Ground color brownish-black; spots and marginal border orange-yellow; discal spots on lower surface of

- secondaries indistinct, forming a straight line;
Georgia and Florida.....6
- 5b. Ground color grayish-black to flat black; spots and marginal border light yellow; discal spots and other spots on lower surface of secondaries irregular in arrangement; South Dakota to Arizona.....7
- 6a. Ground color light brownish-black; marginal border of secondaries broad; discal band on lower surface of secondaries well developed; average expanse 55 mm; Florida.....*cofaqui* (Strecker)
- 6b. Ground color dark brownish-black; marginal border of secondaries medium to narrow; discal band on lower surface of secondaries poorly developed; average expanse 59 mm; north central Georgia.....*harrisi* Freeman
- 7a. Ground color warm grayish-black; spots and marginal border of secondaries dark yellow; a few creamy-yellow spots on lower surface of secondaries; ground color on lower surface of secondaries uniform grayish-brown; average expanse 72 mm; South Dakota to New Mexico.....*texasus* B. & McD.
- 7b. Ground color dull, flat black; spots and marginal border of secondaries yellowish-white; many white spots and dark blotches on lower surface of secondaries giving a mottled appearance; average expanse usually less than 72 mm; Arizona, New Mexico and Colorado.....*streckeri* (Skinner)
- 8a. Ground color dull, dark black; spots 7, 8, and 9 of approximately equal width, dark yellow; under surface of secondaries roughly overscaled with white; Arizona.....*ursus* Poling
- 8b. Ground color shiny black; spots 7, 8, and 9 progressively broader, orange; under surface of secondaries evenly overscaled with white; New Mexico, Texas and northern Mexico.....*violae* S. & T.

Key to the females of *Megathymus*

- 1a. Antennal club one-half or less white, remaining portion black; veins not black on lower surface of secondaries; discal spots on upper surface of secondaries usually present.....2
- 1b. Antennal club all white; veins black on lower surface of secondaries, contrasting with ground color; no discal spots on upper surface of secondaries.....8

- 2a. Wing shape narrow; no discal band on lower surface of secondaries.....3
- 2b. Wing shape narrow; conspicuous white, curved band on lower surface of secondaries.....4
- 2c. Wing shape broad; discal spots on lower surface of secondaries variable from one to many.....5
- 3a. Ground color deep umber black; usually one subcostal spot on lower surface of secondaries; spots and marginal border of secondaries orange-yellow; discal spots on upper surface of secondaries separate, rounded.....*yuccae* (Bdv. & LeC.)
- 3b. Ground color variable from brownish-black to shiny black; usually two subcostal spots on lower surface of secondaries; spots and marginal border variable from white to dark yellow; discal spots on upper surface of secondaries variable from fused to widely separate.....*coloradensis* Riley
- 4a. Ground color dark grayish-black; spot 7 situated beneath inner edge of spot 6; discal band well developed, spots adjacent but separate, especially close on secondaries; spots creamy-white; overscaling near base of wings grayish-brown.....*beulahae* S. & T.
- 4b. Ground color dull black; spot 7 seldom extending beneath inner edge of spot 6; discal band greatly reduced on both primaries and secondaries; spots white; overscaling near base of wings grayish yellow.....*gayleae* S., T. & S.
- 5a. Ground color brownish-black; spots orange-yellow; spot 7 usually extending to inner edge of spot 1; discal spots on lower surface of secondaries usually obsolete; discal spots on upper surface of secondaries forming a straight line.....6
- 5b. Ground color brownish black to black; spots orange yellow to white; spot 7 not extending to inner edge of spot 1; discal spots on lower surface of secondaries well defined; discal spots on upper surface of secondaries if present, slightly curved inward.....7
- 6a. Ground color warm brownish-black; marginal border of secondaries fairly broad; discal spots on upper and lower surfaces of secondaries well-defined; average expanse 55 mm.....*cofaqui* (Strecker)
- 6b. Ground color dark brownish-black; marginal border of secondaries obsolete; discal spots on upper surface of secondaries reduced, on lower surface of

- secondaries obsolete; average expanse 59 mm.....
*harrisi* Freeman
- 7a. Ground color brownish-black; spots and marginal border dark yellow; ground color on lower surface of secondaries evenly brownish-gray, the discal spots creamy, reduced; discal spots on upper surface of secondaries well-defined.....
*texanus* B. & McD.
- 7b. Ground color dark grayish-black; spots and marginal border yellowish-white; under surface of secondaries mottled dark and light grayish-black; discal spots on lower surface of secondaries well-defined, clear white; discal spots on upper surface of secondaries absent or poorly defined.....
*streckeri* (Skinner)
- 8a. Ground color dark, shiny black; spots 7 and 8 usually wider than 9, dark yellow; under surface of secondaries roughly overscaled with white.....
*ursus* Poling
- 8b. Ground color warm black; spots 7, 8 and 9 of approximately equal width, orange; under surface of secondaries evenly overscaled with white.....
*violae* S. & T.

1. *Megathymus yuccae* (Boisduval & LeConte)

Key to the males of the subspecies of *Megathymus yuccae*

- 1a. Ground color dark brownish-black; spots of upper surface deep yellow; overscaling near base of wings medium to heavy; spot 9 in line with spots 7 and 8, not separate from them; marginal border of secondaries medium to broad, deep yellow; usually one subcostal spot on lower surface of the secondaries; average expanse 60 mm; North Carolina to Louisiana..
*yuccae* (Bdv. & LeC.)
- 1b. Ground color deep umber brown; spots of upper surface orange-yellow; overscaling near base of wings heavy; spot 9 separate from and slightly inward from spot 8; marginal border of secondaries broad, orange-yellow; usually one subcostal spot on lower surface of secondaries; average expanse 62 mm; Florida.....
*buchholzi* Freeman

Key to the females of the subspecies of
Megathymus yuccae

- 1a. Ground color dark brownish-black; spots of upper surface deep yellow; dense, deep yellow overscaling near base of wings; spots 7, 8 and 9 broad, about equal in size; fringes of primaries dark, faintly checkered with lighter scales; discal spots of secondaries well developed, 10 and 11 usually fused; marginal border of secondaries wide, deep yellow; under surface of secondaries uniform brownish-black, somewhat lighter around costa and margin; usually one subcostal spot on lower surface of secondaries; average expanse 70 mm...*yuccae* (Bdv. & LeC.)
- 1b. Ground color deep umber brown; spots of upper surface orange-yellow; heavy, orange-yellow, overscaling near base of wings; spot 9 is separate from and slightly inward from spot 8; fringes checkered light and dark on primaries; discal spots well-developed; marginal border of secondaries wide, orange-yellow; under surface of secondaries uniform brownish-black, lighter around costa and margin; usually one subcostal spot on lower surface of secondaries; average expanse 72 mm.....*buchholzi* Freeman

1a. *Megathymus yuccae yuccae* (Boisduval & LeConte)

Eudamus yuccae Boisduval & LeConte, 1833, Lepid. Amer., Sept.: pl. 70.

Megathymus yuccae; Scudder, 1872, Rep. Peab. Acad. Sci., 4:83.

Megathymus yuccae alabamiae Freeman, 1943, Ent. News. 54: 211-217;
Freeman, 1952, Field & Lab., 20:29 (synonymy).

Type locality. - Aiken County, South Carolina.

Distribution. - North Carolina, Southern Pines; South Carolina, Aiken County; Georgia, Stone Mountain, Atlanta, Dallas; Alabama, Anniston, Rockford; Florida, Pensacola; and Louisiana, West Feliciana.

Life history. - Adults emerge during March, April and May. Larvae feed in the caudex of *Yucca filamentosa* Linn., *Yucca smalliana* Fernald, and *Yucca flaccida* Haw.

Chromosome number. - unknown.

1b. *Megathymus yuccae buchholzi* Freeman

Megathymus yuccae buchholzi Freeman, 1952, Field & Lab., 20:31.

Type locality. - Jupiter, Palm Beach Co., Florida.

Distribution. - Florida: Jupiter, Gulfport, Port Sewell, Orlando, St. Petersburg, Sarasota, Melbourne Beach, and St. Augustine.

Life history. - Adults emerge during February, March, April and May. Larval food plant: *Yucca gloriosa* Linn., *Yucca smalliana* Fernald, and *Yucca aloifolia* Linn.

Chromosome number. - 26.

2. *Megathymus coloradensis* Riley

Key to the males of the subspecies complexes of
Megathymus coloradensis

- 1a. Small (average expanse 50 mm); spot 7 extending to or well under spot 6; spots sordid white to light yellow; marginal border of secondaries medium to wide; mid-western and western United States.....2
- 1b. Medium to large (average expanse 58 mm); spot 7 extending to inner edge of spot 6; spots white to deep yellow; marginal border of secondaries narrow to wide; midwestern to southwestern United States....3
- 1c. Large (average expanse 60 mm); spot 7 may or may not reach inner edge of spot 6; spots light sordid white to dull yellow; wing shape narrow to medium; ground color flat black; medium to scant overscaling near base of wings; cell spot small; usually two subcostal spots on lower surface of secondaries; evenly brownish-gray on lower surface of secondaries; southcentral and southern Texas into northern Mexico.....
.....*wilsonorum* complex
- 2a. Ground color brownish-black; wing shape broad; spots of upper surface light yellow; heavy pale yellow overscaling at base of wings; spot 7 extending halfway beneath spot 6; cell spot large; marginal border of secondaries wide, light yellow; one crescentic spot and a curved line beneath costa on lower surface of secondaries; under surface of secondaries mottled dark and light gray; Rocky Mountains eastward to Kansas and Texas Panhandle.....
.....*coloradensis* complex
- 2b. Ground color grayish-black; wing shape medium; spots of upper surface light yellowish-white; indistinctly overscaled at base of wings; spot 7 extending to or slightly beneath spot 6; cell spot medium to small; marginal border of secondaries of medium width,

grayish-white; usually two spots beneath costa on lower surface of secondaries; under surface of secondaries rather evenly gray; Rocky Mountains and westward.....*navajo* Complex

- 3a. Ground color shiny black; wing shape medium to broad; spots lemon-to orange-yellow; faint to heavy overscaling near base of wings; spot 7 reaching inner edge of spot 6; cell spot large; marginal border of secondaries narrow to medium width, same color as spots; one to two subcostal spots on lower surface of secondaries; under surface of secondaries evenly grayish-black to brownish, somewhat lighter near margin; southern Kansas to northern Texas.....*stallingsi* Complex
- 3b. Ground color grayish-black; wing shape narrow to broad; spots white to light yellow; western and southwestern United States.....4
- 4a. Wing shape narrow to medium; spots sordid white; medium to heavy, light gray overscaling near base of wings; cell spot small; marginal border of secondaries of medium width, grayish-white; usually two subcostal spots on lower surface of secondaries; under surface of secondaries evenly gray; California and western Arizona.....*martini* Complex
- 4b. Wing shape medium to broad; spots sordid white to light yellow; heavy overscaling of paler hairs and scales near base of wings; cell spot medium to large; marginal border of secondaries very wide; usually two subcostal spots on lower surface of secondaries; under surface of secondaries usually mottled dark and light gray; southeastern Arizona to southwestern Texas.....*arizonae* Complex

Key to the females of the subspecies complexes of *Megathymus coloradensis*

- 1a. Small (average expanse 58 mm); spot 7 extending well under spot 6; spots sordid white to light yellow; marginal border of secondaries medium to wide; discal band of secondaries well-developed.....2
- 1b. Medium to large (average expanse 68 mm); spot 7 extending to or slightly beneath spot 6; spots white to deep yellow; discal band of secondaries medium to well-developed.....3
- 1c. Large (average expanse 71 mm); wing shape narrow to medium; ground color flat black; spots sordid white to light yellow; scant to medium overscaling near base of wings; spot 7 may or may not reach inner edge

of spot 6; cell spot small to medium; spots 7 and 8 narrow, about equal size, with spot 9 triangular and much wider than the other two, with the apex pointing inward; discal spots of secondaries poorly defined to medium, with 10 and 11 often absent; marginal border of secondaries medium and same general color as spots; under surface of secondaries grayish-black, becoming lighter near the border..*wilsonorum* Complex

- 2a. Ground color brownish-black; wing shape broad; spots of upper surface light yellow; heavy overscaling near base of wings; spot 7 extending halfway beneath spot 6; cell spot large; spots 7, 8 and 9 broad and squarish, about equal in width; discal spots of secondaries large and usually fused, usually with a phantom spot in space 14; marginal border of secondaries broad and yellowish; under surface of secondaries usually mottled light and dark.....*coloradensis* Complex
- 2b. Ground color grayish-black; wing shape medium; spots of upper surface light yellow; indistinct overscaling near base of wings; spot 7 extending to or well beneath inner edge of spot 6; cell spot medium to small; spots 7 and 8 round on inner side, with indication of tooth, spot 9 somewhat wider; discal spots of secondaries small, separate, phantom spot in space 14 usually absent; marginal border of secondaries of narrow to medium width, grayish-yellow; under surface of secondaries usually uniform gray, sometimes lighter near margin.....*navajo* Complex
- 3a. Ground color shiny black; wing shape medium to fairly broad; spots of upper surface lemon- to orange-yellow.....*stallingsi* Complex
- 3b. Ground color grayish-black; wing shape narrow to medium; spots white to light yellow.....4
- 4a. Wing shape narrow to medium; spots sordid white; light to medium overscaling near base of wings; cell spot large; spots 7, 8 and 9 medium to wide; discal spots of secondaries small to medium, separate; marginal border of secondaries medium; under surface of secondaries evenly gray.....*martini* Complex
- 4b. Wing shape medium to wide; spots sordid white to light yellow; medium to heavy overscaling near base of wings; cell spot medium; spots 7, 8 and 9 wide; discal spots of secondaries large, often fused, a well-defined phantom spot in space 14; marginal border of secondaries very wide; under surface of secondaries variable from uniform gray to very mottled dark and light...*arizonae* Complex

Key to the males of the
Megathymus c. coloradensis complex

- 1a. Ground color light brownish-black; spot 7 extending half the distance under spot 6; heavy overscaling of light yellow near base of wings; small, (average expanse 50 mm); Oklahoma panhandle, Texas panhandle, southern Colorado, and northern New Mexico.....
.....*c. coloradensis* Riley
- 1b. Ground color dark brownish-black; spot 7 extending to or about half way under spot 6; light overscaling of yellow near base of wings; size larger (average expanse 54 mm); eastern New Mexico.....
.....*c. elidaensis* S. T. & S.

Key to the females of the
Megathymus c. coloradensis complex

- 1a. Ground color light brownish-black; spot 7 usually extending half the distance under spot 6; usually fairly heavy, pale overscaling near base of wings; discal spots on upper surface of secondaries usually large and fused, with a distinct phantom spot in space 14; small, (average expanse 58 mm).....
.....*c. coloradensis* Riley
- 1b. Ground color dark brownish-black; spot 7 extending usually about a third of the distance under spot 6; overscaling near base of wings medium; discal spots on upper surface of secondaries usually separate, and the phantom spot in space 14 is more or less obsolete; larger (average expanse 68 mm).....
.....*c. elidaensis* S. T. & S.

- 2a. *Megathymus coloradensis coloradensis* Riley,
new combination

Megathymus yuccae coloradensis Riley, 1877, Trans. Acad. Sci. St. Louis, 3:568.

Type locality. - near Colorado Springs, Colorado.

Distribution. - Colorado: Colorado Springs, Springfield; Kansas: Wallace Co.; Oklahoma: Kenton; Texas: Palo Duro Canyon; New Mexico: Santa Fe.

Life history. - Adults emerge during April and May. Larval food plant, *Yucca glauca* Nuttall.

Chromosome number. - 27.

2b. *Megathymus coloradensis elidaensis* Stallings,
Turner & Stallings, new combination

Megathymus yuccae elidaensis Stallings, Turner & Stallings, 1966, Lepid. Soc., 20:170.

Type locality. - near Elida, Roosevelt Co., New Mexico.

Distribution. - known only in the vicinity of the type locality.

Life history. - Adults emerge during March, April and May. Larval food plant, *Yucca glauca* Nuttall.

Chromosome number. - unknown.

Key to the males of the *Megathymus c. navajo* complex

- 1a. Spot 9 same width as spot 8; marginal border of secondaries grayish-white, indistinct; northern New Mexico, northern Arizona, southern Nevada.....
.....*c. navajo* Skinner
- 1b. Spot 9 elongated inward, approximately two times the width of spot 8; marginal border of secondaries yellowish-white, distinct; Utah, southwestern Colorado.....
.....*browni* S. & T.

Key to the females of the *Megathymus c. navajo* complex

- 1a. Spot 9 approximately same width as spot 8, bluntly pointed inward; marginal border of secondaries grayish-white, indistinct....*navajo* Skinner
- 1b. Spot 9 usually wider than spot 8, pointed inward toward base of wing; marginal border of secondaries yellowish-white, rather distinct.....
.....*browni* S. & T.

2c. *Megathymus coloradensis navajo* Skinner,
new combination

Megathymus yuccae navajo Skinner, 1911, Ent. News, 22:300.

Type locality. - Ft. Wingate, Zuni Mountains, McKinley Co., New Mexico.

Distribution. - New Mexico: Ft. Wingate; Jemez Springs; Bandalier; Colorado: Park Co.; Tarryall River Rd.; Arizona: Grand Canyon; Nevada: Charleston Mts., Clark

Co.; California: Little San Bernardino Mts., San Bernardino Co..

Life history. - Adults emerge during April, May, and June. Larval food plants, *Yucca baccata* Torr., *Yucca baileyi* Wooten & Standley, and *Yucca schidigera* Roezl.

Chromosome number. - 27.

2d. *Megathymus coloradensis browni*
Stallings & Turner, new combination

Megathymus yuccae browni Stallings & Turner, 1960, Ent. News, 71:112.

Type locality. - Salina, Sevier Co., Utah.

Distribution. - Utah: Salina; Colorado: Black Canyon, Gunnison Co.

Life history. - Adults emerge during May and June. Larval food plant, *Yucca harrimaniae* Trelease.

Chromosome number. - unknown.

Key to the males of the *Megathymus c. stallingsi* complex

- 1a. Wing shape medium; spots lemon yellow; marginal border of secondaries narrow to medium, usually two subcostal spots on lower surface of secondaries; average expanse 55 mm; southcentral Kansas to northcentral Texas.....*stallingsi* Freeman
- 1b. Wing shape broad; spots deep yellow; marginal border of secondaries medium; usually one subcostal spot on lower surface of secondaries; average expanse 61 mm; east Texas.....*reinthali* Freeman

Key to the females of *Megathymus c. stallingsi* complex

- 1a. Wing shape medium; spots on upper surface lemon yellow; faint grayish-brown overscaling near base of wings; spot 7 reaching under inner edge of spot 6; cell spot of medium size; spots 7 and 8 fairly broad, spot 9 broadly triangular, its apex pointing inward; fringes of primaries black, faintly checkered with gray scales; discal spots of secondaries narrow, yellowish-gray; under surface of secondaries uniform brownish-black, with gray around margin; average expanse 65 mm.....*stallingsi* Freeman
- 1b. Wing shape broad; spots of upper surface dark yellow;

heavy, orange-yellow, overscaling at base of primaries; spot 7 reaching well under spot 6; cell spot large; spots 7, 8, and 9 broad, of about equal width; fringes of primaries yellow, faintly checkered with brown; discal spots of secondaries large and fused, usually a phantom spot in space 14; under surface of secondaries brownish-black over discal area, gray around costa and margin; average expanse 69 mm.....
*reinthalii* Freeman

2e. *Megathymus coloradensis stallingsi* Freeman,
 new combination

Megathymus yuccae stallingsi Freeman, 1943, Ent. News, 54:214.

Megathymus yuccae stallingsi female form *dee* Freeman, 1943, Ent. News, 54:216.

Type locality. - Caldwell, Sumner Co., Kansas.

Distribution. - Kansas: Caldwell; Oklahoma: Medford, Paul's Valley, Ryan, Terral, Cement; Texas: Wheeler, Wheeler Co., Dickens, Dickens Co., Palo Pinto, Palo Pinto Co., Dallas, Lancaster, Garland, Cedar Hill, Vickery, all in Dallas Co., Cleburne, Johnson Co., Waxahachie, and Midlothian, Ellis Co.

Life history. - Adults emerge during March, April, and May. Larval food plants, *Yucca arkansana* Trelease, and *Yucca pallida* McKelvey. pH of soil, 6.1 at type locality, all Texas localities 7.3-8.0.

Chromosome number. - 27.

2f. *Megathymus coloradensis reinthalii* Freeman,
 new combination

Megathymus yuccae reinthalii Freeman, 1963, J. Lepid. Soc., 17:91

Type locality. - two miles west of Ben Wheeler, Van Zandt Co., Texas.

Distribution. - Texas: type locality, 8.8 miles s. Canton, Van Zandt Co., 3.5 miles n. e. Crow, and 1 mile n. Crow, Wood Co., 2 miles n. w. Buffalo, and Oakwood, Leon Co., Tyler State Park, Smith Co., Luling, Caldwell Co., Redwater, Bowie Co., and Floresville, Wilson Co.

Life history. - Adults emerge during March, and April. Larval food plants, *Yucca louisianensis* Trelease, and *Yucca freemanii* Shinnars. Soil pH, type locality 5.0; other locations tested, 4.9-5.1.

Chromosome number. - 27.Key to the males of the *Megathymus c. martini* complex

- 1a. Ground color grayish-black; wing shape narrow; spots 7, 8 and 9 sharply pointed on their inner surface; average size 56 mm; western Mojave desert California.
.....*martini* S. & T.
- 1b. Ground color dark grayish-black; wing shape medium; spots 7 and 8 rounded on their inner surface; average size 60 mm; Providence Mountains, in eastern Mojave Desert, California.....*maudae* S., T. & S.

Key to the females of the *Megathymus c. martini* complex

- 1a. Ground color grayish-black; wing shape narrow; spot 7 reaches one half the distance to the cell spot; spots 10 and 11 displaced slightly inward from spot 12 on the upper surface of the secondaries; spots 12 and 13 small and sometimes indistinct; average size 61 mm..
.....*martini* S. & T.
- 1b. Ground color dark grayish-black; wing shape medium; spot 7 reaching two-thirds the distance to cell spot; spots 10 and 11 in line with spot 12 on the upper surface of the secondaries; spots 12 and 13 large and well defined; average size 70 mm.....
.....*maudae* S., T. & S.

2g. *Megathymus coloradensis martini*
Stallings & Turner, new combination

Megathymus yuccae martini Stallings & Turner, 1956, Bull. So. Calif. Acad. Sci., 55:150, pl. 3.

Type locality. - Little Rock, Los Angeles Co., California.

Distribution. - Western Mojave Desert, California

Life history. - Adults emerge during January, February, March, and April. Larval food plants, *Yucca brevifolia* Engelm., and *Yucca schidigera* Roezl.

Chromosome number. - unknown.

2h. *Megathymus coloradensis maudae* Stallings,
Turner & Stallings, new combination

Megathymus yuccae maudae Stallings, Turner & Stallings, 1966, J.
Lepid. Soc., 20:169.

Type locality. - Providence Mountains, San Bernardino
County, California.

Distribution. - Mountains of eastern Mojave Desert
in California.

Life history. - Adults emerge during March and April.
Larval food plant, *Yucca schidigera* Roezl.

Chromosome number. - unknown.

Key to the males of the *Megathymus c. arizonae* complex

- 1a. Wing shape broad; ground color brownish-black; spots light yellow; overscaling near base of wings medium in density; spot 7 extending just beneath spot 6; marginal border of secondaries broad, light yellow; usually two subcostal spots on lower surface of secondaries; under surface of secondaries evenly light gray; southeastern Arizona.....*arizonae* Tinkham
- 1b. Wing shape broad; ground color flat black; spots sordid white; overscaling near base of wings usually heavy; spot 7 extending about half way beneath spot 6; heavy white overscaling along outer margins; marginal border of secondaries very broad, grayish-white; usually two well-defined, subcostal spots on lower surface of secondaries; under surface of secondaries usually mottled light and dark gray; extreme western Texas (Hueco Mts.).....*reubeni* S.T. & S.
- 1c. Wing shape narrow to medium; ground color grayish-black; spots sordid white; overscaling near base of wings medium; spot 7 extending about one half the distance under spot 6; white overscaling on upper surface of primaries restricted to apical region; marginal border of secondaries broad, grayish-white; one well-defined subcostal spot and one linear spot on lower surface of secondaries; under surface of secondaries even light gray; western Texas (Wink).....*winkensis* Freeman

Key to the females of the *Megathymus c. arizonae* complex

- 1a. Wing shape medium; spots of upper surface light yellow; scant to medium overscaling near base of wings; spot 7 reaching just beneath spot 6; cell spot of medium

size; spots 7, 8 and 9 fairly broad, about equal in size; often a broadly V-shaped phantom spot in space 14; marginal border of secondaries broad, light yellow; under surface of secondaries rather evenly grayish-black; average expanse 70 mm.....
*arizonae* Tinkham

- 1b. Wing shape broad; spots of upper side whitish; medium to heavy overscaling near base of wings; spot 7 reaching well beneath spot 6; cell spot medium to large; spots 7, 8 and 9 broad, spot 7 often reaching inward nearly to cell spot; heavy overscaling of white near outer margins on the upper surface of the primaries; a well-developed V-shaped phantom spot in space 14; marginal border of secondaries very broad, grayish-white; under surface of secondaries mottled dark and light; average expanse 69 mm.....
*reubeni* S., T. & S.
- 1c. Wing shape narrow to medium; spots of upper surface sordid whitish-yellow; medium overscaling near base of wings; spot 7 reaching to or just beneath spot 6; cell spot large; spot 7 never reaching to cell spot; white overscaling is restricted to the apical region; phantom spot in space 14 a broad blotch, not V-shaped; under surface of secondaries evenly gray with little contrast; average expanse 65 mm.....
*winkensis* Freeman

2i. *Megathymus coloradensis arizonae*
 Tinkham, new combination

Megathymus yuccae arizonae Tinkham, 1954, Bull. So. Calif. Acad. Sci., 53:81, pl. 2.

Type locality. - Mountain View, Pima Co., Arizona.

Distribution. - Arizona: south-central, Mountain View, Benson.

Life history. - Adults emerge during March. Larval food plants, *Yucca thornberryi* McKelvey, and *Yucca elata* Engelm. Soil pH, at type locality 7.1.

Chromosome number. - unknown.

2j. *Megathymus coloradensis reubeni* Stallings,
 Turner & Stallings, new combination

Megathymus yuccae reubeni Stallings, Turner & Stallings, 1963, Lepid. Soc., 17:87.

Type locality. - Hueco Mountains, El Paso Co., Texas.

Distribution. - Texas: Hueco Mountains, and near Shafter, Presidio Co.

Life history. - All specimens emerged during January to April except the one female from Shafter which emerged 8 Sept. 1957. Larval food plants, *Yucca baccata* Torrey, and *Yucca elata* Engelman. Soil pH, at type locality 7.3, and the same at the location near Shafter.

Chromosome number. - 27.

2k. *Megathymus coloradensis winkensis*
Freeman, new combination

Megathymus yuccae winkensis Freeman, 1965, J. Lepid. Soc., 19:87.

Type locality. - Wink, Winkler Co., Texas.

Distribution. - Texas: Wink, 3 miles s. Wink, Winkler Co., 6 miles n. Pyote, Ward Co.

Life history. - Adults emerge during February and March. Larval food plant, *Yucca campestris* McKelvey. Soil pH, at type locality 5.

Chromosome number. - unknown.

Key to the males of the *Megathymus c. wilsonorum* complex

- 1a. Wing shape very narrow; spots of upper side dull lemon yellow; dense, dull lemon yellow overscaling near base of wings; spot 7 not reaching inner edge of spot 6; marginal border of secondaries wide, dull lemon yellow; usually one subcostal spot on lower surface of secondaries; average expanse 61 mm; vicinity of Mission, Texas to Victoria, Tamaulipas, Mexico..
.....*wilsonorum* S. & T.
- 1b. Wing shape narrow; spots of upper side sordid yellowish-white; faint scant, gray overscaling at base of wings; spot 7 barely reaching inner edge of spot 6; marginal border of secondaries of medium width, sordid yellowish-white; two subcostal spots on lower surface of secondaries; average expanse 57 mm; San Angelo, Texas southward to Allende, Coahuila, Mexico, and westward to Langtry, Texas...*louiseae* Freeman
- 1c. Wing shape medium; spots and upper side dull lemon yellow; fairly heavy overscaling of lighter scales and hairs near base of wings; spot 7 barely reaching

inner edge of spot 6; marginal border of secondaries of medium width, dull lemon yellow; usually two white subcostal spots on lower surface of secondaries; average expanse 56 mm; northcentral Texas through San Antonio to Laredo, Texas.....*kendalli* Freeman

Key to the females of the *Megathymus c. wilsonorum* complex

- 1a. Wing shape very narrow; spots of upper surface yellowish-white; fairly heavy grayish-yellow overscaling near base of wings; spot 7 not reaching inner edge of spot 6; cell spot medium; spot 9 triangular with apex pointing inward; fringes of primaries distinctly checkered dark gray and sordid white; discal spots of secondaries greatly reduced, 10 and 11 usually absent; marginal border of secondaries broad, light yellow; under surface of secondaries grayish-black, darker over discal area and lighter around costa and margin; average expanse 74 mm.....*wilsonorum* S. & T.
- 1b. Wing shape narrow; spots of upper side yellowish-white; faint grayish-yellow overscaling near base of wings; spot 7 usually reaching to inner edge of spot 6; cell spot medium; spot 9 triangular, apex pointing inward; primaries with fringes of primaries distinctly checkered black and sordid white; discal spots of secondaries reduced, 10 and 11 mere dots, sometimes a phantom spot in space 14; marginal border of secondaries medium in width, sordid white blending into gray; under surface of secondaries uniform grayish-black, with some lighter gray around margin and near costa; average expanse 69 mm.....*loutseae* Freeman
- 1c. Wing shape medium to broad; spots of upper side light yellow; fairly heavy overscaling of yellowish-gray hairs and scales near base of wings; spot 7 may or may not reach inner edge of spot 6; cell spot medium to large; spot 9 shaped like a broad V with the point directed toward base of wing; fringes of primaries checkered light and dark; discal spots of secondaries well-defined, marginal border of secondaries narrow, yellow; under surface of secondaries uniform grayish-black; average expanse 70 mm.....*kendalli* Freeman

21. *Megathymus coloradensis wilsonorum*
Stallings & Turner, new combination

Megathymus yuccae wilsonorum Stallings & Turner, 1958, Lepid. News, 11:129 ["1957"].

Type locality. - Victoria, Tamaulipas, Mexico.

Distribution. - Mexico: Victoria, China, General

Bravo, Tamaulipas; Texas: Mission and Sullivan City, Hidalgo Co., and Rio Grande City, Starr Co.

Life history. - The adults emerge during February, March and April. Larval food plants, *Yucca treculeana* Carr., and *Yucca (Samuela) carnerosana* Trel. Soil pH, 7.3 at type locality and Mission, Texas habitats.

Chromosome number. - 27.

2m. *Megathymus coloradensis louseae* Freeman,
new combination

Megathymus yuccae louseae Freeman, 1963, J. Lepid. Soc., 17:95.

Type locality. - 16 miles north Del Rio, Val Verde Co., Texas.

Distribution. - Western Texas (vicinity of San Angelo to vicinity of Del Rio), and northern Mexico (12 miles south Allende, Coahuila).

Life history. - Adults emerge from February into May. Larval food plants, *Yucca thompsoniana* Trel., *Yucca torreyi* Shafer, and *Yucca reverchonii* Trel. Soil pH, type locality 7.1, varies in locations studied from 7.0 to 7.2.

Chromosome number. - 27.

2n. *Megathymus coloradensis kendalli* Freeman,
new combination

Megathymus yuccae kendalli Freeman, 1965, Lepid. Soc., 19:83.

Type locality. - San Antonio, Bexar Co., Texas.

Distribution. - South central Texas (Erath County to Webb County).

Life history. - Adults emerge during February, March and April. Larval food plants, *Yucca constricta* Buckley, *Yucca rupicola* Scheele, *Yucca pallida* McKelvey, *Yucca necopina* Shinnars, and *Yucca treculeana* Carr. Soil pH, 7.3 at all study habitats.

Chromosome number. - 27.

3. *Megathymus cofaqui* (Strecker)

Aegiale cofaqui Strecker, 1876, Proc. Acad. Nat. Sci. Phila., 28:148.

Megathymus cofaqui; Skinner, 1891, in: Smith, List Lep. Bor. Amer.:17.

Type locality. - Boca Grande, Lee Co., Florida.

Distribution. - Florida: Sarasota, Boca Grande, Longboat Key, Casey Key, and Lutz.

Life history. - Adults emerge during February, March and April. Larval food plant, *Yucca aloifolia* L.

Chromosome number. - unknown.

4. *Megathymus harrisi* Freeman

Megathymus harrisi Freeman, 1955, Amer. Mus. Novitates, no. 1711:2.

Type locality. - Stone Mountain, Dekalb Co., Georgia.

Distribution. - Georgia: Stone Mountain, Atlanta, and Cleveland.

Life history. - Adults emerge during July, and August. Larval food plant, *Yucca filamentosa* L.

Chromosome number. - unknown.

5. *Megathymus streckeri* (Skinner)

Aegiale streckeri Skinner, 1895, Canad. Ent., 27:179.

Megathymus streckeri 1898, Syn. Cat. N. A. Rhop.:99.

Type locality. - Petrified Forest, Apache Co., Arizona.

Distribution. - Arizona: Petrified Forest; New Mexico: Albuquerque, Santa Fe; Colorado: La Veta, Alamosa Co., Alamosa Canyon, 14 miles from Capulin, Conejos Co., Durango, La Plata Co., Del Norte, Monte Vista, Shaw Creek, South Fork, Willow Creek, Wolf Creek 5 miles east of South Fork, Rio Grande Co.

Life history. - unknown.

Chromosome number. - unknown.

6. *Megathymus texanus* Barnes & McDunnough

Megathymus streckeri texana Barnes & McDunnough, 1912, Contrib. Nat. Hist. Lepid. N. A., 1 (3):39, pl. 2, f. 9.

6a. *Megathymus texanus texanus* Barnes & McDunnough

Megathymus streckeri texana Barnes & McDunnough, 1912, Contrib. Nat. Hist. Lepid. N.A., 1:39, pl. 2, f. 9.

Megathymus texana; Freeman, 1944, Ent. News, 55:105.

Megathymus albocincta Holland, 1930, Ann. Carnegie Mus., 19:159;
Freeman, 1944, Ent. News, 55:105 (Synonymy).

Type locality. - Kerrville, Kerr Co., Texas.

Distribution. - Texas: Kerrville, Pampa, Gray Co., Skellytown, Carson Co., Palo Duro Canyon, Armstrong Co., Wheeler Co.; New Mexico: Folsom; Southeastern Colorado.

Life history. - Adults emerge during April, May and June. Larval food plant, *Yucca glauca* Nuttall.

Chromosome number. - unknown.

6b. *Megathymus texanus leussleri* Holland

Megathymus leussleri Holland, 1931, Ann. Carnegie Mus., 20:262;
Freeman, 1944, Ent. News, 55:104 (as synonym of *texana*).

Type locality. - Sand Hills near Valentine, Cherry Co., Nebraska.

Distribution. - Nebraska: Valentine, Hire; South Dakota: Black Hills.

Life History. - Adults emerge during June, and July. Larval food plants, *Yucca glauca* Nuttall.

Chromosome number. - Unknown.

This subspecies differs from typical *texanus* in that the spots are more orange-yellow on the upper surface of the primaries, especially in the females, and the males often have a small yellow spot on the disc of the secondaries where vein M_2 branches from the cell, which is lacking in typical *texanus*.

7. *Megathymus ursus* Poling

Megathymus ursus Poling, 1902, Ent. News, 13:97, pl. 4.

Type locality. - Santa Catalina Mountains, west of Redington, Pima Co., Arizona.

Distribution. - Arizona: west of Redington, Madera Canyon, Mt. Lemmon, Carr Canyon, Paradise.

Life history. - Adults emerge during June, July and August. Larval food plant, *Yucca schottii* Engelm. Soil pH, at type locality, 6.1.

Chromosome number. - unknown.

8. *Megathymus violae* Stallings & Turner

Megathymus violae Stallings & Turner, 1956, Lepid. News, 10:4.

Type locality. - Carlsbad Caverns National Park, Eddy Co., New Mexico.

Distribution. - New Mexico: Carlsbad Caverns National Park; Texas: Big Bend National Park; several locations in northcentral Mexico.

Life history. - Adults emerge during May, June and July. The larval food plant is *Yucca torreyi* Shafer.

Chromosome number. - 27.

9. *Megathymus beulahae* Stallings & Turner

Megathymus beulahae Stallings & Turner, 1958, Lepid. News, 11:121
["1957"]

Type locality. - near Ixmiquilpan, Hidalgo, highway 85, Klm. 176, Mexico.

Distribution. - Mexico: type locality and 10 miles south Ixmiquilpan.

Life history. - Adults emerge during July and August. The larval food plant is *Agave striata* Tucc. Soil pH, type locality, 6.

Chromosome number. - unknown.

10. *Megathymus gayleae* Stallings, Turner & Stallings

Megathymus gayleae Stallings, Turner & Stallings, 1963, J. Lepid. Soc., 17:81.

Type locality. - 23 Km. north Saltillo, Coahuila, Mexico, marker 903.

Distribution. - Northern Mexico: type locality, 25 to 50 miles west of Saltillo, on highway 40, 10 to 20 miles east of Saltillo, on highway 40, 73 miles north of Saltillo, in the pass and on the north slope of the Sierra de la Gavia, on highway 57.

Life history. - Adults emerge during September and October. The larval food plant is *Agave falcata* Engelm. Soil pH, at type locality, 7.4.

Chromosome number. - unknown.

Subfamily AEGIALINAE Stallings & Turner

Aegialinae Stallings & Turner, 1958, Lepid. News, 11:134 ["1957"]

The antennae extend to the outer edge of the cell spot. The pulvillus is well developed. The paronychium is bilobed, with both lobes narrow. The tongue is well developed. The genitalia form is usually complex. The larvae construct from one to two trap doors on the lower surface of the *Agave* leaf. They do not powder the larval tunnel, and the young larvae tunnel directly to the base of the leaf to form the larval chamber. The pupal cremaster is narrowly spoonbilled, and has many hooks. There is one brood each year, with the adults emerging in late summer and fall.

Key to the tribes of AEGIALINAE

- 1a. Cremaster of pupa with a small knobbed termination, usually with hooks; larval tunnel not powdered; proharpe of the male genitalia shorter than cucullus or apparently absent; antennae reaching cell or beyond.....Aegialini
- 1b. Cremaster of pupae nude, or at most with minute bristles; larval tunnel powdered; the proharpe longer than cucullus; antennae barely reaching inner edge of cell.....Agathymini

Tribe AEGIALINI Stallings & Turner

Aegialini Stallings & Turner, 1958, Lepid. News, 11:134 ["1957"]

Key to the genera of AEGIALINI

- 1a. Spot in interspace 1 in line with two above; paronychium bilobed, both lobes narrow; genitalia complex; pupal cremaster narrowly spoonbilled, with many hooks; larvae tunnel directly to base of leaf*Aegiale* Felder
- 1b. Spot in interspace 1 out of line with two above, directed inward basally; paronychium bilobed, broad; genitalia simple in males, complex in females; pupal cremaster broadly spoonbilled, with few hooks; larvae tunnel in irregular pattern to base of leaf.....*Turnerina* Freeman

AEGIALE Felder

Aegiale Felder, 1860, Wiener Ent. Monats., 4:110.

There is at present one recognized species in this genus, *Aegiale hesperiaris* (Walker), which is confined to Mexico.

1. *Aegiale hesperiaris* (Walker)

Castnia hesperiaris Walker, 1856, List Lep. Het. Brit. Mus., 7:1583.

Acentrocneme hesperiaris; Druce, 1896, Biol. Centr. Amer., Lep. Het., 2:319.

Aegiale hesperiaris; Draudt, 1924, in: Seitz, Macrolep. World, 5, Amer. Rhop.,:998.

Aegiale kollari Felder, 1860, Wiener Ent. Monats., 4:111.

Acentrocneme kollari; Scudder, 1875, Proc. Amer. Acad. Arts Sci., 10:100; Druce, 1896, Biol. Centr. Amer., Lep. Het., 2:319 (synonymy).

Terias agavis Blasquez, 1870, La Naturaleza, 1:282; Druce, 1896, Biol. Centr. Amer., Lep. Het., 2:319 (synonymy).

Type locality. - vic. Mexico, D. F., Mexico.

Distribution. - Northern and central Mexico, D. F.; 37 Klm. east Mexico, D. F.; Klm. 227 n. Tehuacan, Puebla; 40 miles south San Luis Potosi, S. L. P.; San Cayetano de las Vacas; Nuevo Leon; San Jose de Raices, Nuevo Leon; 25 mi. east Saltillo; Pass Sierra de la Gavia, Coahuila; Monclova, Coahuila; 10 miles north Jimenez, Tamps.;

Galeana, Nuevo Leon; Ojocaliente, Zacatecas; La Zarca, Durango.

Life history. - Larvae located in bottom leaves of *Agave americana* L. or related species of *Agave*. The adults emerge during August, September, October and November.

Chromosome number. - 24.

TURNERINA Freeman

Turnerina Freeman, 1959, Lepid. News, 12:84 ["1958"].

