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REVISION OF THE BOLORIA EPITHORE COMPLEX, WITH DESCRIPTION OF TWO NEW SUBSPECIES (NYMPHALIDAE).

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INTRODUCTION

Treated as a monotypic species for more than a century, *Boloria epithore* was the object of an initial, somewhat cursory appraisal seven years ago (Perkins and Perkins, 1966); thereafter, the senior author endeavored to compile additional data in order to augment the limited and fragmentary knowledge then available. In addition to the 254 samples employed in the original study, another 901 spread specimens were acquired from British Columbia, Alberta, Washington, Idaho, Montana, Oregon, and California.

The 1,155 individuals were then subjected to 1) a re-evaluation of more complete and extensive distributional records, 2) a more critical evaluation of phenotypic character analyses, 3) a statistical interpretation of linear measurements, and their significance, and 4) a new dimension, not previously employed: namely, an examination of the paleogeological mechanisms that possibly affected the dispersion and geographic isolation of *epithore's* various conspecific populations.

The purpose of this revision, therefore, is to present new data--and subsequent interpretations--dealing with the *epithore* species group, and to integrate these with previous knowledge (including historical background information and original descriptions) by means of review, evaluation, summary, and rearrangement.

Boloria epithore epithore (Edwards)

(Figs. 5—8)

Argynnis epithore Edwards, 1864, Proc. Ent. Soc. Phila., 2: 504.

The following is quoted from Edwards' original description:

"*Argynnis epithore*, Boisduval *in litt* . . . . Male. Expands 1 5/10 inch. Primaries rounded as in Myrina, not angular at apex and excavated on the margin, as in Bellona, to which last it is most closely allied. Upper side pale fulvous at the base; hind margins bordered by a slight, interrupted line, with small lunules; otherwise the usual markings. Under side of primaries fulvous, yellowish at apex, with ferruginous sub-apical patch. Secondaries have an angular submesial band of irregular spots, as in Bellona, each whitish, sprinkled in the centre with ferruginous, in the cell a round black spot; beyond the band to the margin a slight violet tinge, with a submarginal series of round spots and marginal lunules."

When the nominotypic subspecies, *Boloria epithore epithore,* was described by W. H. Edwards in 1864, California was cited as the type locality; an exact locale was not given. Hence, Brown (1965: p. 334) designated and figured a neotype of Edwards' *epithore,* with the data: "Saratoga, Santa Clara Co., Calif., R. C. Winslow, May 13, 1899."

It is debatable whether Edwards' type specimen was collected in the vicinity of San Francisco. In Volume I of his *Butterflies of North America ("Argynnis VI."),* the following statement was made by Edwards regarding *"Argynnis callippe"* Boisduval: "From California. The most common or only species of *Argynnis* found in the vicinity of San Francisco according to Dr. Behr...." Volume I was divided into ten parts; each part had a different date of issuance. Part two of Volume I, which contained *"Argynnis callippe,"* was issued in August, 1868. This is four years after Edwards' description of *epithore* was published. Surely, if Edwards' type specimen of *epithore,* from Behr's collection (Brown, 1965: p. 337), had been collected in the vicinity of San Francisco, Behr would not have made such a misleading statement. Hence, support is lent to the theory that Edwards' *epithore* was collected in the Santa Cruz Mountains, approximately 40 miles SSE of San Francisco.

The presently known range of typical *epithore* extends from southern San Mateo County, south and west, through the Santa Cruz Mountains of Santa Cruz and Santa Clara counties (Map 1). In recent years, typical nominate *epithore* has not been encountered north or south of these limits. However, Williams (1910) stated that *epithore* had been collected "a good many years ago" in Golden Gate Park, San Francisco. Thus, there is reason to believe that it did occur northward, prior to the concentrated urbanization of the San Francisco area.

Throughout its limited range, colonies of peninsular *epithore* are relatively local; they are usually found in association with their food-plant, *Viola ocellata* Torrey & Gray (Comstock, 1927).

The senior author has examined a series of 103 males and 35 females. Pertinent statistical data is outlined in Tables **3** and **4,** as are key phenotypic characters in Tables **1** and **2.**

Although Edwards' original description is essentially applicable to those *epithore* that occur in the Santa Cruz Mountains, there exist two discrepancies. He indicated that the submedian-median band of the ventral secondaries contains "spots, as in Bellona, each whitish, sprinkled in the centre with ferruginous..." Of 138 examples inspected from the Santa Cruz Mountains, only one, weathered female displays "whitish" spots. However, even these have a noticeably yellowish hue; the remainder of the series possess yellowish-cream spots (Table **2**). Perhaps Edwards' connotation--"whitish"--was intended to imply an off-white color. Secondly, his explicit comment regarding the "pale fulvous" color of the dorsal, basal regions is not consistent with those examples used in this study, since all possess a black or fuscous dusting on the hindwings, dorsally (usually extending outwardly as far as the postbasal region); the forewings, dorsally, have only slight black, basal dusting (Table **1**). Perhaps the male specimen used by Edwards to describe *epithore* was an

extreme, which was generally very light in coloration. In size, Edwards' type (which measured "1 5/10 inch" in expanse, or approximately 38 mm.) is smaller than the average size of the 103 male specimens examined. Conversely, Brown *(pers. comm.)* states that the designated neotype of *epithore* has a left forewing (LFW) measurement of 24 mm. This figure is somewhat larger than e averâe measurement derived by the senior author (Table **3**).

TABLE 1. COMPARISON OF DORSAL CHARACTERISTICS OF FOUR RACES OF Boloria epithore[1]

Race	epithore	sierra	chermocki	borealis
Number of typical specimens examined	103♂♂ 35♀♀	242♂♂ 105♀♀	260♂♂ 217♀♀	118♂♂ 75♀♀
Ground color	bright orange	bright orange	yellowish-orange	flat, dull orange
Superimposed pattern markings and spots	sharply demarcated; black/brown-black	sharply demarcated; black/brown-black	sharply demarcated; black	diffuse; grey-black
Black basal suffusion on FW and HW	+	+	+++	+++/++++
Black dusting on veins of FW and HW	+	+	+/+:	++/+++
Black spots of FW and HW median bands contiguous	FW: +/HW: -	+	+	+
HW vein RS connects laterally with bifed figure in cell	RARELY	YES	YES	yes, if not obscured
Black suffusion on marginal area of HW	+	++	+	+++
Relative size of submarginal spots on FW and HW	++	+	++	+++

[1]Based upon the examination of 1,155 spread specimens (not including material from zones of intergradation).

BOISDUVAL'S USE OF THE NAME *EPITHORE*

The introduction of the name *epithore* cannot be attributed to Edwards, although he was the first to publish it. In his original description, he stated: "This species, as I am informed by Dr. Behr, is undescribed and only named in letters of Dr. Boisduval." The original description in which Boisduval used the name *epithore* appeared in 1869 (Ann. Soc. Ent. Belg., 12: 58; no. 50).

In an attempt to determine the locality from which Boisduval's type of *epithore* was taken, the senior author encountered certain contradictory information.

The lectotype of Boisduval's *epithore* (figured by Brown, 1965: p. 335) is in the collection of the Carnegie Museum, Pittsburgh. Its superficial appearance is analogous to female *epithore* from the Santa Cruz Mountains. The large size--25.0 mm. LFW (Brown, *pers. comm.*)--is to be expected of typical *epithore;* however, the greatest LFW measurement made by the senior author on 35 females was only 24.38 mm. Table **3**, therefore, indicates that the LFW radius of the lectotype of Boisduval's *epithore* exceeds even the "99% Limits" (Brown, 1951) of the series used in this study.

The specimen figured by Brown as the 'Type' of *Argynnis epithore* Boisduval" has an unconnected median row of black spots on the dorsal secondaries. On the primaries these spots tend to be slightly fused or connected by transverse black scales along the veins. This characteristic is common only to nominotypic *epithore* (Table **1**). Furthermore, Boisduval refers to the submedian-median area of the ventral secondaries as being "jaune saupoudrée de brun" (brown-powdered yellow). This coloration is also characteristic of *epithore* from the Santa Cruz Mountains (Table **2**). However, in his original description, Boisduval stated: "M. Lorquin a trouvé cette espèce dans les hautes montagnes de l'est oú elle est fort rare et difficile à prendre" (Mr. Lorquin found this species in the high mountains of

the east where it is extremely rare and difficult to capture). Although it would seem that he clearly indicated that the material he had examined did come from an area or areas in the mountains of eastern California, a statement in Volume III of Edwards' *Butterflies of North America* strongly indicates that Boisduval's locality statement may have been misleading.

From (*"Argynnis VIII."*) -- *"Argynnis adiante"* Boisduval, Edwards stated: "The male figured on our Plate is the original type of Dr. Boisduval, sent me by himself, and bearing his label as 'type *adiante'.*" Edwards then quoted Boisduval: "This beautiful *Argynnis* was taken in some numbers by M. Lorquin, on the edges of the woods, in the eastern part of California." Edwards then continues: "Of late years *adiante* has not been a very common species in collections, owing to its local habits, apparently. Professor J. J. Rivers writes me that 'it is found above Los Gatos in the Santa Cruz Mountains. It also occurs at several localities in the same range, and in Santa Clara and San Mateo counties; but it does not appear to be found farther south than about nine miles north of Santa Cruz city.' Apparently Dr. Bosiduval was mistaken in the locality."Boisduval described *adiante,* now a synonym of *Speyeria egleis adiaste* (Edwards), on page 61 of the same publication which contained his original description of *epithore.* Both the *adiante* and *epithore* types used by Boisduval in his original descriptions were collected by Lorquin. In both original descriptions, Boisduval referred to eastern California and the high mountains of the east as the localities from which the respective types were collected. However, dos Passos & Grey (1947) fixed the type locality for *adiante* as the "Santa Cruz Mountains, California." The type locality for Edwards' *adiaste* is also in the vicinity of the Santa Cruz Mountains.

In view of this information, it becomes apparent that Boisduval's type of *epithore* most probably was collected in the vicinity of the Santa Cruz Mountains and not somewhere in "the high mountains of the east."

