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

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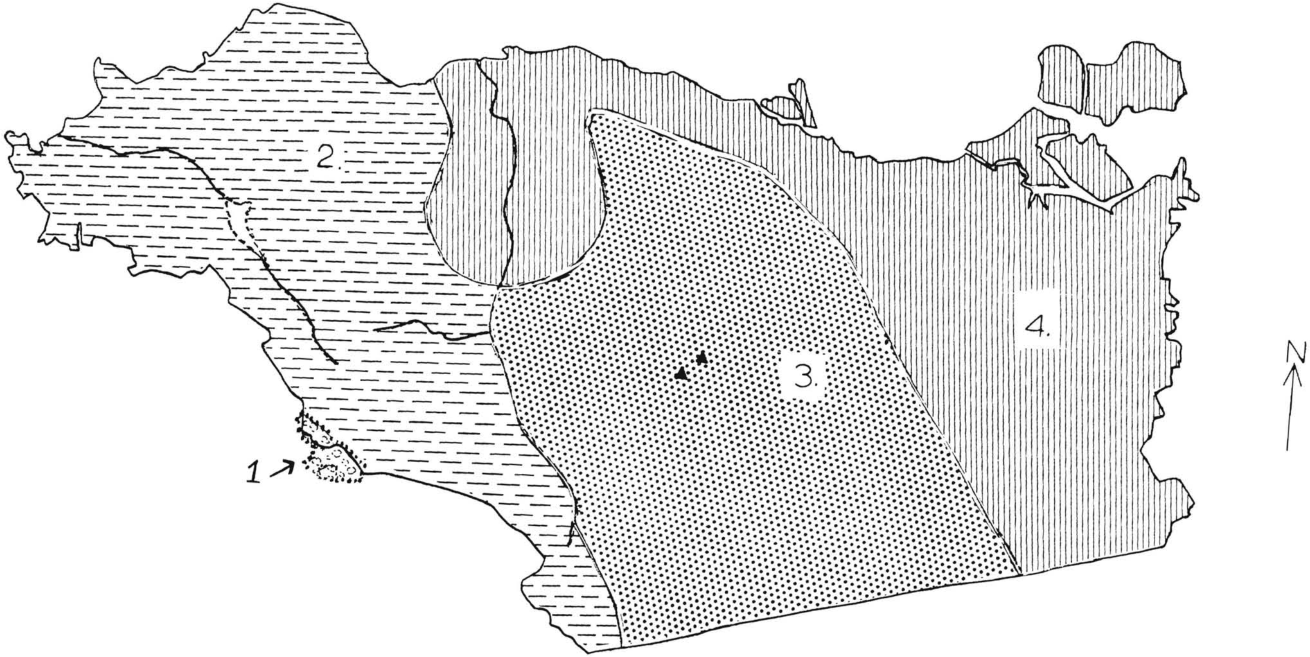
This paper presents geographic and seasonal features of the distribution of the 84 species of butterflies which have been found to occur in Contra Costa County, California. The rhopaloceran fauna of this county is perhaps as well known as that of any other California county due to its proximity to a 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.