Key to the species of the *Turnerina*

- 1a. Average expanse 50 mm; spots of unequal size forming discal band on secondaries, one at anal angle and outer one elongated toward outer margin of wing; two yellow spots above outer discal spot; ground color on under surface of secondaries mottled.....*mejicanus* (Bell)
- 1b. Average expanse 42 mm; spots of about equal size forming discal band on secondaries; no spots above outer discal spot; ground color on under surface of secondaries more uniform.....*hazela* (S. & T.)

1. *Turnerina mejicanus* (Bell)

Megathymus mejicanus Bell, 1938, Amer. Mus. Novitates, no. 1013: 8, figs. 5, 6.

Turnerina mejicanus; Freeman, 1959, Lepid. News, 12:84 ["1958"].

Type locality. - Guanacevi, Durango, Mexico.

Distribution. - Known only from the type series. Four males from Guanacevi, one female from Rio Campo, Mexico.

Life history. - Not known. The adults were collected in October, 1903.

Chromosome number. - unknown.

2. *Turnerina hazela* (Stallings & Turner)

Megathymus hazela Stallings & Turner, 1958, Lepid. News, 11: 127 ["1957"].

Turnerina hazela; Freeman, 1959, Lepid. News, 12:84 ["1958"].

Type locality. - Mexico: near Chilpancingo, Guerrero, highway 95, Km. 235.

Distribution. - Known only from the type locality.

Life history. - The adults emerge during September, October and November. The larvae are found in a succulent *Agave*, which makes it rather difficult to collect them, as the larvae and pupae die very quickly when the humidity in their larval chamber drops below a certain point. The plants grow on rocky cliffs.

Chromosome number. - unknown.

Tribe AGATHYMINI Stallings & Turner

Agathymini Stallings and Turner, 1959, *Lepid. News*, 12:93 ["1958"].

At present there is but one genus in this tribe.

AGATHYMUS Freeman

Agathymus Freeman, 1959, *Lepid. News*, 12:82 ["1958"].

Members of this genus have the following characteristics: Antennal club without an apiculus; antennae not reaching cell spot; thorax clothed with scales and hair-like scales; pulvillus poorly developed; paronychium narrow and ribbon-like, not bilobed; tongue well developed; primaries with outer edge of discal band of spots in line, reaching Vein A well before termen; genitalia complex; pupal cremaster usually pointed and without hooks; larvae trap door builders; food plant of larvae, *Agave*; larval burrow powdered; adults usually emerge in late summer and fall.

Key to the males of species complexes in AGATHYMUS

- 1a. Well developed spots on upper surface of both wings.....2
- 1b. Well developed spots sometimes present on primaries, none on secondaries.....10
- 2a. Spots 7, 8, and 9 on primaries, discal spots of secondaries fused; medium to heavy overscaling of orange-fulvous at base of wings.....3
- 2b. Spots 7, 8, and 9 on primaries, discal spots of secondaries not fused; sparse or no overscaling at base of wings.....7

- 3a. Spots bright orange-yellow; spot 7 usually overlapping spot 6; costa of primaries usually orange-fulvous..
.....4
- 3b. Spots dull yellow; spot 7 not overlapping inner edge of spot 6; costa of primaries dull yellow to same as ground color.....6
- 4a. Cell spot large, usually elongated on costal side toward base of wings; discal spot on secondaries above vein 4 usually elongated toward base of wings producing a sharp point; orange-fulvous overscaling at base of primaries usually reaching cell.....5
- 4b. Cell spot usually small and not elongated toward base of wings; discal spot on secondaries above vein 4 rounded, not elongated into a point; orange-fulvous overscaling usually restricted to interspaces 1 and 2.....*chisosensis* complex
- 5a. Small, average expanse 45 mm; discal band, subcostal spots and cell area usually sordid white on under surface of secondaries; spot 8 wider than spot 7 or 9; fringed checkered white and black.....
.....*polingi* complex
- 5b. Large, average expanse 56 mm; discal band, subcostal spots, and cell area seldom lighter than ground color; spots 7, 8, and 9 of approximately equal size; fringes yellow to sordid white, checkered with black.
.....*neumoegeni* complex
- 6a. Wing shape broad; spot 8 usually wider than either 7 or 9; spot 7 may or may not reach inner edge of spot 6.....*evansi* complex
- 6b. Wing shape narrower; spots 7, 8, and 9 usually about equal in size; spot 7 not reaching inner edge of spot 6; fringes white.....*aryxna* complex
- 6c. Wing shape medium; spots 7, 8, and 9 usually about equal in size; spot 7 usually well basal of spot 6; fringes usually yellow.....*baueri* complex
- 7a. Ground color usually black; maculation usually well developed on lower surface of secondaries; spot 7 not overlapping spot 6 on upper surface of primaries; lower discal spot on secondaries approximately equal in size to the others.....8
- 7ba. Ground color usually brownish-black; maculation usually poorly developed or absent on lower surface of secondaries; spot 7 may or may not overlap spot 6 on primaries; lower discal spot on secondaries usually largest one in row.....9

- 8a. Spots 7, 8, and 9 usually small and slightly rounded; spot or spots present above last discal spot on secondaries; white area on lower surface of secondaries extending into cell, not a distinct white spot; usually 5 spots in discal row on secondaries.....*stephensi* complex
- 8b. Spots 7 and 9 usually somewhat elongated with their points directed basad; spots usually absent above last discal spot on secondaries; usually a small distinct white cell spot on lower surface of secondaries; usually 4 spots in discal row on secondaries.....*remingtoni* complex
- 9a. Average expanse 45 mm; spot 9 usually wider than spots 7 or 8; macular band on lower surface of secondaries distinct to absent.....*mariae* complex
- 9b. Average expanse 64 mm; spots 7 and 8 elongated inward toward base of wing, usually wider than spot 9; macular band on lower surface of secondaries heavily overscaled with sordid yellowish scales.....*alliae* complex
- 10a. Usual spots present on the primaries; long pencil of erectile hairs above cell on upper surface of secondaries; erectile hairs on the cell on the lower surface of the primaries.....*indecis*a complex
- 10b. No distinct spots on the upper surface of the wings; no erectile hairs on secondaries.....*rethon* complex

Key to the females of species complexes in AGATHYMUS

- 1a. Well developed spots on upper surface of both wings.....2
- 1b. Well developed spots sometimes present on primaries, none on secondaries.....10
- 2a. Spots on primaries more or less fused; veins between spots 7, 8, and 9 of approximately same color as spots; discal spots on upper surface of secondaries fused.....3
- 2b. Spots on primaries more or less fused; veins between spots darker than spots; discal spots on upper surface of secondaries more or less separate.....7
- 2c. Spots on primaries separate; discal spots on upper surface of secondaries separated by darker veins or ground color.....8

- 3a. Spots large, bright orange-yellow; spot 7 fused into cell spot; base of both wings heavily overscaled with orange-fulvous.....4
- 3b. Spots medium in width, deep yellow; spot 7 usually reaching under cell spot, not distinctly fused into it ; medium to sparse, yellow overscaling at base of wings.....6
- 4a. Cell on primaries completely surrounded by bright orange.....*neumoegeni* complex
- 4b. Cell on primaries not completely surrounded by bright orange.....5
- 5a. Average expanse 45 mm; spots deep orange; discal spot above vein 4 projecting basad on upper surface of secondaries; maculation lower surface of secondaries, distinct, strongly contrasting.....*polingi* complex
- 5b. Average expanse 59 mm; spots deep reddish-orange; discal spot above vein 4 on upper surface of secondaries not projecting sharply basad; maculation indistinct on lower surface of secondaries.....*chisosensis* complex
- 6a. Spot 7 may or may not overlap edge of spot 6; maculation on lower surface of secondaries usually distinct, some species with a clear, white discal band and other spots; wing shape medium to narrow.....*baueri* complex
- 6b. Spot 7 usually reaching under spot 6; maculation on lower surface of secondaries light to medium, not strongly contrasting; wing shape broad.....*evansi* complex
- 7a. Average expanse 60 mm; spots deep yellow; under surface of secondaries uniform grayish with indistinct lighter spots; spots 7 and 8 usually wider than spot 9.....*aryxna* complex
- 7b. Average expanse 50 mm; spots light yellow; maculation on lower surface of secondaries well developed to none; spot 9 usually wider than spots 7 and 8.....*mariae* complex
- 8a. Average expanse 68 mm; spot 7 extends from beneath inner edge of spot 6 to well beneath spot 1.....*alliae* complex
- 8b. Average expanse 55 mm; spot 7 not extending to spot 1.....9

- 9a. Spots 7 and 8 wider than spot 9, 9 columnar in shape; spots light yellow to nearly white; 7 well developed spots on upper surface of secondaries; maculation well developed on lower surface of secondaries.....
.....*stephensi* complex
- 9b. Spot 9 wider than spots 7 or 8, usually pointed on its inner side; spots deep yellow; usually 6 spots on upper surface of secondaries; maculation indistinct to well developed on lower surface of secondaries...
.....*remingtoni* complex
- 10a. Ground color brownish-black; primaries with well developed maculation on upper surface.....
.....*indecisæ* complex
- 10b. Ground color black; no well developed spots on upper-side, fringes clear white extending onto wings on secondaries.....*rethon* complex

Key to males of the *Agathymus neumoeogeni* complex

- 1a. Orange-fulvous overscaling at base of primaries extending to cell area, of secondaries, extending to discal spots; ground color on lower surface of secondaries light gray.....2
- 1b. Orange-fulvous overscaling at base of primaries barely reaching lower edge of cell, of secondaries, becoming sparse before reaching discal spots; ground color on lower surface of secondaries dark gray...3
- 2a. Discal band on lower surface of secondaries macular, usually lighter than ground color; spot 7 usually wider than spots 8 and 9; discal band of secondaries narrow.....*judithae* (S. & T.)
- 2b. Discal band on lower surface of secondaries indistinct, hardly lighter than ground color; spot 8 usually wider than 7 or 9; discal band on secondaries wide.....
.....*macalpinei* (Freeman)
- 3a. Lower surface of secondaries uniform dark gray to brownish-gray.....4
- 3b. Lower surface of secondaries with discal band distinct to slightly indicated.....5
- 4a. Primaries: spots 7, 8 and 9 of about equal size; dark black beneath most of cell; costa slightly overscaled with orange. Secondaries: discal band narrow; lower surface uniform dark gray.....
.....*neumoeogeni* (Edwards)

- 4b. Primaries: spot 8 usually wider than either spot 7 or 9; usually an irregular orange spot beneath cell; costa usually heavily overscaled with orange. Secondaries: discal band fairly wide; lower surface uniform brownish-gray.....*florenceae* (S. & T.)
- 5a. Spot 8 slightly wider than spots 7 or 9; slight indication of discal band on lower surface of secondaries; wing shape narrow.....*carlsbadensis* (S. & T.)
- 5b. Spots 7, 8 and 9 about equal size; discal band distinct, dull orange, on the lower surface of secondaries; wing shape slightly broader.....*diabloensis* Freeman

Key to females of the *Agathymus neumoegei* complex

- 1a. Discal band on lower surface of secondaries usually well defined, white.....2
- 1b. Discal band on lower surface of secondaries not well defined.....3
- 2a. Distinct black spot at inner edge of spot 8, usually round; spots bright orange; distinct black streak in cell.....*diabloensis* Freeman
- 2b. Indistinct dot at inner edge of spot 8; spots yellowish-orange; indistinct black streak in cell.....*judithae* (S. & T.)
- 3a. Ground color on lower surface of secondaries dark grayish-black.....4
- 3b. Ground color on lower surface of secondaries light gray, sometimes with some brownish scales.....5
- 4a. Spot 9 with a sharp point directed toward base of wing, usually extending half way through the black area.....*neumoegei* (Edwards)
- 4b. Spot 9 with or without sharp point directed toward base, if present, usually short, not extending half way across the black area.....*florenceae* (S. & T.)
- 5a. Large black area inside cell; usually large black area based of spot 8 and 9; discal spots on upper surface of secondaries narrow; orange fulvous overscaling does not extend from base to discal row of spots.....*carlsbadensis* (S. & T.)
- 5b. No black spot in cell; small circular black areas

basal of spots 8 and 9; discal spots on upper surface of secondaries wide; orange fulvous overscaling extending to discal row.....*macalpinei* (Freeman)

1. *Agathymus neumoegeni* (Edwards)

Megathymus neumoegeni Edwards, 1882 Papilio, 2:27.

Agathymus neumoegeni; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - Approximately 9 miles south of Prescott, Yavapai Co., Arizona.

Distribution. - Central Arizona: 9 to 10 miles south of Prescott; Mingus Mountain near Jerome; Oak Creek Canyon.

Life history. - The larvae are found in juvenile *Agave parryi* Engelm. plants. The adults emerge usually during October.

Chromosome number. - unknown.

2. *Agathymus carlsbadensis* (Stallings & Turner)

Megathymus carlsbadensis Stallings & Turner, 1957, Ent. News, 68:8.

Agathymus carlsbadensis; Freeman, 1959. Lepid. News, 12:83 ["1958"].

Type locality. - On the mesa at the head of Yucca Canyon, New Mexico, Guadeloupe Mountains, Carlsbad Caverns National Park, Eddy Co., New Mexico.

Distribution. - Type locality, and Parker Ranch, Nickle, Texas (south of the type locality).

Life history. - Adults emerge during September, and October. Larvae are found in a *parryi*-like *Agave*, usually in mature plants. Soil pH, at type locality, 7.9.

Chromosome number. - unknown.

3. *Agathymus florenceae* (Stallings & Turner)

Megathymus florenceae Stallings & Turner, 1957, Ent. News, 68:12.

Agathymus florenceae; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - Davis Mountains, Scenic Drive, Jeff Davis Co., Texas.

Distribution. - Western Texas: type locality, and 18 miles northeast of Ft. Davis, Texas.

Life history. - The adults emerge during September, and October. The larvae are found in juvenile plants of a *parryi*-like *Agave*, often in grass taller than the *Agave* plant. Soil pH, type locality, 5.9, and at the location 18 miles northeast of Ft. Davis, 6.0.

Chromosome number. - 10.

4. *Agathymus judithae* (Stallings & Turner)

Megathymus judithae Stallings & Turner, 1957, Ent. News, 68:5.

Agathymus judithae; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - Approximately 8 miles east of Hueco, in the Hueco Mountains, El Paso Co., Texas.

Distribution. - Extreme western Texas.

Life history. - The adults emerge during September and October. The larvae are usually located in medium to large plants of *Agave parryi* Engelm., or a closely related species. Soil pH, type locality, 7.3.

Chromosome number. - unknown.

5. *Agathymus diabloensis* Freeman

Agathymus diabloensis Freeman, 1962, Amer. Mus. Novitates, No.2097:1.

Type locality. - Approximately 5 miles west of Victoria Canyon, Diablo Mountains, Hudspeth Co., Texas.

Distribution. - Vicinity of the type locality in extreme western Texas.

Life history. - Adults emerge during September. The larvae are found in a *parryi*-like *Agave*, usually in medium to large plants. Soil pH, type locality, 7.3.

Chromosome number. - unknown.

6. *Agathymus macalpinei* (Freeman)

Megathymus mcalpinei Freeman, 1955, Amer. Mus. Novitates, No. 1711:6.

Agathymus mcalpinei Freeman, 1959, Lepid. News, 12:83 ["1958"].

Agathymus macalpinei (emendatio); dosPassos, 1964, Lepid. Soc. Mem., 1:1.

Type locality. - 5.1 miles north of Marathon, flats near foothills of Glass Mountains, Brewster Co., Texas.

Distribution. - Western Texas: Glass Mountains; 5 miles north and 4.3 miles east of Marathon; and 12 miles northeast of Marathon.

Life history. - The adults emerge during September and October. The larvae feed in a species of *Agave* related to *scabra* L.-D., usually in medium to large plants. Soil pH, type locality, 7.4.

Chromosome number. - 10.

Key to the males of the *Agathymus chisosensis* complex

- 1a. Small, expanse 45 mm; spots 8 and 9 on primaries of about equal size; discal band on secondaries macular, seldom fused; spots deep yellowish-orange.....*hoffmanni* (Freeman)
- 1b. Large, expanse 53 mm; spots 7 and 8 wider than 9; discal band on secondaries usually fused; spots deep orange.....*chisosensis* (Freeman)

Key to females of the *Agathymus chisosensis* complex

- 1a. Small, expanse 46 mm; overscaling at base of wings rather sparse, brownish-orange; spot 7 reaches cell but seldom fused into spot 1; discal band of secondaries narrow; spot 9 not connecting with orange basal overscaling.....*hoffmanni* (Freeman)
- 1b. Large, expanse 58 mm; dense overscaling at base of wings, same color as discal spots; spot 7 fused into spot 1 in cell; discal band of secondaries wide; spot 9 usually connecting to orange basal overscaling; spots and overscaling deep orange.....*chisosensis* (Freeman)

7. *Agathymus chisosensis* (Freeman)

Megathymus chisosensis Freeman, 1952, Amer. Mus. Novitates, No. 1593:1.

Agathymus chisosensis; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - Chisos Mountains, el. 5400 ft., Brewster Co., Texas.

Distribution. - Vicinity of the type locality.

Life history. - Adults emerge during September and October. The larvae are found in medium to large plants of *Agave scabra* L.-D. Soil pH, type locality, 5.2.

Chromosome number. - 18

8. *Agathymus hoffmanni* (Freeman)

Megathymus hoffmanni Freeman, 1952, Amer. Mus. Novitates, No. 1593:4.

Agathymus hoffmanni; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. Valle de Mexico, D. F., Mexico.

Distribution. - Central Mexico: Valle de Mexico; Km. 37 east of Mexico, D. F., el. 8000 ft.; Acambaro, Guanajuato; El Tepeyac, S. L. P.

Life history. - adults emerge during September and October. The larvae feed in small plants of a *parryi*-like *Agave* in the Valle de Mexico. In other locations they were found in large and medium plants of *Agave americana* L. Soil pH, Valle de Mexico, 5.5.

Chromosome number. - unknown.

Agathymus aryxna complex

9. *Agathymus aryxna* (Dyar)

Megathymus aryxna Dyar, 1905, J.N.Y. Ent. Soc., 13:141; Freeman, 1950, Field & Lab., 18:144 (synonymy).

Agathymus aryxna; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Megathymus drucei Skinner, 1911, Trans. Amer. Ent. Soc., 37:207, Stallings and Turner, 1958, Lepid. News, 11:116 (synonymy) ["1957"]

Type locality. - Western slopes of the Patagonia Mountains, southeast of Nogales, Sonora, Mexico.

Distribution. - Northern Sonora, Mexico and southern Arizona: Globe; Portal, and Paradise, in the Chiricahua Mountains; west of Redington, Santa Catalina Mountains; Santa Rita Mountains, near Madera Canyon; Texas Canyon; Baboquivari Mountains; Huachuca Mountains, Ramsey Canyon, Carr Canyon, and Miller Canyon.

Life history. - Adults emerge during September and October. The larvae are found in *Agave palmeri* Engelm., usually in medium to large plants. Soil pH, in most areas tested varied from 5.3-6.1.

Chromosome number. - 5.

This species appears to be the only member of its immediate complex described at the present time. Its chromosome count of 5 makes it unique.

Key to the males in the *Agathymus baueri* complex

- 1a. Spots on primaries large, cell spot well developed, somewhat oval; spot 7 reaching near inner edge of spot 6; maculation on lower surface of secondaries well developed; discal spots on secondaries usually fused.....2
- 1b. Spots on primaries small, well separated; cell spot small, linear; spot 7 located towards base from spot 6; maculation on lower surface of secondaries indistinct; discal spots on secondaries small, separated.....*baueri* (S. & T.)
- 2a. Spots deep orange-yellow; discal band on secondaries wide; heavy orange suffusion at base of both wings; discal band and large central spots on lower surface of secondaries yellowish, distinct.....*freemani* S., T. & S.
- 2b. Spots light yellow; discal band on secondaries narrow; light suffusion of yellowish hairs near base of wings; discal band and small central spot white or sordid white on lower surface of secondaries.....*juliae* (S. & T.)

Key to females of the *Agathymus baueri* complex

- 1a. Spot 7 reaching from cell spot to inner edge of spot 6; maculation on lower surface of secondaries distinct; discal spots on secondaries fused.....2
- 1b. Spot 7 not reaching inner edge of spot 6; maculation on lower surface of secondaries indistinct; discal spots on secondaries not fused...*baueri* (S. & T.)
- 2a. Spots deep orange-yellow; maculation on lower surface of secondaries well-defined, yellowish.....*freemani* S., T. & S.

- 2b. Spots light yellowish-orange; maculation on lower surface of secondaries well-defined, clear white..
*juliae* (S. & T.)

10. *Agathymus baueri* (Stallings & Turner)

Megathymus baueri Stallings & Turner, 1954, Lepid. News, 8:80.

Agathymus baueri; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - Verde Hot Springs, Yavapai Co., Arizona.

Distribution. - West Central Arizona: type locality; Sycamore Creek; Cactus Mountains, and Mayer, all in Yavapai County.

Life history. - The adults emerge during October. The larvae feed in *Agave parryi* Engelm.

Chromosome number. - 15.

11. *Agathymus freemani* Stallings, Turner & Stallings

Agathymus freemani Stallings, Turner & Stallings, 1960, Ent. News, 71: 109.

Type locality. - Bagdad, Yavapai Co., Arizona.

Distribution. - West Central Arizona: type locality; Hillside; Kirkland; and Date Creek, all in Yavapai County.

Life history. - The adults emerge during September and October. The larvae feed in *Agave deserti* Engelm.

Chromosome number. - 15.

12. *Agathymus juliae* (Stallings & Turner)

Megathymus juliae Stallings & Turner, 1958, Lepid. News, 11:125 ["1957"].

Agathymus juliae; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - North of Zarca, Durango, on highway 45 at Km. 1317, Mexico.

Distribution. - Vicinity of the type locality.

Life history. - The adults emerge during September. The larvae feed in a *Parryi*-like *Agave*, usually in rather small plants.

Chromosome number. - unknown.

Key to males of the *Agathymus evansi* complex

- 1a. Spot 7 reaching inner edge of spot 6; spot 8 wider than spot 7 or 9; large expanse 54-58 mm; spots orange-yellow.....2
- 1b. Spot 7 well towards base from spot 6; spots 7, 8, and 9 of about equal size, narrow; smaller, expanse 46 mm; spots deep yellow.....*ricei* S., T. & S.
- 2a. Discal spots on lower surface of secondaries indistinct; cell spot small, narrow; narrow orange streak in space 1 near base; four well developed discal spots on secondaries and a small spot near apex.....*belli* (Freeman)
- 2b. Discal spots on lower surface of secondaries distinct; cell spot large, rounded; oval orange spot in space 1 near base; five well-defined discal spots on secondaries.....*evansi* (Freeman)

Key to females of the *Agathymus evansi* complex

- 1a. Spot 7 reaching spot 1 in cell; spot 7 reaching inner edge of spot 6; spots deep orange-yellow; expanse 55-60 mm; discal spots on secondaries large, close together.....2
- 1b. Spot 7 not reaching cell spot; spot 7 placed well towards base from spot 6; spots deep yellow; expanse 52 mm; discal spots on secondaries small, well separated; maculation indistinct on lower surface of secondaries.....*ricei* S., T. & S.
- 2a. Discal band on lower surface of secondaries indistinct; narrow bar of orange in space 1 near base; usually discal spots of secondaries five large and one small.....*belli* (Freeman)
- 2b. Discal band on lower surface of secondaries usually well developed; oval orange patch in space 1 near base; usually six large discal spots on secondaries.....*evansi* (Freeman)

13. *Agathymus evansi* (Freeman)

Megathymus evansi Freeman, 1950, Field & Lab., 18:144-146.

Agathymus evansi; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - Ramsey Canyon, Cochise Co., Arizona.

Distribution. - Southern Arizona: Ramsey Canyon; Carr Canyon; Miller Canyon; Chiricahua Mountains; and Palmerlee.

Life history. - Adults emerge during September and October. The larvae are found in *Agave parryi* Engelm. and *A. palmeri* Engelm.

Chromosome number. - unknown.

14. *Agathymus belli* (Freeman)

Megathymus belli Freeman, 1955, Amer. Mus. Novitates, No. 1711:5.

Agathymus belli; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - La Bequilla, Durango, Mexico.

Distribution. - Northern Mexico: type locality; north of Chihuahua, Chihuahua, at Km. 1775.

Life history. - The adults emerge during July, September, and October. The larvae feed in a *parryi*-like species of *Agave*.

Chromosome number. - unknown.

15. *Agathymus ricei* Stallings, Turner & Stallings

Agathymus ricei Stallings, Turner & Stallings, 1966, J. Lepid. Soc., 20:163.

Type locality. - Km. 165 east of Puebla, Puebla, Mexico.

Distribution. - Southern Mexico: type locality; Tecamachalco, and km. 227 north of Tehuacan, all in Puebla.

Life history. - The adults emerge during September, October and November. The larvae feed in a *parryi*-like *Agave*, and make a black trap door which is characteristic of the *evansi* complex.

Chromosome number. - unknown.

Key to the males of the *Agathymus mariae* complex

1a. Under surface of secondaries evenly overscaled, with

discal spots indistinct or absent; spots 5 and 6 on under surface of primaries indistinct or absent....2

- 1b. Under surface of secondaries somewhat mottled, cell and discal spots prominent; spot 5 and 6 on under surface of primaries usually distinct.....4
- 2a. Discal spots on upper surface of secondaries forming a straight line.....3
- 2b. Discal spots on upper surface of secondaries evenly curved.....*rindgei* Freeman
- 3a. Spots orange-yellow; spot 9 usually twice as wide as spots 7 and 8, cell spot on primaries small, round; spots 5 and 6 usually prominent on upper surface of primaries; discal spots well developed on secondaries; fringes light tan and dark gray.....*micheneri* S., T. & S.
- 3b. Spots tan; spots 7, 8, and 9 of approximately equal size; cell spot on primaries very small and linear; spots 5 and 6 usually absent on upper surface of primaries; discal spots small, sometimes poorly defined on secondaries; fringes sordid white to light tan, checkered with dark gray....*gilberti* Freeman
- 4a. Ground color brownish-black; overscaling heavy near base of wings; discal spots on secondaries large, close together.....5
- 4b. Ground color dull black, with sparse overscaling; discal spots on secondaries small, separated.....*lajitaensis* Freeman
- 5a. Spot 9 wider than 8, 8 wider than 7; cell spot on upper surface of secondaries usually indistinct; discal spots on secondaries well defined, close together; fringes tan and dark brownish-black.....*mariae* (B. & B.)
- 5b. Spots 7, 8, and 9, large, of approximately equal size; cell spot on upper surface of secondaries usually well defined; discal spots on secondaries large, close together; fringes light tan and brownish-black.....*chinatiensis* Freeman

Key to females of the *Agathymus mariae* complex

- 1a. Overscaling on lower surface of secondaries light to dark gray; discal spots on lower surface of secondaries indistinct, if present usually sordid white.....2

- 1b. Overscaling on lower surface of secondaries tan to brownish-gray; discal spots on lower surface of secondaries distinct, yellowish to clear white....4
- 2a. Spots tan; spot 7 may or may not reach outer edge of cell spot; fringes sordid white and dark gray.....3
- 2b. Spots orange-yellow; spot 7 reaching well under cell spot; fringes yellowish-tan and dark gray.....
.....*micheneri* S., T. & S.
- 3a. Spots 5 and 6 usually separate; discal spots on upper surface of secondaries usually separate, forming a straight line; cell spot on upper surface of secondaries indistinct or absent.....*gilberti* Freeman
- 3b. Spots 5 and 6 usually fused; discal spots on upper surface of secondaries usually large, fused together, evenly curved; cell spot on upper surface of secondaries usually present.....*rindgei* Freeman
- 4a. Overscaling on lower surface of secondaries tan; discal spots on upper surface of secondaries usually fused and large.....5
- 4b. Overscaling on lower surface of secondaries brownish-gray; discal spots on upper surface of secondaries usually separate.....*lajitaensis* Freeman
- 5a. Ground color light brownish-black; under surface of secondaries heavily overscaled with yellowish-tan; discal spots on lower surface of secondaries contrasting slightly with ground color; cell spot on upper surface of secondaries heavily overscaled with yellowish scales; discal spots on upper surface of secondaries fused.....*mariae* (B. & B.)
- 5b. Ground color dark brownish-black; under surface of secondaries sparsely overscaled with yellowish-gray; discal spots on lower surface of secondaries contrasting distinctly with ground color; cell spot on upper surface of secondaries distinct; discal spots on upper surface of secondaries large, separated by dark veins.....*chinatiensis* Freeman

16. *Agathymus mariae* (Barnes & Benjamin)

Megathymus mariae Barnes & Benjamin, 1924, Contrib. Nat. Hist. Lepid. N.A., 5(3):100.

Agathymus mariae; Freeman, 1959, Lepid. News, 12:["1958"].

Type locality. - Franklin Mountains, El Paso, El Paso Co., Texas.

Distribution. - Western Texas: Franklin Mountains, El Paso; Hueco Mountains; Nickle and Kent, Culberson Co.; Diablo Mountains, Eagle Mountains, Sierra Blanca, Van Horn, Hudspeth Co.; Alpine, Marathon, Chisos Mountains, Brewster Co.; Ft. Stockton, Pecos Co.; McCamey, Upton Co.; Sanderson, Terrell Co.; and Langtry, Val Verde Co. New Mexico: Vicinity of Carlsbad Caverns National Park. Mexico: Ciudad Juarez.

Life history. - The adults emerge during September, October, and November. The larvae feed in *Agave lecheguilla* Torre. Soil pH, type locality, 8.4.

Chromosome number. - 22.

17. *Agathymus chinatiensis* Freeman

Agathymus chinatiensis Freeman, 1964, J. Lepid. Soc., 18:172.

Type locality. - 2.7 miles south Shafter, Presidio Co., Texas.

Distribution. - Southwestern Texas: type locality; Chinati Mountains; 19 miles south Marfa, all in Presidio Co.

Life history. - The adults emerge during September and October. The larvae feed in *Agave lecheguilla* Torr. Soil pH, type locality, 7.1.

Chromosome number. - 22.

18. *Agathymus lajitaensis* Freeman

Agathymus lajitaensis Freeman, 1964, J. Lepid. Soc., 18:174.

Type locality. - 10 miles west of Lajita, Presidio Co., Texas.

Distribution. - Known only from the type locality, in the Big Bend area of Texas.

Life history. - The adults emerge during September and October. The larvae feed in *Agave lecheguilla* Torr. Soil pH, type locality, 7.3.

Chromosome number. - 22.

19. *Agathymus rindgei* Freeman

Agathymus rindgei Freeman, 1964, J. Lepid. Soc., 18:180.

Type locality. - 14 miles north Bracketville, Kinney Co., Texas.

Distribution. - Southwestern Texas: type locality; 28 miles north of Del Rio, Vale Verde Co.; 11-12 miles south of Juno, el. 1450 ft.

Life history. - The adults emerge during September, October, and November. The larvae feed in atypical *Agave lecheguilla*. Soil pH, type locality, 7.1.

Chromosome number. - 22.

20. *Agathymus gilberti* Freeman

Agathymus gilberti Freeman, 1964, J. Lepid. Soc., 18:176.

Type locality. - 14 miles north of Bracketville, el. 1500 ft., Kinney Co., Texas.

Distribution. - Southwestern Texas: type locality; 28 miles north of Del Rio, Val Verde Co., el. 1450 ft.; 11-12 miles south of Juno; Pecos River Canyon, el. 1250 ft.; 10 miles east of Langtry, el. 1150 ft.; Langtry; 8 miles west of Dryden; near Boquillas Canyon, Brewster Co., el. 1900 ft.

Life history. - The adults emerge during September, October and November. The larvae feed in atypical *Agave lecheguilla* in the vicinity of the type locality and in typical *A. lecheguilla* westward. Soil pH, type locality, 7.1.

Chromosome number. - 21.

21. *Agathymus micheneri* Stallings, Turner & Stallings

Agathymus mariae micheneri Stallings, Turner & Stallings, 1961, J. Lepid. Soc., 15:19.

Agathymus micheneri; Freeman, 1963, J. Res. Lepid., 2:140

Type locality. - 15-20 miles south of Allende, on highway 57, Km. 89, el. 1300 ft., Coahuila, Mexico.

Distribution. - known only from the type locality, in north central Mexico.

Life history. - The adults emerge during September and October. The larvae feed in *Agave lecheguilla* Torr. Soil pH, type locality, 7.0.

Chromosome number. - 20.

Key to the males of the *Agathymus remingtoni* complex¹

- 1a. Overscaling on lower surface of secondaries grayish-brown to brownish-black; 5-6 discal spots on upper surface of secondaries.....2
- 1b. Overscaling on lower surface of secondaries light gray to grayish-black; 4-6 discal spots on upper surface of secondaries.....3
- 2a. Overscaling on lower surface of secondaries dark, brownish-black; discal spots on lower surface of secondaries rarely visible; spots 7 and 8 usually twice as wide as 9; yellowish-brown overscaling near base of wings; usually 6 discal spots on upper surface of secondaries.....*fieldi* Freeman
- 2b. Overscaling on lower surface of secondaries uniform grayish-brown, with some green scales; discal spots on lower surface of secondaries usually present; spots 7, 8, and 9 of approximately equal width; brownish overscaling near base of wings; usually 5 discal spots on upper surface of secondaries.....*estelleae* (S. & T.)
- 3a. Ground color dark brownish-black; cell spot small, rarely with linear spots on costa above; overscaling on lower surface of secondaries light gray, with some black areas; 4 small, linear, discal spots on lower one-third of secondaries; discal spots on lower surface of secondaries white; fringes checkered sordid white and black.....*valverdiensis* Freeman
- 3b. Ground color brownish-black; cell spot of average size to large, usually one or two linear spots above it; overscaling on lower surface of secondaries grayish-black, mottled; 5 more or less round discal spots on lower one-fourth of secondaries; discal spots on lower surface of secondaries conspicuous, sordid white; fringes checkered yellowish-white and black.....*remingtoni* (S. & T.)

¹*Agathymus escalantei* S., T. & S. is known only from the female.

Key to females of the *Agathymus remingtoni* complex

- 1a. Overscaling on lower surface of secondaries brownish-gray to brownish-black; spot 7 may or may not reach spot 6.....2
- 1b. Overscaling on lower surface of secondaries gray to grayish-black; spot 7 usually reaching under spot 6.....3
- 2a. Overscaling on lower surface of secondaries uniform dark, brownish-black; discal spots on lower surface of secondaries seldom visible; no cell spot on lower surface of secondaries; spot 8 on primaries usually twice as wide as spot 9; spot 7 not reaching spot 6; discal band on upper surface of secondaries, usually of 4 small spots; some yellowish-brown overscaling near base of wings.....*fieldi* Freeman
- 2b. Overscaling on lower surface of secondaries dull brownish black; discal spots on lower surface of secondaries minute, white; spot 1 on primaries unusually large, larger than spot 7; spot 8 on primaries elongated inward almost reaching inner edge of spot 1; discal band on upper surface of secondaries of 4 spots in a straight line, upper two distinct, lower two poorly defined.....*escalantei* S., T. & S.
- 2c. Overscaling on lower surface of secondaries grayish-brown, paler near outer margin; discal spots distinct on lower surface of secondaries; cell spot on lower surface of secondaries usually present; spot 8 on primaries never as wide as spots 7 and 9; spot 7 may or may not reach inner edge of spot 6; usually 5-6 discal spots on upper surface of secondaries; slight brownish overscaling near base of wings.....*estelleae* (S. & T.)
- 3a. Cell spot on lower surface of secondaries seldom present; 4 small, linear, discal spots on upper surface of secondaries; ground color dark brownish-black; under surface of secondaries mottled grayish-black, discal spots white and separate; spots 7, 8 and 9 of approximately equal width; overscaling near base of wings approximately same color as ground color.....*valverdiensis* Freeman
- 3b. Cell spot on lower surface of secondaries usually prominent; 5 large, well-developed, discal spots on upper surface of secondaries; ground color warm, brownish-black; under surface of secondaries fairly uniform to mottled grayish-black, with discal spots sordid white, close together; spot 9 usually nearly twice as wide as spots 7 and 8; overscaling near

remingtoni complex 49
base of wings lighter than ground color.....
.....remingtoni (S. & T.)

22. *Agathymus remingtoni* (Stallings & Turner)

Megathymus remingtoni Stallings & Turner, 1958, Lepid. News, 11:117
["1957"].

Agathymus remingtoni; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - Mountains south of Jacala, on highway 85, Km. 250, el. 6000 ft., Hidalgo, Mexico.

Distribution. - Northeastern Mexico: type locality; Maiz, S. L. P.; Antiguo Morelos, Tamaulipas, el. 1500 ft.

Life history. - The adults emerge during August, September, and October. The larvae feed in a member of the *lecheguilla* complex which looks somewhat like *Agave utahensis* Engelm. In most areas the plants grow on rocky cliffs. Soil pH, type locality, 5.

Chromosome number. - 9.

23. *Agathymus estelleae* (Stallings & Turner)

Megathymus estelleae Stallings & Turner, 1958, Lepid. News., 11: 119
["1957"].

Agathymus estelleae; Freeman, 1959, Lepid. News., 12:83 ["1958"].

Type locality. - Near General Bravo, el. 400 ft., Nuevo Leon, Mexico.

Distribution. - Northern Mexico: type locality; 25 miles east of Saltillo, in Neuvo Leon, el. 3700 ft.; approximately 5 miles east of Saltillo, Coahuila, el. 5000 ft.

Life history. - The adults emerge during August and September. The larvae feed in an atypical *Agave lecheguilla*. Soil, pH, type locality, 7.3, in other locations from 7.0 to 7.3.

Chromosome number. - 9.

24. *Agathymus valverdiensis* Freeman

Agathymus valverdiensis Freeman, 1966, J. Lepid. Soc., 20:182.

Type locality. - 28 miles north of Del Rio, el. 1450 ft., Val Verde Co., Texas.

Distribution. - Del Rio area of western Texas: type locality; 14 miles north of Bracketville, 1500 ft. el.; 11-12 miles south of Juno, 1450 ft., Val Verde Co.

Life history. - The adults usually emerge during August, September, and November. Roy Kendall found two pupae from which adults emerged during April. Soil pH, type locality, 7.1, varies other locations from 7.0 to 7.2. Larvae feed in atypical *Agave lecheguilla* Torrey.

Chromosome number. - 9.

25. *Agathymus fieldi* Freeman

Agathymus fieldi Freeman, 1960, J. Lepid. Soc., 14:59.

Type locality. - Guadalajara, highway 15, km. 724, el. 4400 ft., Jalisco, Mexico.

Distribution. - known only from the vicinity of the type locality.

Life history. - The adults emerge during September and October. The larvae feed in *Agave tequilana* Weber.

Chromosome number. - unknown.

26. *Agathymus escalantei* Stallings, Turner & Stallings

Agathymus escalantei Stallings, Turner & Stallings, 1966, J. Lepid. Soc., 20:167.

Type locality. Nochistlan, 20 km. southwest of Acahuizotla, Guerrero, Mexico.

Distribution. - Known only from the type locality, in southern Mexico.

Life history. - Unknown.

Chromosome number. - Unknown.

This is an unique species and may be found to represent an entirely different complex from what we now believe when we are able to obtain specimens in addition to the female holotype.

Key to males in the *Agathymus stephensi* complex

- 1a. Average expanse 42 mm; maculation on lower surface of secondaries yellowish-white; discal band on secondaries of average width to narrow.....2
- 1b. Average expanse 50 mm; maculation on lower surface of secondaries clear to sordid white; discal band on secondaries of average width to wide.....
.....*stephensi* (Skinner)
- 2a. Spots 7 and 8 of approximately equal size; spot 7 approaching spot 6; discal spots on lower surface of secondaries not fused into a continuous band.....
.....*comstocki* (Harbison)
- 2b. Spot 8 absent or one-half the size of spot 7; spot 7 well separated from spot 6; discal spots on lower surface of secondaries usually fused into a continuous band.....*dawsoni* Harbison

Key to females in the *Agathymus stephensi* complex

- 1a. Average expanse 49 mm; overscaling of paler scales at base of wings sparse; spot 7 not reaching inner edge of spot 6; maculation on lower surface of secondaries yellowish-white.....2
- 1b. Average expanse 52 mm; overscaling of paler scales at base of wings dense; spot 7 reaching inner edge of spot 6; maculation on lower surface of secondaries sordid white.....*stephensi* (Skinner)
- 2a. Spot 9 broadly V-shaped, with the point directed toward base of wings; spots on lower surface of secondaries usually separated.....
.....*comstocki* (Harbison)
- 2b. Spot 9 usually columnar and narrow; spots on lower surface of secondaries close together, often fused..
.....*dawsoni* Harbison

27. *Agathymus stephensi* (Skinner)

Megathymus neumoegei stephensi Skinner, 1912, Ent. News, 23:126.

Agathymus stephensi; Freeman, 1959, Lepid. News 12:83 ["1958"].

Type locality. - Mason Valley (La Puerta), San Diego Co., California.

Distribution. - Western Colorado Desert of California: type locality; Banner Grade; Sentenec Canyon, 9-10 miles east of Julian; Palms to Pines Highway; San Felipe Valley; Vallecitos; near Jacumba. Northern Baja California, Mexico.

Life history. - The adults emerge during September and October. The larvae feed in *Agave deserti* Engelm.

Chromosome number. - unknown.

28. *Agathymus comstocki* (Harbison)

Megathymus comstocki Harbison, 1957, Trans. San Diego Soc. Nat. Hist., 12:241.

Agathymus comstocki; Freeman, 1959, Lepid. News 12:83 ["1958"].

Type locality. - 2 miles northeast of San Simon, Baja California Norte, Mexico.

Distribution. - The vicinity of the type locality, on the west coast of Baja California Norte.

Life history. - The adults emerge during August and September. The larvae feed in *Agave shawii* Engelm.