Because Boisduval's original description of *epithore* appeared five years after Edwards' use of the name, Edwards' *epithore* takes priority.

Boloria epithore chermocki Perkins and Perkins

(Figs. 9-12)

Boloria epithore chermocki Perkins and Perkins, 1966, J. Lepid. Soc., 20 (2): 109-112. The following is quoted from the original description:

"*Males:* Dorsal LFW (Expanse: 21.10 + 2.53 mm.), holotype 21.40 mm."

"*Females:* Dorsal LFW (Expanse: 22.01 + 2.74 mm.), allotype 23.00 mm."

"Male: Upper surface: Black spots within median band on both primaries and secondaries tending to be fused or connected, giving effect of a continuous, irregular black line; on typical *epithore,* these spots only slightly connected on primaries, on secondaries without connecting scales. Black basal suffusion heavily represented, often extending outwardly as far as submedian area; on *epithore,* black suffusion seldom extending beyond post-basal region. Segment of vein RS on secondaries bordering cell noticeably accentuated by black scales connecting this segment to angled figure in cell; rarely an indication of this on *epithore.*"

"Undersurface: On secondaries, submedian-median row of spots chrome-yellow, this region in *epithore* cream to yellow with noticeably heavy, ferruginous dusting. Postbasal area of secondaries, below denticulate white spot bordering vein RS (infrequently invaded by yellow scales) yellow-brown to orange-brown (latter more common), in this respect, basal and post-basal areas analogous; these areas on *epithore* red-brown. Post-median band of secondaries purplish to lilac inwardly, contrasting to the lighter, outward limits of this band; this contrast much less evident on *epithore.*"

"Female similar in appearance to male."

A type locale was affixed to 0.5-2.9 mi. E. of Dolph, Yamhill County, Oregon. The holotype and allotype (collected on 18 June 1962 by S. F. Perkins and E. M. Perkins, respectively), together with 9♂♂ and 6♀♀ paratypes were deposited in the collection of the Los Angeles County Museum of Natural History. Of the remaining paratypes, 6♂♂ and 4♀♀ were placed in each of the following institutions: the California Academy of Sciences, San Francisco, California, The American Museum of Natural History, New York City, New York, and the Allyn Museum of Entomology,

Sarasota, Florida.

The authors agreed to name the new subspecies in honor of Franklin H. Chermock of Baltimore, Maryland. He was the first to call its occurrence to their attention, and although it was difficult at the time to justify the use of a patronymic name, Mr. Chermock was known to be dying of a terminal illness.

The description of *chermocki* was based upon the examination of approximately 250 specimens from various localities in southwestern British Columbia, Washington, Oregon, and north-central California. Throughout this range, the subspecies remained constant in appearance. Both its superficial characters and measurements contrasted favorably to those of peninsular *epithore* (see Tables 1-4). These findings are confirmed by the present study, which employed 260♂♂ and 217♀♀ examples of typical *chermocki.*

Inhabiting moist associations where its probable food-plant, *Viola sempervirens* Greene and/or *Viola glabella* Nuttall is to be found, *chermocki* occurs along the west slope of southwestern British Columbia's Coast Mountains and Lillooet Range, on east-central and southeast Vancouver Island, in the Olympic Mountains of northwestern Washington, and throughout the Coast Range and Cascade Mountains of Washington, Oregon, and extreme northern California (refer to Maps **1** and **2**). Occasional demes also appear at lower elevations along the Coast, and in the more wet, intermountain valleys.

TABLE 2. COMPARISON OF VENTRAL CHARACTERISTICS OF FOUR RACES OF Boloria epithore[1]

Race	epithore	sierra	chermocki	borealis
Number of typical specimens examined	103♂♂ 35 ♀♀	242♂♂ 105 ♀♀	260♂♂ 217♀♀	118♂♂ 75♀♀
Color of submedian-median row of spots	yellowish-cream	yellowish-cream	chrome-yellow	chrome-yellow
Amount of ferruginous dusting overlaying submedian-median spots	++	+++	+	+/++
Color of HW postbasal area	red-brown	red-brown	orange-brown	brown
Color of HW denticulate spot, bordering vein RS	white	white	usually white	usually cream
Postmedian band of HW delimited inwardly by dark, violet scaling	+	+	++	+++
Numbers of ferruginous scales on subapical and outer marginal areas of FW	+++	+++	+	+
Degree to which pale, submarginal locus between veins M_2-M_3 of HW contrasts with surrounding, darker limbal band	+	+	++	+++

[1] Based upon the examination of 1,155 spread specimens (not including material from zones of intergradation).

At the time of the 1966 study, the few available specimens from Clallam, Whatcom and Okanogan counties in Washington, Umatilla and Wallowa counties in Oregon, and Glacier County, Montana all evinced a pronounced melanotic tendency. It was erroneously assumed that these examples merely represented ecophenotypic variants associated with the more extreme elevations from which they came. Hence, the distribution of *chermocki* was described incorrectly to include the remainder of southcentral British Columbia, southwestern Alberta, Idaho, and Montana.

Since then, 118 ♂♂ and 75 ♀♀ examples of *B. epithore ssp.* have been obtained from the above-mentioned geographical areas. Comparison of this material to *chermocki* reveals yet another unique and geographically distinct subspecies of *B. epithore,* not heretofore described.

Boloria epithore borealis Perkins, new subspecies

(Figs. 13—16)

Males: Dorsal LFW (Expanse: 20.10 + 2.74 mm.), holotype 20.20 mm.
Females: Dorsal LFW (Expanse: 21.31 + 2.81 mm.), allotype 21.30 mm.

Male: Upper surface: Ground color flat, dull orange; unlike yellowish-orange ground color of *chermocki.* Like *chermocki* but unlike nominotypic *epithore,* black spots within median band of primaries and secondaries tending to be contiguous and uninterrupted, forming a continuous, irregular black line. Black basal suffusion more heavily represented than in *chermocki,* extending laterally from basal area of HW and FW to submedian-median areas. Segment of vein RS on secondaries connecting laterally with bifed figure in cell, like *chermocki* but unlike peninsular *epithore;* unlike *chermocki* however, figure frequently obscured by black suffusion. Unlike both *chermocki* and *epithore,* degree of black dusting on veins of both FW and HW prounced, as are amount of black suffusion in marginal area of FW and relative size of submarginal spots on both wings. Pattern markings and spots on both FW and HW tending to be greyish black and diffuse, as opposed to those of both *epithore* and *chermocki* which are black to brownish-black and sharply demarcated.

Undersurface: On secondaries, submedian-median row of spots chrome-yellow (like *chermocki*), over which are imposed moderate numbers of ferruginous scales. Postbasal area of HW brown, unlike orange-brown of *chermocki* or red-brown of *epithore.* Denticulate spot on HW, bordering vein RS, usually cream-colored, not white. Postmedian band of secondaries delimited inwardly by marked contrast with dark, refractive blue-violet scaling; this contrast less evident in *chermocki,* and much less evident in nominotypic *epithore.* Like *chermocki* but unlike *epithore,* amount of ferruginous scaling on subapical and outer marginal areas of FW diminished. Degree to which pale, submarginal locus between veins M_2-M_3 of HW contrasts with surrounding, more darkly pigmented limbal band greater than in *chermocki.*

Males and females similar in appearance.

TABLE 3. PARAMETERS OF SAMPLES OF FOUR RACES OF Boloria epithore[1]

Race	sierra		epithore		chermocki		borealis	
	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀	♂♂	♀♀
N	242	105	103	35	260	217	118	75
LFW Mean (mm.)	19.21	20.62	21.93	23.06	21.24	22.12	20.10	21.31
P.e.m. (mm.)	0.010	0.089	0.064	0.095	0.067	0.110	0.105	0.137
S. D. (mm.)	0.75	0.84	0.60	0.51	0.99	1.02	1.06	1.09
v	13.63	17.67	8.93	6.62	24.93	26.02	27.94	29.43
σ	3.742	4.207	2.988	2.571	4.993	5.101	5.286	5.425
99% limits (mm.)	19.21±1.94	20.62±2.17	21.93±1.55	23.06±1.32	21.24±2.55	22.12±2.63	20.10±2.74	21.31±2.81

[1]After Brown, 1951.

Holotype ♂: Shingle Creek Road, Keremeos, BRITISH COLUMBIA, 26 June 1936 (A. N. Gartrell); placed in the collection of the Entomology Research Institute, Canada Department of Agriculture, Ottawa, Ontario, Canada. *Allotype* ♀: Keremeos, BRITISH COLUMBIA, 7 June 1923 (C. Garrett), *ex coll.* J. D. Gunder; placed in the collection of The American Museum of Natural History, New York City, New York.

Paratypes (40): BRITISH COLUMBIA: Keremeos, 1-VI-23, 2-VI-23, 4-VI-23, 6-VI-23, 7-VI-23, 7♂♂, 10 ♀♀ (C. Garrett, *ex coll.* J. D. Gunder); Hedley, 23-VII-23, 2 ♂♂ (C. B. Garrett); Mt. Apex, vic. Hedley, 26-VII-33, 1 ♂, 3 ♀♀ (A. N. Gartrell); Mt. Apex, vic. Hedley, 3-VII-67, 1 ♂ (N. A. Roman); Princeton Summit, 17-VII-09, 1 ♂, 1 ♀ (H. Bower); Princeton, VIII-40, 1 ♀ (L. I. Hewes); Big White Mtn., 40 mi. N. Vernon, 22-VIII-67, 3 ♂♂, 1 ♀ (N. A. Roman). ALBERTA: Racehorse Cr., Kananaskis Rd., 12-VII-67, 1 ♂, 1 ♀ (R. L. Anderson). MONTANA: Beaverhead Co., Polaris, 25-VI-41, 4-VII-41, 14-VII-41, 2 ♂♂, 2 ♀♀ (collector unknown); Flathead Co., Lake MacDonald, Glacier Nat'l Park, 7-VII-30, 2 ♀♀ (E. C. VanDyke). OREGON: Wallowa Co., Ice Lake Trail, Mt. Sacajawea, 29-VIII-67, 1 ♂ (E. M. Perkins). Three ♂♂ and three ♀♀ have been deposited with the holotype; four ♂♂ and seven ♀♀ have been deposited with the allotype. Six ♂♂ and two ♀♀ have been placed in the Allyn Museum of Entomology, Sarasota, Florida. Three ♀♀ have been deposited in the collection of the California Academy of Sciences, San Francisco, California; five ♂♂ and five ♀♀ have been placed in the Los Angeles County Museum of Natural History, Los Angeles, California. One ♂ and one ♀ have been retained by the author.