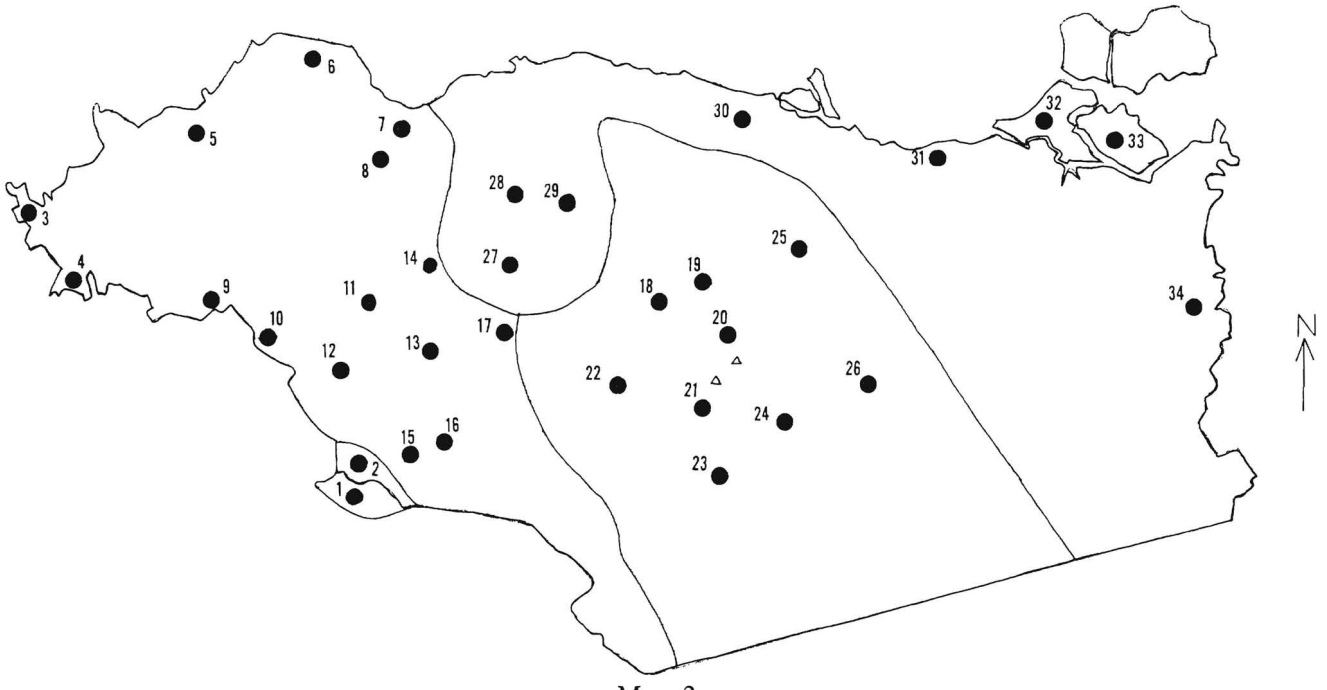
The county possesses a typical Mediterranean climate. The winters are cool and wet while the summers are hot and dry. The rainfall characteristics of the county can be seen by referring to Map 3. The marine influence of breezes and summer fogs from the west moderates temperatures in the western portion 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-