Chromosome number. - unknown.

29. *Agathymus dawsoni* (Harbison)

Agathymus dawsoni Harbison, 1963, Trans. San Diego Soc. Nat. Hist., 13:64.

Type locality. - 17.7 miles north of Punta Prieta, Baja California Norte, Mexico.

Distribution. - Central Baja California: type locality; 20 miles north Punta Prieta.

Life history. - The adults emerge during September and October. The larvae feed in *Agave goldmaniana* Trel.

Chromosome number. - unknown.

The remaining four species are not closely related to the previously discussed species or to one another, and each can be considered to represent a separate complex according to our present knowledge.

Agathymus polingi Complex30. *Agathymus polingi* (Skinner)

Megathymus polingi Skinner, 1905, Ent. News, 16: 232.

Agathymus polingi; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - Baboquivari Mountains, Pima Co., Arizona.

Distribution. - Southern Arizona (all locations in Pima Co.): type locality; Mt. Lemmon Road, el. 4250 ft., 5500 ft., Santa Catalina Mountains; Redington Road near Pass, el. 4400 ft., Santa Catalina Mountains.

Life history. - The adults emerge during September, October and November. The larvae feed in the caudex of *Agave schottii* Engelm. Soil pH, various localities ranged from 5.8 - 6.1.

Chromosome number. - 10.

Agathymus alliae Complex31. *Agathymus alliae* (Stallings & Turner)

Megathymus alliae Stallings & Turner, 1957, Ent. News, 68:1.

Agathymus alliae; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - 15 miles west of Cameron, Coconino Co., along canyon of Little Colorado River, el. 5000 ft., Arizona.

Distribution. - Recorded only from the type locality.

Life history. - The adults emerge during August, September, and October. The larvae feed in *Agave utahensis* Engelm.

Chromosome number. - 38.

Agathymus rethon Complex32. *Agathymus rethon* (Dyar)

Megathymus rethon Dyar, 1913, Proc. U.S. Nat. Mus., 44:282.

Agathymus rethon; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - Sierra de Guerrero, Mexico.

Distribution. - Southern Mexico: type locality; near Cuautla, Morelos; Oaxaca near the Chiapas border.

Life history. - The adults emerge during August and September. The larvae feed in *Agave sisalana* Perrine.

Chromosome number. - unknown.

Agathymus indecisa Complex

33. *Agathymus indecisa* (Butler & Druce)

Aegiale indecisa Butler & Druce, 1872, Cistula Ent. 1:116.

Megathymus indecisa; Druce, 1896, Biol. Centr. Amer., Lep. Het., 2:319.

Agathymus indecisa; Freeman, 1959, Lepid. News, 12:83 ["1958"].

Type locality. - Costa Rica.

Distribution. - Southern Mexico to Panama: type locality; Comitán, Chiapas, Mexico; Guatemala; and Panama.

Life history. - The adults emerge during September and October. The larvae are reported to feed in a *hennigan*-type *Agave*.

Chromosome number. - unknown.

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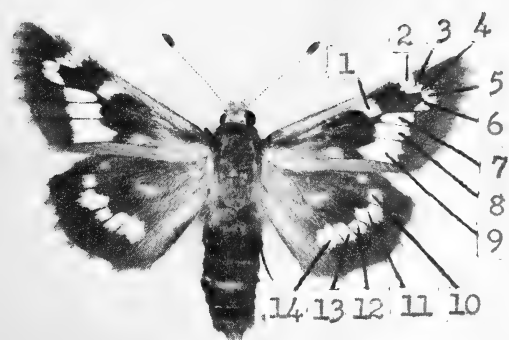
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Explanation of Plate I

- Fig. 1, *Agathymus rindgei* Freeman, ♀, showing how the spots are numbered.
- Fig. 2, *Megathymus yuccae buchholzi* Freeman, ♂, representing broad wing shape.
- Fig. 3, *Megathymus coloradensis navajo* Skinner, ♂, representing medium wing shape.
- Fig. 4, *Megathymus coloradensis wilsonorum* Stallings & Turner, ♂, representing narrow wing shape.



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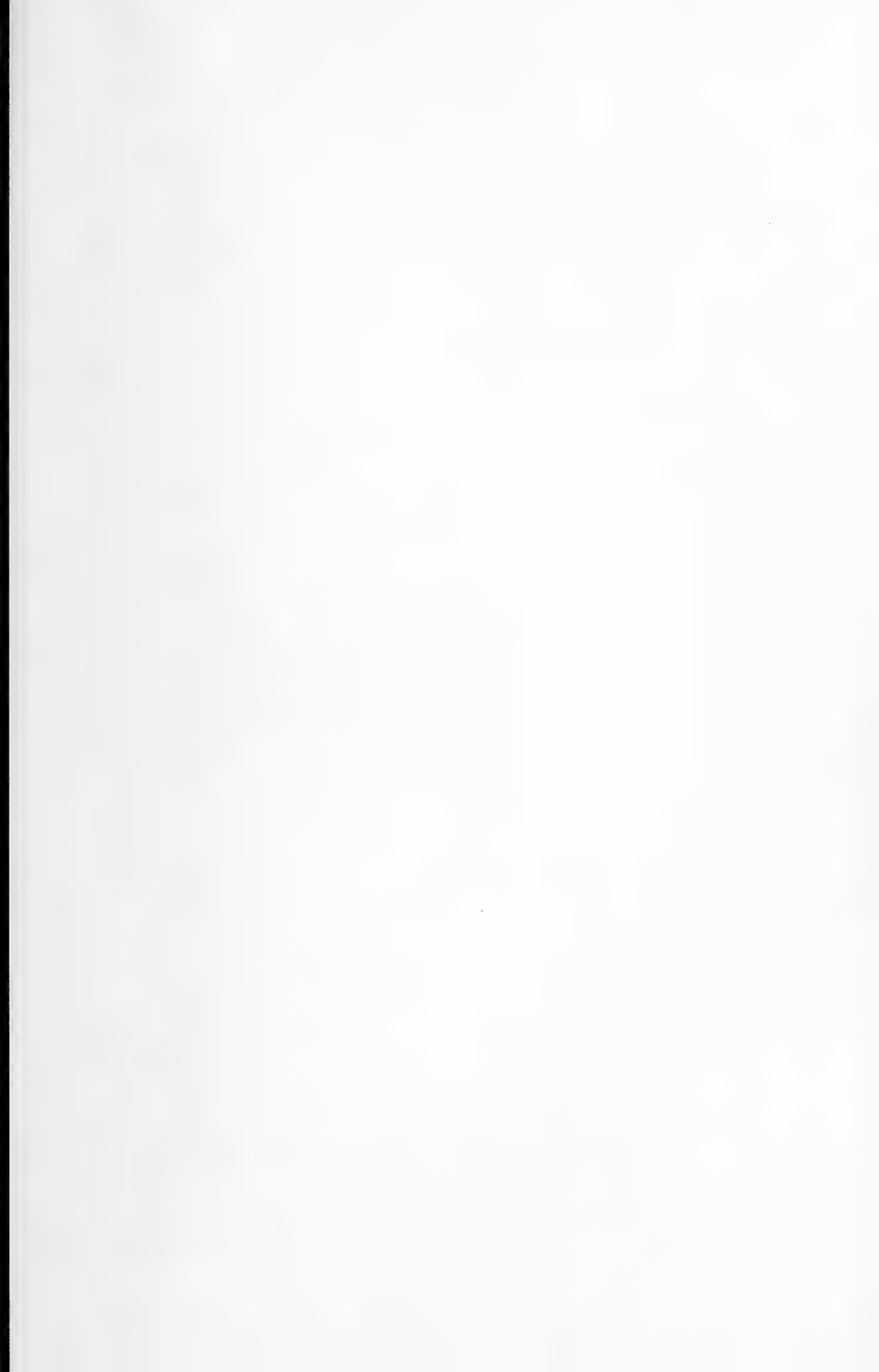


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SUPPLEMENT 2

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OF HESPERIIDAE FROM MEXICO

by H. A. Freeman

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Volume 23

Supplement 2

RECORDS, NEW SPECIES, AND A NEW GENUS
OF HESPERIIDAE FROM MEXICO

H. A. Freeman

1605 Lewis Drive, Garland, Texas

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INTRODUCTION

For a number of years I have been working on the Hesperiidæ of Mexico. The summers of 1966 and 1967 were spent collecting rather extensively over that country as well as identifying Mexican material from various museums and collections. The ultimate purpose of this study is to prepare a publication that will include all of the known species of Hesperiidæ from Mexico, giving synonymy, distributional data, keys for identification, and figures of the male genitalia. While in the process of doing this research a number of new records, species, and a new genus have been discovered and the data pertaining to them is discussed in this article.

In preparing the descriptions of the new species where reference is made to the venation of the wings by number, it follows the English system of numbering the veins of each wing from the lowest vein upward, and the space is that space immediately below the numbered vein. Where reference is made to the stigma or brands on the primaries of certain males, I follow Evans in making a distinction between the two terms. The term stigma applies to the specialized patch of tubular scales and androconia extending between the veins, while the term brand or brands applies to the same type of specialized patch or patches that extend parallel with the vein or veins. In discussing the genitalia two terms are used in reference to parts or areas of the valva (=clasper). The cuiller refers to the dorsal, terminal end of the valva, where the style applies to a process originating from the mid dorsal or anterior portion of the valva. In the genus *Epargyreus* Hubner the tip of the style is rounded, projecting anteriorly, with long hairs present which is a characteristic of the genus, while in *Polythrix* the style projects posteriorly and is usually slender and pointed. Other genera have different modifications of these two areas of the valva. The term apiculus refers to the reflexed portion of the antennal club and nudum to the sensory, bared segments of the antennae, lying on the apiculus and sometimes on the un-reflexed portion of the club: nudum 3/12 means 3 segments on the club and 12 on the apiculus, as used in describing the new genus *Windia* Freeman.

ACKNOWLEDGMENTS

I would like to express my thanks to the National Science Foundation for Research Grant GB-4122 which is making this study of the HesperIIDae of Mexico possible. Through the assistance of Dr. Tarsicio Escalante, Mexico, D.F., many fine specimens of Mexican HesperIIDae were made available for me to study. I would also like to give my thanks to Mr. William L. Skinner, Physics Teacher, Hillcrest High School, Dallas, Texas, and Mr. Don B. Stallings, Caldwell, Kansas, for making the photographs of the adults used in this article.

PYRRHOPYGINAE

Pyrrhopyge tzotzili Freeman, new species

(Plate 1, figures 1-2)

FEMALE. Upperside: Primaries, deep dull black, immaculate. Fringes, white. Secondaries, dull black, with the outer margin slightly crenulate. Fringes, white.

Underside: Primaries, dull black, with no markings. Secondaries, dull black, with no markings.

Wing measurements: Holotype female: primaries; base to apex, 33 mm; apex to outer angle, 24 mm; outer angle to base, 24 mm; secondaries; base to end of vein 3, 23 mm; center of costa to anal angle, 24 mm. Wing spread: 56 mm.

Abdomen: shiny black, above and below, with an orange tuft at caudal end. Thorax: shiny black above and below. Head: black above. Palpi: dark orange below, with a few black scales intermixed with orange dorsally. Antennae: shaft and club black above and below. Legs: black.

MALE. Unknown.

HOLOTYPE female: Ocozingo, Chiapas, Mexico, July, 1942, sent by Dr. Tarsicio Escalante and will be placed in the United States National Museum, Washington, D. C.

This new species is named for the race of Indians that occupy this region of Mexico. The nearest related species to *tzotzili* is *Pyrrhopyge jonas* Felder, from which it can readily be distinguished by its coloration. In *jonas* the wings are a dark shiny blue both above and below, whereas *tzotzili* has dull black wings.

Mysoria wilsoni Freeman, new species

(Plate 6, figure 1,2. Plate 15, figure 1)

MALE. Upperside: Primaries, dull black. Apex evenly round, only slightly produced. Outer margin straight from apex to outer angle. Fringes outwardly white, basally with a narrow yellow line. Secondaries, bluish-black, costal one-fourth having a purplish luster. Outer margin evenly rounded only slightly produced at anal angle. Fringes white, with slight indication of a yellow line at base.

Underside: Primaries, spaces 1 and 2 purplish black, remainder dull black. Secondaries, dull black. Costa with a narrow yellow line continuing around outer margin to anal angle. Fringes white.

Abdomen: dull black, both above and below. Tip dark red. A narrow yellow stripe on each side. Thorax: dull black, both above and below. A fairly broad, orange-yellow stripe just beneath wings. Head: dark blue, collar dark red. Palpi: blue at tips, remainder dark red. Legs: bluish-black. Antennae: both shaft and club dull black, both above and below.

Wing measurements: Holotype male. Primaries: base to apex, 26.5 mm; apex to outer angle, 20 mm; outer angle to base, 17.5 mm. Secondaries: base to end of vein 3, 18 mm; center of costa to anal angle, 17 mm. Wing spread: 49 mm; paratypes vary from 43 to 52 mm total expanse, average 49 mm.

HOLOTYPE male: Mexcala, Guerrero, Mexico, 23 July 1956, collected by Kent Wilson, will be placed in the United States National Museum, Washington, D. C. There are ten male paratypes from the following locations: five specimens from Mexcala, collected by Kent Wilson during July 1956; two specimens from the same location, collected during August 1958, from the Escalante Collection; one specimen, Taxco, Guerrero, 10 August 1956, collected by Stallings and Turner; and one specimen, Mapastepec, Chiapas, August 1951. These paratypes will remain in my collection.

This species has long been confused with *affinis* (Herrich-Schaeffer) with which it flies in certain areas; however, it can readily be separated from that species by the following characteristics: (1) the most obvious difference is in wing shape, *wilsoni* having broader wings than *affinis*, as the following wing measurements of specimens of equal wing spread show: *wilsoni* - Primaries: base to apex, 26.5 mm; apex to outer angle, 20 mm; outer angle to base, 17.5 mm. Secondaries: base to end of vein 3, 18 mm; center of costa to anal angle, 17 mm. wing spread: 49 mm; *affinis* - base to apex, 26.5 mm; apex to outer angle, 18 mm; outer angle to base, 15 mm. Secondaries: base to end of vein 3, 14 mm; center of costa to anal angle, 15 mm. Wing spread: 49 mm. (2) in *wilsoni*

the outer margin of the primaries to the outer angle is straight, while in *affinis* it is concave; (3) the anal angle of the secondaries is more produced in *affinis* than in *wilsoni*, giving a somewhat concave shape to the outer margin from the apex to the anal angle; (4) on the lower surface of the secondaries the yellow marginal border is much wider in *affinis* than in *wilsoni*; and (5) in the genitalia the upturned, terminal end of the valva in *affinis* is evenly rounded on the ventral surface and the tip does not extend to the top of the valva on the dorsal side, while in *wilsoni* the tip is sharply angled on the ventral side and the terminal dorsal tip extends above the top of the rest of the valva. Compare the genitalia of *wilsoni*, figure 1, plate 15, with *affinis*, figure 21, plate 73, in Godman and Salvin's *Biologia Centrali-Americana*. There are other differences that can be determined by the two figures.

PYRGINAE

Epargyreus windi Freeman, new species

(Plate 1, figures 3,4. Plate 2, figure 1)

MALE. Upperside: Primaries, reddish brown, with discal spots yellowish-orange; spot in 1b varying from a tiny dot to a fairly large, triangular spot, approximately centered between spot in space 2 and outer margin; spot in space 2 fairly large, more or less overlapped by cell spot, vein 3 originates directly over center of this spot; cell spot broader at costal than at dorsal margin, a tiny dot just above this and below costa; spot in space 3 variable, from a small triangular spot to none; two apical spots, upper one fairly large, lower one a minute dot. Costal fold well developed. Fringes sordid white, slightly checkered at vein endings. Secondaries, reddish brown, with basal one-third overscaled with golden-yellow scales and hairs. Fringes sordid white, checkered at vein endings.

Underside: Primaries, brown, with all spots well defined, orange. A gradually widening gray marginal area from space 1a to vein 3, there becoming narrower, then gradually widening again near apex. Secondaries, chocolate brown, with an irregular, macular, silver discal line, more or less straight to vein 5, in space 6 the silvery line situated slightly inward from line in space 5; a large silver central spot extending from space 1c to edge of vein 3, which is convex on its inner surface, produced outward over vein 1 and vein 2, on its outer surface; a silver, linear spot in cell, not connecting to the large central spot. Marginal gray scaling well developed, extending from anal angle to apex, approaching or touching the discal silvery band.

Abdomen: light golden brown above, dark brown beneath. Thorax: dark brown above and below, with a tan line separating the segments.

Palpi: light tan, with some golden scales. Antennae: club and shaft dark brown above, lighter beneath. Legs: dark brown.

Wing measurements. Holotype male: Primaries; base to apex, 30 mm; apex to outer angle, 20 mm; outer angle to base, 17 mm; secondaries; base to end of vein 3, 16 mm; center of costa to anal angle, 23 mm. Wing spread: 53 mm (average of the paratypes, 55 mm).

FEMALE: unknown.

HOLOTYPE male: Ajijic, Jalisco, Mexico, October 3, 1965, collected by Robert Wind, will be placed in the U. S. National Museum, Washington, D. C. Six male paratypes in my collection, all from Ajijic, Jalisco, collected during September and October, 1965 by Robert Wind. It gives me great pleasure to name this new species for him.

Dorsally this species superficially resembled *E. orizaba* Scudder; however, on the lower surface of the secondaries there are differences that can readily be noticed: (1) the silvery, discal band is more macular in *windi* and extends closer to the costa; (2) the large central spot is not connected to the linear cell spot in *windi* like it is in *orizaba*; (3) the marginal gray scaling is much better developed in *windi* than it is in *orizaba*; and (4) the ground color is darker brown, chocolate in *windi*, a redder light brown color in *orizaba*.

The genitalia are different from any of the other species of *Epargyreus*, as can be noted by the figure on plate 2, figure 1.

Epargyreus brodkorbi Freeman, new species

(Plate 1, figure 5,6. Plate 2, figure 2)

MALE. Upperside: Primaries, reddish brown, with some golden hairs and scales near base. Discal spots yellowish, spot in space 1b a tiny dot, midway between spot in space 2 and outer margin; spot in space 2 large, triangular, situated slightly nearer to cell spot than to spot in space 1b, with vein 3 originating over its inner edge; cell spot triangular, not close to spot in space 2; no spot over cell spot near costa; a somewhat linear spot in space 3, situated midway between spots in spaces 1b and 2; one apical spot, minute. Costal fold well developed. Fringes uniform tan, not checkered. Secondaries, reddish brown, with center and basal areas overscaled with golden hairs and scales. Fringes, tan, not checkered.

Underside: Primaries, reddish brown, all spots yellowish orange. A faint area of grayish scales between veins 1 and 3. Secondaries, reddish brown, with some faint gray scaling along central portion of outer margin. Discal line faint, represented by a silvery area

in space 1, becoming indistinct above this region; no central silver spot and only a minute silvery dot in cell.

Abdomen: reddish brown above and below, a lighter line between segments. Thorax: golden brown above, darker brown beneath. Palpi: grayish-tan. Antennae: club and shaft dark brown above, somewhat lighter beneath. Legs: dark brown.

Wing measurements. Holotype male: Primaries; base to apex, 31 mm; apex to outer angle, 20 mm; outer angle to base, 18 mm; secondaries; base to end of vein 3, 18 mm; center of costa to anal angle, 23 mm. Wing spread: 58 mm.

FEMALE: Unknown.

HOLOTYPE male: Union Juarez, Chiapas, Mexico, March 19, 1939, collected by R. Brodkorb. This specimen was sent to me from the Museum of Zoology, University of Michigan. It will be placed in that collection.

Dorsally *brodkorbi* resembles *E. clavicornis gaumeri* Godman and Salvin from Ruatan Island, Honduras; however, the spots are yellow in *brodkorbi* and whitish in *clavicornis gaumeri*. Beneath there is also a general similarity to *clavicornis gaumeri* in the absence of the large silver central spot, and the reduction of the silvery discal line on the secondaries.

The genitalia easily separate this species from any of the other species of *Epargyreus* as can be determined by figure 2, plate 2. In some ways there is a slight resemblance to members of the *orizaba* complex, but no resemblance to the *clavicornis* complex.

Astraptes louiseae Freeman, new species

(Plate 1, figure 7,8. Plate 2, figure 3)

MALE. Upperside: Primaries, deep black, with a green sheen over space 1 and basal region. A band of five white hyaline spots from just before center of costal margin diagonally across each wing towards outer margin; upper spot situated on costal margin, elongated and placed directly over cell spot; cell spot 2.5 mm wide, angled outward at dorsal side. Spot in space 2 broad, 4 mm, its upper, inner edge projected one-third the distance under cell spot; spot in space 3 triangular, situated directly over spot in space 2, its point directed toward cell spot; spot in space 1b linear, located slightly closer to spot in space 2 to outer margin. Costal fold feebly developed. Fringe concolorous with rest of wing except in space 1a, white. Secondaries, deep black, overscaled with greenish hairs and scales, except from costal margin to vein 5. Fringes feebly checkered.

Underside: Primaries, dull black, all spots reappearing. No greenish overscaling. Secondaries, dull black, some faint greenish overscaling at anal angle, extending slightly up anal fold. No other markings.

Abdomen: dull greenish-black above, black beneath. Thorax: dull greenish-black above, black beneath. Head: above greenish-black. Palpi: brownish-black, with intermixed clear white scales. Antennae: club and shaft black above, shaft ventrally lighter brownish, club yellowish. Legs: black, heavy black hairs on femur and tibia.

Wing measurements. Holotype male, primaries: base to apex, 31 mm; apex to outer angle, 21 mm; outer angle to base, 21 mm; secondaries: base to end of vein 3, 18 mm; center of costa to anal angle, 22 mm. Wing spread: 58 mm.

FEMALE: Unknown.

HOLOTYPE male: Presidio, Veracruz, Mexico, August, 1951. This specimen was obtained from Dr. Tarsicio Escalante, and will be placed in the U. S. National Museum, Washington, D. C.

I take pleasure in naming this new species for my wife, Louise, who has collected many fine specimens of *Astraptēs*.

This species is a member of the *parisi* complex of *Astraptēs*. Included are *parisi* Williams from South America, and *helen* Evans from Mexico, Honduras, Nicaragua, and Panama. Evans considered *helen* to be a subspecies of *parisi*; however, I believe the genitalia are sufficiently distinct to consider the two as distinct species. Superficially *louiseae* can be distinguished from *helen*, which occurs in the same general area of Mexico (Paraje Nuevo, Veracruz), by the shape and disposition of three spots on the primaries. In *louiseae* the spot over the cell is elongated and almost the same length as the width of the cell spot, while in *helen* this spot is smaller and is about one-fourth the width of the cell spot. In *louiseae* the spot in space 3 is broadly triangular almost reaching the cell spot, while in *helen* this spot is a mere dot over the outer tip of the spot in space 2. In *louiseae* the spot in space 1b is linear, and is situated away from the spot in space 2, while in *helen* this spot is broadly triangular and comes almost to the lower outer edge of the spot in space 2.

The genitalia readily separate the three species. In *parisi* the elongated process on the valva is dentated on its outer surface and not as tall as in *louiseae* while in *louiseae* the process extends well above the top of the valva, and the outer, lower tip of the valva is evenly

rounded and not dentate. In *helen* there is a prominent tooth extending forward from the base of the elongated process, and the lower tip of the valva is bluntly rounded. The elongated process of *helen* is about the same height as that of *louiseae*.

Astraptes gilberti Freeman, new species

(Plate 3, figure 1,2,3,4. Plate 4, figure 1)

MALE. Upperside: Primaries, dull black, basal one-third heavily overscaled with brilliant, shiny blue scales; a few green scales in spaces 1 and 2 intermixed with the blue. Outer margin more or less straight. No costal fold. Fringes black. Secondaries, dull black, basal one-third heavily overscaled with brilliant, shiny blue scales. Outer margin slightly convex. Fringes black, with a few yellowish scales intermixed.

Underside: Primaries, brownish black, with black areas near apex, near end of cell, and over basal one-third of wing. A sordid white tornal area extending broadly over spaces 1 and 2, becoming much narrower in space 2 where it terminates beneath the cell; costa light yellow from base to end of cell; a few yellowish white scales below costa from end of cell to apex. Secondaries, brownish black, with some scattered yellowish scales. Two black bands, one in discal area, one over central portion, both more or less straight. A sordid white area from base to mid costa, with a few black scales at center of this area at base of wing.

Wing measurements. Holotype male, Primaries: base to apex, 23 mm; apex to outer angle, 16 mm; outer angle to base, 15 mm. Secondaries: base to end of vein 3, 15 mm; center of costa to anal angle, 19 mm. Wing spread: 43 mm (average of paratypes, 43 mm).

Thorax: Upperside black, with heavy overscaling of bluish-green scales; beneath, dull, yellow. Abdomen: upperside black, heavily overscaled with bluish-green scales; beneath, brownish-black. Head: black, with a few dull green and yellowish scales. Palpi: sordid yellowish-white. Antennae: shaft, black above and below; club, black above including apiculus; beneath, lower half dull yellow, remainder of club black, except apiculus dull yellowish. Legs: prothoracic legs, yellowish, meso- and metathoracic legs, black.

FEMALE. Upperside: Primaries, dull, black, basal one-third heavily overscaled with brilliant, shiny blue, intermixed with shiny green scales. A slightly lighter area in space 2 below outer edge of cell, due to lack of black scaling. Fringes uniform black. Secondaries, dull, black, heavily overscaled with brilliant, shiny blue over basal one-third. Outer margin evenly rounded. Fringes black.

Underside: Primaries, brownish-black, with a black area near apex, another near outer edge of cell and basal one-third of wing.

An extensive tornal white area extending broadly over space 1, becoming narrower in space 2, terminating at upper edge of cell; base of costa yellowish, becoming sordid white above outer edge of cell; some sordid white scales between end of cell and apex. Secondaries, brownish-black, two dark brownish-black, nearly straight bands, one in discal area, the other in central portion of wing; costa yellowish-white from base to near middle.

Wing measurements. Allotype female, primaries: base to apex, 26 mm; apex to outer angle, 18 mm; outer angle to base, 17.5 mm. Secondaries: base to end of vein 3, 18 mm; center of costa to anal angle, 19 mm. Wing spread: 48 mm (average of paratypes, 47.5 mm).

Thorax: Upperside black, with heavy overscaling of bluish-green; beneath, dull, yellow. Abdomen: upperside black, heavily overscaled with bluish-green; beneath, brown. Head: black, with a few dull green and yellowish scales. Palpi: sordid, yellowish-white. Antennae: shaft, black above and below; club, black above including apiculus; below, lower half dull yellow, remainder black, except apiculus, dull yellowish. Legs: prothoracic legs, yellowish, meso- and metathoracic legs, black.

HOLOTYPE male: Seven miles south of Valles, (Grounds of Hotel Covadonga) San Luis Potosi, Mexico, August 1, 1966, collected by H. A. Freeman. This specimen will be placed in the U. S. National Museum, Washington, D. C. Allotype female, same location and collector, June 10, 1966. There are five male paratypes; one collected by H. A. Freeman at Victoria, Tamaulipas, Mexico, June 8, 1966; three collected at the type locality by the same collector, (one June 11, 1966, one July 28, 1966, and one August 4, 1966); and one collected by Stallings & Turner and El Salto, San Luis Potosi, Mexico, August 21, 1966. There are six female paratypes; one collected at El Salto, San Luis Potosi, Mexico, July 17, 1963; four collected at the type locality, (one July 30, 1966, one July 31, 1966, one August 3, 1966, and one August 7, 1966); and one from Pharr, Hidalgo County Texas, October 21, 1944. All female paratypes were collected by H. A. Freeman. The allotype and paratypes will remain in my collection.

I take much pleasure in naming this new species for my son Gilbert who is very interested in the genus *Astrartes*.

This new species belongs to the *alector* complex of *Astrartes*, which contains *alector* (Felder) and *hopfferi* (Ploetz). *A. gilberti* differs from these two in the following ways: (1) somewhat smaller size, the primaries of males of *gilberti* average 23 mm, whereas the other two species average 25 mm; (2) *gilberti* has the wing bases blue like *alector* but lacks the opaque white central band from the cell to space 2 in the males and to space 1b in the females of *alector*; the females of *gilberti* have only the

slightest indication of this whitish area in some specimens somewhat like *hopfferi*, but in the latter the wing bases are green; (3) *gilberti* has the costa on the underside of the primaries yellowish to the cell, while *alector* has this area orange turning to white near the cell, and *hopfferi* has this area shining green at the base turning to white at mid costa; (4) the tornal white area on the underside of the primaries does not enter the cell in *gilberti* and *alector*, but does in *hopfferi*; and (5) in *gilberti* the genitalia are different from the other two species basically in three ways; first, the posterior process on the dorsal side of the valva is much broader than in the other two species; second, the anterior process is taller than in the other two; and third, the uncus is differently shaped on both the lateral and ventral surfaces from that of either *alector* or *hopfferi* (Plate 4, fig. 1).

Astraptes hopfferi has been recorded from several localities in Mexico, through Central America, and well into South America. *Astraptes alector* has so far been recorded only from Colombia.

I recorded *Astraptes hopfferi* (Ploetz) for the United States based on a female that I collected at Pharr, Texas, October 21, 1944 (Freeman, 1945). This specimen is now known to be *Astraptes gilberti* Freeman and therefore the name *hopfferi* should be removed from the United States list of HesperIIDae.

Genus POLYTHRIX Watson

There are several species in *Polythrix* which exhibit similar superficial characteristics and are perhaps best defined as sibling species. In order to be positive of their identification, an examination of the genitalia is necessary. While collecting in Mexico during the summer of 1966, I caught a number of such *Polythrix*, all of which were readily identified with the exception of one species. Since *asine* (Hewitson) is the most familiar species of *Polythrix* in Mexico, I at first thought that all of the *asine*-like specimens which I collected at Valles, S.L.P., were that species. After spreading the material it was possible to recognize the differences between *asine* and a previously undescribed species, the description of which follows.

Polythrix mexicanus Freeman, new species (Plate 5, figures 1-4)

MALE. Upperside: Primaries light brown, slightly darker along

outer margin. A small squarish spot in space 3, barely overlapping outer edge of spot in space 2; spot in space 2 straight on its inner surface, concave on its outer surface, situated under outer half of cell spot; cell spot broader at bottom than at top; a small spot over center of cell spot in space 10; five apical spots, one in space 5 round and small, one in space 9 about the same size, one in space 6 elongated, 2 mm wide, one in space 7 smaller, 1 mm wide, and one in space 8 about .5 mm wide. All spots are hyaline, sordid yellowish-white. Two faint dark spots beneath the spot in space 2, a somewhat darker spot midway between these two spots and base. Costal fold well developed. Fringes slightly lighter than ground color, especially at apex and termen. Secondaries light brown, an irregular, macular discal and central band of indistinct brownish spots. Outer margin evenly curved from apex to origin of the elongated tail. Tail averaging 12-14 mm in length, its center concolorous light brown with rest of wings, its outer edges much darker, nearly black. Fringes from apex to origin of tail light, sordid, yellowish-white.

Underside: Primaries similar to upper surface except in space 1, a light tan area from termen to base. Secondaries similar to upper side with somewhat lighter area along discal band, especially in space 1. Entire tail slightly darker than above.

Length of primaries, 19-22 mm, average 21 mm. Wing measurements: holotype: primaries: base to apex, 21 mm; apex to outer angle, 15 mm; outer angle to base, 15 mm; secondaries: base to end of Cu_1 , 14 mm; center of costa to end of tail, 30 mm; wing spread: 36 mm (average of paratypes 36 mm).

Abdomen: light olive-brown, above and below. Thorax: dull olive-brown, above and below. Palpi: olive-brown above and below. Antennae: club and shaft same olive-brown color above and below. Legs: same color as rest of body.

FEMALE. Same as male, except: (1) spots in spaces 2, 3, and cell are somewhat larger; (2) fringes of secondaries more whitish; (3) tails solid brownish-black above. General shape of wings much like that of males.

Length of primaries, 21 mm. Wing measurements: allotype: primaries: base to apex, 21 mm; apex to outer angle, 15 mm; outer angle to base, 15 mm; secondaries: base to end of Cu_1 , 14 mm; center of costa to end of tail, 30 mm. Wing spread: 38 mm.

Abdomen, thorax, palpi, antennae, and legs, same as males.

HOLOTYPE male: Seven miles south Valles (grounds of Hotel Covadonga), San Luis Potosi, Mexico, August 2, 1966, collected by H. A. Freeman, will be deposited in the U. S. National Museum, Washington, D. C. Allotype female: Ajijic, Jalisco, Mexico, October 22, 1965, collected by Robert Wind, will remain in the collection of H. A. Freeman. There are eight male paratypes, all collected at the

same place as the holotype during July and August, 1966, by H. A. Freeman, also in the collection of H. A. Freeman.

This new species belongs to the *asine* complex of the genus *Polythrix*, which contains *asine* (Hewitson), *roma* Evans, *hirtius* (Butler), and *gyges* Evans. The last three species are South American, and although they show superficial resemblances to *mexicanus*, the genitalia readily separate them. *asine* occurs rather widely over Mexico, through Central America to northwestern Peru. During the past three summers I collected *asine* at Catemaco, Veracruz, Juchitan, Oaxaca, and at the type locality of *mexicanus* (Valles, San Luis Potosi). In comparing *asine* and *mexicanus* there are a number of ways that they differ superficially, (1) *asine* is darker brown than *mexicanus*; (2) the tails of the males of *asine* are shorter, (7-8 mm) than those of *mexicanus*; (3) *asine* has four apical spots, whereas *mexicanus* has five; (4) in *asine* the spot in space 2 is almost even on its inner side with the cell spot, while in *mexicanus* the spot in space 2 is shifted outward, with its inner edge under the center of the cell spot; and (5) in the females of *asine* there is a hyaline spot in space 1b below the spot in space 2, while in *mexicanus* there is no hyaline spot there in either sex. One of the most distinguishing characteristics of *mexicanus* is the fact that the males have the same general wing shape as the females of *asine*, with the outer margin of the secondaries evenly curved from the apex to the origin of the tail, while in *asine* the males have this same area nearly straight, causing the tail to be shorter.

The genitalia readily separate *mexicanus* from any other member of *Polythrix* due to the much shorter, blunt tip to the cuiller, and the sharp pointed style of the valva. *P. roma* has the valva with the pointed tips of the cuiller and the style approximate. *P. asine* has the valva with the tips of the cuiller and style wide apart and the same general height. *P. hirtius* has the style of the valva very short, and the cuiller slender and pointed. *P. gyges* has the style of the valva fairly short, and the cuiller long, broad, and blunt-ended. There are other differences in the genitalia that can be determined by figures 3,4 on plate 5.

Ridens crison (Godman & Salvin, 1893)

This beautiful species was described from a female specimen collected in Guatemala. Evans (1952) recorded *cachinnans* (Godman) as a subspecies of *crison*, and stated that there was only the female type of *crison* in the British Museum; and that there was a male *cachinnans* from

Costa Rica, one male and a female from Panama, as well as the type in the museum. In his figures of the genitalia of the American HesperIIDae (1952: plate 17), he shows the male genitalia of what he called *crison* which apparently was made from one of the males of *cachinnans*, since he considered them to be the same species. In material which I received from Dr. Escalante there were five males of *crison* collected at Santa Rosa, Comitán, Chiapas, Mexico, during May, 1965. I found that the genitalia of these specimens did not match the figure that Evans illustrates for *crison*. This indicates that true *crison* has not been figured, and the genitalia Evans attributes to *crison* actually came from *cachinnans*, which is not a subspecies of *crison* but a distinct species.

This record from Comitán, Chiapas is the first record of *crison* for Mexico.

Superficially the males of *crison* closely resemble the Godman and Salvin figure of the type female. The only differences noted are the somewhat smaller size of the spots in spaces 1b, 2, 3, 4 and 5, and the slightly deeper blue coloration of the discal band on the lower surface of the secondaries in the Godman and Salvin figure.

Urbanus albimargo (Mabille, 1875)

This species was described from Colombia and appears to have a rather wide range throughout the American tropics. Evans (1952) recorded *albimargo* from Guatemala, Honduras, Costa Rica, Panama, Colombia, Venezuela, and Ecuador. In specimens received from Dr. Escalante, there was a male collected at Catemaco, Veracruz, August, 1961, and a female from Santa Rosa, Comitán, Chiapas, August, 1965. While collecting on the grounds of Hotel Covadonga, seven miles south of Valles, San Luis Potosí, on June 11, 1966, I caught a fresh male specimen of *albimargo*. It was flying in company with individuals of *Urbanus doryssus* (Swainson) but later examination revealed it could readily be separated from them by the tail color and general wing shape, as well as the genitalia. This constitutes another new HesperIIDae record for Mexico.

Aethilla chiapa Freeman, new species

(Plate 3, figure 5,6. Plate 4, figure 5)

MALE. Upperside: Primaries, dark brownish-black. Outer margin straight. No costal fold. Fringes, orange-yellow. Secondaries, dark brownish-black. Outer margin convex. Fringes, orange-yellow, the orange coloration extending slightly onto wing just outside of anal angle.

Underside: Primaries, dark reddish-brown, slightly lighter from apex to outer angle. Space 1a lighter due to a few orange scales. Secondaries, dark brownish-black, with a broad orange-yellow marginal border, 5 mm wide at end of vein 1, extending from anal angle to just below vein 4.

Wing measurements. Holotype male. Primaries: base to apex, 28 mm; apex to outer angle, 20 mm; outer angle to base, 20 mm. Secondaries: base to end of vein 3, 20 mm; center of costa to anal angle, 21 mm. Spread expanse: 50.5 mm (average of paratypes, 50 mm).

Abdomen: dark brownish-black, both above and below. Thorax: dark brownish-black, both above and below. Head: dark brown. Palpi: dark brownish-black. Legs: black. Antennae: shaft, brownish-black, both above and below; club, brownish-black above, slightly yellowish beneath.

FEMALE. Upperside: Primaries, dark brownish-black, with a slight purplish sheen. A slightly lighter area at end of cell. Two somewhat lighter bands, one 3 mm in from outer margin, extending from space 1b to costa, this band 5 mm wide; second band slightly inward from first, 3 mm wide, extending from space 1b to costa. Outer margin slightly convex. Fringes, orange-yellow, narrow. Secondaries, dark brownish-black, with the same purplish sheen as on primaries. The two lighter bands in approximately the same position as on primaries. A slightly lighter bar at end of cell. Outer margin evenly convex. Fringes, bright orange-yellow.

Underside: Primaries, reddish brownish-black, with the slightest indication of the lighter bands of upperside. Somewhat lighter in space 1a. Secondaries, dark brownish-black, a broad sordid orange-yellow marginal border from anal angle to just below vein 4.

Wing measurements. Allotype female. Primaries: base to apex, 31 mm; apex to outer angle, 21 mm; outer angle to base, 21.5 mm. Secondaries: base to end of vein 3, 23 mm; center of costa to anal angle, 22 mm. Wing spread: 54 mm.

Abdomen: dark brownish-black both above and below. Thorax: dark brownish-black both above and below. Head: dark brown. Palpi: dark brownish-black. Legs: black. Antennae: shaft, brownish-black above and below; club, brownish-black above, slightly yellowish beneath.

HOLOTYPE male, Ocozingo, Chiapas, Mexico, August 1958. This specimen as well as the allotype and three of the male paratypes were received from Dr. Escalante. The holotype will be placed in the U. S. National Museum, Washington, D. C. Allotype female, Ocozingo, Chiapas, Mexico, July 1942. There are five male paratypes: three from Ocozingo, Chiapas, two July 1942, and one July 1948; and there are two from Volcan San Maria, Guatemala, no date, in the U. S. National Museum. There is a female

paratype in the U. S. National Museum from Chiapas, Mexico with no other data. The allotype and one male paratype will remain in my collection. Two male paratypes will be placed in the Escalante collection, Mexico, D. F.

This new species bears a slight resemblance to *Aethilla lavoehrea* Butler but can readily be separated from it by the following characteristics: (1) *chiapa* is darker, with the lighter bands much less distinct than in *lavoehrea*; (2) the secondaries of the males of *chiapa* have the outer margin evenly convex, whereas *lavoehrea* has this area straight from the anal angle nearly to the apex, thus giving *chiapa* a broader secondary; (3) the fringes of both wings of *chiapa* are orange-yellow, while those of *lavoehrea* are more yellowish; (4) the orange marginal border on the underside of the secondaries of *chiapa* is narrower than in *lavoehrea*, and it does not have the dark line extending into the upper part of this area which *lavoehrea* has; and (5) the genitalia are different from any other species of *Aethilla*, (figure 5, plate 4).

Mimia chiapaensis Freeman, new species

(Plate 6, figure 5,6. Plate 15, figure 2)

MALE. Upperside: Primaries, dark brown, with faint submarginal and discal bands. A faint, dark line in spaces 4 and 5 beneath apical spot in space 6. Apical spots in spaces 7 and 8 are in line, the one in space 6 displaced outward from the other two. A black spot in outer one-third of cell. A long, narrow costal fold. Fringes dark brown. Secondaries, dark brown, with a darker marginal border, a curved discal band, and a dark spot in the cell. Outer margin evenly round. Fringes dark brown.

Underside: Primaries, brown, basal half and outer margin to apex darker than discal area and space 1, this area a lighter reddish brown. The three hyaline white apical spots prominent. Secondaries, dark chocolate brown, with a darker discal and basal band.

Abdomen and Thorax: dark brown, both above and below. Head: dark brown. Palpi: brown. Legs: brown. Antennae: dark brown above and below, both shaft and club.