TABLE 4. COMPARISON OF SERIES OF FOUR RACES OF *Boloria epithore*[1]

Race		*sierra*	*epithore*	*chermocki*	*borealis*
"t" score compared to:					
	sierra	---	26.9	17.3	6.0
	epithore	26.9	---	6.8	12.3
	chermocki	17.3	6.8	---	6.5
	borealis	6.0	12.3	6.5	---

[1]After Brown, 1951; where "t" score of at least 6 to 7 supports noticeable difference in samples.

At present, the northernmost, known record for *borealis* is Smithers, British Columbia (Map **1**). From here it ranges south, through the Fraser Plateau and fertile, inland valleys of south-central British Columbia, east of the Coast Mountains and Lillooet Range. In southeastern British Columbia, it occurs in both the Selkirk and Purcell mountains, extending east to the Continental Divide at a latitude comparable to that of Revelstoke. Confined in Alberta to the contiguous Rocky Mountains, it ranges in the north from Bow Pass (north of Lake Louise, Banff National Park), south to Waterton Lakes National Park, Alberta and Glacier National Park, Montana. Restricted to extreme western Montana, it occupies principally the Flathead, Big Hole, and Bitterroot ranges. Found throughout the northeastern Bitterroot and south-central Sawtooth ranges of Idaho (the latter representing its southernmost extension), it also occurs in Idaho's north-central

Payette and Nezperce National Forests, to the west of which it "leaks" across to Oregon's Blue and Wallowa mountains (see Maps **1** and **2**).

Records also exist for, or imply, the occurrence of *borealis* in northwestern Wyoming, Colorado, and southeastern Alaska; they are, however, somewhat dubious. Ferris (1971) lists both Yellowstone National Park and Wyoming's Big Horn Mountains. The former locality was obtained through a collector, second-hand to him (Ferris, *pers. comm.*); although the Yellowstone record is possible (Map **2**), the Big Horn Mountains locality is questionable. The senior author has examined a specimen in the collection of the California Academy of Sciences bearing the data: "Big Horn Mts., Wy., July, 1925 (?), L. I. Hewes collection." The example agrees favorably with *chermocki,* but in no way resembles *borealis.* Certainly, in this case, inaccurate locality information had been affixed to the specimen; however, as Ferris points out (*pers. comm.*), it is possible that isolated Wyoming colonies of *B. toddi* have been confused with *B. epithore.* The senior author agrees. Among several museum collections examined during this study, the following species were inaccurately determined *epithore: toddi* (Holland), *frigga* (Thunberg), *helena* (Edwards), and *kriemhild* (Strecker). Such taxonomic confusion probably accounts for the spurious Colorado records; additionally, neither Eff nor Brown *(pers. comm.)* are aware of any legitimate Colorado records of *B. epithore.* Similarly perplexing are the Alaska records: although southeastern Alaska has not been sampled extensively, not one of the some 15,000 butterfly specimens assembled for the Alaska Lepidoptera Survey has been *B. epithore* (Philip, *pers. comm.).* Again it is likely that *frigga,* which is common over much of the state, has been confused for *epithore;* such was probably the case regarding a St. Michaels, Alaska record (Wright, 1906).

Food-plant preferences for *borealis* are not known. Dethier (1937) lists none. Shepard (in press) states: "The author has reared *epithore* from *Viola sp.* in Montana. Overwinters as next to last instar larvae." No other information ia available, although it is tempting to speculate that *V. glabella* Nuttall may serve as one of the food-plants, since Munz and Keck (1968) cite its distribution to include Alaska and the northern Rocky Mountains.

ab. *obscuripennis* (Gunder)

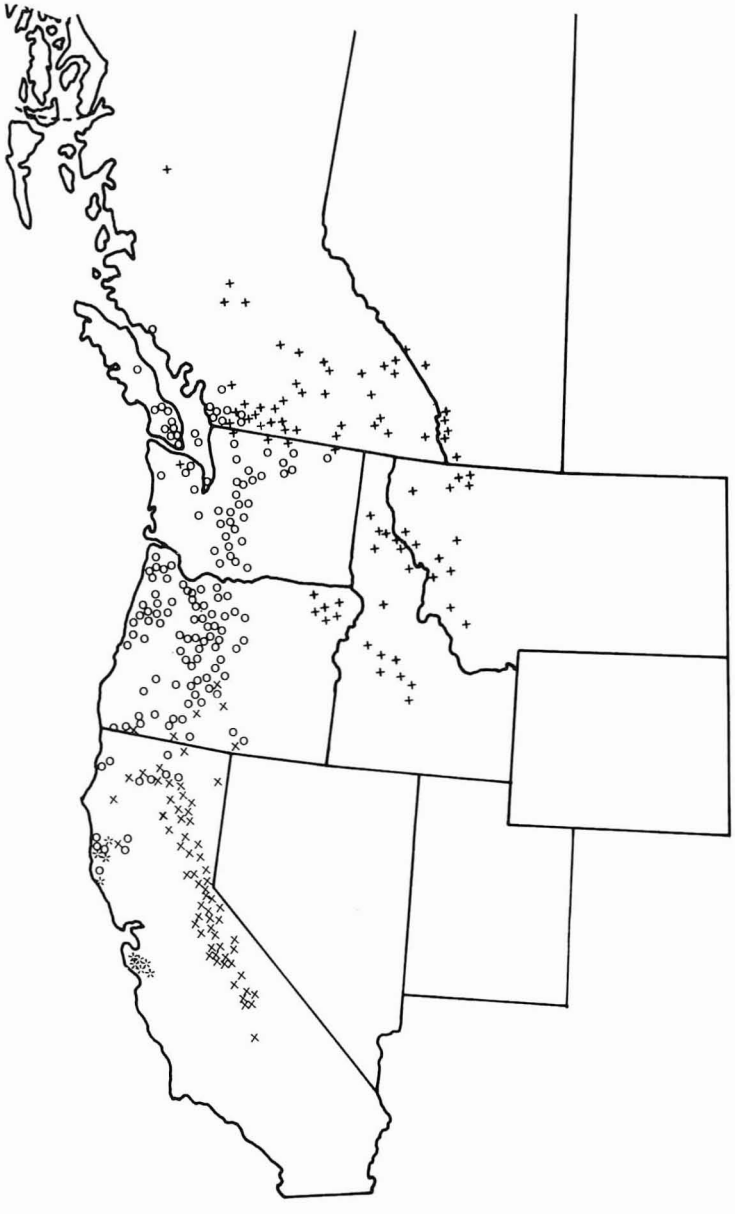
Brenthis epithore Bdv., ab. *obscuripennis* Gunder, 1926, Ent. News, 37(1): 7.

The type of this aberration, a female, was collected at Chilcotin, British Columbia, on May 30, 1915. Other examples have been reported by Jones from Alexis Creek and Shuswap Lake, British Columbia (Occ. paper #1, Ent. Soc. B. C., June, 1951). In the original description Gunder stated: "Primaries entirely fogged over with dark shading, obscuring and submerging maculation, especially on the inner half with cell quite dense where only a single yellow brown spot shows; normal row of round black spots indistinctly visible. Secondaries, outer half normal; confused yellow brown maculation of inner half externally edged by black shading which extends also along the costal margin, basal area quite dark." The preceding description applies to the dorsal surfaces. Because it is a melanic aberration, originally described as such, *obscuripennis* must be considered infrasubspecific to *B. epithore borealis.*

Although, in the 1966 study, certain examples of *B. epithore* from Oregon and California were noted to be somewhat unusual, insufficient numbers (57 ♂♂ and 27 ♀♀), compounded by inadequate knowledge of their biology and the inability to interpret the meaning of their bifid distribution in California and zones of intergradation in both states, cast considerable doubt upon their taxonomic validity. The authors were also reticent to affix a new taxon based solely upon the criterion of size--even though the specimens were statistically smaller. Hence, the opportunity to assign a subspecific rank to the possibly new entity was precluded.

Since then, 242 ♂♂ and 105 ♀♀ have been assembled and examined. Comparison of this material to both *chermocki* and nominate *epithore* reveals yet another unique and geographically distinct subspecies of *B. epithore,* not heretofore

described.



Map 1: known distribution of the *Boloria epithore* complex, based upon the determination of one or more of the 1,155 specimens examined during this study. Various symbols correspond to respective subspecies: (*) = *B. e. epithore,* (o) = *B. e. chermocki,* (+) = *B. e. borealis,* and (x) = *B. e. sierra.*

Boloria epithore sierra Perkins, new subspecies

(Figs. 1—4)

Males: Dorsal LFW (Expanse: 19.21 + 1.94 mm.), holotype 18.40 mm.
Females: Dorsal LFW (Expanse: 20.62 + 2.17 mm.), allotype 19.00 mm.

Male: Upper surface: Ground color bright orange, with sharply demarcated, black to brown-black superimposed pattern markings and spots; black basal suffusion and melanic dusting along veins of FW and HW mild, as in nominotypic *epithore.* Like *chermocki* but unlike *epithore,* HW vein RS connecting laterally with bifed figure in cell, and black spots of FW and HW median bands contiguous. Unlike either *epithore* or *chermocki,* black basal suffusion on HW marginal area moderate, and relative size of submarginal spots on both wings small.