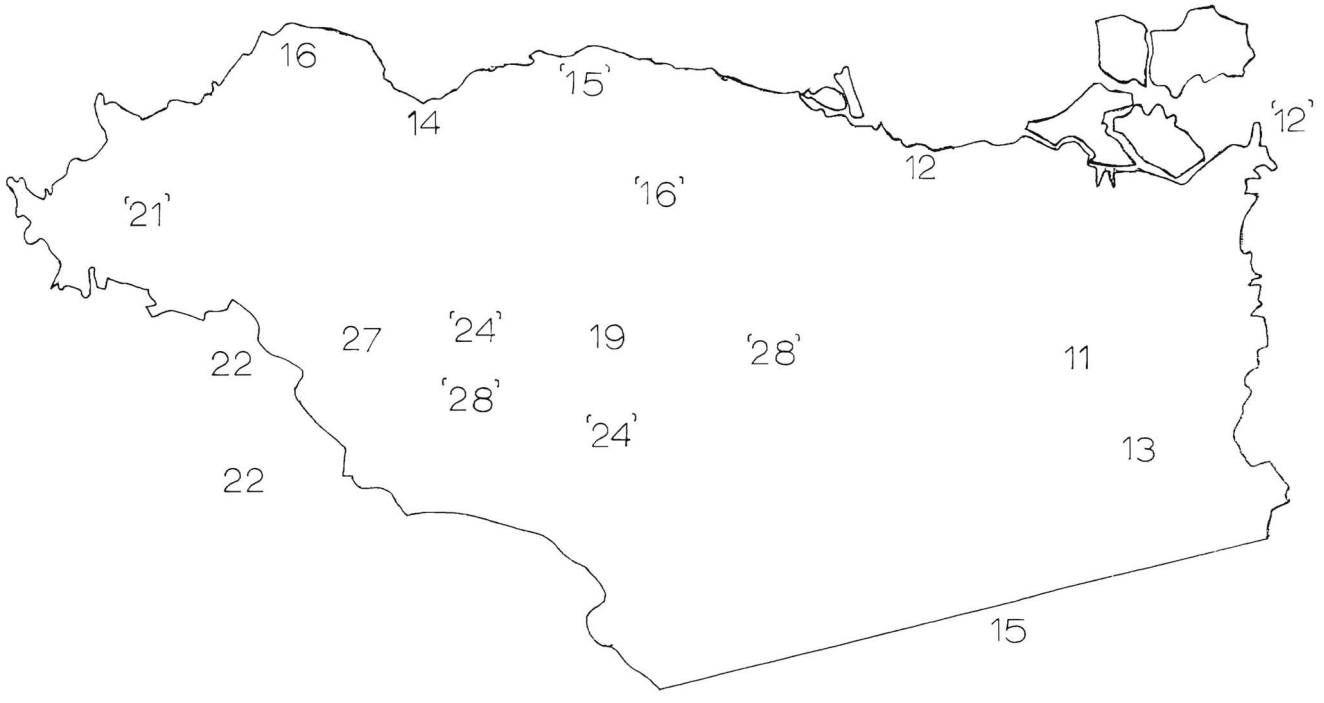
MAP 1

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. Russelman 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.eufala																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		1				3	3	1	1							
P.sabuleti								2	2	3	3	2	3		2	4	2	3	2	3	3	5	8	5	4	5			1			
H h dodgei																			1		1	3	2		1							
H.lindseyi												2	1	4	3																	
H columbia								1	1	5		1	1	1																		
H juba									1													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		3					2		5									
H ericetorum										1		1										2	2									
P scriptura			1		1	5	1	2		1	2		1	3	2						2	2	5		1							
P c communis					1		2	1	1	2	4	1		4	6	6	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	1		1	1	2	3	4	3	5	4		1					1		
E propertius			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		2	1	2	4	2	1		4	1		2				
P zelicaon		1	2	2	4	5	8	6	4	6	2	3	9	5	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									
P multicaudata							2	1	2	5	5	8	4	3	2	2	2	2	1		1											
P eurymedon								1		6	4	7	7	8	3	2	2		1	1												
P protodice		1										2	1			1				1	2	4	7	1								
P n.venosa			3	2	1	3	5	4		2	1																					
gen castoria											3	1			2																	
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	
C.eurytheme	1	1	2	4	8	10	11	9	4	7	13	16	23	11	4	8		4	1	2	8	9	9	13	9	12	10	3	2	1		
C.eurydice											1		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 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