Wing measurements: Holotype male. Primaries: base to apex, 21 mm; apex to outer angle, 15 mm; outer angle to base, 15 mm. Secondaries: base to end of vein 3, 16 mm; center of costa to anal angle, 16 mm. Wing spread: 34 mm.

FEMALE: unknown.

HOLOTYPE male, Santa Rosa, Comitán, Chiapas, Mexico, May 1965. This specimen was obtained from Dr. Tarsicio Escalante and will be placed in the U. S. National Museum, Washington, D. C.

Evans (1953) proposed the genus *Mimia* to accommodate one species, *phidyle* (Godman & Salvin), and he described *pazana* as a new subspecies of that species from Bolivia. The only specimen of *phidyle* in the British Museum is the female type from Panama. From the available information it appears to be they are actually separate species and I am going to treat them as such.

In separating *chiapaensis* from the other two species the following characteristics will suffice: (1) *chiapaensis* differs from *phidyle* in that the primaries on the lower surface do not have the apical half unmarked yellow as is present in *phidyle*. (2) *chiapaensis* differs from *pazana* in three basic ways, (a) the shape of the apical spots in *pazana*, as the ones in spaces 7 and 8 are minute, and the one in space 6 unusually large, while in *chiapaensis* they are equal in size with the one in space 6 displaced outward from the other two, (b) *pazana* has the outer half of the primaries on the lower surface pale yellowish-brown, while in *chiapaensis* this area differs, being only slightly lighter brown than the rest of the wing, and (c) differences in the genitalia, refer to Evans' (1953) figure of "*phidyle*," which must be *pazana*.

Windia Freeman, new genus

Type of the genus. - *Windia windi* Freeman

Antenna approximately one half the length of the costa, bent to apiculus beyond thickest part of the club. Nudum 3/12. Apiculus approximately one-third the length of club. Shaft and club brown above, yellowish beneath. Head, brownish-gray above. Palpi elongated, extending well beyond head, brown above, sordid white beneath. Mid tibia smooth, with one pair of spurs. Hind tibia smooth, with two pairs of spurs. Short, sparse, white hair-like fringe on both mid and hind tibiae. Primaries produced, apex more or less pointed, more or less straight from outer angle to apex. A very slender costal fold. Hyaline apical and discal spots present. Wing venation of both primaries and secondaries as in *Noctuana* Bell. Secondaries with the outer margin more or less concave, anal angle slightly produced. With semi-hyaline discal and basal spots. Genitalia with valvae asymmetrical.

This genus is proposed for a new species collected by Robert Wind, and I take great pleasure in naming it for him. Superficially the general color and maculation somewhat resemble members of the genus *Udranomia* Butler; structurally there is no similarity. *Udranomia* is in the *Augiades* Group of Group B of the Pyrginae, following Evans's arrangement, which is characterized by the peculiar

palpi: third segment stout, spatulate, set on the outer edge of the second segment, divergent. *Windia* is in the *Telemiades* Group of Group E of the Pyrginae, which is characterized by having the third segment of the palpi always porrect (extended forward) and pendulous (drooping). *Windia* is more closely related structurally to the genus *Noctuana* Bell than to any other, however the following differences separate the two genera: (1) *Windia* does not have the truncate primaries that are present in *Noctuana*; (2) members of the genus *Noctuana* have no hyaline spots on the primaries other than the apical spots and these are directed toward the upper half of the outer margin, while *Windia* has not only the hyaline apical spots which are toward the lower half of the outer margin but also hyaline spots in spaces 2, 3, 4, and two in the cell; (3) *Windia* has semi-hyaline discal and basal spots on the secondaries, approaching *Udranomia*, which are absent in *Noctuana*; (4) in *Noctuana* the hind tibia of the males have a long fringe, while in *Windia* this is short and rather sparse; and (5) there are basic genitalic differences in the general shape of the valvae and the aedeagus (see Evans, 1953, plate 34).

Windia windi Freeman, new species

(Plate 6, figure 7,8. Plate 15, figure 6)

MALE. Upperside: Primaries, grayish-brown, mottled dark and light. Outer margin alternately light and dark brown from outer angle to apex. Three dark bands in space 1; squarish, apical spots in a straight line in spaces 6, 7, and 8 directed toward lower half of outer margin. A minute dot in space 9 situated inward from the apical spot in space 8; two spots in space 2 situated beneath lower cell spot; a small spot in space 3, and a minute dot in space 4, directly beneath apical spot in space 6; somewhat triangular cell spots, the largest spots on the wing; all spots white hyaline. A dark area just inside apical spots, another inside cell spots and inner spot in space 2. A narrow costal fold. Wings produced apically, outer margin straight from outer angle to apex, which is more or less pointed. Fringes checkered dark and light brown. Secondaries, mottled dark and light grayish-brown, with some discal, basal and subcostal spots semi-hyaline. A black bar in cell, as well as dark discal and submarginal spots. Outer margin slightly concave, anal angle somewhat produced. Fringes checkered light brown.

Underside: Primaries, light brown, with ochreous markings in submarginal area from outer angle to apex. A light area in space 1 below spots in space 2. All spots reappear, paler. Secondaries, light brown, all veins lighter than ground color. Opaque discal spots, two at end of cell, one in cell, one above cell. Minute ochreous markings in submarginal area from anal angle to vein 5.

Abdomen: dark grayish-brown above, lighter brown beneath.

Thorax: dark grayish-brown above, yellowish-brown beneath. Head: dark brown. Palpi: dark brown above, sordid white beneath. Legs: yellowish-brown. Antennae: shaft brown above, yellow beneath; club brown above, yellow beneath, apiculus yellowish-brown.

Wing measurements: Holotype male. Primaries: base to apex, 15 mm; apex to outer angle, 12 mm; outer angle to base, 11 mm. Secondaries: base to end of vein 3, 10 mm; center of costa to anal angle, 13 mm. Wing spread: 29 mm (one paratype 28 mm, and the other 30.5 mm).

FEMALE: unknown.

HOLOTYPE male, Salada, Colima, Mexico, 13 June 1967 (collected by Robert Wind) will be placed in the U. S. National Museum, Washington, D. C. One male paratype, same location and collector, 19 June 1967, and one male paratype, Milpillas, Guerrero, Mexico, 4 July 1956 (collected by Kent Wilson) are in my collection.

Superficially there is a slight resemblance between *windi* and *Udranomia oreinus* (Felder) in the mottled appearance and arrangement of the white hyaline spots on the primaries.

Staphylus veytius Freeman, new species

(Plate 7, Figure 7,8. Plate 15, Figure 5)

MALE. Upperside: Primaries, dark brown, with the slightest indication of a darker submarginal band. Two minute apical spots and a minute dot in space 2. Fringes concolorous with ground color. A costal fold present. Secondaries, dark brown, with only the slightest indication of darker bands. Termen slightly undulate. Fringes same color as wing.

Underside: Primaries, dark brown, slightly lighter than upper-side. Apical and discal spot in space 2 only slightly visible. Secondaries, uniform brown.

Abdomen and thorax: dark brown, both above and below.

Wing measurements: Holotype male. Primaries: base to apex, 11.5 mm; apex to outer angle, 7 mm; outer angle to base, 9 mm. Secondaries: base to end of vein 3, 9 mm; center of costa to anal angle, 8 mm. Wing spread: 22 mm (paratype 24 mm).

FEMALE. Upperside: Primaries, dark brown, with dark brown central, discal and submarginal bands. Two apical spots, a tiny dot in cell, a small spot in space 2. All spots white, hyaline. Fringes same color as wing ground color. Secondaries, dark brown, with darker bands in central and discal areas. Fringes same color as ground color of wing.

Abdomen, thorax, head, palpi, legs, and antennae same as in males.

Wing Measurements: Allotype female. Primaries: base to apex, 13 mm; apex to outer angle, 9 mm; outer angle to base, 11 mm. Secondaries: base to end of vein 3, 10 mm; center of costa to anal angle, 9 mm. Wing spread: 27.5 mm.

HOLOTYPE male, Cintalapa, Chiapas, Mexico, 17 August 1964, will be placed in the U. S. National Museum, Washington, D. C. Allotype female and one male paratype same data as holotype are in my collection. All three specimens collected by H. A. Freeman. Named for the Mexican historian, Don Mariano Veytia.

This is another member of the *mazans* complex. Evans lists four subspecies of *mazans*, *mazans* (Reakirt) from Veracruz; *hayhurstii* (Edwards) from central and eastern United States; *tierra* Evans from Guerrero, Jalisco, Sonora, and Nayarit; and *ascaphalus* (Staudinger) from southern Mexico to South America. Since the genitalia of all four are different and in some areas certain ones fly together, it seems most unlikely that we should consider them to be subspecies so I propose that we consider each to be a valid species. The new species *veytius* is closer related to *tierra* than any of the other members of this group. Superficially it resembles *tierra* in general appearance but is smaller. Structurally the genitalia differs from *tierra* in that there are three equal size long bristles on the dorsal side of the valva and five at the apex of the valva. *S. tierra* was described as having two bristles on the upperside of the cuiller and conspicuous vinculum brushes. These brushes are not as conspicuous in *veytius*. I have found that *tierra* often has three bristles on the upper side of the cuiller, however the third one is always much shorter than the other two.

I have found that in the State of Chiapas, *mazans*, *ascaphalus*, and *veytius* all fly together in various areas. While collecting at the Guatemala border, I found only *ascaphalus*. At Cintalapa *mazans*, *veytius*, and *ascaphalus* Near Comitán *mazans* and *ascaphalus* were found.

Staphylus zuritus Freeman, new species

(Plate 7, figure 5,6. Plate 15, figure 4)

MALE. Upperside: Primaries, dark brown, with two darker brown bands from costal to inner margin, one outside end of cell, from apical region to inner margin, where it becomes slightly narrower; second band extending from just below costa, through cell to inner margin, broad, extending nearly to base of wing. No apical or discal spots. No costal fold present. Fringes darker at base, remainder concolorous with ground color of wings. Secondaries, dark brown,

three dark bands, first narrow, submarginal, second discal, wide below costa becoming much narrower above anal angle, third band sub-basal, extending to base. Outer margin evenly round. Fringes same as on primaries.

Underside: Primaries, light brown, with a lighter submarginal band. A few yellow scales scattered over entire surface. Secondaries brown, with slightest indication of darker bands present. Some scattered yellow scales over entire surface.

Abdomen and thorax: dark brown above, lighter beneath. Head: brown. Palpi: white, with a few intermixed gray scales. Legs: yellowish. Antennae: shaft and club black above, yellowish beneath.

Wing measurements: Holotype male. Primaries: base to apex, 14.5 mm; apex to outer angle, 10 mm; outer angle to base, 13 mm. Secondaries: base to end of vein 3, 12 mm; center of costa to anal angle, 11 mm. Wing spread: 29 mm.

FEMALE. Upperside: Primaries, brown, similar to male except with two minute apical spots, and a greater contrast between dark bands and ground color. Fringes same as in male. Secondaries, brown similar to male, except more contrast between dark bands and ground color. Fringes same as in male.

Underside: Primaries, lighter than above, the apical spots prominent. No indication of darker bands. Secondaries, uniform pale brown, with no indication of darker bands.

Abdomen, thorax, head, palpi, legs, and antennae same as in the male.

Wing measurements: Allotype female. Primaries: base to apex, 15.5 mm; apex to outer angle, 10 mm; outer angle to base, 12 mm. Secondaries: base to end of vein 3, 13 mm; center of costa to anal angle, 11 mm. Wing spread: 29 mm. Paratype, wing spread: 27.5 mm.

HOLOTYPE male, Cintalapa, Chiapas, Mexico, 17 August 1964, will be placed in the U. S. National Museum, Washington, D. C. Allotype female, Oaxaca, Oaxaca, 23 June 1966, and one female paratype same location, 22 June 1966 are in the collection of H. A. Freeman. All specimens collected by H. A. Freeman.

This new species is named for Zurita the Mexican historian.

Superficially *S. zuritus* resembles *S. semitincta* (Dyar) more closely than any other species. *S. zuritus* differs by being a darker brown, by not having any white hyaline spots, by not having whitish scaling on the lower surface of the secondaries, by having the under surface of the secondaries uniform brown instead of the posterior

half tinged gray. The best way to separate the two species is by the genitalia. The scaphium of the male genitalia is missing in *zuritus* while present in *semitincta*. In *semitincta* the valva terminates in a broad apex extending well above the rest of the valva, back of which the dorsal edge is produced inwardly into a somewhat triangular flange with two teeth at the apex. In *zuritus* the valva terminates in a lobed apex which barely extends above the rest of the valva, back of which the dorsal edge is produced inwardly into a somewhat triangular flange with one tooth at the apex. In preparing this description, *zuritus* was compared with specimens of *semitincta*, in my collection, from Villa Juarez, Puebla; Ajijic, Jalisco (collected by Robert Wind); and San Jose Purua, Michoacan (collected by Bryant Mather).

Quadrus francesius Freeman, new species

(Plate 7, figure 1-4. Plate 15, figure 3)

MALE. Upperside: Primaries, light brown, with a darker submarginal band and a broad central band extending from inner margin through cell to costa. Base darker brown. Three apical spots, the lowest one displaced outward from the other two; a discal spot in space 2, a linear, opaque spot below in space 1b, a smaller one in space 3 slightly outward from the spot in space 2; a small spot in upper part of cell, above this, just below costa is a minute, linear spot. All spots white hyaline. Cell black surrounding cell spot. Fringes concolorous with rest of wing. Secondaries, light brown, with darker submarginal, discal, and subbasal bands. A dark spot in cell. Fringes concolorous with rest of wing.

Underside: Primaries, brown, the darker bands plainly visible. All hyaline spots repeated, somewhat paler. Secondaries, brown, all dark bands repeated. A heavy suffusion of blue scales over all the wing except outer margin.

Abdomen: dark brown above, gray beneath, some blue scales at base. Thorax: dark brown above, lighter beneath, some sparse white hairs. Head: brown. Palpi: light brown, some white scales. Legs: brown. Antennae: shaft dark brown above, slightly lighter beneath; club dark brown above, slightly lighter beneath.

Wing measurements: Holotype male. Primaries: base to apex, 17 mm; apex to outer angle, 12 mm; outer angle to base, 13 mm. Secondaries: base to end of vein 3, 12 mm; center of costa to anal angle, 14 mm. Wing spread: 32 mm.

FEMALE. Upperside: Primaries, similar to male except darker. Secondaries, same as male except darker.

Underside: Primaries, similar to male except a paler area in space 1, and a small, yellowish submarginal spot in space 1b.

Secondaries, similar to male, except a pronounced dark bar in discal area of space 5. Blue overscaling of basal and discal areas extending along veins into submarginal area.

Abdomen, thorax, head, palpi, legs, and antennae same as male.

Wing measurements: Allotype female. Primaries: base to apex, 18 mm; apex to outer angle, 12 mm; outer angle to base, 14 mm. Secondaries: base to end of vein 3, 14 mm; center of costa to anal angle, 14 mm. Wing spread: 34 mm.

HOLOTYPE male, Santa Rosa, Comitan, Chiapas, Mexico, May 1965, will be placed in the U. S. National Museum, Washington, D. C. Allotype female, Comitan, Chiapas, September 1962, will remain in my collection. Both specimens were sent to me by Dr. Tarsicio Escalante.

I take pleasure in naming this new species for Sr. Alberto Diaz Frances, Mexico, D. F., who is an enthusiastic collector of Lepidoptera.

Superficially this new species slightly resembles *cerealis* (Cramer), however, it can readily be separated by the following characteristics: (1) the maculation of the primaries is greatly reduced in *francesius*, lacking the two spots below spot 2 which are present in *cerealis* and lacking the elongated lower cell spot; (2) the bluish white bands present in *cerealis* on the upper surface of the secondaries in both sexes are absent in *francesius*; (3) the lighter area on the under surface of the primaries in space 1 of *francesius* is not as pronounced in *cerealis*; and (4) the genitalia have a style on the valvae like *cerealis* but more closely approach the general shape of the genitalia of *fanda* Evans which lacks this style, and there are other differences as can be determined by my figure of the genitalia of *francesius* (Plate 15, fig. 3).

HESPERIINAE

Enosis matheri Freeman, new species

(Plate 7, figure 9, 10. Plate 15, figure 7)

MALE. Upperside: Primaries, dark brown, unmarked. Stigma dark brown. Fringes, tan. Secondaries, dark brown, unmarked. Fringes, tan.

Underside: Primaries, dark reddish brown. A distinct, yellowish-white apical spot in space 6. Apex with a slight ferruginous overscaling; space 1 slightly paler than remainder of wing. Secondaries, dark chocolate brown, with an indistinct, yellowish-white discal spot in space 3.

Abdomen and thorax: dark brown, both above and below. Head: dark brown. Palpi: dark brown. Legs: dark brown, with some yellow scales. Antennae: shaft, dark brown above and below; club, slightly yellowish at base and underside of apiculus, slightly yellowish, remainder dark brown.

Wing measurements: Holotype male. Primaries: base to apex, 19 mm; apex to outer angle, 12 mm; outer angle to base, 13 mm. Secondaries: base to end of vein 3, 13.5 mm; center of costa to anal angle, 13.5 mm. Wing spread: 36 mm.

FEMALE. Upperside: Primaries, dark brown, with an indistinct, yellowish-white apical spot in space 6. Fringes, sordid white. Secondaries, dark brown, unmarked. Fringes, sordid white.

Underside: Primaries, dark brown, except lighter in space 1. An indistinct, yellowish-white discal spot in space 3 and an apical spot of same color in space 6. Secondaries, dark chocolate brown, with a yellowish-white discal spot in space 3.

Abdomen, thorax, head, palpi, legs, and antennae, same as in male.

Wing measurements: Allotype female. Primaries: base to apex, 19 mm; apex to outer angle, 14 mm; outer angle to base, 15 mm. Secondaries: base to end of vein 3, 14 mm; center of costa to anal angle, 13 mm (wing torn at anal angle). Wing spread: 35 mm.

HOLOTYPE male, Catemaco, Veracruz, Mexico, December 1963 (obtained from Dr. Tarsicio Escalante, Mexico, D.F.), will be placed in the U. S. National Museum, Washington, D. C. Allotype female, Tuxpango, Veracruz, Mexico, 4 December 1957 (collected by Bryant Mather), will remain in my collection.

I take pleasure in naming this new species for Bryant Mather, Jackson, Mississippi.

This is another member of a genus of obscurely marked species that can only be definitely identified by an examination of the genitalia. The new species resembles *immaculata* (Hewitson) in the depth of coloration, especially on the underside, and has the stigma less conspicuous due to its dark brown color. The genitalia are different from any of the other species of *Enosis* as can be determined by comparing my figure (plate 15, fig. 7) with Evans' (1955) illustrations (plate 68, K. 4., 1-11).

Dalla ramirezi Freeman, new species

(Plate 8, figure 1, 2. Plate 4, figure 2)

MALE. Upperside: Primaries, brown. A light yellow, rectangular

hyaline spot in space 2, 3 mm wide, which is completely overlapped by the longer cell spot; the light yellow hyaline cell spot bluntly triangular, is 2 mm wide in the center; three yellowish hyaline apical spots in a line. Fringes same brown as wings. Secondaries, brown, a large oval spot in center of wing, covering most of cell; this spot 4.5 mm wide, 2.5 mm tall, with the inner half orange-yellow, the outer half semi-hyaline, nearly clear. Fringes, yellowish-tan, with some brown scales intermixed.

Underside: Primaries, brownish-black, with the hyaline spots somewhat lighter than above; four yellowish spots between apical spots and outer margin and apex. Base of costa yellowish. Ground color slightly lighter in space 1. Secondaries, brownish-black, with some yellow scales along costa, on the anal fold, and just outside anal angle; a broad, yellowish, strip extending from base through cell to just inside outer margin, with the semi-hyaline spot two-thirds from base.

Wing measurements. Holotype male, primaries: base to apex, 16.5 mm; apex to outer angle, 11 mm; outer angle to base, 13 mm. Secondaries: base to end of vein 3, 13 mm; center of costa to anal angle, 11 mm. Wing spread: 34 mm.

Abdomen: brownish-black above, yellow beneath. Thorax: brownish-black above, yellowish beneath. Head: brown, with some yellow scales. Palpi: elongate, yellowish-white with outer edges and tips black. Legs: yellow and black. Antennae: shaft, black above, yellowish beneath; (club missing from this specimen).

FEMALE. Unknown.

HOLOTYPE male, Catemaco, Veracruz, Mexico, August 1958, collected by Abraham Ramirez. This specimen was obtained from Dr. Escalante and will be placed in the U. S. National Museum, Washington, D. C.

I am unable to locate any species of *Dalla* that shows any close macular resemblance to this new species. The genitalia are not like any of the other species in this genus, as shown by figure 2 on plate 4.

Vettius argentus Freeman, new species
(Plate 8, figure 3, 4. Plate 4, figure 3)

MALE. Upperside: Primaries, light olive brown, with ochreous scales along costa from base to middle. An oval white spot in space 2, a smaller white spot beyond, in space 3. No costal fold. No apical spots. Fringes, same olive brown as wings. Secondaries, even olive brown. Fringes, same color as rest of wing.

Underside: Primaries, brownish-black, outer margin, apex, and

costa ferruginous. The two spots of upperside reappear, slightly paler. A broad silver spot in space 4, a somewhat smaller silver spot in space 6; a tiny silver spot in space 7. Secondaries, shiny silver, three ferruginous stripes: first along costa from base to end of vein 7; second from base through cell to outer margin; third from base of mid space 1c to outer margin just beneath end of vein 2. Outer margin narrowly edged with ferruginous scales.

Wing measurements. Holotype male, primaries: base to apex, 17.5 mm; apex to outer angle, 10.5 mm; outer angle to base, 14 mm. Secondaries: base to end of vein 3, 12.5 mm; center of costa to anal angle, 13 mm. Wing spread: 34.5 mm (average of paratypes, 31 mm).

Abdomen: brownish-black above, white beneath. Thorax: brownish-black above, white beneath. Head: brownish-black. Palpi: intermixed white and black. Legs: whitish. Antennae: shaft, brownish-black above and below, except at base of club, somewhat lighter; club, brownish-black above and below, somewhat lighter at base.

FEMALE. Upperside: Primaries as in male. Secondaries as in male, except broader.

Underside: Primaries as in male, except for silver spots in apical region somewhat duller. Secondaries as in male.

Wing measurements. Allotype female, primaries: base to apex, 18 mm; apex to outer angle 11 mm; outer angle to base, 14 mm. Secondaries: base to end of vein 3, 14 mm; center of costa to anal angle, 13.5 mm. Wing spread: 35 mm.

Abdomen, thorax, head, palpi, legs, and antennae as in male.

HOLOTYPE male, Santa Rosa, Comitán, Chiapas, Mexico, May 1965, will be placed in the U. S. National Museum, Washington, D. C. Allotype and two male paratypes, same date and location. These specimens were sent to me by Dr. Escalante; paratypes will be placed in his collection and the allotype will remain in my collection.

This new species is related to *Vettius coryna* (Hewitson) and its subspecies *conka* Evans and *catargyra* (Felder) by the silvery lower surface of the secondaries and the three ferruginous bands. *V. argentus* differs in having no apical spots, while *conka* has one, and *catargyra* and *coryna* have two. There is a cell spot in *coryna* which is not present in either *argentus* or *conka*. In *coryna* and its subspecies the costal edge of the last, and anal edge of the middle, ferruginous streaks on the lower surface of the secondaries are black edged, while this does not occur in *argentus*. The genitalia differ in that the terminal end of the valva is more upturned and the shape of the uncus is different (Plate 4, fig. 3).

Niconiades comitana Freeman, new species
(Plate 8, figure 5, 6. Plate 4, figure 4)

MALE. Upperside: Primaries, dark brownish-black, a few green scales near base and in space 1a. A squarish white hyaline spot in space 2; an oval rather small, yellowish spot in space 1b, basad from the spot in space 2; another square, white, hyaline spot in space 3, situated outward from space 2; two white, hyaline spots in cell which barely touch in the center; three white, hyaline apical spots, one nearest costa a mere dot. Three brands, brown, rather inconspicuous, a very small one over middle of vein 1; second one somewhat elongated, below vein 2 near its origin; third one shorter, above vein 2 directly over the elongated one. Fringes, dark brown becoming somewhat lighter near outer angle. Secondaries, dark brownish-black, some green scales near base. Two white hyaline spots, one in space 3, 1.5 mm wide, one in space 2, 1 mm wide. Outer margin convex, only slightly produced at anal angle. Fringes, sordid yellowish-white.

Underside: Primaries, dark brown, a heavy suffusion of yellow at costa above cell, becoming indistinct toward base. Vein 1 white edged, vein 2 slightly edged in yellow. The white hyaline spots of upperside all reappear, somewhat paler; a small yellowish area in space 1b just beneath outer edge of spot in space 2; a clear white, oval spot inward from this, directly over vein 1. Apex is slightly lighter brown than remainder of wing. Secondaries, dark brown, a wide band from edge of costa to space 1c, bright yellow from costa to spots in spaces 2 and 3, from there downward, yellowish-white. A yellow streak along vein 1a extending 7 mm. from base.

Wing measurements. Holotype male, primaries: base to apex, 17.5 mm; apex to outer angle, 12 mm; outer angle to base, 13 mm. Secondaries: base to end of vein 3, 12 mm; center of costa to anal angle, 14 mm. Wing spread: 33 mm.

Abdomen: brownish-black above, base heavily overscaled with green, below brownish-black. Thorax: brownish-black above heavily overscaled with green, underside brown. Head: black, with green scales. Palpi: yellowish-white. Legs: brown, with some yellow. Antennae: shaft, black above, slightly ringed beneath; club, black above, below basal half slightly yellowish, remainder black.

FEMALE. Upperside: Primaries, dark brown, a few green scales near base. Spots same as in males except cell spots fused, the rest somewhat larger. Secondaries, dark brown, green scales over basal one-fourth of wing. A tiny, white, hyaline dot in space.

Underside: Primaries, same as male except the yellow costal area broader and wider. Secondaries, like male except yellow stripe a little wider, not as dark, more yellowish-white.

Wing measurements: Allotype female, Primaries: base to apex, 19 mm; apex to outer angle, 12 mm; outer angle to base, 15 mm.

Secondaries: base to end of vein 3, 13 mm; center of costa to anal angle, 14 mm. Wing spread: 33 mm.

Abdomen, thorax, head, palpi, legs, and antennae same as in male.

HOLOTYPE male, Comitán, Chiapas, Mexico, July 1964, will be placed in the U. S. National Museum, Washington, D. C. Allotype female, Catemaco, Veracruz, Mexico, March 1961, is in my collection. These two specimens were sent to me by Dr. Tarsicio Escalante.

The nearest related species is *Niconiades xanthaphes* Hübner, from which *comitana* can readily be separated by the following characteristics: (1) the outer margin of the secondaries of *comitana* is convex and only slightly produced at the anal angle, while the outer margin of the secondaries of *xanthaphes* is concave and the anal angle is much more produced; (2) the iridescence is more extensive over the basal part of the wings of *xanthaphes* than in *comitana*; (3) the costa on the lower surface of the primaries is yellow from the base to the cell spot in *xanthaphes*, while this yellowish area in *comitana* is broader apically and does not extend to the base of the wings; (4) on the lower surface of the secondaries the stripe is white in *xanthaphes* and rather narrow and originates below the costa, while in *comitana* this stripe originates on the costa and is yellow and broader; and (5) there are differences in the genitalia as can be noted by comparing the figure of *comitana* (Plate 4, fig. 4) with Evans' illustration of *xanthaphes* (1955, Plate 85).

Anthoptus macalpinei Freeman, new species
(Plate 9, figure 1, 2. Plate 10, figure 1)

MALE. Upperside: Primaries, dark brownish-black, costa deep fulvous from base to outer edge of cell. Veins fulvous from end of cell to termen below costa; three fulvous apical spots, the lowest a mere dot; a bright fulvous discal band divided into spots by the veins, tapering from basal half of inner margin to just under vein 5, directly beneath the apical spots. No cell spot. Fringes brownish-black, slightly fulvous at outer angle. Secondaries, dark brownish-black. A discal band of four elongate, bright fulvous spots, forming an oblique patch approximately 3 mm wide. Some elongated, slightly fulvous, hair-like scales covering basal half of wing. Fringes concolorous with rest of wing, except at anal angle, fulvous.

Underside: Primaries, base cell and lower half deep black, outer margin, apex, costa and area occupied by discal spots from space 2 upward, bright yellow. A black line at end of cell. Secondaries, bright yellow, slightly darker along outer margin. An indistinct dot in cell. Anal fold slightly overscaled with sparse black.

Abdomen: brownish-black above with some fulvous hairs, bright yellow below. Thorax: dark brownish-black above with some fulvous hairs, below bright yellow. Head: black, with a large number of yellow hairs. Palpi: bright yellow with a few black scales intermixed. Legs: sordid yellow. Antennae: shaft, black above, yellow beneath; club, base yellowish, remainder and apiculus black above and beneath.

Wing measurements. Holotype male, primaries: base to apex, 16 mm; apex to outer angle, 10.5 mm; outer angle to base, 12 mm. Secondaries: base to end of vein 3, 11 mm; center of costa to anal angle, 12 mm. Wing spread: 31 mm. (Paratype male, same measurements).

FEMALE: unknown.

HOLOTYPE male, Fortin de las Flores, Veracruz, Mexico. 26 September 1966, will be placed in the U. S. National Museum, Washington, D. C. There is a male paratype collected at the same location and date in my collection. Both specimens were collected by W. S. McAlpine and it gives me great pleasure to name this species after him.

This new species is in the *calcarea* complex, which is composed of *calcarea* (Schaus), *maracanae* (Bell), and *visendus* Bell. It can be distinguished from other members of the complex by the following characteristics: (1) from *calcarea* by the brighter yellow on the under side of the wings, by the better developed discal bands on both wings, and in not having the borders below shaded brown; (2) from *maracanae* by the discal band on the under surface of the primaries not extending into space 1, by the brighter yellow on the under surface of the secondaries, and by not having the discal bands on both wings as broad and (3) from *visendus* by the brighter yellow under surface, which in *visendus* is pale rufous brown with the veins yellow, by the discal band on the primaries terminating directly beneath the apical spots while in *visendus* the apical spots are situated inward from the discal band, by not having a dark spot at the tornus with a yellow streak above it like is found in *visendus*, and by the discal band which is better developed in *macalpinei* than it is in *visendus*. The genitalia are different from any other species of *Anthoptus* (plate 10, fig. 1).

Pheraeus covadonga Freeman, new species

(Plate 9, figures 3, 4, 5, 6. Plate 10, figure 2)

MALE. Upperside: Primaries, black. Three yellow apical spots; costa yellow from base to apical spots; a bright yellow discal band, divided into spots by the veins, tapering from basal half of inner margin to apical spots; spots in spaces 2 and 3 semi-hyaline,

fairly broad, the one in space 2, 2.5 mm wide, the one in space 3, 2 mm wide. An indistinct sagittate dark band over the origin of vein 3. No cell spot. Fringes bright yellow. Secondaries, black, with a heavy suffusion of yellowish scales over anal fold to base. A bright yellow, discal spot extending from near outer margin, through the cell to near base, not divided into spots by the veins. Fringes bright yellow.

Underside: Primaries, dorsal half black, the remainder from vein 3 to costa ochreous. A slight ochreous suffusion under the spot in space 2. Five indistinct marginal spots extending from space 3 to costa near apex. Apical spots appear as black dashes, the one in space 6 having a tiny yellow center. A black bar at end of cell, a slightly lighter yellow spot just beyond. Spots in spaces 2 and 3 semi-hyaline, much lighter than the ochreous color of the costal half of wing. Secondaries, bright ochreous, anal fold heavily overscaled with black. An irregular row of five discal spots extending from space 1c to 6; the one in space 1c a tiny black dot situated one-third the distance to base; the one in space 2 a black circle with a yellow center, located closer to outer margin, only about one-fourth the distance inward toward base; the one in space 3 a black circle with a tiny yellow center situated slightly outward from the spot in space 2; the one in space 5 a black dot, located about one-fourth of the distance toward base; the one in space 6 a black oval, with the center yellow, located one-third the distance toward the base; a prominent black oval cell spot located inward from discal spots, with the outer one-half pupilled with yellow.

Abdomen and Thorax: black, upperside with a heavy suffusion of yellowish hairs, yellow beneath. Head: black, with a heavy suffusion of yellowish scales. Palpi: bright yellow, with a few black scales. Legs: yellow. Antennae: shaft, black ringed with yellow both above and below; club, basal half yellow, both above and below, apical half black with the apiculus yellow.

Wing measurements. Holotype male, primaries: base to apex, 13 mm; apex to outer angle, 9 mm; outer angle to base, 10 mm. Secondaries: base to end of vein 3, 9 mm; center of costa to anal angle, 10 mm. Wing spread: 26 mm (one male paratype 24 mm, the other 22.5 mm).

FEMALE. Upperside: Primaries, brownish-black. Three indistinct apical spots, one in space 6 largest, a mere yellow dot. Two semi-hyaline, tan spots in discal area; one in space 2 somewhat square, one in space 3 elongated, narrow; a slightly lighter, elongated, tan area in space 1b midway between outer margin and base. Fringes brownish-black. Secondaries, brownish-black, only slightly paler over discal area. Fringes brownish-black.

Underside: Primaries, brownish-black, a few ochreous scales along costa from base to apex where they extend two-thirds the distance down outer margin. Five indistinct marginal dots from space 3 to costa near apex. No indication of the apical spots of male except

a tiny dot in space 6. Secondaries, similar to male, ground color darker, tan instead of bright ochreous. Discal and cell spots same as in male.

Abdomen: brownish-black, upperside with a very few ochreous scales, beneath somewhat paler. Thorax: brownish-black, upperside with a few ochreous scales, underside slightly lighter. Head: brownish-black, with a very few ochreous scales. Palpi: sordid gray, with some black scales. Legs: brownish-yellow. Antennae: shaft, black above, slightly paler beneath; club, black above, beneath slightly paler at base, remainder of club and apiculus both above and below, black.

Wing measurements. Allotype female, primaries: base to apex, 12 mm; apex to outer angle, 8 mm; outer angle to base, 9 mm. Secondaries: base to end of vein 3, 9 mm; center of costa to anal angle, 8 mm. Wing spread: 25 mm.

HOLOTYPE male, seven miles south of Valles, (on the grounds of Hotel Covadonga) San Luis Potosi, Mexico, 10 June 1966, will be placed in the U. S. National Museum, Washington, D. C. Allotype female same location, 5 August 1966. There are two male paratypes from the same location, one collected 5 August 1966, and the other 6 August 1966. All four specimens were collected by H. A. Freeman. The allotype and paratypes will remain in my collection.

The males of this new species show a superficial resemblance to *Anthoptus epictetus* (Fabr.) on the upperside, but the two can be separated by the lighter color of the semi-hyaline spots in spaces 2 and 3 in *covadonga*, and the absence of a cell spot which is present in *epictetus*. On the lower surface there is no similarity in the two species. These species fly together in dense vegetation at the type locality of *covadonga*. *P. covadonga* belongs in the *fastus* complex along with *fastus* Hayward from Brazil and Paraguay, and *honta* Evans from Peru. *P. covadonga* can be separated from *fastus* by the following characteristics: (1) the discal spots are a clearer yellow in *covadonga* due to the tendency of these areas to be shaded darker on both the secondaries and primaries of *fastus*; (2) on the lower surface of the secondaries of *fastus* the ground color is greenish-ochreous, whereas in *covadonga* it is more yellowish-ochreous; and (3) in *covadonga* on the lower surface of the secondaries the discal spots and cell spot are black, in some cases with a yellow pupil, while in *fastus* these spots are white with the black edging faint or absent. *P. covadonga* can be separated from *honta* by the following characteristics: (1) in *honta* on the lower surface of the primaries there is a broad spot in space 1b which is absent in *covadonga*; (2) on the upper surface of the secondaries in *honta* the tawny discal spot extends to the base of the wing, while in *covadonga* it

does not reach the base; and (3) on the lower surface of the secondaries in *honta* the discal and cell spots are white, edge in black, while in *covadonga* the spots are black with some having a yellow pupil. The genitalia are different from any of the other species in this genus (Plate 10, fig. 2).

This is the first record for the genus *Pheraeus* in Mexico.

Cynea nigricola Freeman, new species

(Plate 9, figures 7, 8. Plate 10, figure 3)

MALE. Upperside: Primaries, dark brown, unmarked. An elongated band over vein 1, slightly covered by short hairs. A dark brown hair tuft originating on the dorsal margin of the wings. Fringes dark brown. Secondaries, dark brown. Secondaries, dark brown, with no markings. Fringes dark brown.

Underside: Primaries, dark brown, only slightly lighter than above. No markings present. Secondaries, dark chocolate brown. No markings present.

Abdomen: Dark brown both above and below. Thorax: dark brown above with some long, dark brown hairs, beneath dark brown. Head: dark brown with some dark green scales. No red behind collar. Palpi: dark brown with some golden yellow scales intermixed. Legs: dark brown with a few yellowish hairs. Antennae: shaft, dark brown both above and beneath; club, yellowish at base, remainder and apiculus dark brown above, entire club yellowish beneath.

Wing measurements. Holotype male, primaries: base to apex, 18 mm; apex to outer angle, 12 mm; outer angle to base, 14 mm. Secondaries: base to end of vein 3, 13 mm; center of costa to anal angle, 14 mm. Wing spread: 33 mm.

FEMALE: unknown.

HOLOTYPE male, Santa Rosa, Comitán, Chiapas, Mexico, May 1965, will be placed in the U. S. National Museum, Washington, D. C. This specimen was obtained from Dr. Tarsicio Escalante.

This new species belongs to the *corisana* complex of the genus *Cynea* which is a group of several superficially similar species which can be separated only by study of the male genitalia. The only member of this complex so far recorded from Mexico is *megalops* (Godman) which can be separated from *nigricola* by the following characteristics: (1) *megalops* has the dorsal margin on the under surface of the primaries paler than the rest of the ground color, while this does not occur in *nigricola*; (2) in *megalops*

there are sometimes indistinct spots on the underside of the primaries, one in space 2 and another in space 3, in the holotype of *nigricola* these are not present; (3) *megalops* has some reddish behind the collar which is absent in *nigricola*; (4) the band over vein 1 is short and obscure in *megalops*, while in *nigricola* it is elongate and prominent; (5) the head scaling is green in *megalops*, while in *nigricola* it is more brownish with some green scales intermixed; and (6) the genitalia of *nigricola* is different from any other members of this genus (Plate 10, fig. 3).

Methionopsis typhon Godman, 1901

This species was described from Guatemala, and Evans (1955) states that there are four males from that country in the British Museum. This constitutes all the known records for *typhon*. While collecting in a remote area of jungle-like growth on the grounds of Hotel Covadonga, seven miles south of Valles, San Luis Potosi, on August 4, 1966, I caught a male of this species, the first record from Mexico.

Since *typhon* belongs to a group of skippers which are obscurely marked, the only positive way to check its identity is through an examination of the genitalia.

Moeris duena Evans, 1955

This is apparently another very rare species, as it was described from four specimens from Guatemala, and I know of no other records. The male type came from Duenas, Guatemala and is in the British Museum. In specimens received from Dr. Escalante were two males of this species collected at Santa Rosa, Comitán, Chiapas, May, 1965. This is the first record for *duena* in Mexico.

Genus CARYSTOIDES Godman

The genus *Carystoides* is made up of a large number of closely related species in the American tropics. There are two major complexes in this genus, the first is the *basoches* complex, made up of *basoches* (Latreille), *yenna* Evans, *nosedá* (Hewitson), *certima* (Hewitson), and *lota* (Hewitson). This complex is basically characterized by the males having the wings produced and the females having a white spot in space 1b of both upper and underside of the primaries. The second complex is the *lebbaeus* complex, which is made up of *lebbaeus* (Hewitson), *cundina* Evans, *benchos* Weeks, *manta* Evans, *balza* Evans, *lila* Evans,

and *hondura* Evans. This complex is basically characterized by the males having the wings rounded and not produced, and the absence of the spot in space 1b on the primaries in the females. There are four other names species in this genus, *sicania* (Hewitson), *orbis* (Godman), *maroma* (Möschler), and *cathaea* (Hewitson), that have individual characteristics and do not seem to fit into the two major complexes.

Records for the occurrence of members of this genus in Mexico are confined to *basoches* (Latreille) from Colima and southern Veracruz (Hoffman, 1941). Evans records no species from Mexico in the British Museum. I recorded *lila* Evans from Tamazunchale, San Luis Potosi, based on a female collected by Stallings and Turner (Freeman, 1967). Apparently one reason why so few records are available from Mexico is due to the habits of members of this genus. I observed in the Valles area that the adults feed early in the morning around the edge of the jungle and promptly retire into the most dense growth of plants available to settle during the remainder of the day. It is then only possible to locate the skippers by going into this dense vegetation and carefully beating the plants with your net and then watching where the specimens eventually settle, since they seldom fly very far from their original resting spot.

In specimens received for determination from Dr. Tarsicio Escalante, Mexico, D.F., and specimens that I collected during the summer of 1966 in Mexico four new species were found in the *lebbaeus* complex, the descriptions of which follow.

Carystoides escalantei Freeman, new species

(Plate 11, figure 1, 2. Plate 12, figure 1)

MALE. Upperside: Primaries, black, not produced, somewhat round, apex clear white, 1-2 mm wide; a tiny, white, hyaline dot in space 6; cell spot somewhat squarish, completely overlapping spot in space 3; spot in space 3 somewhat triangular, outer point directed toward center of outer margin; spot in space 2 fairly broad, 3 mm, extending from vein 1 to vein 2. All spots clear white, hyaline. Fringes, dark gray, only slightly lighter than ground color, not checkered. Secondaries, black, three white, hyaline spots in spaces 3, 4, and 5; the one in space 3 minute, round; the one in space 4 larger, 2 mm wide; the one in space 5 small, triangular. Fringes, sordid white, not checkered.