Undersurface: On secondaries, submedian-median row of spots yellowish-cream (like *epithore),* over which are imposed large numbers of ferruginous scales, sometimes so numerous as to obscure color of spots in submedian-median row; in this respect, unlike nominotypic *epithore* or any other subspecies. Like *epithore* but unlike *chermocki,* color of HW postbasal area red-brown; postmedian band of HW meagerly delimited inwardly by dark violet scaling; and ferruginous scales on subapical and outer marginal areas of FW plentiful. In other respects, comparable to peninsular *epithore.*

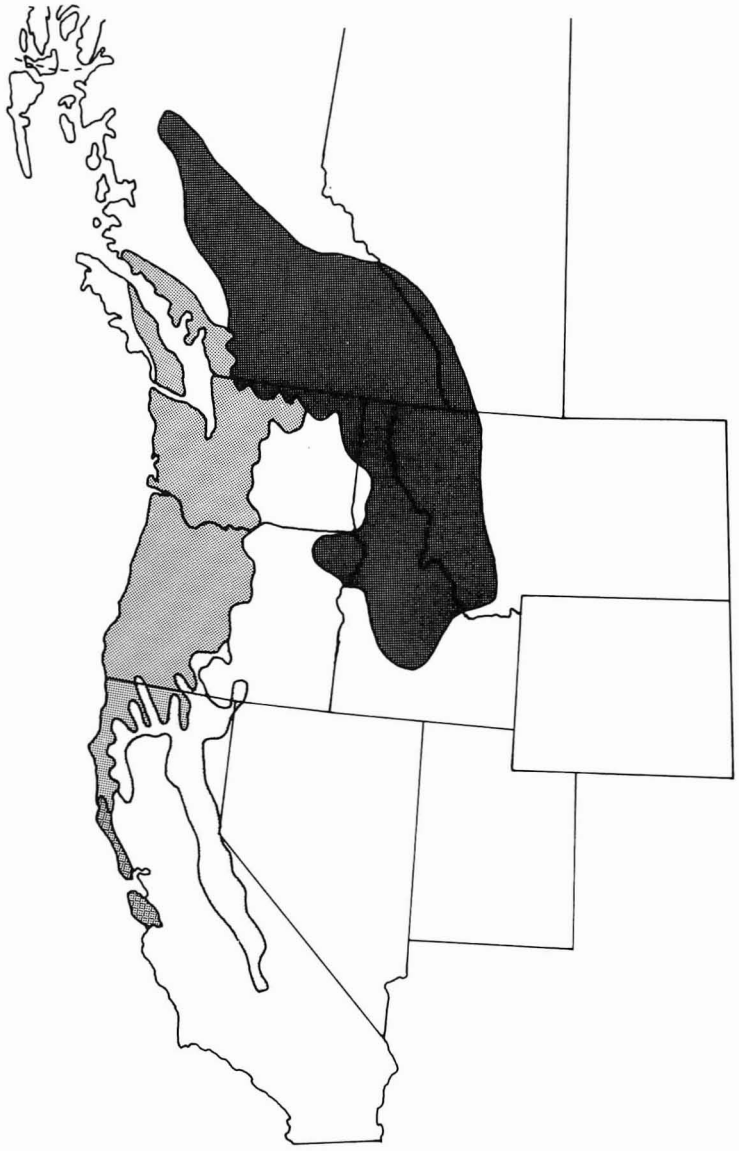
Males and females similar in appearance.

Holotype ♂: Sentinel Dome, Yosemite National Park, Mariposa County, CALIFORNIA, 3 July 1946 (F. H. Rindge, *ex. colln.* D. C. Ferguson); placed in the collection of the Allyn Museum of Entomology, Sarasota, Florida. *Allotype* ♀: Glacier Point, Yosemite National Park, Mariposa County, CALIFORNIA, 2 July 1921 (J. A. Comstock); placed in the collection of the Los Angeles County Museum of Natural History, Los Angeles, California.

Paratypes (42): CALIFORNIA, Yosemite Nat'l Park, Mariposa Co.: Glacier Point, 28-VI-21, 2-VII-21, 16 ♂♂, 7 ♀♀ (J. A. Comstock), (Note: some labels on the 23 preceding Comstock specimens simply bear the hand-written data: "nr. Yosemite, 7700' el., July 2, 1921." However, because they are identical to Comstock's other data-determination labels, and because the specimens bear the same date, elevation, and were borrowed from the same institution as were those specimens clearly labelled: "Glacier Point, nr. Yosemite, Cal., July 2, 1921, 7700 ft. elev., *Br. epithore,*" it is assumed that they indeed represent Glacier Point material, spread or labelled at a different time or by a different individual); Tenaya Canyon, 11-VII-58, 3 ♂♂, 1 ♀ (A. O. Shields); Yosemite, 21-VI-34, 2 ♂♂, 1 ♀ (T. Craig); Yosemite Valley, 20-VII-30, 1 ♂, 3 ♀♀ (E. C. Zimmermann); Hy. 120, Yosemite Nat'l Park, 15-VI-61, 3-VII-62, 5 ♂♂, 1 ♀ (E. M. & S. F. Perkins); Tuolumne Co.: Tioga Pass, 11-VII-31, 1 ♀ (J. W. Tilden); vic. Tioga Pass, 1-VIII-52, 1 ♂ (P. A. Opler). Five ♂♂ and one ♀ have been deposited with the holotype; 15 ♂♂ and six ♀♀ have been deposited with the allotype. Three ♂♂ and one ♀ have been placed in The American Museum of Natural History, New York City, New York; four ♂♂ and five ♀♀ have been deposited in the California Academy of Sciences, San Francisco, California. One ♂ and one ♀ have been retained by the author.

Although sympatric populations and intergradations between *chermocki* and *sierra* typify drier, south-central Oregon (Jackson, Klamath and Lake counties) and lava-strewn, north-central and northeastern California (Lassen, Modoc, Siskiyou and Shasta counties), demes of typical *sierra* occasionally occur to the south and west--at higher elevations--in the Coast Range Mountains (Glenn, Lake, Mendocino, Tehama and Trinity counties) and consistently occur to the south and east, throughout the length of the Sierra Nevada (from Plumas and Sierra counties in the north, to Kern County in the south). See Maps **1** and **2.** The southernmost extension of *sierra* was discovered in 1961 by Stanford (Perkins and Perkins, 1966), who was collecting in the vicinity of Tobias Peak, located in the Greenhorn Mountains south of the Tulare-Kern county line. It is interesting to note, botanically,

that Tobias Peak also represents the southernmost limit of *sierra's* known foodplant: *V. glabella* Nuttall (J. F. Emmel, *pers. comm.).*



Map 2: projected distribution of *Boloria epithore's* four subspecies in western North America, based upon all determinations and records presented in this revision. Variously shaded areas correspond to respective subspecies: dark (restricted to areas immediately north and south of San Francisco Bay) = *B. e. epithore;* medium = *B. e. chermocki;* very dark = *B. e. borealis;* and light = *B. e. sierra.*

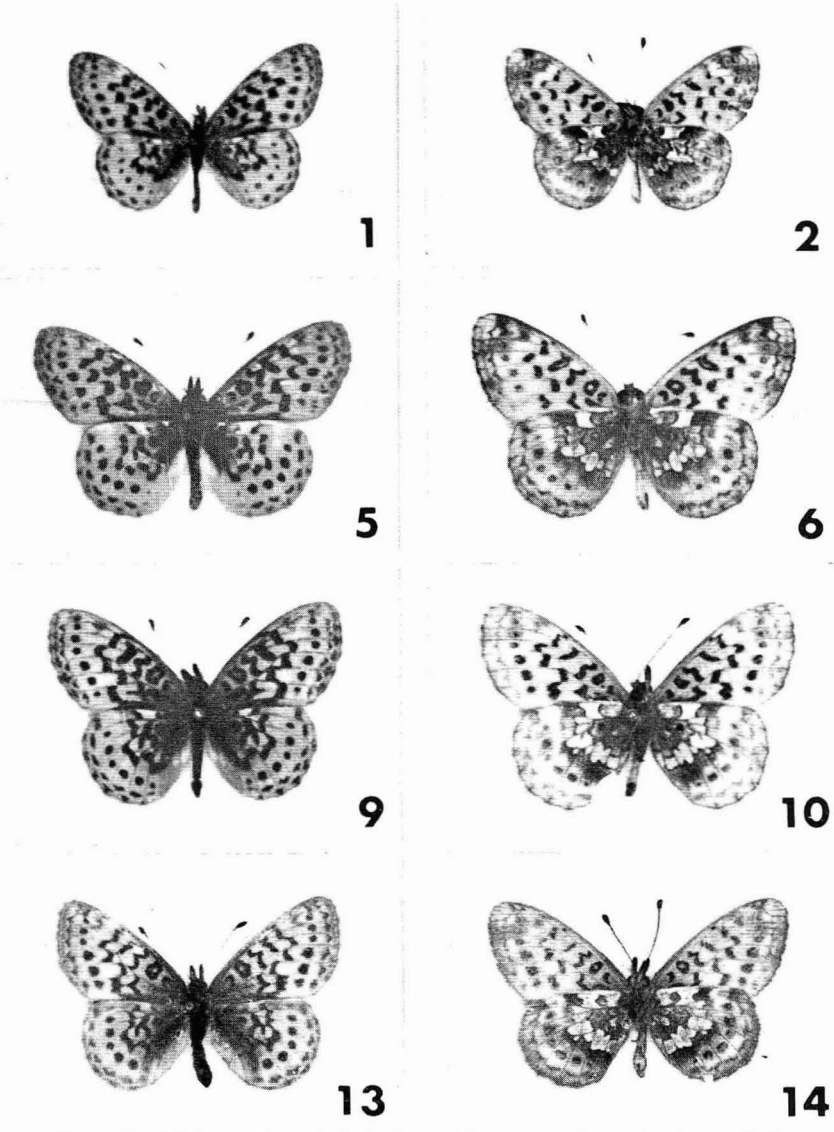


Plate I: Adult males of *Boloria epithore* complex: 1) *sierra* (holotype), Sentinel Dome, Yosemite Nat'l Park, Mariposa Co., Calif., 3-VII-46 (F.H. Rindge); 2) *sierra* (paratype), Glacier Point, Yosemite Nat'l Park, Mariposa Co., Calif., 2-VII-21 (J.A. Comstock); 5) *epithore,* Big Basin, Santa Cruz Mts., Santa Cruz Co., Calif., 4-V-46 (O.E. Sette); 6) *epithore,* Santa Cruz Mts., Santa Cruz Co., Calif., 15-VI-46 (T.W.Davies); 9) *chermocki* (topotype), 2.9 mi. E. Dolph, Yamhill Co., Oregon, 18-V-68 (S.F. Perkins); 10) *chermocki* (topotype), 2.9 mi. E. Dolph, Yamhill Co., Oregon, 18-V-68 (S.F. Perkins); 13) *borealis* (holotype), Shingle Creek Road, Keremeos, B.C., 26-VI-36 (A.N. Gartrell); 14) *borealis* (paratype), Keremeos, B.C., 2-VI-23 (C. Garrett). Figures to the left are dorsal; those to the right are ventral. All specimens actual size.