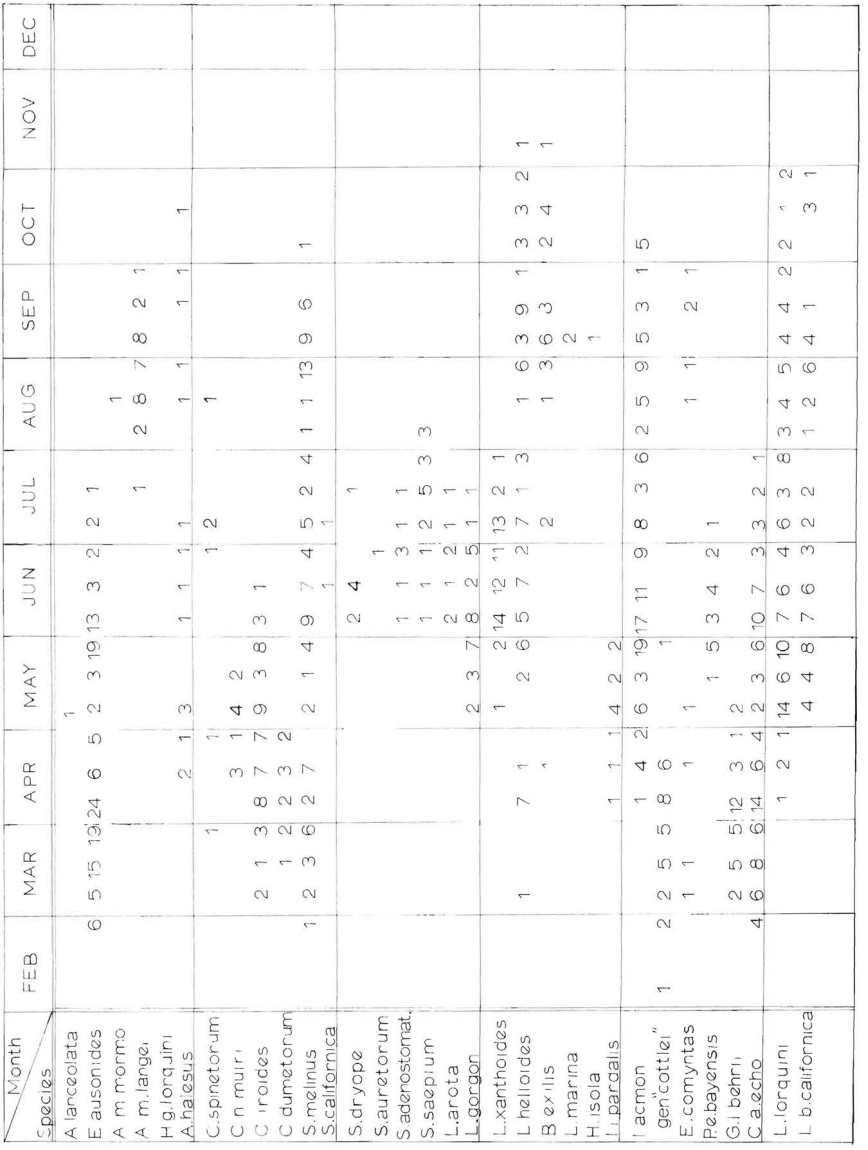


CHART 2

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 muiri (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 (Dbldy)
Euphydryas editha bayensis Sternitzky
Speyeria coronis (Behr)
Speyeria zerene ssp.
Speyeria callippe (Bdv.)
Agraulis vanillae incarnata (Riley)

DANAIDAE

Danaus plexippus (L.)

SATYRIDAE

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

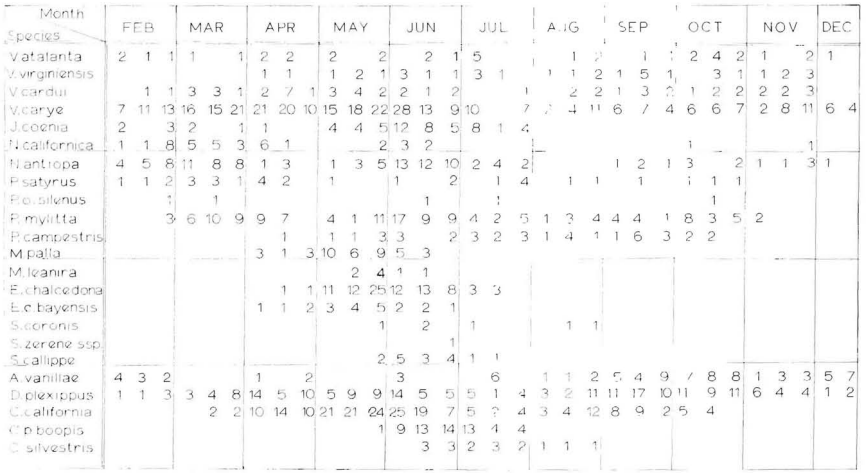
Williams and Grinnell (1905) reported *Thorybes pylades*, *Erynnis juvenalis*, and *Scolitantides piasus* from Contra Costa County. MacNeill (personal communication) reports that *T. pylades* most likely occurs in the vicinity of Canyon. The other species may be misidentifications of *Erynnis propertius* 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. california*.