Underside: Primaries, grayish-black, lighter in space 1. Apex overscaled with grayish-ochreous; a concentration of ochreous scales between cell spot and costa; costa narrowly ochreous from base to

area over cell spot; the four hyaline spots reappear, the same color; two black spots forming a straight line above the hyaline dot in space 6, one in space 7, and the other in space 8; two black, linear spots, in line, one in space 4, and the other in space 5, forming a straight line directed toward apex. Secondaries, grayish-black, heavily overscaled over basal half from vein 2 to costa with ochreous; the white, hyaline spots reappear, black-edged; a black spot in space 2, slightly basad from the spot in space 3, another black spot in space 4, 2 mm from the hyaline spot in a basad position.

Thorax: brownish-black above, lighter beneath. Abdomen: brownish-black above, ochreous beneath. Head: brownish-black. Palpi: yellowish-white. Legs: ochreous, black at apical part of segments. Antennae: missing from this specimen.

Wing measurements. Holotype male, primaries: base to apex, 22 mm; apex to outer angle, 15 mm; outer angle to base, 15 mm. Secondaries: base to end of vein 3, 16 mm; center of costa to anal angle, 16 mm. Wing spread: 43 mm.

FEMALE: Unknown.

HOLOTYPE Male, Villa Juarez, Puebla, Mexico, August 1954. This specimen was sent by Dr. Escalante and will be placed in the U. S. National Museum, Washington, D. C. I take great pleasure in naming this new species for my good friend, Dr. Tarsicio Escalante.

This new species has the wings rounded somewhat in the same manner as *hondura* Evans, and also has the same white, hyaline spot in space 6 on the primaries. However, its larger size (forewing length 22 mm) as compared with *hondura* (14 mm) and the difference in the genitalia readily separate these two species. It differs from the next new species in the shape of the spot in space 3 on the primaries; the larger white spots on the secondaries; the more rounded wings; and the genitalia.

Carystoides abrahami Freeman, new species
(Plate 11, figure 3,4. Plate 12, figure 2)

MALE. Upperside: Primaries, black, not produced but slightly round, with apex clear white, 1-3 mm wide; three clear white, hyaline spots: cell spot taller, 2.5 mm, than wide, 1.5 mm, completely overlapping the somewhat rounded spot in space 3; spot in space 2 somewhat squarish, 2.5 mm wide. Fringes, dark gray, only slightly lighter than ground color. Secondaries, black, with three minute white, hyaline spots; the one in space 3 a tiny dot; the one in space 4 round, just under 1 mm wide; and the one in space 5 just visible as a tiny dot. Fringes, uniform sordid yellowish-white.

Underside: Primaries, black, paler in space 1. Apex over-scaled with purplish-gray, a few intermixed ochreous scales; a light concentration of ochreous scales between cell spot and costa; costa narrowly edged with ochreous, almost to apex; three hyaline spots reappear in about the same coloration as above; a black spot in space 6; a black dot in space 4 and another directly above, in space 5. Secondaries, purplish-black, with ochreous overscaling from anal angle to costa over basal half of wing; a few ochreous scales intermixed with the purplish-black in outer half of wing; hyaline spots in spaces 3, 4, and 5 black edged; a black spot in space 2, slightly basad from spot in space 3, latter spot white pupiled; a black spot with a few ochreous scales in its center, in space 4, 2 mm basad from hyaline spot in this space.

Thorax: brownish-black above, slightly lighter beneath. Abdomen: brownish-black above, somewhat ochreous beneath. Head: brownish-black. Palpi: yellowish-white. Legs: ochreous and black. Antennae: missing from the unique specimen.

Wing measurements. Holotype male, primaries: base to apex, 21.5 mm; apex to outer angle, 14 mm; outer angle to base, 16 mm. Secondaries: base to end of vein 3, 16 mm; center of costa to anal angle, 15 mm. Wing spread: 44 mm.

FEMALE: unknown.

HOLOTYPE male, Catemaco, Veracruz, Mexico, July 1951. This specimen was sent to me by Dr. Escalante and was collected by Senor Abraham Ramirez. I take pleasure in naming this new species for the collector. This specimen will be placed in the U. S. National Museum, Washington, D. C.

This species is somewhat similar to *escalantei*, but can be separated by the less rounded wing shape, the shape of the spot in space 3 on the primaries, the much smaller size of the hyaline spots on the secondaries, and the genitalia.

Carystoides floresi Freeman, new species

(Plate 11, figures 5,6,7,8. Plate 12, figure 3)

MALE. Upperside: Primaries, black, not produced, white apex, 2.5 mm wide. Three clear white, hyaline spots; the spot in cell taller, 2 mm, than wide, 1.5 mm; the spot in space 3 somewhat ovate, situated beneath outer half of cell spot; spot in space 2 somewhat squarish, 2.5 mm wide. Fringes, uniform light tan. Secondaries, black, a single round, minute, white, hyaline spot in space 4. Fringes, sordid white.

Underside: Primaries, grayish-black, overscaled with olive-brown scales along costa and apex. Spots same color as above; a

black spot in space 4, another in space 5, located closer to outer margin than the one in space 4; a distinct black spot in space 6 directly over spot in space 4, an indistinct black dot in space 7 inward from the one in space 6. Secondaries, black, heavily overscaled with olive, except at the anal fold; a round, white, hyaline spot in space 4, edged in black. A black dot with a white pupil in space 3, directly below the spot in space 4; a black dot in space 5, slightly outward from spot in space 4.

Thorax: brownish-black above, lighter beneath. Abdomen: black above, slightly lighter beneath. Head: black above, sordid white next to eyes. Palpi: yellowish-white, with some intermixed black scales. Legs: black, with some yellow scales. Antennae: shaft black, ringed with white; club white above, yellowish beneath, with the apiculus black.

Wing measurements. Holotype male, primaries: base to apex, 22.5 mm; apex to outer angle, 14 mm; outer angle to base, 15 mm. Secondaries: base to end of vein 3, 16.5 mm; center of costa to anal angle, 15 mm. Wing spread: 43.5 mm.

FEMALE. Upperside: Primaries, black, with a slight purplish sheen. Three white, hyaline spots; cell spot broader at dorsal side than on costal side, 2.5 mm wide in center; spot in space 2 broad, 6 mm wide, broader at costal side than at dorsal side, situated directly beneath cell spot, their edges forming a straight line toward outer angle of wing; the spot in space 3 rounded, 1.5 mm wide, located outward from spot in space 2. Fringes, light, uniform gray. Secondaries, black, with a few scattered olive scales near base. A tiny white, hyaline spot in space 4. Fringes, yellowish-white.

Underside: Primaries, black, with space 1 lighter, brownish-black. Some lilaceous scales intermixed with brown in apical region and along costa. Spots same as above; an indistinct black spot in space 6; an indistinct black dot in space 4, outward from this another black dot in space 5. Secondaries, black, heavily overscaled with ochreous and brown scales over basal half of wing from anal angle to costa. Outer half of wing with a few ochreous scales, and a slight purplish sheen. A white, hyaline spot in space 4, edged in black; a black spot in space 3, slightly basad from spot in space 4; a black spot in space 5, slightly outward from spot in space 4. Two specimens with minute black dot at outer edge of cell.

Thorax: black, some brownish scales above, slightly lighter beneath. Abdomen: black above, lighter beneath. Head: brownish-black, whitish near eyes. Palpi: yellowish-white, some black scales intermixed. Legs: brownish-yellow. Antennae: shaft black, ringed with white; club, basal half white, upper half and apiculus black.

Wing measurements. Allotype female, primaries: base to apex, 24 mm; apex to outer angle, 15 mm; outer angle to base, 17 mm. Secondaries: base to end of vein 3, 18 mm; center of costa to anal angle, 16 mm. Wing spread: 49 mm (average of paratypes, 48 mm).

HOLOTYPE male, seven miles south of Valles, (jungle section of the grounds of Hotel Covadonga) San Luis Potosi, Mexico, August 4, 1966, collected by H. A. Freeman. This specimen will be placed in the U. S. National Museum, Washington, D. C. Allotype female, same location and collector, August 7, 1966. There are six female paratypes (same location and collector) collected from August 1-7, 1966. The allotype and paratypes are in my collection.

I take pleasure in naming this new species for my friend Senor Pedro Flores, former manager of the Hotel Covadonga, who so kindly gave me assistance in my collecting while I was there during the summer of 1966.

This species differs from any of the other *Carystoides* in this complex in having a single white, hyaline spot on the secondaries in both sexes. The genitalia differ from the other species (Plate 12, fig. 3).

Carystoides mexicana Freeman, new species
(Plate 11, figures 9,10,11. Plate 12, figure 4)

MALE. Upperside: Primaries, black, apex white, 2-3 mm wide. Three white, hyaline spots; cell spot straight on its outer margin, concave on its inner margin, 1.5 mm wide; spot in space 3 situated two-thirds the distance under outer margin of cell spot, 2 mm wide; spot in space 2 broader at dorsal side than at costal side, 3 mm wide. Fringes, light tan. Secondaries, black, with three white, hyaline spots and an opaque spot in space 2, basad from the rounded hyaline spot in space 3; an oval white, hyaline spot in space 4, a small hyaline dot in space 5 at outer edge of spot in space 4. Fringes yellowish-white.

Underside: Primaries, black over discal region, with grayish scales over apex and along costa; with a purplish sheen. Spots same as above; a black spot in space 6; another black spot directly below in space 4; a black spot in space 5 situated slightly outward from the other two black spots. Secondaries, grayish-black, only slightly lighter over basal half of wing; with a purplish sheen. White, hyaline spot in space 3 and spot in space 4; only half edged in black; small spot in space 5 completely edged in black; a black spot basad from the others in space 2, with a white pupil; a tiny black dot directly above, at end of cell.

Thorax: black above with some lighter hairs present, somewhat lighter beneath. Abdomen: black above, yellowish beneath. Head: grayish-black, white near eyes. Palpi: yellowish-white. Legs: yellowish-white. Antennae: shaft, checkered black and white half the distance to club, remainder black; club, white above, apiculus black, sordid yellowish-black beneath.

Wing measurements. Holotype male. Primaries: base to apex,

22.5 mm; apex to outer angle, 13.5 mm; outer angle to base, 15.5 mm. Secondaries: base to end of vein 3, 15 mm; center of costa to anal angle, 14 mm. Wing spread: 43 mm (average of paratypes, 43 mm).

FEMALE. Upperside: Primaries, black, some brown scales along costa. Three white, hyaline spots; cell spot straight on its inner surface, concave on its outer surface, 2.5 mm wide at costal side and 3.2 mm wide at dorsal side; spot in space 2 located directly beneath cell spot, straight on its outer surface, concave on its inner surface, 4 mm wide; a somewhat broadly columnar spot in space 3, 1.5 mm wide. Fringes, dark gray. Secondaries, brownish-black, the hyaline and opaque spots arranged as in male. Fringes, sordid white.

Underside: Primaries, dull grayish-black over discal portion of wing, brownish-black over remainder. Spots same as on upper surface; a black spot in space 4, another slightly outward in space 5; a black spot in space 6, slightly inward from the one in space 4. Secondaries, brownish-black, only slightly lighter in basal one-third of wing. Spots same as in male.

Thorax: brownish-black above, somewhat lighter beneath. Abdomen: black, some brownish hairs above, only slightly lighter beneath. Head: Brownish-black, white near eyes. Palpi: yellowish-white. Legs: brownish-black. Antennae: shaft black ringed with white; club, basal half white, remainder and apiculus black.

Wing measurements. Allotype female, primaries: base to apex, 23.5 mm; apex to outer angle, 14 mm; outer angle to base, 17 mm. Secondaries: base to end of vein 3, 18 mm; center of costa to anal angle, 15 mm. Wing spread: 47 mm.

HOLOTYPE male, Seven miles south of Valles, San Luis Potosi, Mexico, August 5, 1966, collected by H. A. Freeman, will be placed in the U. S. National Museum, Washington, D. C. Allotype female, same location and collector, August 7, 1966. There are four male paratypes from the same location, collected from July 31-August 7, 1966 by H. A. Freeman in a jungle section of the grounds of Hotel Covadonga. The allotype and paratypes will remain in my collection.

The primaries of both sexes of this new species somewhat resemble those of *floresi*, however the secondaries differ as to the spot arrangement as well as the ground color on the underside. In *mexicana* there are four white spots on the secondaries, while in *floresi* there is but one. The ground color is somewhat lighter beneath in *mexicana* than it is in *floresi*. The best way to positively identify *mexicana* is by its genitalia, which differ from other members of the genus in a definite manner (Plate 12, fig. 4).

Atrytone mazai Freeman, new species

(Plate 13, figure 1,2. Plate 15, figure 8)

MALE. Upperside: Primaries, bright orange-yellow, with a narrow (1-1.5 mm) dark marginal border. Veins black, with an indistinct, dark bar at end of cell. Fringes, sordid yellowish-white. Secondaries, bright orange-yellow, with costal margin, anal fold, and a very narrow marginal border, black. All veins black. Fringes, sordid yellowish-white.

Underside: Primaries, bright orange-yellow, basal half of space 1b and most of 1a black. Veins orange. Secondaries, bright orange-yellow, costa and anal fold orange; veins orange, contrasting with the more yellowish ground color.

Abdomen and thorax: dark brownish-orange above, yellowish-white below. Head: dark orange-yellow. Palpi: bright yellow, except at base, intermixed with white scales. Legs: orange-yellow. Antennae: shaft and club brown above, yellow beneath.

Wing measurements: Holotype male. Primaries: base to apex, 14 mm; apex to outer angle, 10 mm; outer angle to base, 11.5 mm. Secondaries: base to end of vein 3, 10.5 mm; center of costa to anal angle, 11 mm. Wing spread: 27.5 mm (average of paratypes, 27.5 mm).

FEMALE: unknown.

HOLOTYPE male, Mexcala, Guerrero, Mexico, 13 July 1956 (collected by Kent Wilson), will be placed in the U. S. National Museum, Washington, D. C. There are eight male paratypes, from the following locations: three from the type locality, same date and collector; one from Acuitlapan, Guerrero, 21 July 1956, same collector; one from Acahuezatlan, Guerrero, August 1948; one Tierra Colorado, Guerrero, September 1961; one Presidio, Veracruz, July 1951 (these last three were obtained from Dr. Escalante); and one from Laredo, Texas, 2 June 1935, collected by H. A. Freeman. Part of the paratypes will be returned to Dr. Escalante, and the rest will remain in my collection.

I take pleasure in naming this new species for Sr. Roberto de la Maza, Mexico, D. F., who is an enthusiastic collector of Lepidoptera.

Superficially *mazai* resembles *lagus* Edwards, the western subspecies of *logan* Edwards, in the narrow dark marginal border of both wings. In the coloration of the veins above it resembles *logan*, while *lagus* has the veins less conspicuously dark. The basic difference between *mazai* and *logan* or *lagus* lies in the coloration of the

secondaries on the under side. *A. mazai* has the costa and anal fold as well as the veins orange, contrasting with the orange-yellow ground color, while *logan* and *lagus* have this side of the secondaries uniform orange-yellow. The genitalia differ as can be determined by comparing figure 8, plate 15 of *mazai* with Godman & Salvin's (1900) figure of *delaware* (Edwards), which is a synonym of *logan* (Plate 94, figure 6) which was made from a specimen from the United States. Their figures 4 and 5 are from a specimen from Rincon, Guerrero and represent *mazai*.

In the United States *logan* and *lagus* are both found in the Dallas, Texas, area. In the Big Bend area of Texas only *lagus* occurs. I have never seen any examples of either from southern Texas. The male *mazai* that I collected at Laredo represents the only specimen of that species that I have seen from the United States.

Atrytone potosiensis Freeman, new species
(Plate 13, figure 3,4. Plate 15, figure 9)

MALE. Upperside: Primaries, dark orange-yellow, with a broad (2.5-3.0 mm), dark brownish-black marginal border. Space 1a dark brownish-black from marginal border to base; a dark bar at end of cell; veins black with some black scales parallel to them. Fringes, dark orange-yellow. Secondaries, dark orange-yellow, with costa, outer margin, base, and anal fold through space 1b, dark brownish-black. Veins black. Fringes, orange.

Underside: Primaries, bright orange, except base and space 1a to near outer angle, black, extending into space 1b in submarginal area. Secondaries, deep orange, veins yellow, contrasting sharply with ground color.

Abdomen: dark brownish-black above, bright yellow beneath. Thorax: dark brownish-black above, bright orange-yellow below. Head: orange. Palpi: yellow at tip, whitish near base. Legs: orange. Antennae: shaft and club deep orange above with a few black scales, orange-yellow below.

Wing measurements: Holotype male. Primaries: base to apex, 16 mm; apex to outer angle, 10 mm; outer angle to base, 11 mm. Secondaries: base to end of vein 3, 11 mm; center of costa to anal angle, 11.5 mm. Wing spread: 31.5 mm (paratypes average, 30.5 mm).

FEMALE: Unknown.

HOLOTYPE Male, seven miles south of Valles, San Luis Potosi, Mexico, 4 August 1966, will be placed in the U. S. National Museum, Washington, D. C. There are two male paratypes from the same location, one collected 28 July 1966, and the other 15 June 1967. All three specimens

collected by H. A. Freeman on the grounds of Hotel Cova-donga.

This new species superficially looks somewhat like the females of *logan* Edwards. It can readily be separated from either *logan* or *mazai* by the much broader marginal border of the primaries and by the bright orange ground color of the underside of the secondaries, with the veins yellow instead of orange as in *mazai*, or the uniform color of *logan*. The genitalia readily separate this species from any of the other *Atrytone* (Plate 15, fig. 9).

Mellana montezuma Freeman, new species

(Plate 13, figure 5,6,7,8. Plate 15, figure 10)

MALE. Upperside: Primaries, with a broad, dark brown outer marginal border. A discal band of four broad, orange-yellow spots, one in space 1 extending from marginal border to base, completely filling space 1b; one in space 2 extends from marginal border to origin of vein 2; one in space 3 extending to dark bar at end of cell; and one in space 4 narrow, extending from marginal border to bar at end of cell; entire cell orange-yellow, some specimens having a dark line in the center; costa orange-yellow from base to apical spots; apical spots linear, fusing into the costal orange-yellow. Veins black. Space 5 brown from cell to marginal border. Fringes orange. Secondaries with a narrow brownish-black marginal border, costal area, and anal fold. A broad discal band of orange-yellow spots, one in space 1 extending from marginal border to near base of wing; one in space 2 extending from dark border to cell; one in space 3 triangular, extending from border to cell; one in space 4 extending from border to cell; and one in space 5 located directly over spot in space 4, extending approximately half the distance space 4 spot does. Entire cell orange-yellow, some specimens with some scattered black scales near base. Veins black. Fringes bright orange.

Underside: Primaries, bright yellow, with base and space 1a black. A large, black submarginal spot in space 1b, a smaller black, submarginal spot in space 2; dark bar at end of cell prominent; vein beneath cell and veins 2 and 3 black. Secondaries, bright orange-yellow, with the slightest indication of lighter discal spots.

Abdomen and thorax: brown above with some orange hairs, yellowish-white beneath. Head: brownish-black with some orange hairs. Palpi: yellowish-white. Legs: yellowish-orange. Antennae: shaft brown above, yellowish beneath; club brown above, yellowish beneath with apiculus reddish.

Wing measurements: Holotype male. Primaries: base to apex, 16 mm; apex to outer angle, 10.5 mm; outer angle to base, 12 mm. Secondaries: base to end of vein 3, 11.5 mm; center of costa to anal angle, 12 mm. Wing spread: 31 mm; paratypes range 30-33 mm, averaging 31 mm.

FEMALE. Upperside: Primaries, dull, dark brown, A rectangular yellowish-white hyaline spot in space 2, a somewhat smaller yellowish-white hyaline spot in space 3, outward from the spot in space 2. Cell spot varying from a single yellowish-white hyaline spot located over inner edge of spot in space 2 to a double cell spot, fused in the center; three well-defined yellowish-white apical spots in a straight line; a yellowish, opaque spot in space 1b, beneath inner edge of the spot in space 2; costa orange-brown from base to end of cell. A few basal orange scales and hairs. Fringes, ochreous. Secondaries, slightly redder brown, an orange cell spot and four small, orange, discal spots, one in space 2 slightly linear; one in space 3 minutely triangular; one in space 4 somewhat squarish; and one in space 5 also slightly squarish. Some ochreous hairs near base of wings. Fringes, ochreous.

Underside: Primaries, costa and apex ochreous-brown, remainder black. Opaque spot in space 1b broad, sordid white; spots in cell, spaces 2, 3, and apical ones white hyaline. Secondaries, ochreous-brown, with a yellow cell spot, and the four discal spots prominent and yellowish.

Abdomen and thorax: dark brown above, yellowish beneath. Head: dark brown, with some scattered ochreous scales. Palpi: yellowish at tips, remainder white. Legs: yellowish-brown. Antennae: shaft brown above, checkered yellow and black beneath; club yellowish at base, remainder black above, yellowish beneath, apiculus reddish.

Wing measurements: Allotype female. Primaries: base to apex, 18 mm; apex to outer angle, 11 mm; outer angle to base, 13.5 mm. Secondaries: base to end of vein 3, 13 mm; center of costa to anal angle, 12 mm. Wing spread: 35 mm; paratypes vary from 31-35 mm, averaging 34.5 mm.

HOLOTYPE male, seven miles south of Valles, San Luis Potosi, Mexico, 27 July 1966, will be placed in the U. S. National Museum, Washington, D. C. Allotype female, same location, 3 August 1966, will remain in the collection of H. A. Freeman. There are 25 male paratypes and nine female paratypes from the same location collected during June, July and August of 1966 and 1967. All specimens were collected by H. A. Freeman on the grounds of Hotel Covadonga.

This new species belongs in the *nayana* complex, which is characterized by having the apical spots forming a part of a series of streaks from spaces 6-11, joining up with the tawny costal area, and by having the fulvous markings rather extensive over both the primaries and secondaries. The nearest relatives are *nayana* (Bell) and *mulleri* (Bell) from which *montezuma* can readily be separated by the following characteristics: (1) the fulvous markings are more extensive in the males of *montezuma*; (2) in the males of *nayana* the fringes are rather dark at the base becoming

whitish at the tips; in the males of *nayana* they are dusky yellowish-white; while in *montezuma* they are bright orange; (3) *montezuma* is slightly larger than the other two species; (4) the under surface of the secondaries of the males differ--*nayana* is bright lemon yellow, *mulleri* is dull orange-yellow, both without spots, while *montezuma* is bright orange with the discal spots appearing faintly (5) in the females the discal, cell and apical spots of *montezuma* are much lighter, nearly white, than in the other two species; (6) the spots are better defined in the females of *montezuma* than in the other two; and (7) the genitalia of the males differ from any other species of *Mellana* (Plate 15, fig. 10).

Euphyes peneia (Godman, 1900)

This species was described from specimens collected in Panama. Evans states that *peneia* is a member of a group of *Euphyes* confined to central and South America, and records specimens in the British Museum from Honduras, Panama, Colombia, Venezuela, Tobago, Trinidad, British Guiana, French Guiana, western Ecuador (Manabi), Peru (Maranon), and Amazonas. In specimens received from Dr. Escalante there was a male *peneia* from Catemaco, Veracruz, August, 1965. This is the first record for this species from Mexico.

Euphyes chamuli Freeman, new species

(Plate 14, figure 1,2. Plate 10, figure 4)

MALE. Upperside: Primaries, dull dark brown. No maculation present. A prominent black stigma extending from base of vein 3 to middle of vein 1. Fringes are primarily dull, dark brown, becoming lighter at scale tips. Secondaries, dull dark brown. No maculation present. Fringes as on primaries.

Underside: Primaries, dull dark brown, slightly lighter just outside stigma. No maculation present. Secondaries, dull dark brown. No maculation present.

Abdomen and thorax: dull dark brown both above and below. Head: brown and golden yellow intermixed. Palpi: bright orange-yellow. Legs: dark brown. Antennae: shaft, black above, slightly yellowish beneath; club, and apiculus black above, yellowish beneath.

Wing measurements. Holotype male, Primaries: base to apex, 16 mm; apex to outer angle, 11 mm; outer angle to base, 11 mm. Secondaries: base to end of vein 3, 11.5 mm; center of costa to anal angle, 12 mm. Wing spread: 28.5 mm (average of paratypes, 29 mm).

FEMALE: unknown.

HOLOTYPE male, Santa Rosa, Comitán, Chiapas, Mexico, May 1965, will be placed in the U. S. National Museum, Washington, D. C. There are four male paratypes with the same data. These five specimens were sent to me by Dr. Tarsicio Escalante, Mexico, D. F. Two of the paratypes will be placed in the Escalante collection, and two will remain in my collection.

The species nearest related to *chamuli* is *vestris* (Bdv.) and it is possible to separate the two species in the following ways: (1) in size *chamuli* is the same as typical *vestris* from California, but runs just a little larger than the subspecies *metacomet* (Harris); (2) both *vestris* and *metacomet* are shining brown above, while *chamuli* is dark, dull brown; (3) there is a tendency toward maculation on the under side of both the primaries and secondaries in both *vestris* and *metacomet*, while this does not occur in *chamuli*; (4) there is a lighter area outside of the stigma in both *vestris* and *metacomet* which is absent or very indistinct in *chamuli*; (5) the palpi are more orange in *chamuli* than in *vestris* and *metacomet*; and (6) the genitalia are constantly different from *vestris* (Plate 10, fig. 4).

Tirynthia huasteca Freeman, new species

(Plate 14, figure 3,4,5,6. Plate 10, figure 5)

MALE. Upperside: Primaries, dark brown, with heavy suffusion of green hairs along costa from base to middle, in space 1 near base and along inner margin from base to two-thirds the distance toward outer angle. Three hyaline, yellowish-white, apical spots, the lowest one largest, middle one smaller, upper one a mere dot; two yellowish-white, hyaline cell spots of about equal size; an elongated yellowish-white hyaline spot in space 2 terminating slightly inward from cell spots; a yellow, hyaline spot in space 1b just beneath inner edge of spot in space 2; an elongated, yellowish-white, hyaline spot in space 3 terminating just above upper, outer margin of spot in space 2. Some specimens with a small yellowish-white hyaline spot in space 4 just above outer edge of spot in space 3. Fringes concolorous with ground color, becoming lighter at the scale tips. Secondaries, dark brown, with long green hairs over basal half of wing. Two elongated, yellowish-white, hyaline discal spots, one in space 2, and one in space 3. Fringes sordid yellowish-white.

Underside: Primaries, dark brown, ferruginous at apex. A few golden scales below costa just outside cell; a golden-yellow line below costa running from base to just above cell spots. All hyaline spots reappear, more golden-yellow than on upperside; a broad yellowish spot in space 1b. Secondaries, chocolate brown, heavily overscaled with golden. Discal spots darker yellow than on upperside, with a golden cast. Anal fold redder brown than rest of wing.

Abdomen and thorax: dark brown above with some greenish-golden hairs, sordid yellow beneath. Head: greenish-gold. Palpi: bright lemon yellow. Legs: femora, brown; tibiae, yellow and brown; and tarsi, yellow. Antennae: shaft, black, both above and below; club, basal half yellow both above and below, remainder and apiculus brown above and below.

Wing measurements. Holotype male, primaries: base to apex, 20.5 mm; apex to outer angle, 13 mm; outer angle to base, 13 mm. Secondaries: base to end of vein 3, 12 mm; center of costa to anal angle, 13 mm. Wing spread: 38 mm (paratypes vary from 34-39 mm).

FEMALE. Upperside: Primaries, just like male, except spot in space 2 broader, 4.5 mm wide. Secondaries, just like male.

Upperside: Primaries, just like male, except yellowish spot in space 1b broader and somewhat paler. Secondaries, just like male.

Abdomen, thorax, head, palpi, legs, and antennae same as in male.

Wing measurements. Allotype female, primaries: base to apex, 22 mm; apex to outer angle, 14 mm; outer angle to base, 16 mm. Secondaries: base to end of vein 3, 14 mm; center of costa to anal angle, 13 mm. Wing spread: 43 mm.

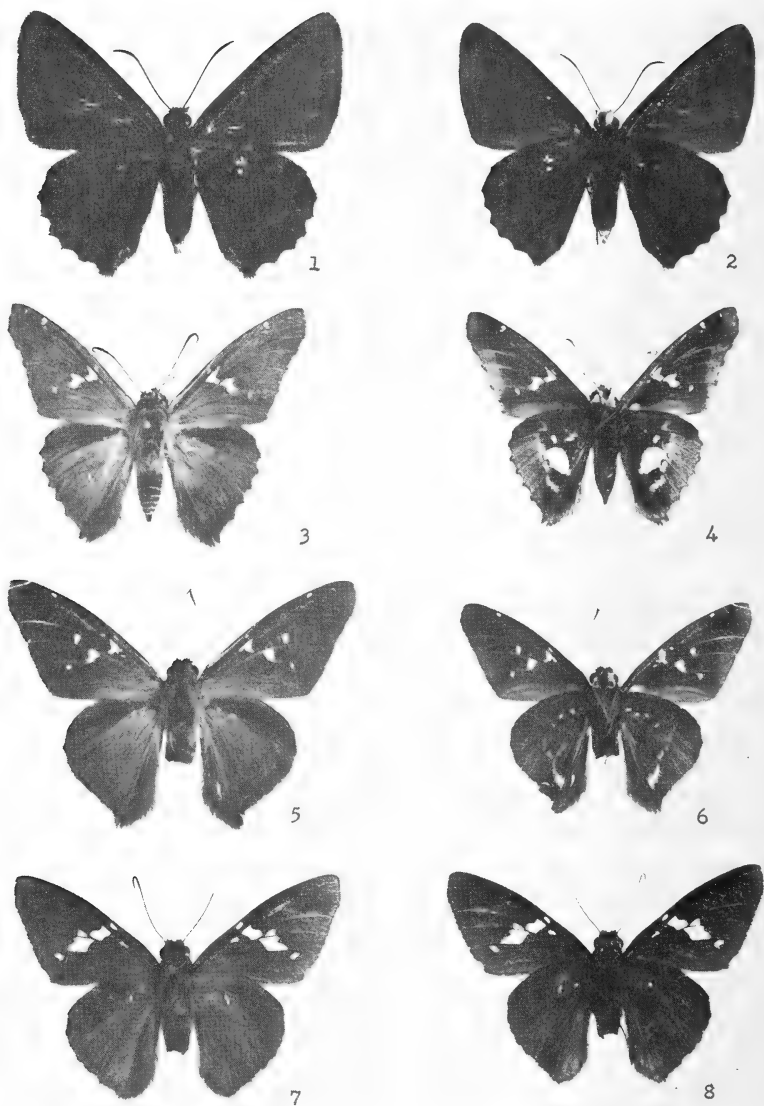
HOLOTYPE Male, seven miles south of Valles, San Luis Potosi, Mexico, 7 August 1966. Allotype female, same location, 6 August 1966. There are three male paratypes from the same location, one 10 June 1966, one 5 August 1966, and one 7 August 1966. All specimens were collected on the grounds of Hotel Covadonga by H. A. Freeman. The Holotype will be placed in the U. S. National Museum, Washington, D. C. The allotype and paratypes will remain in my collection.

This new species differs from the other species in the genus *Tirynthia* by not having the white band on the lower surface of the secondaries from mid costa to vein 1b, and by having a double cell spot. The genitalia differ from the other species (Plate 10, fig. 5).

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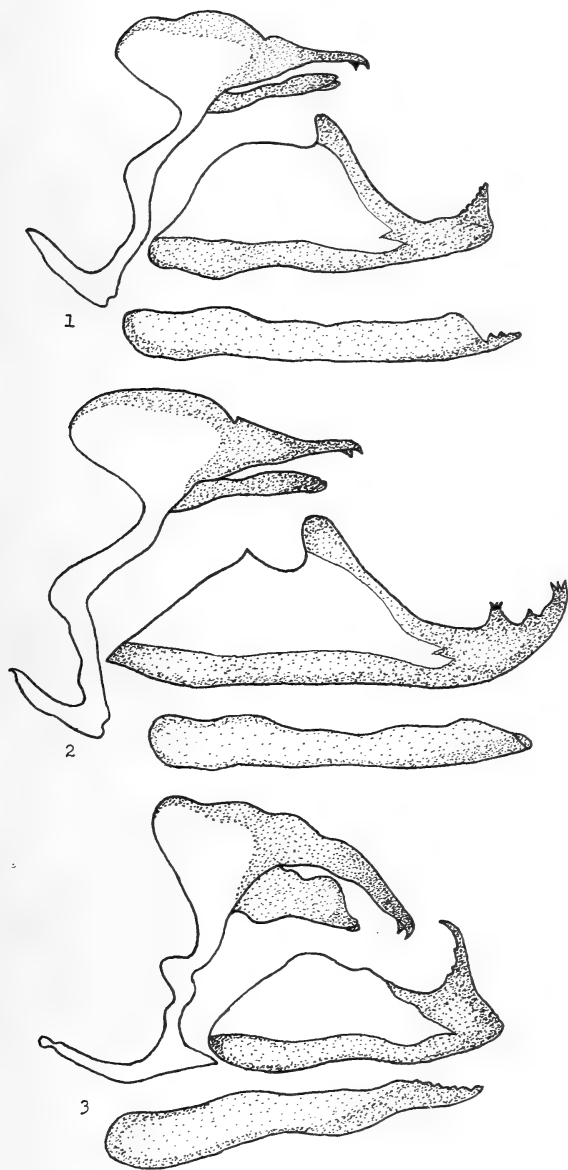
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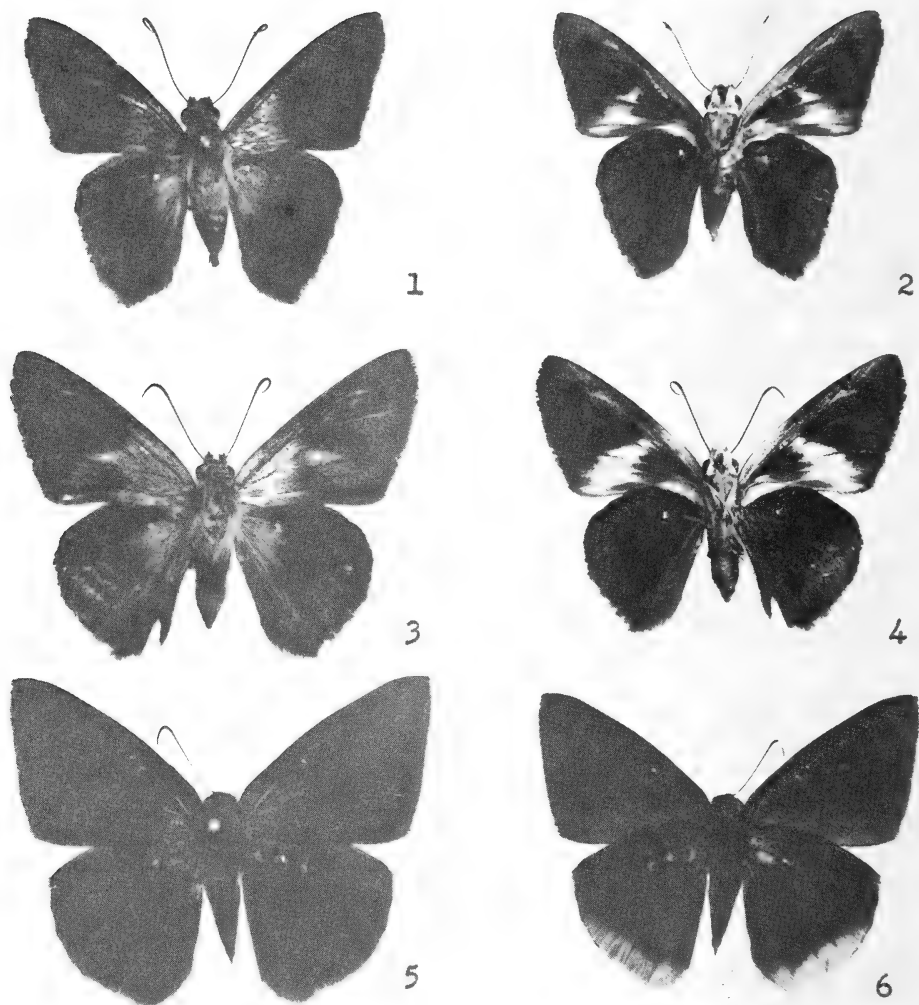
Explanation of Plate I

Figs. 1 and 2, *Pyrrhopyge tzotzili* Freeman, Holotype ♀, Ocozingo, Chiapas, Mexico, July, 1942; 3 and 4; *Epargyreus windi* Freeman, paratype no. 1 ♂, Ajijic, Jalisco, Mexico, 12 September 1965; 5 and 6, *Epargyreus brodkorbi* Freeman, Holotype ♂, Union Juarez, Chiapas, Mexico, 19 March 1939; 7 and 8, *Astraptes louiseae* Freeman, Holotype ♂, Presidio, Veracruz, Mexico, August, 1951.



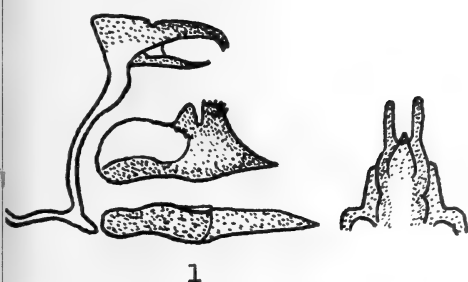
Explanation of Plate 2

Male genitalia of Mexican Hesperiliidae. Fig. 1, *Epargyreus windi* Freeman; 2, *Epargyreus brodkorbi* Freeman; 3, *Astraptes louiseae* Freeman.

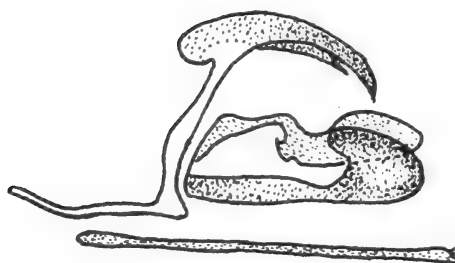


Explanation of Plate 3

Figs. 1 and 2; *Astraptes gilberti* Freeman, Paratype ♂, Victoria, Tamaulipas, Mexico, 8 June 1966; 3 and 4, *Astraptes gilberti* Freeman, Paratype ♀, 7 miles south of Valles, San Luis Potosi, Mexico, 3 August 1966; 5 and 6, *Aethilla chiapa* Freeman, Holotype ♂, Ocozingo, Chiapas, Mexico, August 1958.



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Explanation of Plate 4

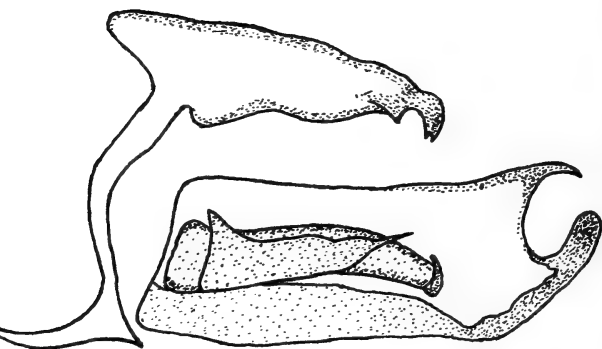
Male genitalia of Mexican Hesperiidæ. Fig. 1, *Astraptus gilberti* Freeman; 2, *Dalla ramirezi* Freeman; 3, *Vettius argentus* Freeman; 4, *Niconiades comitana* Freeman; 5, *Aethilla chiapa* Freeman.



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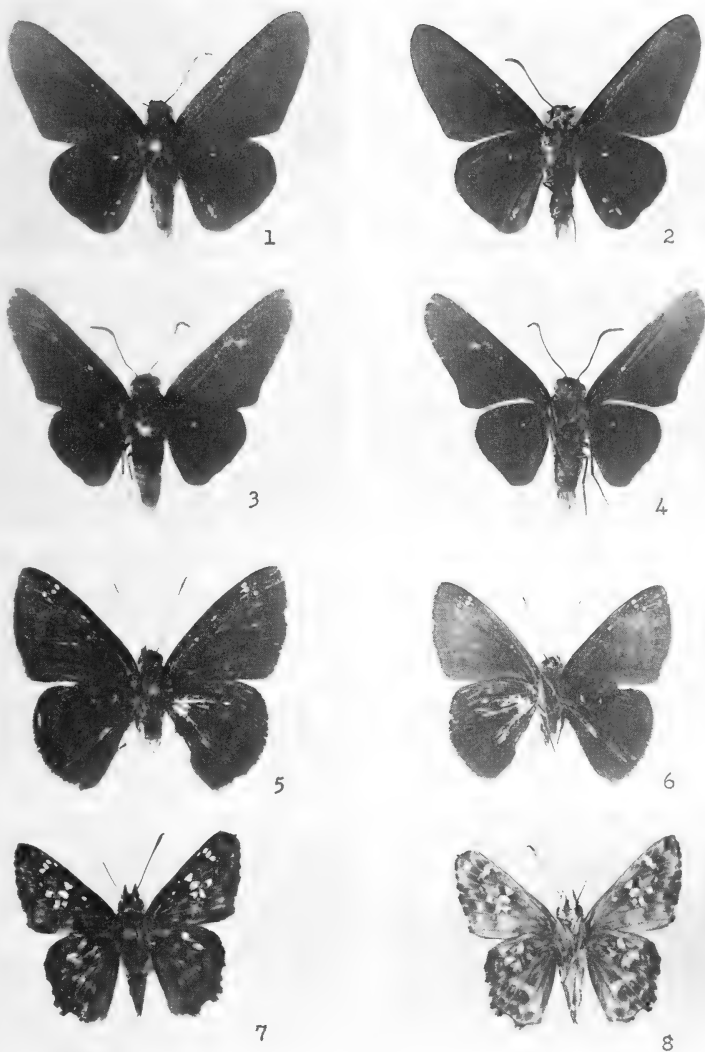
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Explanation of Plate 5

Fig. 1, Upper side, *Polythrix mexicanus* Freeman, Paratype ♂, Valles, San Luis Potosi, Mexico, 30 July, 1966; 2, Under side, *Polythrix mexicanus* Freeman, Paratype ♂, Valles, San Luis Potosi, Mexico, 30 July, 1966; 3, Male genitalia of *Polythrix mexicanus* Freeman, showing tegumen, uncus, aedeagus, and inner aspect of left valva. Drawing made from Paratype, Valles, San Luis Potosi, Mexico, 29 July, 1966; 4, Male genitalia of *Polythrix mexicanus* Freeman, showing under side of tegumen and uncus, with the aedeagus in natural position.