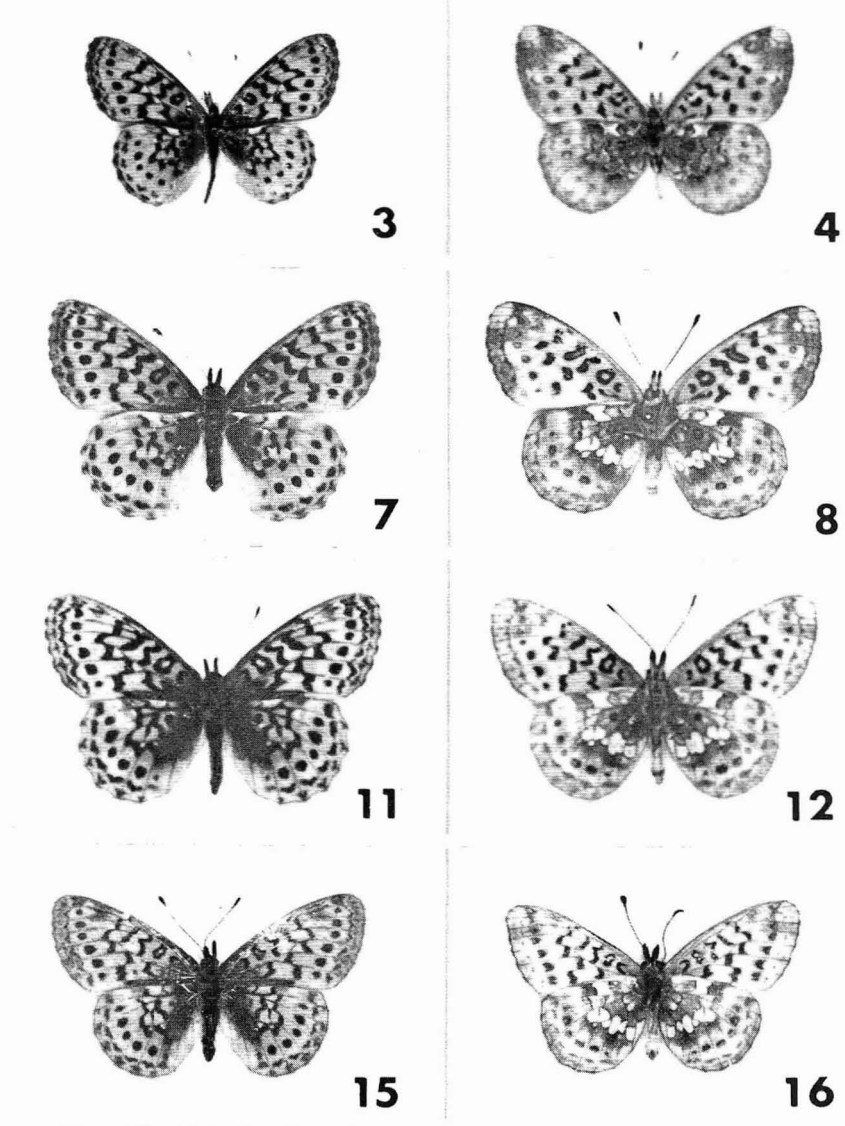


Plate II: Adult females of *Boloria epithore* complex: 3) *sierra* (allotype), Glacier Point, Yosemite Nat'l Park, Mariposa Co., Calif., 2-VII-21 (J.A. Comstock); 4) *sierra* (paratype), Glacier Point, Yosemite Nat'l Park, Mariposa Co., Calif., 2-VII-21 (J.A. Comstock); 7) *epithore,* Big Basin, Santa Cruz Mts., Santa Cruz Co., Calif., 4-V-46 (O.E. Sette); 8) *epithore,* Gazos Creek Road, 5.2 mi. N.E. Hy. 1, San Mateo Co., Calif., 30-V-68 (J.F. Emmel); 11) *chermocki* (paratype), 2.9 mi. E. Dolph, Yamhill Co., Oregon, 10-VI-62 (E.M. Perkins); 12) *chermocki* (paratype), 2.9 mi. E. Dolph, Yamhill Co., Oregon, 12-VI-63 (E.M. Perkins); 15) *borealis* (allotype), Keremeos, B. C., 7-VI-23 (C. Garrett); 16) *borealis* (paratype), Keremeos, B. C., 7-VI-23 (C. Garrett). Figures to the left are dorsal; those to the right are ventral. All specimens actual size.

Map 3: proposed evolvement, dispersal and geographic isolation of *Boloria epithore* complex. Arrows indicate probable, southerly movements from points of origin, where broken arrows = *B. e. epithore;* large, open arrows = *B. e. chermocki;* large, solid arrows = *B. e. borealis;* and narrow, elongated arrows = *B. e. sierra.*

ab. *eldorado* (Strand)

Brenthis epithore Bdv., cum. ab. *eldorado* Strand, 1914, Archiv für Naturgeschichte, 80 (A) pt. 11: 156.

Described on the basis of six examples from Plumas County, California (collected June 10-17, 1913), and one specimen from El Dorado County, California (collected between June 25 and June 28, 1913), the distinguishing features of *eldorado,* as indicated by Strand in his original description, include: (1) the black markings on the underside of the forewings are large and consequently appear to be near to one another; (2) the two transverse spots in the middle of the field (in cells $M_3$and CU_1) are connected by means of a median, black longitudinal line; (3) the angled figure in the cell (discal cell) completely or almost completely touches the discocellular spots; and (4) the three or four postmedian spots touch or almost touch the transverse lines in the form of black flecks. Strand also mentioned that the black design above is stronger in both wings.

From this information and a study of material from both Plumas and El Dorado counties, the senior author concludes that Strand's name, *eldorado,* represents an aberration. Under the rules of the International Code of Zoological Nomenclature, *eldorado* must therefore be regarded as being infrasubspecific in rank to *B. epithore sierra.*

ab. *wawonae* (Gunder)

Brenthis epithore Bdv., ab. *wawonae* Gunder, 1924, Ent. News, 35(5): 156.

The type was collected at Wawona (in Yosemite National Park), Mariposa County, California on July 6, 1922. It is pictured in J. A. Comstock's *Butterflies of California,* Pl. 26, fig. 10. The distinctive feature of *wawonae* is found on the secondaries where the row of postmedian spots is "lacking."

As is *eldorado, wawonae* is now considered an infrasubspecific entity of *B. epithore sierra.*

DISCUSSION

A revision of the *Boloria epithore* complex would be incomplete without briefly reviewing and summarizing the salient phenotypic characters of each of its races. In order to avoid redundancy, the reader is referred to Plates **1-2** and Tables **1-4,** which serve this purpose.

Similarly, it would be less meaningful if present knowledge regarding the geographic distribution, zones of intergradation, ecological associations, and food-plant preferences of *B. epithore's* four subspecies were not incorporated into an overview of those paleogeological mechanisms that possibly affected the dispersion and geographic isolation of its various conspecific populations.

During the Pleistocene, polar isotherms were depressed southward throughout the Northern Hemisphere, causing continental glaciation in central North America, and alpine glaciation in the Cordillera, Sierras, and Pacific Coastal ranges. Atmospheric and physiographic control of climate may be linked to Pleistocene tectonic and glacial events, which apparently controlled the distribution of the four subspecies of *Boloria epithore.*

It appears that *borealis* represents the parent stock from which the other subspecies evolved during southern migration (see Map **3**). It is possible that the migration of *borealis,* and the southward progression of the floral ecosystem (Axelrod, 1957; Munz & Keck, 1968) upon which the species is dependent, was initiated with the onset of Wisconsin glaciation and the associated southward depression of isotherms. The southeasterly dispersal trend parallels the predominant structural trends of the central Cordillera, following valley-conduits

during southward migration. This structural trend eliminates wind shadow effects, allowing penetration of moisture-laden sea winds into the continental interior. Examination of Map **2** would indicate that *borealis* and the other subspecies of *B. epithore* are dependent upon a wet, montane habitat; hence, their distribution is limited to such areas.

To the south, *borealis* split into western and eastern tongues, separated by the Columbia plateau (see Map **3**). Underlain by Miocene and possibly Pliocene basalt flows, the Columbia plateau is now capped by loess deposits accumulated during successive Pleistocene glaciations (Richmond *et al.,* 1965), producing a foreign ecosystem not inhabitable by *borealis.*

A rather sharp transition between *borealis* and *chermocki* occurs in the Fraser lowlands (see Maps **2-3**). During Wisconsin glaciation, the Fraser lowlands were occupied by an alpine glacial system (Crandell, 1965) that effectively eliminated communication between areas north and south of it. Such a boundary would have existed until 11,000 ybp (years before present) when glacial retreat opened the Pacific Northwest (Bandy and Wilcoxin, 1970).

As indicated by Map **2**, *chermocki* inhabits the rain forests of Oregon and Washington. This peculiar climate occurs where moisture-laden marine winds, blocked by the Klamath and Cascade Mountain ranges, are forced to rise, cool adiabatically, and release their water content. Hence, *chermocki* is essentially limited to the windward sides of these ranges, indicating that abundant rainfall is necessary for its survival. Leeward of these ranges, the climate is considerably drier due to rain shadow effects; therefore, the crest of these mountains acts as an effective physiographic and ecologic barrier.