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 / Species	FEB			MAR			APR			MAY			JUN			JUL			AUG			SEP			OCT			NOV		DEC
V. atalanta	2	1	1	1		1	2	2		2		2		2	1	5			1	2		1	1		2	4	2	1		2	1
V. virginiensis							1	1		1	2	1	3	1	1	3	1		1	1	2	1	5	1		3	1	1	2	3	
V. cardui			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	3
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	8	11	6	4
J. coenia	2		3	2		1	1			4	4	5	12	8	5	8	1	4													
N. californica	1	1	8	5	5	3	6	1				2	3	2											1					1	
N. antiopa	4	5	8	11	8	8	1	3		1	3	5	13	12	10	2	4	2				1	2	1	3		2	1	1	3	1
P. satyrus	1	1	2	3	3	1	4	2		1			1		2		1	4		1	1		1		1	1	1				
Rh. silvenus			1		1									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	2			
P. campestris								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		1				1	1										
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. californica					2	2	10	14	10	21	21	24	25	19	7	5	?	4	3	4	12	8	9	2	5	4					
C. p. boopis												1	9	13	14	13	4	4													
C. silvestris														3	3	2	3	2	1	1	1										

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. auretorum, 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. ocho, 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 (*fide* 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. muiri, 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. auretorum, 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 foodplants 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 / Species	Rwd A'sh.	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
L eufala						X				X																	X				X	X	X	X
P melane	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	X
O agricola	X	X	X	X		X	X			X	X			X				X			X	X	X										
O yuma																															X	X	X	X
A campestris										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																														
H lindseyi			X	X																X	X													
H columbia	X																			X	X						X							
H juba										X																					X			
H phyleus	X		X			X			X	X			X	X	X		X			X		X					X			X	X	X	X
P catullus																							X				X		X	X	X		X	
H ericetorum										X							X	X													X			
P scriptura																											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			
E tristis	X	X							X			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	
P zelicaon	X		X	X	X		X		X	X			X	X				X		X	X	X	X	X			X	X	X		X		X	X
P rutulus	X				X	X	X	X	X	X			X	X		X	X	X		X	X	X	X	X			X	X	X		X		X	X
P multicaudata						X								X				X		X	X	X	X	X		X								
P eurymedon	X								X	X				X				X		X	X	X												
P protodice																X					X						X		X		X		X	
P n venosa	X	X								X				X				X		X	X													
gen castoria								X		X								X								X								
P rapae	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	X				X	X	X		X		X	X
C eurydice													X														X		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																	X																	
E ausonides	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X			X		X		X					
A m mormo																		X																
A m langei																														X				
H g lorquini																		X		X	X													
A halesus													X					X		X	X						X		X					
C spinetorum																		X		X														
C n muiri																				X	X													
C iroides				X	X				X	X	X		X	X			X	X		X	X	X	X				X							
C dumetorum		X					X						X	X																X				
S melinus	X		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	Rw'd A's'n	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
S californica																			X	X		X					X							
S dryope								X											X						X		X							
S auretorum																				X														
S adenostomat																		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		
L helloides	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
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			
E comyntas										X																	X		X		X			
Pe bayensis			X	X																														
G.i behrii	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						
L lorquini	X	X				X	X		X	X		X		X				X	X		X	X	X			X	X		X		X		X	
A bcalifornica	X	X					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			
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
J coenia	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
P satyrus	X	X						X	X	X			X	X						X							X							
P o silenus	X									X																								
P mylitta	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	X
M palla	X	X	X			X	X			X	X		X	X					X		X													
M.leanira																			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
C t california	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 area[4]. *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.

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[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 endemicity 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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