Explanation of Plate 6

Figs. 1 and 2, *Mysoria wilsoni* Freeman, Paratype ♂, Mexcala, Guerrero, Mexico, 22 July 1956; 3 and 4, *Mysoria affinis* (H.-S.) ♂, Tepic, Nayarit, Mexico, September, 1964; 5 and 6, *Mimie chiapaensis* Freeman, Holotype ♂, Santa Rosa, Comitán, Chiapas, Mexico, May, 1965; 7 and 8, *Windia windi* Freeman, Holotype ♂, Salada, Colima, Mexico, 19 June 1967.



Explanation of Plate 7

Figs. 1 and 2, *Quadrus francesius* Freeman, Holotype ♂, Santa Rosa, Comitán, Chiapas, Mexico, May 1965; 3 and 4, *Quadrus francesius* Freeman, Allotype ♀, Comitán, Chiapas, Mexico, September 1962; 5 and 6, *Staphylus zuritus* Freeman, Holotype ♂, Cintalapa, Chiapas, Mexico, 17 August 1964; 7 and 8, *Staphylus veytius* Freeman, Holotype ♂, Cintalapa, Chiapas, Mexico, 17 August 1964; 9 and 10, *Enosis matheri* Freeman, Holotype ♂, Catemaco, Veracruz, Mexico, December, 1963.



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Explanation of Plate 8

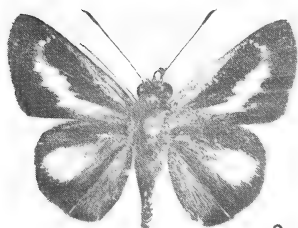
Figs. 1 and 2, *Dalla ramirezi* Freeman, Holotype ♂, Catemaco, Veracruz, Mexico, August 1958; 3 and 4, *Vettius argentus* Freeman, Holotype ♂, Santa Rosa, Comitán, Chiapas, Mexico, May, 1965; 5 and 6, *Niconiades comitana* Freeman, Holotype ♂, Comitán, Chiapas, Mexico, July, 1964.



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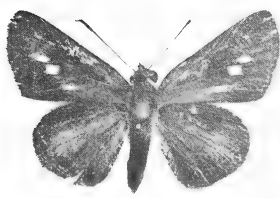
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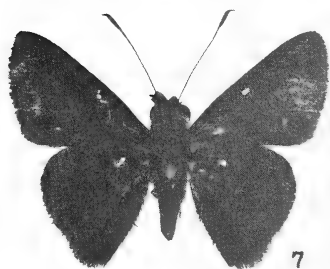
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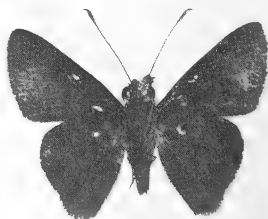
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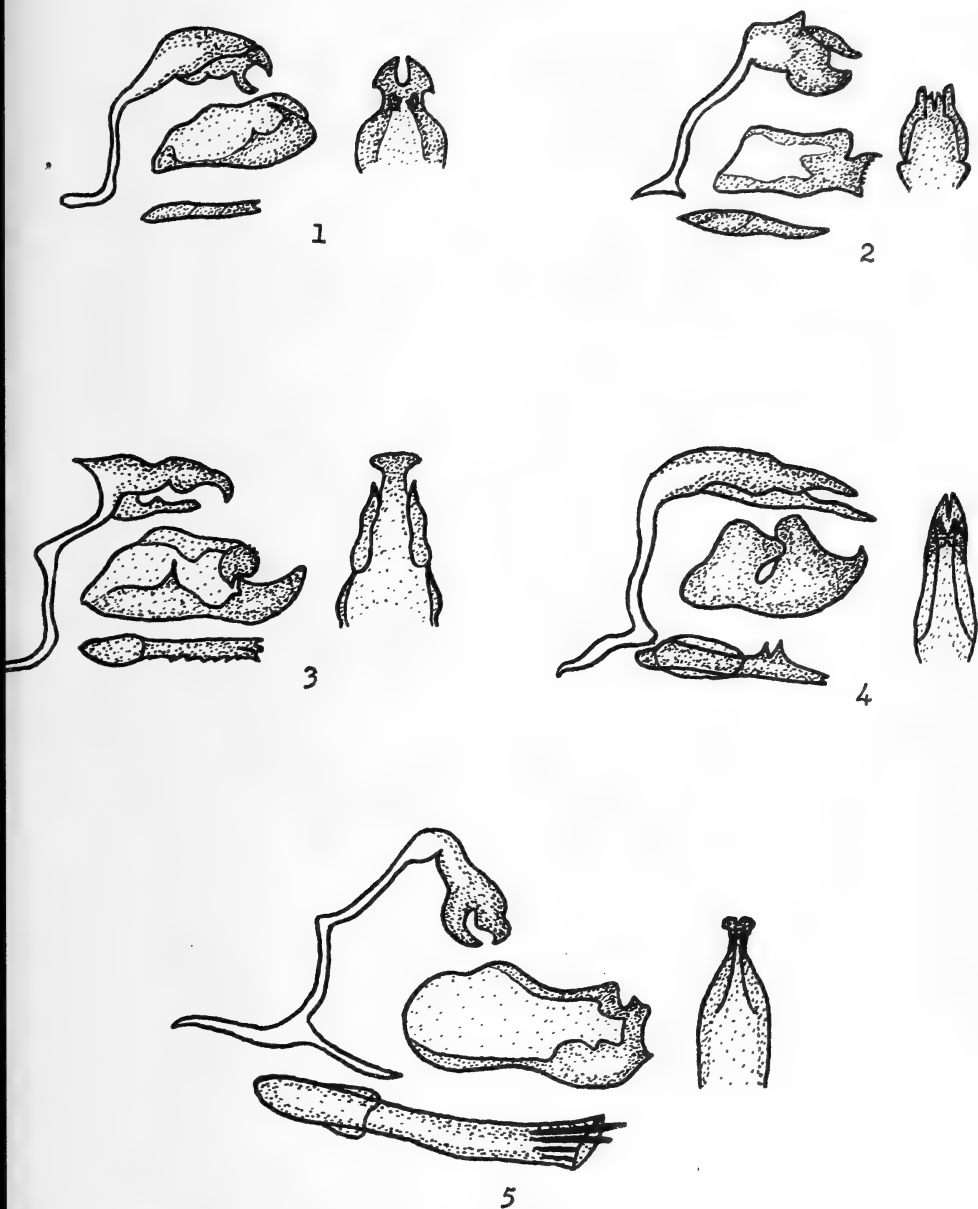
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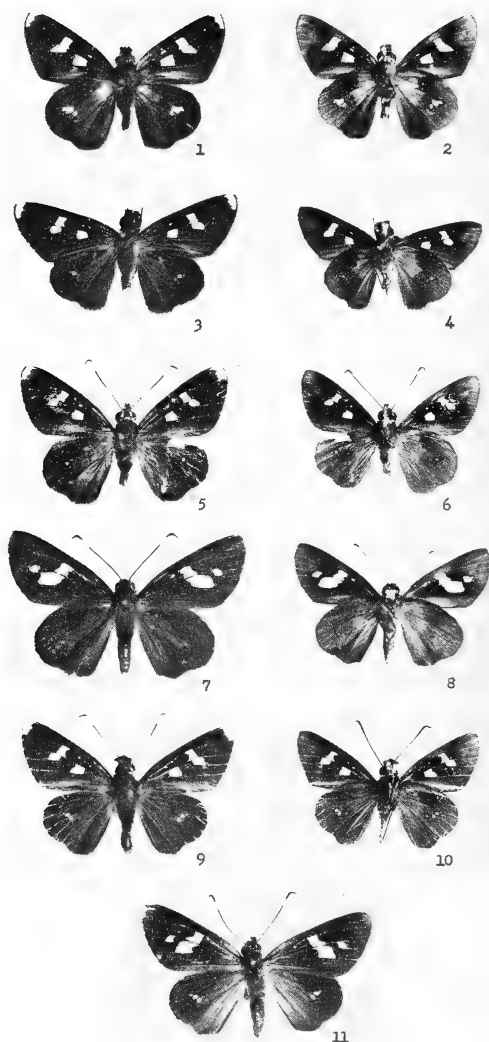
Explanation of Plate 9

Figs. 1 and 2, *Anthoptus macalpinei* Freeman, Holotype ♂, Fortín de las Flores, Veracruz, Mexico, 26 September 1966; 3 and 4, *Pheraeus covadonga* Freeman, Holotype ♂, grounds of Hotel Covadonga, 7 miles south of Valles, San Luis Potosí, Mexico, 10 June 1966; 5 and 6, *Pheraeus covadonga* Freeman, Allotype ♀, same locality, 5 August 1966; 7 and 8, *Cynea nigricola* Freeman, Holotype ♂, Santa Rosa, Comitan, Chiapas, Mexico, May, 1965.



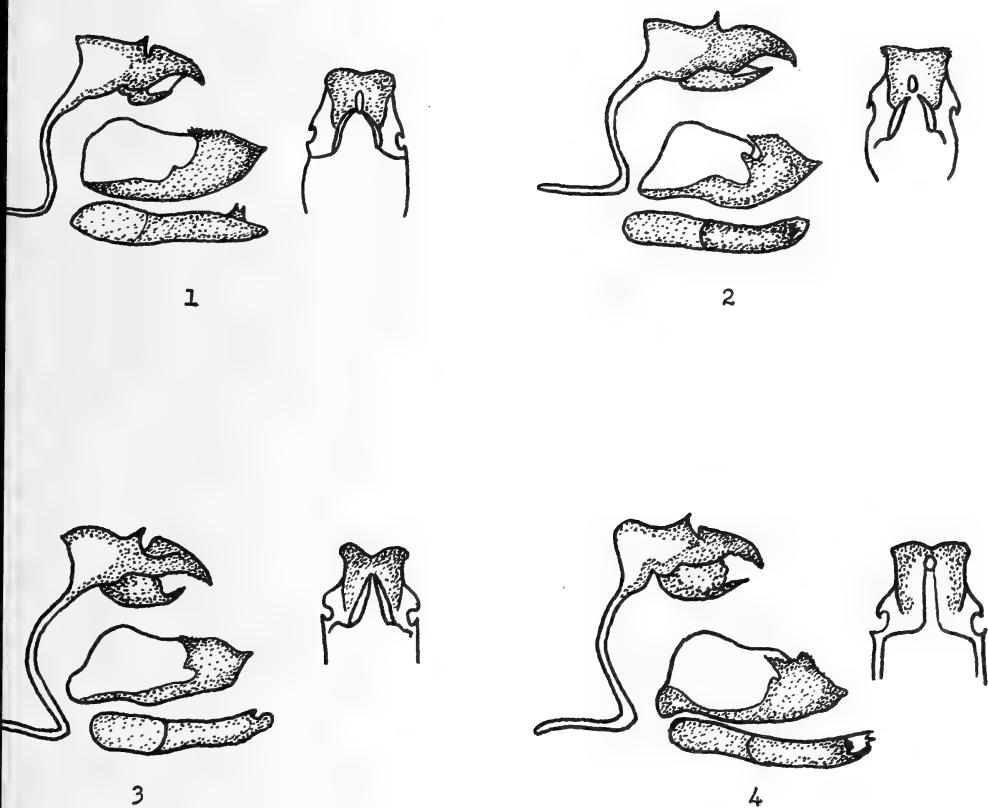
Explanation of Plate 10

Male genitalia of Mexican Hesperiidæ. Fig. 1, *Anthoptus macalpinei* Freeman; 2, *Pheraeus covadonga* Freeman, 3, *Cynea nigricola* Freeman; 4, *Euphyes chamuli* Freeman; 5, *Tirynthia huasteca* Freeman.



Explanation of Plate 11

Figs. 1 and 2, *Carystoides escalantei* Freeman, Holotype ♂, Villa Juarez, Puebla, Mexico, August, 1954; 3 and 4, *Carystoides abrahami* Freeman, Holotype ♂, Catemaco, Veracruz, Mexico, July, 1951; 5 and 6, *Carystoides floresi* Freeman, Holotype ♂, grounds of Hotel Covadonga, 7 miles south of Valles, San Luis Potosi, Mexico, 4 August 1966; 7 and 8, *Carystoides floresi* Freeman, Allotype ♀, same locality, 7 August 1966; 9 and 10, *Carystoides mexicana* Freeman, Holotype ♂, same locality, 5 August 1966; 11, *Carystoides mexicana* Freeman, Allotype ♀, same locality, 7 August 1966.



Explanation of Plate 12

Male genitalia of Mexican Hesperiiidae. Fig. 1, *Carystoides escalantei* Freeman; 2, *Carystoides abrahami* Freeman; 3, *Carystoides floresi* Freeman; 4, *Carystoides mexicana* Freeman.



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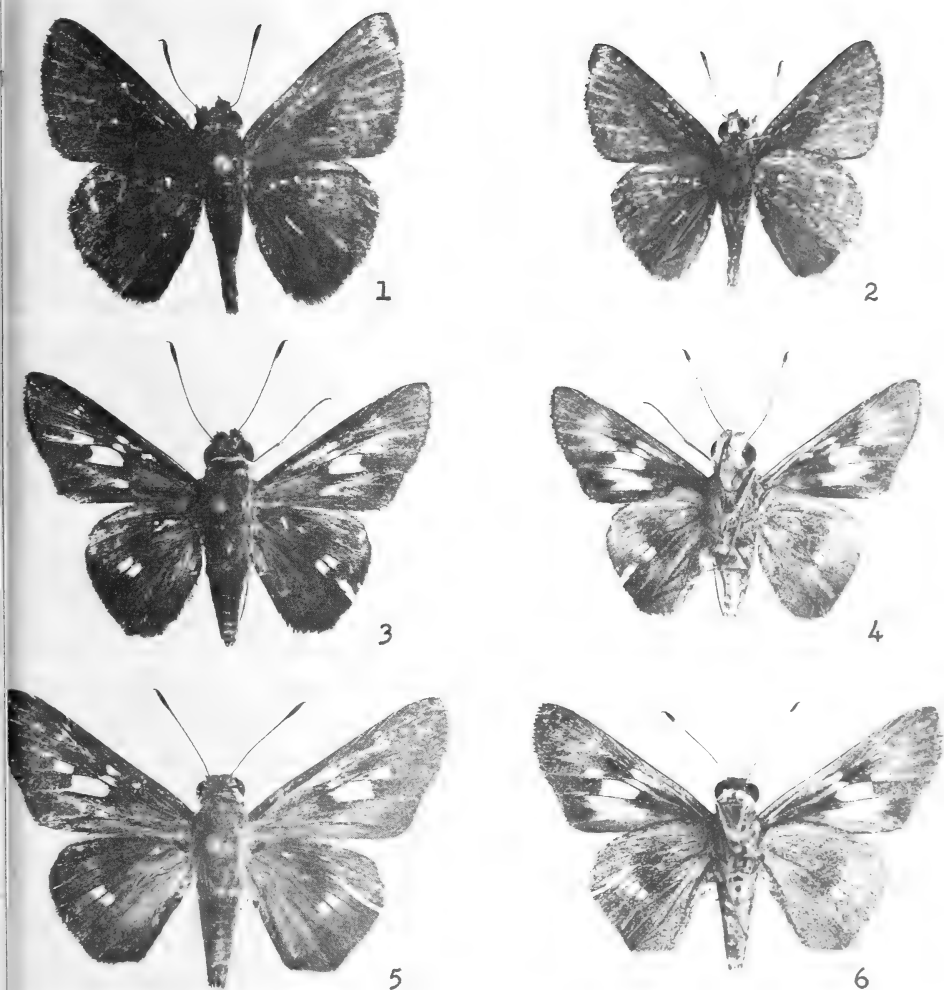
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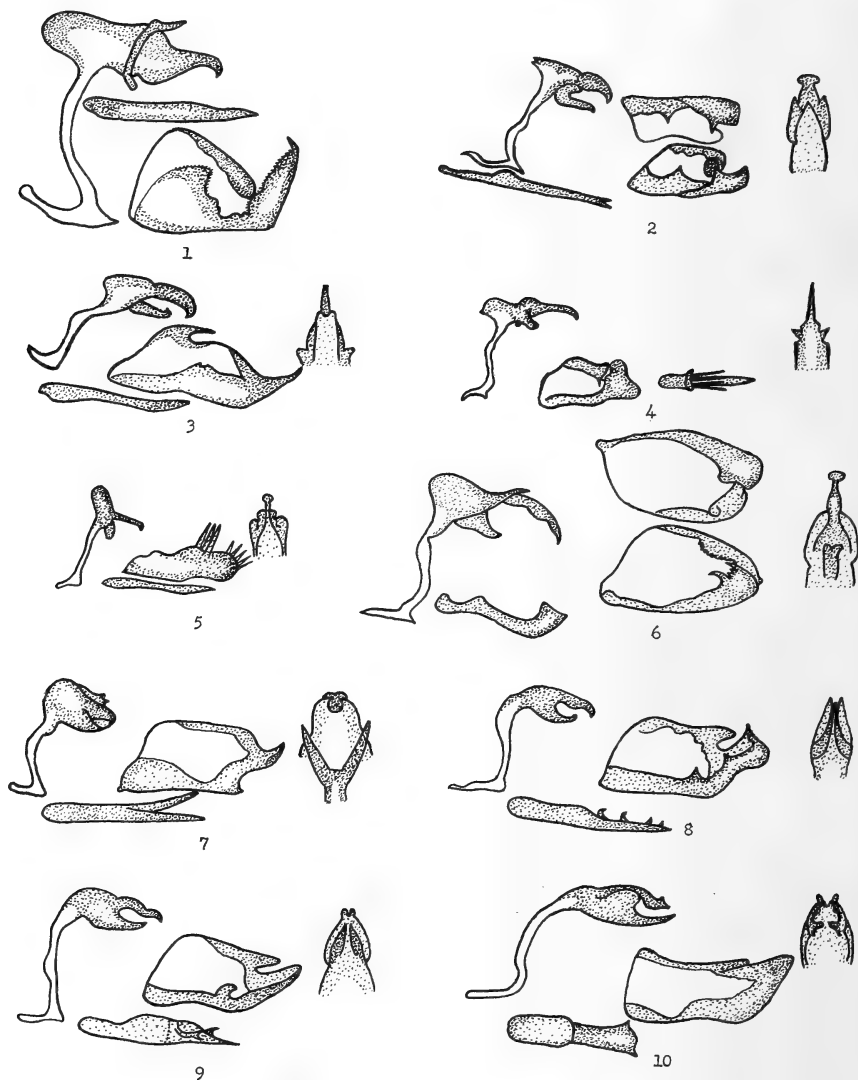
Explanation of Plate 13

Figs. 1 and 2, *Atrytone mazai* Freeman, Holotype ♂, Mexcala, Guerrero, Mexico, 13 July 1956; 3 and 4, *Atrytone potosiensis* Freeman, Holotype ♂, grounds of Hotel Covadonga, 7 miles south of Valles, San Luis Potosi, Mexico, 4 August 1966, 5 and 6; *Mellana montezuma* Freeman, Holotype ♂, same locality, 27 July 1966; 7 and 8, *Mellana montezuma* Freeman, Allotype ♀, same locality, 3 August 1966.



Explanation of Plate 14

Figs. 1 and 2, *Euphyes chamuli* Freeman, Holotype ♂, Santa Rosa, Comitán, Chiapas, Mexico, May, 1965; 3 and 4, *Tirynthia huasteca* Freeman, Paratype ♂, grounds of Hotel Covadonga, 7 miles south of Valles, San Luis Potosí, Mexico, 5 August 1966; 5 and 6, *Tirynthia huasteca* Freeman, Allotype ♀, same locality, 6 August 1966.



Explanation of Plate 15

Male genitalia of Mexican Hesperiiidae; lateral aspect of tegumen and associated structures, inner face of valva, and ventral view of uncus. Fig. 1, *Mysoria wilsoni* Freeman; 2, *Mimia chiapaensis* Freeman; 3, *Quadrus francesius* Freeman; 4, *Staphylus zuritus* Freeman; 5, *Staphylus veytius* Freeman; 6, *Windia windi* Freeman; 7, *Enosis matheri* Freeman; 8, *Atrytone masai* Freeman; 9, *Atrytone potosiensis* Freeman; 10, *Mellana montezuma* Freeman.

NOTICE TO CONTRIBUTORS

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1969

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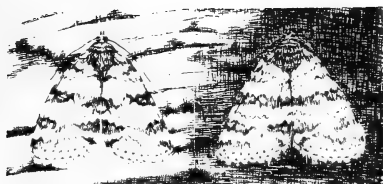
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VOLUME 23

SUPPLEMENT 3

ON THE FREQUENCY OF BUTTERFLIES IN EASTERN
BRAZIL, WITH A LIST OF THE BUTTERFLY
FAUNA OF POCOS de CALDAS, MINAS GERAIS

by Heinz Ebert

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JOURNAL OF THE LEPIDOPTERISTS' SOCIETY

Volume 23

Supplement 3

ON THE FREQUENCY OF BUTTERFLIES IN EASTERN BRAZIL,
WITH A LIST OF THE BUTTERFLY FAUNA OF
POCOS de CALDAS, MINAS GERAIS

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¹With the aid of the "Fundação de Amparo à Pesquisa do Estado de São Paulo" and of the "Conselho Nacional de Pesquisas."



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I. INTRODUCTION

Since C. L. Remington (1955) first recorded his highest catch of butterfly species in one day, from the eastern part of the U.S.A., various contributions have been published on the same subject in *The Journal of the Lepidopterists' Society*: Hemming (1955) and Langer (1955) from the French Alps, Wiltshire (1956) from Persia, Shull (1958, 1962) from northern India. As is to be expected, the highest number from any Holarctic locality (50 to 60) is lower than the value obtained in the Palaetropics (101), although comparison is difficult because the last value was the result of a party of seven collectors, whereas all others refer to one observer only. Nothing from the Neotropics has been published on this subject.

The present writer paid special attention to problems of butterfly frequency from the fall of 1950 through 1966. After every field trip any species met with and identified was noted in a card file, with its individual frequency, using five ranks from very rare to abundant. Also, since July, 1958, the number of species, grouped into subfamilies, was noted in a special table. The present data (through December, 1966) result from 212 full-day excursions, nine from the Amazonian region and 203 from eastern Brazil. Only the latter are taken into consideration here. A "full-day trip" is defined as an excursion with at least four hours of collecting time, five to six hours of physical effort being, in our experience, the upper limit for a European in the Tropics. Half-day trips and those made under bad weather have been excluded. The distribution of full-day trips in the sense given above, by years, is as follows (number of days given in parentheses): before 1959 (21), 1959 (19[+9]), 1960 (16), 1961(27), 1962(11), 1963(44), 1964(22), 1965(11), 1966(32), Total (203[+9]). The card-file, however, contains all observations, including short or unsuccessful trips. Since April, 1961, the individual frequency of any species noted has been also added to the statistics of species, making available presently the results of 138 full-day trips for this data.

Initially inspired by the above-cited papers, which deal only with the highest values observed, the author has here attempted to give a more complete treatment of the matter. Certainly, a greater number of observations would lead to more reliable conclusions; however, other duties may oblige the author to cease this very time-consuming statistical work. Thus this contribution is now presented, although it is certainly susceptible to improvement.

II. TYPES OF BUTTERFLY FREQUENCY

The total number of species and individuals found in a given day is, naturally, a complicated function of several independent frequency variables:

1. The individual frequency, i.e., the number of individuals

which characterizes a given population. This could also be called intensive frequency.

2. The seasonal variation of the individual frequency, which could also be called seasonal frequency.

3. The frequency of populations of a given species within a certain faunistical unit. This could be called also regional or extensive frequency.

In this contribution, the intensive and extensive frequency of species, as used during this study, will be discussed first. Then the number of species and individuals found during full-day excursions ("Daily frequency of species" and "Total frequency of individuals") will be discussed, with the seasonal variation of the last two categories. A number of more than 100 species found in one day is not rare in Brazil. The highest value obtained hitherto was 153, but as will be shown below, a value of 200 is well within real possibility², at least for a group of three or more collectors.

III. THE REGIONAL (EXTENSIVE) FREQUENCY

Reliable information on the frequency of butterfly species within a given region is extremely difficult to obtain, especially when the number of species present in it is 600 or more, as is the normal case in the Neotropics. Some approximation is possible if the collector frequents a great number of localities and if the excursions are equally distributed through the year. Then the number of observations of any species recorded during a given period must be a relatively simple function of the three frequency types mentioned above, and the only one in which the extensive frequency plays an important part. For practical use, a period has been chosen during which the most frequent species (e.g. *Pyrgus oileus orcus*, *Euptychia hermes*, *Heliconius erato phyllis*, etc.) were noted more than one hundred times. This period normally covered five years. As all notes on the card file were used, the observations made on days not counted as collecting days (half days and those in bad weather) are also included. The number of observations for the various species have been grouped into five classes:

Very isolated	(ii)	1 or 2 times seen during period chosen
Isolated	(i)	3 to 9 times " " " "
Moderately distributed	(id)	10 to 20 times " " " "
Well distributed	(d)	21 to 50 times " " " "
Very well distributed	(dd)	more than 50 times seen during period chosen

² After this was written, higher values (cf. footnote 4) were obtained by other collectors with more intensive methods (ten hours in the field--a physical exertion possible only to very well trained persons, in a tropical climate).

Three regions were studied in this way: the eastern part of the State of Pernambuco, where the author collected from April 1957 until January 1962; the eastern part of the State of São Paulo (April 1962-December 1966); and the surroundings of Rio de Janeiro (State of Guanabara) with the neighboring areas of Niterói and the Organ Mountains (State of Rio de Janeiro; 1951-1956 and 1962-1966). The total numbers of species identified during this time are: 532 (Pernambuco), 742 (Rio) and 759 (S. Paulo). If the western parts of the State of Rio de Janeiro (Serra do Itatiaia) were to be included, the number for "Rio" would be 853. The number of species actually caught may be 10 to 20% higher, as a great number of species, mostly Hesperinae and Theclinae, but also many *Euptychia* and some Rio-dinidae, are awaiting determination, still not being noted in the card file.

The statistics gave the following result:

Table 1: The number of species belonging to each of the five ranks of regional frequency and (in parentheses) its relative percentage.

Rank	Eastern Pernambuco	Rio de Janeiro etc.	Eastern S. Paulo	Median Percentage
ii	149 (28)	247 (33)	241 (32)	32
i	198 (38)	228 (31)	286 (38)	36
id	78 (15)	110 (15)	131 (17)	15
d	72 (13)	117 (16)	83 (11)	13
dd	<u>35 (6)</u>	<u>40 (5)</u>	<u>18 (2)</u>	<u>4</u>
Total	532	742	759	100

The median percentages in the last column have been calculated with consideration of the relative weight of each region, e.g., for the rank dd: $(6 \times 532 + 5 \times 742 + 2 \times 759) : 2033$. A more detailed form of Table 1 is given in Appendix I, containing the values separated for all families (and subfamilies) for the Hesperidae.

It may be noted that two-thirds of all species found have been seen less than 10 times, i.e., in less than 10% of the excursions made, and that only 4% of the total species have been seen in 50% of the trips.

There can be no question that the greater part of the neotropical species has a very scattered distribution, being encountered only occasionally. Populations must be generally of very restricted size and widely separated from one another. Such behavior would be easily understood in a land with great variability of biotopes. It is, however, difficult to understand in tropical Brazil with its very monotonous vegetation (rarely more than half a dozen natural ("climax") associations in areas of hundreds of square kilometers).

IV. THE INDIVIDUAL (INTENSIVE) FREQUENCY

The following five-rank scale has been used by the writer, all ranks referring to the number of individuals observed (for the greater part not caught) of any species, during at least four hours of field work:

very rare	(rr)	1 or 2 specimens
rare	(r)	3 to 9 specimens
infrequent	(rf)	10 to 20 specimens
common	(f)	21 to 50 specimens
abundant	(ff)	more than 50 specimens

At the beginning of the statistical work, these ranks were checked by real counting of a limited number of species. After some training it proved easy to estimate the limiting values with sufficient reliability. Thus, the values used here are the result of estimation. They are adapted to the frequency features typical for the Neotropics; in other faunistical regions different limiting values may be more convenient, especially in the Holarctic region with its frequently high number of individuals in a limited space, such as in meadows.

Table 2 summarizes the results of the 138 full-day excursions, for which the statistics of individual frequency have been made. To permit comparison, all real values of the ranks have been transformed into percentages, and at the end of every column the number of species involved is given. The first value of every column indicates the median value of the respective group, the values in parentheses being the extreme percentages observed; for example, rr 53 (45-63) signifies that 53% of the observed species were in the rank rr (only 1 or 2 specimens seen during one day) and that the real values of percentage of rank rr varied between 45 and 63. The same holds good for the number of species given in the last line, e.t., 91 (57 - 114) signifies that the number of species found in one day varied between 57 and 114, 91 being the median value of all days.

Table 2: Percentages of individual (intensive) frequencies resulting from 138 full-day trips in eastern Brazil.

	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
rr	44 (22-60)	49 (38-60)	38 (32-43)	53 (45-63)
r	36 (23-61)	36 (28-52)	36 (33-40)	36 (30-42)
rf	15 (6-28)	12 (6-22)	16 (15-18)	8 (3-12)
f	4 (0-11)	3 (0-7)	8 (5-11)	3 (0-8)
ff	1 (0-5)	0 (0-1)	2 (1-3)	0 (0-2.)
species	72(43-114)	96 (77-135)	118(110-129)	91 (57-114)

Table 2 - continued

	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>
rr	55 (42-63)	51 (33-70)	48 (29-83)	47 (19-64)
r	36 (29-42)	34 (21-45)	34 (13-45)	38 (29-44)
rf	8 (0-13)	10 (5-20)	13 (3-24)	12 (3-31)
f	1 (0-4)	4 (1-11)	4 (0-11)	3 (0-10)
ff	0 (0-2)	1 (0-3)	1 (0-6)	0 (0-3)
species	75 (54-113)	62 (23-89)	83 (15-153)	70 (37-86)

	<u>J</u>	<u>Median Value</u>
rr	46 (32-62)	48 (19-83)
r	42 (33-49)	36 (13-61)
rf	10 (5-18)	12 (3-31)
f	2 (0-7)	3 (0-11)
ff	0 (0)	1 (0-6)
species	61 (21-90)	77 (15-153)

- A) 24 excursions made in northeastern Brazil (states of Pernambuco and Paraíba) between April, 1961, and January, 1962.
- B) 14 excursions made near Poços de Caldas (Minas Gerais, 1250 m) from 27 January to 13 February, 1963.
- C) 4 excursions from 1 to 5 May, 1963, at the same locality as B.
- D) 6 excursions between 23 and 28 March, 1964, at the same locality as B.
- E) 7 excursions to the same locality as B, between 10 and 18 December, 1966.
- F) 17 excursions in mountains of southern Brazil (Organ Mts., Itatiaia Mts., Serra de Bocaina, Campos do Jordão; States of Rio de Janeiro and São Paulo), during January, February, March, July, September, November and December; elevation between 800 and 1700 m.
- G) 40 excursions in medium altitude (500 to 700 m) forest areas of eastern São Paulo, distributed through all months of the year.
- H) 16 excursions in the humid coastal region between Rio de Janeiro and Santos (below 200 m), from December to March and from July to August.

J) 10 excursions in the "Cerrado" of central São Paulo (700 to 800 m), in January, April, May, June, August, October and November.

The median values are calculated with consideration of the relative weight of the group values.

From these values it is clear that nearly half of all species are in the lowest rank (rr), only one or two specimens having been seen during a normal full-day excursion. In addition, more than 80% of all species were represented by less than ten individuals, whereas only 3% were seen to the extent of more than 20 and only 1% in more than 50 individuals. This phenomenon is quite contrary to that familiar to collectors in the Holarctic where a great number of individuals is typical for many species. Thus frequently a Neotropical forest or "Cerrado" appears to the collector surprisingly poor in butterflies. This scarcity of individuals of most of the species seen on the wing is, however, by and large compensated by the high number of species found. The median value of the 138 excursions, 77 species, is higher than the highest records found in the Holarctics. Thus it can be stated:

In eastern Brazil the individual frequency of butterflies is generally very low. The success of an excursion is exclusively determined by the number of species found. The higher the number of species found during a trip, the higher the chance to find regionally (and/or individually) rare species (ranks ii and i of the foregoing section, rr and r of this section).

V. THE DAILY FREQUENCY OF SPECIES

The extreme values mentioned above (Table 2, G) of 15 and 153 species respectively for a single day are the extremes of all values noted by the author since July, 1958³. The highest values, 150 and 153, were observed on two successive Sundays, the total number of species found during these two days being 204.

For statistic interpretation, the values of daily frequency of species have been grouped in the following classes: 16 to 20, 21 to 25, 26 to 30, 31 to 40 etc., until 151 to 155. Table 3 and Figure 1 show the frequency of these classes. The individual values are shown in Tables 4 and 5.

The special curves for Northeastern (N) and Southeastern (S) Brazil show, that the tendency for median values is more pronounced in the North, where the extremely low and high values found in the South are lacking. This may be the consequence of the more uniform climate during the year, i.e., the influence of a lower seasonal variation of the frequency.

³

See, however, footnote 4.

Table 3: Number of days (X) with values (Y) of daily frequency of species

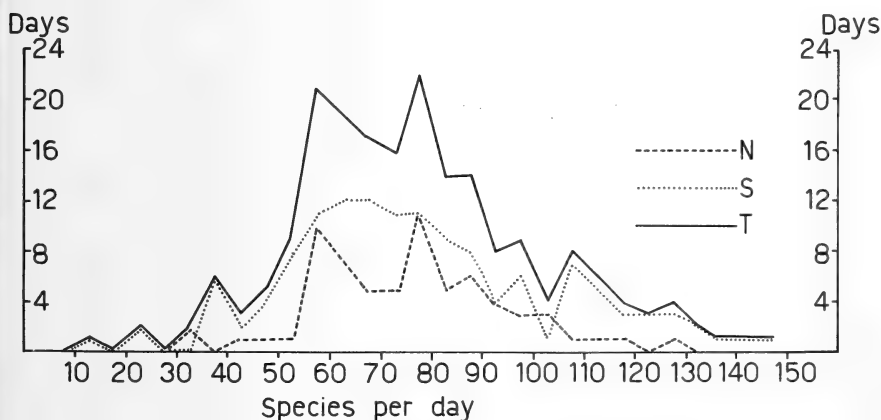
	10	16	21	26	31	36	41	46	51	56	61	66	71	76	81	86	91
Y	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to
	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
X_N	0	0	0	0	2	0	1	1	1	10	7	5	5	11	5	6	4
X_S	1	0	2	0	0	6	2	4	8	11	12	12	11	11	9	8	4
X_T	1	0	2	0	2	6	3	5	9	21	19	17	16	22	14	14	8

	96	101	106	111	116	121	126	131	136	141	146	151	No. of excursions
Y	to	to	to	to	to	to	to	to	to	to	to	to	
	100	105	110	115	120	125	130	135	140	145	150	155	
X_N	3	3	1	1	1	0	1	0	0	0	0	0	68
X_S	6	1	7	5	3	3	3	2	1	1	1	1	135
X_T	9	4	8	6	4	3	4	2	1	1	1	1	203

X_N : Northeastern Brazil (Pernambuco and Paraíba).

X_S : Southern Brazil (Rio de Janeiro, São Paulo, Minas Gerais).

X_T : Total values.

Fig. 1 Daily frequency of butterflies in Eastern Brazil

N: Northeast (Pernambuco, Paraíba). S: Southeast (Rio de Janeiro, São Paulo, Minas Gerais). T: Total

The curve of the total values shows a very pronounced sub-division into three parts:

- 28 days (14%) with fewer than 55 species in one day
- 123 days (60%) with 56 to 90 species
- 52 days (26%) with more than 90 species

The first group can be considered as corresponding to bad collecting days, the second as normal, the third as referring to very good days.

Theoretically, bad and fine days should be equally frequent, and the curve must be symmetrical. The asymmetry observed is purely subjective: the experienced collector naturally knows the season of the year which gives the best results (cf. the following section) and concentrates his efforts to it.

The median value of all 203 excursions is nearly the same as reported above (Table 2) for 138: 78 species per day. Thus a number of 75 to 80 species for one day may be considered as the normal value in eastern Brazil.

VI. THE SEASONAL VARIATION OF THE DAILY FREQUENCY OF SPECIES

Very little is known, quantitatively, of seasonal variation of butterflies' frequency in the Neotropics, although any collector knows that during the dry season the number of species and individuals diminishes. Tables 4 and 5 and figures 2 and 3 will give some idea of this variation; they show the singular values already used for the construction of table 2 and figure 1.

Table 4: Seasonal variation of frequency of butterfly species in Northeastern Brazil (States of Pernambuco and Paraíba)

Region	Jan.	Feb.	March	Apr.	May	June
CR	55	57	60	57	100	98
	58	58		69		
	74			74		
	76			84		
	85					
	85					
	89					
	94					
M _{CR}	77	58	60	71	100	98
A		32	34		57	74
					76	76
						80
M _A		32	34		67	77

Table 4 - continued

Region	July	Aug.	Sept.	Oct.	Nov.	Dec.
CR	78	63	47	56	66	56
	94	64	65	68	87	57
	99	81	72	76	114	77
	102	89	83	78		79
	104	93	87	80		
	107	104	93	86		
	116		104	89		
				95		
M _{CR}	100	87	79	78	89	67
A	61	43	56		65	
	64	70	73		77	
	69					
M _A	65	57	65		71	

CR Coastal region (sea level to 100 m); 52 excursions

M_{CR} Median values for the coastal region

A "Agreste" (higher and less humid elevations at some distance from the coast; 300 to 900 m); 16 excursions

M_A Median values for the "Agreste"

The coastal region was originally covered by rain forest, presently substituted for the most part by sugar cane plantations. The "Agreste" receives less precipitation than the coastal zone, but still sufficient to allow the growth of a low forest, partly defoliated during the dry season.

Table 4 and figure 2 show the following: in the coastal region the seasonal variation of frequency of species is low. Its maximum value coincides with the period of maximal precipitation. With the beginning of the dry season, the frequency diminishes only slowly, not accompanying the decrease of rain frequency. Apparently the densely foliated forest conserves appreciable humidity during the dry season. The lowest value, which is still higher than half the maximum value, is reached at the beginning of the rainy season. The secondary peak at the time of greatest drought may be caused by the appearance of a second generation of many species.

In the "Agreste" the precipitation is much lower than near the coast, however its periodicity is the same. Also here the butterfly frequency reaches its lowest value at the beginning of the rainy season, and the diminution of frequency is also slow after the end of the rains, showing the same secondary peak during the strongest drought. The number of species is lower in all months than near the coast, certainly a consequence of the impoverishment of the flora.

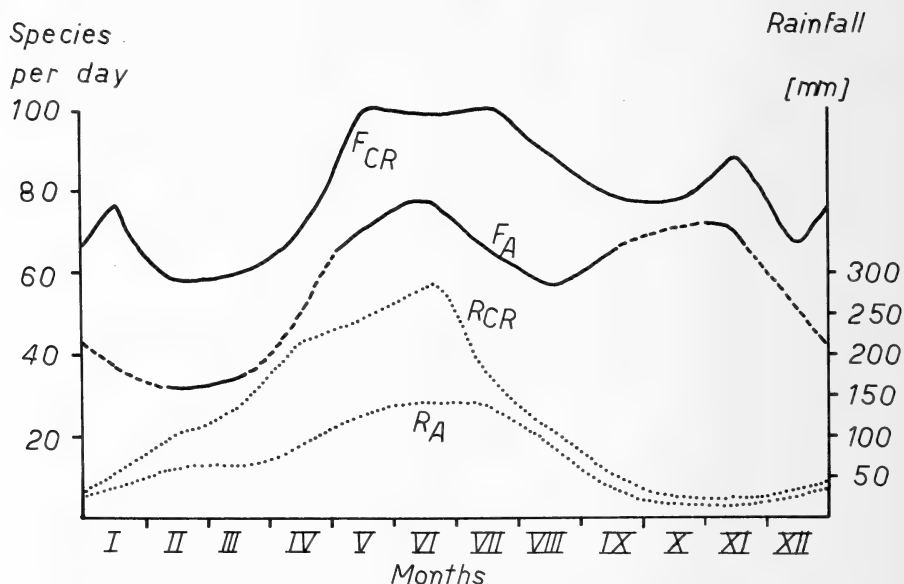


Fig. 2 Seasonal variation of the daily frequency of species in Northeastern Brazil, compared with the monthly distribution of rainfall.