It is possible that the southward migration of *borealis* and its concomitant evolvement into *chermocki* (Map **3**) was made possible by tectonic events in the Klamath and Cascade mountains. Because these mountains are young, probably attaining their present altitude and relief in the Pleistocene (Wahrhaftig and Birman, 1965), the moist climate necessary for survival of *chermocki* may not have developed in this area until these coastal ranges had been sufficiently uplifed to form a barrier to the inland penetration of moisture-laden winds.

A zone of intergradation between *chermocki* and *sierra* occurs in the area of the Modoc plateau and adjacent volcanic terrains of south-central Oregon and north-central California (Klamath, Lake, Siskiyou, Modoc, Shasta, and Lassen counties). The area is characterized by an irregular basaltic plateau, 1,200-1,500 m. high. The presence of a recently active volcano, Lassen Peak (Wahrhaftig and Birman, 1965), indicates that this transitional faunal boundary may still be in the process of forming. Hence, an overlap of subspecies in this area might be expected (see Maps **1-3**).

The Great Valley of California represents a major ecologic boundary that divided the further, southward dispersal of *chermocki* into two populations: nominate *epithore* and *sierra* (Map **3**).

The present distribution of *epithore* is spotty, being limited 1) to the wet western face of the California coastal ranges immediately adjacent to the coast, e. g., Mendocino County, where its recorded food-plant is *Viola sempervirens* Greene, and 2) to its major occurrence as an outlie--an area confined to the Santa Cruz Mountains (600 m.), some 120 miles south of its discontinuous, Mendocino County parent group (Maps **1-2**). The area separating these two populations has been rather extensively cultivated, thus eliminating to some extent the availablility of *V. sempervirens,* upon which it was dependent. The resultant isolation of peninsular *epithore,* therefore, may have led to its subspeciation from *chermocki,* and adoption of *V. ocellata* Torrey & Gray as its major food-plant in the Santa Cruz Mountains.

As described by Peabody and Savage (1958), southern migration of Arcto-Tertiary amphibians occurred along a coastal corridor opened by eustatic lowering of sea level accompanying Pleistocene glaciation. So too might have *epithore* effected its southward migration, from Mendocino County in the north to San Mateo, Santa

Clara, and Santa Cruz counties in the south. *B. e. sierra,* however, was confined to the mountainous terrain of the North Coast Range, where it was associated with its food-plant, *V. glabella* Nuttall (J. F. Emmel, *pers. comm.).* Because the lowering of sea level caused the emergence of coastal lowlands only, its migration potential remained unaffected by the emergent corridor (Maps **2-3**).

The California coastal ranges inhabited by *sierra* are not high (800-2,200 m.), and would trap only a portion of the moisture borne by sea breezes. The remaining moisture passes over the coast ranges and is screened by the western face of the Sierra Nevada (750-3,100 m.), east of the Great Valley. Hence, with the exception of an apparent southerly false start down the eastern coastal ranges, where its aborted penetration terminates, north of the Napa Valley, *sierra* is presently distributed largely along the wet western slope of the Sierra Nevada between Plumas and Kern counties (Maps **1-3**), where its recorded food-plant is *V. glabella* Nuttall.

CONCLUSIONS

(1) As of 1966, the *Boloria epithore* complex consisted of two distinct subspecies: *Boloria epithore epithore* Edwards and *Boloria epithore chermocki* Perkins & Perkins. A revised treatment of the complex was proposed. At the time, limited numbers of available specimens, together with inadequate criteria for additional systematic analysis, negated further nomenclatorial designation.

(2) In the present revision, 920 spread specimens have been acquired and examined, in addition to the original 254 employed in the 1966 study. A reevaluation of distributional records, coupled with a more critical examination of phenotypic character analyses and statistical interpretation of linear measurements, clearly demonstrates that the *Boloria epithore* complex is comprised of four distinct subspecies: *Boloria epithore epithore* Edwards, *Boloria epithore chermocki* Perkins & Perkins, *Boloria epithore borealis* Perkins, and *Boloria epithore sierra* Perkins.

(3) A revised treatment of the *epithore* complex is proposed:

603 *epithore* (Edwards), 1864
- a *e. epithore* (Edwards), 1864
- b *e. chermocki* Perkins & Perkins, 1966
- c *e. borealis* Perkins, 1973
  - ab. *obscuripennis* (Gunder), 1926
- d *e. sierra* Perkins, 1973
  - ab. *eldorado* (Strand), 1914
  - ab. *wawonae* (Gunder), 1924

The following records represent 1,155 examples of *Boloria epithore* examined by the senior author during the course of this study (collectors are listed alphabetically at the end):

ALBERTA

Banff, (?), (ERI coll.); Blairmore, (?), (R.H.); Carbondale, Crow's Nest Pass Forest, 14 mi. S. Coleman, 20-VII-68, (S.S.); Jct. Kananaskis Hy. & Oldman R., 24 mi. N. Coleman, 16-VII-67, (R.E.W.); 39 mi. N. Lake Louise, Banff Nat'l Park, (?), (J.L.); Racehorse Creek, Bow River Forest Reserve, 16 mi. N. Coleman, 10-VII-67, (S.S.); Racehorse Creek on Kananaskis Rd., 12-VII-67, (R.L.A.); Waterton Lakes Nat'l Park, (?)/8-VI-58, (J.B./S.S.).

BRITISH COLUMBIA

Ainsworth, 3-VI-03, (G.H.F.); Alexis Creek, VII, (?); Alta Lake, 10/12-VI-26, (J.M.); Apex Mtn., Hedley, 26-VII-33, (A.N.G.); Apex Mtn. L.O., 34 mi. W. Penticton, 3-VII-67, (N.A.R.); Big White Mtn., 40 mi. N. Vernon, 22-VIII-67, (N.A.R.); Coalmont, nr. Princeton, 3-VII-68, (S.S.); Duncan, Vancouver Island, (?), (C.L.); Fitzgerald,

S. Shawnigan Lake, V. I., 26-V-19, 15/26-VI-19, 3-VI-21, (W.R.C.); Forbidden Plateau, V. I., 10-VII-38, (T.D.G.); Glacier, Glacier Nat'l Park, 13-VII-04, (ERI coll.); Goldstream, V. I., 2-VI-18, (W.D.); Grouse Mtn., (?), (S.S.); Harrison Lake, (?), (S.S.); Hedley, 16/23-VII-23, (C.B.G.); Hope, (?), (S.S.); Hope Mts., 20-VII/8-VIII-32, (A.N.G.); Kaslo, 7-VI-03, (J.D.G.); Kelowna, VII-20/(?), (A.T./J.L.); Keremeos, 1/7-VI-?, (C.B.G.); Keremeos, Shingle Creek Rd., 26-VI-36, (A.N.G.); Lambly Lake, nr. Kelowna, (?), (H.F.M.); Lihumption Park, nr. Cultus Lake, 1/2-VIII-27, (C.H.Y.); McCheam, 22-VII-16, 28-VII-15, (R.C.T.); Maillardville, N. New Westminster, 28-VI-29, 2-VII-29, (R.H.R.); Maillardville, 28-VI-29, 30-VI-29, 2/11-VII-29, (A.E.W.); Malahat, 6-VI-23, (W.D.); Mt. Kobau, nr. Oliver, (?), (H.F.M.); Nanaimo, V. I., 23/27-VI-20, (E.C.V.); Nanoose, V. I., 9-VI-55, (D.E.); N. Vancouver, 24-V-02, (ERI coll.); Princeton, 17-VII-09/VIII-40, (H.M.B./L.I.H.); Quamichan, V. I., 27-IV-31, (J.F.); Revelstoke, 17-V-70, (D.T.); Rogers Pass, (?), (J.L.); Rossland, 19-VI-00, (W.H.D.); Royal Oak, 12-VI-17, (W.D.); Salmon Arm, vic. Shuswap Lake, (?), (D.T.); Shuswap Lake, VII, (?); Silver Star Mtn., nr. Vernon, (?), (D.T.); Smithers, 19/31-VII-31, (J.D.G.); Stuart Island, '33-'36, (F.H.R.); Tod Inlet, 13/20-VI-28, (W.H.A.P.); Vancouver, 28-V-06, 30-V-03, (ERI coll.); Victoria, V. I., 20-V-93, (ERI coll.); Wellington, V. I., 23-V-50/ 15-VI-50/ 4-VI-49/ 6-III-04/ 27-VK˙/ 16-V-56/ 26-VI-02, (T.W.D./T.W.D./R.G./E.A.D./D.E./D.E./ ERI coll.).

CALIFORNIA

ALPINE CO.: Elephant Lake, 4-VII-54, (P.A.O.); Lake Alpine, 24-VII-30, (R.P.A.); AMADOR CO.: Cook's Station, Kit Carson Pass Rd., 20-VI-40/23-VI-40, (T.W.D./ W.A.H.); 27 mi. E.N.E. Jackson, 14-VII-58, (O.E.S.); CALAVERAS CO.: nr. Big Meadows, along Stanislaus R., 4-VII-68, (A.O.S.); EL DORADO CO.: Mt. Tallac, 20-VII-09, (F.X.W.); Echo Lake, 29-VI-61, (A.O.S.); Gillmore's Ranch, head of Fallen Leaf Lake, 23-VII-92, (W.G.W.); Fallen Leaf Lake, VII-15, VII-16, (L.S.R.); Glen Alpine Creek, 17/18-VII-09, (F.X.W.); Glen Alpine, 29-VI-29, (E.P.V.); Union Valley Reservoir, (?), (N.L.L.); FRESNO CO.: Round Meadow, Huntington Lake, 3/4-VII-31/ 9-VII-60, (M.L.W./O.E.S.); Huntington Lake, 14/18-VII-35/ 3-VII-19/ 18-VI-30/ 4-VII-50, (M.L.W./E.P.V./R.H.R./?); GLENN CO.: Plaskett Meadows Camp, 4-VII-72, (N.L.L.); HUMBOLDT CO.: Green Point, 10/12-VI-16, (E.C.V.); Redwood Creek, 5-VI-16, (E.C.V.); KERN CO.: AIGER Flat Campground Rd., Greenhorn Mts., 24-VI-61, (R.E.S.); MARIPOSA CO.: Glacier Point, Yosemite Nat'l Park, 1/2-VII-21/ 28-VI-21/ 29-VI-37, (J.A.C./J.A.C./?); Yosemite Valley, 20-VII-30, (E.O.Z.); Hy. 120, Yosemite Nat'l Park, 15-VI-61, 3-VII-62, (E.M.P.); Yosemite, 21-VI-34/ 30-VII-28, (T.C./?); Yosemite Park, VI-24, (J.A.C.); Wawona, 25-VI-21, (J.A.C.); Wawona, 25-VI-21, (J.A.C.); Sentinel Dome, Yosemite Nat'l Park, 3-VII-46, (F.H.R.); Tioga Rd., high Sierras, Yosemite Nat'l Park, VII-19, (S.T.); Tenaya Cy., Yosemite Nat'l Park, 11-VII-58, (A.O.S.); MENDOCINO CO.: nr. Casper, 4 mi N. Mendocino, 30-V-70; (P.A.O.), Ukiah, Halfway House, 18-VI-94, (W.G.W.); Manchester, 13/16-VIII-05, (E.J.N.); Mendocino, 28-IV-85, (W.G.W.); Graveyard Rd., E. Russian Gulch State Park, 30-V-70, (J.F.E.); Chipmunk Spgs., N.W.Hull Mtn., 31-V-70, (J.F.E.); Russian Gulch State Park, 28-III-70, (R.L.L.); MODOC CO.: nr. Eagleville, 24-VII-37, (J.A.C.); MONO CO.: Tioga Lodge, Mono Lake, 22-VI-29, (E.P.V.); NEVADA CO.: Donner Summit, nr. Truckee, 23/30-VI-60, (J.F.E.); PLACER CO.: Deer Park, 2 mi. W. Lake Tahoe, 5-VII-63, (E.M.P.); Deer Park, 7/14-VII-09, (E.J.N.); McKinney Creek, 3 mi. S.W. Tahoma P.O., 10-VII-48, (O.E.S.); Lake Tahoe, 22-VII-53, 29-VI-30, (LACM coll.); nr. Lake Tahoe, 8-VIII-22, (LACM coll.); Ward Creek, 2 mi S. Tahoe City, VII-66, (N.W.); PLUMAS CO.: Gold Lake, 15-VIII-53, (T.W.D.); Buck's Lake, 23-VI-49/ 4-VII-57, (C.I.S./R.L.L.); vic. Quincy, (?), (T.W.D.); SAN MATEO CO.: Portola State Park, 19-VI-60, (C.N.S.); Wood Haven Girl Scout Camp, nr. La Honda, 13-VI-54, (D.H.B.); San Lorenzo Woods, (?), (O.E.S.); Gazos Creek Rd., 5.2 mi. N.E. Hy. 1, 30-V-68, (J.F.E.); SANTA CLARA CO.: Santa Clara, 29-V-04, (E.A.D.); Saratoga, 7-VI-44, (ERI coll.); SANTA CRUZ CO.: Big Basin, Santa Cruz Mts., 10/19-VI-45, 4-V-46, 4-V-47, (O.E.S.); Big Basin Redwoods State

Park, 19-VI-50, (D.M.); 7 mi. N.W. Boulder Creek, 4-V-47, (O.E.S.); 6 mi. N.W. Boulder Creek, 16-V-63, (O.E.S.); Santa Cruz Mts., 15/16-VI-46/ 14/18-V-95/VII-01/ ?, (T.W.D./CAS coll./LACM coll./CAS coll.); Felton, 20-V-56, (J.W.T.); Santa Cruz, 18-V-24, (J.F.S.); Santa Cruz, 12-V-35, (J.W.T.); Santa Cruz, 2-VI-19, (E.P.V.); Hecker Pass, 22-IV-56, (P.A.O.); Soquel, 12-V-29, (C.E.P.); Santa Cruz, 7-VI-92, (W.G.W); Boulder Creek, Big Basin State Park, Santa Cruz Mts., 17-VI-61, (J.S. & P.E.); Boulder Canyon, 28-IV-55, (D.E.); China Grade, 2-VI-62, (D.E.); Bear Creek, 4 mi. E. Boulder Creek, 28-V-72, (D.S.); SHASTA CO.: Lassen Nat'l Park, 21-VII-37, (J.A.C.); SIERRA CO.: Gold Lake, 15/16-VII-35/ 12-VII-41/ 1-VII-41, (R.H.R./ D.E./D.E.); nr. Gold Lake Lodge, 18/19-VII-65, (A.O.S.); Yuba Pass, 15-VII-62, (R.L.W.); Bassetts, 12/13-VI-60, (P.A.O.); Yuba Pass, 30-VI-61, (A.O.S.); SISKIYOU CO.: vic. McCloud, S. base Mt. Shasta, 24-VI-67, (E.M.P.); Bigelow Meadows, 16 mi. S.E. Mt. Shasta, 27-VI-59, (O.E.S.); Mt. Shasta, VII-04, (F.X.W.); 0.25 mi. S. Toad Lake, 19 mi. W. Mt. Shasta, 22-VII-67, (E.M.P.); Castle Lake, 9-VII-60/ 9-VII-41/ 18-VII-50/ 28-VI-47/ 22-VII-67/ 24-VII-48/ 24-VI-48, (?/ A.J.U./ R.F./ T.W.D./ E.M.P./D.E./D.E.); TEHAMA CO.: Mill Creek, 22-VI-61, (J.W.T.); Mill Creek, 8 mi. S.W. Mt. Lassen, 1/4-VII-56, (O.E.S.); Mineral, 26/27-VI-30, (?); TRINITY CO.: Trinity Center, 6-VI-31/ 6-V-31, (H.M.B./ ERI coll.); Carrville, 18-VI-31, (E.C.V.); Forest Glen, (?), (D.B.); TULARE CO.: Sequoia Nat'l Park, 9-VII-29/ 7/8-VII-39/ 21-VII-37, (G.H./?/A.J.U.); Mineral King, 26-VII-36, (G.H.); TUOLUMNE CO.: Tioga Pass, Yosemite Nat'l Park, 11-VII-31/ 1-VIII-52, (J.W.T./ P.A.O.); Pinecrest, VI-27, (G.H.).

IDAHO

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MONTANA

BEAVERHEAD CO.: Polaris, 25-VI-41, 4-VII-41, 14-VII-41, (LACM coll.); Big Hole National Monument, 10-VII-59, (T.W.D.); Polaris, 13-VII-42, 5-VII-48, 14-VII-43, 26-VI-43,11-VII-42, (D.E.); FLATHEAD CO.: Sperry Chalets, Glacier Nat'l Park, 24-VIII-25, (C.E.P.); Lake McDonald, Glacier Nat'l Park, 7-VII-30, (E.C.V.); GLACIER CO.: St. Mary Lake, Glacier Nat'l Park, 1-VII-61, (E.M.P.); E. boundary Glacier Nat'l Park, 9-VII-56, (R.L.A.); MINERAL CO.: Randolph Creek, 5-VII-72, (S.K.); Lookout Pass, 11-VIII-61, (S.F.P.); 2 mi. S. St. Regis, Hy. 10, 10-VIII-61, (S.F.P.); MISSOULA CO.: Miller Creek, 12-VI-71, 19-VI-71, (S.K.); Ninemile Creek, 3-VII-72, 10-VII-72, (S.K.).

OREGON

BENTON CO.: McDonald Forest, 5 mi. N.W. Corvallis, 29-V-60/ 28-V-65/ 21-V-58/ 25-VI-62/ 20-V-59/ 16-V-58, (R.E.W./E.M.P./E.M.P./E.M.P./E.J.D./E.J.D.); Mary's Peak, 1-VI-60/10-VI-61/21-VI-61/5-VII-58/25-V-54/6-VII-56/14-VII-56/15-VIII-71, (E.J.D./E.J.D./E.J.D./E.J.D./F.F.H., OSU coll./ F.F.H., OSU coll./A.H.M./ E.G.); Alsea Fish Hatchery, 31-V-64/25-V-30, (E.J.D./L.G.H., OSU coll.); Hoskins, 1-VI-58, (E.J.D.); Corvallis, 11-VI-25, (E.C.V.); CLACKAMAS CO.: Clackamas R., Rd. 284, 7-VI-62, (E.M.P.); 6 mi. W. Timothy Lake, 7-VI-62, (E.M.P.); Mt. Hood,