Frequency (scale to the left): F_{CR} : Coastal Region (sea level)
 F_A : "Agreste" (300 to 900 m)
 Rainfall (scale to the right): R_R : Recife (Pern.; sea level)
 R_A : Garanhuns (Pern.; 850 m)

Interpolated parts of the curves are broken.

The minimal values are lower than half of the maximal. This greater seasonal variation is similar to that we shall find in the south (figure 3). The faunistic character reflects the same analogy: in the "Agreste" nearly all hylaeen species are lacking, being partially substituted by typical species of the south.

Figure 3 and Table 5 show the seasonal variation in southern Brazil. Here the collecting localities are subdivided, in accordance with their floristic-faunistic character, into three groups, low regions (below 200 m) (L), higher regions (500-1500 m) (H) and savanna-like "Cerrado" (C).

The number of observations in the lowlands and in the "Cerrado" is still low, and the values given here may not be fully representative. In the coastal zone the highest values have been observed in April and May, as the author remembers from the years 1951 to 1956 when he was not yet noting frequency data. This high season may continue until July (verbal communication by K. Brown).

Table 5 Seasonal variation of the daily frequency of butterfly species in southern Brazil (States of São Paulo, Rio de Janeiro and Minas Gerais)

Region	Jan.	Feb.	Mar.	Apr.	May	June
L	68 68 90	80	84			
M _L	75	80	84		(high)	
	44	55 78	54 107	70	50	42
	48	57 78	56 113	71	84	63
	56	60 78	57 114	75	97	108
	59	63 79	73 117	93	107	
	73	64 79	81 126	95	108	
H	80	65 80	82	107	110	
	82	66 86	82	107	116	
	90	67 98	89	111	117	
	96	68 100	91	122	129	
	97	69 114	93	124	150	
	104	71 124		129	153	
		73 135		131		
		73 138		143		
		77				
M _H	75	81	89	106	111	71
C	36			90	62 68 81	84
M _C	36			90	70 ^b	84
Region	July	Aug.	Sept.	Oct.	Nov.	Dec.
L	68 75 75 86	82	55 59 74 76 86			37 55 62
M _L	78	82	70			51
	23 37 40 62	39	15 55 64	68	50 51 52 59 61 66 67	54 58 59 59 62 64 65 75 90 98 113
H						

^aAfter this was written, a total of 162 species was recorded in

Table 5 - continued

Region	July	Aug.	Sept.	Oct.	Nov.	Dec.
M _H	41	39	45	68	58	73
C		77		39	21 49	
M _C		77		39	35	
L	Low regions near the coast with nearly tropical conditions, between Rio de Janeiro and Santos (18 excursions).					
H	Higher regions (500 to 1500 m) in the Interior, less humid and with a tendency to subtropical conditions, however, sufficiently humid to allow forest vegetation (Poços de Caldas, M. G.; eastern S. Paulo; Itatiaia Mts., R.J.; some data are from the Serra do Mar); 103 excursions.					
C	Savanna-like "Cerrado" with only very narrow strips of low wood along the water-courses, in the Interior of the State of São Paulo (10 excursions).					
M _L M _H M _C	Median values for the zones L, H, and C.					

The dependence of the frequency of species on climatic conditions is evident from figure 3. In the humid coastal zone the seasonal variation is small, the lowest values corresponding to the beginning of the rainy season. The same has been observed in tropical northern Brazil (cf. figure 2). Perhaps this feature may be typical for other Neotropical areas. According to a note of D. Zayziw (1958:5-7), the behavior of Coleoptera is quite different: the Cerambycidae studied by him showed clearly their maximum frequency at the beginning of the wet season (October-November). This may be the result of the different way of life of the larva and of different "hibernation" stage; as egg or imago in butterflies, as larva or pupa in beetles. Butterflies reach their maximal frequency at the end of the wet season.

the "Cerrado" of Itirapina (S.P.) by the author's son Karl and Dr. Keith Brown of Rio de Janeiro, on May 21, 1967. The value transforms the above median value for May to 93. This value has been used for the construction of Figure 3, but was relegated otherwise to avoid tedious rewriting, recalculation of tables and reconstruction of curves. Still higher values were found by Dr. Brown, made by more intensive collecting (cf. footnote 2) in Central Minas Gerais and near Rio de Janeiro, including several days with counts of over 200 species and one of more than 250 (Brown, verbal communication).

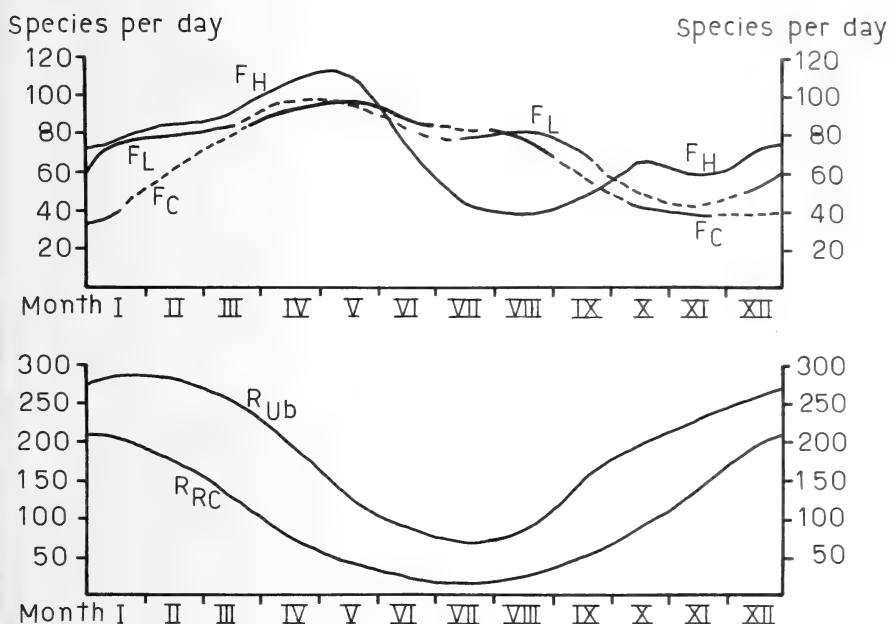


Fig. 3 Seasonal variation of the daily frequency of species in Southeastern Brazil, compared with the monthly distribution of rainfall

Frequency (upper diagram; details
cf. explication of Table 4):

L: Lowlands (below 200 m). H:
Highlands (above 500 m). C: "Cerrado"

Rainfall (lower diagram):

Ub Ubatuba (S. Paulo; sea level)
R. Cl. Rio Claro (S. Paulo; 600 m; at the
limits of forest zone and "Cerrado").

Interpolated parts of the curves are broken.

In the less humid Interior, the type of variation is similar: highest frequency at the time of the last rains, lowest values at the end of the dry season. The decline of the curve, at the beginning of the dry season, is sharper and the seasonal variation greater than near the coast.

In the forests of the Interior the curve is simple: a high peak in April-May with more than 100 species every day, and a notable decrease in June and July. The minimum with less than fifty species

occurs at the end of the dry season; the rise to the new maximum is slow.

In the "Cerrado" the general trend of the frequency curve is more similar to that of the coastal zone, notwithstanding the different character of the "winter" with its hot days and cold nights. The minimum occurs also at the beginning of the wet season here. It has been a great surprise to the author to observe during the "winter" (June - August), a much higher number of species, in the midst of a totally dry vegetation, than at the beginning of the wet season (October - November), when all the vegetation is covered with fresh foliage and many blossoms.

Generally the best time for collecting in southern Brazil is the end of the wet season, April - May. At this time a daily catch of more than a hundred species can be expected in a good locality, with some variation in the vegetation and many blossoms.

VII. THE DAILY FREQUENCY OF THE TOTAL NUMBER OF INDIVIDUALS

It is possible to reach some quantitative conclusions on the total number of butterfly individuals seen during one day, including all species identified, with the aid of the values of the daily frequency of species and the individual (intensive) frequency of these species grouped in the five ranks discussed above. Thus 1.5 is the median value for the rank rr, 6 for the rank r, etc., (rr) is the number of species found in rank rr, (r) the same for rank r, etc. The following formula for the total number of individuals results:

$$F_{TI} = 1.5 (rr) + 6 (r) + 15 (rf) + 35 (f) + 100 (ff)$$

Such a calculation is, naturally, quite schematic and only an approximation to the real number of the individuals on the wing, but it furnishes comparable values for the different days and regions.

The following table and Figure 4 represent the statistics of F_{TI} -values for the same 138 excursions used in Table 2. The group here includes hundreds of individuals (the individual values are shown in Table 6):

1	101	201	301	401	501	601	701	801
to	to	to	to	to	to	to	to	to
100	200	300	400	500	600	700	800	900
2	7	21	22	22	27	8	7	9
901	1001	1101	1201	1301	1401	1501	1601	
to	to	to	to	to	to	to	to	
1000	1100	1200	1300	1400	1500	1600	1700	
1	4	1	2	2	2	0	1	

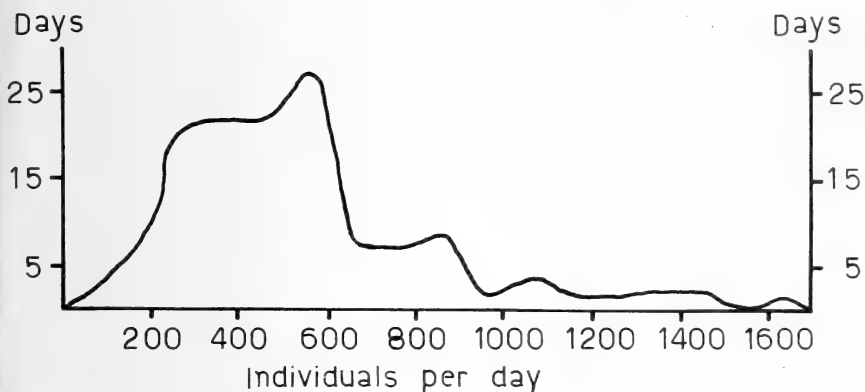


Fig. 4 Variation of the number of individuals of butterflies in Eastern Brazil.

Northeastern and southeastern Brazil are not separated in Figure 4, because of the low number of values (24) from the north-east. Figure 4 shows the same subdivision into three groups as the sum curve of Figure 1:

- 9 low days (7%) with less than 201 individuals per day
- 92 "normal" days (66%) with 201 to 600 individuals per day
- 37 high days (27%) with more than 600

The motive for the greater frequency of high days in relation to low ones is the same already discussed in connection with Table 2.

VIII. THE SEASONAL VARIATION OF THE TOTAL NUMBER OF INDIVIDUALS

In Table 6 and Figure 5, the values are grouped in accordance with the months and with the regions, in analogy with Table 4 and 5 and Figures 2 and 3.

Comparison of Figure 5 with Figures 3 and 4 shows that the seasonal variation of number of individuals is the same as that of species, with the maximum and minimum parts of the curves more pronounced. The upper diagram (I) represents observations in tropic climate: in the northeast and at the Littoral between Rio de Janeiro and Santos. The lower diagram (II) shows the situation in the less humid higher regions of southern Brazil. All frequency curves show more than one maximum and interesting relations with the rainfall curve.

Table 6 Seasonal variation of number of individuals of butterflies in eastern Brazil

Region	Jan.	Feb.	March	Apr.	May	June
NE	449			225	486	599
	469			273	866	776
	662					871
M _{NE}	527			299	676	749
C	200			533	264	365
					397	
					591	
M _C	200			533	417	365
	662	415	727			
L						
M _L	662	415	727			
	243	339	207	351	298	203
	253	347	235	402	519	271
	286	374	417	563	595	902
	395	406	432	794	716	
	434	408	463	1059	805	
	435	430	534	1095	1067	
	542	440	536	1095	1158	
	562	506	545	1348	1223	
H	619	518	556	1460	1310	
	673	519	569		1482	
	872	613	574		1670	
		734	587			
		736	637			
		895	720			
		1249	820			
M _H	483	568	521	907	984	459
Region	July	Aug.	Sept.	Oct.	Nov.	Dec.
N _E	456	249	354	542	438	337
	848	343	392		873	
		359	410			
			446			
			605			
M _{NE}	652	317	442	542	650	337
C		517		198	77	
					354	

Table 6 - continued

Region	July	Aug.	Sept.	Oct.	Nov.	Dec.
M_C		517		198	215	
	479	515	245			189
L	509		376			229
	560		442			268
	591		549			
			613			
M_L	528	515	445			229
	124	231	54	580	137	189
	168		294		290	255
	360		334		341	260
					381	276
					383	295
					404	320
					493	385
						502
H						865
M_H	227	231	227	580	344	372

NE: Group A of Table 2

C: Group I of Table 2

L: Group H of Table 2

H: Groups B to G of Table 2

 M_{NE} etc.: Monthly median values of the four groups.

The main maximum coincides in the northeast (F_{NE}) with the rain maximum: in the Littoral (F_L) it is retarded two months, and in the higher forest areas (F_H) four months in relation to the rain maximum. Two secondary maxima appear in the northeast during the dry season; probably only one secondary maximum exists here, the minimum value for December not being representative. In the coastal area of the south the minimum coincides with the beginning of the rainy season, being retarded four months against the rain minimum. The second minimum of the F_L curve may be fictitious, the only value for February not being representative. The same doubt exists for the secondary maximum of the F_L curve, as the single value for October may be exceptionally high.^H Typical for the semi-dry forests of the Interior is the sudden decline between May and July, at the beginning of the strongest drought. It may be the effect of the first cold nights. The minimum corresponds to the end of the dry season.

In the "Cerrado" the main maximum coincides with that of the other regions of the South, the minimum with that of the Littoral, being retarded four to five months after the driest months. The secondary maximum in the month of August is still dubious, as the only high value perhaps is not representative.

Fig. 5 Seasonal variation of frequency of individuals in Eastern Brazil

Upper diagram (I): Areas with tropical features

Frequency (scale to the left): F_{NE} : Brazilian Northeast.
 F_L : Littoral between Rio de Janeiro and Santos.

Rainfall (scale to the right): R_R : Recife (Pern.).
 R_U : Ubatuba (S. Paulo)

Lower diagram(II): Regions with the beginning of subtropical features

Frequency (scale to the left): F_H : Highland forests.
 F_C : "Cerrado"

Rainfall (scale to the right): R_{RC} : Rio Claro (S. Paulo; 600 m; at the limits of the forest zone and the "Cerrado").

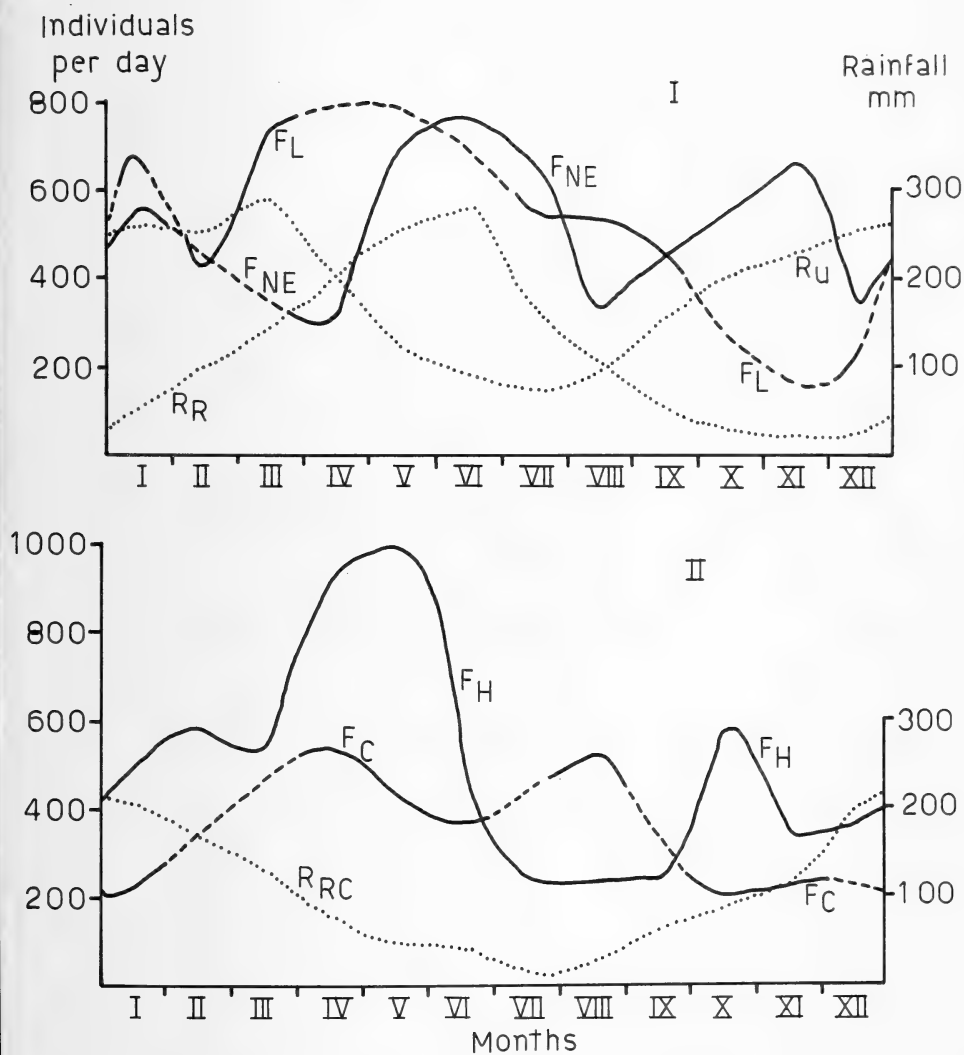


Figure 5

A great variation of frequency within the same month is notable, e.g. for the F_H values of 243-872 (January), 339-1249 (February), 351-1460 (April), 298-1760 (May), 189-865 (December). Here the influence of the annual variation may be reflected. Also in the Neotropics "good" and "bad" years exist. Some values typical for this type of variation are given below in Section Xc.

IX. CONCLUSIONS

From the foregoing data the following conclusions may be drawn:

(a) Generally, butterflies appear in the Neotropics in very low numbers of individuals.

(b) This scarcity refers to the low density of populations as well as to the low numbers of individuals belonging to many of them.

Thus the frequently defended hypothesis that any butterfly species may be abundant at one, possibly hidden, locality and during a defined, probably very short, time seems to be not valid for eastern Brazil. Here certain species have been found only once in only one specimen in ± 450 excursions during 15 years at the most varied localities between the 6th and the 23rd parallel.

(c) Only very few species are seen everywhere and always in great number. These are common and widely distributed species as *Agraulis vanillae*, *Dryas julia*, *Pyrgus oileus orcus*, *Euptychia hermes*, *Heliconius erato phyllis*, *Phyciodes claudina*, etc.

(d) The seasonal frequency variation of species as well as of individuals is very large, more than would be expected in tropical zones. The variation in the number of individuals is still stronger than that of species.

(e) In zones near the equator the frequency variation accompanies the rainfall curve, showing a second peak during the dry season.

(f) In the southern areas, partially with subtropical tendency, the frequency variation is much retarded in relation to the rainfall curve. Temperature may be of influence at the end of the summer, when the first cold nights coincide with an abrupt diminution of individuals.

(g) A second, much lower, frequency peak may exist two months before the highest peak of the rainy season (curves F_L and F_C in figure 5); this feature needs confirmation, as the number of observations is still insufficient.

(h) The number of individuals seen on the wing in the Neotropical Region may be more or less equal to that seen on a summer day in the Holarctic. However, the relation between number of species and their individuals is the inverse, the number of species compensating their lower number of individuals.

(i) A catch of more than 100 species per day is normal during the short time of maximal frequency. The highest value, hitherto found by the author, has been 162, other collectors being still more fortunate (cf. footnote 4).

The median values of individuals per day are: 518 in the north-east, 461 in the coastal zone of southern Brazil and 562 in the higher forest regions of the South, the total median value of the forest zones being 542. Since we found as a median number of species a value of 77 to 78 for a day, the median number of individuals per species per day is only seven, a very low value compared with that familiar for the collector in the Holarctics (cf. Newcomer, 1962). In the "Cerrado" the median number of individuals is lower: 350. The median value for all 138 excursions is 528.

Thus we come to the following conclusion: in the Neotropic the relation between the number of species and their number of individuals is the inverse of that normally observed in the Holarctic; many species with very low number of individuals in the Neotropics; far fewer species in far more individuals in the Holarctic. The total number of individuals observed during one day may not be very different in both regions.

X. ADDITIONAL OBSERVATIONS

In the following we shall discuss briefly the influence of the number of observers and of the time of observation.

(a) Influence of the number of observers

For the study of the influence of the number of hunters on the number of species found, sometimes a separate analysis has been made for the catch of the present writer and of that of his son (presently 19 years old); the results are given in Table 7 (the number in parentheses refer to percentages):

Table 7 Number of species found by two hunters (with percentages)

Date	1962 27/1	1963 27/1	1962 2/X1	1962 11/X1	1962 25/X1	1962 9/X11	1963 6/1
Found only by father	39(44)	23(29)	16(32)	24(40)	29(43)	26(45)	27(46)
Found only by son	23(26)	20(25)	22(44)	17(29)	14(21)	20(34)	17(29)
Found by both	27(30)	36(46)	12(24)	18(31)	24(36)	12(21)	15(25)
Sum of Species	89	79	50	59	67	58	59

Ebert: Influence of collecting hours

Date	1963 2/III	1963 4/III	1963 10/III	1966 6/I	1966 29/V	1966 9/VI	1966 19/VI	1966 15/VIII
Father	49(42)	47(50)	55(44)	22(23)	37(38)	26(31)	38(35)	29(38)
Son	32(27)	21(23)	30(24)	38(39)	26(27)	38(45)	33(31)	27(35)
Both	36(31)	25(27)	41(32)	37(38)	34(35)	20(24)	37(34)	21(27)
Sum	117	93	126	97	97	84	107	77

27/I 62: Recife (Pern., sea level)

27/I 63: Poços de Caldas (Min. Ger., 1300 m)

2/XI 62 to 10/III 63: Rio Claro (São Paulo, 600 m)

6/I, 29/V and 19/VI 66: Araras (São Paulo, 600 m)

(Forest)

9/VI and 15/VIII 66: Itirapina (S. Paulo, 750 m)

("Cerrado")

The median and extreme percentage values are:

Found by the first hunter (father) only:	38.8% (23 - 50)
Found by the second hunter (son) only:	30.6% (21 - 45)
Observation common to both hunters:	30.6% (21 - 46)

During the 15 full-day trips on which these separate annotations were made, an average of only 31% of all species found, i.e., less than one-third, have been collected by both hunters, and more than two-thirds only by one or the other. It is evident that by an increase of the number of hunters the number of species found would increase also. The number of 150 and 153 species caught by two hunters on the 8th and 15th of May, 1966, and the observation that on these two succeeding Sundays the total number was 204, only 98 (48%) of them found on both days permit the conclusion that a team of three or four hunters, during the best season, may get easily more than 200 and perhaps 300 species during one day in eastern Brazil (cf. footnote 4), many more than Shull (1962) refers to for a trip of seven collectors in India. The frequently defended hypothesis that the Neotropical Region is the richest of all may thus be considered proven quantitatively.

(b) Influence of amount of collecting hours

The last example already suggests that for a series of succeeding days, every day species previously not seen, will appear, whereas others will seem to have disappeared. Really they all have been on the wing all the days, however most species are seen only occasionally owing to their very great scarcity. This observation corroborates the conclusion already drawn from other data: the majority of Neotropical butterflies are rare in the sense of extensive distribution as well as of intensive frequency. Thus some observations on the number of species found during a group of days may be of general interest. Table 8 summarizes the results of four stays in Poços de Caldas (State of Minas Gerais; 1000 to 1500 m) during January, February and May of 1963, March of 1964 and December of 1966.

X is the number of species found on the single days, Y the number of species found for the first time, during the respective stay, on every day.

Table 8 Increase in number of species during collecting periods

Day(I/II):	27	28	29	31	1	2	3	5	7	8	10	11	12	13
X :	80	82	96	104	86	77	79	78	98	80	135	124	114	138
Y :	80	31	29	26	39	13	12	21	20	6	13	29	16	8

Total: 343

Day(V):	1	2	3	5	Day(III):	23	24	25	26	27	28
X :	129	116	110	117	X:	81	57	113	107	73	114
Y :	129	56	41	20	Y:	81	31	53	32	19	31

Total : 246

Total: 247

Day(XII):	10	11	12	13	14	17	18
X :	75	54	65	59	62	98	113
Y :	75	37	31	21	27	33	37

Total: 261

We note that every new day brings species not seen before, where others seem to disappear. Thus the total number of species found during a several day period is two to three times higher than the median species number per day.

But also any subsequent visit reveals species never seen during the earlier, as is shown in the following table, which includes more recent observations:

<u>Period</u>	<u>Total Number of Species</u>	<u>New For Locality</u>	<u>Total</u>
Jan./Feb. 1963 (14 days)	343	343	343
May 1963 (4 days)	246	72	415
March 1964 (6 days)	247	47	462
December 1966 (7 days)	261	53	515
April/May 1967 (6 days)	301	57	572

A list of these 572 species is given in the Appendix

A catch of 572 species during five stays with 37 collecting days during six months may be unrivaled outside of the Neotropics. Diagram I of Figure 6 represents as accumulative curve the continuous increase of species with every new stay; the curve rises steadily without any sign of asymptotic approximation to a final value. There

is a vague possibility only to estimate the total value of species occurring at this locality (700 to 800?).

It is highly interesting that the same feature holds for longer periods of time, as tables 9 and 10 and the diagrams II, III, IV of figure 6 show.

Table 9 First observation of species during five successive years in Eastern Pernambuco (accumulative values in parentheses)

	1957	1958	1959	1960	1961	total
Acraeidae	0	0	0	0	2	2
Brassolidae	7	0	0	0	0	7
Danaidae	3	0	0	0	0	3
Heliconiidae	10	0	0	2	0	12
Hesperiinae	43	21	3	6	3	76
Pyrginae	21	17	6	9	9	62
Pyrrhopyginae	2	0	0	0	0	2
Urbaninae	19	13	6	7	9	54
Ithomiidae	9	2	0	4	0	15
Libytheidae	1	0	0	0	0	1
Lycaenidae	23	36	8	16	18	101
Morphidae	1	1	0	1	0	3
Nymphalidae	46	2	5	9	3	65
Papilionidae	3	0	0	0	0	3
Pieridae	15	4	3	2	3	27
Riodinidae	27	29	4	11	5	76
Satyridae	20	2	0	0	1	23
Total	250 (250)	127 (377)	35 (412)	67 (479)	53 (532)	532

Table 10 First observation of species during successive years in Southeastern Brazil

Year	1951	1952	1953	⁵ 1954/5	1956	1957	⁵ 1963-1965	1966
Species	292	168	85	50	40	43	22	42
Accumulative Values	292	460	545	595	635	678	700	742

R i o d e J a n e i r o , e t c .

⁵In some cases two or three years have been combined to one observation period, to warrant equal weight of the periods (\pm equal number of excursions).

Table 10 - continued

Year	1962	1963	1964-1965	1966
Species	332	277	83	67
Accumulative Values	332	609	692	759

E a s t e r n S ã o P a u l o

All curves show, for three long-period observations, the same nearly rectilinear rise of the curves as that of the short-period observations of Poços de Caldas. The number of species is higher, owing to the greater number of observation days (more than 100), but the general form of the curves is the same. There is not the slightest sign of asymptotic approximation to a final value. The real number of species remains unknown although in two areas already values of +750 species have been reached. To conclude from the material found in other collections and by ourselves in other parts of the states of Rio de Janeiro and Sao Paulo, in both states the total number of species surely surpasses 1,000, perhaps reaching 1100 or 1200.

Table 9 shows the different behavior of different families; the frequent and easily noted groups such as Brassolidae, Danaidae, Heliconidae, Pyrrhopyginae, Papilionidae, do not contribute to the increase of number of species in the later years. This increase is due essentially to the "little species" as Hesperiiidae, Lycaenidae and Riodinidae which constitute $\frac{2}{3}$ of the total number of species (cf. Appendix I). Collectors who do not give special attention to these groups will never know their local fauna in the Neotropics. All our observations on frequency and distribution of species refer thus essentially to these three families.

The fact that at frequently visited localities species never seen before appear constantly, whereas others seem to disappear for a very long time, and the observations made on frequency above may be interpreted as follows:

(1) In the (eastern) Neotropics the populations of many species of butterflies, especially of the most numerous families Hesperiiidae, Lycaenidae and Riodinidae, are small (intensive frequency low).

(2) The different populations of such species are dispersed widely and with great distances between them (extensive frequency low).

(3) These populations do not maintain constant their localities of habitat but migrate continuously within a great area of favorable biotopes leaving their old habitats and creating new colonies which will be left after a short time too. Such behavior would explain the continuous appearing and disappearing of species. Perhaps it is typical for many Neotropical creatures, as it is well known also in birds and in the primitive men of the forest, the Amerindians.

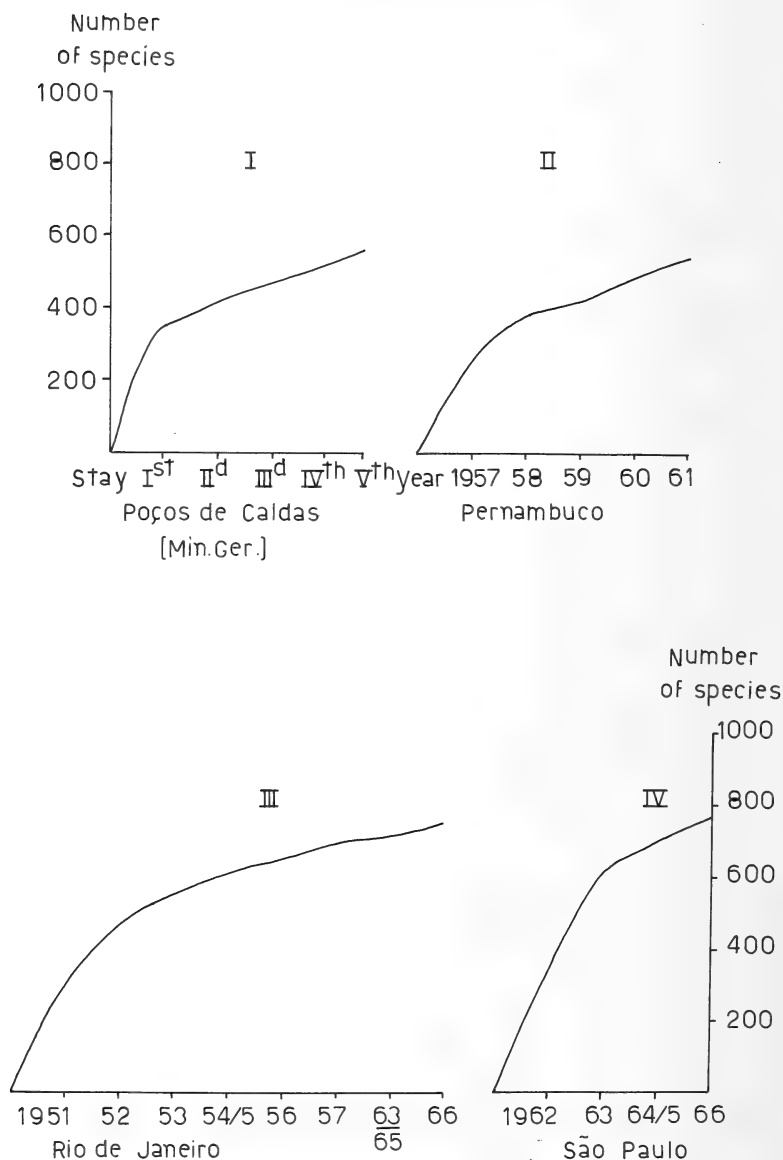


Fig. 6 The rise of the number of butterflies species with prolonged observation time, in four selected areas. Accumulative curves. No asymptotic approximation to a final value has appeared.

(c) Observations on annual frequency of species numbers

As the time-consuming statistical work used for this paper cannot be continued, in consequence of professional duties, some observations on annual variations may be added:

Tiúma (Pern.)	20.VII.58	26.VII.58	31.VII.58	3.VIII.58	9.VIII.58
	102	116	99	101	129
" "	27.VII.59	8.VII.60	14.VIII.60	8.VIII.61	4.X.58
	94	66	89	64	68
" "	18.X.58	26.IX.59	8.IX.60		
	89	65	80		
Camaragibe (Pern.)	7.IX.58	7.IX.59	24.IX.60	2.IX.61	
	93	104	83	87	

From the above values it may be concluded that in really tropical areas the frequency variation between different years is low. Thus the seasonal frequency curves for such areas shown above (Table 4 and Figure 2) may be reliable, even though having only a limited number of observation years.

Foot of the Organ Mountains (R. Jan)	21.I.59	29.I.59	24.II.67	
	68	90	88	
Litoral Norte (S.P.)	18.IX.62	1.IX.63	4.IX.63	5.IX.67
	59	86	76	74
Itatiaia South (R. Jan.)	6.II.58	26.II.59	17.II.60	19.II.60
	78	79	100	73
	24.II.64	26.II.64	1.III.64	
	73	69	56	

The humid regions of southern Brazil seem to possess the same low annual variation of frequency as do the tropical zones.

Itirapina - Brotas (S.P.)	21.IV.63	3.V.64	1.V.65	1.V.66	6.VI.66	21.V.67
	90	62	68	81	84	162
	13.VI.68					
	48					
Araras (S.P.)	17.IV.66	24.IV.66	8.V.66	15.V.66	19.VI.66	
	124	107	150	153	108	
	20.V.67	3.V.68				
	152	87				
Mirassol (S.P.)	13.V.67	25.IV.68				
	109	68				

Faz. S. Jose,	13.IV.63	23.V.63	5.V.64	28.III.65	16.V.65	19.V.66
Rio Claro (S.P.)	143	108	75	82	84	107

In the less humid areas of the interior, of nearly subtropical climate, the annual variation of frequency is great, as is the seasonal. The years 1963, 1966 and 1967 were good years; 1964 and 1965 average and 1968 a poor year. The extreme high values of daily frequency mentioned above will be reached only in exceptionally good years. Particularly striking is the difference between 1967 and 1968, notwithstanding the lack of clear climatological difference which could be observed between the rainy seasons of 1966-67 and 1967-68.

(d) Observations in the high Tropics

From high tropical regions only data for the daily frequency of nine days are available: 4.-9.XI. British Guiana (Parika, Atkinson Field), 12.XI. Belém (Utinga), 14-23.XI. Rio Ampari (Amapa; Serra do Navio and Porto Platon).

1959	4/XI	7/XI	8/XI	9/XI	12/XI	14/XI	19/XI	21/XI	23/XI
Species per day	71	69	57	81	86	51	62	60	66

The median value (69) is lower than that from eastern Brazil (77-78), and also the total number for the four days in Amapa (179) is lower than comparable values from Poços de Caldas, but as the observations are from one month only, the values may not be representative for the year.

The following table shows the percentage by which the different families are represented:

	British Guiana	Belém	Rio Ampari
Acraeidae	0	0	0
Brassolidae	3	0	1
Danaidae	1	0	1
Heliconiidae	9	2	6
Hesperiidae	41	22	14
Ithomiidae	0	5	7
Libytheidae	0	0	0
Lycaenidae	9	9	14
Morphidae	1	1	3
Nymphalidae	10	8	12
Papilionidae	1	2	1
Pieridae	3	2	4
Riodinidae	11	36	25
Satyridae	11	13	12

With respect to the relative frequency of families, the coastal zone of British Guianas shows the same predominance of the HesperIIDae as eastern Brazil, whereas at the borders of the Amazon the RiODINIDae are the most frequent family. Perhaps during another time of the year the proportions may be different.

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APPENDIX I

Extensive frequency of the different families of butterflies in three selected areas of Eastern Brazil (Values in parentheses refer to percentages).

(A) Eastern Pernambuco

Rank	Acraeidae	Brassolidae	Danaidae	Heliconidae
ii	2 (100)	1 (14)	0 -	0 -
i	0 -	3 (44)	2 (66)	2 (17)
id	0 -	2 (28)	0 -	1 (8)
d	0 -	1 (14)	0 -	4 (33)
dd	0 -	0 -	1 (34)	5 (42)
Total	2 (0.4)	7 (1.3)	3 (0.6)	12 (2.3)

(B) Rio de Janeiro and surroundings

ii	1 (20)	7 (37)	1 (25)	2 (13)
i	0 -	8 (42)	0 -	1 (7)
id	2 (40)	1 (5)	2 (50)	5 (33)
d	0 -	3 (16)	1 (25)	3 (20)
dd	2 (40)	0 -	0 -	4 (27)
Total	5 (0.7)	19 (2.6)	4 (0.5)	15 (2.0)

(C) Eastern São Paulo

ii	1 (13)	7 (37)	1 (20)	0 -
i	5 (62)	10 (53)	1 (20)	3 (21)
id	2 (25)	2 (10)	0 -	4 (29)
d	0 -	0 -	2 (40)	4 (29)
dd	0 -	0 -	1 (20)	3 (21)
Total	8 (1.1)	19 (2.5)	5 (0.7)	14 (1.8)

(A) Eastern Pernambuco

Rank	Hesperiinae	Hesperiidae		Urbaninae	Ithomiidae
		Pyrginae	Pyrrhopyginae		
ii	16 (21)	21 (34)	0 -	22 (41)	1 (7)
i	41 (54)	24 (39)	1 (50)	17 (31)	6 (40)
id	15 (20)	10 (16)	1 (50)	6 (11)	2 (13)
d	4 (5)	5 (8)	0 -	8 (15)	2 (13)
dd	0 -	2 (3)	0 -	1 (2)	4 (27)
Total	76 (14.3)	62 (11.6)	2 (0.4)	54 (10.)	15 (2.8)
		194 (36.3)			

(B) Rio de Janeiro and surroundings

Rank	Hesperiinae	Pyrginae	Hesperiidae		Urbaninae	Ithomiidae
			Pyrrhopyginae			
ii	52 (38)	33 (39)	3 (60)		21 (37)	6 (25)
i	48 (35)	19 (23)	2 (40)		21 (37)	11 (40)
id	24 (17)	15 (18)	0 -		7 (12)	3 (12)
d	13 (10)	13 (15)	0 -		7 (12)	4 (15)
dd	0 -	4 (5)	0 -		1 (2)	2 (8)
Total	137 (18.4)	84 (11.3)	5 (0.7)		57 (7.7)	26 (3.5)

283 (38.2)

(C) Eastern São Paulo

Rank	Hesperiinae	Pyrginae	Hesperiidae		Urbaninae	Ithomiidae
			Pyrrhopyginae			
ii	42 (36)	27 (31)	9 (64)		22 (41)	12 (38)
i	49 (42)	33 (37)	5 (36)		19 (35)	6 (19)
id	18 (16)	18 (20)	0 -		6 (11)	4 (12)
d	7 (6)	10 (11)	0 -		7 (13)	6 (19)
dd	0 -	1 (1)	0 -		0 -	4 (12)
Total	116 (15.3)	89 (11.6)	14 (1.8)		54 (7.1)	32 (4.2)

273 (35.8)

(A) Eastern Pernambuco

Rank	Libytheidae	Lycaenidae	Morphidae	Nymphalidae
ii	0 -	40 (39)	1 (33)	14 (22)
i	1 (100)	34 (34)	1 (33)	19 (29)
id	0 -	14 (14)	0 -	8 (12)
d	0 -	12 (12)	0 -	16 (25)
dd	0 -	1 (1)	1 (34)	8 (12)
Total	1 (0.2)	101 (19.0)	3 (0.6)	65 (12.2)

(B) Rio de Janeiro and surroundings

Rank	Libytheidae	Lycaenidae	Morphidae	Nymphalidae
ii	0 -	46 (38)	1 (17)	18 (20)
i	1 (100)	31 (26)	2 (32)	28 (31)
id	0 -	15 (12)	1 (17)	10 (11)
d	0 -	21 (18)	1 (17)	24 (27)
dd	0 -	7 (6)	1 (17)	10 (11)
Total	1 (0.1)	120 (16.1)	6 (0.8)	90 (12.)

(C) Eastern São Paulo

Rank	Libytheidae	Lycaenidae	Morphidae	Nymphalidae
ii	0 -	39 (43)	3 (43)	20 (19)
i	0 -	31 (34)	3 (43)	32 (30)
id	1 (100)	15 (16)	0 -	32 (30)
d	0 -	6 (7)	0 -	17 (16)
dd	0 -	0 -	1 (14)	4 (5)
Total	1 (0.1)	91 (12.0)	7 (0.9)	105 (13.9)

(A) Eastern Pernambuco

Rank	Papilionidae	Pieridae	Riodinidae	Satyridae	Total
ii	0 -	4 (15)	26 (34)	1 (4)	149(28)
i	0 -	8 (30)	33 (43)	6(26)	198(38)
id	0 -	7 (26)	9 (12)	3(13)	78(15)
d	3 (100)	3 (11)	8 (11)	6(26)	72(13)
dd	0 -	5 (18)	0 -	7(31)	35(6)
Total	3 (0.6)	27 (5.1)	76 (14.3)	23(4.3)	532

(B) Rio de Janeiro and surroundings

Rank	Papilionidae	Pieridae	Riodinidae	Satyridae	Total
ii	4 (21)	9 (24)	26 (34)	17 (44)	247 (33)
i	8 (43)	11 (29)	28 (35)	10 (26)	228 (31)
id	1 (5)	8 (21)	13 (17)	2 (5)	109 (15)
d	5 (26)	7 (18)	9 (12)	6 (15)	117 (16)
dd	1 (5)	3 (8)	2 (2)	4 (10)	41 (5)
Total	19 (2.8)	38 (5.1)	77 (10.4)	39 (5.3)	742

(C) Eastern São Paulo

Rank	Papilionidae	Pieridae	Riodinidae	Satyridae	Total
ii	5 (24)	4 (9)	39 (42)	10 (21)	241 (32)
i	6 (29)	21 (48)	40 (43)	22 (48)	286 (38)
id	3 (14)	8 (18)	8 (9)	10 (21)	131 (17)
d	7 (33)	9 (20)	6 (6)	2 (5)	83 (11)
dd	0 -	2 (5)	0 -	2 (5)	18 (2)
Total	21 (2.8)	44 (5.8)	93 (12.2)	46 (6.1)	759

DISCUSSION OF APPENDIX I

The detailed table of extensive frequency leads to the following conclusions:

(1) In eastern Brazil, the total number of species is higher in the south than in the north, notwithstanding the more tropical character of the latter. Apparently the fauna of the northern parts (Pernambuco, etc.) is impoverished, the direction of the immigration here being from the south (Bahia) to the north.