27-VI-26/16-VI-61, (L.I.H./R.J.A.); Clackamas Lake, 3-VII-61, (E.J.N.); Austin Hot Spgs., 16-VI-57, (S.G.J.); Big Eddy, 18-V-58, 1-VI-52, (S.G.J.); Eagle Fern Park, 4-V-58, 2-VI-57, 4-VI-61, (S.G.J.); Barton, 15-V-60, (S.G.J.); CLATSOP CO.: Saddle Mtn. State Park, 27-V-64, 12-VII-64, (E.M.P.); Saddle Mtn., 8-VII-61, (S.G.J.); COLUMBIA CO.: Vernonia, 20-V-38, (OSU coll.); 4 mi. N. Vernonia, 6-VI-70, (C.W.N.); CURRY CO.: Winechuck R., 17-VI-67, (G.M.H.); DESCHUTES CO.: Deschutes R. Bridge, W. Terrebonne, 8-VII-53, (S.G.J.); 3 Creeks Meadow, 6-VII-72, (E.J.D.); DOUGLAS CO.: Diamond Lake, 13-VII-61/1-VII-47/8-VII-?/ 28-VII-53, (A.O.S./T.W.D./E.A.D./S.G.J.); Drew, 7-V-39, (L.I.H.); Scottsburg, 24-V-31, (L.I.H.); Reedsport, 15-V-26, (E.M.); Bradley Creek Meadows, 2-VIII-62, (E.J.N.); Jct. Muir Creek & Rogue R., 19-VII-56, (A.H.M.); HOOD RIVER CO.: Cloud Cap Rd., Mt. Hood, Hy. 35, 12-VI-62, (E.M.P.); W. Dee, 5-VII-70, (J.H.); JACKSON CO.: Mt. Ashland Loop Rd., 8-VII-61/9-VII-61, (A.O.S./D.D.); Tubb Spgs., 4 mi. W. Pinehurst, 19-VI-58, 17-VI-58, (E.J.D.); Kane Creek, 5 mi. W. Gold Hill, 23-VI-37, (S.G.J., OSU coll.); Butte Falls, 5-V-68, (D.E.); Dead Indian Soda Spgs., 17-V-62, (J.H.S.); Mt. Ashland, 16-VI-68, 19-VI-70, (E.J.D.); French Gulch Rd., 22-V-64, (E.J.D.); JEFFERSON CO.: Camp Sherman, Metolius R., 21-VI-64/ 21-VI-66/ 27-V-66/ 14-VI-64/ 28-V-50, (E.M.P./E.M.P./E.M.P./C.W.N./S.G.J.); Summit Santiam Pass, 31-VII-53, 8-VII-59, (S.G.J.); JOSEPHINE CO.: vic. O'Brien, 15-VII-58, (R.J.A.); KLAMATH CO.: Gilchrist, 15-VI-58/ 24-V-59/ 15-VI-60/ 10-VII-60/ 15-VI-53, (E.J.D./E.J.D./D.E./D.E./D.E.); 8-10 mi. E. Beaver Marsh, 14-VII-61, (A.O.S.); Davis Lake, 15-VII-56/ 22-VII-34, (A.H.M./ S.G.J., OSU coll.); Crater Lake Nat'l Park, Annie Creek, 16-VII-56, (A.H.M.); Crescent Creek at Hy. 58, 27-VI-62, (K.G.); Skookum Meadows, 23-VII-61, 30-VI-62, (E.J.N.); 6 mi. S. La Pine, 3-VII-68, (E.J.D.); LAKE CO.: Camas Creek, Summit Prairie, S.E. Warner Cy., 12-VI-62, (E.J.N.); Lakeview, 27-VII-30, (OSU coll.); LANE CO.: 3 mi. W. Willamette Pass, 2-VII-60, (R.E.W.); Willamette Pass, 3-VII-59, (E.J.D.); Oakridge, 11-VI-55, (E.J.D.); Hills Creek Dam Rd., 13-VI-64, (E.J.D.); Blue Pond Forest Camp, 13-VI-64, (E.J.D.); Mule Prairie, 13-VI-64, 18-VI-57, 22-VI-58, 3-VII-59, (E.J.D.); Mule Prairie, 2-VIII-62, (E.J.N.); LINCOLN CO.: Elk City, 30-V-59, (E.J.D.); LINN CO.: Lost Prairie, 28-VI-60/ 15-VII-65/ 11-VIII-64/ 20-VI-65/22-VII-64/ 12-VI-66/ 15-VII-65/2-VII-67/ 21-VI-59/ 30-VI-61/ 14-VI-62/ (D.E./D.E./ E.M.P./E.M.P./E.M.P./E.M.P./E.M.P./E.M.P./ E.J.D./ E.J.N./ E.J.N.); Tombstone Prairie, 17-VI-67/ 22-VII-61/ 22-VII-60/ 29-VI-62/ 22-VII-64/ 16-VI-67/ 23-VI-61/ 19-VII-58/ 16-VIII-71/ 4-VIII-60/ 11-VIII-64, (E.M.P./ E.J.N./E.J.N./E.J.N./E.M.P./E.J.D./E.J.D./E.J.D./E.J.D./E.J.D./E.J.D.); Hoodoo Bowl, S. Santiam Pass, 6-VII-68, (S.F.P.); Cascadia State Park, 13-VI-61/ 23-V-59/ 10-VI-62/ 28-VI-60/ 19-V-35, (E.J.D./E.J.D./E.J.D./E.J.D./H.A.S., OSU coll); Big Meadows, Santiam PUASS£`&|VII-56, 18-VII-48, 11-VIII-47, (R.J.A.); Monument Peak, (?)/ 16-VII-60/ 12-VII-72, (C.W.N./F.F.H., OSU coll./E.J.D.); Front Creek Camp, S. Santiam Hy., (?), (E.J.D.); Marion Mtn., 11-VII-64, (D.R.S.); Trout Creek Camp, S. Santiam Hy., 19-V-40, (H.A.S., OSU coll.); 9 mi. S. Marion Falls, Hy. 22, 22-VI-62, (K.G.); MARION CO.: Elk Lake, 6-VII-58, (S.G.J.); POLK CO.: Valsetz, 30-V-64, (D.V.M.); Falls City, Valsetz Rd., 6-VII-64, (D.V.M.); 5 mi. S. Falls City, 17-IV-65, 11-V-65, (D.V.M.); TILLAMOOK CO.: 1 mi. E. Lee's Camp, 18-VI-62, 16-VI-63, (E.M.P.); Bell Mtn., (?), (C.W.N.); UMATILLA CO.: Blue Mts., N.E. Tollgate, 11-VII-64, (E.M.P.); UNION CO.: nr. Spout Spg., 15-VII-70, (E.J.D.); WALLOWA CO.: Wallowa Lake, 29-VII-54/ 26-VII-67, (A.O.S./ E.J.D.); Ice Lake Trail, Mt. Sacajawea, 29-VIII-67, (E.M.P.); Lostine R., 15-VII-64, 28-VII-65, (E.J.D.); Hurricane Creek, 23-VII-67, (E.J.D.); Aneoid Lake Trail, 22-VII-67, (E.J.D.); Wallowa R., N. Wallowa Lake, 25-VII-53, (R.L.C.); WASCO CO.: Bear Spgs. Camp Ground, 20-VI-62, 13-VI-64, 30-V-65, 25-VI-62, (E.M.P.); Wapanitia, 17-VI-47, (R.J.A.); Bear Spgs., 3-VII-61, (E.J.N.); WASHINGTON CO.: Lee Falls Rd., 2-V-70, (J.H.); YAMHILL CO.: 2.9 mi. E. Dolph, Hy.22, Siuslaw Nat'l Forest, 18-V-68, 10-VI-62, 18-VI-62, 12-VI-63, 27-V-65, 29-V-66, (E.M.P. & S.F.P.); 0.5 mi. E. Dolph, U.S.F.S. Rd. #S-581, Siuslaw Nat'l Forest, 18-VI-62, 12-VI-63, 27-V-65, (E.M.P. & S.F.P.); Willamina, 18-V-29, (?); Baker Creek Valley,

17-V-30, 4-VI-30, (K.M.F.); McMinnville, (?), (K.M.F.).

WASHINGTON

CHELAN CO.: Stevens Pass, (?), (V.C.); CLALLAM CO.: Hurricane Ridge, Olympic Nat'l Park, 27-VII-67, (S.F.P.); Deer Park Camp Ground, Olympic Nat'l Park, (?), (S.F.P.); FERRY CO.: O'Brien Creek, E. Republic, 27-VI-61, (E.J.N.); JEFFERSON CO.: Hoh R., Olympic Peninsula, 22-VI-59, (R.L.C.); KING CO.: Stevens Pass, 24-VII-60/ 9-VIII-59, (R.E.W./V.C.); Stevens Pass, White Rock Spgs., 14-VII-30, (E.C.V.); McBean's Peak, N.W. Snoqualmie, (?), (E.C.V.); vic. Snoqualmie Pass, 26-V-68, (D.E.); KITTITAS CO.: Morp Mtn. L.O., 13-VII-71, (E.G.); Ravens Roost L.O., 8-VIII-71, (E.G.); Tamarack Spgs., W. Clay Elum, 7-VII-65, (E.J.N.); KITSAP CO.: Bremerton, (?), (D.F.); KLICKITAT CO.: Bowman Creek, N.E. Goldendale, (?), (E.J.N.); LEWIS CO.: Longmire Spgs. Wash, Ranier Nat'l Park, 27/28-VII-20, (E.C.V.); White Pass, (?), (E.J.N.); MASON CO.: Belfair, 22-V-49, (D.F.); OKANOGAN CO.: Salmon Meadows, 16-VII-57/ 12-VII-55/ 4-VIII-46/ 24-26-VI-60/ 8-VII-60/ 21/22-VI-65/ 7-VII-64/ 6-VII-64, (J.C.H./J.C.H./T.W.D./ J.C.H./J.C.H./D.E./D.E./R.E.W.); Tiffany Lake, 1-VIII-37, (T.W.D.); Alta Lake State Park, (?), (J.C.H.); Brewster, 15-VII-59/ 23-VI-60/ 7/8-VII-60/ 2-VII-44, (J.C.H./J.C.H./J.C.H./D.E.); vic. Harts Pass, 24-VII-68, 28-VII-68, (R.E.W.); Harts Pass, N.W. Mazama, 25-VII-62, 4-VIII-71, (E.J.N.); PIERCE CO.: Sunrise Peak, Ranier Nat'l Park, 26-VII-36, (E.C.V.); Carbonado, 18-V-58, (D.E.); SAN JUAN CO.: Rosario, Orcas Island, (?), (D.F.); SNOHOMISH CO.: Sloan Peak, (?), (C.W.N.); Darrington, 4-VII-37, (ERI coll.); THURSTON CO.: Tenino, (?), (D.F.); WHATCOM CO.: Mt. Baker Lodge, (?), (R.E.W.); YAKIMA CO.: 10 mi. E.N.E. Chinook Pass, American R., 8-VIII-64/ 8-VII-58, (E.M.P./R.L.L.); Oak Creek, 13-VI-60, (E.J.N.); S.E. slope Mt. Adams, Bird Creek Meadows, 16/19-VII-64, (E.M.P.).

Additional records have been obtained for Butte Co., California and Lincoln Co., Montana. Although received too late to be incorporated into the manuscript proper, these locales are represented in Maps **1-2**.

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