(2) Notwithstanding the different absolute values of the number of species, the relative frequency of the families is nearly the same in the three regions. Note for example the values for the Hesperidae (36.3 - 38.2 - 35.8%), Pieridae (5.1 - 5.1 - 5.8%), Nymphalidae (12.2 - 12.0 - 13.9%), etc. Remarkable are the low values for the Acraeidae, Brassolidae and Papilionidae in the northeast.

(3) The percentage of the different ranks in the three regions are very similar: 28-38-15-13-6 in the northeast, 33-31-15-16-5 at Rio, 32-38-17-11-2 in São Paulo. Apparently the number of observations is high enough, and our values can be considered representative. Nearly all families show the typical predominance of the lower ranks, but there are some exceptions: in the Papilionidae the ranks are nearly equally distributed, and in the Heliconiidae frequent species prevail.

NOTE I: It must be kept in mind that the values of the Table refer to determined species only; the real numbers of species of Hesperinae and Lycaenidae, and in a lesser degree those of Riodinidae and Satyridae, are much higher as a great percentage of these groups could not be determined, hitherto (some of them will prove to be new).

NOTE II: The subdivision of the Rhopalocera into Families and Subfamilies, and the generic and specific names used here and in Appendix II are not in all cases in accordance with the use of other authors (d'Almeida, Clench, Emsley, Forbes, Fox, etc.). These modifications are based on taxonomic studies which are beyond the limits of problems discussed in this paper. Some remarks are made in Appendix II. To avoid phylogenetical speculations, alphabetical order has been chosen for the sequence of names.

APPENDIX II

List of the 572 species of butterflies found during 37 collecting days between December and May near Poços de Caldas (State of Minas Gerais; 1000 to 1500 m)

We add a list of all species found at this locality as a contribution to the knowledge of the fauna of the transitional zone between the central highlands (Brown & Mielke, 1967, 1968) and the coastal zone of median Brazil.

Collecting places

- R Remnants of high (primary) forest ("Mata") by the riverside of the Rio Pardo (1000 m).
- F Low (primary?) forest of the mountains at the north of the town ("Caixa d'Água," 1300 m; highway to Botelhos, 1400 m).
- C Low (secondary) forest ("Capoeira") near Cascata (1300 m) and above the gorge of the Rio das Antas (1200 m).
- O Open grassland ("Campo") at the south of the town (1300 m) and above the mountain-forest ("Serra de Poços"; 1450 to 1500 m).

1, 2 12: Months of observation

rr, r, rf, f, ff: Frequency, as discussed in the text.

Some observations made during shorter stays (August, October, November) have been included.

Acraeidae (7 sp.)

- Actinote alalia (Felder, 1860) F, C, - 4, 12 - rr, r
- pyrrha (Fabricius, 1775) (=brasiliensis Almeida, 1922)
R, F, C, - 4, 5, 12 - r-ff
- carycina Jordan, 1913 R, F, C, - 3, 5, 12 - rr-f
- conspicua Jordan, 1913 F - 12 r-f
- melanisans Oberthür, 1917 (=rhodope Almeida, 1922)
R, F, C, - 2-5, 11-12 - rr-f
- parapheles Jordan, 1913 F - 12 - rr
- surima (Schaus, 1902) F, C, - 1, 5, 12 - rr, r

Brassolidae (7 spp.)

- Blepolenis batea batea (Hübner, 1821) F, C, - 2, 3, - rr-rf
- Caligo arisbe Hübner, 1822 F, C, - 1-4 - rr-r
- illioneus illioneus (Cramer, 1775) R - 4 - rr
- Dasyophthalma rusina (Godart, 1821) F - 1-3, 5 - rr
- Eryphanis reevesi (Doubleday & Hewitson, 1849) F - 12 - rr-r
- Opoptera aorsa (Godart, 1821) F - 3, 12 - rr-r
- syme (Hübner, 1821) F, C - 1-3, 5 - rr-r

Danaiidae (4 spp.)

- Anosia gilippus gilippus (Cramer, 1775) R,F,C,O - 2-5, 10-12 - rr-r
 Danaus plexippus erippus (Cramer, 1775) F,C - 1-3,5,10 - rr-rf
 Ituna ilione (Cramer, 1775) F,C, - 1,2,5,11 - rr,r
 Lycorea ceres halia (Hübner, 1825) F - 2,3 - rr

Heliconiidae (9 spp.)

Dryadinae

- Agraulis vanillae maculosa (Stichel, 1907) F,C, - 1-5,8,10,12 - rr-rf
 Dione moneta moneta Hübner, 1825 R,F,C, - 5 - r,rf
 Dryadula phaetusa (Linné, 1758) F,C - 2-5 - rr,r
 Dryas julia julia (Fabricius, 1775) R,F,C, - 1-5 - rr-rf
 Philaethria wernickei (Röber, 1906) F - 2,3,5 - rr,r

Heliconiinae (4 spp.)

- Heliconius besckei Ménétriés, 1857 R,C,F - 1-5,11,12 - rr-rf
 ethilla Latr. narcaea Latreille, 1820 R,F,C - 1-5,8,11,12 - rr-rf
 erato phyllis (Fabricius, 1793) R,F,C,O - 1-5,8,11,12 rr-f
 Eueides aliphera aliphera (Latreille, 1820) F,R,C,O - 1,2,4,5 - rr-rf

Hesperiidae (223 spp.)

Hesperiinae (113 spp.)

- Anthoptus epictetus (Fabricius, 1793) R,F,C, - 1-5,11,12 - rr,r
 Artines aquilina (Plötz, 1883) F - 2 rr
 Callimormus beda (Plötz, 1886) R,F,C, - 2-5,12 - rr
 interpunctatus (Plötz, 1884) R,F, - 2-5,12 - rr,r
 saturnus (Herrich-Schaeffer, 1864) C - 5 - r
 Cantha honor Evans, 1955 F,O - 1-3,11 - rr
 Conga urqua (Schaus, 1902) F - 12 - rr
 Copaeodes jean favor Evans, 1955 F,C,O - 2-5,12 - rr,r
 Corticea noctis (Plötz, 1888) F - 1,3 - rr
 Cumbre cumbre (Schaus, 1902) R,F,C, - 1-5,12 - rr-rf
 Cymaenes alumna (Butler, 1877) R,C, - 5,12 - r
 tripuncta theogenis (Capronnier, 1874) O - 2 - rr
 tripunctata (Latreille, 1824) R,F,C,O - 1-5, 10-12- rr-f
 Cynea corope (Herrich-Schaeffer, 1869) F - 2 - rr
 Dion meda (Hewitson, 1877) F - 1,2 - rr,r
 Enosis misera (Schaus, 1902) F - 12 - rr,r
 Euphyes dera (Herrich-Schaeffer, 1869) F,C - 1-3 - rr-rf
 Eutyche phycella (Hewitson, 1866) F - 4,5 - rr,r
 Evansiella cordela (Plötz, 1882) F - 12 - rr
 Hylephyla phylaeus (Drury, 1770) F,C, - 2,5 - rr,r
 Lamponia elegantula (Herrich-Schaeffer, 1869) F,O - 1,2 - rr
 lamponia (Hewitson, 1876) F,O - 2,5 - rr,r

- Lerodea eufala eufala* (Edwards, 1869) F,C,O - 2,3,5,8 - rr-rf
Levina levina (Plötz, 1884) F,O - 1-3,12 - rr-rf
Libra anatolica (Plötz, 1883) F,O - 1,2 - r-f
Lucida lucia (Capronnier, 1874) R,F,C,O - 1,2,4,5,11,12 - rr,r
 ranes (Schaus, 1902) R,F,C,O - 1-4,12 - rr,r
Lycas argentea (Hewitson, 1866) F - 2 - rr
Lychnuchoides ozias ozias (Hewitson, 1878) F,C, - 2,4,5,12 - rr
Lychnuchus celsus (Fabricius, 1793) R,F, - 2,5,11,12 - rr-rf
Mellana monica (Plötz, 1886) F - 2 - rr
Metron chrysogastra (Btl.) (ssp. n.?) F,C,O - 2 - rr,r
 schrötkyi (Giac.) (ssp. *tomba* Evans, 1955?) F,O - 2 - rr
Miltomiges cinnamomea (Herrich-Schaeffer, 1869) R,F - 1-5,11,12 - rr,r

Moeris remus (Fabricius, 1798) F - 1-3 - rr
 striga striga (Geyer, 1832) R,F,C, - 5,12 - rr
Naevolus orius orius (Mabille, 1883) R - 5 - r
Nastra insignis (Plötz, 1882) R,F, - 1-3,5,12 - r,r,f
 lurida (Herrich-Schaeffer, 1869) F,C,O - 2,5,11,12 - rr,r
Niconiades caeso (Mabille, 1891) F,C, - 2,5 - rr
 merenda (Mabille, 1878) F,C, - 2,5,8,12 - rr
Nyctelius nyctelius (Latreille, 1824) R,F,C, - 2-5,12 - rr
Orses itea (Swainson, 1831) F - 2,4,5,12 - rr,r
Panoquina sylvicola (Herrich-Schaeffer, 1865) F,C, - 2,5 - rr,r
Paracarystus evansi Hayward, 1938 C - 4 - rr
Perichares philetes aurina Evans, 1955 R,F,C - 4,5 - rr,r
Phanes aletes (Geyer, 1832) C - 4,12 - rr
Pheraeus argynnis (Plötz, 1883) F - 2 - rr
Polites vibex catilina (Plötz, 1886) R,F,C, - 3-5,10,11 - rr-rf
Pompeius pompeius (Latreille, 1824) F,C, - 2,3,5 - rr,r
Psoralis stacara (Schaus, 1902) R,F,C - 1,2,4,5,10-12 - rr-f
Pyrrhopygopsis socrates socrates (Ménétriés, 1855) F - 11 - rr
Quinta cannae (Herrich-Schaeffer, 1869) F - 3 - rr
Sabina sabina (Plötz, 1883) F - 5,12 - rr
Saliana longirostris (Sepp, 1848) F - 5 - rr
Thespieus abatira Zikan, 1938 F,O - 1-3 - rr-f
 ethemides (Burmeister, 1878) F,C,O - 1,2,8 - rr,r
 himella (Hewitson, 1868) F,C - 1,2 - rr
 vividus (Mabille, 1891) F - 2-4 - rr
 xarippe xarippe (Butler, 1878) F - 1,12 - rr,r
Thoon circellatum (Plötz, 1882) F,C - 1,2,5 - rr,r
Vehilius clavicula (Plötz, 1884) R,P,C - 1,2,4,5,11,12 - rr,r
 inca (Scudder, 1872) (?) F - 2 - rr
 stictomenes (Butler, 1877) R,F,C - 1,3-5,12 - rr-rf
Vertica pudor Evans, 1955 F - 5 - rr
Vettius artona (Hewitson, 1868) F - 12 - rr
 diversus diversus (Herrich-Schaeffer, 1869) R,F,C, - 3-5,8,11,12 - rr,r
 marcus marcus (Fabricius, 1787) F,C - 2,3 - rr-rf
Vidius vidius (Mabille, 1891) F - 12 - rr
Vinius letis (Plötz, 1883) R,F,C - 1-5,11,12 - rr,r
Virga austrinus (Hayward, 1934) R,F,C - 1-5,11,12 - rr-rf
Xeniades chalestra corna Evans, 1955 F,C - 2,3 - rr
 victoria Evans, 1955 F,C,O - 1,2 - rr,r

- Zariaspes mys (Hübner, 1808) F,C, - 2,3 - rr
 Zenis jebus jebus (Plötz, 1882) F - 2 - rr
 minos (Latreille, 1824) F - 2 - rr
 37 Gen. et sp. ign.

Pyrginae ("Pyrginae, Section B"; 62 spp.)

- Achlyodes mithridates peruvianus Mabilille & Bouillet, 1917 (thraso
 (Jung 1792) is a homonym) F,C,O - 1,2,4,5,12 - rr,r
 busiris rioja Evans, 1953 R,F,C - 2,3,5,10 - rr,r
 Anisochoria pedaliodes extincta Hayward, 1933 F,C, - 3 - rr,r
 sublimbata Mabilille, 1883 F,C,O - 2-5,11,12 - rr
 superior Mabilille, 1897 F - 3 - rr
 Antigonus liborius (Plötz, 1884) (ssp. areta Evans, 1953?) F,C -
 1,2 - r
 Bolla atahuallpai (Lindsey, 1925) C - 2 - rr
 catharina Bell, 1937 R,F,C,O - 3-5,11,12 - rr,r
 Charidiaempolaeus (Westwood, 1852) F - 5,11 - rr
 Chiomara asychis (Stoll) autander (Mabilille, 1891) F - 3 - rr
 crenda Evans, 1953 F - 12 - r
 punctum (Mabilille, 1878) O - 2,5,12 - r
 Cogia calchas (Herrich-Schaeffer, 1869) C,O - 2,3,12 - rr,r
 hassan evansi Bell, 1937 F - 5,12 - rr
 Cycloglypha thrasibulus thrasibulus (Fabricius, 1793) F - 3 - rr
 Diaeus lacaena lacaena (Hewitson, 1871) F,C - 1-4,12 - rr,r
 Ebrietas anacreon (Staudinger, 1876) R,F,C - 2,5 - rr
 Gesta gesta (Herrich-Schaeffer, 1863) F,C,O - 1-3,5 - rr,r
 heteroptera (Plötz, 1884) F,O - 2,3 - rr
 Gindanes brebissoni (Latreille, 1822) F,O - 1,2,12 - rr
 Gorgopas petale (Mabilille, 1888) F,C - 2,5,8,12 - rr
 Gorgythion begga (Prittwitz, 1868) R,F,C - 1-5,12 - rr-rf
 beggina beggina Mabilille, 1897 F,O - 1-3,5 - rr
 escalophoides Hayward, 1941 R - 2 - rr
 Helias phalaenoides palpalis (Latreille, 1824) R,F,C - 2-5,12 -
 rr,r
 Heliopetes alana (Reakirt, 1868) F,C - 1-3,5,11 - rr,r
 arsalte (Linné, 1758) F,O-2,3,12 - r
 laviana (Hew.) libra Evans, 1944 F - 3 - rr
 omrina (Butler, 1870) R,F,C - 2-5,12 - rr-rf
 domicella willi (Plötz, 1884) F - 4 - rr
 Marelata thamyroides (Felder, 1867) R - 5 - rr
 Milanion leucaspis (Mabilille, 1878) F,C - 1,2,4,5 - rr
 Mylon menippus (Fabricius, 1776) R,F, - 2,5 - rr,r
 Nisoniades bipuncta (Schaus, 1902) R,F,O - 5 - rr
 macarius (Herrich-Schaeffer, 1870) F,C - 3,5 - rr
 bessus maura Mabilille & Bouillet, 1916 F - 12 - rr
 Noctuana diurna (Butler, 1870) F - 5,12 - rr
 Oechydrys chersis (H.-S.) evelinda (Butler, 1876) F,C - 2,11 -
 rr,r
 rufus Evans, 1953 F,C - 2,11,12 - rr
 Pachyneuria inops (Mabilille, 1877) F - 11 - rr
 Pellicia dimidiata zama Plötz, 1882 O - 2 - rr
 Polycctor polycctor (Prittwitz, 1868) R - 4 - rr

- neis (Geyer, 1832) R,F, - 3,5,11 - rr
 reflexum (Mabille & Boulet, 1912) F - 3 - rr
 zarex (Hübner, 1832) F,C, - 2,3,5,11 - r,rf
 Celaenorrhinus punctiger (Burmeister, 1878) F - 3-5,12 - rr-rf
 similis Hayward, 1933 R,F,C - 3,4 - rr
 Chioides catillus catillus (Cramer, 1779) F,C,O - 2,3,5 - rr,r
 Epargyreus exadeus exadeus (Cramer, 1779) F - 4 - rr
 socus socus Hübner, 1825 F,O - 1,2,12 - rr
 Phanes vitreus (Stoll, 1781) C - 2 rr
 Phocides maxima Mabille, 1888 C - 2 - rr
 pialia parva Röber, 1925 F - 3 - rr
 polybius phanias (Burmeister, 1880) F - 2,3,12 - rr
 Polygonus leo (Gmelin, 1790) F - 2 - rr
 manueli Bell & Comstock, 1948 F,C,O - 2 - rr,r
 Polythrix canus (Herrich-Schaeffer, 1869) C - 5 - rr
 Ridens fulima Evans, 1952 F,C,O - 5 - rr
 Typhedanus undulatus (Hewitson, 1867) F - 3 - rr
 Urbanus doryssus albicuspis (Herrich-Schaeffer, 1869) F - 3 - rr
 viterboana alva Evans, 1952 F,C - 4,5 - rr
 dorantes (Stoll, 1790) R,F,C - 2-5,11,12 - rr,r
 esta Evans, 1952 R,F,C - 2,3,5 - rr-rf
 evenus (Ménétriés, 1855) F,O - 2,3,12 - r,rf
 evona Evans, 1952 (?) R - 5 - r
 procne (Plötz, 1881) C,O - 2,3,5 - rr-rf
 proteus (Linne, 1758) F,C - 2-5,12 - rr
 pronta Evans, 1952 (?) C - 4 - rr
 simplicius (Stoll, 1790) R,F,C - 2,3,5,12 - rr-rf
 teleus (Hübner, 1821) R,F,C - 2,4,5,12 - rr,r

Ithomiidae (21 spp.)

- Aeria olena Weymer, 1875 R,F,C - 1-5,12 - rr-f
 Dircenna dero (Hübner, 1823) R,F,C - 1,2,4,5,12 - rr-rf
 Episcada carcinia Schaus, 1902 R,F,C - 2-5,12 - rr-rf
 pascua Schaus, 1902 F,C - 2,5 - rr-rf
 Epityches eupompe (Geyer, 1832) F,C - 1-5,11,12 - rr,r
 Hypoleria emyra (Haensch, 1906) R,F - 2,5 - rr
 oreas Weymer, 1898 F - 1,2 - rr,r
 salonina (Hewitson, 1855) R - 2,4,12 - r
 Hypothyris daeta daeta (Boisduval, 1836) R,F - 5,11,12 - rr,r
 Ithomia agnosia zikani Almeida, 1940 R - 2,4 - rr,r
 Mechanitis polymnia casabranca Haensch, 1906 R,F,C - 1-5,12 - rr-ff
 lysinnia lysinnia (Fabricius, 1793) R,F,C,O - 1-5 - rr-f
 Methona themisto (Hübner, 1818) R,F,O - 1,2,5,12 - rr,r
 Placidula euryanassa (Felder, 1860) R,F,C - 2,4,5,12 - rr-rf
 Prittwitzia hymenaea (Prittwitz, 1865) I-5,11,12 - rr-rf
 Pseudoscada adasa (Hewitson, 1854) R,F - 2,4,5,12 - rr-rf
 erruca (Hewitson, 1855) R,F - 2,3,5,11,12 - rr-rf
 Pteronymia carlia Schaus, 1902 - R,F,C - 3-5 - rr,r
 Thyridia hippodamia (Fabricius, 1775) F,O - 1,2 - rr
 psidii pytho (Felder, 1860) F,O - 1,2,3,5 - rr,r
 Tithorea harmonia pseudethra Butler, 1873 F - 2 - rr

Libytheidae (1 sp.)

Libytheana carinenta (Cramer, 1777) C - 3 - rr

Lycaenidae (87 spp.)

Plebejinae - (Catochrysopinae - Glaucopsychinae)

Hemiargus hanno (Stoll, 1790) R,F,C,O - 2-5 - rr,r

Leptotes cassius cassius (Cramer, 1775) R,F,C - 2,3,5,10,11 - rr
(Gen. ign.) cogina (Schaus, 1902) R,F,O - 2,4,5 - rr

Theclinae ("Thecla" without respect of subgenera)

acaste Prittwitz, 1865 R,C,O - 2,3,5 - rr,r

agricolor Butler & Druce, 1872 ssp.n. F - 4,5 - rr,r

aphaca Hewitson, 1867 C - 2 - rr

badeta Hewitson, 1873 C,O - 2 - rr

bazochii (Godart, 1824) (=thius Hb.; ♀=cydia Hew.) F,C - 2-4,11 -

beon (Stoll, 1780) R,F,C - 2,3,12 - rr,r rr,r

bertha Jones, 1912 F - 3 - rr

bolima Schaus, 1902 O - 12 - rr

bubastus (Stoll, 1780) F - 3 - rr

campa Jones, 1912 F - 2 - rr

cardus Hewitson, 1874 C - 2 - rr

castrena Jones, 1912 O - 3 - rr

celestata Hewitson, 1874 F,C - 2,5 - rr

celmus (Cramer, 1776) R - 12 - rr,r

hebraea cimelium Gosse, 1880 F - 3-5 - rr,r

conchylimum Druce, 1907 F - 3 - rr

cosa Hewitson, 1867 F - 5,12 - rr

crambusa Hewitson, 1874 R - 12 - rr

crolus (Stoll, 1782) F - 2,12 - rr

davara Hewitson, 1868 F,C - 2,11 - rr,r

deniva Hewitson, 1874 F - 1-3,10 - rr

dindymus (Cramer, 1775) R - 12 - rr

ducalis Doubleday & Hewitson, 1852 C - 2 - rr

elika Hewitson, 1867 R - 4 - rr

ellida Hewitson, 1867 R,F, - 1-3,12 - rr

eurytulus (Hübner, 1819) F,C - 2,12 - rr

faunalia Hewitson, 1874 F,C - 2,4,5,11,12 - rr

geba Hewitson, 1877 F - 5 - rr

guacanagari Wallengren, 1860 (=azia Hewitson, 1873) F - 2,10,12 - rr,r

hemon (Cramer, 1775) R - 4,5-r

hirsuta Prittwitz, 1865 (=casmilla Hewitson, 1874) F - 3 - rr

hygela Hewitson, 1868 R,F - 5,12 - rr,r

inna Prittwitz, 1865 (=orcynia Hewitson, 1869 =annia Hewitson, 1874) R,F,C - 3-5 - rr,r

janthina Hewitson, 1867 R,F - 12 - r

latreillei Hewitson, 1865 F - 5 - rr

lisus (Stoll, 1790) C - 2 - rr

malina Hewitson, 1867 F,C - 2,4,5 - rr,r

- marsyas (Linné, 1758) F,C - 3,4 - r
 melibaeus (Fabricius, 1793) R,F,C,O - 1-5,8,11,12 - rr-rf
 mulucha Hewitson, 1867 F - 3,12 - rr
 (nubilum Druce, 1907) F,O - 8 - rf not counted)
 opisena Druce, 1912 F - 5 - rr
 oreala Hewitson, 1868 O - 2,12 - rr,r
 palegon (Stoll, 1780) R,F - 3,5 - rr
 (phrosine Druce, 1909 O - 8 - r not counted)
 phrutus (Geyer, 1832) R - 5 - rr
 phydela Hewitson, 1867 R,F,C - 1,2,4,5,12 - rr,r
 puppius pisidula Druce, 1907 R - 12 - rr
 polibetes (Stoll, 1782) F,C - 2-4 - rr
 pseudolongula Clench, 1944(?) R,F,C - 1-3,5,12 - rr,r
 sangala Hewitson, 1869 F,C,O - 1-3,5 - rr-rf
 schausa Jones, 1912 O - 4,12 - rr
 silumena Hewitson, 1867 F,C - 2,5 - rr
 sophocles (Fabricius, 1793) R,F,C - 3-5,8,12 - rr,r
 strophius (Godart, 1824) (=panchaea Hewitson, 1869) R,F,C - 3-5,
 12 - rr
 tadita Hewitson, 1877 F,C,O - 1-5 - rr
 tarania Hewitson, 1868 F - 3,5 - rr,r
 tegaea Hewitson, 1868 O - 2-5,12 - rr-rf
 tephraeus (Geyer, 1837) R - 12 - rr
 thordesa Hewitson, 1867 R,F - 5,12 - rr
 thrasyllus (Geyer, 1837) (thales Fabr. 1793 is a homonym) R,F -
 5,12 - rr
 thyrea Hewitson, 1867 F - 5 - rr
 triquetra Hewitson, 1865 F,C,O - 2-5,12 - rr
 umbrata (Geyer, 1837) F,C - 5 - rr
 xeneta Hewitson, 1877 R - 5 - rr
 yojoa Reakirt, 1866 F,R,C - 2,5 - rr
 20 sp. awaiting determination

Morphidae (5 spp.)

- Morpho aega (Hübner, 1822) R,F,C - 4,5,12 - rr,r
 anaxibia (Esper, 1798) R,F - 2,3 - rr,r
 epistrophus (Fabricius, 1796) (laertes (Drury, 1782) is
 homonym) ssp.n. F,C - 1-3 - rr-rf
 achilles (Linné, 1758) paulista Fruhstorfer, 1907
 R,C - 2,5 - rr,r
 portis portis (Hübner, 1821) F - 1-3,12 - rr-f

Nymphalidae (76 spp.)

Apaturinae

- Doxocopa kallina (Staudinger, 1886) F - 5 - rr
 selina (Bates, 1865) C - 5 - rr
 seraphina (Hübner, 1825) R,F,C - 1-5,12 - rr-rf
 zunilda (Godart, 1821) F - 1,5 - rr

Argynninae

Euptoieta hegesia (Cramer, 1779) F - 3 - rr

Biblinae

Biblis hyperia (Cramer, 1779) R,F,C,O - 2-5 - rr,r

Mestra apicalis (Staudinger, 1886) F - 5 - r

Callicorinae

Callicore sorana (Godart, 1824) R,F,C - 3,5 - rr

Diaethria candrena (Godart, 1824) R,F,C - 2-5,11,12 - rr-rf
clymena (Cramer, 1775) R,F - 5 - rr

eluina (Hewitson, 1854) R,F,C - 2,4,5 - rr-rf

Paulogramma pyracmon (Godart, 1824) R - 5 - rr

Catonephelinae

Catonephele sabrina (Hewitson, 1852) F,C - 1,4,5,12 - rr,r

Cybdelis phaesula (Hübner, 1827-1831) R,F,C - 1,2,4,5 - rr-rf

Epiphile hübnéri (Hewitson, 1861) R,C - 4,5 - rr,r

orea (Hübner, 1823) R,F,C - 1,2,4,5,12 - rr,r

Myscelia orsis (Drury, 1782) R,F - 2,4,5 - rr,r

Temenis laothoe meridionalis Ebert, 1965 R - 5 - rr

Charaxinae

Hypna clytemnestra hübnéri (Butler, 1866) F - 5 - rr

Memphis arachne victoria (Druce, 1877)

R - 5 - rr

appias (Hübner, 1825) R,F,C - 1-5 - rr,r

otrere (Hübner, 1825) R,F,C - 1-5,11,12 - rr,r

ryphaea phidile (Geyer, 1837) R,C - 4,5 - rr,r

morvus sthenos (Prittwitz, 1865) R,F - 1,4 - rr

Prepona chalciope (Hübner, 1823) F - 1,2,11 - rr

Zaretas itys strigosa (Gmelin, 1791) F - 3,5,12 - rr

Coloburinae

Historis odius orion (Fabricius, 1775) R,F - 3,5 - rr

Smyrna blomfieldia (Fabricius, 1781) F,C - 2,3 - rr

Eunicinae

Eunica tatila bellaria (Fruhstorfer, 1908) F,C - 2,3,12 - rr

eburnea (Fruhstorfer, 1899) R,F,C - 4,5,12 - rr,r

maja (Fabricius, 1775) C - 2 - rr,r

margarita (Godart, 1824) R,C - 2-5,12 - rr,r

Hamadryadinae

- Ectima lirissa lirissa (Godart, 1824) (liria Fabr. 1793 is a homonym) R,F,O - 1-5,12 - rr
 Hamadryas amphinome (Linné, 1767) R,F,C - 3-5,12 - rr,r
 arete (Doubleday & Hewitson, 1847) F - 2,5 - rr
 epinome (Felder, 1867) F,R,C - 1-5,12 - rr
 februa (Hübner, 1823) R - 3,5 - rr,r
 feronia (Linné, 1758) (the "subsp." of Fruhstorfer are synonyms) F - 3 - rr
 fornax (Hübner, 1823) R,F,O - 1,2,5,12 - rr

Limenitinae

- Adelpha abia (Hewitson, 1850) F - 3,5,12 - rr
 calliphane Fruhstorfer, 1915 R,F,C - 1,2,4,5 - rr,r
 falcipennis Fruhstorfer, 1915 R,F - 1-5,12 - rr,r
 gavina Fruhstorfer, 1915 R,F - 4,5,11,12 - rr-rf
 hyas (Boisduval, 1836) R,F,C - 3,5 - rr,r
 ampla Hayw. mincia Hall, 1938 F,C - 1-5,12 - rr,r
 mythra (Godart, 1824) R,F,C - 1,2,4,5,11,12 - rr-rf
 poltius Hall, 1938 R,F,C - 1-5,12 - rr,r
 isis pseudagrias Fruhstorfer, 1908 R,F - 1,3,4,5 - rr
 serpa (Boisduval, 1836) F - 2,3,5,12 - rr
 syma (Godart, 1824) R,F,C - 1-5,11,12 - rr-rf
 zea (Hewitson, 1850) F - 5 - rr,r
 Dynamine agacles (Dalman, 1823) R,C - 3-5,12 - rr,r
 artemisia (Fabricius, 1793) R - 5 - rr
 tithia (Hübner, 1823) R,C - 2-5,11 - rr,r
 meridionalis Röber, 1915 F - 5 - rr
 myrrhina (Doubleday, 1849) F - 5 - rr

Marpesiinae

- Marpesia chiron (Fabricius, 1775) F - 3 - rr
 petreus (Cramer, 1776) F - 3 - rr

Melitaeinae

- Chlosyne lacinia saundersi (Doubleday & Hewitson, 1847) R,C - 4,5 - rr,f
 Eresia lansdorffi (Latreille, 1820) R,F,C - 3-5,12 - rr-rf
 Phyciodes claudina (Eschscholtz, 1821) R,F,C,O - 1-5,8,11,12 - rr-f
 drusilla (Felder, 1861) ssp.n. R,F,C - 2-5,11,12 - rr-f
 orthia evanescens Röber, 1913 F,C - 1-5,11,12 - rr-rf
 hermas (Hewitson, 1864) C - 12 - rr
 ithra Kirby 1910 R,F,C,O - 1-5,11,12 - rr-rf
 teletusa teletusa (Godart, 1824) R,F,C - 1-5,8,11,12 - rr-rf

Nymphalinae

- Anartia jatrophae* (Johansson, 1763) F,R,C - 3-5 - rr-rf
amathea roeselia (Eschscholtz, 1821) R,F,C - 1-5,12 - rr-rf
Hypanartia bella (Fabricius, 1793) F,C,O - 1-5 - rr
lethe (Fabricius, 1793) R,F,C - 1-5 - rr-rf
Junonia evarete (Cramer, 1779) R,F,C,O - 1-5,8,11,12 - rr,r
Metamorphia stelenes (Linné, 1758) R,C - 5 - rr
Siproeta trayja (Hübner, 1823) F,C,O - 1-5 - rr,r
Vanessa virginiensis braziliensis (Moore, 1883) R,F,C,O - 1-5,12 - rr,r
myrinna (Doubleday, 1849) R,O - 2,4,5,12 - rr

Papilionidae (16 spp.)

- Battus polydamas polydamas* (Linné, 1758) R,F,C - 1-4,12 - rr,r
polystictes janira (Rothschild & Jordan, 1906) F,C - 1,2,5,12 - rr,r
Eurytides dolicaon deicoon (Felder, 1864) F,O - 1-3 - rr
lysithous lysithous (Hübner, 1821) F,C - 1-4,11,12 - rr-rf
Papilio astyalus astyalus Latreille, 1819 F - 3,12 - rr
thoas brasiliensis Rothschild & Jordan, 1906 F,C - 1,3,4,12 - rr,r
anchisiades capys (Hübner, 1809) F,O - 1-3,5,11,12 - rr,r
scamander grayi Boisduval, 1836 F,C,O - 2-5,10,12 - rr,r
hectorides Esper, 1794 R,F,C,O - 1-3,5,11,12 - rr,r
torquatus polybius Swainson, 1823 C - 2 - rf
Parides agavus (Drury, 1782) R,F,C - 3-5 - rr,r
bunichus bunichus (Hübner, 1821) R,F,C - 1-5,10-12 - rr-rf
nephalion (Latreille, 1819) F,R - 1-3,5,12 - rr-rf
proneus (Hübner, 1827-1831) R,F,C,O - 11,12 - rr,f
Protesilaus bellorophon (Dalman, 1823) F,C - 11,12 - rr,r
sp.ign. (helias) (Rothsch. & Jord. 1906?) F - 3,12 - rr

Pieridae (35 spp.)

Coliadinae

- Anteos clorinde* (Godart, 1824) F,C - 1,3 - rr
menippe (Hübner, 1816) F,C - 2,5 - rr
Aphrissa statira (Cramer, 1777) F - 2,11 - r
Eurema albula (Cramer, 1775) R,F,C,O - 1,2,4,5,12 rr-rf
deva deva (Doubleday, 1847) F,C - 2,5,12 - rr,r
elatheia (Cramer, 1777) R,F,C,O - 1-5 - rr-f
"jucunda" (sensu d'Almeida, 1936, nec Boisd. & Lec. 1833)
lemnia (Felder, 1865) R,F,C - 3-5 - r,r,f
musa (Fabricius, 1793) R,C,O - 3-5 - r-f(=gen.hib.of phiale)
agave pallida (Chavannes, 1849) F,C - 3,5,7,8,12 rr,r
phiale (Cramer, 1775) F,C,O - 2,4,12 - rr-rf
Leucidia elvina (Latreille, 1819) F - 1,2 - rr-r
exigua Prittwitz, 1865 F,C - 2,5 - rr-f
pygmaea Prittwitz, 1865 F - 1,2,5 - r

- Phoebis argante argante* (Fabricius, 1775) F - 5 r
 neocypris (Hübner, 1823) F,R,C - 2,4,5,11,12 - rr-rf
 philea philea (Johansson, 1763) F,C - 3-5,11,12 - rr,r
 sennae sennae (Linné, 1758) R,F,C - 3,5,12 - rr,r
Pyrisitia dina leuce (Boisduval, 1836) F - 3 - rr
 nise tenella (Boisduval, 1836) R,F,C,O - 2-5,8,11,12 - rr-rf
Rhabdodryas trite (Linné, 1758) F - 5 - r
Sphaenogona arbela arbela (Geyer, 1826) R,F,C - 2,5,8 - rr,r

Dismorphinae

- Dismorphia astyocha* Hübner, 1827-1831 R,F,C - 1,2,5 - rr,r
 melite (Linné, 1765) R,F,C,O - 2,4,5 - rr,r
 thermesia (Latreille, 1819) F - 2,5 - rr,r
Pseudopieris nehemia (Boisduval, 1836) R,F,C,O - 1-5,8,11,12 - rr-rf

Euchloinae

- Hesperocharis anguitia* (Latreille, 1819) F - 1,2,5 - rr,r

Pierinae

- Archonias tereas* (Latreille, 1819) F,C - 2-5,10-12 - rr-ff
Ascia monuste orseis (Latreille, 1819) R,F,C - 1-5 - rr-rf
Catasticta bithys (Hübner, 1827-1831) R,F,C,O - 1,2,4,5,10-12 - rr-ff
Charonias theano (Boisduval, 1836) R - 5 - rr
Glutophrissa drusilla (Cramer, 1777) F,C - 1,2,11 - rr,r
Melete lycimnia pantoporia (Geyer, 1832) R,F,C - 2,4,5,11,12 - rr-rf
Pereute antodyca (Boisduval, 1836) F - 1-5,11,12 - rr-rf
 swainsoni (Gray, 1832) F,C - 1,2,4,5,11,12 - rr-rf

Riodinidae

Euselasiinae

- Euselasia euploea* (Hewitson, 1854) R - 5 - rr
 eusepus (Hewitson, 1852) F - 5 - rr
 mys lara Stichel, 1919 R,F,C - 2,5,10,12 - rr
 hygenius occulta Stichel, 1925 R - 4,5 - rr
 zara (Hewitson, 1851) R - 12 - rr

Riodininae

- Anteros formosus* (Cramer, 1777) F - 2 - rr
 sp. ign. (n.?) F - 11 - rr
Apodemia castanea (Prittwitz, 1865) R,F,C,O - 2-4,8,11,12 - rr,r
 stalactioides Butler, 1867 F,O - 2,12 - rr,r
Aricoris tutana (Godart, 1822) O - 12 - rr
Audre epulus signata (Stichel, 1910) O - 4,12 - rr,r
Baeotis hisbon (Cramer, 1775) C - 2 - rr
Barbicornis mona Westwood & Hewitson, 1851 R - 4 - rr
Calephelis nilus (Felder, 1861) R,F,C - 3,5,12 - rr,r

- Calospila bolena* (Butler, 1867) F,C - 1,2 - rr
Charis cadytis Hewitson, 1866 R,F - 2-5,10,11,12 - rr-rf
 theodora Felder, 1862 R,C - 2,5 - rr,r
Chorinea licursis (Fabricius, 1775) R,F - 3-5,12 - rr-rf
Cremna alector (Geyer, 1837) F - 12 - rr
Echenais sejuncta Stichel, 1910 (?) F - 1,12 - rr,r
 " sp. ign. F,C - 1,2 - rr,r
Emesis diogenia (Prittwitz, 1865) F,C - 2-4,12 - rr
 fastidiosa Ménétériés, 1855 F - 3,5 - rr
 ocypore (Geyer, 1837) R,F,C - 1-3,5 - rr
 russula Stichel, 1910 F - 5 - rr
 sp. ign. C - 3 - rr
Eurybia misellivestis Stichel, 1910 C - 4 - rr
Lasaea agesilas (Latreille, 1805) R,F - 3,5 - rr
Lepricornis teras Stichel, 1910 F - 5,12 - rr
Melanis jarbas (Fabricius, 1787) R,F,C - 3,5 - rr
 lycea (Hübner, 1823) R - 5 - rr
 marathon (Felder, 1865) R - 5 - rr
 sp. ign. F - 1 - rr
Mesene pyrippe Hewitson, 1874 R,F - 5,12 - rr
Mesosemia acuta Hewitson, 1873 (belongs to *Eurybia*?) F - 2,12 - rr
 odice (Godart, 1824) R,F,C - 1-5,10-12 - rr-rf
 rhodia (Godart, 1824) R,F,C - 1-5,12 - rr,r
 sp. ign. F - 5 - rr
Napaea nepos orpheus (Westwood, 1851) F - 12 - rr
Panara thisbe soana Hewitson, 1874 F - 3-5,12 - rr-rf
Pterographium satnius (Dalman, 1823) R - 5 - rr
Rhetus periander coerulans Zikan, 1952 F - 12 - rr
Stichelia dukinfieldia (Schaus, 1902) F,C,O - 2,5 - rr
 suavis (Stichel, 1910) F,C,O - 2 - r
Symmachia arion (Felder, 1865) F - 12 - rr
Synargis calyce (Felder, 1862)? C - 4 - rr
 phillone (Godart, 1824) R,C,O - 1,2 - rr-rf

Satyridae (34 spp.)

Euptychiinae

- Euptychia abretia* (Capronnier, 1874) F,C - 2-4 - rr,r
 ambigua Butler, 1866 C - 2 - r
 angularis Butler, 1867 C - 2 - r
 doxes (Godart, 1824) F - 4,12 - r
 grimon (Godart, 1824) F - 2,11 - rr
 hermes (Fabricius, 1775) R,F,C - 1-5,8,11,12 - r-ff
 hygina Butler, 1877 F - 4,5 - r,r,f
 mucosa Butler, 1870 R,F,C - 1-5,10-12 - rr-f
 necys (Godart, 1824) R,F,C - 1,2,4,5,12 - rr-f
 ocelloides Schaus, 1902 F - 5 - rr
 ochracea Butler, 1867 F,C,O - 2,4,12 - rr-rf
 pacta Weymer, 1911 O - 2,3 - rr-rf
 paeon (Godart, 1824) R,F,C - 1-5,12 - rr,r
 phares (Godart, 1824) ssp. ign. C - 3,12 - r
 phronius (Godart, 1824) R,F,C - 2,4,5,11,12 - rr-f
 pronophila Butler, 1867 F,C - 2-5,12 - rr-rf

quandtius (Godart, 1821) F,R,C - 1-5,12 - rr-f

soter Butler, 1877 F - 3,11 - rr

vestigiata Butler, 1867 R - 4,5,12 - rr-rf

10 sp. ign. (all: 0 - 1-4)

Taygetis thamyras marginata Staudinger, 1887 R - 4 - r

ypthima Hübner, 1821 F,C - 1-3,12 rr,r

Pronophilinae:

Eteona tisiphone (Boisduval, 1836) F,C - 2,5,12 - rr,r

Pedaliodes exul Thieme, 1905(?) F - 5,12 - rr,r

phanias (Hewitson, 1862) R,F,C - 1,2,4,5,11,12 - rr-rf

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